CLIVIA YEARBOOK 1998

ACKNOWLEDGEMENTS

The Clivia Club acknowledges with appreciation the consent given as follows to publish the photographs printed in this Yearbook.

Mr Yoshikazu Nakamura, Clivia Plantation, Mobara-city, Japan:

Page 1: Photograph 1; Page 11: Photographs 3 and 4;
Page 21: Photographs 8 and 9; Page 22 Photographs 10 to 13;
Page 23: Photographs 14to 17; Page 29 Photographs 18 to 20;
Page 30: Photographs 22 and 23; Page 35 Photograph 27;
Page 37: Photographs 32 and 33; Page 43 Photographs 36 to 38;
Page 44: Photographs 39 and 40; Page 50 Photographs 41 and 42;
Page 51: Photographs 43 to 45;

Mr Graham Duncan, National Botanical Institute :

Page 12: Photographs 5 and 6; Page 35: Photographs 24 to 26;
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Mr John Winter, National Botanical Institute :

Page 61: Photograph 50;

Mr Jean-Luc Bestel:

Page 12: Photograph 7; Page 38: Photograph 34;

Mr Wessel Lotter :

Page 11: Photograph 2; Page 30 Photograph 21;
Page 36: Photographs 28 to 30; Page 37 Photograph 31;
Page 52: Photograph 46; Page 62 Photograph 53;
Page 64: Photographs 54 and 55; Page 72 Photographs 56 and 57;

Mr Jim Holmes, Cape Seed and Bulb:

Page 38: Photograph 35; Page 64: Photographs 54 and 55;

Mr Bob Adshade:

Page 52: Photograph 47; Page 62: photographs 51 and 52;
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EDITORIAL BOARD

Claude Felbert, John Winter, Mick Dower

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CLIVIA YEARB00K 1998

Nakamura Hybrid 1

The naming of plants in this publication is informal and subject to official recognition.

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Photographs are shown on the following page numbers:

1,11,12,21,22,23,29,30,35,36,37,38,43,44,50,51,52,61,62,64,72 & Back Cover.

Mr Nakamura presented his address in the form of slides. A selection of those slides, as well as others, are printed throughout this publication.

EDITORIAL

The genus clivia is endemic to South Africa. It consists of four species, three of which i.e. *C. nobilis, C.gardenii* and *C.caulescens* are pendulous-flowered. The fourth, *C.miniata,* is the most well known and generally considered the most attractive.

Lindley named the genus clivia in 1828, in honour of Lady Charlotte Clive, Duchess of Northumberland who flowered *C.nobilis* in her conservatory in England.

C.miniata was collected in the forests of Natal and sent to Kew in 1853. It became a popular indoor plant in Europe where horticulturists developed and named a number of hybrids and colour variants.

Although their popularity waned when they did not thrive in the new era of air conditioning, specialist breeders at Bodnant in Wales and in California, Australia and Japan continued to develop new colour and leaf variations, especially the rare yellow flowered *C.miniata* which had been collected in Natal in 1893. This development also continued with variegated and broad leafed *C.miniata* which are popular in Japan and China, as well as interspecific hybrids.

With these developments there has been a renewed interest in clivia as a pot plant amongst professional horticulturists, amateur breeders and the public.

This inspired Nick Primich to bring together enthusiasts in South Africa, California, Australia and Japan in 1992, to form the Clivia Club, which held its first International Conference at Pretoria in 1994.

CLIVIA '98, the Second International Clivia Conference, was hosted by the Cape Province Branch of the Clivia Club and held at Kirstenbosch National Botanical Gardens, Cape Town, in September 1998. This Garden displays approximately 5000 of the 8000 species of the rich and diverse Cape floral kingdom. Situated in natural vegetation, on the eastern slopes of Table Mountain, this was a unique and magnificent setting for the coming together of clivia enthusiasts from across South Africa and the world.

The theme of **CLIVIA '98** was GROWING CLIVIA, the focus being on the cultivation of these magnificent plants. The conference was attended by 122 delegates representing seven countries and speakers were drawn from researchers, eminent clivia growers and specialist enthusiasts.

This, the first Clivia Yearbook, is based on those proceedings and is intended to not only serve the interests of the members of the Clivia Club, but also to stimulate world wide public interest in this remarkable plant.

INTRODUCTORY REVIEW

by

DR JOHN ROURKE

DR JOHN ROURKE *is the Curator of the Compton Herbarium, National Botanical Institute at Kirstenbosch.*

This, the first Clivia Yearbook, centers on the presentations made at the second International Clivia Conference held at Kirstenbosch National Botanical Gardens in September, 1998. This summary was originally made as an overview at the conclusion of the conference.

It was an informative, fascinating and exciting day. We had a remarkable gathering with delegates from no less than seven different countries and an extraordinary range of topics was presented. As a simple amateur clivia grower, it was a great delight to me.

I was particularly intrigued by Jeff Finnie's account of *in vitro* tissue culture. For years one has been brought up on the notion that clivia is almost impossible to culture *in vitro* but today a chink has been opened in which we now learn that clivia will respond to *in vitro* and can ultimately give rise to a reasonable number of plants being produced in this way.

It was enormously interesting to hear from Dr Johan van Huylenbroeck how flowering is dependent on leaf number and that this can be manipulated by increasing and modifying the temperature and the atmosphere in which the clivias grow. This surely is an important piece of information for us all.

We listened with rapt attention to the breeders, Pierre de Coster, Yoshikazu Nakamura and Pen Henry on the very interesting forms and variations that have been cultivated in different parts of the world and the different tastes and styles in China, Japan, Belgium and Australia. Many of these are illustrated in this Yearbook.

Chris Lotter gave us some very practical information on issues of cultivation and especially on nutrition, which seems to be so easily overlooked.

Nick Primich discussed the subject of variegations, also a thorny problem and a matter of taste according to one's fancy.

Being a taxonomist, I do work in the field as well as with dry specimens! Although, as Keith Hammett suggests, I'm mostly like a mortician in a morgue, I do actually get out into the field! Recently I had the good fortune of travelling with John Winter and Mick Dower for two weeks on a series of excursions into the Transkei and Natal to look at wild populations of clivia. It was truly amazing to see the degree of variation within an area scarcely half the size of the conference room. Some populations are definitely evolving or mutating very much more rapidly than others. I found Keith Hammett's comment on the importance of preserving our wild resources incredibly relevant to our situation today. In this regard I want to give you a text for the day - rather like a preacher! It is the words of a very famous Australian scientist, Sir Otto Frankel: *"Cherish variation, for without it life will perish"*.

The whole issue of clivia growing and clivia breeding revolves to a large degree around variation. Fashion is a very fickle human foible and although we may be very interested today in broad leaves, short leaves, bright red Clivias or yellow Clivias, they may be out of fashion in a century or two from now. We are not to know what human beings will desire in the future. The only certainty about fashion is that there will be change. For that reason we do have a huge responsibility to preserve a broad base of material for future breeding.

I go back to Otto Frankel's words "Cherish variation". Variation unfortunately is an expensive commodity to preserve. John Winter has begun to develop a collection of *C.miniata* variants and other species here at Kirstenbosch - but even that is not enough. It is desirable that every country that has a substantial clivia collection should try to set aside a good collection of variants, which will be preserved and perpetuated for future breeders. That is the thought that I would like to leave with you.

Wessel Lotter spoke to us at some length about variation and he also talked about cultivar names. Cultivar names are very useful but they are regulated by a rather curious document called the "International Code of Nomenclature of Cultivated Plants". I would like to suggest that the Clivia Club should look into that document before deciding on names. Its use is generally acknowledged the world over and we need to bow to higher authority on these matters. It is really quite important.

It was a great privilege to attend this conference. May the publication, in this Yearbook, of its proceedings and of some of the variations which have been achieved continue to inspire even greater achievements with this rewarding genus.

OPENING ADDRESS

by

PROFESSOR CHARLES STIRTON

PROFESSOR STIRTON is the Director of the National Botanic Garden of Wales situated in Carmarthenshire. He was previously Deputy Director of the Royal Botanic Gardens, Kew. He was educated at the University of Natal in Pietermaritzburg. His garden in Wales is one of the more modern and innovative gardens in Britain. He is a frequent visitor to South Africa and particularly Cape Town.

Welcome to **CLIVIA '98** held in beautiful Kirstenbosch and this fantastic country.

Clivia miniata grows all over South Africa and perhaps all around the world. It's bursting into bloom; it's spring again, the passions are stirring. All three branches of the Clivia Club in South Africa are really getting going and here we are gathered today from all over the world. I wonder what John Lindley, who gave us the genus *Clivia* in 1828, would think of this gathering and this venue? I am sure that Lady Charlotte Florentina would have been thrilled.

Clivia is one of the many groups of magnificent South African bulbous plants of the family Amaryllidaceae, plus Iridaceae and Liliaceae. These are being studied by a series of distinguished taxonomists. I have met many of them and I work with some of them. I would like to mention a few, as much as a tribute to the South African flora as to the passion and excitement and the joy that they have brought to so many people throughout the world.

John Gilbert Baker, from Kew, Allan Dyer from Pretoria, Amelia Obermeyer (Mrs Mauve), Professor Miriam de Vos from Stellenbosch, Joyce Lewis for her work on *Agapanthus,* Leslie Codd, Professor Tom Barnard for *Gladioli,* Kostokowitch from Poland, Captain Paymaster, T M Salter for *Oxalis,* Peter Goldblatt for *Gladioli,* Pauline Perry on *Eriospermum,* Dr Deidre Snijman for *Haemanthus,* Graham Duncan, and many, many more. Without the dedication of these people, we would not be here nor would we have the taxa to grow and hybridise. Do we pay them enough tribute?

The world is changing in terms of the biological diversity, global climatic change, trade and economic pursuits. Enormous profits are being made from the Cape flora. The Cape *Pelargonium* alone, I heard this week, was probably worth one and a half million US dollars annually.

Could clivia become a multi-billion industry? I would say potentially yes. There is an opportunity here for you to set a new path, not only for the country which has given us the resource *Clivia* but also for those people who enabled us to take and develop it.

I would therefore like to ask you to consider creating a Clivia Development Fund to study its taxonomy, physiology and horticulture. There are many *Clivia* in the wild disappearing at a phenomenal rate. I spoke to some horticulturists in Natal - *Clivia* is a muti plant and it has been unsustainably harmed. NBI has just started a project to conserve these natural resources.

What I'm saying is that your industry could collapse around you because the diversity is disappearing.

In 1976 I wrote a small paper. I wrote about the potential exploitation of the monocots of South Africa. Ten years later I am staggered at how this industry, has developed. I am also upset that so little of that money has gone back to the country of origin or to the study of the flora.

I leave that thought with you - a Clivia Development Fund - or something like that.

I have pleasure in declaring **CLIVIA '98** open.

IN VITRO CULTURE OF CLIVIA MINIATA

By

J.F. FINNIE

DR JEFFREY FINNIE is Senior Lecturer at the Botany Department of the University of Natal, Pietermaritzburg.

Abstract:

The highly sought after *Clivia miniata* var. *citrina* can be successfully cultured using fruit and floral explants. Use of these explants may limit the number of plants produced in culture due to the seasonal nature of flowering.

Clivia miniata Regel bears an inflorescence of red to orange flowers, many hybrids have been cultivated, but the horticulturally most valuable form of *Clivia* is the yellow flowering *Clivia miniata* var. *citrina* Watson. The long maturation period of five to seven years for seedlings, variable flower quality, and the poor vegetative growth of selfed plants makes cultivation difficult.

Explants were taken from the root; rhizome/corm; meristem; leaf; inflorescence peduncle; flower; fruit; seed and embryo at all the stages during the growth season. Sterile explants were placed on Murashige and Skoog's medium with 30g 1-1 sucrose added and supplemented with varying levels of plant growth regulators. Cultures were maintained in a growth room at 25 + 2°C with a 16 h light/ 8 h dark cycle. Illumination was supplied by cool white fluorescent tubes with a light intensity of 27u mol m-2s-1.

All floral explants, except the style, showed some callusing and regenerative ability. Callus tissue derived from the petal, ovary and pedicel became embryogenic, pedicel tissue taken closest to the receptacle was found to be a region of major plantlet regeneration. *Clivia* inflorescence cultures were markedly affected by hormone levels, with both equal and higher ratios of cytokin to auxin proving stimulatory. Fruit explants (berries) were used to maximise callus production. This led to the production of multiple plantlets (5mgl-lBA & NAA). Anatomical investigations of the surface of the fruit tissue showed that it was covered with crystalline callus. Within the fruit wall, areas showing meristematic activity was observed. From these areas proembryonic structures developed. These proembryoids enlarged and eventually protruded beyond the explant surface. If separated out individually they developed into entire plantlets.

The highly sought after *Clivia miniata* var. *citrina* can be successfully cultured using fruit and floral explants. Anatomical investigation revealed that the plantlets were derived from proembryonic structures within the fruit wall. Use of these explants may limit the number of plants produced in culture due to the seasonal nature of flowering.

INTRODUCTION

There are numerous horticultural studies on *Clivia* for propagation and growth (Hieke 1971: Mori & Sakanishi 1974; Eldabh et al 1978; Niu et al 1986); but very little has been published on the *in vitro* culture of *Clivia. Clivia* has been cultured using direct adventitious organogenesis, indirect organogenesis and multiple axillary shoot techniques (Holdgate et al 1975; George & Sherrington 1984; Vasil 1985). *Clivia nobilis* has also been cultured using immature embryos as an explant source. Petals and ovary walls have been used for *in vitro* experi-

mentation and "different kinds of calli and plantlets appeared" (Min & Jinsheng 1984), although specific details are lacking. This study explored possible explant sources and techniques for *Clivia* tissue culture.

MATERIALS and METHODS

Explants from the root; rhizome/corm; meristem; leaf; inflorescence peduncle; flower; fruit; seed and embryo at all stages during the growth season, were surface sterilized in either 2% NaOCl (leaf, fruits, flowers), 0,1% HgC12 (root, rhizome) or 10% H_20_2 (ovary) for 15 minutes. Sterile explants were placed on Murashige and Skoog's (MS) with 30 g $1-^{1}$ sucrose and supplemented with varying levels of naphaleneacetic acid (NAA); idoleacetic acid (IAA); 2,4- dichlorophenoxyacetic acid (2,4-D); benzyladenine (BA); kinetin and zeatin. Media was adjusted to pH 5.8 and solidified with 0.8% agar. Cultures were maintained in a growth room at 25 ± 2°C with a 16 h light/ 8 h dark cycle (27 u mol $m-^{2}$ $s-^{1}$).

Fruit explants were taken at three developmental stages:

1. Just after pollination;
2. During seed development;
3. With the onset of ripening.

Explants were cultured on full strength MS medium supplemented with 0.8% agar, 40 g 1-1 sucrose, BA and NAA.

RESULTS and DISCUSSION

All *Clivia* explants apart from the root produced callus. Rhizome, leaf and peduncle explants produced "wound" callus. These callus cells, despite large nuclei, were non-meristematic with minimal amounts of cytoplasm. Isolation of meristem explants resulted in the destruction of the plant, and although the meristem developed into a plantlet, multiple shooting was not obtained. Excised embryos grown on media containing 1 mg 1-1 BA and 1 mg 1-1 NAA, were stimulated to produce shoots, when sections were cut into the embryo axis.

All floral explants, except from the style, showed some callusing and regenerative ability. Callus tissue derived from the petal, ovary and pedicel became embryogenic. *Clivia* inflorescence cultures were markedly affected by hormone levels, with both equal and higher ratios of cytokinin to auxin proving stimulatory. BA was the most effective cytokinin.

Subculture of initiated callus did not result in plantlet formation, however, some callus was inherently rhizogenic.

Fruit explants (berries) led to the production of multiple plantlets using certain concentrations of cytokinin to auxin. Anatomical investigations, of the surface of the fruit tissue showed that it was covered with crystalline callus. Within the fruit wall, areas showing meristematic activity was observed. From these areas proembryonic structures developed. These proembryoids enlarged and eventually protruded beyond the explant surface. If separated out individually they developed into entire plantlets.

This study has shown that the fruit wall is the most successful explant for in vitro multiplication of *Clivia.* Plantlet regeneration was, however, very slow.

There are two major drawbacks with respect to commercial application of the described technique. Firstly, fruit wall material is only available seasonally. The ideal stage for taking explants is very specific, with no easy morphological or physiological means to ascertain the critical stage. Secondly, embryoid formation is slow. It is, however, interesting to note that the response of *Clivia miniata* and *Clivia nobilis* (Min & Jinsheng 1984), in terms of explant selection and plantlet formation, in culture appears to be similar.

The response of different *Clivia* explants in culture

Explant	No. Response	Callus	Direct Organogenesis	Indirect Organogenesis
Root	+			
Rhizome		+		
Meristem		+	+	
Leaf		+		
Inflorescence peduncle		+		
Flower		+		+
Fruit		+	+	
Seed/Embryo		+	+	+

The *in vitro* regenerative ability of *Clivia* floral explants.

EXPLANT	CALLUS REGENE-RATION	PLANTLET	REMARKS
Petal stage			
1 (1-3 mm)	+		
2 (3-10 mm)	+		
3 (10-15 mm)	+		Extension growth of petal, formation of pigments as in normal flower.
4 (15-20 mm)			
5 (> 20mm)			
Ovary	+	+	
Pedicel	+	+	Plant production via callus.
Filament	+		
Style			Extension growth, no callus
Entire Bud	+		

Clivia berry explant response to a cytokinin/auxin hormone grid (Full strength MS medium plus 1 g 1-1 PVP and 40 g 1-1)

Key:

1. No callus
2. Fine yellow non embryonic callus
3. Yellow/green marginally embryonic callus
4. yel low/green/red callus, embryogenic

		BA	Mg1-1	
		0	1	5
NAA	0	1	1	3
Mg1-1	1	2	4	-
	5	3	-	4

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Acknowledgments

Mr and Mrs English are thanked for providing *Clivia miniata* var *citrina* explant material.

Pat Gore's "Diana" 2

Nakamura hybrid 3

Nakamura hybrid 4

5

6

Two forms of Clivia nobilis collected from the habitat in the Eastern Cape Province, South Africa

"Wittig's Peach"

7

CLIVIA MINIATA REGEL
CONTROL OF PLANT DEVELOPMENT AND FLOWERING

by

JOHAN M. VAN HUYLENBROECK

DR JOHAN VAN HUYLENBROECK is a plant breeder with the Department of Plant Genetics and Breeding at the Agricultural Research Centre, Ghent.

Abstract:

During the last decade a new commercial interest in *Clivia miniata* is seen in Europe. Especially early flowering (before Christmas), compact plants with the umbel above the foliage are desired. Traditionally, plants are cultured in frost protected greenhouses and from seed to a marketable flowering plant takes about three years. This long culture period together with an unpredictable flowering (flowering percentage vary from year to year and frequently unwanted summer flowering is observed), increased considerably the production costs. In order to come to a better control of growth and flowering of *Clivia*, the impact of temperature, supplementary lighting, photoperiod, drought and cold treatments were examined.

Increasing the temperature significantly hastened leaf formation. Compared to control plants grown at 7°C, average monthly leaf formation increased by 50 to 100% when temperature was increased to 16°C or 20°C respectively. Supplementary lighting (to reach a photoperiod of 16h) during winter time did not hasten leaf formation but promoted leaf elongation especially in young plants, resulting in poorer plant quality. Neither higher temperature nor supplementary lighting influenced leaf width.

Flower initiation was not influenced by temperature or light conditions. Also drought stresses or cold treatments, applied at different times during culture, had no significant effect on flower initiation. In all our experiments the first flower bud was initiated after 12-13 leaves were formed. Subsequent flower buds were initiated after each set of 4 -5 leaves. This apparently strict juvenile period explains why under traditional culture practices plants only flower in the third year, since it takes more than two years before 13 leaves are formed. When vegetative growth is hastened (by higher growing temperatures), this stage is already reached after 14-16 months.

In contrast with flower initiation, flower bud development and scape elongation can be influenced by light and cold treatments. Additional lighting resulted in a higher percentage of flowering plants and hastened flower development. For scape elongation a cold treatment during several weeks is required. Lighting can partially replace this cold treatment. It seems that the minimum flower bud height required to have a good reaction on the cold stimulus is +20mfn. Smaller buds do not react. This can explain why a cold treatment in August is not efficient. Further research should focus on the interaction between a cold stimulus and the level of the endogenous hormones.

Introduction

In the second part of the 19th century: *Clivia miniata* Regel first came to Europe. Since then numerous new varieties were introduced to the market, from which the compact type, with broad leaves, became the most popular one. Until 1960 Clivia was a common flowering pot plant, but due to the long culture period and an "old-fashioned" image a decrease in the production was observed. However, during the last decade new commercial interest in *Clivia* is seen in some European countries (e.g. England). Especially early flowering (before Christmas), compact plants with broad leaves and the umbel above the

foliage are desired. Today, Belgium is the most important *Clivia* producer in Europe with a yearly production of about 700000 flowering plants

Traditionally, plants are cultured in frost protected greenhouses and from seed to a marketable flowering plant takes about 3 years. This long culture period together with an unpredictable flowering (flowering percentage vary from year to year and frequently unwanted summer flowering or flower abortion is observed), increases considerably the production costs. In order to come to a better control of growth and flowering of *Clivia*, the impact of temperature, supplementary lighting, photoperiod, drought stress and a cold treatment was examined.

Materials and methods

In the experiments, both seedlings and 1-year-old *Clivia miniata* plants were used. Plants were sown in November (1992 for the 1-year-old plants; 1993 for the fresh seedlings) and potted 6 weeks later in an 8 cm pot with a peat/leaf mould mixture. In October of the following year, plants were transplanted into 13-cm pots. During the experiments plants were regularly fertilised with Peters Professional (15N-11P-29K). Henceforth in the text seedlings and 1-year-old plants will always refer to the start of the experiment.

Following parameters were tested in different experiments:

1. Effect of paclobutrazol soil treatments (1, 2.5 or 5 mg a.s. per pot) and spraying (1,2 or 5 mg a.s.) on growth and development of Clivia
2. Effect of different growing temperatures (7, 16 and 20°C) and supplementary lighting (for the 16 and 20°C treatment) on growth and flowering. Supplementary lighting was given each year from the end of September until the beginning of May (photoperiod 16 h with a light intensity of 35 umo1 m-2 s-1 from 03:00 until 09:00 h and from 17:00 until 19:00 h).
3. Effect of different inductive treatments cold (4°C), long day (16 h), short day (8 h) and drought on flowering of Clivia. The inductive treatments were applied at 4 differ ent times in the year each time during a 2 months period. Afterwards plants were grown at 7 or 16°C under natural light conditions.

Results

Vegetative growth

Paclobutrazol, both as spray or as soil drench, retarded vegetative growth of *Clivia miniata* as is shown in Table 1. However flowering was also negatively influenced, so that in practice paclobutrazol is not satisfactory. In some treatments side shoot formation was stimulated (Table 1).

Leaf formation was hastened by increasing the growing temperature as is illustrated in Fig. 1. This promotive effect was already visible after a few months and continued throughout the whole experimental period (more than two years). The average monthly leaf formation increased from 30 % (1-year-old-plants) to 50 % (seedlings) at 16°C, and from 80 % (1-year-old-plants) to 110 % (seedlings) at 20°C compared with reference

plants at 7°C (Table 2). New leaves were formed at an almost constant rate during the whole year for plants growing at higher temperatures, while the control plants had certain rest periods. By increasing the culture temperature, natural periods of slow growth (summer and winter) could be minimised. Supplementary lighting did not influence leaf formation at all (Fig. 1 and Table 2).

Higher temperatures and supplementary lighting promoted leaf development, especially in younger plants, as was seen in the monthly increase of leaf length (Table 2). However, these results should be interpreted cautiously, as only the longest leaf was measured. Each newly formed leaf of a *Clivia* will, once it is fully developed, be larger then the older ones. As temperature influenced leaf number, it is logical to find higher growth rates at higher temperatures. To the contrary, supplementary lighting had almost no effect on leaf formation, while leaf growth is hastened. This resulted in a more open plant structure and poorer quality. Leaf width was not influenced by any of the treatments.

Flower initiation and flowering

First flower bud is initiated after 12 to 13 leaves are formed (Table 3). This juvenile period was found to be constant and neither temperature nor supplementary lighting had any influence on it. Once the juvenile period is over, or once 12 to 13 leaves are developed, subsequent flower buds are initiated every four to five leaves (Table 3). Also this rhythmic initiation of flower buds is independent of climatic parameters or growth rate. Besides growing temperature and supplementary lighting, we also investigated the effect of various inductive treatments: cold, drought stress, long and short days. These inductive treatments were applied at different periods of the year during 8 weeks, but none of them had effect on flower initiation (Fig. 4). From these results, we can conclude that *Clivia* clearly exhibits an autonomous flower induction. The juvenile period of the plants (= the number of leaves that has to be formed before the first flower bud is initiated) is most probably genetically determined. This means that it can be shortened by continuous selection on flower precocity.

Since increasing the culture temperature significantly hastened leaf formation (Fig. 1), also the time to the initiation of the first flower bud (12-13 leaves formed) is shortened as is illustrated in Fig. 2. A linear relation between both temperature and time to first flower initiation is observed. Starting from a seedling, it takes about 16 months at 20°C before the first flower bud is initiated, while the reference plants, grown at 7°C, reach the same stage almost one year later. This is also reflected in the percentage of flowering plants in the second year of culture (Fig. 3). At 20°C about 80 % of the plants flowered within the second year, at 16°C this was about 30 %, while none of the reference plants at 7°C flowered, since these plants were still in a juvenile stage. Supplementary lighting at 20°C resulted in earlier flowering plants (50 % flowered before Christmas). In the third year almost 90 % of the plants (also of the control) flowered (data not shown). Also then supplementary lighting hastened flower development, but a better quality of the flower was observed in the control plants (scape elongation was better and the umbel was standing above the leaves). These findings are in agreement with other researchers who reported that for flower scape elongation a cold treatment is necessary. The duration of this chilling period should be at least 45 days at 10°C. Insufficient chilling can partly

be compensated by supplementary light. Once the chilling period is finished, higher temperatures hasten flower development. The positive effect of colder growing conditions is also illustrated in Fig. 4. More good quality flowers were observed in three year old plants grown at 7°C compared to those at 16°C without supplementary lighting, while none of the inductive treatments had effect on the percentage of flowering plants.

By advancing the chilling period, plants can be forced for earlier flowering, although the earliest date to start with a cold treatment is said to be September. Also in some of our trials it was found that when a cold period started early August, less good results were obtained However, our results suggest that there might be a correlation between bud development (height) at the moment the cold treatment starts and the success of the treatment. It seems that the minimum flower bud height required to have a good reaction on the cold stimulus is ± 20 mm (data not shown). Smaller buds do not react. This can possibly explain why a cold treatment is not efficient when it is applied too early.

Conclusions

The culture of *Clivia miniata* as flowering potplant is economically feasible when the culture period can be shortened and homogenous flowering can be obtained. By increasing the growing temperature, vegetative growth is hastened and hence the period to the initiation of the first flower can be reduced drastically. This resulted in 80 % flowering plants within the second year of culture at 20°C (Fig. 5). Still, a cold period of several weeks is necessary to stimulate flower stalk elongation and to obtain high quality flowers. Afterwards flower development can be hastened by higher temperatures and supplementary lighting. However, before a controlled year round production system is possible, more information about the relation between flower initiation, flower bud development, growing conditions and the exact time the cold period should be applied, is needed.

Table 1. Effects of paclobutrazol soil treatments and spraying on growth (cm) and shoot formation in *Clivia miniata*

Treatment	mg a.s./pot	Leaf length		Number of new
		Day 80	Day 500	Shoots
Control	0	26	3	0
Soil drench	1	25	26	0.7
	2.5	25	26	0
	5	24	24	4.7
Spraying	1	23	24	0.7
	2	23	23	0
	5	23	23	1.3

Table 2. Average number of leaves, formed monthly, and average monthly leaf growth (cm per month) for *Clivia miniata* seedlings and 1-year-old plants as influenced by growing temperature (°C) and supplementary lighting

Temperature	Supplementary	Number of leaves formed		Leaf growth	
	lighting	Seedling	1-year-old plant	Seedling	1-year-old plant
7	No	0.33 az	0.46 a	0.80 a	1.15 a
16	No	0.49 b	0.60 b	1.18 b	1.48 c
16	Yes	0.50 b	0.59 b	1.32 c	1.35 b
20	No	0.68 c	0.81 c	1.57 d	1.24 ab
20	Yes	0.73 d	0.85 c	2.10 e	1.55 c

'Mean separation in columns by LSD, P=0.05

Table 3. Average number of leaves until first or between two subsequent flower buds (results are averages of different experiments and of different plant ages)

Temperature	Supplementary lighting	1 st bud	1 st-2nd bud	2nd-3rd bud
7	No	12.5 ±0.47	4.3 ± 0.43	—
16	No	13.1 ±0.91	4.2 ±0.41	3.8 ±0.45
16	Yes	12.9 ± 1.11	4.5 ± 0.67	4.3 ± 0.42
20	No	12.7 ± 1.53	4.8 ± 0.99	4.7 ± 0.80
20	Yes	12.1 ± 1.49	4.6 ± 0.60	4.2 ±0.41

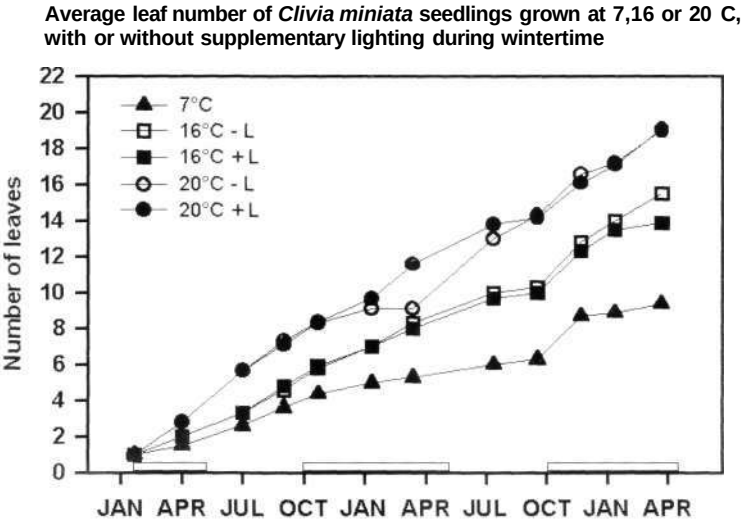

Figure 1. Average leaf number (>2cm) of *Clivia miniata* seedlings grown at 7, 16 or 20 °C, with or without supplementary lighting during wintertime (lighting period is indicated in the X-axis)

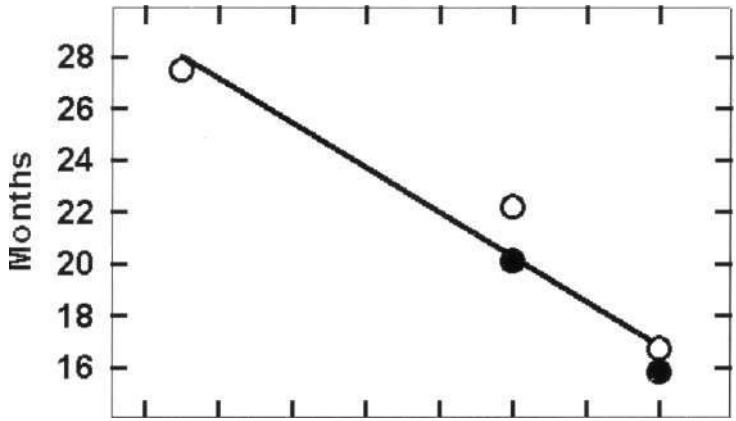

Figure 2. Relation between growing temperature with (closed symbols) or without (open symbols) supplementary lighting and time (months) before the initiation of the first flower bud in *Clivia miniata* seedlings

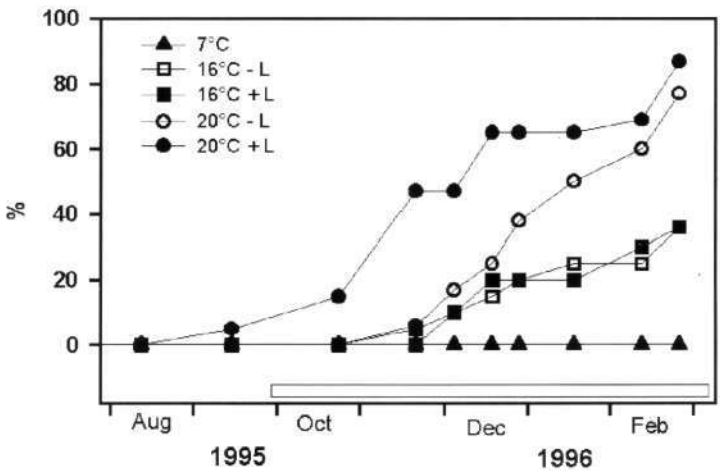

Figure 3. Percentage of flowering *Clivia miniata* plants in the second year of culture as influenced by growing temperature and supplementary lighting (lighting period is indicated in the X-axis)

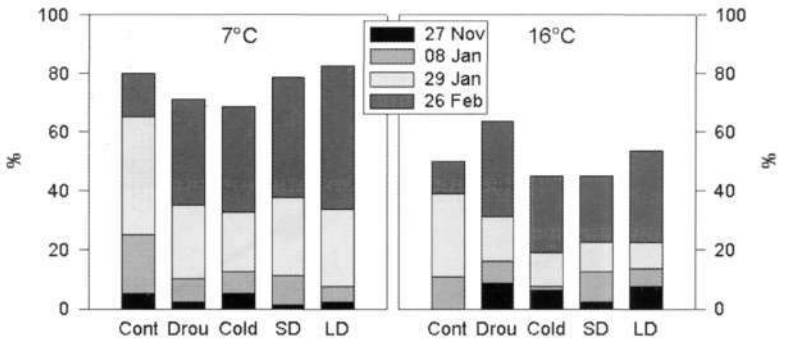

Figure 4. Influence of several inductive treatments and the growing temperature (7°C or 16°C without supplementary lighting) on the percentage *Clivia miniata* plants with visible flower buds in the third year (Cont, control; Drou, drought stress; Cold, cold treatment at 4°C; SD, short day: photoperiod 8h; LD, long day: photoperiod 16h)

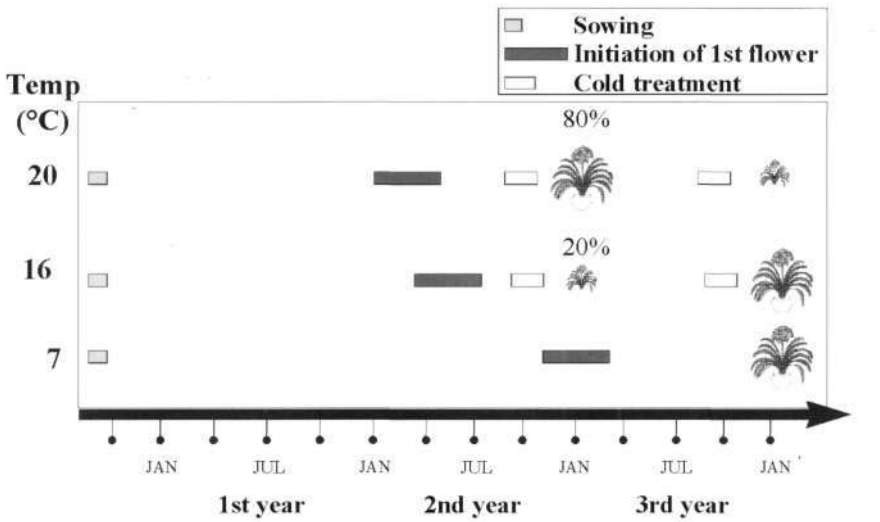

Figure 5. Schematic overview of the culture of *Clivia miniata* (from seed to flowering plant) at

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CLIVIA BREEDING IN JAPAN

Presented by

YOSHIKAZU NAKAMURA

(assisted by interpreter **TADAHIRO MINAMI)**

Abstract:

Clivias are very commercialised in Japan and are widely used as general pot plants. The Japanese, however, do not place emphasis on the flower alone, but on the whole plant. This is why Japan does not have a wide variety of flowers as is the case in other parts of the world. Nevertheless Japan has succeeded in producing plants with beautiful foliage, short and medium width leaves, and variegated foliage.

The variegated leaf is especially popular. There are two types of variegated leaf, that propagated by seed and that propagated by division. The type produced from seed is commercialized.

The present target is to breed a variegated yellow *Clivia* with as short and wide a leaf as possible. My 77 year old mother has succeeded in propagating a variegated cross yellow with only one crossing.

Clivia breeding in Japan is developing through the dedication of Clivia enthusiasts.

The slides presented, with explanations, by Mr Nakamura were translated into English by Mr Minami. A selection of these slides, as well as others, are printed throughout this publication.

Nakamura hybrid 8

Nakamura hybrid 9

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NAKAMURA HYBRIDS

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NAKAMURA HYBRIDS

A COMPREHENSIVE DISCUSSION OF THE CULTIVATION OF CLIVIA

by

CHRISTO LOTTER

Abstract:

1. Potting soil and growing mediums
2. Nutrition
3. Spraying of pesticides
4. Collecting and storing pollen
5. Collecting, cleaning, sterilizing and germinating seeds

1. POTTING SOIL and GROWING MEDIUMS

When one has to decide on a potting mixture, two important factors have to be borne in mind: pore space and good drainage. Clivias are to a great extent lithophytic or epiphytic and therefore will require more oxygen around the root system and this is where pore space becomes important. Let us also bear in mind that when we feed plants, the dissolved salts from the fertilizer will stay behind as the water evaporates. Consecutive feedings will result in a quick build-up of salts to such an extent that the roots will be damaged. It is advisable to flush the containers once a month using only tap water. Make sure that the water runs out through the drain holes at the bottom of the container.

1.1 Colloids

These are the very fine particles in any soil and are represented by humus and clay. Because these particles have an electric charge on the surface and because dissolved salts are also electrically charged (either positively or negatively) they will adhere to the colloidal system of the potting mixture.

Allow me to explain this in more scientific detail. Water, H_20, is polar; on the one side, the Oxygen side, it is negatively charged and on the other side, the Hydrogen side, it is positively charged. It is for this reason that a salt like Potassium nitrate, $KN0_3$, can dissolve in water. It becomes dissociated to form K+ and $KN0_3$- called ions. The potassium will be drawn towards the oxygen side of the water molecule and the nitrate toward the hydrogen side of the molecule. When it gets to the colloids in the growing medium, it will adhere to these electrically charged particles and can therefore not be leached out easily.

1.2 Growing - or potting mediums

I use 50/50 mixture of sand and milled pine bark. Alternatively a potting soil that will drain well containing leaf mould, sand and a good quality compost will also be suitable (even crumpled newspaper with a layer of sand (+ 3 cm) on top and - last but not least - even pure building sand!).

2. NUTRITION

You will always find the letters N.P.K. on the container in which you buy your fertilizer. N (Nitrogen) stimulates luxuriant growth, but has to be balanced by K (Potash), otherwise the plant tissues will become soft (thin cell walls) and will have less resistance to disease and drought. Assisted by Calcium, Potash plays an important part in the growth zone at the bases of leaves and peduncles.

A deficiency of Potash will result in flowers blooming between leaves. It also affects the size, intensity of colours, quality and lifespan of flowers. P (Phosphorous) plays an important role in the development of a good root system AND will determine the number of flowers in the umbel and the number of ovules in the locules.

2.1 Nutrition and the quality of your seeds

The food supply of your seeds is exendospermous which simply means that it is a separate food supply for the embryo plant and is stored outside the cotyledon, (seed leaf of the embryo) but the embryo plant is attached to the food supply by the epicotyl and serves as a channel through which the food - after it has been made soluble by enzymes - can reach the developing embryo plant. Just below the longitudinal slit through which the first seed leaf appears, we find the hypocotyl from which the radical develops. On the radical you will see a dense growth of adhesive root hairs. In nature this serves to adhere to anything with which it comes into contact (even a radical from another seed). The radical tends to grow straight down to anchor the developing embryo plant firmly. For all this growth, a lot of energy (food) is needed.

The chlorophyll in the leaves of a plant form simple sugars from $C0_2$ and H_20 during photosynthesis. Potassium is needed to convert the simple sugars into starch which is stored in the food supply of the seed. Plant protein is also synthesized from sugars and mineral salts (especially nitrogenous salts) and is likewise stored in the seeds as a good supply for the developing embryo after germination.

It is therefore important to feed your plants well with at least a basic 3.1.5 fertilizer and, if possible, with the necessary trace elements. The Scotts Peters Professional fertilizers (15 . 11 . 29 = ± N3 : P2 :K6) has the important additional Phosphorous and Potash for reasons already explained. I feed my plants at least once a month with a hydroponic mixture just to make sure that the plant medium does not become deficient in trace elements which are equally important (for example: Fe and Mg are both necessary to form chlorophyll).

So, if you feed your plants well during the development of the seeds, they will be larger and germinate and develop faster with an adequate food supply available for development until the first true leaf has developed to a stage where the seedling can manufacture its own food. If the seeds do not have an ample food supply, the developing seedlings become runts and the subsequent development will be slow.

2.2 Nutrition of seedlings

I can recommend spraying seedlings with a plant stimulant like concentrated liquid seaweed extract (Kelpak) which contains auxins like Gibberellins and Cytokinins or Supranure which contains indoleacetic acid. (Commence this programme only after all the stored food in the seed has been used up.) Use a hydroponic mixture - mainly for the trace elements - about once a month.

3. SPRAYING PESTICIDES

3.1 The most important spray for seedlings is a systemic fungicide (like Benlate). The same applies to mature plants that develop brown spots (brown rust).

3.2 The best insecticide to use is chlorpiriphos because it is systemic and kills beetles, lily borers, mealy bug and scale. As an alternative one can use garden Ripcord.
If you are allergic to these substances, use a watering can.

4. COLLECTING AND STORING POLLEN

One can pick the ripe anthers with the aid of tweezers and a very small container. Put this small container in a big container containing a drying agent (silica gel) for 24 hours. After this, one can transfer the pollen to a numbered gelatine capsule which can then be entered in your record book. The capsule can be placed in an airtight small container with a drying agent and placed in your deepfreeze. If you keep it dry and cold enough, it will still be viable after three years!

To pollinate, wait until all the anthers of the flowers to be pollinated are mature. Use a very fine brush to take the pollen from the capsule. Clean the brush afterwards by submerging in methylated spirits - do not dry! Pollinate early in the morning before the bees start collecting pollen!

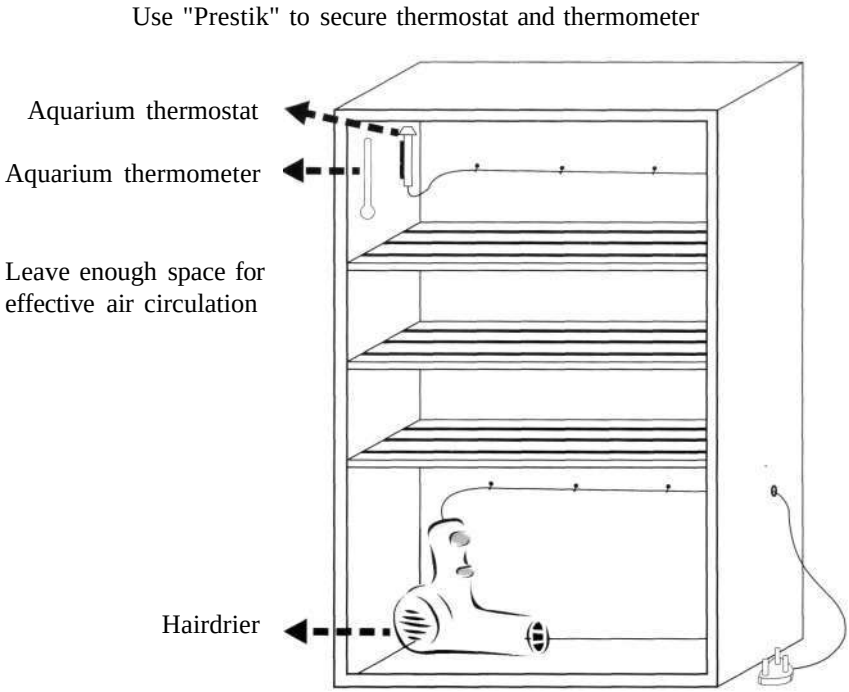
If the stigmas are dry or damaged, cut off the style halfway down to the ovary and apply sugar solution (6 level teaspoons to one cup of water). Wait for + 5 minutes and place pollen on the cut surface. The sugar solution can also be used on stigmas that are reluctant to allow pollen to germinate. If you have a microscope, you can establish the viability of your pollen by placing the pollen + sugar solution on a microscope slide, cover, and leave overnight. Inspection the next morning will show pollen tubes developing should the pollen still be viable. Pollen stored at -18°C in a deep freeze will still be 100% viable after 3 years.

5. COLLECTING AND GERMINATING SEEDS

5.1 "Green pod sowing": One can pick the berries after 5 1/2 months. The seeds will come out easily because the fruit-wall is still firm. However, should you harvest the berries in July, it is better to put them in a basin of water before you crush and wash them to separate the seeds from what remains of the pulp and membranes. You will find this a much easier and cleaner operation. You must make sure that the inner membrane of the fruit-wall surrounding the seed coat is also removed, otherwise the membrane will become infected with bacteria or fungi.

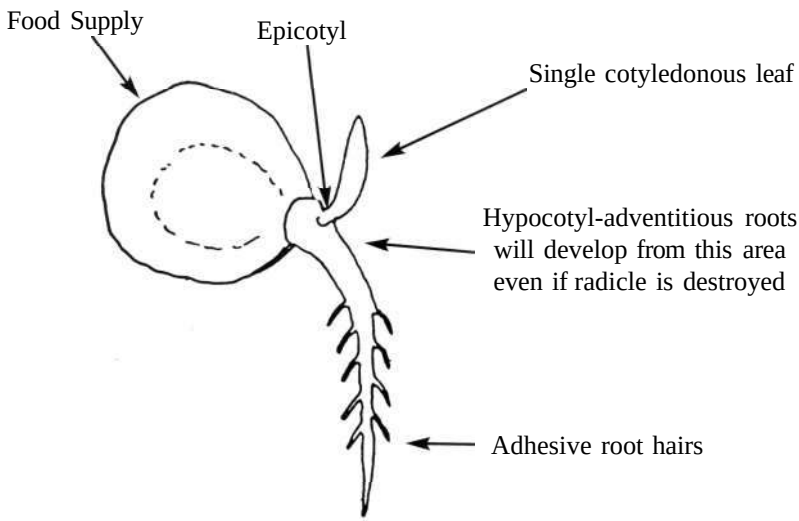
5.2 Sterilizing by washing with Sunlight dishwasher liquid (one teaspoon to one litre of water), followed by rinsing with clean water, is usually adequate. Wash your containers (plastic ice cream containers) with Sunlight liquid and rinse. Place a folded paper towel at the bottom, then moisten, place seeds on moist towelling and close the lid firmly. It can now be placed in a propagator. (Sunlight liquid dissolves cell walls of microbes and fungus spores.)

5.3 You can make your own propagator as follows : Construct a wooden box, approximately 75cm x 45cm x 25cm, with a close-fitting door. Construct a slatted shelf under which you can place a hair dryer. This should be placed centred at the bottom of the box. Place an aquarium thermostat (without the test-tube) right at the top of the box. More slatted shelves on which one can place the seed containers can now be installed. Use an aquarium thermometer to monitor the temperature. An average temperature of 25°C will give the best results. Do not be upset if the thermometer reads 27°C. It usually switches off at that temperature and on again at 24°C. Use the setting screw at the back of the thermostat to attain an optimally functioning system.



A SIMPLE PROPAGATOR

5.4 After about one month, the radicle should be - at an average - 2cm long. Use a container - pot or bag - + 15cm in diameter and plant the seeds - about 25 to a container. Use a pencil-thick screwdriver to push holes into the medium (sand) to receive only the radicle. Push down on the seed to let it sit firmly on the medium and water with a spray can. These seedlings will need protection from rain until the first leaf is about 4cm long, otherwise they may be washed out. Should the seed be lifted up by a developing taproot, make a new hole deep enough to receive the entire taproot, then water as indicated above. Transplant into individual bags (after + 10 months) at the beginning of spring the following year.



18 Multipetal floret compared with standard floret

New leaf variations developed in Japan 19

Japanese fan leafed form 20

Wessel Lotter interspecific Hybrid 21

22 Nakamura Hybrid

Nakamura Hybrid 23

HISTORY OF THE *CLIVIA* IN BELGIUM

By

PIERRE DE COSTER

Abstract:

This paper will trace the history of clivia through to the present day.

The city of Ghent and the surrounding region is the centre of ornamental plant cultivation in Belgium. As early as 1648, the growers were united in the "Conferie Sint Dorothea" (Brotherhood of St. Dorothy). In 1808 the "Agricultural and Botanical Society of Ghent" was founded, whose goal was to organise annual exhibitions following the English example. There can be no doubt that within this group of collectors there was a cross-border trade in plants, and thus the clivia entered Belgium.

In Flore des serres (1853-1854), we have the description of *Clivia (Imanthophyllum) miniatum*, with its narrow leaves and 50 cm long flower stalk containing 12 to 15 flowers. The Clivia miniata was the most highly prized variety in the last century - and is still the most popular in our own. Another popular variety was the cross made by Charles Raes between *C. nobilis* and *C. miniata,* which was called the "*Clivia cyrtantiflora* (Flore des serres, 1869).

"Many new varieties of *C. miniata* were introduced at the expositions held between 1873 and 1878. Progress was made in the number of flowers per stalk and in the colour of these flowers. But none of these varieties surpasses the C. *miniata lindeni,* developed by Mr. Theodore REIMERS, who was the head gardener for Mrs. DONNER in Ottenhousen near Hamburg, Germany. It has a very heavy flower stalk and a nice arrangement of the perianths, with lovely colour and flowers which are reminiscent of Vallota. The umbel can contain up to 39 flowers" (Illustration Horticole, 1879, vol. 26, by J. Linden). The MARIE REIMERS variety from the same grower has a lot in common with the *C. miniata lindeni* (Flore des serres, 1880, vol. 23).

From 1879 onward, the seedlings of the *C miniata lindeni* variety were very much in demand. Some of the seedlings reflected the type in its purest form, while other divergent specimens gave us numerous new varieties with large umbels, large flowers and/or broad leaves. Dozens of varieties have been described (Revue de 1'Horticulture Beige et Etrangere of 1875 to 1913).

After the First World War, BIER & ANKERSMIT introduced the C. *miniata compacta robusta* to the market. "A more compact plant, with leaves twice as broad as we are accustomed to and rounded rather than pointed (Gartenwelt, 1967). Through its participation in exhibitions and its catalogue publications, this large commercial grower in Melle near Ghent, Belgium, made this type known around the world. It was to become the starting point for the 'Belgian strain (Gartenwelt, 1976, E. Hahn).

This does not take away from the fact that in this period other growers won the first prize in the exhibitions ('Floralien') in Ghent from 1922 to 1950, including the CAMPENS Bros, in Melle and Louis DE CALUWE in Merelbeke, along with many others in the Ghent region. It was these growers who selected the clivia with the most beautiful flowers and the broadest leaves (8 to 12 cm).

After the Second World War there was a greater demand for less expensive plants. The 3 to 5 year cultivation cycle of the 'Belgian strain' was no longer profitable. In addition, clivias in general had gone out of fashion. Beginning in the 1950s, Ernest DE COSTER in Melle selected for early flowering clivias. These are compact plants, with 5 to 7 cm broad leaves, and 20% of the plants are already flowering after two years.

In 1990 the Clivia Study Group was set up on the initiative of a horticultural engineer employed by the Ministry of Agriculture, Mr. Adrien SAVERWYNS. The group functions to bring clivia growers together to discuss the technical problems of cultivation and, in some instances, to propose testing by the Provincial Research Station.

In 1998 most clivia growers are cultivating early flowering varieties, and the 'Belgian strain' is in danger of becoming a rarity.

SELECTION AND COMMERCIAL PRODUCTION OF CLIVIA IN EUROPE

by

PIERRE DE COSTER

Abstract:

This paper looks at the techniques of commercial cultivation and production of Clivia in Europe, diseases and pests, sales, packaging and transport.

1. SELECTION

In the 1960s, most growers in Europe found the old 'Belgian hybrid'- big and beautiful as it was - to be no longer marketable (too large) or profitable (4-6 year growing cycle). A more compact, rapid grower with highly supple, broad short leaves that would not break during packing was developed. It had to be an early flowering variety (10%-20% after two years, and the rest after three years). The umbels, which ideally stick out above the leaves, needed to be closed and globular in form. The flowers themselves needed to have broad petals - either touching or overlapping one another, and curving slightly outward. The desired colour was dark orange.

BELGIUM: is the country in which the most important developments in selection have taken place. (See previous page: HISTORY OF THE CLIVIA IN BELGIUM.)

GERMANY: has a long history of clivia breeders. REIMERS in Neumuhlen, followed by E. NEUBERT in Wandsbek, and LOBNER in Bonn-Friesdorf, who developed the

dark orange Friesdorfer type in 1917. Other breeders, such as BALL in Gaggenau, SHAFER in Rastatt and SCHMID in Donzdorf, developed the compact "PALMEN-GARTEN-RASSE" (Gartenwelt by O.Koch / E. Hahn, and Pareys Blumen Gartnerei).

ITALY: has for years been importing young plant material from Belgium, which is then raised to maturity. Now they have also developed their own production to cover domestic needs, which is supplemented only to a minor extent by Belgian clivias.

FRANCE: "has limited production, and they have the Belgian growers to thank for their most beautiful varieties." (Plantes des serres, Bellair & Saint-Leger, Paris, 1939).

GENERAL: Northern Europeans seem to prefer smaller plants, whereas Southern Europeans prefer the larger varieties.

2. CULTIVATION

2.1 Multiplication

2.1.1. From seed: Mother plants possessing all the right characteristics are kept for years. Each year, improved types are added to the stock. There are some growers, however, who totally renew their stocks every year. Pollination is done with a brush. Cross pollination is used for making selections.

In Europe, the fruit ripens between mid-November and January. The coloured, ripe fruit is extruded, washed, rinsed and dried. The other method is to let the extruded fruit dry, and then extract the seeds from the dried pulp. The seeds are often disinfected by submerging them in a fungicide (e.g. captan).

2.1.2. Vegetative multiplication: Side-shoots are not used very much. In vitro culturing is possible, but the process takes too long and does not provide a cost-effective means of multiplication. It does, however, offer possibilities for developing lines from superior plants.

2.2 Raising

Clivias are raised in heated greenhouses. Each grower has his own growing methods, which work best for his farm and fit best with the working customs in his own particular culture. The following is an example of one particular growing method.

TIME (IN MONTHS) AFTER SOWING

MONTH 1 SOWING: In multi-pot trays containing 51 to 73 cups per tray.

Substrate: 50% pine needle compost and 50% peat, unfertilized, with Mg-Ca added to bring the Ph to between 5.5 and 6.0.

The seeds are pressed lightly into the soil, and kept damp and covered.

Light is not important. Temperature: 18-20°C.

MONTH 9 TRANSFERRING FROM MULTIPOTS TO 9 cm POTS (MECHANIZED)

The largest plants are repotted first. This results in the plants being sorted by size. They are arranged pot to pot, with 140 pots per M^2.

Substrate: The same soil is used as for sowing, though with 0.5 kg organic or inorganic fertilizer added per M^3 (14/16/18 + trace elements) and 1 kg coated fertilizer (e.g. 8-9 months, 9/11/18 + 1.5 mg Mg + trace elements).

Temperature: 16-18°C.

MONTHS 15-19 REPOTTING FROM 9 cm TO 13 cm CONTAINERS (MECHANIZED)

The largest plants are sorted first. The same substrate is used. The plants are then arranged in rows, with the leaves in the same position, 48 plants per M^2.

Temperature: 16-18°C, and 10-14°C in winter.

MONTHS 24-25 FLOWERING: 10-20% of the 2-year-old plants

MONTH 27 INCREASE SPACING BETWEEN PLANTS: 32/m^2

MONTHS 34-35 RESTING PERIOD: under 10°C

MONTHS 35-38 FLOWERING: 90% of the 3-year-old plants

SUPPLEMENTARY FERTILIZER: as needed, according to Ph and salt concentration, usually in the ratio of 2/1/5.

2.3 LIGHT: MAX. LIGHT INTENSITY +110 W/m^2

3. DISEASES AND PESTS

3.1 ANIMAL PARASITES	PESTICIDES
Woolly aphid: Pseudococcus citri	Carbamates
Scale insects: Diaspinae	Carbamates
Thrips: Thysanoptera	Methiocarb., synth. pyrethroide
Red spider mites and other mites:	Endosulphan, Bromopropylate, Amitraz,
Cicofol	Carbofuran
Sciara fly	Mercaptomethur
Slugs	

➤ 39

24 "Kirstenbosch Yellow

'Natal Yellow" 25

26 'Noyce's Sunburst'

27

28 Bred by Michael Bertram

Bred by Wessel Lotter 29

Bred by Wessel Lotter 30

Tienie Holzhausen "Green Girl"
Best on Show: Pretoria 1997

31

32 Nakamura Hybrid

Nakamura Hybrid 33

Ndedwe "Gamma Peach" 34

Clivia miniata var. citrina 35

3.2 FUNGI

Fusarium, Verticillium, Cylindrocarpon, Rhizoctonia, Sclerotinia, Phytophthora and *Phytium* can attack roots in the primary form of the infection. In their secondary form, they can occur on weakened plants due to poor growing conditions.

PREVENTIVE TREATMENT

Systemic remedies

CURATIVE TREATMENT

***B.C.M. remedies

3.3 BACTERIAL DISEASES: Remove affected plants.

3.4 PHYSIOLOGICAL DISEASES

Cork proliferation: Air humidity too high.
Flower stalk does not extend: Failure to provide for rest period.
Leaf spots on the edge and top: Probably due to disturbed growing conditions.

4. PRODUCTION

Belgium is the largest producer of CLIVIA in Europe, producing an estimated 700,000 plants per year. Most of the clivia sold in the Dutch auctions in 1997 (278,000 plants) was of Belgian origin. The average price paid at these auctions was 7.76 NLG (3.9 USD) per plant. Approximately 200,000 clivias are raised in Holland each year. Italy also has a significant level of production, followed by Germany and France.

5. SALES

Sales are carried out either by the grower himself or by a local wholesaler, who sells to wholesalers abroad, to wholesale markets or to supermarkets. The Dutch auctions also sell a large portion of the production through auctions or middlemen.

6. TRANSPORT

- PACKAGING: In boxes or palettes custom made to fit the trolley.

- The Danish 'CC' trolley is used throughout all of Europe.

- TRANSPORT: By truck.

VARIEGATION IN CLIVIA MINIATA

by

NICHOLAS PRIMICH

Abstract:

Ornamental flowers are, by their nature, blessed with parts that attract them to human beings. Variegated plants have attractive (to many people) leaves which cause them to be sought after. It will be found on closer investigation that other parts are also variegated, and it is problematical as to how one may define these plants. We will take a cursory look at types of variegation and what causes them. We will deal by and large with chimeras, which are the main, if not the only type of variegation that is found among *Clivia.*

Assumptions are made as there is no direct evidence that *Clivia* do have what has been found in other monocots. Yet it would seem that on the balance of probabilities there would be no other possibility. The transfer of genetic material through the plastids is discussed, and the results obtained by *Clivia miniata* breeders is compared with the theoretical probabilities.

Various successful clones are discussed and compared. The future for variegated *Clivia miniata* comes under review.

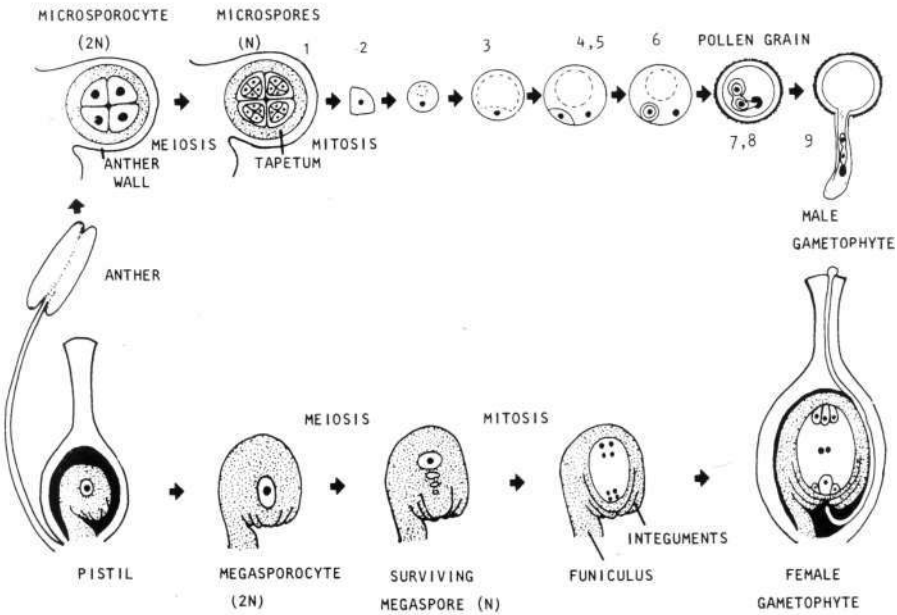
Ornamental plants are grown to be looked at. When I looked at variegated plants I often wondered why they were variegated whilst others were not. Nobody seemed to know very much about them at all. This was in my youth, and as I left home to work I lost my intimate contact with plants that I had with my parents and became involved in the technical world where I was making my living. Later on in my life I re-oriented myself and my underlying interest in plants resurfaced. The question was still there. What exactly are variegated plants, and why are they variegated? I often looked for references to them when visiting libraries, but found the facts to be few and far between. One day in 1996 I read the September New Plantsman and found many answers in Carlos Sombrero's article "Enigma of Variegation". This was followed by Ken Burras' article in the January 1997 The Garden. Through these articles I was then referred to a book by Drs. Richard Tilney-Basset and J. Kirk, as well as two more by Tilney-Basset alone. The problem of obtaining these works was solved for me by our editor, Meg Hart, and Mick Dower of Cape Town. My thanks to these people for their help.

As the aforementioned good Doctors have battled to give a good definition of variegation, I shall not attempt to do so except to say that with clivia we are talking about the striped leaves, some white, some yellow and some shades of green that appear on some of our plants. It is thought that variegated plants may be found amongst all of the species, and they consist in about four percent of modern plants in the nursery trade. I do not think that they are up to that percentage yet amongst the *Clivia* collectors, but I feel they will eventually overtake that mark. Most people like a variegated plant. Of course there are many shades of opinion among the aficionados. It does have the benefit of being decorative even without its flower. Naturally some are more decorative than others. It has also been my observation that the variegation changes, sometimes getting stronger, and sometimes disappearing altogether.

Sombrero (1996) describes six types of variegation to be found among the angiosperms:

1. Natural pigmentation: Many plants have a range of natural pigmentation where greens, whites, reds, yellows, etc. are caused by chlorophyll, lack of pigmentation, anthocyanin, carotene and several other pigments which are in the leaf. A great range of colour is possible by addition and diffusion of the various pigments. A good example is *Coleus.* Another is *Amaranthus.* This pigmentation is in the genes of the plant.
2. Unstable genes: Unstable nuclear gene mutations cause unpredictable leaf patterns as the pigments are turned on and off. A probable cause of this is transposable genes. That is a transposon, or section of gene coding that is capable of inserting itself in different positions in the gene chain. The *Nasturtium* is an example of this form.
3. Viruses: At one time many variegations were blamed upon viruses, and any pale yellow streaks or patches were thought to be caused by viruses. Only 12 plants out of 400 examined at the University of Oxford were found to have their variegation caused by disease (Burras 1967). The "Parrot" *Tulips,* and several *Orchids* exhibit flowers with "colour-break" caused by virus. *Abutilon pictum* is a shrub that has a specific virus mottling.
4. Air blisters: The aluminium plant, *Pilea cadierei,* is a well known example of a plant where cavities form under the surface layer of the leaf and cause silvery patterns. This is natural to the plant and breeds true to pattern. Another well known example is the *Cyclamen* which has such beautiful traceries on its leaves. There is a possibility that the *C. nobilis* that has the silvery stripe down the median line of its leaf may belong here. I am not at all sure about this, but it seems a distinct possibility to me.
5. Developmental: Certain plants attain certain colours, mostly in the leaves, at certain times of the year. *Photinia* is an example of this. The causes are not know, but it has been suggested that temperatures have a hand in this. Probably the best example are the autumn leaves that become suffused with anthocyanins before they drop.
6. Chimeras: This is the most important type of variegation as far as cultivated plants go, and the only type that concerns the clivia grower. Plant chimeras can be divided into three types, periclinal, mericlinal and sectorial. Periclinal are the most numerous and as the other types are highly unstable and do not concern the clivia grower, we will ignore them. Periclinal means "around the outer surface"; the growth of new cells takes place in an anticlinal direction, i.e. at right angles to the surface. The word chimera comes from the Greek, the chimera being a mythical monster like a fire-breathing lion with a goat's head growing out of his back and his tail being a venomous serpent. However, our plant chimeras are less offensive, the analogy coming from the different types of plant growing on the one unit. It is a difficult thing for the layman to understand, but the primordial buds that generate the leaves, or the apical meristem in the clivia's case, consist of at least two different plant types. There are various stages of this phenomenon. Some do not have any green parts or not enough, so the plants die as seedlings. Some have much white tissue which is parasitic on the green tissue so the plant grows very slowly or hardly at all. When seeds are produced, one finds that in clivia the pollen parent has no effect on the variegation. As far as I can find out, there appears to have been no work done on

clivia variegations as far as genealogy is concerned, but taking a line through other monocots, it seems certain that the variegation is passed by the plastids in the mother cell. In most monocot fertilisations, the plastids in the male cell are lost in the process, and only the nucleus fuses with the mother cell. This accounts for the mother plant alone being responsible for the variegation in the seeds. As the angiosperms have a very different meiosis to the animal kingdom, perhaps one should say a few words about it. The plant reproductive system is clearly illustrated as follows by Piyada Theerakulpisut et al in "Genetics and Breeding of Ornamental Species", J Harding et al (Edits) 1991, Vol 2 current. Plant Science and Biotechnology in Agriculture:



Plant Reproductive Systems. Male development (left to right) : The anther contains, the diploid microsporocytes which undergo meiosis to each produce (1) a tetrad of microspores; (2) microspores are released into another cavity; (3) microspore vacuolation; (4) microspore meiosis; (5) generative cell attached to pollen wall; (6) generative cell rounds off; (7) generative cell mitosis with sperm cells and vegetative nucleus forming and male germ unit; (8) vegetative cell accumulates reserves during maturation and dehydration; (9) pollen tube production and entry of male germ unit into tube. This is the male gametophyte. Female development (left to right) : the ovule is housed within the ovary of the pistil; a megasporocyte differentiates within the nucleus and undergoes meiosis to produce four haphloid megaspores, three of which generally degenerate; the surviving megaspore enlarges to form the embryo sac, and there are three mitosis to form the eight nucleate, seven-celled embyro sac. The egg (the female gamete) differentiates at the micropylar end while the pair of polar nucleii are in the central cell. This is the female gamophyte.

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NAKAMURA VARIEGATED FORMS

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Thus in angiosperms (and a few others) the union of the male and female gamete is a bit more complicated than in the animal kingdom. The anther contains diploid microsporocytes, which undergo meiosis to each produce a tetrad of microspores. The microspores are released into the anther cavity where they undergo vacuolation. They then undergo mitosis. The generative cell undergoes mitosis again, the sperm cells and the vegetative nucleus form a male germ unit. The vegetative cell accumulates reserves during maturation and dehydration. The pollen tube is produced and the male unit enters the tube. This is male gametophyte. The female develops within the ovule in the ovary. A megasporocyte develops within the nucleus, and undergoes meiosis to produce four haploid megaspores; three of these usually degenerate. The survivor undergoes three mitoses to form the eight-nucleate, seven-celled embryo sac. The egg, the female gamete, differentiates at the micropylar end while the pair of polar muclei are in the central cell. This is the female gametophyte. What really interests us here is the fate of the plastids.

When a pollen grain carrying the two sperm cells and the vegetative nucleus falls on the stigma, the pollen tube grows down the style and enters the ovule through the micropyle. The one sperm cell fertilises the egg cell, while the other fuses with the endosperm nucleus, forming the endosperm mother cell. Usually the pollen parent plastids perish in the pollination process, but not always. There are records of occasional male plastids in some species and regular ones in a few others. As the seeds rely on the sorting-out of plastid conditions to account for their variegation or not, the numbers of variegated against non-variegated are not mendelian, but random numbers. Thus there is not a certain inheritance of variegation in clivia. One must, however, take good care to use a suitable male when pollinating a variegated, as there are the leaves and the flower to consider. The pollen parent will certainly have a say in these matters.

Radiation, stress and certain chemicals can and do cause mutations in plants. If mutations occur in the plastids of a normal mother cell it is possible that variegated plants will be produced. Plastids carry the pigments for the plant, and the leaves and petals could be affected by such changes. The flavones or anthocyanin group however, form in the vacuoles of the epiderm layer.

Perhaps we should have a word about the wonderful world of the plastid. This is really a cell within a cell. When cytologists were studying cells under the light microscope they were limited to magnifications of + 1200, which has been increased to 1500 by modern technology.

The advent of the electron microscope brought cytology alive. With magnifications in excess of 1000 times and resolutions far exceeding those of the light microscope, the window into the world of cells was opened. Between the transmission electron microscope, and the scanning type which gave a three-dimensional view of the microcosm, research surged forwards. If a plastid which was a few microns across appeared as a grain in the light microscope, it became a football in the electron microscope.

A plastid is usually lenticular in shape - it does vary and some become quite elongated. The outer membrane of the plastid is double. They start off as protoplastids and can develop into chloroplasts which carry the chlorophyll, amyloplasts which are colourless and carry starch, chromoplasts which carry carotenoids and other auxiliary pigments, and one for lipids. Plastids are filled with a proton dense matrix, which is called the stroma. In this are embedded ribosomes, globuli or drops of lipids, and the grana. The grana consists of an intricate system of vesicles that in the chloroplast, predominate. Seen from the side the vesicles seem to be stratified, and are indeed called lamella. Seen from above, the grana look like stacks of coins. There is however, a complicated connecting system with side linkages from one coin stack to another, and also into the stroma. The grana are usually called thylakoids. Sometimes there are 4-7 plastids in a cell. Shade plants can have as many as 70 in a cell.

The chlorophyll resides in the thylakoids and the light reaction takes place there whilst the dark reaction takes place in the stroma. All this in a tiny organelle about 5u across.

Now the plastids have their own chromosomes. In fact plants have three genomes, that of the nucleus, the plastids and the mitochondria. The plastids are fairly autonomous, with their own nucleus and chromosomes, and manufacture most of their own requirements. When pollination takes place, the male cell usually loses its plastids, whilst the female cell usually retains its. This is where the expression maternal inheritance comes from. This can be misleading, because sometimes the male plastid gets through, and the female one does not. That is why I prefer the term cytoplasmic inheritance.

The apical meristem, from where our clivia grows, is a three-layer system of cellular development (2 and 4 layer plants also occur). If one considers a hand in a glove, then the glove would be the outer layer, the skin of the hand the second layer and the flesh the third or inner layer. This is the tunica corpus principle. It's simple. The tunica is the shirt, and the corpus is the body. From the tunica only the epidermis or outer cell layer grows one or two layers thick. This grows in an anticlinal or at right angles to the surface mode. The others are a trifle more complicated like Rubik's cube. We know how it starts and we know how it ends, but the middle bit is a little tricky.

When a faulty chloroplast appears, it will divide and make further chloroplasts, as the good ones do, and then it is a matter of sorting out, as the cytologists call the random process when the white and green chloroplasts multiply and proliferate in a race to see which one dominates. Remember, these chloroplasts are within a cell, and the mutation is within the chloroplast, not the cell nucleus. If there are too many white ones, the plant will be in danger of dying, as the white tissue is dependent upon the green tissue for its food. So some cells will have mixed populations, and some will be entirely white or green. This is usually an unstable process, and this causes the variegations to fluctuate as the plant grows. As the leaf is growing rapidly vertically, and slowly in width, the variegations appear as stripes.

I am not certain what Mr Nakamura's "peace" variegation is, but mine start in a young leaf and have all grown out by the time the leaf matures. Perhaps it is a sectorial variegation which is very unstable.

Mr Nakamura's variegated plants have been developed by him from an original Japanese clone which has been in Japan for a long time. He traded plants with Bill Morris and Kevin Walters, and developed his clones further. I got Mrs Dobson to write him a letter, as I was certain that the article which appeared in Clivia Club's newsletter of January 1998 gave the wrong information when it inferred that his variegated plants were developed from x-rayed or y-rayed seeds. The seed that was treated to a dose of cobalt -60 were done a long time ago by Mr Nakamura in an attempt to emulate an experiment on hemerocallis seeds. The idea of this experiment was that colour changes would appear in the fourth or fifth generation. This is also based on the apical meristem, where a gene may be displaced or altered by a ray, it then starts to grow in a new form, but the alteration is so small that it cannot be seen by eye. If it continues to develop, by the fourth or fifth generation or more, it will have started to become visible. Mr Nakamura's plants are designed for indoors. I have many fine specimens of them, but they suffered badly from a fungal disease that I have only recently come to terms with. I believe that they can be hardened up and grown outdoors. I will have some flowering specimens next season, I am certain. Much the same goes for the samples I have from Bill Morris and Kevin Walters. The one local variegated specimen that I know well is that of Bertie Guillaume. This is a strong and vigorous plant that makes offsets like crazy. The flower needs improving, and I'm certain I will get that right before long. The vigour of this plant is amazing. I have never seen a more vigorous clivia of any type. It has produced many vigorous seedlings with a wide variety of leaf forms, and mostly variegated. Very few are all green or all white. I have seen quite a few others around, and have even acquired a few more, but have not been able to accumulate any knowledge on these specimens. I know Jim Holmes has some successful clones, but know little about them. I will welcome any further information from anyone about any successful forms of variegated clivia.

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RESEARCH IN CLIVIA CHROMOSOMES

Yidong Ran, B.G. Murray and K.R.W. Hammett

Presented by

DR KEITH HAMMETT

DR KEITH HAMMETT trained in botany and plant pathology and went to New Zealand 31 years ago. Gradually he changed his career and became a breeder Today he is a private breeder but he retains his scientific link with a series of MSc and PhD students at Auckland and Massey Universities.

Abstract:

Various staining techniques have confirmed that all four species of *Clivia* have 22 chromosome sets, and that the chromosome sets (karyotype) of each species can be distinguished. This information is being used to investigate the phylogenetic relationships between species and the development of the plant in cultivation.

To start with I would like to say what a privilege it is to speak immediately after Nick Primich who founded this Club. I had the privilege to attend the first International Clivia Conference in Pretoria four years ago. In my estimation about 75% of the people who are currently members were not involved in the Clivia Club four years ago. It must be an enormous thrill for Nick to see the small group that he started having grown into what it is today. What I'm going to talk about today would not have been possible if it wasn't for the formation of the Clivia Club.

Four years ago Nick took me in a car for a week or so and we went up and had a look at *C. caulescens* growing up in the northern part of the country and then we came down through the Transkei and ended up in the Eastern Cape. I remember the Transkei particularly. This year Connie and James Abel took me around for a couple of weeks and we made much the same trip. This is important to me because I live on the other side of the world where we do not have clivia. They all grow here!

In order to work on a plant as a breeder, you have to have a lot of plant material. So it is very important for me to understand what the species are doing in the wild. On the last trip I saw two populations of C. *nobilis* in absolutely pristine condition. This was the first time I had seen C. *nobilis* not growing in a pot. In fact it was the first time I saw *Streptocarpus* and *Strelitzia* growing in the wild. It was close to a religious experience for me to get to stand and look at these magnificent plants and to realise that I was looking at plants that I had only ever seen growing in pots. This time two of these sites were almost totally decimated, one of them had chalets built on top of them, and the other property had goats grazing on the land. It made me very sad indeed.

So, do you understand how fragile the resource that you have is? The other thing that I came away with was people like Nick Primich saying, "We haven't done as much with our flower as people elsewhere in the rest of the world". At the end of my first trip I was not sure that this was true. After this trip however, from what I have seen, I am absolutely certain that no one has done more with your flower than you have and

you can be very proud that the Clivia Club is here in South Africa. What is happening is that you have become aware of each other, you are networking. There are the most wonderful collections here in this country, the most wonderful gardens. So, all you South Africans, can be proud.

First of all, as a breeder I am very interested in the relationship of the Clivia species. We've got three species which are pendulous - *C. caulescens, C. nobilis* and C. *gardenii,* and then we have one upright flower, *C. miniata.*

We had very little material in New Zealand to start with. In New Zealand we had one accession of *C. miniata* species. We know from old catalogues that its been in New Zealand and Australia for over 100 years. Its been disseminated quite widely and it represents one accession. I have seen in the wild here in South Africa, in an area no greater than the corner of this room, more variation than existed in the whole of Australasia. I have been absolutely amazed at the form and quality of some of the naturally occurring C. *miniata* and other species that you have. You have an absolute need and responsibility to maintain that diversity. If it can not be done in the wild, then it is very important to do what John Winter and Mick Dower are doing, and that is to go out and get this material and bring it to safety. I can not emphasise the importance of this too much.

The other plant which is reasonably widely disseminated in Australasia, more particularly in Australia than in New Zealand, is the first known hybrid, namely *C. cyrtanthiflora* which is made between *C. nobilis* and *C. miniata.* This was developed in Belgium in the middle of the last century and has been divided and disseminated throughout Australasia.

The other species we have in New Zealand is *C. gardenii.*

Any pendulous clivia in New Zealand has been referred to as *C. nobilis,* but without exception I have found that this has always been *C. gardenii!* It is only since I have been associated with the Clivia Club and have been able to access genuine *C. nobilis,* that I am quite certain that *C. nobilis* has not existed in Australasia until quite recently.

What first got me started on clivia, was a plant of *C. miniata* which I found growing in the conservatory at Southampton University. I had it in a pot and showed it at the local flower shows in England. My interest was reawakened 18 years ago when I read an article by Kevin Walters which had a picture of a yellow clivia and which absolutely blew me away! So I wrote to Kevin who was very kind and he sent me seed. I duly waited for 4-5 years and then I was able to start crossing with what we had in New Zealand, which was very little.

We then have one or two of the European hybrids which have come either from Belgium or German seed. Understand how limited our resources were. We now have *C. nobilis.* Yoshikazu gave me one when I visited him some years ago in Chiba, and it is the same form as we saw recently in the wild in Grahamstown. We now have *C. caulescens.*

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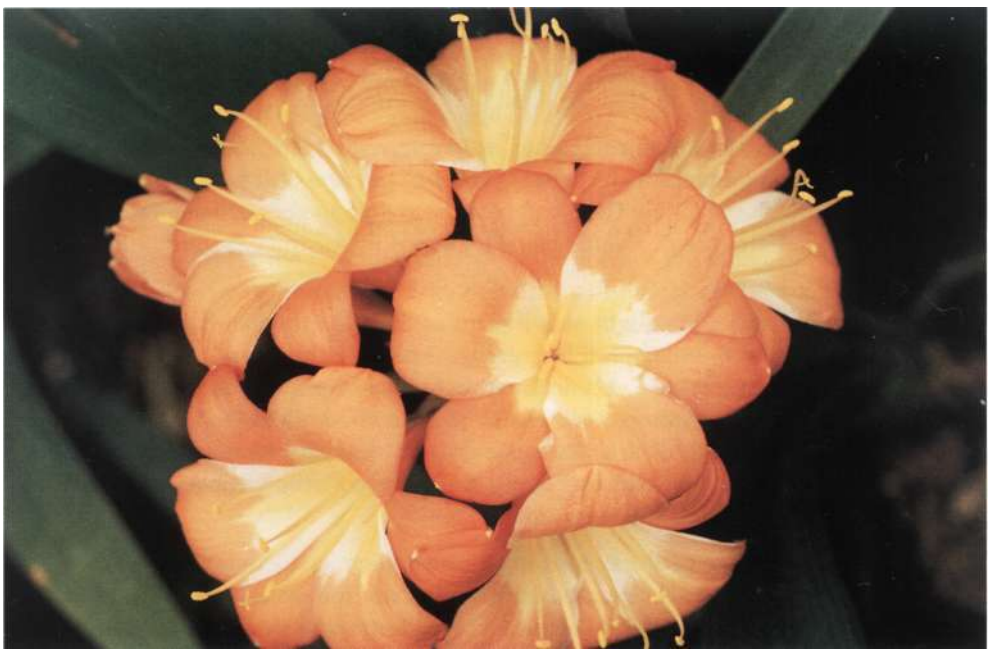

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Tino Ferero: "Yellow Greengirl" 46

Gert Wiese: Best on Show, Cape Town 1998 47

What you find now is that if you take open pollinated seed of *C. cyrtanthiflora* you get a whole range of hybrids and these range from ones that look remarkably like *C. nobilis* and grow as slowly as *C. nobilis,* while others look remarkably like *C. miniata.* I think that this often leads to confusion when people try to identify such plants. Thanks to Yoshikazu we also now have hybrids between *C. caulescens* and *C. miniata,* and *C. miniata* and *C. gardenii.*

I have drawn a rough map of the distribution of clivia in this country. As most of you would realise, the locations are separated by several hundred kilometers and can be separated by several hundreds of metres in altitude. Most of the dots on my map come from herbarium specimens. Taxonomists most frequently work with dead plants. Gardeners and field botanists work on live plants. That influences their thinking.

I have been tremendously fascinated by the importance that clivia plays in the Oriental culture. South African plants can not have been there for more than a couple of hundred years. When I visited China 15 years ago, it was the only plant I found growing in barbed wire cages and this says to me that this plant is important to the Chinese. I am curious to understand how they got clivia and why it assumes such significance.

The work I am presenting this afternoon in many ways is not mine. I initiated it but it is the work of a student from China called Yidong Ran, and my colleague Professor Brian Murray.

We know that the plant went from South Africa to England. We heard this morning about its development on the continent in Belgium and Germany. We are pretty sure that the plants that first came to Australia and New Zealand would have come from Britain. However I am curious to know how the material got to China, Japan and to Korea where, I understand from Kees Sahin, that Clivia is also held in high esteem.

How did clivia get to China? Did it go directly from South Africa? Did it go to Europe and then across to China? Although I urge my Chinese students to chase people in China who might know, the only thing we have found out so far is that the plant was introduced into north-east China, a pretty cold place, by a German priest about 100 years ago. We still do not know for sure but I think it is most likely that clivia went to China via Europe.

That is one question that interested me and I posed my students.
The other question was the relationship between the species right here in South Africa.

Chromosomes, when I studied biology, were represented as sausages floating around in a jelly. The science of cytogenetics and the whole area of genetic engineering and DNA have exploded in the last 25 years in exactly the same way as computer science and it is difficult to keep up with it even if you are involved in the field as I am as a breeder.

Chromosomes most of the time, do not occur like sausages in a jelly. The DNA is spread out in huge chains associated with proteins while genes are essentially specific areas along those chains. At a particular stage in the division of the cells and meiosis, they condense and by chemical treatment they can be condensed further. They are attached to the spindle by the centromere. You can stain different chromosomes so that they develop bands or stripes. It is rather like a football team, the different teams have different stripes. It is possible to stain the chromosomes of different species of clivia. What you do is to take photographs and recognise different chromosomes by their length and by where the centromere occurs. Then you cut them out and mount them in a nice straight line and see what's happening.

In clivia there are 22 chromosomes. This has been universally reported in literature. These 22 chromosomes are arranged in 11 pairs and are quite remarkably uniform. In essence what this banding shows is that the chromosomes of C. *miniata* and *C. gardenii* are quite closely related and they have bands at their centromeres. In contrast those of *C. caulescens* do not have any bands at their centromeres any more than does *C. nobilis.* So on that criterion, the chromosomes of *C. caulescens* which occurs up in the north is most similar to *C. nobilis* which occurs in the south. It is kind of perverse. At the same time *C. miniata* and *C. gardenii* which grow in much the same area have chromosomes that are similar.

The important thing is that the species appear to be quite recognisable at the chromosome level.

When you have a hybrid between *C. nobilis* and *C. miniata,* you can clearly see chromosomes from the two specific partners. Remember that we tend to classify the species by certain morphological characteristics.

If you think about it, the stripes of a chromosome have no greater or lesser importance. It is just another characteristic. So bear that in mind. You can look at different things on chromosomes as well as banding. One of the things we are interested in is NOR region which occurs on some choromsomes. This is quite important in the physiology of the cells. The NOR region can be recognised by a different staining techniques. What happens when you look at that characteristic is that the relationship between the species appears to change.

C.g*ardenii* has only one pair with NORs, C. *nobilis* in contrast has three, while *C. miniata* and *C. caulescens* have two each.

On that criterion, *C. miniata* and *C. caulescens* appear to be more closely related than the other two species. So the two pieces of information we have from the chromosomes appear to be in conflict.

We are bringing together a range of techniques which at the moment appear to be producing conflicting results and certainly one of the reasons why I am here is because I want to get a better understanding of how the plant has evolved here in South Africa. What was the ancestral climate, what are the other factors that caused them to be isolated and widely separated in different parts of the country? This is

where I need your help and I am really excited that you are going out and bringing material together and I think we can work together cooperatively. We need to talk to climatologists to discover what happened with the climate in the past.

There are so many questions; what are the pollinators, bird or insect? What is the difference in the anatomy of C. *caulescens* and C. *miniata?* Is *C.miniata* just a compressed *C. caulescens?*

While various pieces of information seem conflicting now, maybe it is only contradictory because we have a perception of what a species should be like.

The tendency of humans is to put things into boxes, and to make things linear.

But when you look at nature the only things that are straight are the things that we build.

It has been said that nature made a continuum and man tried to make the divisions.

I find it much more useful instead of thinking of a genus as being made up of species allocated to rigid pigeon holes, to think of a genus as a cloud which has a range of characteristics. Species will have many of these characteristics in common but may be distinguished by some differences. A cloud moving across the sky changes shape. Similarly a genus moving through time changes shape. With this paradigm it should not be surprising to find that characteristics do not occur in neat boxes but come together in somewhat confusing combinations.

It also explains why it is very important that if you are working with a plant you do not just take one accession of a species from one location. Unfortunately this is what has happened to many of our garden plants. Often they are founded on a very narrow genetic base. Almost invariably one plant has been collected and taken into cultivation and then all variations that we have got are derived from that one plant. It is important to have as many accessions within a species as is possible.

The work of the Clivia Club in going out and tracing the source of the various variations within the genus is very important.

CLIVIA IN AUSTRALIA

Kenneth R.Smith1 and Pen Henry2

Presented by

PEN HENRY

Abstract:

This paper deals with the past and present use of clivia in Australia. The writers have gleaned information from various sources to present a picture of the history of clivias in the landscape, as well as giving an insight to the present work being carried out by enthusiasts today. Documented cases of introductions to Australian horticulture are cited. Reference to current work is by journal article or personal correspondence. The future direction for clivias is given.

The paper will be presented at the conference by Pen Henry, principal of Clivia Garden Nursery, Western Australia, the first specialist Clivia nursery in Australia.

Introduction.

When asked to present an account of clivia cultivation in Australia, it is easy to recall the past ten years of seed and information exchange. So much has been learnt by corresponding with new friends worldwide and the growing of new material in our shadehouses around Australia. The Clivia Club has seen to that.

But I would like to take a look at the "development" of clivia in Australia from a much earlier perspective. We are certainly blessed in Australia when it comes to growing clivia. The plant is so accommodating in a shady garden that mass plantings have been extensively utilised, the reward being a bright flower display in spring.

The details of the early introductions and plantings are sketchy to say the least and are proving to be quite a puzzle to solve. One reference indicates clivia being grown during the period 1850 - 1900 with a diagram indicating a large flower form. Likewise, the catalogue of Arthur Yates & Co Ltd, 1923 lists, and I quote

> "Veitchs New Hybrids. A magnificent strain, and a great improvement on the old type. They are recognised as the finest strain of clivias in existence."

From early days it appears that we had some selections already being cultivated in our gardens.

Our "common" *C. miniata* is a narrow foliage plant that produces umbels of paler, apricot flowers. The petals are narrower than the improved forms and seed set is generally poor unless hand pollinated, although one garden I know of has a planting of a somewhat better "common" form with wider petals and a good display of fruits each season. Extensive plantings in Botanic Gardens, older estates and private gardens generally prove to be this form. It is easily propagated by division and whilst I know it is also grown by seed, the resultant plants are fairly true to the narrow flower form of pale apricot. Obviously, the result varies if other clivia selections are grown in the same garden bed. It is intriguing that this smaller "common" form abounds. Is it tougher? Does it grow faster?

The Seed/Plant Market.

Clivia miniata forms are certainly the main plants in our gardens. The documents just mentioned show that plant importation occurred. The material was sold through the nurseries to be planted into the gardens where they probably still exist today. For many years though, the clivia being sold in Australian nurseries has invariably been grown from imported seed. Seed companies offer many lines such as - Belgian Hybrids, Dutch Hybrids, French Hybrids, Californian Strain, Santa Barbara Strain, South African Hybrids, European Hybrids as well as just Hybrids! In the late 1980's, Jerd Seeds, based then in Victoria, released several new lines of improved clivia to the market. They were - Twins, Variegated, New Hybrids, Midget and Mammoth. Many thousands of seeds were sold and the resultant plants reached the gardening public. Depending on the nursery involved, plants end up being variously labelled C. *miniata* or *C. miniata* 'Grandiflora'. The mail order nurseries tend to sell the plants as the named strain or seed line. Twins seems to be the main line offered today.

The result of all this importation is a wealth of broader leaf forms showing brighter, deep orange colour in a bolder flower display. Garden plantings put on a good show and it is only when you take a closer look that you see the subtle changes in flower colour, markings and petal width. Also we could go into the fruit colour differences.

A constant supply of plants is required to meet the demand by the gardening public and landscapers. Sales are best when the flowering season is upon us, a potted clivia in flower commands a good price. As a result of the increased awareness of clivia in recent years, the yellow flowered forms of C. *miniata* are in greater demand.

Some People, Past and Present.

Forms sold as *C. miniata* 'Aurea' have been available via mail order for many years. Reference to a Victorian nurseryman, Mr F H Pollard of Caulfield, obtaining plants from the late Mr Dearing, was reported in Your Garden magazine of December 1980. One of the plants obtained was 'Ailsa Dearing', a reputed cross between *C. miniata* 'Aurea' and a common *C. miniata.* I wonder what other clivia plants Mr Dearing produced?

Jean Kent has been selling offsets of her "cream" clivia by mail order from Victoria for many years. Her stock was purchased from "an elderly gentleman" because she liked the flower colour. Maybe that gentleman was Mr Dearing? David Bearlin, of Burwood Nurseries is breeding yellow clivia for sale based on 'Aurea' stock. Several other people in Victoria and South Australia offer offsets from time to time. In a recent article in Gardening Australia, Don Barrett's clivia breeding is mentioned. Allan Clarke, from South Australia, tells me he has been growing a yellow purchased from "an old gentleman in Melbourne" about twenty years ago. Warren Glover wrote about breeding yellows in the early 1980's, in his article in Herbertia.

The clivia breeding endeavours of Kevin Walters, from Queensland, are outlined in a detailed article in The Australian Garden Journal, April/May 1987. Kevin has been growing and developing clivias for nearly thirty-five years and in that time has

produced some splendid, large flowered forms, including yellows. To my knowledge, he has named at least a dozen clones of merit. Work on clivia in Queensland is continuing at the nursery of Kev and Coral Larsen where yellow *C. miniata* figure in their breeding programme.

Members of the Clivia Club will be well aware of the breeding work of Bill Morris. Bill's early breeding goals were to produce improved flowers on plants that were hardy in the garden. This work was carried out in conjunction with his friend, Alan Bull. Plants obtained from a nurseryman in the 1950's formed the basis of this work. Then during the early 1960's, Bill received seed carrying the yellow gene from Les Hannibal in America. Six seedlings formed the start of a yellow breeding programme and through careful selection and improvement, Bill has achieved an excellent, yellow breeding strain of clivia today. He is still busy improving the forms in his collection.

Many others have gone before, or during this same period, and have worked in their own way towards improving clivia. Cliff Grove, from Western Australia, presented a paper on clivia to a Horticulture Conference held in September, 1988. It was based on his experiences with clivia. The collection that Cliff developed now forms the basis of Pen Henry's Clivia Garden Nursery, Australia's first nursery devoted to the genus *Clivia.*

When the work of earlier breeders is documented, information is passed along to those following. I am hopeful of learning more about the plants produced by Mr Sinclair of Waratah Nursery, New South Wales. Clones like 'Salmon Queen' and 'Giant No 3' are in my possession but as to their history, no details of any substance are available. The benefit of a forum like this conference is that someone reading this paper may know more about the history of some of our clivia breeders and will let us know.

Up until now our discussion has been focused on *C. miniata* and the yellow flowered form. It is interesting to note that a paper outlining breeding results of G. Keith Cowlishaw was published in the Herbertia Yearbook of 1935. Several genera were dealt with but the clivia breeding is one of the few documented accounts which allow us to fill in the puzzle. Two points are interesting regarding his development of the plant. Firstly, no yellows were used in his programme even though he states

> "Mr R.W.Finch has raised some very fair varieties, and some very good pale ones, one in particular, almost a white."

Several other breeders' names are included, as well as the statement that

> "a number of hybrid forms were imported from England."

Alas, no names of the forms are given. It makes the search very awkward and time consuming, but fascinating none the less.

The second point of interest regarding clivia is the mention of *C. nobilis* and C. *cyrthanthiflorum* (sic). The Cowlishaw plants growing in my collection today do not show any evidence of pendulous forms in their breeding. A critical reading of the

complete article suggests that perhaps improved forms were crossed with a plant of the "common" C. m*iniata* that was labelled *C. nobilis.* Further evidence that *C. nobilis* was incorrectly represented on the marketplace is shown in advertisements as late as 1974 in Your Garden. A picture of *C. miniata* is labelled *Clivia nobilis.* The 1996 Gardening Australia article makes the same mistake! How long did this situation exist? Bill Morris has written a more detailed critique of the Cowlishaw clivia breeding for a new issue of Herbertia.

C. nobilis, or at least the pendulous flowering form that we know in Australian horticulture, is found in old garden plantings. It is certainly not commonly offered in nurseries, except the few that specialise in bulbous plants by mail order. Flower colour varies somewhat but tends to be darker, orange-red. Plants are found that may have a pale shade inside the floral tube and darker outside. Perhaps the form we grow segregates to its parents? Who knows? The Western Australian form tends towards larger plants and flowers, with a lighter flower colour. Foliage has the blunt leaf tip shape and the rough leaf edges, but the green tipped flowers as described in the texts is not as pronounced. This is particularly so when comparing photographs of the true *C. nobilis* from overseas growers.

Plants labelled *Clivia x cyrtanthiflora* in the Sydney Botanic Gardens are larger growing clumps than *C. miniata* or our Australian *C. nobilis.* Like the other pendulous flowering type, this plant is found in older gardens and is not common in nurseries. It is often referred to as *C. nobilis.* The flowers flare at the mouth a bit more and the colour is a pale apricot.

C. gardenii is represented as large plantings in Sydney Botanic Gardens. Other Botanic Gardens would have similar plantings yet it is not common in nurseries or private gardens. It appears to be more widespread in Western Australia than on the East Coast. Only now are the specialist growers offering this species. As a flower display in the garden it is not as showy as the selections of *C. miniata* and perhaps that is why it is less widespread? Growth is vigorous due to the rhizomes, but seed set is not great in a garden situation unless hand pollinated. It is worth growing for the bright pink fruits.

The least known species of clivia would have to be *C. caulescens.* This would only be in the collections of a few enthusiasts. I have not come across any reference to it in gardens or nurseries. Hybrids including this species are now in Australia.

A Summary

There is a strong association with clivia as a garden plant in Australia. Their use may have gone in and out of fashion over the years. Clivia has certainly been used extensively in the landscape and the documented evidence found so far points to early introductions of improved forms, a situation that continues today. The "renewed" interest in the past ten years will only enhance the cultivation of many clivia types in Australia. The plants will grace our gardens and the search for answers to the early introductions will stimulate our minds.

The Future

For those who love clivia, the future is bright indeed. The dissemination of diverse genetic material of clivia species and selections to the members of the Clivia Club in Australia can only advance the standing of clivia as a desirable ornamental plant. Its role as an outstanding shaded garden plant is well known. Large flowers, small flowers, pendulous flowering types, flower colours of varied intensity and pattern, multiple petal forms and variegated foliage all add up to an exciting future. I know that Pen and I find it very exciting.

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CLIVIA MINIATA FORMS FROM THE TRANSKEI,
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CLIVIA MUTATIONS AND COLOUR VARIATIONS

by

WESSEL LOTTER

Abstract:

For many years clivia breeders were puzzled by the strange phenomenon of orange progeny, when Natal yellow was crossed with another yellow known to be true breeding. Not surprisingly Natal yellow was blamed for this odd breeding behaviour.

During 1996 a second clone related to Natal yellow was identified. Test breeding has proved that these "Natal yellows" are as true breeding as any other yellow strains. Unlike the true yellows which show no signs of anthocyanin (red pigment), the Natal yellow sometimes displays red spots or streaks on it's flowers and/or berries. As the latter can now be produced in significant numbers, a name had to be found to differentiate it from the true yellows. The name par-yellow was suggested as its breeding behaviour is on a par with that of the true yellows. Furthermore, it is just a matter of two different genes responsible for the production of anthocyanin, being non-functional which gave rise to true yellow and par-yellow. No doubt these F1 orange progeny from true yellow x par-yellow if selfed or crossed with true yellow will give rise to yellows of different genotypes. These yellows in turn were crossed with true yellows again with the result that yellow x yellow might produce certain percentages of orange progeny. It now appears that there is a third yellow produced by a plant with normal functioning anthocyanin but for some reason does not distribute it to its flowers.

Another phenotype which is closely related to the yellows is called a dilute or peach. Test breeding has proved that it is recessive to orange but dominant over true yellow. The orange colour of the flowers is the combined effect of the presence of anthocyanin (red pigment) in the epidermis and xanthophylls (yellow pigments) in the underlying tissues. The different shades from pastels to red are due to the ratio of cells containing leucoplasts, that are colourless, chromoplasts that contain yellow xanthophylls and the concentration of anthocyanin. Chromoplasts are not only present in the flowers, but also in the leaves where they fulfil a vital function together with the chlorophyll. The elusive white will therefore not appear as a sudden mutation of the yellow pigments, but may be achieved by selecting and breeding from the palest yellows.

The colour of the berries is effected in much the same way as the flowers. The only difference is that in some berries the pulp remains green when ripe. These berries when containing anthocyanin in the epidermis will appear purple.

1. DEFINITIONS AND TERMINOLOGY

Flavonoids

Pigments dissolved in the cell sap, such as anthocyanidins, which are red or blue, betaxanthins, which are yellow and anthoxanthins which are yellow or cream. Unrelated compounds are betacyanins of which betanidin found in beet is an example.

Carotenoids

Pigments in plastids within the plant cell, namely carotenes, which are orange and xanthophylls, which are yellow.

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True yellow

For the purpose of this article, true yellow shall be a clivia which displays a complete lack of anthocyanin in its flowers, berries and seedlings.

Par-yellow

This plant is still able to produce very little anthocyanin, which sometimes shows up as spots or streaks on the flowers and/or berries. The seedlings however are unpigmented. It has only recently been identified as a second mutation. The term "par" is not my creation but an already established term in some bird mutations, e.g. blue and par-blue, which are not equal in colour but equal in its inheritance (recessive over the normal green colour). Further in birds where the colour is equal and the inheritance differs, the mode of inheritance is used to differentiate between the two, e.g. sex-linked yellow and recessive yellow. The par-yellow clivias are definitely not freaks or rogues but merely a mutation of another gene in the anthocyanin pathway (Figure 1). Natal Yellow A and B are examples.

True breeding

A phenotype can only be true breeding if it is homozygous. This means that a true yellow of the genotype aaJJ or a par-yellow of the genotype AAjj will be true breeding if selfed or crossed with its own genotype. A true yellow of the genotype aaJj is heterozygous (carrying factor for par-yellow), and if selfed will produce three different genotypes. Genetically it will not be regarded as true breeding even if its phenotype remains unaltered. The three different genotypes are aaJJ, aaJj and aajj. The latter can be crossed with true yellow or par-yellow producing 100% yellow progeny, true yellow or par-yellow, as the case may be of the genotypes aaJj and Aajj respectively. If these two genotypes are crossed 25% orange will be produced as will be demonstrated in the concluding section of this article. The term true

2. COMBINED MUTATIONS

At the meeting on 14 February 1998, I demonstrated three different methods to indicate how I arrived at my prediction as set out in item 10 of my article (Newsletter vol. 7, Jan. 1998, p. 13)). I was asked to do an article on this for the newsletter, but I was reluctant to do so, as I had no literature to substantiate my views. I was fortunate enough to receive an article by R.J. Griesbach of the United States Department of Agricultural Research Service, Beltsville, Maryland, 20705, under the heading "Genetics and Biochemistry of Anthocyanin Albinism in *Paphiopedilums"* and I quote: *"Most plants are diploid and have two copies of every gene. For discussion purposes, Paph. faireanum fma. Alba's genotype could be designated AABBCCDDEEFFGGHHjj.*

The two copies of the "j" anthocyanin gene are non-functional and anthocyanin is not produced. On the other hand one could designate Paph. bellatum fma. Alba's geneotype as aaBBCCDDEEFFGGHHIIJJ. In this case, the two copies of the "a" anthocyanin gene are non-functional. The hybrid Paph. x Iona, would have one gene from each parent and would be designated AaBBCCDDEEFFGGHHIIJj. In Iona, there would be at least one functional copy of each anthocyanin gene, which would result in red flowers. Two copies of each gene are not needed for anthocyanin production. When Paph. x Iona is selfed, one would find that 7/16 or 44% of the progeny are alba (Table I).

Table I Genetics of diploid Paph. x lona (AaJj) = Paph. faireanum alba (AAjj) x bellatum alba (aaJJ).

Parents Fl	AaJj	x	AaJj
Sex cells	25% AJ		25% AJ
	25% Aj		25% Aj
	25% aJ		25% aJ
	25% aj		25% aj

Progeny F2:	AJ	Aj	aJ	aj
AJ	AAJJ	AAJj	AaJJ	AaJj
Aj	AAJj	AAjj	AaJj	Aajj
aJ	AaJJ	AaJj	aaJJ	aaJj
aj	AaJj	Aajj	aaJj	aajj

Alba genotypes = AAjj, Aajj, aaJJ, aaJj, aajj.

Figure 1 Anthocyanin biosynthetic pathway showing the action of ten genes (G. Stotz, et al, 1985. Theor. Appl Genet. 70:300)

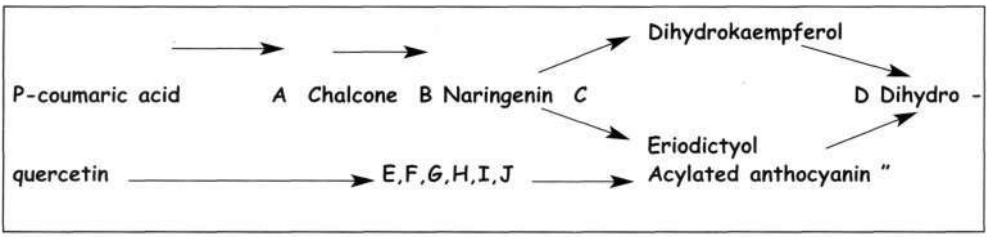

Table 1 by Griesbach as set out above was one of the methods demonstrated by me at the meeting on 14 February 1998, the only difference being the symbols I used. Apart from the 7/16 or 44% (to the nearest) albino progeny, Griesbach did not give a full analysis of all the genotypes and their percentages. For convenience I shall use his symbols for our yellow clivias, i.e.

P-generation: aaJJ for true yellow x AAjj for par-yellow

F1-generation: AaJj F1-orange

These Fl-orange parents will give rise to the following genotypes in the F2-generation:

F2-generation:

1.	AAJJ	1/16	6.25%	Orange
2.	AAJj	2/16	12.5%	Orange split par-yellow
3.	AaJJ	2/16	12.5%	Orange split true yellows
4.	AaJj	4/16	25%	Orange split true and par-yellow
5.	AAjj	1/16	6.25%	Par-yellow
6.	Aajj	2/16	12.5%	Par-yellow split true yellow
7.	aaJJ	1/16	6.25%	True yellow
8.	aaJj	2/16	12.5%	True yellow split par-yellow
9.	aajj	1/16	6.25%	True yellow and par-yellow combined

Genotypes 1-4 are orange and represent a total of 56.25%
Genotypes 5-9 are yellow and represent a total of 43.75% in total

Phenotypic ratio of 9:7

Please note that 12.5% as stated in item 10(d) of my article in the January 1998 issue of the newsletter is a typing error and should read 25%.

The genotype in item 9 above is true yellow as well as par-yellow, but its phenotype is true yellow only. The reason for this is that the anthocyanin pathway is totally blocked by the genes responsible for true yellow and thus the phenotypic expression of the genes responsible for par-yellow is suppressed. This is called epistasis or masking. There are several forms of epistasis. They have one thing in common and that is that they change the normal expected phenotypic ratio of breeding results considerably. The British geneticist Bateson discovered this particular form involving the inter-action of two different recessive gene pairs early in the 20th century. He crossed two true breeding sweet peas with white flowers. To his surprise this resulted in purple flowers only. This Fl-generation was allowed to self and out of a total of 651 F2-plants, 382 produced purple flowers and 269 white flowers, a ratio of 9:7. The following table was used to demonstrate the interaction of the genes and the 9:7 ratio.

P-generation aaBB (White) x AAbb (White)

Or alternatively AABB (Purple) x aabb (White)

Gametes : (sex **cells)** aB and Ab

Fl-generation: AaBb (Purple)

F2-generation AaBb x AaBb

Gametes	AB	Ab	AB	ab
AB	AABB	AABb	AaBB	AaBb
Ab	AABb	AAbb	AaBb	Aabb
aB	AaBB	AaBb	aaBB	aaBb
ab	AaBb	Aabb	aaBb	aabb

Genotypes shaded are purple

F2-generation : Phenotypic ratio of 9 purple and 7 white.

This deviates from the normal expected phenotypic ratio of 3:1 in the F2-generation when a single recessive gene pair is involved.

Example (as for Clivias)

AA (orange) x aa (yellow) =100% AaF1 -orange

Aa x Aa =25% AA (orange), 50% Aa (orange) and 25% aa (yellow)

F2-generation = 75% orange and 25% yellow, a ratio of 3:1

3. ABERRANT YELLOW FORMS

A clivia is variable in many respects and colour is no exception. For example it may be able to produce anthocyanin in the normal way, but the intensity of the colour as well as the extension thereof, wherever it may occur in the plant, may vary considerably. In Mirian Meltzer's vast collection of some 50,000 orange clivias, mostly grown from seed, there are two or three with orange flowers and yellow berries. It is not surprising that in this vast collection three yellows arose, but with a difference. The one has orange midribs on the outside of its petals, the other one is the picotee as illustrated in the Clivia Review 1998. The third one is a clear yellow with orange berries. Further more Nick Primich produced a yellow from a normal orange plant. He selfed this yellow and I know he does this meticulously, but the seedlings were all pigmented. Hopefully we will now be able to see whether some of these pigmented seedlings will produce yellow flowers. Mirian Meltzer's seedlings from her yellow are also all pigmented. I myself used the pollen of the picotee on a yellow with faint red tips to its petals, but the progeny are all pigmented. I am now more than ever before convinced that a plant with normal functioning anthocyanin can produce yellow flowers in as much as an orange flowering plant can produce yellow berries.

4. DILUTE

This is another phenotype, which is closely related to our yellow mutations. In a dilute the intensity of the pigmentation is so diluted that very pale flowers result. Chubb's peach is a good example of this. By analysing the breeding behaviour of a plant, its genotype can be deduced. The following breeding results were obtained from Chubb's peach:

(a) Natal Yellow B x Chubb's peach = 100% orange flowering plants

(b) True Yellow x Chubb's peach = 100% unpigmented seedlings

This implies that the defect, which is responsible for Chubb's peach, acts on the same gene as that which is responsible for true yellow. Experience with other genera of plants has proved that a normal plant is dominant over both dilute and albino, but that dilute in turn is dominant over albino. As Chubb's peach originated in an orange flowering population where no yellows occur, the genotype **A'A'** could be designated to it. **A'A** would be orange flowering as orange is dominant over dilute.

The genotype of the progeny in (a) above would therefore be **A'AJj (Orange).** The genotype of the progeny in (b) would be **A'a**, and therefore all dilutes, as **A' (dilute)** is dominant over **a (true yellow).** If the dilute of the genotype A'a, is crossed with a true yellow (**aa**), 50% dilute and 50% true yellow would be produced.

Example

	a	a
A'	A'a	A'a
a	aa	aa

50% dilute and 50% yellow

The origin of Naude's peach is unknown and so is its genotype. Preliminary experiments indicate that it could be of the same genotype as Chubb's peach, but further research is necessary to confirm this. Few of the ten genes in the anthocyanin pathway give rise to viable mutants for reasons as set out in the next section dealing with white. We already have two of the ten genes responsible for clivia mutations, i.e. one for true yellow and Chubb's peach and one for par-yellow. The possibility of a third gene being involved is therefore unlikely. The allelic relationship (being different forms of the same gene) of Naude's peach with par-yellow has been ruled out. The following breeding results confirm this and suggest a relationship between true yellow and Chubb's peach:

(a) Natal yellow x Naude's peach : 100% pigmented seedling

(b) Natal yellow x Chubb's peach (F1-orange) x Naude's peach : 5 seedlings - 3 pigmented and 2 unpigmented.

(c) True yellow x Natal yellow B (F1-orange) x Naude's peach : 18 seedlings - 12 pigmented and 6 unpigmented. This deviation from the expected 50% may be due to the fact that one third of the flowers of the seed plant were already open when pollination with Naude's peach commenced.

Meg Hart unintentionally and without knowing which the parents were, bred three dilutes. Either she must have an orange flowering plant of the genotype **A'A**, which selfed or a peach which is so diluted that it appears yellow.

Dilute should not be confused with pastels, which are very pale orange forms. Pastels can be crossed with any colour within the orange spectrum producing a variety of shades. It is not yet known whether Mayer's Peach is a dilute or a very pale pastel. If pollen can be made available,the necessary experiments will be done to determine its genotype.

5. THE MYTHICAL WHITE

Griesbach defines an albino as follows : "An albino will by definition display a lack of anthocyanin pigmentation, but will contain chlorophyll and carotenoid pigments." Our yellow clivias are therefore already albinos. The yellow colour of the flowers is mainly due to carotenoids, which are also present in the leaves. Without this the plant cannot survive. It not only protects the chlorophyll, but is also involved in the absorption of certain rays of the sun. Furthermore, the vast majority of albinotic mutations are blocked at the same step in the anthocyanin pathway. The reason for this is that the ten genes in the anthocyanin pathway are also involved in other flavanoid pathways, which are essential for growth and protection from the harmful effects of ultra-violet irradiation. Admittedly yellow pigments are not essential in the flower and it may be possible to produce a white by selective breeding.

The clivia with the white and green centre as depicted on page 6 of the Clivia Review 1998, preferably as a mother plant, would be an excellent choice. By crossing this plant with yellow you may get whites or nearly so, with green in the centre in the F2-generation. If I had a choice for a yellow as pollen plant, it would be one which already has green in the centre, like that on page 8 of the Clivia Review 1998. The reason why this breeding should not be done the other way round (yellow as mother plant) is because yellow is said to be maternal and may be a dominating factor if you have white in mind.

6. COLOUR

Colour in the clivia is the combined effect of the presence of anthocyanin in the epidermis and carotenoids in the mesophyll (underlying tissue). Removing the epidermis of an orange flower can prove this. The epidermis will be red and the exposed mesophyll will be yellow. If this red epidermis is placed on any yellow surface, the colour will change to orange. The different shades from pastel to red are the result of the ratio of leucoplasts (transparent cells), chromoplasts (cells containing carotenoids) and the concentration of anthocyanin.

Example

(a) A flower with few chromoplasts and a high concentration of anthocyanin will be red.

(b) A flower with few chromoplasts and a low concentration of anthocyanin will be pink.

(c) A flower with leucoplasts only and no anthocyanin will be white.

(d) A flower with chromoplasts in abundance and a low concentration of anthocyanin is salmon.

(e) The epidermis of a yellow clivia flower contains no anthocyanin and is transparent. The yellow colour is displayed by carotenoids in the mesophyll underneath.
The colour of the berries is influenced by an additional factor, namely chlorophyll which is retained in the mesocarp (pulp) of some plants.

Example

(a) Orange-red berries have yellow pulp and a high concentration of anthocyanin in the epidermis.

(b) Yellow berries have yellow pulp and a transparent epidermis.

(c) Pale green berries have green pulp and a transparent epidermis.

(d) Purple berries have green pulp and a red epidermis. If the epidermis of this berry is removed and thoroughly washed it will be red. Place it on a green surface, press it well down and it will appear purple again.

7. CONCLUSION

This study has proved that there is not a pair of genes for red and a pair of genes for yellow as previously accepted. Yellow is due to a gene, which is responsible for one of the enzymes necessary for the production of anthocyanin, being non-functional. In the case of a dilute the gene is defective. Furthermore the theory of the hidden red gene can now also be explained. We may already have yellows of five different genotypes, namely **aaJJ, aaJj, aajj, AAjj and Aajj.**

Not all of these would produce 100% yellow progeny. We already know that true yellow (aaJJ) x par-yellow (AAjj) produce 100% orange, but aaJJ x Aajj would produce 50% orange and 50% yellow, whereas Aajj x aaJj would produce 25% Orange and 75% yellow progeny.

Example 1

P-generation		aaJJ	x	Aajj
Gametes	aJ	aJ	Aj	aj

Progeny:

	Aj	aj
aJ	AaJj	aaJj
aJ	AaJj	aaJj

50% orange and 50% yellow

Example 2

P-generation		Aajj	x	aaJj
Gametes	Aj	aj	aJ	aj

Progeny:

	aJ	aj
Aj	AaJj	Aajj
aj	aaJj	aajj

Yellow genotypes Aajj, aaJj and aajj = 75%. Orange genotype AaJj = 25%

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Front cover: *Clivia nobilis* (emblem of the Cape Province branch)
Back cover: *Clivia miniaia* 'Apple Blossom"

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CLIVIA

YEARBOOK

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Clivia Yearbook 2

Nakamura hybrid 1

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Writing in about 1990 on his breeding of *Clivia miniata x kewensis* ' Vico Yellow' Sir Peter Smithers remarked :

> *"Clivia* have suffered from being distributed commercially in a very indifferent form and also because of one of their great merits. They are amongst the most long-suffering pot plants which, like the *Aspidistra*, will put up with almost anything except over-attention. Just so! They are bracketed with the *Aspidistra* as inhabitants of lodging-house parlours".

Fortunately, however, in Australia and California and particularly in Japan and more recently in China over the past 50 years *Clivia* enthusiasts have been developing the potential of the other outstanding attributes of this most versatile plant.

This, the second Clivia Year Book, covers the astonishing results which are being achieved in Australia and Japan and more recently in South Africa in improving the form and colour of the *Clivia miniata* flower and umbel, not only in the better known orange form but also in the yellow form which is the product of a recessive gene. Pure breeding yellows have been developed and with them pastel colour forms, including pinks, but the pure white remains elusive. The four species of *Clivia* have also been hybridised to produce different flower forms and colours and to extend the flowering period, but this is still in its infancy. However, Sir Peter has also pointed out that:

"The modern improved clivias are spectacular plants when in flower, but it must be admitted that when out of flower they are inconspicuous to the point of boredom".

Yoshikazu Nakamura of the Clivia Breeding Foundation, Chiba Prefecture, Japan, a good friend of Sir Peter and an honorary member and benefactor of the Clivia Club, has made available to us publications on *Clivia* in Japan and China, revealing the extraordinary extent to which the potential of improving the "inconspicuous" leaf form of the *Clivia miniata* has been recognised in forms

McNeil interspecific hybrid

Nakamura hybrid

which are shorter, broader, thicker and more symmetrical, with enhanced vein patterns and variegated colour. Attention has also been drawn to the ornamental value of the development of the seed pods and of their change in colour as they ripen.

Thus in Japan and China in particular, *Clivia* has been rescued from its "condition of neglect" and "divorced at last from the *Aspidistra"* to become treasured for its ornamental value throughout the year with its "four season leaf, three season fruit and one season flower".

One publication by the China Clivia Association has been reviewed in this Yearbook and we look forward to publication in English also of other outstanding books being published in China on *Clivia.*

The publication of the first 1998 Clivia Year Book was facilitated by the papers read at the International Conference on Clivia held at Kirstenbosch National Botanical Garden in Cape Town 1998, but it also featured the improvement of the flower in Japan and more recently in South Africa, and the development of the variegated leaf in Japan. For this the second Clivia Year Book, we have had to rely on the willingness of *Clivia* enthusiasts to prepare articles suitable for publication. These have included in particular improvement of the *Clivia* flower in Australia and in England. It includes also an important overview of the distribution of *Clivia* in its natural habitat, where mutations of flower colour and form have been discovered which challenge man's own achievements in that regard. We are most grateful for their assistance and trust that this publication will inspire others also to produce articles for publication in the next Clivia Yearbook, especially those in California, whose rumoured outstanding achievements remain unpublished!

Cape Town, July 2000

Clivia miniata 'Spider'

The Natural Distribution and Ecology of Clivia

by John Winter

John Winter is the Deputy Director of Gardens and Horticultural Services of the National Botanical Institute in South Africa, and the Chairman of the Clivia Club

The genus *Clivia* is indigenous to South Africa, but has been grown extensively for more than 150 years in Australia, United States of America, Japan, China, the United Kingdom and Europe, where the commercial production of *Clivia* as a pot plant has been well developed.

There are four *Clivia* species of which *C miniata is* the most well known and spectacular. The other three species, *C. nobilis, C gardenii* and *C. caulescens,* all produce pendulous flowers and do not flower at the same time as *C miniata,* which flowers in spring.

Where do all these magnificent plants come from? Although *Clivia* have been improved through selection and breeding, all plants originate from the natural habitat. Unfortunately very few records exist which show the original location of these plants. A good example of this is *Clivia miniata* var. *citrina,* of which Kirstenbosch National Botanical Garden has approximately nine clones. These all originate from other growers of *Clivia,* none of whom can provide exact details of from where their plants originate.

They occur in Southern Africa from the Eastern Cape in the south, stretching up through the Transkei and Kwazulu-Natal into Swaziland, Mpumalanga and the Northern Province. Verbal reports have been made of *Clivia* occurring in Kenya and Uganda, but no herbarium records exist to confirm this.

However, not sufficient is known about the natural distribution of *Clivia* in South Africa, their taxonomy and ecology They are poorly represented in herbarium records and living plant collections of *Clivia* in the botanic gardens of the National Botanical Institute are most inadequate.

As a result in1996 I launched a project to establish a living collection of *Clivia* representative of the species and forms which occur in nature to be used for display, selection and breeding and to improve the living collections in the botanic gardens as well as the herbarium records. No taxonomic revision has ever been done of the genus *Clivia* and any species that has been described has been done on an *ad hoc* basis. Once sufficient field work has been undertaken a taxonomic revision of the genus may well follow.

Ecology

All *Clivia* are essentially shade loving. The wide variety of the conditions in which they thrive is remarkable. During the last

four years I have observed *Clivia* occurring on secondary coastal dunes (*C. nobilis),* in coastal forests (G *miniata, C nobilis),* on river banks and in swamps *(C gardenii),* rock screes, leaf litter and on tree trunks (C *miniata, C caulescens).* *Clivia* occur in isolated pockets which are difficult to locate. The populations that have survived are extremely old and in most instances very little seed is produced. Having the ability to multiply vegetatively ensures their survival in situations where pollination is poor.

Their roots are thick and succulent, obviously functioning as a storage organ, and they spread out on, or just below, the surface, anchoring the plant and making it secure. These growing conditions indicate that *Clivia* require little water and in cultivation they require a very sharply drained growing medium and cool conditions.

In nature *Clivia* occur in varying degrees of shade. Heavy shade limits flowering of all four species and the leaves tend to lengthen excessively. For example, *C nobilis* in heavy shade, produces leaves a metre in length, while the same species growing on coastal sand dunes in light shade produces a very stunted plant with leaves of approximately 300 mm in length, all with the characteristic notched tip and serrated edges. Populations exposed to sufficient light with a high canopy produce a delightful display of colour and the leaves maintain a dark green appearance. In cases where there has been a deterioration of the tree canopy, the foliage yellows due to over exposure and the plants become very stressed. Very few flowers are produced and growth is stunted.

Forest environments are cool and moist. However *C miniata* also occurs at sea level in the Eastern Cape, in Kwazulu-Natal which is sub-tropical, and in the northern Drakensberg where they also grow even at an altitude of 1500m. The latter populations are subject to mist, snow and extreme cold at times, which I could not endure for more than 10 minutes! In the mountainous regions of Mpumalanga *C caulescens* is common, despite being subjected to snow occasionally.

C. miniata pastel form growing in the habitat

Distribution

C. miniata

Known populations of *C. miniata* occur in isolated pockets from west of the Kei river, eastwards through the Transkei.

C. miniata, red form, growing in the habitat

Some of these populations are large, while others are mere remnants of clivia populations which have been decimated by man for medicinal purposes, and as a result of the removal of tree cover for fuel or agricultural purposes. Distribution continues north east through Kwazulu-Natal into Swaziland and Mpumalanga on the Sondeza range of mountains (northern boundary of Swaziland), growing on dolerite and sandstone geological formations.

While the predominant flower colour is orange and is uniform in most populations, in some populations the flower colour is almost red and in others there are pastel colour variants within the population, including yellow and pink.

In some populations the floret size is substantially bigger than usual with wider petals and in others, narrower petal forms are seen.

Leaf forms also vary from population to population, some populations having considerably longer leaves than others in the same light conditions, and others having narrower or broader leaves.

The size of the seed in the most western populations is also considerably larger than the usual size.

C. nobilis

Clivia nobilis occurs mainly on the coast from Alexandria Forest northwards to the Nqabara River. Occasional populations occur inland as far as Grahamstown. I have seen *C. nobilis* growing and flowering in populations of *C. miniata* but have not come across any hybrids, possibly because they have different pollinators. Coastal populations occur on

C. nobilis

dune sand while forest and inland populations are found on river banks, on shale and on rocky outcrops. Both on the coast and in inland populations they have been found growing both in low bush cover and with a high forest canopy which, as stated above, affects the leaf length. While the flower tips are always green there is a wide variety of the flower colour from deep red, pastel pinks and oranges to yellow.

C. gardenii growing in the habitat

C. garden ii

The most southerly record of this species is at Port St Johns with scattered populations occurring northwards as far as the northern boundary of Kwazulu-Natal. Some of the populations I have observed grow in wet seepage areas and swamps and on flooded riverbanks, while others are relatively dry. It is felt that the swamp variety may be a different species and this is being investigated. *C. gardenii* seems to have the ability to adapt to wet or dry conditions. I have noted *C. miniata* and *C. gardenii* growing in close proximity to one another but because the flowering times are September and June respectively, there is little likelihood of natural hybrids being produced. A wide variety of umbels was also noted with florets ranging from about 15 to about 35 per umbel. The basic colour range does not vary to the same extent as *C. nobilis* but there are pastel forms (also with yellow predominant).

C. caulescens

This species is apparently fairly common in the Mpumalanga and Northern Provinces. However, to date I have only had the opportunity of visiting a couple of populations, namely the Sodenza range of mountains on the northern border of Swaziland where it grows amongst *C. miniata* at an altitude of 1500m and at Elandshoogte where the mountains were covered in snow at an altitude of over 1770m.

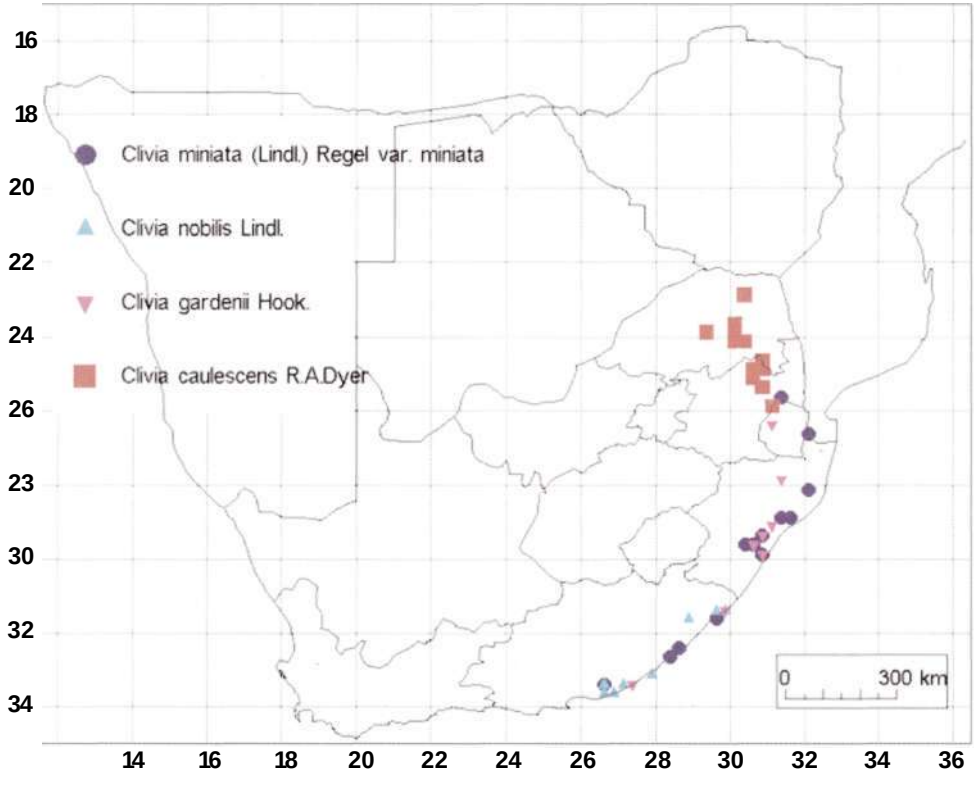
C. caulescens growing in the habitat

According to reports, populations occur at Sabie, Mount Sheba, God's Window and as far north as the Soutpansberg. The populations which I visited were all growing in association with sandstone.

Thus *C. miniata* is the most widely distributed species with growing conditions varying from coastal to subtropical and populations growing at 1500m in the northern extreme of their range. The pendulous species of *C. caulescens, C. gardenii* and *C. nobilis* are all found growing with *C. miniata* in the various areas where they occur. However, *C. miniata* has obviously had a greater attraction to the specific birds which have through the years been responsible for distributing this very attractive species.

The fact that *Clivia* occur in isolated communities which are not easily accessible makes it likely that new distribution records will be established in the future.

The following map of the distribution of clivia represents the existing records of the National Botanical Institute. I question the accuracy of some of the localities indicated of *C. miniata*, *C. gardenii* and *C. nobilis* in the southern section of the map. These need to be confirmed.



The Great Yellow Clivia Jigsaw Puzzle

by Brian Tarr

Brian Tarr is the curator of the Natal National Botanical Garden

C. miniata 'Golden Glow'

The yellow *Clivia* has, since its introduction into horticulture in the 1880's been a sought after addition to the plant collectors garden.

Over the years plants have been given, sold and acquired by people all over the world. As a result, the Yellow *Clivia* picture has become a bit of a jigsaw puzzle, the pieces being various clones and peoples names! (Who got what from whom with a bit of misinformation thrown in to complicate the picture). From literature it appears that to begin with two yellow clones were known to have originated in Zululand and one in the Natal Midlands. One of the Zululand plants was named *Clivia miniata van citrina.* This clone is, by all accounts, a recessive yellow while the other, which has become known as 'Noyce's Yellow' is a true breeding yellow *Clivia.* The third clone is known as''Mare's Yellow' and seems to be recessive when selfed.

C. miniata 'Natal Yellow'. Note the pronounced green colour on opening flowers

The story of *Clivia miniata var. citrina* is well known, how the plant was discovered in the Entumeni Forest in Eshowe and grown by Sir Melmoth Osborne. Plants were given to Sir Charles Saunders who in turn sent a

flower and bulb to his mother, Mrs J.H. Saunders, who did a water colour painting which was sent, with a plant, to Kew. This plant was described and published as *Clivia miniata var. citrina*. Sir Charles Saunder's daughter, Mrs M.M.K. Robinson, inherited his plants and grew them in Pietermaritzburg until at least the mid 1960's. Information about anyone who has plants from Mrs Robinson would help add some more pieces to the jigsaw.

Plants from Sir Melmoth's plant were grown by Mrs Essie Osborne, whose husband was a nephew of Sir Melmoth. A plant was given to Mrs J de Villiers of Manderston outside Pietermaritzburg. When she self pollinated this plant, the results were orange plants.
Mrs Robinson's plants gave the same results. The fate of Mrs de Villier's plants, kept in a clump of bamboo's behind her house, is unknown. It is also recorded that she received a plant from Mr Vernon Crookes which was different to hers, and gave a plant to the Natal Botanical Garden in 1986. It flowered in 1990 and was selfed. The resulting plants were all yellow flowered. The history of these plants is unknown and information would be welcome.

The second Zululand clone was bought by Michael Noyce from Mr & Mrs Faircliff of Hilton in 1980. Mrs Faircliff said that they had bought the plants from the wife of an Eshowe doctor (name unknown) who had received the plants from a grateful patient. When the doctor's wife moved into an old age home, she advertised her plants in the Farmer's Weekly as 'Rare plants for sale'! Mr & Mrs Faircliff bought the last clump in a half drum in 1955. This magnificent robust plant, with well proportioned flowers on a tight umbel has the added characteristic of breeding true yellow when selfed thus distinguishing it from the described clone.

This trio of yellows is completed by the well documented 'Mare's Yellow' which was grown and sold by Miss Grace Mare from her home, 'Silver Oak' in Mare Street, Howick. The original plant was collected at the foot of the Howick waterfall in 1891. When Miss Mare left Howick, she gave her plants to Mrs A.D. Tanner who grew them at her house in Blackridge, Pietermaritzburg. She describes this plant as having dark green narrow leaves and the flowers a clear, deep, butter yellow with no trace of orange (or green)! She tried self pollinating these plants but the resulting plants were all orange with more yellow in the throat than her orange plants. Plants of this clone are found in many gardens in Howick and the Karkloof. At present they are being sold by Mr Gavin Westbrook.

To complete this section of our great Yellow Clivia puzzle, it is necessary to introduce the hybrid known as 'Watkins Yellow'. It was developed by Mr Hal Watkins of Hilton, a keen plantsman and trained horticulturist. He had in his collection of plants, clones of

both the 'Mare's Yellow' and what is now known as 'Noyce's Yellow' (possibly bought from the Eshowe doctor's wife?). Just before he died earlier this year, he told me that the yellows which he sold from his nursery, 'Leprechaun Leap', were the result of crossing these two clones. 'Watkin's Yellow' is a robust free flowering plant which has a compact head of well formed flowers carried well above the leaves. When selfed it produces yellow flowered plants. The plant *C. miniata* 'Golden Glow', which has twice been awarded best on show at the KwaZulu Natal Clivia Show, is the result of selfing 'Watkin's Yellow'.

In view of the fact that both these clones have been available for a century, it is probable that this cross has been made in the past both here in South Africa as well as overseas. It will be interesting to see whether gene 'finger printing' will show this to be the case.

In the collection at the Natal Botanical Garden, we have two plants which as yet do not fit neatly into the puzzle as a result of insufficient information about their origins. The first is the popular plant 'Natal Yellow', said to have been collected somewhere in the KwaZulu Natal midlands. With Cynthia Giddy's untimely death, the true origin of this plant will probably never be known.

The second plant was given to me by Mrs B. Smith who lived in the Transkei. This plant is also without a locality apart from the comment that it was collected in the Transkei. It is an attractive compact plant bearing an umbel of well shaped campanulate flowers of a medium to light yellow. When selfed, the seedlings are orange. If any old residents of the Transkei have any information about this plant and its origins, I would welcome a call.

In recent years, further clones of yellow *Clivia* have been discovered in Zululand and the Transkei, and in one unfortunate case the area was completely stripped of plants by persons unknown, thus destroying a very valuable genetic resource.

These, however, are pieces which belong to another section of the Great Yellow *Clivia* Puzzle, which will be dealt with in the future, when more information is available.

'Noyce's Sunburst' a cultivar of 'Noyce's Yellow'

Clivia miniata x kewensis 'Vico Yellow'.

This plant finds a place here not because it is of my own raising, but because of the curious and instructive story of its origin. This, in addition to its undoubted beauty

Clivia have suffered from being distributed commercially in a very indifferent form and also because of one of their great merits. They are amongst the most long-suffering of pot plants which, like the *Aspidistra*, will put up with almost anything except over-attention. Just so! They are bracketed with the *Aspidistra* as inhabitants of lodging-house parlours.

I did not feel any of these inhibitions with a very handsome plant. From Mr Russell at Castle Howard I obtained three forms of *C. miniata* under the name of *'Kewensis'*. One was yellow, though called *'Cream'*. All had been bred by Charles Raffill at Kew, selecting back to recover a lost South African yellow.

'Vico Yellow ' Breeder Sir Peter Smithers.
Top flower – original clone. Bottom flower – tissue culture plant

In one of my few idle moments in the early days of planting this garden I crossed the orange and yellow clones. After the necessary five or six years there were flowers: no yellows, though some worthy orange plants. However, I had had too many seedlings to be able to keep them all and had discarded a number under the greenhouse stage. Then '*Kewensis* Cream' died, mysteriously, just as the South African

yellow had done at Kew many years before.

It was some years later that to my astonishment a yellow Clivia bloomed under the stage. It seemed to me good, perhaps an improvement on 'Kewensis Cream'. I rescued it, potted it, and in due course sent an offset to my friend Dr Shuichi Hirao in Japan. I thought no more about it. After a couple of years Shu sent me *Japan Horticulture* No. 89 for 1985. My yellow *Clivia* was the cover picture and there was an article about it inside. Inexcusably, for the Japanese are consummate plantsmen, I did not take this event too seriously. Then 'Shu' Hirao died, sadly and prematurely.

It was a couple of years after his death that I had a letter from Yoshikazu Nakamura, at Clivia Breeding Plantation, Mobara, Japan, to say that Shu's widow had sent the yellow *Clivia* to him. He would like permission to breed from 'Smithers Yellow', 'world's best yellow Clivia, the one to beat'. I was astonished! Of course he was perfectly free to make any use of the plant which he liked, but might it be called 'Vico Yellow'? Perhaps it was too late: 'Smithers Yellow' was already in the trade in Japan.

Subsequently another yellow flowered amongst my seedlings. It was very similar to the first but in my opinion slightly superior in form. Only time would tell. It was of course a separate clone. No 'Smithers Gold' this time: it is named *Clivia x kewensis* 'Vico Gold'.

The latest development in this story of entirely unmerited success, is that the C. *miniata x kewensis* ' Vico Yellow' is now to be registered in Japan and will be micro-propagated by Miyoshi & Co. of Yamanashi, for mass distribution.

Clivia miniata var. citrina seedhead

Nakamura hybrid

The Eastern Cape – of its People and Plants

by Charl Malan

Introduction

The Eastern Cape province of South Africa has a rich mosaic of people and plants. This is where *Clivia* was first discovered by early explorers, and also where Ms Gladys Blackbeard started and grew her *Clivia* collection. This article aims to give the reader some information on *Clivia nobilis* in its natural habitat, and a window into the world of Gladys Blackbeard.

***Clivia nobilis* in the Eastern Cape**

At the dawn of the new millenium the Eastern Cape still has vast areas of natural, undisturbed vegetation which is protected by a large number of formal and informal nature reserves.

The vegetation of the Eastern Cape is complex and is transitional between the Cape and sub-tropical floras, and many taxa of diverse phytogeographical affinities reach the limits of their distribution in this region. All the major biomes of South Africa can be found within a 150 km radius of Grahamstown, with the exception of the desert. These biomes include :

Cape Fynbos - a shrubby complex of Cape species found on nutrient poor soils. Cape Fynbos includes Dune, Mountain and Grassy Fynbos.

Karoo - composed of succulents, some grasses and many small bushes.

Sub-tropical thicket - dense, woody vegetation type composed of shrubs and small trees. Dune thicket exists along the coastal strip, the climax vegetation type which appears as true coastal forest. The more succulent thickets, which extend from the river valleys inland and invade savannah and grasslands, are often referred to as Valley Bushveld.

Savannah - grasslands with small trees (often *Acacia)* scattered throughout.

Grassland - either Sourveld, Sweetveld or Mixed Grassland.

C. Nobilis

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C. nobilis habitat at Kei River mouth

Afromontaine Forest - the large forest trees of this region have affinities with those of the montaine forests of central Africa.

Clivia nobilis is most commonly found in the Sub-tropical thicket or Valley Bushveld and its climax types, i.e. coastal and inland forests. The Eastern Cape is subjected to major movements of air masses extending over hundreds of kilometres. Altitude, mountains and distance from the Indian Ocean are important variables acting on the prevailing conditions, and as a result, there are major variations in temperature, rainfall and windiness.

With its tough, leathery leaves and extensive root system, *C. nobilis* is particularly well adapted to a habitat with an unpredictable and variable climate. Populations occur from West of Grahamstown through the Albany and Bathurst districts and from there along the Eastern Cape coastal belt well east of the mouth of the Kei River.

These populations are found in a number of diverse localities, ranging from primary coastal dunes to wooded kloofs further inland, where plants normally occur on river banks and along forest margins. Within this range marked differences in growth habit can be distinguished.

The coastal varieties very often are found under a low (2 - 5m) canopy on coastal dunes, where plants may be exposed to the sun for a large part of the day. Under such conditions the tendency is for plants to form large clumps with leaves that are no longer than 70 cm long. As the plants occur in alkaline marine sand, they mostly depend on falling leaves from surrounding vegetation for the supply of nutrients.

At Kei Mouth, on the other hand, plants occur right up to the high water mark under a canopy of ± 20 metres high. During severe storms in 1998, large areas of the primary dunes were damaged, and countless numbers of plants were washed away by the sea.

The plants under a high forest canopy do not form the large clumps normally associated with more exposed positions under a low canopy.

Mature plants tend to have leaves exceeding one metre in length, and plants tend to be solitary. This is also the

case under forest canopies at inland localities such as Grahamstown.

In habitat, *C. nobilis* grows on the surface of the sand or soil. The roots of a mature plant can spread up to 80 centimetres around the plant and quite clearly obtain the majority of their nutrients from the detritus collecting on the forest floor.

Mature *C. nobilis* plants in cultivation in containers (bags/pots) tend to produce astonishing numbers of offspring around the base of the plant. This is especially noticeable when the basal plate is damaged, whether naturally or artificially.

Flower colour in *C. nobilis* varies from one population to the other and even within fairly localized populations.

At Grahamstown within a radius of five kilometers one finds flowers that range in colour from pale apricot/pink with light yellow and green tips to a dark red form with tips which are dark green.

C. nobilis is a rewarding plant in cultivation, whether in containers or planted in the garden. It prefers a well drained soil and dappled shade, preferably under an evergreen canopy, but can tolerate sunlight for part of the day.

Interspecific hybridization using *C. nobilis* took place in Europe as early as the late 19th century, giving rise to the so-called C. Cyrtanthiflora hybrids.

From her writings we know that for her first interspecific hybridization attempts, Ms Blackbeard used *C. miniata* and *C. nobilis.* Where *C. miniata* is used as the pollen parent, the progeny grow at the same rate or even faster! This 'hybrid vigour' accounts for some plants first flowering under Grahamstown conditions in 42 months.

As reported by Ms Blackbeard, you also find such hybrids flowering at odd times during the year, and mature plants will produce flowers twice a year at different times.

Already in the F1 generation the leaves have lost the blunt tip feature of *C. nobilis.* The flower has a large number of florets (up to 50) and makes for a very attractive show.

C. nobilis habitat near Grahamstown

Karyotype analysis of the Genus Clivia by Giemsa and Fluorochrome Banding and in situ Hybridization

by Y. Ran[1], B.G. Murray[1*], & K.R.W. Hammett[2]

Key words : *Clivia*, fluorochrome banding, Giemsa banding, *in situ* hybridization, karyotype analysis, silver nitrate staining.

Abstract

The karyotypes of species in the genus *Clivia* were analyzed by using Giemsa C-banding, fluorochrome staining, silver impregnation and *in situ* hybridization. Banded ideograms were established with computer aided image analysis.

A chromosome number of 2n = 22 and a similar basic karyotype, based on relative chromosome length and arm ratio, was found in all the four species. There were clear differences in banding pattern between the species which allowed their karyotypes, and consequently the species, to be unambiguously identified. Apart from at the centromere, heterochromatin was mainly distributed on the short arms of the smaller chromosomes. Amounts of heterochromatin in *C miniata* and *C gardenii* were greater than in the other two species. The number of pairs of rDNA sites, identified by *in situ* hybridization, ranged from one to three.

Introduction

The genus *Clivia* Lindl. (Amaryllidaceae) is recognised as consisting of four species, *C nobilis* Lindl., *C. miniata* Regel, *C. caulescens* R.A. Dyer and *C gardenii* Hook. f. The species are all native to South Africa. Although *Clivia* has been cultivated as an ornamental for more than a hundred years (Weathers, 1911; Vorster, 1994), and several groups of hybrids have been reported (Bryan, 1995; Nakamura, 1995), very little information is available on the karyotypes, relationships and evolution of the genus.

Previous chromosome studies have concentrated on obtaining chromosome numbers and karyotypes from conventionally stained material (Inariyama, 1937; Sato, 1938; Gouws, 1949; He & Deng, 1989). In general the results confirm chromosome numbers as 2n = 22, although Sato (1938) found 2n = 44 in *C nobilis*, with some apparent variation in karyotype between the four species. Confusion has arisen from Inariyama (1937) having quoted Van Camp (1924) as reporting n = 9 for *C miniata* but giving no reference. Although being further quoted (Gouws, 1949), no subsequent author claims to have found the Van Camp reference.

The development and application of differential banding techniques for plants (Vosa, 1970; Schweizer, 1976a) has resulted in many more characters or

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markers being available for karyotype analysis. For example, base pair-specific fluorochromes such as DAPI (4' - 6-diamidino-2-phenylindole) and CMA (chromomycin A3), which preferentially bind to AT- or GC-rich regions of the genome respectively, allow the cytochemical characterization of heterochromatin (Schweizer, 1976a, 1976b; Deumling & Greilhuber, 1982; Ebert et al., 1996). The number and location of nucleolar organizer regions (NORs) also provide valuable chromosome landmarks and these can readily be identified by their selective staining with aqueous silver nitrate (Kodoma et al., 1980) and by *in situ* hybridization (ISH) with rRNA gene probes (Mukai et al., 1991; Murray et al., 1992).

In this study, a variety of banding techniques together with silver staining with ISH have been used to characterize the chromosomes of the four *Clivia* species.

Materials and methods

The plants of the four different species analyzed in the present investigation were a mixture of commercial cultivars and plants originally obtained from wild populations in South Africa (Table 1). They were grown in pots in a shade house. For karyotype studies, root tips were pretreated with a saturated solution of paradichlorobenzene for 18 - 24 h at 4°C, fixed in 3:1 (v/v) ethanol:acetic acid for at least 24 h and stored in 70% ethanol at 4°C. Chromosome spreads were made as described in Murray & Davies (1996). The technique for C-banding followed that described by Schwarzacher et al. (1980) modified by increasing the incubation time in barium hydroxide at 25°C to 15 min. Triple staining with CMA, distamycin A and DAPI for consecutive observation of CMA and DAPI fluorescence (Schweizer, 1981) used the modifications of Jacobs et al. (1999) where chromosome denaturation with barium hydroxide was carried out at 24°C for 10-13 min. Silver staining for NORs was done in two steps: first using 50% AgN03 in distilled water and a nylon net coverslip and incubating the slides at 60°C for 1 h (Kodoma et al., 1980); and then impregnating with 100% AgN03 in sodium citrate (pH3) under a glass coverslip at 60°C for 15 min to 1 h. Staining intensity was monitored under the microscope. For ISH, the plasmid pTIP6, which contains the 26S rDNA of Asparagus officinalis L. (King & Davies, 1992), was used as probe. Probe DNA was digoxigenin labelled by nick translation (Boehringer Mannheim). ISH was performed following the procedures outlined in Leitch et al. (1994). Hybridization was carried out overnight at 37°C in a thermal cycler (Hybaid Omnislide). Hybridization sites were detected using the HNPP/Fast Red TR fluorescence detection kit (Boehringer Mannheim), the chromosomes were counter stained with 0.5 mg/ml DAPI in phosphate-buffered saline (pH 7) and mounted with 1.8%

DABCO (Sigma D-2522) in 90% glycerol v/v 20mM Tris, pH 7.5. Selected chromosome spreads were observed with a Zeiss Universal microscope with epi-fluorescence and photographed with PanF or Ektachrome 400 film, the images digitized with a Nikon LS1000 film scanner and merged using Adobe Photoshop 3.0.5.

Chromosome measurements of five well-spread metaphases per species were made using the public domain Macintosh software NIH Image (developed at the US National Institutes of Health and available on the Internet at http://rsb.info.nih.gov/nih-image/)

This software allows the analysis of the following chromosome parameters: total chromosome length (T), short arm length (S), long arm length (L), arm ratio (AR), relative length of individual chromosomes (RL), the mean total karyotype length (TKL), the width of differentially stained bands (w) including bands on short arm (Sb), long arm(Lb) and centromere (Cb), the distance of the centre of a band from the centromere (p), and the total heterochromatin amount (HC). The banding patterns were validated from more than 30 cells. Chromosomes were classified according to Levan et al. (1964).

Results

Chromosome number and basic karyotype

The same chromosome number (2n = 22) was found in all plants of the four different species. The basic orcein-stained karyotope was also similar in all species (Figures 1a-d, 2a) with four pairs of metacentrics (1, 2, 8 & 10) and seven pairs of submetacentrics. Within a karyotype, there were large differences in chromosome length, three pairs (1, 2 & 3) were obviously larger than the others and three pairs (9, 10 & 11) were smaller than the others. Many of the chromosomes can be recognised from the length measurements, the exceptions being the medium sized submetacentric pairs 4, 5 and 6 and the two small submetacentric pairs 9 and 11.

Banding patterns

Giesma C-banding allowed the species to be divided into two groups. The most obvious difference was that C. *miniata* and *C. gardenii* had small, dot-like bands at the centromeres of all chromosomes whereas *C. nobilis* and *C. caulescens* did not (Figure 2b). All the species showed an interstitial band in the short arm of chromosome 8 and with the exception of *C. gardenii* also had a terminal band on the same arm. *C. miniata* and *C. gardenii* also had a terminal band on the long arm of chromosome 2 that was absent in the other two species. Terminal bands were present on the short arm of chromosome 9 in *C. caulescens* and *C. nobilis* which, in addition, had a terminal band on the short arm of chromosome 10 (Figure 3). There was a range in variation in the amounts of heterochromatin present in the species, viz. *C. miniata* (9.77%), *C. gardenii* (7.86%), *C. nobilis* (4.87%) and C. *caulescens (1.55%).*

With DAPI, the banding patterns in the four species were very similar to the C-banded ones (Figure 2c); the exception being that the terminal bands on the short arms of chromosomes 8 and 9 in *C. caulescens* were missing. Many fewer CMA bands than DAPI bands were observed. All the species could be identified by their CMA banding pattern (Figure2d; Figure 3); *C. caulescens* along with *C. miniata* and *C. nobilis* had a terminal band and an intercalary band on the short arm of chromosome 8, *C. miniata* and *C. gardenii* had an additional terminal band on chromosome 3. *C. caulescens* and *C. nobilis* had a terminal band on chromosome 9 and C. *nobilis* had an additional terminal band on chromosome 10. A faint interstitial band was observed on the short arm of chromosome 8 in all species.

Silver positive bands consistent with CMA ones were seen in *C. miniata* (four bands) and *C. gardenii* (two bands) but not in the other species (Figure 2e). In *C. caulescens* and *C. nobilis* a silver band was observed at the end of the short arm of chromosome 9 and of chromosome 10 respectively, and in *C. caulescens* silver positive bands were found at the centromeres of all chromosomes (Figure 3).

Intraspecific variation in banding pattern

The three populations of *C. caulescens* could be placed into two groups based on their banding pattern. The six plants from population 8288 all had an interstitial band on the short arm of chromosome 8 and a terminal one on the short arm of chromosome 9 when DAPI and Giemsa staining were used. Only one terminal CMA band on the short arm of chromosome 9 was found.

There was another example of band polymorphism in *C. nobilis.* In some plants chromosome 9 showed a CMA band on both homologues, but only one of the chromosomes had a DAPI band at the same site; the intensity of the C-band at this site also varied between homologues.

In situ hybridization with a rRNA gene probe

The chromosomal locations of rRNA genes in all species of the genus *Clivia* were determined by ISH. Two pairs of hybridization sites were seen in both *C. miniata* and *C. caulescens* with three pairs in *C. nobilis* but only one pair in C. *gardenii* (Figure 2f). The locations of the sites in all species coincided with the bright terminal CMA bands described above (Figure 3).

Discussion

Our study has found that the chromosome number of all four species of *Clivia* from a variety of different sources is 2n = 22. This confirms the previous reports of Inariyama (1937), Gouws (1949) and He & Deng (1989) but not the tetraploid number for *C. nobilis* (Sato, 1938). The species all had similar karyotypes consisting of

three large, five intermediate and three small chromosome pairs including four pairs of metacentric chromosomes. Thus, there appear to be some differences from the previous karyotype analyses. Gouws (1949) reported that in *C caulescens* there were two large pairs, five medium and five small pairs of chromosomes. In *C miniata*, he found two large pairs and three small pairs and six medium sized pairs. He & Deng (1989) reported only one pair of large metacentric chromosomes (the longest one) in *C nobilis.* Some of these karyotype differences may result from using sectioned material, the variability in contraction of the large *Clivia* chromosomes and the use of different arm ratio criteria, which were not clearly defined.

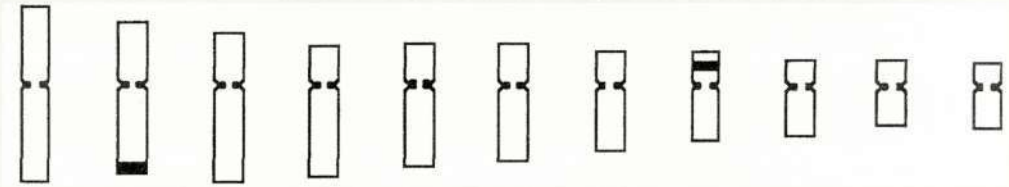
Vorster (1994) has suggested that the similarity in morphology, particularly in their vegetative characters, makes it difficult to justify the separation of *Clivia* species into different species. However, our karyotype studies, in particular the observations on the number, position and size of bands produced by the different staining schedules, along with the differences in chromosome length, allow the karyotypes of the species to be readily distinguished. In fact the species can be identified from their karyotypes by using all of the chromosome banding techniques. This is particularly useful in *Clivia* as plants can take several years to flower, when they are most readily identifiable. Thus, both seedlings and hybrids can be readily identified at an early stage. Within a species, a combination of length measurements and the ratios of chromosome arms together with banding pattern or ISH sites allows the identification of many chromosome pairs; five in *C miniata* and *C gardenii* (1, 2, 3, 8 & 10) and seven in *C caulescens* and in C. *nobilis* (1, 2, 3, 8, 9, 10 & 11). It will be necessary to find other molecular markers, such as the 5S rDNA (Fominaya et al., 1997) or microsatellites (Pedersen & Langridge, 1997), if all the chromosomes are to be unambiguously identified.

The overall similarity of the orcein stained chromosomes of the four *Clivia* species suggests that they have similar genomes. This is reinforced by similarities in the banding patterns of several of the chromosomes. Amongst the more conspicuous is pair 8 in all species, except *C gardenii*, where there are similar intercalary and terminal bands. The NOR-bearing pair number 2 of *C miniata* is similar to pair 2 of *C gardenii* with matching band patterns and arm ratios. Pair 9 of *C nobilis* is similar to pair 9 of *C caulescens*, again with similar banding patterns and *in situ* hybridization sites. There are other possible chromosome similarities based on banding patterns and arm ratio between *C miniata* and *C gardenii*, and between *C. nobilis* and *C caulescens* but more markers are needed. However, clear differences also exist between the complements; this is particularly clear from the ISH results where from two to

Table 1. Origin of plant material used in this study

Species	Population code/name	Origin	No. of individuals
C. miniata	886	Wild population, Howick, South Africa	10
	8312	Yellow Clone, Australia	4
	Daruma	Dwarf broad leaf clone, Japan	4
C. nobilis	871	Kirstenbosch, South Africa	4
	8317	Clone, Japan	4
	8659	Wild population, Kei River Mouth, South Africa	11
	8660	Wild population, Featherstones Kloof, South Africa	9
	8661	Wild population, Riet River, South Africa	7
C. gardenii	875	Cultivated population, South Africa	6
	812	Cultivated population, New Zealand	8
	827	South Africa, via UK	4
	8305	Clone, Japan	1
	8310	Clone, Japan	1
C. caulescens	880	Wild population, Venus plantation, South Africa	5
	840	Wild population, South Africa (obtained via Australia)	6
	8304	Wild population, South Africa (obtained in NZ)	5
	879	Wild population, God's Window, South Africa	2
	881	Cultivated population, South Africa	2
	8333	Wild population, God's Window, South Africa	1

a

	1	2	3	4	5	6	7	8	9	10	11
											
S	7.45±0.41	6.56±0.39	4.97±0.45	4.23±0.35	4.27±0.16	3.62±0.14	3.58±0.24	3.55±0.22	2.68±0.19	2.72±0.19	2.29±0.12
L	10.36±0.64	9.31±0.48	10.14±0.54	9.69±0.48	8.69±0.51	8.24±0.39	6.90±0.48	5.85±0.44	5.31±0.42	4.30±0.34	4.39±0.28
T	18.05±0.72	15.86±0.95	15.16±0.92	13.99±0.71	12.94±0.47	11.75±0.54	10.32±0.60	9.42±0.62	7.95±0.36	7.05±0.39	6.63±0.38
AR	1.42±0.05	1.42±0.10	2.13±0.13	2.38±0.07	2.04±0.07	2.28±0.06	1.94±0.07	1.65±0.06	2.04±0.12	1.60±0.11	1.92±0.14
RL	14.04±0.21	12.24±0.28	11.68±0.16	10.84±0.14	10.11±0.27	9.11±0.12	7.96±0.12	7.25±0.18	6.17±0.08	5.47±0.16	5.13±0.12
C-band											
Cb	-0.73	-0.73	-0.73	-0.73	-0.73	-0.73	-0.73	-0.73	-0.73	-0.73	-0.73
Sb1-w											
-p											
Sb2-w								0.79±0.07			
-p								2.87±0.67			
Lb1-w		1.33±0.22									
-p		8.65±0.36									
TKL=258.26±4.46				HC=7.86%							

b

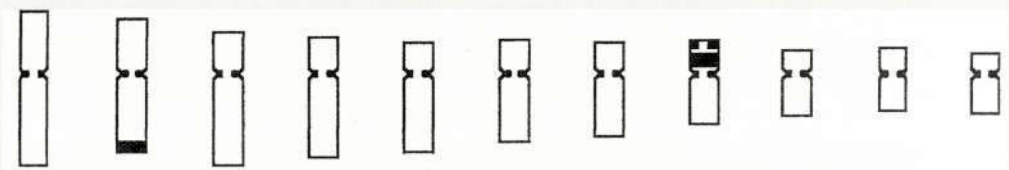
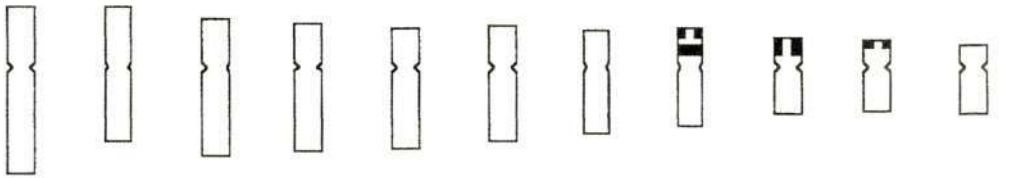
	1	2	3	4	5	6	7	8	9	10	11
											
S	6.76±0.34	5.84±0.30	4.25±0.20	3.78±0.18	3.43±0.12	3.61±0.12	3.45±0.12	3.54±0.11	2.35±0.09	2.78±0.13	2.18±0.08
L	9.75±0.21	8.36±0.31	9.87±0.28	9.07±0.36	8.29±0.31	7.14±0.23	6.55±0.19	5.45±0.19	4.50±0.12	3.92±0.09	4.23±0.13
T	16.56±0.40	14.20±0.46	14.13±0.46	12.79±0.23	11.68±0.26	10.91±0.33	10.02±0.21	9.00±0.30	6.94±0.17	6.73±0.22	6.40±0.19
AR	1.47±0.07	1.42±0.06	2.34±0.07	2.46±0.16	2.45±0.16	1.98±0.05	1.92±0.10	1.54±0.03	1.93±0.07	1.43±0.07	1.95±0.06
RL	13.96±0.23	11.92±0.24	11.76±0.26	10.73±0.17	9.78±0.10	9.13±0.17	8.39±0.09	7.53±0.14	5.81±0.11	5.62±0.08	5.35±0.06
C-bands											
Cb	-0.73	-0.73	-0.73	-0.73	-0.73	-0.73	-0.73	-0.73	-0.73	-0.73	-0.73
Sb1-w								1.10±0.08			
-p								2.99±0.10			
Sb2-w								1.52±0.09			
-p								2.85±0.09			
Lb1-w		1.02±0.10									
-p		7.85±0.43									
TKL=238.82±2.87				HC=9.77%							

Figure 1a-b **Karyotype ideograms and chromosome measurements in (a) *C. gardenii* and *C. miniata***

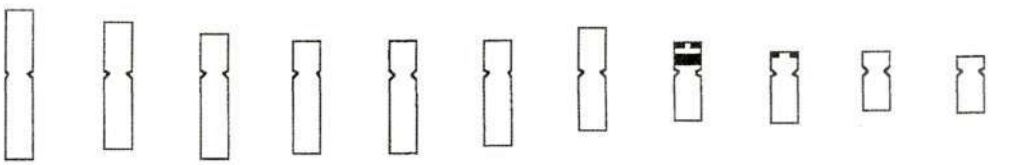
c



	1	2	3	4	5	6	7	8	9	10	11
S	7.91±0.30	7.06±0.50	5.45±0.53	4.83±0.29	4.42±0.26	4.61±0.25	4.02±0.30	4.49±0.26	3.20±0.26	3.00±0.19	2.75±0.37
L	11.69±0.64	8.30±0.48	10.01±0.54	9.48±0.48	9.29±0.51	8.31±0.39	7.58±0.48	6.75±0.44	5.98±0.42	5.05±0.34	5.32±0.28
T	19.53±0.82	15.59±0.83	15.41±0.86	14.25±0.75	13.75±0.73	12.98±0.66	11.59±0.76	11.28±0.66	9.16±0.54	8.12±0.46	8.09±0.59
AR	1.48±0.05	1.21±0.10	1.90±0.13	2.02±0.07	2.12±0.07	1.82±0.06	1.91±0.07	1.51±0.06	1.92±0.12	1.72±0.11	1.96±0.14
RL	13.96±0.34	11.08±0.16	10.94±0.08	10.09±0.06	9.78±0.10	9.24±0.14	8.20±0.15	8.00±0.11	6.50±0.10	5.77±0.12	5.68±0.15
C-bands											
Cb											
Sb1-w									1.26±0.16	1.18±0.10	1.27±0.15
-p									3.86±0.17	2.61±0.10	2.37±0.53
Sb2-w									2.16±0.18		
-p									2.90±0.21		
Lb1-w											
-p											

TKL=281.40±4.82 HC=4.87%

d



	1	2	3	4	5	6	7	8	9	10	11
S	6.93±0.35	6.23±0.34	4.54±0.29	3.87±0.26	3.77±0.22	3.97±0.23	3.51±0.26	3.16±0.16	2.31±0.19	2.56±0.21	2.04±0.10
L	10.04±0.59	8.20±0.49	9.42±0.53	8.93±0.51	8.49±0.48	7.94±0.52	6.43±0.41	5.39±0.30	5.03±0.28	4.33±0.34	4.41±0.25
T	16.95±0.90	14.33±0.80	13.96±0.76	12.80±0.63	12.26±0.67	11.91±0.71	10.44±0.65	8.54±0.44	7.34±0.39	7.21±0.45	6.39±0.39
AR	1.45±0.05	1.32±0.03	2.10±0.10	2.38±0.16	2.27±0.10	2.00±0.08	1.83±0.06	1.71±0.06	2.27±0.20	1.70±0.08	2.18±0.11
RL	13.88±0.18	11.72±0.22	11.42±0.15	10.51±0.22	10.03±0.14	9.71±0.16	8.51±0.15	7.02±0.18	6.02±0.10	5.95±0.33	5.21±0.11
C-bands											
Cb											
Sb1-w								0.63±0.08	0.45±0.04		
-p								2.94±0.20	2.09±0.13		
Sb2-w								0.82±0.05	-		
-p								2.34±0.15			
Lb1-w											
-p											

TKL=244.28±4.46 HC=1.55%

Figure 1c-d **Karyotype ideograms and chromosome measurements in (c) *C. nobilis* and (d) *c. caulescens* (bar represents 10 µm).**

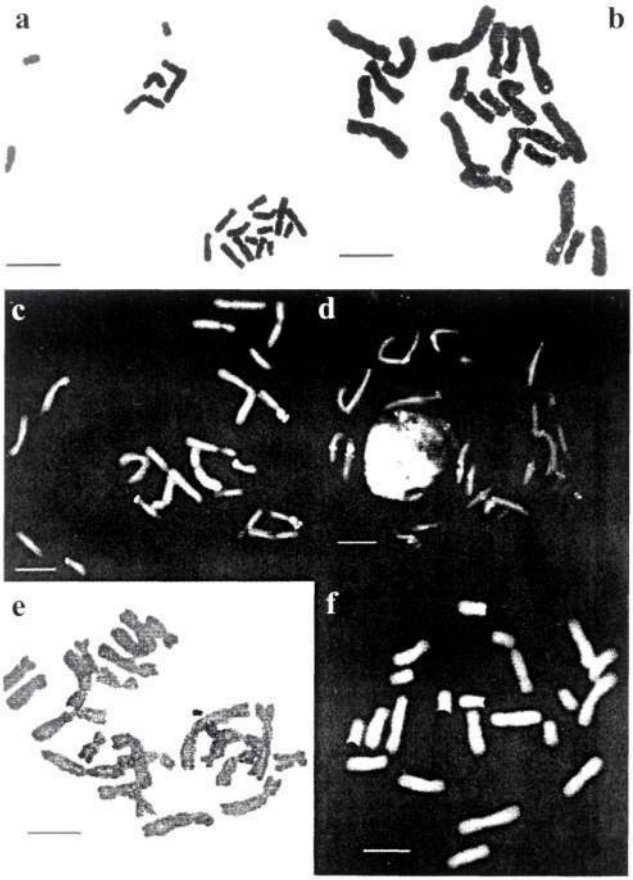


Figure 2. Mitotic metaphase chromosomes of *Clivia* species.

(a) *C. nobilis* stained with orcein.

(b) *C. miniata* C-banded with Giemsa.

(c) *C. nobilis* DAPI–banded.

(d) *C. miniata* CMA-banded

(e) *C. gardenii* stained with silver nitrate.

(f) *C. caulescens* showing rDNA hybridization sites. Bar represents 10µm.

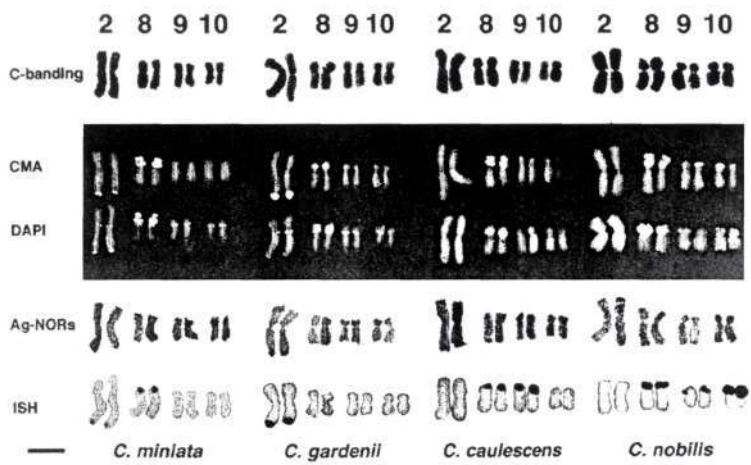


Figure 3.
A comparison of the different banding patterns and ISH sites in the four *Clivia* species.

six sites were seen in the different species.

There is good correspondence in banding pattern between fluorochrome-stained and C-banded chromosomes of the same species and both DAPI and CMA bands were heterochromatic. Generally, because CMA and DAPI fluorochromes perferentially bind to GC- and AT-rich DNA sequence (Schweizer, 1976b; Lin & Comings, 1977), the CMA positive regions are usually DAPI negative in most plants and animals (Schwarzacher & Schweizer, 1982; Sumner, 1990; Moscone et al., 1996). However, in *Clivia,* most of the CMA positive bands are also DAPI positive; the exception being the two pairs of terminal bands on chromosomes 8 and 9 in *C. caulescens* and that on one of the homologues of pair 9 in *C. nobilis.* There are two possible explanations for this. First, there may be AT-rich and the GC-rich clusters in closely adjacent regions in the heterochromatin that are large enough to produce distinct bands with either fluorochrome. Alternatively, although DAPI has a preference for AT-rich regions, the DAPI fluroescence bands might arise for reasons other than the presence of AT-rich clusters, because other flurochromes such as quinacrine, which also preferentially binds to AT-rich regions, give different banding patterns to the DAPI one in other species of plants (Leeman & Ruch, 1978; Schwarzacher & Schweizer, 1982; Sumner et al., 1973). It is possible that factors other than base sequence composition of the DNA may also play a role in fluorochrome banding of chromosomes (Comings & Drets, 1976; Sumner, 1990).

All rRNA gene sites on *Clivia* chromosomes in all species coincide with CMA positive bands, a common feature in a wide variety of plants (Ebert et al., 1996; Sumner, 1990). All these sites in *C. miniata* and *C. gardenii* were also stained with AgNO3, indicating they are active NORs (Sumner, 1990). Only one pair of sites, on chromosome 9 in C. *caulescens* and on chromosome 10 in C. *nobilis,* were silver positive.

The intraspecific polymorphism in banding pattern in *C. caulescens* is interesting as it has been found between plants within a single population. Our samples of this species are fairly extensive, though not exhaustive, and it would be interesting to make more population studies of this species.

Karyotype analysis appears to divide the genus into two groups; *C. miniata* and *C. gardenii* with centromeric C-bands and *C. caulescens* and *C. nobilis,* which do not. We plan to use DNA sequence information to construct a phylogeny of the genus and this will then provide an evolutionary framework that should allow the direction of evolution of karyotype characteristics, such as genome size, amount of heterochromatin, number of rDNA sites, to be determined.

Acknowledgements

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Clivia Names
by Harold Koopowitz

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C. Cyrtanthifiora

There appears to be much confusion concerning the names given to clivia plants. Here we will try and sort out and elucidate some of the problems. Currently there are several different kinds of names in use that are applied to various *Clivia* plants and people have not clearly distinguished between them. As more people become involved with breeding these plants it will become increasingly important to keep the record straight. In this article I will distinguish between the different categories of name and also make some suggestions on how to standardize name usage. This report is the result of discussions held with various *Clivia* enthusiasts both in South Africa and California.

Species Names:

These are the names conferred upon different types of *Clivia* found in wild populations. Fortunately *Clivia* belong to a small genus with only four currently recognized species (at least at the time of writing this account). There has been relatively little confusion between these names compared to the situation in many other much larger genera. Currently, the four *Clivia* species recognized are *Clivia caulescens, C. gardenii, C. miniata* and *C. nobilis.*

Grex **Names:**

Grex names can be given to all of the progeny of a cross and any time that that cross is repeated, the same grex name applies. This is also true if different individuals of the same grex are mated. For example, *Clivia* Cyrtanthifiora is the grex name, applied to the offspring of

C. gardenii (swamp form) x C. *miniata*

C. miniata x *C. nobilis*. Any *C. miniata* crossed with any C. *nobilis* has offspring that can be referred to as C. Cyrtanthiflora. It does not matter which is the pollen or pod parent. Crossing any C. Cyrtanthiflora with itself or with any other C. Cyrtanthiflora still results in C. Cyrtanthiflora. However, if C. Cyrtanthiflora is back-crossed to either *C. miniata* or *C. nobilis*, a new grex name would be required. Note that when the grex results from an artificial cross the name is always capitalized and is not written in italics. If the grex is the result of a naturally occurring hybrid it would be written as C. x *cyrtanthiflora* with an 'x' before the epithet and the name is italicized. (Naturally occurring C. x *cyrtanthiflora* does not appear to have been described.

In order to be valid, grex names must have been published together with the names of the parents. Up until this point the only valid grex name for the genus is C. Cyrtanthiflora published as *Imantophyllum* Cyrtanthiflorum in 1877.

The use of C. Cyrtanthiflora for *Clivia* crosses involving any of the other species is invalid and new grex names are needed. Grex names could be any short descriptor and may be a single word or name. In orchids where grex names are commonly used the length of the grex name is usually limited to three words. For modern grex names, latinized words are usually not allowed. It is useful for breeders, if they make up grex names that reflect the parentage of the plant, but that is not necessary.

Primary hybrids are the results of crosses between two different species. Crosses between primary hybrids and other parents are often called advanced hybrids. One such advanced hybrid, between C. Cyrtanthiflora and *C. miniata* appears to have been made several times and that deserves its own grex name. Below is a list of both new and the old grex names for some of these clivia combinations.

Des Andersson *C. miniata var. citrina x C. gardenii*

GREX NAME	PARENTAGE
Clivia Caulgard	*C. gardenii x C. caulescens*
Clivia Cyrtanthiflora	*C. miniata x C. nobilis*
Clivia Minicyrt	C. Cyrtanthiflora x *C. miniata*
Clivia Minigard	*C. gardenii x C. miniata*
Clivia Minilescent	*C. miniata x C. caulescens*
Clivia Nobilescent	*C. nobilis x C.* caulescens
Clivia Noble Guard	*C. gardenii x C. nobilis*

With this publication the above grex names have precedence unless one can show a previously published name for a cross. As an aside, the plural of grex is strictly greges, but the RHS now uses grexes and I would suggest we follow their example.

Cultivar Names:

Within a grex or a species, desirable individuals may need to be singled out for special recognition. In that case they can be given cultivar names. Asexually propagated divisions, or the result of tissue culture multiplication of the same individual, then obviously will all share the same cultivar name. Cultivars are genetically identical. If sports or mutations appear then they should be given new cultivar names. Cultivar names are written in Roman script and can also contain numerals or codes. The first letter of each word is capitalized and the epithet embraced by single quotes such as 'Wittig's Peach' or 'Orange Belle' or even 'Bill #87'. In orchids, only three words are allowed in the cultivar name and the entire name is a combination containing both the species or grex name plus the cultivar name, e.g. *Clivia miniata* 'Vico Yellow' or C. Cyrtanthiflora 'First Love.'

In many plant groups, grex names are not used and registries only contain cultivar names. This is true of daffodils where the register now contains tens of thousands of names. Roses are another case where cultivar names are used and grex names usually ignored. If grex names are used then one can reuse cultivar names e.g,. C. Cyrtanthiflora 'Imperial' and C. Minicyrt 'Imperial'.

Cultivar-group names:

The siblings of a cross can sometimes appear to be very similar to each other and one may not want to bother to differentiate between them; in those cases they can be given group names. This is what appears to have happened with some of the yellow clivias. Those names should be written in Roman letters and ending with Group. These names are not set off in quotation marks. Perhaps the most famous clivia example is Watkin's Yellow, which should be written or identified as C. Watkin's Yellow Group. Here is an assemblage of flowers that are genetically related and relatively uniform in appearance, but see the next category.

Strains:

Line breeding towards a certain end point often also leads to relative genetic uniformity and similar looking plants. The term, strain, could also be used to identify these plants. The naming would be similar to cultivar-group names. One might then write about C. New Dawn Strain, which is the name that Jim Holmes has given to his yellow clivias where he has consistantly weeded out any orange colors and now has an almost pure yellow breeding strain. Two other commonly used names are C. Belgian Strain and *C.* Sahin's Twin Strain. I suggest that the *Clivia* fraternity find some consensus about whether to call these assemblages groups or strains. Either word could be used. Strains and groups are seed grown and hence not genetically identical and it is possible to derive new strains from older ones, by further line breeding.

Within a group or strain an exceptional clone can still be singled out for a cultivar name. One such plant, bred by Jim Holmes from his C. New Dawn Strain, is very pale and he has named it, *C. miniata'* Cape Snowflake' One does not refer to the group or strain from which the particular cultivar was derived.

This may seem very complicated but it really is not. We are also fortunate in that we have many options in how to proceed with naming *Clivia.* For breeding purposes cultivar names are most important. For commercial trade seed-grown sales groups or strains are most important until tissue culture becomes commonplace and the cultivar names will assume more prominence. Our major decision is whether or not to call plants groups or strains and how much importance is to be placed on grex names. Grex names are helpful in understanding the species contributions to breeding but after several generations they tend to lose their value. Irrespective of how we decide to proceed, one important point is that a register of names needs to be initiated. This is another function the Clivia Club can play in the world. A registry is useful for avoiding future confusion but it will also act as an historic document for the evolution of this beautiful and horticulturally important plant.

Nakamura hybrid

Advanced Hybridising of Clivias a sacrifice but rewarding

by W J Lötter

The interspecific hybrid of *Clivia miniata* and *C.nobilis* has been known since 1850 and was described as *Clivia* Cyrtanthiflora. No doubt this cross has been repeated over and over as well as C. *miniata x C. gardenii* and *C. miniata x C. caulescens.* I myself have produced many of these crosses and fortunately always used *C. miniata var. citrina* as one parent.

As far as I am aware, intergeneric hybrids with *Clivia* do not exist and claims to this effect should be disregarded until substantial proof is submitted. I myself attempted a few with closely related genera within the *Amaryllidaceae* such as *Crinum* and *Amaryllis belladonna,* as well as the more remote *Hippeastrum,* without success. 1 doubt whether the recent attempt to cross Clivia with *Cryptostephanus* will succeed as the latter, although superficially resembling a *Clivia,* belongs to the *Liliaceae* and is more closely related to the *Alliums.*

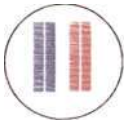
'Chanel'

Although not identical, little variation exists in the F1 hybrids produced from C. *miniata x C. nobilis, gardenii* or *C. caulescens* as these offspring receive 50% of their genetic material for open erect flowers from one parent, and 50% for tubular pendulous flowers from the other. In the F2 hybrids this situation changes dramatically. The F1 hybrids possess two sets of chromosomes, one set from each parent. In *meiosis* when sex cells are formed, the chromosomes 'split' lengthwise to produce exact duplicates of themselves. That means that there are now four sets of chromosomes, i.e. two from each parent. In the next step homologous chromosomes, one from each parent, form *chiasmatas* (crosswise arrangements) whereby genetic material is exchanged by breaking off very precisely at exactly the same loci on the chromosome and connecting again crosswise to its partner. Although one *chiasmata* is illustrated in diagram 1, as many as four may occur in any one pair. Now the cell is ready for its first division whereby chromosomes are reduced to two sets again. In this process Mendel's

rule of independent assortment comes into operation. Although the *Clivia* possesses 22 chromosomes (11 pairs) only two pairs are used to illustrate this process in diagram 2. While there are only four possible arrangements for the two pairs, this figure escalates to 2048 for all 11 pairs. Believe it or not, for the human being with our 23 pairs of chromosomes, this figure soars to an incredible 8388608! In the second division when four daughter cells or sex cells are produced, the chromosome pairs are once again split to provide each sex cell with half the number of chromosomes of the parent. Each of these sex cells contain different genetic information due to the exchanging of chromosome segments and independent assortment. When sex cells unite again (fertilization) the original number of chromosomes is restored.

Diagram 1;

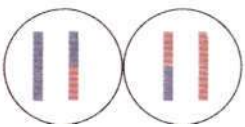
Pair of homologous chromosomes: blue from parent 1: red from parent 2.



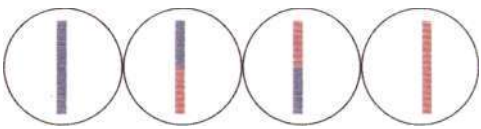
Chromosomes doubled

Chiasmata formed

Genetic material exchanged



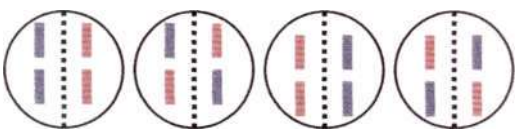
First division



Second division - four daughter cells, each containing different genetic information.

Diagram 2:

Blue - parent 1, red - parent 2.



Four different possible arrangements adopted by two pairs of chromosomes, prior to division - to illustrate Mendel's rule of independent assortment.

Clivia from the habitat in the

living collection at Kirstenbosch

The reason for these two ways of mixing genetic material is to provide an organism of as much variation as possible in its natural population. This enables it to adapt to changes in the environment and to cope successfully with competitors.

Now that the genetic material is thoroughly mixed, the sex cells may contain the following combinations:

Open erect flowers (O E)	Tubular pendulous flowers (T P)
Open pendulous flowers (O P)	Tubular erect flowers (T E)

As each F_1 hybrid produces these sex cells the following combinations are possible in the F_2 hybrids

	OE	OP	TP	TE
OE	OOEE	OOPE	TOPE	TOEE
OP	OOPE	OOPP	TOPP	TOPE
TP	TOPE	TOPP	TTPP	TTPE
TE	TOEE	TOPE	TTPE	TTEE

				ratio
1.	OOEE	-	open, erect	1
2.	OOPE	-	open, semi erect	2
3.	OOPP	-	open, pendulous	1
4.	TOEE	-	semi open, erect	2
5.	TOPE	-	semi open, semi erect	4
6.	TOPP	-	semi open, pendulous	2
7.	TTEE	-	tubular, erect	1
8.	TTPE	-	tubular, semi erect	2
9.	TTPP	-	tubular, pendulous	1

1, 2 and 4 resemble inferior *C miniata*.

3 may be mistaken for a wilted flower.

5 and 6 produce some very fine specimens.

7, 8 and 9 - none more attractive than the tubular species.

Although all these phenotypes have been observed, they may not necessarily appear in accordance with the ratios as set out above. Some of these, like nos. 3 and 7, are rarely seen. Furthermore the phenotypes are not precisely demarcated as a considerable degree of integration is rife. The reasons for this may be attributed to the following:

1) The examples as set out above cover only the basic differences, namely, open erect and tubular pendulous. Other aspects such as colour, shape (curvature of the flowers), size, length and width of the petals and sepals also play a role. These may be controlled by modifying genes which are responsible for the variation in a natural population, let alone the tremendous variation in modern day C. *miniata*. This no doubt has a significant effect on the phenotype of a hybrid or mutant. Modifying genes may inherit, just like mutant genes, dominantly or recessively.

2) The exchanging of genetic material as illustrated in diagram 1, takes place at random as anything from 0-4 *chiasmatas* may be formed in any one pair of chromosomes. Inheritance of characteristics as set out in 1) above cannot therefore be as predictable as in the case of the yellow colour mutant *Clivia* where a single recessive gene is involved and which is not affected by the exchanging of genetic material. No matter on which chromosome this mutant gene is located it will appear in 50% of the sex cells produced by an orange split for yellow plant, and in 100% of the sex cells produced by the mutant yellow phenotype.

3) Genetic information is also transmitted by the mitochondrions and plastids which are present in the cytoplasm of the egg cell. In the male sex cell (pollen), very little or no cytoplasmic genetic information is transmitted. Apparently the cytoplasm is utilised t6 form the pollen tube down the style to the egg cell. The progeny, therefore, receive a little more genetic information from the seed parent than from the pollen parent.

'Moondrops'

Bestel Interspecific hybrid

4) Some characteristics may be linked, i.e. the genes concerned lie so close to each other on the chromosome that they act as a unit, inheriting together. They are seldom separated by a *chiasmata* (crossing over) for a transfer of one of them to the other chromosome of the pair. It is only when this happens that unusual combinations can be formed. When genes are far apart on the chromosome, they cross over freely.

It will still be many years before the genetics at play will be fully understood. Without delving too deeply into the secrets of genetics, it is tempting to believe that the following may be examples of linked genes which were separated by crossing over to form new rare combinations. The inside of the tubular species are very pale pink, greenish-yellow or greenish-white. Although the hybrids are more or less uniformly coloured on the outside as well as the inside of the flower, specimens are sometimes seen with an inside colour which is much paler than the outside, featuring a somewhat bi-coloured effect. Such an extreme example as illustrated by 'Chanel' is very rare indeed. There is also a tendency to develop a yellow centre in the more open phenotypes. 'High Noon', without this yellow centre, is therefore also one of those rarities.

Not all F2 hybrids are desirable. The flowers of the majority are either too narrow, too open, too straight, too pendulous or too erect, to create the impression of a proper hybrid with its semi-pendulous, semi-open, gracefully curving flowers. I would say that not more than 10% will have the desired requirements.

But all this effort is not in vain. An extended flowering time may be a bonus. With C. *miniata* flowering in Spring,

'High Noon'

C. gardenii in Autumn, *C. nobilis* in Spring - early Summer and *C. caulescens* mainly in early Summer (November - December), a deviation from the normal flowering time may be expected in the hybrids. C. *miniata* x C. *gardenii* flowers late Winter and *C. miniata x C. nobilis* in Spring, but also at other times of the year. *C. miniata x C. caulescens* has not yet been properly observed, but such a hybrid flowered this year in February - March and two others in April. If these hybrids are intercrossed, i.e. *C. miniata x C. nobilis x C. miniata x C. gardenii* etc. flowers may be expected to appear at any time of the year.

In my opinion the *modus operandi* will now be to select from the best F2 hybrids, matching the phenotypes with a view to developing proper strains. To cross extremes such as 'Chanel' and 'High Noon' may again result in a vast number of unwanted forms.

As mentioned above, yellow *C. miniata* were used in producing the F1 hybrids with the result that 25% of the F2 progeny are the yellow phenotypes. As they lack anthocyanin, many more of them resemble a very poor quality *C. miniata* as shape alone determines the desirability. A phenotype like 'Moon Drops' which can appear in the F2 generation only, is also rare.

Hybridising *C. miniata. var citrina* with other species does not change the mutant gene in any way. The yellow hybrids inherit in exactly the same way as yellow C. *miniata* e.g.

(1) C. *miniata var. citrina x C. nobilis* = 100% F1 orange split yellow hybrids.

(2) F1 orange split yellow hybrid x F1 orange split yellow hybrid =

25% F2 yellow hybrids

25% F2 orange hybrids; and

50% F2 orange split yellow hybrids.

(3) F2 yellow hybrid x F2 yellow hybrid = 100% F2 yellow hybrids.

Note

1. 'Chanel', 'High Noon' and 'Moon Drops' are preliminary names for identification only and are not yet registered.

2. *Clivia x* C. Cyrtanthiflora refers to the original cross raised by Charles Raes of Belgium in 1850 and published by van Houtte in 1869. It is, therefore, incorrect to refer to any other interspecific hybrids, including subsequent *C. miniata x C. nobilis* crosses as C. Cyrtanthiflora.

Nakamura hybrid

Gladys Blackbeard ~ Clivia Pioneer

by Charl Malan

In an accompanying article I have described the incidence of *Clivia nobilis* in the Eastern Cape Province where it was first discovered in 1828. Like *Clivia miniata* which was discovered in the Natal Province some thirty years later, these plants were sent to Europe where they were improved and hybridised to become very popular house plants. Their popularity spread to Australia, California and Japan and more recently to China.

In their native land, however, *Clivia* received little attention from breeders. While interest has grown over the past ten years with the advent of the Clivia Club, in the Eastern Cape sub-branches have been formed at George, Port Elizabeth and East London only over the past year.

However, there has been one outstanding exception to this lack of interest in *Clivia,* namely Gladys Ivy Blackbeard who was born in Grahamstown on 19 May 1891 and died there on 11 September 1975. Her great grandfather, Francis Blackbeard, arrived in the Eastern Cape as a British settler in 1820 and the family established Blackbeard's Boot and Shoe Warehouse in Grahamstown. She had three sisters and a brother, but only her oldest sister Gertrude, married. When she was widowed all three sisters lived at Scotts Farm on the outskirts of Grahamstown where they established an animal and bird sanctuary and private nature reserve. There Gladys built up the only collection of *Clivia* of any consequence in South Africa and set about improving and hybridising them.

Her success and expertise are well illustrated in an article which she wrote in 1939. The copy which follows is from her manuscript which is kept in the Cory Library for Historical Research at Rhodes University, Grahamstown.

Unfortunately Scotts Farm was some distance from the Botanic Gardens at Grahamstown and the Grahamstown Municipality could not justify the expense of maintaining and continuing the nature reserve at Scotts Farm and with it, the *Clivia* collection.

It came to an end in any event as a result of the application of the apartheid laws and the planned demarcation of Scotts Farm as a racial group area.

Fortunately, Gladys found in Gordon McNeil an enthusiast willing to take over the whole of her *Clivia* collection in 1962, which was then transported to Ofcalaco in the Northern Transvaal. Many collections elsewhere, particularly in California, have benefitted from the *C.miniata van C citrina* and *C miniata var flava,* the yellow and cream forms of *C miniata,* which he supplied as offsets from plants acquired from Gladys Blackbeard.

Scotts Farm, Grahamstown, Cape Province. 26th May 1939

Of the many interesting flowering plants of South Africa, the *Clivia* is worthy of special mention. A handsome lily with dark green leaves, strong erect stems which carry a massive flower head, in brilliant shades of nasturtium red to copper and gold. A most desirable pot plant, even in winter, with its evergreen leaves and brilliant red fruit seeds. My early interest in the *Clivia* was awakened by my mother, who was deeply interested in South African flowers and gardening generally - an art almost despised in women folk at that time. Gardening, like freemasonery, brought her in contact with all flower lovers and gardeners of the old true type. She was fortunate in making the acquaintance of an old English gardener, who came to South Africa. He soon saw the possibilities of exporting bulbs etc. to England. He collected the very handsome Red *Clivia*[1] and presented my mother with one plant. As a child I well remember the joy of seeing that bloom each year. This increased and after many years, this true type has gone on almost as a family heirloom. I was fortunate in securing a plant from a friend, the origin of which she could not give. The shade being a pale apricot tint - the individual blooms having broader petals and not such depth of flower as the red one. This gave me light on the subject and soon I made a cross between these two Some five and a half to six years and longer saw the result of my crossing. The cross had considerably enhanced colour and form, from the palest to deep shades, with larger flower heads and broad petals. Truly a handsome crown. Year after year I made crosses from the best plants and today those early crosses represent a family of some 2000 plants, flowering to year old seedlings.

Branching out from this family and making a fresh cross, I took again as my pollen parent the pale apricot one and the seed parent a variety that is indigenous to this part *(Clivia nobilis).*

The blooms of this species are tube like and hang down in a massive cluster, being supported by a strong flower stem. This is a very hardy and robust family - growing under various conditions in shaded moist kloofs some 36 miles away from the sea, down to within a few hundred feet from the sea shore, on the slopes of the hillside, in part shade from the tall tree *Euphorbia.* (Locality Bushmens River). In this particular spot these *Clivia* have stood the test of time and remained, whereas the rest of the undergrowth has faded out with the advance of civilisation.

It must be remembered that all details given in this brief summary are purely my own personal experiments, unaided in any way. Therefore my experiments have not advanced as rapidly as I should

1 Probably the red form which grows in the most western part of the C.miniata habitat near the Kei River - Eds

Clivia miniata named 'Giadys Biackbeard' by Gordon McNeii

have wished. However many things are developed from small beginnings and the joy and keen interest shown in my collections has more than repaid me.

The flower head of the true *Clivia miniata* is erect whereas that of the *C nobilis* droops like flower bells. The hybrids in this cross are somewhat varied in shade and form.

The shades of these hybrids are from dark to light shades of apricot pink. These hybrids flower out of season, that is to say my general collection flower in the spring, late August to September, whereas the *C miniata x C nobilis* hybrids flower in May and a few in July, the flowering period having completely changed. If this will continue season after season, is yet to be proved. This will be of immense value for making crosses with other lilies that bloom at this time, such as I have ventured to try, using this late flowering *Clivia* (hybrid) as a seed parent and as a pollen parent the large pink *Nerine bowdenii* (locality : Queenstown, Cape Province). But at the moment of writing it is not possible to tell if this cross has taken.2

Cultivation

From the time the seeds start to form the pods or fruits gradually develop to the size of a large cherry, only pear shaped. As they ripen they turn to brilliant scarlet and have a handsome appearance. It takes from 10 to 12 months for them to ripen and they would remain much longer, only I prefer to remove seeds as soon as possible before other flower buds appear. It is possible to gather same as soon as the fruits show any colour. After removing pods I leave same for about 10 days to two weeks when I peel and remove seeds. Each fruit contains an average of 5 to 7 seeds. Do not leave your seeds in their fruit pods too long as they will start growing and shoots may be broken off when removing seeds.

For planting I use flat pans or boxes, moss as drainage and fill with a light mixture of one part each of sand, leaf mould to two of good light garden soil, well mixed. Place your seeds in rows 1 inch apart, cover with soil and give your seed pan a tap down, by lifting up and tap down at least twice. This settles the seed into position. This can be their home for some time. Eighteen months to two years.

When transplanting never give the seedlings much pot room and never transplant until the roots are pressing above and over the side of the pot. They

2 *The cross was not successful. Gordon McNeil persisted with these attempts to cross Clivia with other genera, particularly Agapanthus, also without any success. — Eds*

will flower well in 9 in. pots. Never over pot or spoil clivia plants as they will not flower, but only increase in leaf and root system. The secret of flowering is to rather starve your plants than overfeed. The general cry from most people is 'my *Clivia* will not flower and I keep potting it on'. I always reply 'starve them to enhance the bloom'.

When buds show, sprinkle round each plant a little well decayed horse or cow manure. This is all I have ever done for mine.

Conditions for cultivation is a bush house with flat roof, but before flowering it is advisable to put plants under more shelter such as a glass house or verandah to protect the blooms from damaging.

Plants can be broken up and sub-divided.

Gladys I Blackbeard

McNeil planting of *Clivia* hybrids

Crossing Clivia with other Amarylids?

by J G Niederwieser

Dr Niederwieser is a research scientist with the Vegetable & Ornamental Plant Institute, ARC, Private Bag X293, Pretoria 0001

Introduction

A number of years ago, attempts were made at the Institute to successfully cross *Clivia miniata* with other genera of the Amarylhdaceae, namely *Cyrtanthus, Nerine,* the purpose being to introduce variation in both *Clivia* and the other genera. However, few seedlings were obtained from combination *Crinum moorei* and *Amaryllis belladonna.* In the family a number of other intergeneric crossings do exist, for example, *Amaryllis belladonna x Nerine bowdenii* (Amarine); *Nerine bowdenii x Lycoris aurea* and *Amaryllis belladonna x Brunsvigia josephinae.*

Needless to say, many attempts have been made world-wide to cross *Clivia* with other genera of the family. Why is the success rate so low?

Incompatability

In the case where pollination of a flower leads to the formation of a viable seedling, a large number of processes are completed successfully within the flower.

recognition of the pollen on the stigma

hydration, activation and germination of the pollen

pollen tube growth through the stigma and style into the ovule

fertilisation and embryogenesis

germination of the embryo and development of a viable seedling.

In nature, plants tend to isolate themselves from other species. Man, on the other hand, is continuously trying to break down the natural barriers between plants to combine specific characteristics of one plant with another. The more distant one species is to another, the more difficult it is to overcome the natural reproductive barriers. The low rate of success with intergenera crossings in the Amaryllidaceae comes therefore as no surprise.

Overcoming incompatability

Many techniques have been used successfully to overcome natural isolation barriers in plants.
A few examples are :

Bud pollination. Removal or mutilating of the stigma. Delayed pollination.

Pollination and fertilisation *in vitro*. Irradiation of styles.

Embryo culture. Mentor pollen.

Genetic manipulation. Pistil grafting.

The application of these techniques depends on the site of incompatibility. At the Institute two relatively simple techniques are used to determine where incompatibility is manifested, namely staining and fluorescence of the pollen tube, and a clearing technique to determine whether fertilisation has taken place. (This method cannot be used on *Clivia* because of the storage tissue in the ovules). Once it is determined where the incompatibility reaction takes place, one can investigate techniques to try to overcome the barrier.

We did not investigate the problem of incompatibility in *Clivia* as it was decided to focus the breeding on interspecies crosses in the genus *Cyrtanthus*. Valuable information can, however, be obtained by fluorescence microscopy to determine where incompatibility takes place.

('Col Pitman' x Kevin Walters Yellow) Breeder Ken Smith

Named Cultivars of Clivia in Australia
by Kenneth R Smith

Winmalee, NSW Australia

When looking for named cultivars of *Clivia* in Australia it seems that they are few and far between. Many hundreds of seed grown plants are produced for the marketplace, but few, if any, named clones are sold. A search through my files and a few discussions with other enthusiasts brought forth about 50 named forms. Most are still cultivated, whilst a few have been lost.

'Relly Williams'. Breeder Kevin Walters

The excellent article by Kevin Walters in the Garden Journal, Vol 6/4 April/May 1987, described his breeding efforts to date. The photographs showed glorious blooms and would have been a source of encouragement for other collectors. The increased range of Kevin's named clones is described here. '**Relly Williams**' was produced from a cross between '**Aurea**' and a large

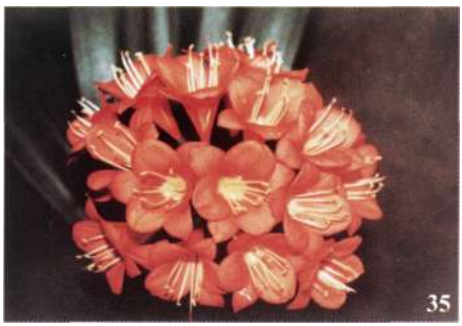
'Valerie Martin Supreme' Breeder Kevin Walters

flowered Belgian hybrid, the seed having been planted in the spring of 1977. This clone produces large flowerheads of broad petal, orange blooms. Two other selections from the same cross are **'Valerie Martin',** a large salmon flower and **'Valerie Martin Supreme',** a superior selection for bloom size. Kevin's aim was to produce large, hemi-spherical flowerheads, held on robust stems. Each floret had to be evenly spaced to give a good display of the individual broad petal blooms. I have found that **'Valerie Martin Supreme'** does not set seed, even when hand pollinated.

Daphne Lodington' is an orange flowered selection from Schenkel seed. This plant, from unknown parentage, produces large florets, each petal 45mm wide, arranged in a flowerhead approx. 23cm across. The foliage is broad. A second Schenkel seedling, named **'Dulcie Whittaker',** has been selected

for its large, white-throated orange blooms.

Three named selections from 'Aurea' crossed with a Kewensis orange C. *miniata* are **'Myrtle Park', Ruth McLennan'** and **'Monica Conquest'.** The first, **'Myrtle Park',** is a large



'May McPherson', Breeder Kevin Walters

flowered orange. **'Ruth McLennan'** and **'Monica Conquest'** are yellow selections, **'Ruth McLennan'** being sterile, with no pollen produced, and **'Monica Conquest'** showing some green in the throat. Other seedlings from this cross are being evaluated, one in particular, a taller growing, large flowered yellow.

'May McPherson' was selected from a batch of **'Valerie Martin'** seedlings. It is noteworthy for its prominent stamens. The colour is a darker, deep orange. **'Ivy Henderson'** is a self-coloured orange form grown from C. Cyrtanthiflora x *C. miniata* seed. The smaller, solid colour blooms without a throat colour are quite eye-catching. A second selection from this batch, **'August Delight',** was discarded as not outstanding even though the darker flower colour was initially noted. A possible sibling to these two is a selection called 'Sakura'. This beautiful clone has flowers the colour of cherry blossoms and was named by Mr Yoshikazu Nakamura, who had been sent a plant and photographs. The flowering of 'Sakura' seedlings is awaited with expectation to see what range of pastel colours might result. The last selection Kevin has made is a Midget strain seedling that produced a very neat, large flowerhead of orange blooms. It has been called **'Pomander'.**

An interesting form derived from Twins has been selected out by a friend of Kevin, Mr John Henderson, and named **'Green Walters'.** This plant is notable as it produces flowerheads of mostly green florets with no orange in

'Myrtie Park'. Breeder Kevin Walters

the petals. Some flowers are all green, at other times it has both all green and normal orange flowers. So far the plant has refused to make offsets but has been used in cross-pollination to determine if the green flower character will reproduce from seed.

Enthusiasts are cultivating two named

'James Dearing'

clones from an early Australian breeder of *Clivia*, Mr James Dearing of Melbourne. The more common **'Ailsa Dearing'** is described as a vivid, deep apricot bloom. It is reputedly a cross between *Clivia miniata* and **'Aurea'.** Perhaps one parent was our common narrow petal form of *C. miniata* and the improved petal shape of this clone came from the **'Aurea'** parent. It was named for Mr Dearing's daughter and was described in an article in Your Garden, December 1980, along with a description of **'Aurea'.** The clone **'James Dearing'** comes from the same breeder and named for himself. I am told it is a strong grower, with long, broad foliage, quite different to **'Ailsa Dearing'.** The flowers are described as a pale apricot with white and green throats. It is a late season flower. I am unsure whether the clone **'James Dearing'** carries the yellow parentage or is from another cross. To the best of my knowledge these two clones are not offered for sale in the marketplace.

An interesting outcome of a discussion with Mrs Irene Broadbent about these plants was the possibility that Mr Dearing brought **'Aurea'** from England in the early 1920's. Mr Dearing worked as the Head Gardener for Sir Benjamin Nathan, who owned 'Rippon Lea' during the period 1910- 1935. He was given an open cheque to purchase 'anything of merit for the garden'. It is quite possible that the choice clivias were brought back from a trip to England. Whilst there is no hard evidence amongst the books and papers that Mrs Broadbent received from Mr Dearing's niece, we certainly consider it worth looking into.

The cultivar name **'Aurea'** is applied to a cream flower form that is common in the marketplace. The origin of the stock is proving difficult to track down. It appears that nurseries in Victoria were propagating and selling offsets for many years. I have received plants from

'Col Pitman'. Chance seedling

Australia-wide sources and when they flower they are all the same. Contact with distributors indicates that only divisions are sold. The situation will be rapidly changing now as more and more seedling yellows reach the market. The name 'Aurea' is very likely to be used indiscriminately for any yellow *Clivia.*

The yellow form **'Col Pitman'** has

'Goiden Fanfare'. Breeder Cliff Grove

been described in the Clivia Club newsletter (Vol 2, No3 - July 1993). It was selected out of a batch of orange flowered plants grown from imported seed in the early 1980's. The principal of Civic Trees, the late Mr Colin Pitman, kept the plant aside as a treasured acquisition. Leaf width averages 50mm and a mound of foliage approx. 75cm high is produced. The cream bloom (RHS colour chart 12D) has broad petals. This form is not commercially available but is being propagated by a few collectors.

Larsens Warm Climate Bulbs were recently featured in an article in Australian Horticulture. The purpose was to highlight the Larsen Sunset Colours strain of *Clivia.* It was interesting to note two clones mentioned. **'Moonlight'** had a flower described as 'almost pure white with a green throat', and **'Almost Yellow'** was shown as a photograph of a cream flower with a darker yellow throat.

Cliff Grove was cultivating quite a few named clones at the time he sold his collection to Pen Henry of Clivia Gardens Nursery in Wanneroo, Western Australia. About 30 named accessions were listed by Pen when I requested information. The plants selected out are being developed as nursery stock. Seed, obtained from several sources, produced a selection of yellow flowered clones. Plants selected from Bill Morris seed are **'Golden Grove', 'Golden Beauty', 'Golden Shower', 'Golden Fanfare'** and **'Golden Heart'.** Warren Glover supplied seed that gave rise to **'Golden Delight', Golden Girl'** and **Golden West',** while Pam Elliot stock produced **'Golden Dream'** and **'Golden Time'.** Two yellow

Bill Morris seedling

'Hula Girl' a Twins seedling

selections out of a '**Relly Williams**' cross are **Golden Light**' and '**Limelight',** which is described as having a green tinge to the yellow-cream flower.

Some improved orange selections have been made from German and English seed, including seed from Albert Schenkel. Clones like '**Royal Show',** '**Western Ruby', 'Grand Prix', 'Royal Trumpet**' and **Grandifolia**' (sic) are being increased for stock and for use in continuing breeding programmes. Two Twins selections are '**Emerald Lady',** which shows the green flower

'Peach Glow'. Breeder Cliff Grove

characteristic, and '**Hula Girl',** a selection made for the interesting way the stamens are presented in each flower. A yellow cross orange breeding programme has so far resulted in **Apricot Splendour**' and '**Apricot Delight';** both selected out for improved pastel flower colour. An interesting green on green variegated clone is listed as '**Lime Dash'.** This orange flowered plant is described as having lime green stripes

'Orange Jade', Breeder Cliff Grove

on the foliage. A dark orange flowered seedling from a Grandiflora and '**Aurea**' cross has been named '**Kaye Dorothy',** in memory of one of Pen's relatives.

Two red flowered selections of unknown parentage are '**Burgundy Boy**' and '**Tropical Red'.** Presumably a sibling to this last named clone is '**Tropical Sunset**' a pinkish-orange flowered selection. '**Peach Glow**' is also a pale flower selection, possibly a Twins selection. No details on parentage are available. I have four photographs of

'Fireball'. Breeder Cliff Grove

Cliff Grove selections that remain as names only at this stage.
The **'Orange Jade'** shows the green colouration on the petals, **'Sunburst'** has a larger throat with the colour on the tips of the tepals. **'Sunrise'** and **'Fireball'** look similar to me and are possibly Twins selections also. The most recent selections that Pen has named are three broad leaf yellow clones, named **Connie', Elizabeth'** and **'Toy'.** As Pen put it 'special *Clivia* named after special people'. This extensive selection of *Clivia* forms is the result of more than a decade of growing and selecting Clivias. I know that many more will be coming from Clivia Gardens Nursery.

Bill Morris is also constantly selecting and improving his collection of Clivias. At this stage Bill is simply allocating numbers to selections that are to be used in further breeding work. An improved yellow from his collection (#96/1) is illustrated. When fully satisfied that a clone is worthy of naming, Bill will be releasing details. There are some in the pipeline.

It is pleasing to report that the clone ' **Vico Yellow'** is now in Australia. I imported it in September 1999, from Yoshikazu Nakamura of Japan. They are tissue-cultured plants so it will be interesting to compare the flowers of this type to the original material. The plants are a welcome addition to the named clones existing and being developed by the Australian *Clivia* enthusiasts.

I have in my collection plants bearing the names **'Giant No 3', 'Fireglow'** and a few clones that were labeled **['Salmon Queen'** X B308 Yellow]. I have since learned that the B308 yellow is the 'Aurea' from Flowerdale Nursery in Victoria, but the origin or details of **'Salmon Queen'** are waiting to be discovered. I will keep looking. I am

'Giant No 3'

referring to a gold median stripe form of the common *Clivia miniata* as **'Tao Stripe'.** The flower is the narrow petal type like the green foliage form. There is more to be said about the Clivia strains that are cultivated in Australia but that will be for another article.

If I have missed out any named clones it is because I haven't come

'Tao Stripe'

across them yet and it was not intentional. I welcome any feed-back from members on this matter. The clones listed in this article are not necessarily well known cultivars, indeed only a few would be. My intention was to list and highlight those forms that have been selected, named and disseminated as distinct cultivars. I know that continued development of *Clivia* is going on due to the increased exchange of information and plant material, worldwide, over the past decade or so. The ever-increasing number of named *Clivia* on the marketplace highlights the need for a Register of Cultivars.

I would like to thank the following people who gave details of the *Clivia* in their collections and sent photos to help illustrate the forms mentioned in the article. Kevin Walters for sharing information and photographs of his named forms, Irene Broadbent and Don Barrett for discussions about the Dearing cultivars, Cliff Grove and Pen Henry for the Western Australian connection. Also thanks to Bill Morris and Coral Larsen for the telephone discussions about aspects of the draft article.

'Salmon Queen' x B308 yellow

'Aurea'

Selection of orange Clivia miniata

by Michael Jeans

To me the most exciting moment in plant propagation is when a seedling flowers for the first time. It is then that hopes and aspirations are either fulfilled or shattered. The potential of any breeding program is limited by the gene pool available. I chose to try selective breeding of the orange *Clivia miniata* as I had a much larger gene pool than if I had favoured the yellow.

For about 150 years up to World War II, plants from all over the world were bred in Europe by very wealthy and knowledgeable patrons of horticulture. It is, therefore, likely that the orange *C. miniata* offered in garden centres today are the product of selective breeding over a century or more. Many named cultivars of C. *miniata* were recorded in Europe during that period. Sadly most of these are now lost without trace, but even so, they will have sired most of the European *C. miniata* of today.

I acquired my original stock from garden centres where I was able to choose plants that had good flower heads and flowers of reasonable size and shape. By selecting the seedlings with the best flowers and sowing their seed, I was able to secure second generation plants. Usually the seed had 'selfed' on its own but sometimes I had crossed it with another plant in flower at the time. In England, a generation in the life of *C. miniata* usually takes four years, almost a year for the seed to ripen, and a further three years for the seedlings to flower.

Nearly all C. *miniata* grown in Europe is of the board leafed form which appears to have rather shorter and wider leaves than those found in the wild in South Africa. The petals are also wider, and often overlap for much of their length. Fig. 1 shows a plant with a well formed head of flowers which are fairly flat and measure about

'Westonbirt Perfection'

Fig. 1

9cm across. I have plants with larger flowers; one with flowers 10cm across had 21 flowers but the head looked rather untidy as the flowers overlapped each other. I feel that the general impression given by the flower head and its stem is every bit as important as the colour and form of the actual flowers. I think that in Europe where clivia are grown under glass or on windowsills, the plant is cultivated as a formal plant. Hence the need for symmetry in a plant with a tidy and well proportioned head of flowers. Fig. 2 shows a deep orange or possibly, depending on definition, a red clone flowering in March. The individual flowers are of good form measuring 9cm in petal length and the same across. The flowers are well shaped, and the colour deep enough to make the plant look spectacular. Unfortunately there are only about a dozen flowers in the head and that is not enough to give the impression of a really solid round head, even though the individual flowers are substantial.

Fig. 3

Fig. 3 shows the same clone as Fig. 2 producing a second set of flowers in August. The flowers are fewer and smaller, and have a much more dominant yellow centre. Whereas *C. miniata* occasionally produces a second flower, *C.* Cyrtanthiflora flowers for a large part of the year. Fig. 4 shows C. Cyrtanthiflora in January with flowers that are pale salmon or peach on the outside and pale yellow on the inside. Fig. 5 shows the same clone in June when the flowers are deep orange on the outside and salmon or peach on the inside. I have yet to attempt to 'back cross' it with, say the *C. miniata* of Fig. 1. Such a cross might just produce a seedling

Fig. 2

Fig. 4 C. Cyrtanthiflora

with a widely flared flower that flowered several times a year and changed from yellow flowers in the winter to peach in the summer. Such are the hopes that dreams are made of.

I have not been too interested in multi-petalled flowers on *Clivia*. However Fig. 6 shows a sport that occurred last year. The plant produced a normal head of flowers, and then sent up a much shorter stem surmounted by one formal double flower 9cm across. Fig. 7 shows a close-up

Fig. 5 C. Cyrtanthiflora

of the comparatively flat ten petalled flower. The petals were arranged perfectly symmetrically in two neat rows, each petal

Fig. 6

Fig. 7

filling the gap between two petals in the other row, and the whole flower resembling that of a small water lily. With no other double flower available, the flower was self pollinated. A large seed pod followed and I now have five one year old seedlings, and more hopes than expectations!

Fig. 8

Fig. 9

Fig. 10

Fig. 8 shows flowers that are chalice shaped and offer something different from the usual form. Fig. 9 shows flowers with a pronounced green centre stripe. Unfortunately in my experience, the more dominant the green, the more dull or matt is the orange. Taken to its extreme Fig. 10 shows green flowers that are sterile, do not open fully but last for several months on the plant - if that is considered an advantage! Sometimes they share a flower head with the flowers shown in Fig. 9 and sometimes the entire head is composed of them.

This article has attempted to show that selective breeding from even a modest collection of *C. miniata*, be they orange or yellow, should produce some interesting seedlings. Seedlings from any good plant are always capable of surpassing the quality of the parent. My experience is that this is particularly true of the yellow *C. miniata*. I grew a batch of seedlings taken from a *C. miniata var. citrina* 'New Dawn' and all five seedlings that have flowered to date are superior to the parent in several respects. It should be remembered that a seedling will only produce its true flowers after its second or third year of flowering. Until then the grower is merely given a glimpse of what is to come.

Possibly'Bodnant Yellow'

Storage & Germination of *Clivia miniata* Seeds

by Neville Brown and Dianne Prosch

Dr Brown and Mrs Prosch are research scientists at Kirstenbosch Research Centre, National Botanical Institute, Cape Town

INTRODUCTION

In his new booklet 'Grow Clivias' Graham Duncan gives a description of the formation of fruits and seeds in *Clivia.* He writes: 'After successful pollination of the flowers, fruits containing the developing seeds begin to form at the base of the flower stalks (pedicels). The individual fruit containing the seeds is known as a berry, and consists of an outer fleshy, pulpy layer that encloses the seeds within. The number of seeds within each berry varies and may contain from one to as many as twenty-five or even more seeds. In general, it is the berries of *C miniata* that contain the most seeds. *C. gardenii* has the largest seeds (with a diameter of approximately 18 mm), followed by *C. miniata* (15 mm in diameter), *C. caulescens* (12 mm in diameter), while *C. nobilis* has the smallest seeds (9 mm in diameter)'. He continues later in the book: 'Propagation *of Clivia* by means of seed is an easy, inexpensive way of increasing stocks. The seeds are harvested once the ripe berries have turned bright orange-red or yellow'. (Duncan, 1999). These quotes form a useful introduction to the consideration of a number of questions concerning *Clivia* seeds and seed germination that are frequently asked by those interested in growing these plants. These questions include the following:

Can ripe seeds be stored successfully or must they be germinated as soon as they are ripe?

If storage is an option can seeds be stored successfully in the refrigerator?

Should seeds be cleaned before storage or can they be stored successfully enclosed in the ripe berries?

Can germination be improved by pre-soaking seeds in solutions of the commercially available germination stimulators such as Regulex (gibberellin GA4 + GA7) or Promalin (GA4 + GA7+ benzyladenine)?.

Can germination be improved by pre-soaking seeds in solutions of Kirstenbosch Smoke-Plus Seed Primer?. (This product is also a commercially available germination stimulator and contains extracts of plant-derived smoke and GA4 + GA7).

Will leaching of seeds to remove supposed germination inhibitors lead to improved germination results?

A series of experiments was conducted in the Seed Laboratory at the Kirstenbosch Research Centre in an attempt to provide answers to these questions.

LOW TEMPERATURE STORAGE OF *Clivia miniata* SEEDS AND ITS EFFECT ON GERMINATION

Seed storage conditions

A month after being harvested in June 1999, *Clivia miniata* seeds were placed in a cold room at 5°C. At regular intervals over a 12-month period seeds were removed from cold storage and germination tests were conducted to determine the effect of the storage conditions on subsequent germination.

In one set of treatments, seeds were stored within the fleshy fruits or berries. These berries were spread out in cardboard containers.

In the second set of treatments the seeds were removed from the berries and all traces of the fleshy fruit were removed. These cleaned seeds were stored in brown paper packets.

Seeds were removed from cold storage after: 0 days (Control); 30 days; 60 days ; 90 days; 180 days; and 360 days.

Seed germination conditions

Germination containers

Seeds were germinated in 9cm petri dishes on a thick filter paper (Whatman No. 3). The paper was kept moist by the addition of distilled water as required.

Germination temperatures

Two sets of germination temperature conditions were compared using controlled temperature germination cabinets.

Alternating temperatures of 10°C (14h) and 22°C(10h).

Alternating temperatures of 15°C (14h) and 28°C(10h).

In both cases light was provided to coincide with the higher temperature period.

Pre-germination seed treatments

At the end of each storage period a batch of seed from each group was removed from the 5°C conditions and each batch was divided up into five sub-groups. Each sub-group was given a different pre-germination treatment.

These treatments were:

Seeds were soaked for 24h in a 1% solution of Promalin (a commercially available growth regulator / germination stimulator containing gibberellins GA4 + GA7 plus a cytokinin, benzyladenine.

Seeds were soaked for 24 h in a 1% solution of Regulex (a commercially available growth regulator / germination stimulant, containing gibberellins GA4 + GA7.

Seeds were soaked for 24h in a solution of Kirstenbosch Smoke-Plus Seed Primer (a commercially available germination stimulator containing plant-derived smoke extract plus gibberellins GA4 + GA7.

Seeds were leached intermittently in running tap water for three days to remove any possible germination inhibitors.

Control treatment — no pre-treatment before germination.

EXPERIMENTAL RESULTS AND CONCLUSIONS

1. Pre-cleaned seeds stored at 5°C retained their viability in storage and gave a high percentage germination even after 360 days (12 months) storage. (See overleaf)

2. Seeds stored at 5°C in the fleshy fruits or berries initially gave a high percentage germination. However, after 90-180 days (3-6 months) of storage, seeds apparently lost viability and considerably lower germination percentages were obtained. (See overleaf.) The fruits became heavily infected with fungi and the seeds tended to rot during storage.

4. The leaching pre-treatment to remove possible inhibitors was detrimental to the seeds and gave reduced germination.

5. Pre-treatment with Regulex (Gibberellins GA4 and GA7) did not give any improvement in germination over the control.

6. Pre soaking in the growth regulator Promalin did give some improvement in germination particularly early in the storage period. It was, however, not able to reverse the effect of fungal infection on seeds stored in berries.

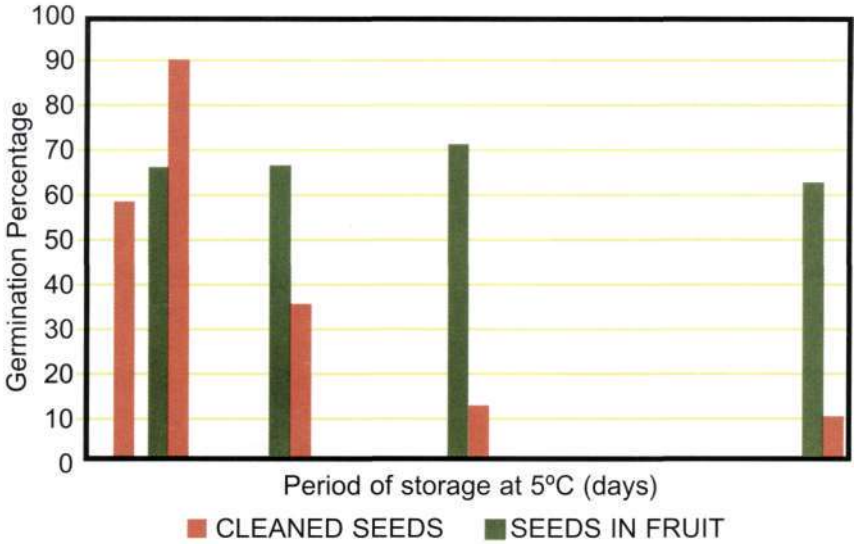
7. Pre-soaking in Kirstenbosch Smoke-Plus Seed Primer also gave some improvement in germination. In some cases this was superior to the Promalin treatment. In the berry-stored seeds the smoke primer solution, like Promalin, was unable to reverse the deleterious effects of storing the seeds within the fruits.

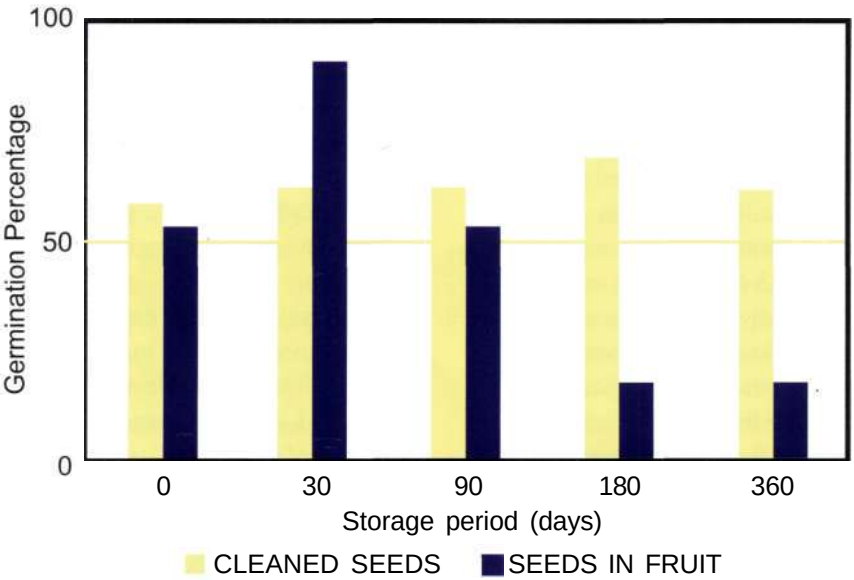
8. As far as germination temperature regimes were concerned, there was very little difference in the germination results between the two regimes.

9. In the control treatments germination of pre-cleaned seeds was in the region of 60%—70% and radicle emergence occurred 11—18 days from the beginning of incubation.

10. Seed size did not appear to influence germination. The very small seeds and the very large seeds both germinated.

Germination of Clivia miniata seeds following their storage at 5°C.





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Propagation of Clivia by Leaf Cuttings

from BULLETINS D'ARBORICULTURE

According to V. Teran (Bouturage de Glaiule et de Clivia; Bul. Cerele dArboric, de Belg. 1899, page 86), Clivia may be propagated by means of leaf cuttings. Apparently in a greenhouse a number of Clivia plants had been trimmed and the leaves left on ashes under a bench. Later it was observed that tiny plants had formed at the bases of the leaves.

Translation from an article in BULLETINS D'ARBORICULTURE
Good things can come from a chance observation.

Many of our colleagues have mentioned the multiplication procedures of *Gladiolus* and *Clivia* - ways that we had not expected.

A certain Mr Justin Rhein discovered by chance the procedure of making cuttings from *Gladiolus.* In previous attempts at propagation half the bulbs developed around the placents of the central bulb.

In the new procedure the 'mother bulbs' were planted early on a heated bed. After a few days, new shoots emerged, when they had reached a height of 1 Ocm, they were cut off next to the bulb and planted in heated soil. Two weeks later the cuttings rooted. The 'mother bulb' had produced, during the same time, two or three new shoots which could be used in the same way.

The rooted cuttings, after having been repotted into bigger pots, were distinguishable by their vigorous foliage. This procedure could be used for multiplication of new varieties, more or less, as said prudently by Wiener, which will continue to produce good results.

Regarding *Clivia,* one finds the same offering of leaves for multiplication. In a glasshouse there was a certain number of *Clivia* samples abandoned on the workbench - the leaves were more or less damaged at the top and detached from the base of the plant.

Comment from Pierre De Coster:
Ash was used in those times to cover greenhouse tables. It was obtained from Steam and Heating apparatus that used coal. This medium was inert, and obviously sterile. It was kept humid by water from the base of terra cotta pots. Today this medium would be hard to find as most heating is done by gas or paraffin.

Bacterial Soft Rot of Clivias

by Mark Laing

Professor Laing is the Professor of Plant Pathology at the University of Kwazulu-Natal, Pietermaritzburg

Causal Organism:

A bacterium called *Erwinia carotovora* pathovar *carotovora*

Hosts:

The bacterium has many hosts, attacking any fruit or vegetable with a juicy, sugary head or stem. Commonly, this bacterium attacks cabbage, cauliflower, broccoli, lettuce, chicory, Swiss chard, carrots, parsley and celery. Another strain attacks potatoes, causing potato blackleg. It also attacks the bulbs of many Amaryllidaceae, especially if another agent such as the Amaryllis worm, has already attacked the bulb and made a wound into which it can enter. This year (2000) was extremely wet in summer, and several of my *Clivia* which were in a dense growing medium, have succumbed to this bacterium. The symptoms are initially a yellowing of one or two of the bottom leaves. On investigation, one finds a dark, watersoaked lesion (wound) at the base of the plant. This may spread right up infected leaves. As the disease progresses, it often completely dissolves the base of the plant and the root crown, so that the plant falls over, leaving the bundle of leaves lying horizontal (see photos overleaf).

It is a very serious pathogen of Arum lilies *(Zantedeschia* species), being transmitted in bulbs, cuttings and even tissue cultured plantlets. This year I also isolated it from the heads of *Agapanthus* flowers, in the bud stage, just before and after the bud opened up

Epidemiology and Disease Cycle

Ideal Weather Conditions:

Hot :30-40°C, and wet : summer rainfall

Carryover: The bacterium lives in the soil or in plant debris in between attacking hosts. It may also be carried in the gut of insect and snail vectors.

Infection process: It usually infects hosts through wounds made by insects, nematodes (eelworms), snails, birds or people. However, under ideal weather conditions, it infects without the need of injuries.

Vectors: (agents of movement): It is moved from plant to plant by insects (especially houseflies), snails, birds and people. It is also commonly moved on pruning secateurs or a knife for harvesting vegetables. Houseflies are perhaps the most efficient of its vectors. When this bacterium rots a plant, it does so with external enzymes (extracellular cellulases and pectinases), creating a smelly, soft, watery rot, to which flies are very attracted: a rotting cabbage really stinks. The flies feed on the semi-digested

plant, then fly off and settle on a nearby plant. There they clean themselves, which involves a regurgitation process, depositing thousands of bacteria on that plant, and initiating another infection process.

When snails feed on infected plants, they ingest copious quantities of the bacterium, then having moved onto fresh plants, defecate there. Their faeces may contain thousands of bacterial cells, which again initiate another infectious process.

I would guess that the *Amaryllis* worm can vector this bacterium, carrying the bacterial cells in its gut from the stage of caterpillar to adult moth, to transmission at egg laying. However, it is unlikely that it carries through into eggs.

Raindrops also splash-disperse bacteria between plants. This form of disease spread is usually over a distance of 1 -2m, but in a heavy rainstorm, aerosols can form, carrying bacteria up to a one kilometre.

Control on Clivias

It can be difficult to control, if conditions suit the bacterium, i.e., under hot, wet conditions.

1. For outdoor plants, use a very porous growing medium so that no waterlogging ever occurs, even when heavy rains occur repeatedly. Waterlogging is probably the single biggest cause of this problem, creating a stressed plant, with roots dying from lack of oxygen. For indoor plants, make sure that one does not overwater the plants.
2. Have adequate shade levels, ideally under trees. Shade cloth does provide shade, but increases heating, especially black shade cloth, and this favours soft rot.
3. Control *Amaryllis* worm with weekly sprays of a pyrethroid insecticide such as alphamethrin or cypermethrin (Ripcord is available in South Africa in 100ml quantities for the home gardener). This spray will also control houseflies. Spray diseased plants with a pyrethroid to stop further disease transmission by houseflies. For example, this year I stopped the spread of soft rot of *Agapanthus* flowers by spraying cypermethrin onto *Agapanthus* flowers and buds, killing the flies that were moving the bacterium between plants.
4. Control snails with regular applications of snail bait.
5. Eliminate other diseased plants, and their debris from the garden (especially vegetables with soft rot). Compost the debris in a deep compost stack which gets hot. This will eliminate the harmful bacteria. Move compost heaps well away from *Clivia* plants.
6. This bacterium prefers plants with a high nitrogen fertilization, and high sugar content. Altering the fertilization regime is therefore an important part of controlling it in vegetable crops. The trick is to increase the ratio of calcium, magnesium and potassium to nitrogen

Close-up example of soft rot *(Erwinia)*

being applied. The first three elements make for stronger cell walls, making it harder for the bacterium to break them down. Dolomitic lime is a source of both calcium and magnesium, and potassium can be applied as potassium chloride or potassium nitrate, or by using a 3.1.5 fertilizer (3N : IP : 5K).

7. When using knives or secateurs to harvest, prune or cut plants, the cutting implements must be sterilized between plants. Use a 70% alcohol (use methylated spirits diluted 7:3 with water), or Jik (3% sodium hypochlorite) diluted 1:3 with water to sterilize cutting surfaces. This is clumsy, slow and difficult to do in practice. But it is worth it if the bacterium is present.
8. Where a *Clivia* plant becomes lightly infected, remove the infected leaf or leaves using a razor blade or scalpel. Sterilize the blade between cuts using one of the above sterilants. Doctor the wound site directly with sulphur dust or copper oxychloride dust.
9. Where the plant is severely infected and has fallen over, remove it from its pot. Remove any soft or dead tissue from the base of the plant. Dust with sulphur dust or copper oxychloride dust. Plant into sharp silica sand (swimming pool sand). Treat it like a plant cutting, giving it frequent light watering, and keeping it under 60-70% shade. *Clivias* are remarkably tough, and they recover quite well.

Soft rot in a potted *Clivia*

Amarylis worm

An Australian Peach Clone?

by Kenneth R Smith

Winmalee Australia

Over the past few years the peach clones have received increased focus. When I first came across the form, I was comparing it with the pale orange (apricot) types that I was familiar with in my collection. Further reading of some of the excellent articles on *Clivia* genetics has cleared up the picture for me.

Of particular interest is a plant that I flowered during the spring of 1999. I consider it to be a *miniata* type that conforms to the description of a 'Peach'. *Clivia miniata* forms were the basis of my collection when I first started growing *Clivias.* At that time (1989), one of the various batches that I had was the Sahin Twins strain. I remember selecting out one seedling because it had pigment free leaf bases, or so I thought. I knew that it was probably wishful thinking on my part. Anyway, I marked the pot with a label 'this plant might be a yellow?' The seedling was unremarkable in the early stages of development and soon became just one of the ever increasing collection of plants.

Not much thought was given to the plant until I noticed a flowerstalk

Green flowered twins owned by Ken Smith

developing in 1997. Only a few buds were forming, but a distinct yellow, a much darker yellow I thought. This of course was an exciting outcome, although short lived, as the stem rotted at the base before the flowers fully opened. The plant didn't flower the following season so I completely cleaned the plant up and repotted into new media. This action was rewarded with a much stronger plant this season. It had several suckers developing and produced a strong flowerstalk, topped with 19 blooms, which opened to reveal an intriguing shade of yellow. Certainly a dirty mustard yellow due to the orange overlay. The colour was near to RHS colour chart code 22C when I checked it. Trouble was, the depth of colour changed over the life of the flowerhead to a marked degree. The outside of the tepals was a darker shade and the blooms developed small red spots as they aged. I will be taking more detailed colour chart readings next flowering season. The flowers were of good form and I have cross-pollinated with a good yellow, both ways, as well as selfing a few flowers. Time will tell what the breeding behaviour is.

I have not seen a 'normal' cream-yellow flower in the Twins on the market in Australia, nor have I read about any being in the strain's background. I have, however, selected out some other interesting variants in this strain such as green, multi-petal, ridged-petal, large throat and self-coloured flowers. I find that the potential to grow and flower some extremely beautiful forms is a totally absorbing aspect of the hobby of *Clivia* cultivation. The fact that I found some interesting forms only makes me look more closely at every *Clivia* in my collection.

Whenever I read about or see a photograph of a new *Clivia* cultivar I am amazed at the diversity within the genus. A look at any batch of *Clivia* will generally show up some clear variants worthy of selection. I suppose the purpose of this short article is to let *Clivia* enthusiasts know that anything is possible. I was certainly surprised at the outcome of this Twins! Enjoy your plants.

Ken Smith, Twins 'Peach'

Clivia in China
by Yoshikazu Nakamura

It is well know that *Clivia* has won popularity in China. However, when one visits China, one is impressed by a lot of new experiences with *Clivia* plants and people there who have not been referred to in the related articles.

The places where *Clivia* is most remarkably popular in China are the three provinces of the North-Eastern region. In Changchun City of Jilin Province, people adore and enjoy *Clivia*, where it has secured a status as the flower of the city. People are involved in *Clivia* at various levels; aged people are seen to sell only a few *Clivia* seedlings on the street, while there are some who run a large glass greenhouse and a gardening supply store. Many kinds of cut flowers are seen to be sold at the gardening supply store, one after another - like hot cakes! When you look up at a tall apartment house building, *Clivia* are seen in the bay window of each household.

I occasionally visit a foreign country to observe local *Clivia.* Often I did not understand the local language or know my way around - of course in China too. Many of my Chinese friends, even on the occasion of our first meeting, warmly welcomed me and arranged my observation of *Clivia* in a vast glass greenhouse where visitors are not usually allowed to enter. Living facilities are built in a growing greenhouse. Although these friends usually entertained me at a splendid foreigners-only hotel or with local cuisine, I would have rather preferred to stay at such living facilities as in the greenhouses, so that I could have spent more time with *Clivia* and friends.

Pots for *Clivia* planting in China are all unglazed eathernware and the growing medium used is 100% leaf mold. To maintain foliage alignment, an aluminium foil is wound around a deformed leaf. We have to understand

'66

Bred in China

that the value of a small number of selected *Clivia* plants can be as much as a few hundred thousand rands! So you cannot take too much care of *Clivia!*

Breeding and growing techniques of Chinese *Clivia* are at the highest level and have almost reached the ultimate level. It seems, however, that they have had little experience in attempting interspecific crossing or crossing with yellows because, as in Japan, the emphasis is placed on leaves rather than on flowers. For my part, as I have given preference to hobby breeding rather than commercial breeding, my breeding objectives cover all ranges of *Clivia*, but in China, their breeding is concentrated only on foliage.

I know that an amazing *Clivia* plant was just bred in Changchun. It also makes me excited whenever I think of development potential of a new *Clivia* by the many enthusiastic *Clivia* breeders taking up the challenge, using the excellent genes available in South Africa. What impressed me most is the devotion to *Clivia* by Chinese people. I recommend you visit Changchun. Really, seeing is believing!

Clivia bred in China

PUBLICATION BY CHINA'S ASSOCIATION OF *CLIVIA* ON UNIFORM STANDARDS FOR APPRAISAL OF *CLIVIA* BRED IN CHINA

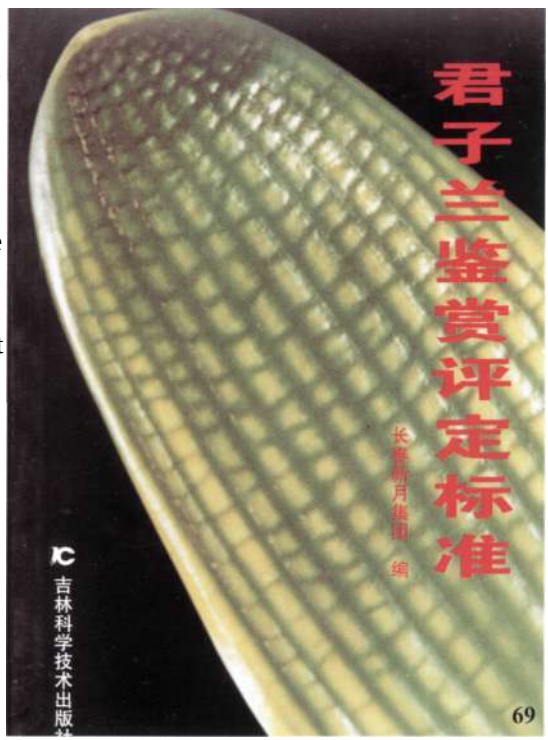
Published in December 1999
ISBN 7-5384-2206-4.

Dr John Rourke is the Curator of the Compton Herbarium, National Botanical Institute at Kirstenbosch, South Africa.

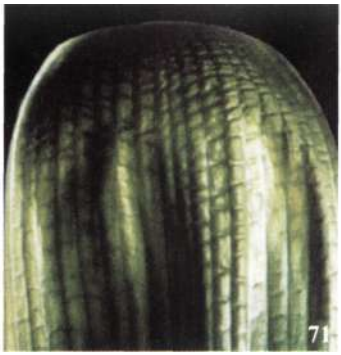
This is the title of a 63 page booklet issued by the 'China Association of Clivia'. The booklet is an extensively illustrated guide to the standards, ideals and judging criteria used by the above Society in assessing show plants in terms of Chinese horticultural aesthetics. And how different their standards are to those applied in this country. The main interest is centred on the leaves and growth form of plants rather than the scape of flowers. Of the 62 excellent colour photographs in the booklet only 8 show plants with flowers, the remainder concentrate exclusively on leaves. Some of these are reproduced with this review.

Dwarf squat plants with very short erect leaves having blunt rounded apices are greatly desired, as are leaves with raised tessellate surfaces of light green against a background of darker green veins. Striped, variegated leaves are also greatly coveted. Then detailed, illustrated criteria are set out for assessing these leaf characters, including what is described as 'the seat' which is the form and angle at which the distichous leaves emerge from the base of the plant. The *minutiae* into which Chinese growers have divided leaf characters in *Clivia miniata* are quite extraordinary in their detailed specifications.

The booklet tells us that *Clivia miniata* has been cultivated in China for half a century. This being so, it is



The worst apex shape, Not symmetrical, with a little sharp point

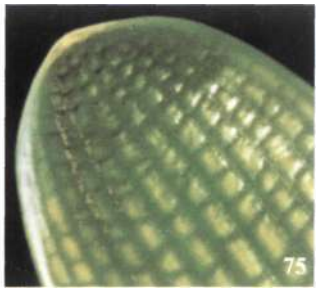


The better apex shape; nearly symmetrical

The best apex shape; symmetrical and half round

The worst vein; the vein is not convex

The best vein; th corttinous



The best colour; the vein and leaf *have* biggest contrast

The best shape of the base of the clivia

sobering to see the extent to which the wild type of this species has so recently been selected and virtually redesigned by breeders to suit a very specific horticultural taste. Clearly *Clivia miniata* is a species greatly treasured in China. This extraordinary veneration is delightfully expressed in the publication's concluding remarks:

'The Clivia is unfathomable. Many people can not observe the marvelous of it.'

In short, it provides a fascinating insight into the achievements of Chinese *Clivia* growers in their striving towards their concept of perfection in clivias as container plants with year-long rather than seasonal appeal.

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'Kirstenbosch Supreme'

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CLIVIA

THREE

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CLIVIA

THREE

*Clivia miniata mu*ltipetal. Breeder: Y. Nakamura Grower: Ian Brown

EDITORS

John Winter Mick Dower Claude Felbert

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EDITORIAL

What is most striking in every new publication on *Clivia* is the extraordinary versatility of the genetic make-up of this genus. As John van der Linde points out in his article on plant related manias, this genetic richness has ensured that there have always been, and always will be, plant enthusiasts who are infatuated with the prospect of breeding new *Clivia* cultivars.

It is a richness which has enabled those enthusiasts to breed *Clivia* which satisfy the aesthetic needs of many very different cultures. In Japan it has been a preference for unique shapes and variegations in the leaves; in China it has been for well emphasised and prominent patterns of leaf veins and unique rounded leaf shapes; in Europe naturally miniature forms and plants which flower within two years have been selected; in temperate climates in the Western world the emphasis has been on unique flowers. Twenty years ago it was the yellow flower which was rare. Today it is not, but a range of different yellows and brilliant red, pink, pastel and bi-coloured flower colours has been developed and is continually being improved with broader, narrower, straight, rolled or recurved petals and more prominent umbels well proportioned to the size of the plant.

Yoshikazu Nakamura is unique in that he has developed this richness of the *Clivia* genes not only to satisfy the preference of Japanese culture for variegated and dwarf leaf forms, but he has also taken the lead in the development of flowers with new colours and shapes, and in exploring the potential of hybridising the different *Clivia* species. His article reminds us that the potential for further improvement is far from being exhausted.

This is all the more remarkable when one remembers that *Clivia* are endemic to South Africa and the material which has been used in developing those cultivars has been confined, in the case of *Clivia miniata,* to those few plants which found their way in the 19th Century only from Kwa Zulu-Natal to Europe, where they were improved before going also to Australia, Japan, China and California. In the 20th Century yellow forms in particular were exported from South Africa by breeders such as the late Gordon McNeil and Cynthia Giddy, mostly to Japan and California, adding to the genetic material used to produce new cultivars. But those plants also originated from the KwaZulu-Natal gene pool.

In the past six years John Winter has led explorations in the area south west of KwaZulu-Natal between Port Edward and East London, known as the Transkei, where different forms of *Clivia miniata* have been found in the habitat. These include two mutating populations. The one has normal florets which are 7.5 cm. in diameter but with colours ranging from orange to yellow to pink and pink suffused with yellow. In the other population the florets are much larger (10 to 12 cm. in diameter) with wider petals and a whole range of pastel colours. These explorations have also found different forms of swamp C. *gardenii* in the eastern Transkei and widely different forms of C. *gardenii* (including a robust yellow form) in KwaZulu-Natal. Some of these have been illustrated in this publication.

They are an important extension of the *Clivia* gene pool, adding to its versatility and the potential for even more exciting cultivars, emphasizing Craig Honiball's conclusion that 'rich, diverse and underutilised variation exists' in this genus.

The South African National Botanical Institute has recently acquired state-of-the-

art equipment at Kirstenbosch to map the DNA of plants. The Cape Province Clivia Club has helped sponsor financially the use of this facility to establish the DNA and inter-relationships of the *Clivia* species. This will reveal whether the swamp C. *gardenii* is indeed a different species, as Keith Hammet suspects, or whether the many different forms of C. *gardenii* found and collected in the habitat (including the robust yellow form) are in fact all one species. All members and Clubs of the Clivia Society are encouraged to *add* their financial support to this project.

The Yearbooks are entirely dependent on contributions by *Clivia* enthusiasts. The Editorial Committee invites each and all to submit their contributions for publication of their best *Clivia* and of new cultivars, including good quality photographs with true colours.

While this publication has been delayed because two of the editors have undergone heart surgery, the planning for Clivia Four is already far advanced. It will bring you the results of the investigation into the DN A of the species, and also details of new discoveries, one quite miraculous, which can be made public only then.

Cape Town, November 2001.

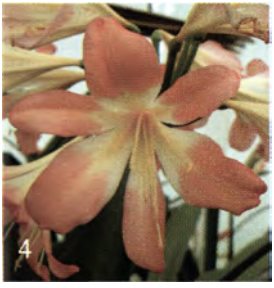
Clivia names

The use ofgrex names by Harold Koopozvitz in his article on Clivia Names *in Clivia Yearbook 2 has been criticized on the grounds that the International Code stipulates that grex names be used only for orchids.*

Professor Koopozvitz has agreed therefore that the word 'group' should be substituted for 'grex' wherever it is used in his article. Eds.

Northern Club Best on Show 2000.
Anna Mever

C. *miniata* - Special Merit Award. Northern Club Show 2000. Anna Mever



PHOTOGRAPHING CLIVIA - DIGITALLY

Mike Jeans

Digital photography, which is developing at an ever increasing pace, has now reached the point where it is a viable alternative to conventional film photography in nearly all respects. This article is intended to set out in simple terms the case for and against using a digital camera to photograph your *Clivia.* To add some *Clivia* interest to the article, I have illustrated it with some of my digital photographs of what I hope are my more interesting *Clivia.*

The digital camera can only work efficiently when used with other equipment:

A **PC** or **laptop computer** through which the camera is downloaded. The computer needs to have a spare port compatible with the needs of the camera - usually a USB port. The photos can be stored on the computer hard disc drive, but scope is greatly extended if the computer has a **CD writer,** or a **ZIP drive.** Many hundreds of photos can be stored on a single CD, but it should be noted that you can only record once on a normal CD. If the CD is a re-writable one, then it is possible to record over the top of what is already on it, but not to add to it.

A reasonably good quality **monitor.** This will let you view your photos, choose those that are to be kept and make any alterations required.

An **inkjet printer,** preferably of photo quality so that you can make high quality prints of up to A4 size of any of the photos.

The above equipment constitutes a 'digital darkroom' where you can manipulate and alter your photographs with a flexability that cannot be approached in a conventional darkroom. It is likely that both the camera and the inkjet printer will come with software that is more than adequate to do all the editing, re-sizing, colour adjustments and a mass of special effects that you did not know even existed - that is if you are so inclined!

Digital Cameras

The main section of the market is that of the 'consumer' camera which is intended for the mass market. The camera is a sealed (but not waterproof!) unit with a fixed lens, usually a zoom lens equivalent to about 35-105 mm focal length in a conventional 35 mm camera. The only moving parts are those associated with the operation of the lens.

The light from the object to be photographed is focused by the lens onto a CCD (Charge-coupled device), which is a light sensitive chip that converts the beams of light into electrical signals. These signals are stored in the camera's memory which is usually in the form of a removable card. This card can be removed and read in a card reader, or, in most cases, be downloaded directly into the computer whilst still in the camera.

Most digital cameras are designed to give the operator whatever degree of control is required. They work very well as 'point and shoot' cameras, but also have sufficient overriding controls to let the operator have what is virtually a manual control camera. The photograph is previewed on a LCD screen usually built into the back of the camera - this tends to drain the power so an optical viewfinder is a worthwhile

additional feature. This is also a great help in bright light when it is difficult to see the image on the LCD. The LCD screen can be used to view the photos that have been taken and those that are unsatisfactory can be deleted from the camera's memory.

Clivia gardenii with flowers darker coloured and longer than usual. From a clone that came to England about 150 years ago. File size 883 KB.

Cameras can be set to give a range of image sizes; the image size is measured in pixels (Picture ELements), which are the minute elements that make up the picture. A given picture can be enlarged or reduced physically without altering the image size - it is also possible to reduce the image size in the computer by compressing it into an image with less pixels which will reduce its resolution (or detail). At present consumer cameras have a maximum image size of 5.2 Mpixel. There are many qualities needed to produce good image quality in a digital camera; for instance the lens is critical as it has to focus the object onto the CCD which is very small in area compared to a 35mm negative. Merely increasing the number of pixels that the CCD will resolve does not necessarily mean that the picture quality will improve accordingly as light may spill over from one pixel into its neighbour. A good 3.1 Mpixel camera is capable of producing a high quality A4 size print.

Clivia nobilis of good form and colour. File size 140 KB.

The maximum image size of the illustrations is 2 Mpixel about 850 Kb file size in JPEG format. Photo 11 was photographed in highly compressed form (640x480 pixels - file size 60 Kb), and is the size that I use for e-mail as it takes about 30 sec to transmit or download. For website use the photos have to be compressed quite a lot more to stop browsers becoming bored while downloading. Much of the detail of the illustrations will be lost in the printing process and it may be difficult to see the extra detail in the larger files.

The memory card bundled with the camera is often of insufficient capacity for practical purposes, and additional capacity in the form of another card may need to be bought.

For the best pictures, such as would be required for submission for publication or printing at A3 size, the photo is downloaded uncompressed from the camera, usually in TIFF or RAW format. This will result in a very large file size, typically a 5 Mpixel photo will produce a file of 14 Mb. Most of the photos in this article were compressed to 2 Mpixel in JPEG format in the camera which enabled a 32 Mb memory card to store about 40 photos. In attempting to assess the quality of a digital photo, the easiest route is to print it onto photo glossy paper using a good photo quality inkjet printer, correctly set. Even a good monitor screen will miss much of the detail.

PROS. AND CONS. OF DIGITAL

The main advantages are :

The ability to examine a photo as soon as it has been taken, and if below expectation, corrections can be made to achieve the desired result.

Operational flexibility is far greater, and photographs are easier in dull conditions. Whereas with a conventional camera, photos taken earlv or late in the dav, indoors, in glare and sundry adverse conditions all require a suitable filter to be attached to the front of the lens, the electronics (white balance) of a digital camera can do it automatically, or if the user prefers, let him set it manually.

Named C. *miniata* clone, probably 50 years or more old. Colour of flowers (RHS colour chart 37B/38B) corrected on computer. File size 210 KB

Photos for e-mails and web sites can not only be produced direct from the camera, but also in a much more efficient form than by scanning a conventional print or negative. Like for like quality, the file size is a fraction of that produced by a scanner. Consequently the transmission and downloading times are greatly reduced.

Once the camera has been bought, the only running costs are for the purchase of photographic paper and ink for the printer.

Not only is the cost of, say, an A4 size photo a fraction of that charged by a laboratory, but you have a preview on your computer screen to enable you to make any improvements that are required.

China miniata 'Red Starburst' (RMS colour chart 41 A), large flowers; petals up to 8,75cm long. File size 807 KB.

Although a digital camera cannot produce slides, you can view your photos on your television set subject to the television using the same colour system as your camera. This offers tremendous scope for parties to view your holiday photos if you feel the need to return the favour to any of your friends! Also useful for business presentations.

Many cameras have the facility of movie clips or sound recording. The resolution of the movie clips, typically 30 sec total, is not great, but adequate to analyse a golf swing or record an embarrassing party moment.

The main disadvantages are :

The cost of a 4 or 5.2 Mpixel 'consumer' digital camera is 50 to 100% more than a middle range 35mm SLR such as a Nikon 80 complete with a zoom lens, which in turn is slightly more than a 3.1 Mpixel camera.

If the cameras are used extensively, the reduced costs associated with the digital would cancel out the extra initial cost within a year or two. However digital cameras prices are dropping week by week whereas conventional camera prices are steady.

Many digital cameras are unable to take a sequence of action photos as several seconds preparation is often required. An increasing proportion of digital cameras are offering the facility of taking a few photographs at high shutter speeds to capture fast moving action. These photos are put in a buffer memory within the camera and then transferred to its memory card at a more leisurely pace later.

C. miniata var. *citrina*, 'Dr. Hirao x Y. Nakamura'. (RHS colour chart 12D). Flowers 10cm across with obvious 'Vico Yellow' influence. File size 846 Kb.

Digital cameras cannot produce slides. For a lecture, digital photos can be projected using a digital projector. It is a very neat and effective system, but has the twin drawbacks of needing to download the

photos from a laptop and, even worse ,the extremely high cost of the digital projector. Alternatively, digital photos can be printed onto transparent film, and light passed through will give a satisfactory image.

No camera, digital or conventional, thrives in extreme heat such as that in a glove box in a car with its windows shut on a sunny day. The electronics in the digital camera will produce electrical noise (equivalent to grain on film) and degrade the image. The latest digital cameras have seen much development in reducing noise almost totally. Even so, the camera is far better kept in a well padded case secured against movement in the boot of the car.

CHOOSING A DIGITAL CAMERA

For general photography such as views and social gatherings any camera, be it conventional or digital will give good results as this is the work that it was primarily designed for. For plant photography I have found the following features to be of assistance or to have suffered because my camera lacked them:

A range of programs. I have found 'Shutter Priority' particularly useful as it gives the minimum aperture required to maintain the minimum shutter speed to avoid camera shake. This in turn gives maximum depth of field.

A range of operating speeds equivalent to 100 - 400 ASA in conventional photography. In low light the higher speed allows the use of a smaller aperture and consequently gives a greater depth of field.

Spot exposure metering in addition to the normal centre weighted average metering. This is useful if there is backlight, as the exposure will be determined by the actual colours of the flowers and will result in more realistic flower colours.

In addition to auto focus, manual and spot focus are two extremely valuable, if not essential features.

Much can be done at a later stage to correct errors in exposure and white balance. Little can be done to correct out of focus photos !

Exposure compensation. Many cameras have the ability to vary the exposure by up to 2 stops (+2 EV to -2 EV), usually in steps of .3 or .5 of a stop. To me it is important to record the colours of a flower correctly and I play around with under/over exposing the image to get the correct colour. The colour can also be corrected on the computer at a later stage.

Very dark red (RHS colourt chart 44A/45A) C. *miniata*, small flowers. Colour absolutely constant from opening until the flower is over. Recently bought from a garden centre to add to my gene pool. File size 847Kb.

Macro facility. This is useful when photographing *Clivia* but a really powerful macro is not required as nearly all photographs are of the full head of flowers which is quite a large object.

Most digital cameras combine a wide range of controls and features with ease of use. They come with easy to follow instructions and within a matter of half an hour of unpacking the box you should be taking some simple photos; always assuming that the rechargeable battery pack has been fully charged as a first step in your introduction to digital photography !

As a starting point to choosing a digital camera, those listed below have been particularly well received for build quality, operational capability and image quality as well as representing performance equivalent to a reasonable SLR:

Canon G2: 4.1 Mpixel, 3x zoom lens. Recent addition to the digital scene, hence mass of features. Very solidly built. Excellent quality images.

Fujifilm Fine Pix 6900 Zoom: 6x zoom lens, SLR design and handling , unusual CCD arrangement gives performance at least equivalent to 4 Mpixel cameras.

Minolta Dimage 7: 5.2 Mpixel, 7x zoom lens. Amazing list of features including spot focussing on moveable cross hairs. Highly detailed image and excellent colour reproduction.

Olympus Camedia C2040 ZOOM : 2.1 Mpixel, easy controls, 3x zoom lens. Probably the best 2.1 Mpixel camera, producing superb results despite budget price.

Olympus Camedia C4040 ZOOM : 4.1 Mpixel, gives outstanding results, 3x zoom lens.

Nikon Coolpix 995: 3.3 Mpixel, 4x zoom lens, a wealth of features and a true enthusiast's camera, superb macro performance. Outstanding build quality.

New 5.2 Mpixel Nikon Coolpix 5000 due in January 2002.

None of the above are likely to disappoint and all of them are capable of producing very high quality images. Choosing a digital camera is like buying a computer, you need to select on the basis of build quality, back-up service and the capability of offering all the features that you are likely to require. If you buy the very latest model, you may pay an unnecessary premium for a camera that will be anything but 'cutting edge' in a year's time. Digital cameras are developing even faster than PCs.

If you are able to get hold of the current issue of any specialist digital photography magazine, you will realise just how heavily the prices of cameras and consumables are discounted if ordered through the Internet or mail order. However this has to be balanced against the advantage in buying from a source with a good help line if you do not have access to knowledgeable help.

Initially the problems I came up against were related to computer software rather than the operation of the camera, and resulted from trying to do far more with the system than I had ever attempted with my conventional photography.

Very vigorous, large flowered *Clivia caulescens* with heads of up to 35 flowers. Possibly some *C. miniata* blood. File size 60Kb.

C. miniata - Bill Morris

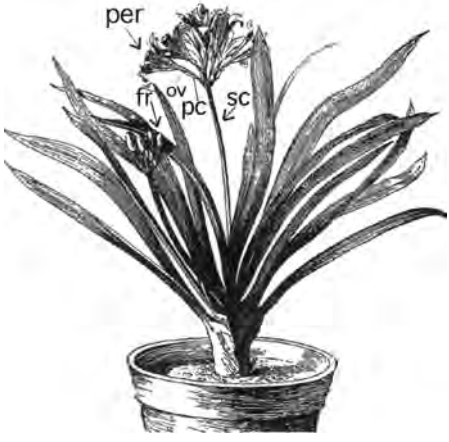
CLIVIA TERMINOLOGY

Terminology of Reproductive Parts

Prof. H. Robbertse

Hannes Robbertse spent the greater part of his career in the Department of Botany, University of Pretoria, but joined the Department of Plant Production and Soil Science in 1994. His main interests are the relation between plant structure and function, especially in the field of flowering and fruit development. He is a former Director of the Margaretha Mes Institute for Seed Research, University of Pretoria.

This article deals briefly with the terminology of the *Clivia* reproductive system. It is essential that we all use the same terminology especially when it comes to plant descriptions for registration or at shows when plants and plant parts are compared.



The branch system bearing the flowers in *Clivia*, is called an **inflorescence.** In *Clivia* the type of inflorescence is classified as an **umbel.** It consists of an elongated, leafless branch, called the **scape** (Fig. 1, sc), which comes from one of the leaf axils and reaches up to the point where the flowers are borne, all more or less at the same level on an extremely condensed axis.. Each flower is attached to the inflorescence axis by means of a flower stalk, called the **pedicel** (Fig. 1, pc). Then follows the **ovary** of the flower (Fig. 1, ov), situated below the **perianth** (Fig. 1, per). The perianth consists of three outer and three inner perianth members, called **tepals. i**nside the perianth, are the six **stamens,** each consisting of an **anther,** containing the pollen and a **filament,** which is the stalk of the anther. The **stigma** and **style** are situated in the flower centre. The style is attached to the **ovary** and together the three parts form the **pistil.** The ovary in *Clivia* has three cavities or **locules,** each containing about eight to ten **ovules.** After pollination and fertilization, each fertilized ovule will form a **seed,** and the developing seeds will stimulate the ovary wall to grow and become the succulent part of the **fruit** (F^{io-} 1 fr)

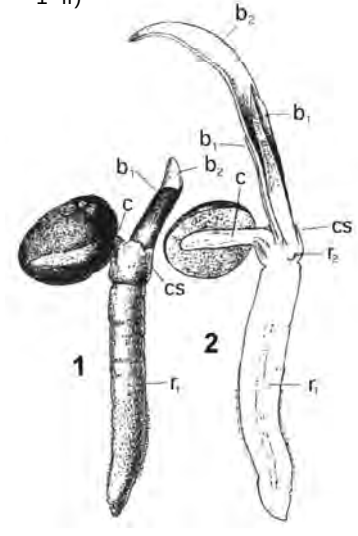


Figure 2 This figure shows a young seedling (kiemplant) of *Clivia miniata* (1) as well as a longitudinal section of a slightly older seedling (2). The figure was copied from R Wettstein (1935). Handbuch der Systamatischen Botanik.

The *Clivia* fruit is called a **berry,** containing 1 to 15 **seeds** depending on how many of the ovules inside the ovary were fertilized. Some of the fertilized ovules (now called young seeds) may abort at an early stage, thus reducing the number of seeds per berry. The membranous layer covering each seed is part of the inner layer of the fruit wall or endocarp. The fruit wall (derived from the ovary wall), consists of three layers, namely the outer, pigmented **exocarp,** the fleshy **mesocarp** and the inner, membranous **endocarp.** The suffix **-carp** refers to fruit.

Please note that the *Clivia* fruit is not a ***pod*** or ***seed pod*** as so often referred to in the literature. Pods are the fruit of peas, beans and other leguminous plants and the *Clivia* is surely not a legume. The *Clivia* fruit is also not a *seed,* since the seeds are contained inside the ***fruit*** which is classified as a ***berry***. In future, please use the names given in bold in the previous paragraph.

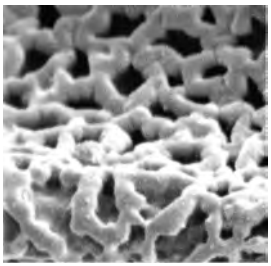
Terminology of Vegetative Parts

(Afrikaans terminology is given in brackets.)

The vegetative plant starts with the germinating seed. *Clivia* seeds are naked since they do not have a seed coat. They are also recalcitrant (onortodoks), which means that they can germinate spontaneously, even in the ripe fruit; they can only be stored for a limited period of time and will die if desiccated beyond a certain point. The seed consists of the endosperm (kiemwit) enclosing the embryo (embrio) consisting of one cotyledon (c in the figure), a plumule (pluimpie) and a radicle (kiemwortel of radikula). Being a Monocotyledonous plant (eensaadlobbige plant), the embryo (embrio) contains one cotyledon (saadlob). The whole embryo is embedded in the endosperm (kiemwit of endosperm). The tip of the radicle can be observed as a small round spot opposite the larger brown spot (hypostase) on the side of the seed where it was connected to the placenta. During germination the cotyledon elongates to about 0,5 to 1 cm, thus pushing the plumule (plumula) and radicle out of the seed, whilst the radicle (kiemwortel) starts to elongate to become the primary root (primere wortel). The primary root immediately produces a collar of root hairs (wortelhare) behind the root tip, and continues to do so as the root grows. The primary root (r^1 in Figure 2) normally does not form secondary roots (sy wortels). It has a limited life span and is soon followed by adventitious roots (bywortels) originating from the first and later nodes (r^2 in Figure 2) of the stem.

The junction of the plumule or apical bud (apikale groeiknop) and the primary root forms the first node (knoop) of the stem where the cotyledon with its cotyledonary sheath (saadlobskede) (cs in Figure 2) is attached. The cotyledon acts as a haustorium, (suigorgaan) responsible for absorbing nutrients from the endosperm. The first vegetative leaf (b^1 Figure 2), produced by the apical meristem (apiekale meristeem) of the plumule, consists of a sheath (blaarskede) with a very small lamina (blaarskyf). In orange and red *Clivia* the sheath of the first leaf is pigmented.

C. *miniata* - Best Orange. Cape Club Show 2000. Ben Marais



CLIVIA POLLEN: Function & Structure

Prof. H. Robbertse & Z.H. Swanevelder

Z.H. (Dirk) Swanevelder is an MSc student in the Department of Botany /FABI, University of Pretoria, South Africa. The aim of his Masters Degree project is to investigate the genetic diversity of wild *Clivia* populations. Dirk is an enthusiastic member of the Clivia Society and is busy building up his own collection.

Most people know pollen as the yellow powdery "stuff found on the anthers of flowers or carried on the hind legs of honeybees (as feed for their young). The high nutrient content of the pollen plays an important role in attracting insects, birds and other small animals to the flowers.

Their role as pollinators, is to transfer the pollen from the anthers of one flower to a compatible stigma of another flower of the same species. The transfer of pollen is critical, since pollen grains contain the precursor of the sperm cell (as in *Clivia),* or the actual sperm cells required for fertilization. In animals and even primitive plants like mosses, ferns and cycads, the sperm cells are mobile and when deposited in the female organ, they can actively swim to the egg cell for fertilization. In flowering plants like *Clivia,* the sperm cells are immobile and first have to be transported from the anther, through the atmosphere, to the stigma where they will arrive in a fairly dehydrated condition. On the stigma, the pollen grain has to be recognized by the stigma before the stigma will supply it with water for rehydration and germination. During germination a pollen tube is produced which grows through the stigma, style and ovary, thus transporting the two sperm cells to the embryo sac where the egg cell and the central cells are waiting to be fertilized.

How and where is pollen produced?

Clivia pollen is produced inside the young anthers, at a stage where the flower buds are still very small and the inflorescence still embedded in the leaf bases of the plant.

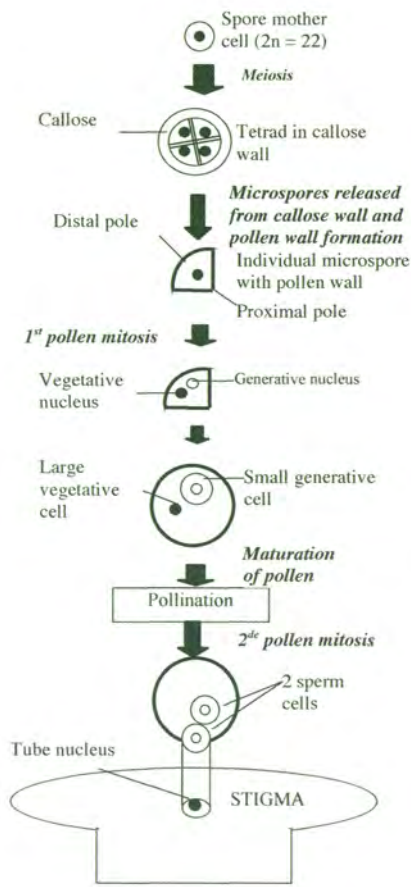


Figure 1. Schematic representation of general pollen formation.

All vegetative cells of the plant (leaves, roots and stem), as well as the young flower parts, contain diploid nuclei (2n) with 22 chromosomes (each nucleus with two sets of 11 chromosomes). Inside the young anther the **spore mother cells** *(Figure 1*) are located.

Each spore mother cell becomes encapsulated in a layer of isolating material, called **callose,** before undergoing two cell divisions, known as **meiosis or reduction division.** This gives rise to a **tetrad** of four daughter ceils, each containing half the number of chromosomes (11) of the spore mother cell (see *Figure* 2). At this stage, the inner cell layer of the anther wall has become a specialized nutritious layer known as the **tapetum.**

The single cells of the tetrad, now pollen grains, become separated and released from the callose wall through the action of a tapetal-derived enzyme, callase. Their cell walls become thicker, impregnated with substances from the disintegrating tapetal cells and develop its characteristic ornamentation as shown in *Figure* 2.

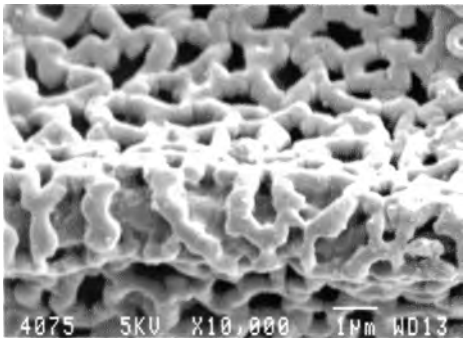


Figure 2. A SEM photo showing the exine of the *Clivia* pollen.

The first mitotic cell division in the pollen grain is asymmetrical, resulting in a larger **vegetative cell** and a smaller **generative cell.** The latter is engulfed by the vegetative cell and will give rise to the two **sperm cells,** only after pollination and the formation of a pollen tube formed by the vegetative cell *(Figure 1).*

Pollen shedding and structure

The mature anther consists of two lobes, each containing two pollen sacs filled with pollen. The partitioning between adjacent pollen sacks in each lobe breaks down prior to dehiscence of the anther and pollen shedding. At this stage the pollen is covered with another tapetal-derived, sticky substance, called the **pollenkit.** The latter allows the pollen to stick to pollinators, e.g. insect, bird or brush in the case of hand pollination. *Figure* 3 shows the pollen grain as seen under the light microscope at the stage of pollination with the curved generative cell embedded in the cytoplasm of the vegetative cell, also called the tube cell.

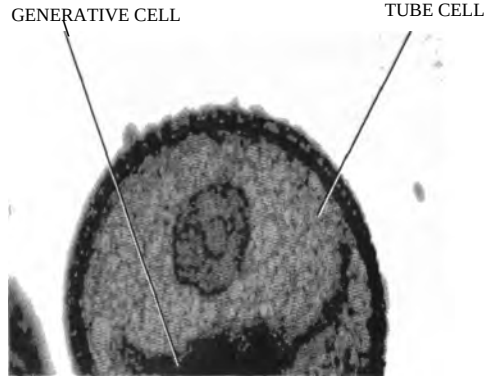


Figure 3. A mature pollen grain of the genus *Lilium*, containing a generative (giving rise to two sperm cells) and a larger tube cell (forming the pollen tube).

As viewed with the scanning electron microscope (SEM), the three dimensional structure of the *Clivia* pollen grain reminds one of a quarter segment cut from an orange with the peel side as the distal pole and the other end as the proximal pole *(Figure 1 &*

Figure 4). The wall of the pollen grain consists of a thick outer layer **(exine)** and an inner membranous layer **(intine).** The exine is reticulate (net-like, see *Figure 2)* and is composed of a very resistant substance known as **sporopollenin,** which apparently is derived from the tapetum and partly from the callose-derived substances during the breakdown of the callose wall.

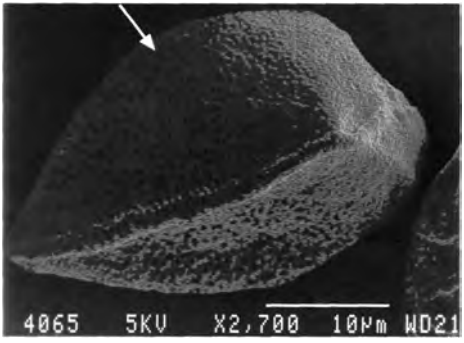


Figure 4. SEM photo of *China* pollen. Proximal pole indicated by arrow.

Due to the highly resistant nature of sporopollenin, the exine of pollen grains is preserved during fossilization, with the result that fossilized pollen can be identified in the same way as fresh pollen.

The open spaces in the reticulate exine contain tapetum-derived, easily leaching proteins that play a role during the recognition of the pollen by the stigma. These proteins ensure that the pollen grain will germinate only on a compatible stigma.

At the distal pole, a section of the exine is much thinner than the rest and this part is called the **sulcus** *{Figure* 5). The sulcus is the site where the pollen tube will emerge during germination.

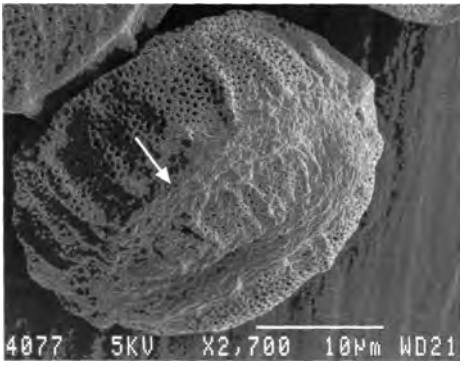


Figure 5. An equatorial view of the distal pole of a *Clivia* pollen grain showing the partly closed sulcus, (arrow).

Dehydration will cause a fold in the sulcus resulting in a change in the shape of the pollen grain as seen in *Figure* 6.

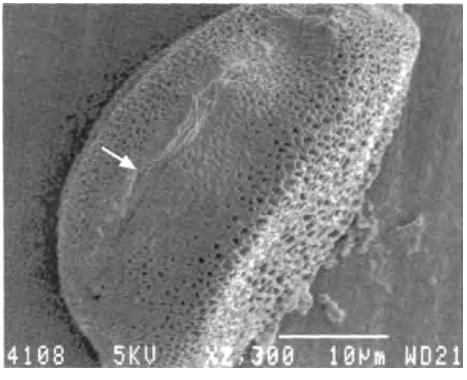


Figure 6. A SEM shoto showing a dehydrated pollen grain of *China* with closed sulcus (arrow).

In the next article we will discuss the process of fertilization, embryo and seed development.

THE CLIVIA PISTIL: STRUCTURE AND FUNCTION

Hannes Robbertse

Clivia seeds can only be formed after the **ovules,** from which they develop, are fertilized. As in all flowering plants, fertilization in *Clivia* is a **double fertilization** process where **two sperm cells** are required for the fertilization of each ovule, one for fertilizing the **egg cell** and the other for fertilizing the **central cell** in the embryo sac contained in the ovule. In the previous paper we explained the origin and development of pollen grains which are the 'carriers' of the precursor of the sperm cells from the anther to the stigma. In this paper the development of the stigma with all its sub-parts will be discussed. To really understand the structure and functioning of the pistil, it is necessary to look at the whole developmental process.

Origin of the flower

Each flower develops from a dome of cells (apical meristem) at the stage when the young inflorescence is still concealed in the leaf sheath, long before actual flowering. Being a monocotyledonous plant, the *Clivia* flower consists of whorls of three units each: one outer and one inner whorl of tepals, outer and inner whorls of stamens and one whorl of carpels. The three **carpel** primordia (initials) giving rise to the pistil, are the last whorl of flower parts formed by the apical meristem. During the development of the tepals and stamen initials (Figure 1), the apex becomes concave so that at the time the carpel initials appear, the young flower base is cup-shaped with the tepal and stamen initials situated at the rim of the 'cup' and the carpels developing inside the 'cup'.

The terminal ends of the folded carpel initials can be seen as three separate units (Figure 1B). They remain separate to form the three lobes of the stigma, while the fused middle parts elongate to form the style. The basal parts of the carpels give rise to the three-locular **ovary,** embedded in the flower base (receptacle). The carpels do not only fuse sideways with the adjacent carpels, but each carpel also fuses at its margins to form a closed ovary cavity (locule).

The **ovules** develop from the inner margins of each carpel and are therefore arranged back-to-back in two rows in each locule (Figure 2).

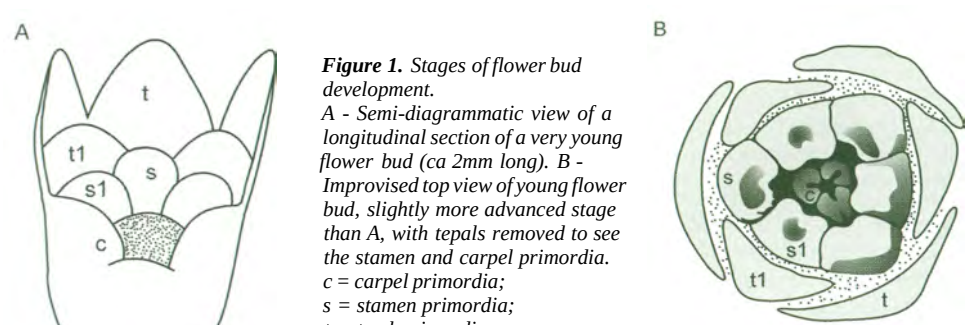
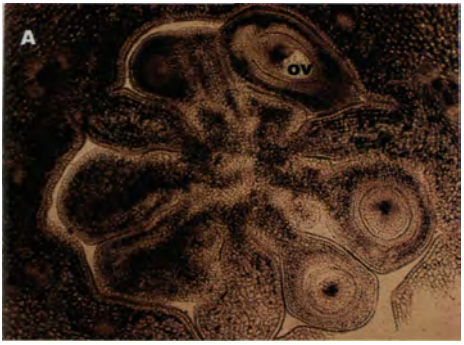


Figure 1. *Stages of flower bud development.*
A - Semi-diagrammatic view of a longitudinal section of a very young flower bud (ca 2mm long). B - Improvised top view of young flower bud, slightly more advanced stage than A, with tepals removed to see the stamen and carpel primordia.
c = carpel primordia;
s = stamen primordia;
t = tepel primordia



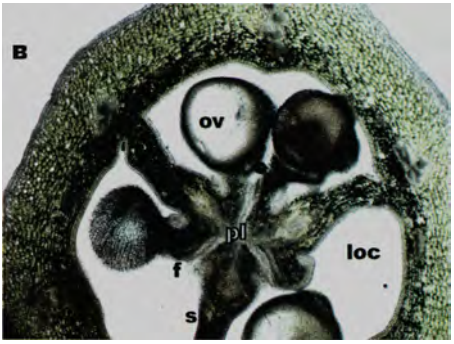


Figure 2. *Cross sections of* **Clivia miniata** *ovary at the stage of A - inflorescence just appearing from the leaf sheath and B - opening of the flower.*
f=funicle; loc = locule (ovary cavity); pi = placenta; s = septum (wall separating locules).

Each ovule is attached to the carpel margin (now the placenta), by means of a **funicle** containing the vascular elements which supply the ovule with water and nutrients.

Development of the ovule

Similar to the whole flower, the ovule develops from a globular cell mass.
The integuments start to develop as ring-shaped outgrowths (at A on Fig. 3) at the base of the globular ovule primordium and finally cover the whole central part now known as the **nucellus.** One of the sub-epidermal cells of the nucellus, close to the apex, start enlarging to form the **megaspore mother cell** containing a diploid nucleus (with two sets of chromosomes).
This cell (at C on Fig. 3) undergoes meiosis and produces four haploid cells (each with one set of chromosomes). Three of the haploid cells disintegrate (at D on Fig. 3) and the remaining one gives rise to the **embryo** sac. The embryo sac, ready for fertilization, consists of an egg cell accompanied by two synergid cells, one large central cell containing two nuclei, and three antipodal cells (at E on Fig. 3). The egg cell contains a fair amount of cytoplasm with plastids. These plastids also contain DNA which plays an important role in cytoplasmic heredity as in variegated *Clivia.*

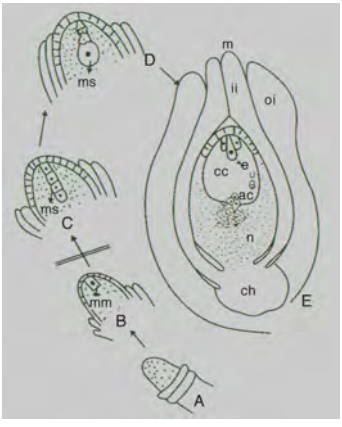


Figure 3. Diagrammatic illustrations of ovular development (A - D) and a line drawing of a young ovule shown in Figure 2A (ov).
a = antipodal cells; cc = central cell; ch = chalaza; e = egg cell; ii - inner integument; m = micropyle; mm = megaspore mother cell; ms = megaspores; n = nucellus; oi = outer integument

Stigma and pollination

The three lobes of the *Clivia* stigma are the unfused terminal parts of the three carpels. In the bud-stage of the flower, the three lobes are pressed together, but shortly after the flower has opened, they separate and unfold. Only the very tip of each stigma lobe becomes receptive to pollen (Figure 4). The receptive stage can be recognized by the appearance of papillae (short hairs) at the tip of each lobe and receptivity will only last as long as the papillae are turgid (swollen with water).

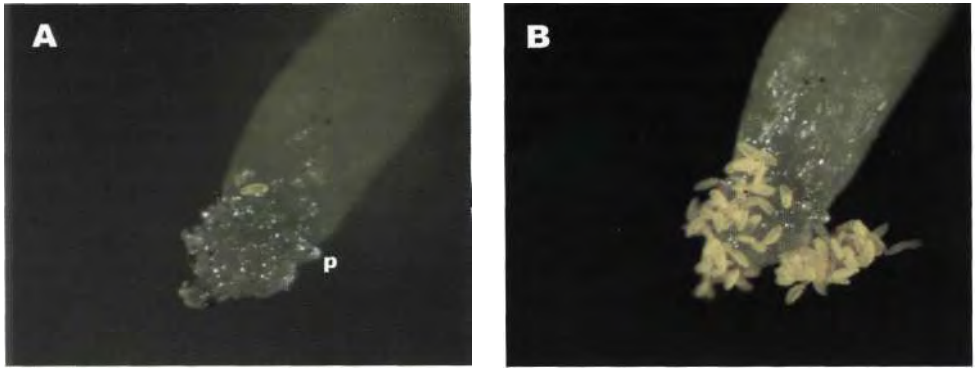


Figure 4. *One lobe of the three-lobed stigma (A) un-pollinated (except for one pollen grain), showing papillae on receptive part and (B) with pollen sticking onto the papillae. Note the mass of pollen on the right sticking together.*

When the stigma is receptive, pollination can be a once-off operation provided that an effective pollen load can be provided on each stigma lobe as demonstrated in Figure 4B. The fresh pollen as well as the stigma papillae are sticky, so that there should be no problem for the pollen to remain on the stigma long enough for gemination. If the pollen is recognized by the stigma papillae (see previous paper), the papillae will supply the pollen grains with water and they will start germinating within an hour.

Figure 5A shows fresh pollen germinated on an artificial medium at 23°C, two hours after the pollen was placed on the medium and Figure 5B shows the same medium with pollen 24 hours later. For good results stored pollen must be tested before being used for pollination.

The papillae on the receptive part of the stigma are actually outgrowths of the upper epidermal cells on the 'open' tips of the stigma lobes. This 'upper' epidermis also lines the inside of the stigma and the ovular

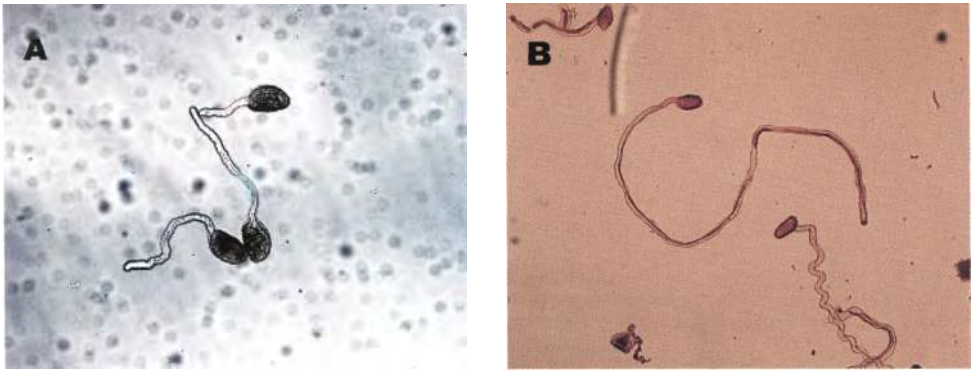


Figure 5. In vitro *germination of clivia pollen, two hours after the pollen was placed on the medium (A) and 24 hours later (B)*

cavities and forms the transmitting tract for the pollen tube from the stigma to the ovules in the ovary. Under favourable conditions pollen tubes can reach the ovules within 24 hours after pollination. One pollen grain is required for each ovule, since the pollen tube growing from the grain, carries only two sperm cells which are both needed for fertilizing one ovule. However, the more pollen tubes taking part in the'race' to the ovules, the better the chances for only the strongest to fertilize the ovule.

After reaching the ovule, the pollen tube enters the ovule through the micropyle (see E on Fig. 3) and the two sperm cells are deposited into one of the synergid cells. From there they move on their own - one fertilizes the egg cell and the other fertilizes the central cell.

Seed development

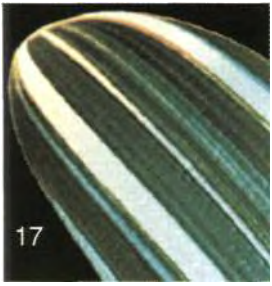
After fertilization, the zygote (product of fusion) resulting from the fertilized egg cell goes into a resting phase. The triploid nucleus of the fertilized central cell, however, divides rapidly to form a great number of free endosperm nuclei before cell formation will start from the outside, progressing towards the centre of the original embryo sac. The zygote of the fertilized egg cell starts dividing during the free nuclear stage of endosperm development and gives rise to the embryo of the seed.

In my first paper (see p. 11) I mentioned that *Clivia* has naked seeds (without a seed coat). However, as can be seen in Figure 3E, the young ovule does contain two integuments.

The ovule at E in Fig. 3 was taken from the ovary of a very young (Figure 2A) flower bud (at the stage when the inflorescence was just emerging from the leaf sheath). The two integuments are well developed and the embryo sac is complete. At a later stage (Figure 2B), when the flower has just opened, the embryo sac is occupying most of the volume of the ovule and the integuments have deteriorated to merely a few layers of epidermis cells. These cells deteriorate further during seed development so that in the mature seed, there is hardly anything left of the original integuments and no true seed coat can be distinguished except for the brown hypostaze remaining in the chalazal zone. The mature seed, therefore, consists of an embryo enveloped in a mass of endosperm. The tip of the radicle (embryonic root of the embryo) can be seen as a round spot opposite the brown spot (hypostase) on the mature seed.

Acknowledgments

The photographs used in this paper were taken by members of the Laboratory for Microscopy and Micro-analysis of the University of Pretoria.



THE GREAT CHINESE CLIVIA 'BUBBLE'

John van der Linde

The tulip 'bubble' in Holland in the 1630's is well known. The events are briefly summarized below, as an introduction to what happened in China around 350 years later.

Over a three-year period rare tulip bulbs changed hands in Holland for sums that would have bought a house in Amsterdam! Thousands of people, from the wealthiest of merchants to the lowliest of street traders, were caught in a frenzy of buying and selling.

The most valuable bulbs were rare, and the flowers they produced were extraordinarily beautiful (usually due to a mosaic virus, which caused an attractive streaking). However many bought, not because they wanted the plants, but to sell on at a profit. Prices had already risen rapidly for more than two years. Buyers believed that the huge sums the bulbs commanded were justified by the fact that they were in high demand and in short supply. Prices were confidently expected to go higher still.

But then the bubble burst. Tulip prices dropped suddenly and without warning. Within a matter of days confidence evaporated and flowers plummeted to one-tenth or less of their old values.

By the end of February 1637 men who had been amongst the richest in Holland had lost everything they had, and those who had invested heavily in tulips faced bankruptcy and ruin. The tulip mania had run its course.

Similar plant-related manias have recurred from time to time, fed on the human emotions of appreciation of beauty and greed for money. There was a craze for dahlias in France around 1838. In 1912 it was the turn of Dutch gladioli to enjoy a very similar, but equally short-lived, boom.

Clivia had their turn in the 1980's when a mania broke out in China, almost exactly following the pattern of the Dutch tulip craze three and a half centuries before.

Clivia reached China from Europe in the latter half of the 19th century, introduced by German missionaries. A secondary introduction occurred when the Japanese invaded China from 1931 onwards. They annexed Manchuria in the north-east and set up Puyi, ('the last Emperor' who had been forced to abdicate as a six year old boy as Emperor of China in 1912) as their 'ruler' of the occupied territory. Changchun was made the seat of government of the Japanese puppet state and Puyi had his palace and court there. Changchun lies just below the 44th parallel, some 850 kilometres to the Northeast of Beijing. It is today the capital of Jilin Province, which has over 26 million inhabitants.

Japanese horticulturists brought some excellent flowers from Japan, including *Clivia.* Also, rare *Clivia* were presented to Puyi by the Japanese emperor. These 'royal' plants could only be seen at the palace in Changchun at receptions, banquets, funerals, etc, as ornamental plants. Thus they could only, in practice, be enjoyed by a small number of the Japanese, the royal family, courtiers and high government officials. Laymen had no access to these particular plants.

At the end of the Second World War the three north-eastern provinces were recovered and Puyi was disgraced. From 1945 onwards *Clivia,* including the rarer specimens, slowly became accessible to a wider public, but how did this occur?

The Emperor's second concubine, Jade Years, had died in 1942 and her funeral was held at the Guardian Wisdom Temple in Changchun where a pot of *Clivia* was displayed on the orders of Emperor Puyi. This pot was not returned to the palace after the funeral and the plant continued to be cultivated by a monk of the temple. This plant was duly named 'Monk' when it reappeared in the 1960's.

A pot of *Clivia* taken from the palace was later presented to Chanchun Park. To celebrate the People's Liberation this plant was named 'Great Victory'. Another pot came into the possession of the manager of the Changchun Tung Hsing Dyeing Factory This plant became known as 'Dyer'.

Until the later 1950's plants only became available from offsets, so it was difficult for many *Clivia* enthusiasts to have even one super quality plant. Then growers began to pollinate the flowers, as they did with cherry flowers, and in the early 1960's a crossbreeding union was established. Over the next few years excellent plants were developed, like 'Engineer Huang' and 'Painter' (Botanists are known in China as Plant Engineers, and Huang was a botanist or horticulturist rather than someone working with machines). Ownership of special plants rapidly became more widespread.

Then came the Cultural Revolution, which lasted from 1966 to 1976. Young people, the so-called Red Guards, campaigned to destroy remnants of the old society. They destroyed temples and historic sites, and broke into private homes to smash and burn books, jewellery and art. In Changchun many special *Clivia*, which had historically been seen as a mark of distinction and thus elitist, were destroyed, and prominent *Clivia* growers were amongst those who faced persecution and even death.

Clearly, many *Clivia* plants escaped destruction because by 1980, it is estimated, half the families (maybe 150,000) in Changchun grew the flower. Indeed, the flower was so prominent that it was designated the official flower of the City.

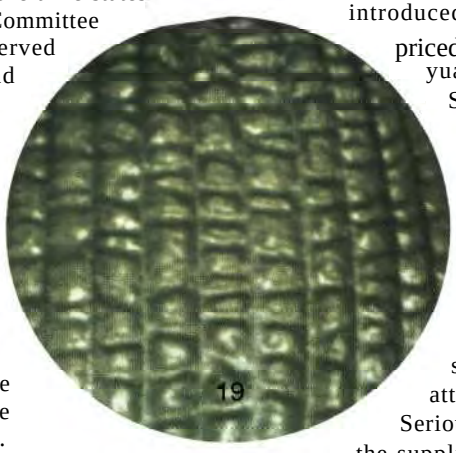
Until this point it would seem that *Clivia* growing, and serious breeding, was largely confined to just one city, Changchun.

Clivia mania only broke out in earnest a few years later, after the Chinese government had commenced a process of economic reform. Markets sprang up for all sorts of products, including household plants. The situation in Changchun was then quite similar to that in Holland during the 1630's. Because of the increased economic activity people had surplus cash at their disposal, but investment (as opposed to spending) opportunities were few. In these circumstances, the *Clivia* growers, especially the serious breeders in Changchun, took advantage of the increasing investment demand for their flowers from neighbouring regions. As one pair of writers put it, 'The development came into a sudden luxuriant phase, and *Clivia* fever quickly occurred in the three provinces in the North-eastern Region of China, and the wave later reached nation-wide. At a time *Clivia* swept the whole nation.' As prices began their inevitable rise, speculation - financed in many cases with borrowed money - followed right behind.

In 1981 or 1982, prior to the boom, desirable plants were selling for 100 yuan. I don't

know the equivalents at the time, but at 2001 rates of exchange 100 yuan would get you around R100 or 12 US dollars. This was already a considerable sum of money for a plant, given the low level of incomes then usual in China. But by 1985, plants with the loveliest characteristics are reported to have changed hands for the stratospheric amount of 200,000 yuan, an amount that puts even the sums paid at the height of the Dutch tulip craze to shame. In fact, the highest prices quoted during the Chinese *Clivia* mania were equivalent to around 300 times the then annual earnings of the typical Chinese University graduate, a quite staggering sum.

A newspaper article of the time states The Communist Party Committee of Changchun City observed these cases seriously and established a *Clivia* control public office to watch transactions and prosecute tax evasion. However, it does not seem to be an easy thing because many of the officials of the City and the authorities themselves are *Clivia* enthusiasts!' At one time up to 30000 people were trading plants each day.



In such circumstances it is hardly surprising that the *Clivia* craze was short-lived even by the standards of flower manias. It collapsed in the northern summer of 1985. The whole market was quickly flooded with panicked dealers desperate to sell, and prices fell sharply. Just as the Chinese boom had exceeded even the heights attained during the tulip years, so the crash, when it came, was still more severe. By the time the *Clivia* market stabilised at last, prices had plunged by anything up to 99 per cent. As contemporary Chinese writers have said, Trice of *Clivia* fell into the bottomless pit.'

Through the boom and bust of every flower mania there are those who persist in their enthusiasm. The same writers refer to *Clivia* lovers who are 'unchanged in their infatuation' and who 'respect and are intoxicated with such richly elegant royal beauty'. They add 'as consistent introduction of excellent cultivars of *Clivia* continues, its history of development will lead to the brilliant future'.

Thus, as *Clivia* ceased to be a public craze, they nevertheless remained a private passion amongst dedicated collectors. Large sums were still demanded for highly regarded plants. For example, 'Sparrow *Clivia'* was introduced to the market in 1992, priced post-mania at 180000 yuan. A plant 'Steel Wall Short-Leaf which had been awarded a gold prize at a Chinese Flower Exhibition was traded at a price in the order of 100,000 yuan. The fashion amongst serious collectors tends to be to cultivate single specimens of the most attractive plants.

Serious growers try to keep the supplies of the most favoured plants low. They thus try to maintain prices - rather like pharmaceutical companies exploiting the drugs they have developed and patented - and resist the temptation to risk flooding this specialist market, because rarity commands a premium. In time, even rare plants become more commonplace, so growers continually try to breed new plants that will be attractive to connoisseurs; how many Chinese *Clivia* are today being sold around the world? There is nothing new in this - it is all good capitalistic logic and marketing strategy, is it not?

Looking at the four flower manias I have mentioned - tulips ex Central Asia, dahlias ex Mexico, gladioli from Africa and the Middle East, and *Clivia* ex South Africa - and their associated price 'bubbles', there seem to be several common factors, including

In each case the plants were not indigenous;

They were relative newcomers to the markets in which they had become highly desirable;

It was not the native species that were in demand, rather people craved the newly developed advanced strains;

There was a long time lag in years from seed to mature flowering plant, i.e. a high 'anticipation factor';

Demand, fuelled by borrowings, increased substantially but, because of the long growing time, supplies could not be increased immediately;

In each case, confidence, which had fed on itself and sustained prices, collapsed, bringing the market crashing down.

In the case of *Clivia*, there is an additional factor, possibly unique to China, which may explain why their boom reached such dizzying heights. *Clivia* (Jun zi Ian, or noble orchid in Mandarin) beautify and are hardy and long-lived. They are symbolic of long life, strength and fortitude, qualities highly admired in Chinese culture. Mystique commands a premium price.

Finally two speculations: Just before Japan surrendered to the Allies in August 1945,Soviet forces in north-east China dismantled key industrial installations and removed them to the Soviet Union. Did they 'liberate' any *Clivia* plants at the same time, especially any of those in Puyi's palace?

In March 1960, after release from prison and 're-education', the former Emperor Puyi was given a part-time job as an assistant at the Beijing Botanical Gardens, transplanting seedlings and cleaning hothouses. Who knows, he may even have worked with *Clivia* seedlings bred from the very plants taken from the palace where he had reigned as Emperor?

In writing this article I have relied heavily on four primary sources:

'A random walk down Wall Street', by Burton Malkiel;

'Tulipomania', by Mike Dash;

'Chinese *Clivia'*, by Tao Men and Wang Yung Pao; and

A newspaper cutting sent to John Winter by Yoshikazu Nakamura.

I am sure that there will be readers of this article who will be able to add to (or correct) my interpretation of this interesting episode in the ongoing Great *Clivia* Story.

CLIVIA IN JAPAN

Shigetaka Sasaki

In our view this Clivia Three is incomplete without a full report on the proceedings at the Clivia Symposium held in San Francisco during March 2001. Despite every effort, we have not succeeded in sourcing any part of those proceedings, including any photographs, except this paper, which was translated by Masashi Yamaguchi. The translation was revised by Nicholas Primich and by us. Eds.

Introduction

I am sorry to tell you that Mr Nakamura is not here to join us. As you know, he is Japanese, and one of the best clivia breeders in the world. March is the flowering season of *Clivia miniata* in Japan and he is busy with pollinating his *Clivia* now. One day, he told me, 'Go to Huntington, take photos of *Clivia* instead of me'. I thought he was joking, but afterwards I made up my mind to join the symposium. The reason I came here is that it might be useful for all *Clivia* enthusiasts to share the information of *Clivia* in Japan and Mr Nakamura's breeding results.

Clivia **in Japan**

Clivia generally means *C. miniata* in Japan. Other species, C. *caulescens,* C. *gardenii* and C. *nobilis* are not well known in the Japanese market. Most of the *Clivia* enthusiasts there find the beauty of C. *miniata* in its leaves. They have aimed to breed a *Clivia* with short and broad leaves. They call this strain of C. *miniata* with broad and short leaves 'Daruma'. There are many commercial names in the 'Daruma' strain, based on subtle differences in their unique leaf shapes and variegations. Japanese enthusiasts prefer the variegated C. *miniata* to the usual green one; they also prefer the dwarf shapes to the large one. I do not know much about the naming of 'Daruma'. Daruma is a small doll sold at Buddhist temples as a symbol of good fortune. According to some books, there was a monk called 'Daruma' in old China. Japanese people made a round shaped statue in his image to worship him. I imagine some people thought that the shape of C. *miniata* with round and short leaves looked like a 'Daruma' doll in some ways, and came to call that type of C. *miniata* the 'Daruma' strain.

I go on to explain the variegation types. There are seven types of variegation in Japan as follows (FU means 'variegation' in the Japanese language):

1. FUKURIN 2. SHIMA-FU 3. AKEBONO-FU 4. NEGISHI-FU 5. NAKA-FU 6. TORA-FU 7. GENPEI-FU

TORA-FU means 'Tiger Variegation' because the variegation looks like the stripes on a tiger's body. A TORA-FU Clivia named 'TAIHOH' is well known to Japanese enthusiasts, but the variegation is caused by virus infection. Japanese enthusiasts consider that variegation like very thin strings is the best form of variegation but it seems that a more contrasting variegation is preferred in other countries.

AKEBONO-FU is very popular among enthusiasts in Japan. Multiplication of these

plants usually depends on production of offsets, because we cannot breed good AKEBONO from seed easily. AKEBONO plants are still rare in Japan and therefore much sought after by enthusiasts.

AKEBONO plants with long and narrow leaves have been common for a long time but AKEBONO Daruma (short and broad leaf type) plants are not common. According to some *Clivia* breeders, when they tried pollinating common AKEBONO plants by using Daruma strain's pollen, most of the seedlings did not keep the vivid white colour of the AKEBONO variegation when they matured, and were not suitable for sale. Therefore AKEBONO Daruma plants are still rare.

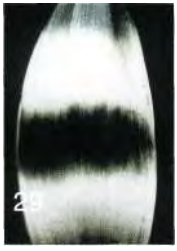
I remember that Mr and Mrs Abel raised AKEBONO plants from Nakamura seeds and recently one of them had a yellow flower. I think AKEBONO will be more popular all over the world in the future. In Japan because we prefer the Daruma strain of *Clivia*, we must breed AKEBONO Daruma that will keep a good variegation after it matures.

I think that the Japanese favouring the dwarf C. *miniata* with variegation and unique leaf shapes is related to the history of Japanese horticulture. In the Edo period of Japan (1603- 1867), gardening popularity was at its height. This enthusiasm ranged from the ordinary citizens to the ruler called 'Shogun'. All of them tried to collect wild mutations and to trade these plants at very high prices.

There are two plants upon which the Japanese model their *Clivia;* one is 'OMOTO' *(Rhodea japonica* Roth) which belongs to the *Liliaceae* family; the other is 'FUHKIRAN' *(Neofinetia faciata)* which belongs to *Orchidaceae* family. These two species look like the 'Daruma' strain in leaf shape, they have various forms of variegation and some of the commercial names of both these plants are the same as those of the Daruma strain *Clivia.* There are many points of appreciation in their leaf shapes and variegations. In the case of 'FUHKIRAN', enthusiasts also appreciate their beautiful red or blue roots. The variety of leaf shape and variegation in the 'Daruma' strain is not yet more perfect than what is found in these two plants. I hope that another new form of variegation will be bred in the future to please *Clivia* enthusiasts.

As mentioned earlier, the 'Daruma' strain has been welcomed by Japanese traditional plant enthusiasts. They have dominated *Clivia* in Japan and consequently the Japanese have not focused on the flower. Twin type C. *miniata* plants have been on sale at gardening shops for the past few years. They are called 'GRANDIFLORA' in the Japanese market. They are quite small in size and flower in two or three years from germination. They are useful for breeders because they do not need a large space and shorten the growing period. What is now required is to breed a yellow or variegated one in this strain. In fact 'yellow' C. *miniata* has become quite common in the past few years and I can say that interest in flower variety is now becoming popular in Japan. *Clivia* breeders may well now aim to breed better *Clivia* in this country, which have a well balanced appearance with both beautiful flowers and leaves with a good variegation.

Over the past twenty years, Mr Nakamura has dedicated himself to breed special *Clivia*



Left to right:
FUKURIN;
SHIMA-FU;
AKEBONO-FU;
NEGISHI-FU;
NAKA-FU;
TORA-FU (TAIHOH);
GENPEI-FU;
AKEBONO TORA-FU

hybrids including new flower forms and colours. Having regard to the preferences in the Japanese market, which I have described above, by doing this Mr Nakamura has isolated himself in that market and has suffered hardship for many years.

I think his excellent breeding results have been based on 'VICO Yellow'.

Mr Nakamura's breeding results based on 'VICO Yellow'

There are already several articles explaining how Sir Peter Smithers created this wonder 'VICO Yellow' and why the plant was introduced to Japan, but I will tell you the story briefly. Sir Peter Smithers kindly sent an offset of 'VICO Yellow' to Dr Shuichi Hirao who was an innovative botanist in Japan. The plant flowered in 1984. After Dr Hirao's death, Mr Nakamura took over his whole collection including 'VICO Yellow' and then started to breed new *Clivia.* The reason why Mr Nakamura used 'VICO Yellow' as a pollen parent is because it has special genetic qualities as follows :

1. 'VICO Yellow' hybrids will produce large flowers with good forms.
2. 'VICO Yellow' hybrids will produce a well reflexed petal.
3. 'VICO Yellow' pollen is very fertile and produces a good seed set.

I will introduce you to four typical Nakamura hybrids that are good samples of the above three points.

C. miniata 'Chiba Orange'

'CHIBA Orange' and 'CHIBA Yellow'

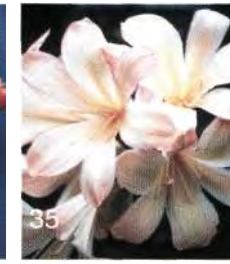
These two plants have the characteristic large flowers. Mr Nakamura says that 'CHIBA Orange' has the largest flower of his hybrids. The flower size is three times that of the usual C. *miniata.* The petals are well reflexed as a result of the genetic influence of 'VICO Yellow'. The outer petals of 'CHIBA Yellow' are more reflexed than those of 'VICO Yellow'. The flower form as a whole looks more sophisticated than 'VICO Yellow'.

C.miniata var. *citrina* 'Chiba Yellow'

'Waved-Petal Yellow' and 'Rolled-Petal Orange'

As an experiment in naming I called these two plants 'Waved-Petal Yellow' and 'Rolled-Petal Orange' after their flower forms. 'Waved-Petal Yellow' (photo 32) has a very unique flower form with playful spirits. It might be interesting to create a 'Waved-Veined-Petal' *Clivia,* 'Waved-Petal with red tips' Clivia and 'Waved-Petal Peach' *Clivia* and so on. 'Rolled-Petal Orange' (photo 33) also has a unique flower form which might not appeal to everybody. However, this plant has the potential to develop new flower forms. If one crosses 'Rolled-Petal Orange' with C. *gardenii,* C. *caulescens* or C. *nobilis,* extremely unique hybrids may result.

Mr Nakamura says that although the pollen of 'VICO Yellow' fertilizes other *Clivia* well, the seeds from this pollen tend to be large. Consequently we cannot expect to harvest a good quantity of seed from 'VICO Yellow' pollen.



When you use 'VICO Yellow' pollen only once {eg. (orange x yellow)xVico Yellow}, it is possible to get a high percentage of good flowers with twice the size of the usual *C. miniata* and also with good rolled and waved petals.

One problem is that 'VICO Yellow' hybrids are quite large sized plants just like 'VICO Yellow'. When I think about the Japanese *Clivia* market, the next goal of 'VICO Yellow' hybrids is to create dwarf leafed hybrids or multi-petal hybrids based on these special 'VICO Yellow'hybrids.

Mr Nakamura's Interspecific Hybrids

I would like to introduce Mr Nakamura's interspecific hybrids to you. His Fl hybrids of (C. m*iniata* x C. *gardenii)* are called 'Candoll' (photo 34), a name inspired by 'Christmas Candle' because they usually begin to flower at Christmas time. These hybrids have tubular orange flowers, the flowers are half-erect from the stem (this is because of the C. *miniata* influence), some have open flowers, some have pale orange petals, some have green tips on the petals (this is because of C. *gardenii* influence) and they show a range of variations (e.g. see photograph 41 on Page 50 of CLIVIA YEARBOOK 1998 - Eds.)

He mostly used orange C. *miniata* as the mother plant of"Candoll'. Therefore, the plants often have flowers in which anthocyanin dominates chlorophyll on the petals. If you pollinate yellow C. *miniata* with C. *gardenii*, it is possible to create a new 'Candoll' with marked green tips on the petals. I would like to share with you more information about interspecific hybrids. They show a light white stripe on the centre of the leaf. Mr Nakamura told me that this stripe is one of the characteristics of interspecific hybrids, not only in the case of (C. *miniata* x C. *gardenii).*

His Fl hybrids of (C. *miniata* x C. *caulescens)* mostly have pendulous flowers. The genetic influence of C. *caulescens* seems to be stronger than that of C. *miniata* in this case. It seems that the characteristic of C. *caulescens* also appears on the tip of their leaves. There is a Fl hybrid called 'Day Dream' (see photo 29 in Yearbook 2): {(orange C. *miniata* x yellow C. *miniata)* x (C. *caulescens* x yellow C. *miniata)}.* This plant shows excellent pendulous flowers and we can also recognize a characteristic of C. *caulescens* in its leaves. The flowers are quite open compared with other interspecific hybrids. The inside of the petals is green to start with, then changes its colour to yellow. I am not certain how he created such a good flower, but it really is outstanding and is of a very high quality. He has also created hybrids of which the flowers look like C. *miniata.* He tried breeding hybrids by using cobalt 60 before. He created 'CHIBA ZAKURA' (photo 35) in the end. This plant has so many flowers that the umbel is like a ball. The flower colour is slightly orange. This may be because of the influence of cobalt 60.

I was able to see a totally white flower when I visited Mr Nakamura's greenhouse in February of last year. The flower was small and not well open. The base was strong green. Actually it was an interspecific hybrid. There is also a near white interspecific flower called 'Chameleon', the colour of which

Interspecific hybrid - white

Clivia miniata 'Veined Petal'

changes from strong green to near white, then a little red appears on the tips at the end. This means this flower contains some anthocyanin. In this regard I can refer to Mr Wessel Lotter's comments about the genetic dilution of anthocyanin in his article in CLIVIA YEARBOOK 1998. So it is possible to create a totally white flower by interspecific hybridization.

It seems that one of the Nakamura hybrids called 'Veined Petal' (photo 37) was bred by crossing orange C. *miniata* with yellow C. *miniata.* His F1 hybrid between 'Veined Petal' and yellow C. *miniata* will produce both pigmented and unpigmented seedlings, but I think pigmented seedlings will grow to have more interesting flowers.

He has also created a 'Super Multi-Petal' flower, which is a mutation of a multipetaled plant and has forty to fifty petals. What is more he created a 'Folded Petal' flower of which the stamens are attached to the inner petals.

Mr Nakamura is very interested in Chinese people's enthusiasm for *Clivia.* However up to now their interest has been mainly based on leaf shapes and the form of the plants seen as a whole. He often says if their interest will extend to the variety of flowers, they will communicate more with South Africa, the *Clivia* homeland, USA and Australia - countries in which *Clivia* breeding is far advanced. Then *Clivia* will become even more popular in the future. That is his dream. He sometimes visits China and provides Chinese breeders with his various *Clivia* hybrids. He has made continuous efforts to report wonderful developments in the breeding of *Clivia* to the Chinese people.

Clivia flower colour mutation

Finally, I would like to share with you two articles written by Japanese botanists. Both articles explain about the pigment 'anthocyanin' which I am most interested in these days.

One is from a report 'Analysis of pigmentation in C. *miniata'* written by Professor Takao Matsuno.

'As the result of analysis, I can say as follows. Orange C. *miniata* contains pelargonidin (which is one of the anthocyanidin pigments) and carotinoid. On the other hand, yellow C. *miniata* contains only carotinoid. In other words, orange C. *miniata* contains red pigment and yellow pigment. Please refer to the following data. The content of pigment is expressed by (ug/g).

	Anthocyanidin Content:	Carotinoid Content:
Commercial C. *miniata*	21.4	21.4
Wild C. *miniata A*	26.5	35.6
Wild C. *miniata* B	20.2	24.6
Yellow C. *miniata*	0.0	16.0

According to the above data, orange C. *miniata* contains both pigments equally or some plants contain more carotinoid than anthocyanidin. However, yellow C. *miniata* contains no anthocyanidin and in addition contains less carotinoid compared with orange C. *miniata.* There are many kinds of anthocyanidin which make factors of red, pink or purple colours. Some plants contain several anthocyanidin pigments. C. *miniata* contains only pelargonidin. It is possible to make a flower colour variation from just pelargonidin, but we cannot anticipate a purple or blue flower unless there is a sudden mutation. There are so many kinds of carotinoid: carrot contains *Bc*arotene; yellow *Ginkgo* leaf contains lutein; C. *miniata* contains both carotinoids as follows.

	lutein	*B*carotene
commercial C. *miniata*	61%	13%
wild C. *miniata*	68-70%	12%
yellow C. *miniata*	61%	9%

According to the above data, a plant with less carotinoids will show a whiter flower, a plant with more carotinoids will show a more yellow flower. C. *miniata* also contains other carotinoids; they might be a half generation of carotinoids/

Another article is from a book named The Mystery of Flower Colour' written by Dr. Hitoshi Yasuda.

The process of generating various kinds of anthocyanin is as follows. At first, some gene generates orange coloured pelargonidin type anthocyanin. We call it gene B. Gene B is essential for generating pelargonidin type anthocyanin. Then we suppose gene C that is essential for generating red coloured cyanidin type anthocyanin. Gene C generates cyanidin type anthocyanin from pelargonidin type anthocyanin. Then we suppose gene D. Gene D generates purple-blue coloured delphinidin type anthocyanin. Without gene D, purple-blue coloured pigment is not generated from cyanidin type anthocyanin. The genetic dominance of flower colour is in the following order in nature: orange-red-purple-blue. This means that a pelargonidin type will be dominant to a cyanidin type and a cyanidin type will be dominant to a delphinidin type.'

While the thought may be far from reality, we could try to make a sudden mutation of pelargonidin in C. *miniata* by using cobalt 60 or chemicals. Then it might be possible to breed blue *Clivia.* Then this might lead us in another direction to extend the range of flower colour of *Clivia.*

Clivia minita 'Ghost'

I am not a *Clivia* specialist. I am just one of the *Clivia* enthusiasts and my breeding ability is limited. But as one of the enthusiasts who believe in the potential of *Clivia,* I would like to put my breeding ideas into practice and cooperate with other *Clivia* lovers. I wonder if I can create just one new flower so that I can share that joy with all *Clivia* lovers.

Note that where the author refers to 'yellow C. *miniata'* the taxanomically correct description is *C. miniata* var. *citrina.* Eds.

MANIPULATION OF FLOWERING PERIOD AND SHOOT MULTIPLICATION IN CLIVIA MINIATA REGEL

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DEPARTMENT: Plant Production and Soil Science DEGREE: MSc(Agric): Ornamental Horticulture

Craig Honiball completed his MSc on flower manipulation and shoot multiplication of Clivia miniata *in the Department of Plant Production and soil Science (Horticulture), University of Pretoria, concurrently with a BCom. degree.*

Abstract

Clivia miniata Regel is widely cultivated as a garden ornamental and a pot plant and can be forced to flower outside the natural flowering period by applying a cold treatment. Under local conditions this could be achieved by using a treatment of *7.5* to 10 °C for 14 days. This caused a significant number of the cold treated plants to flower earlier in the season with the result that the naturally short flowering period could be extended. The 14 day period of cold treatment which was required was shorter than a period of 60 days previously described.

Little information exists regarding its use as a cut flower. It was found that inflorescences could be harvested at the stage when all flowers were still closed and that more than 90% of flowers opened and developed normal colouration either in distilled water or in a commercial postharvest product (Chrysal AKC™). The product also reduced the incidence of stem splitting.

Clivia has been propagated *in vitro* with varying degrees of success but the methods are still relatively slow. Commercial protocols for propagation exist but have not been published. Therefore, the use of *in vivo* foliar applications of paclobutrazol (PAC) and Promalin™ (PRO), to stimulate branching and shoot formation, was investigated.

The main effect of PAC could be seen as the stimulation of bud formation from meristematic zones on the abaxial side of leaf bases in the older, proximal axils. The mean number of shoots produced by PAC at concentrations between 250 and 25 000 ppm varied from 2.3 to 7.1 per plant, without any statistically significant difference between treatments. However, at concentrations of 5 000 ppm and higher, growth inhibition was unacceptable. PRO had the effect of stimulating bud formation from leaf bases situated near the apical meristem, in the younger distal axils. PRO also caused dichotomous branching of apical meristems. PRO applied 10 times, at 200 or 500 ppm a.i., resulted in branching of 50% of treated plants into 2 or 3 modules. However, the latter results could not be analysed statistically. The most significant benefit arising from the use of PRO was survival of the parent plant without any inhibition of vegetative growth. Both PAC and PRO had a negative effect on flowering at the concentrations tested. The use of PAC to stimulate *in vitro* shoot formation was attempted unsuccessfully, probably due to an inappropriate medium composition.

An understanding of plant architecture is important when trying to manipulate propagation and phenology. *Clivia* has a modular growth form and exhibits sympodial branching under natural circumstances.

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Abbreviations

a. i.	: active ingredient	l	: litre
CHRYS	:ChrysalAKC™	ml	: millilitre
cm	: centimeter	mm	: millimeter
2,4-D	: 2,4-dichlorophenoxyacetic acid	mg	: milligram
dH_20	: distilled water	M	: Mol/ litre
g	: gram	MS	: Murashige and Skoog
GA_3	: gibberellic acid	PRO	: Promalin™
GA_4	: gibberellin no.4	PAC	: paclobutrazol
GA_7	: gibberellin no. 7	ppm	: parts per million

INTRODUCTION

Literature Review

Botany and history

The genus *Clivia* Lindl. belongs to the family Amaryllidaceae and comprises 4 species; C. *miniata* Regel, *C. nobilis* Lindl., C. *caulescens* R A Dyer and C. *gardenii* Hook. Interspecific hybrids have been created (Lotter, 2000) but no reliable reports of successful intergeneric hybrids involving *Clivia* could be found, despite attempts at such crosses having been made (Niederwieser, 2000). The chromosome number in all four species of *Clivia* is 2n = 22 (Ran, Murray & Hammet, 1999). *Clivia* spp. are indigenous to the eastern regions of southern Africa and their natural habitat varies from coastal forest to secondary coastal dunes and tree trunks (Winter, 2000). Many attractive forms exist in shades of pink, orange (Glover, 1985), apricot (Smith, 1999), yellow (Morris, 1990), red (Lotter, 1998) and near white (McNeil, 1985). *Clivia* has a modular, sympodial growth form and inflorescences are produced terminally on modules. This pattern is similar to that seen in other amarylids such as *Hippeastrum* sp. (Rees, 1985) and *Cyrtanthus* sp. (Slabbert, 1997).

Clivia has been in cultivation in Belgium for approximately 150 years where it is still grown today (De Koster, 1998a). It also enjoys popularity in China (Nakamura, 2000), Japan (Nakamura, 1998), Australia (Smith & Henry, 1998) and North America (Koopowitz, 2000).

Cultivation

Investigation of optimal growing conditions for *Clivia* with respect to lighting and temperature have been undertaken in Japan (Mori & Sakanishi, 1974), and Europe (Vissers & Haleydt, 1994, De Smedt, Van Huylenbroeck & Debergh, 1996). An outline of growing conditions and stages of *Clivia* production in Belgium has also been described (De Koster, 1998 b). By contrast, in local production of *Clivia* there is often no control of growing temperature and flowering occurs mainly from August to September. Propagation of *Clivia* occurs largely through seed which results in heterogeneous offspring. However, amongst certain groups or strains, elucidation of the mechanism of inheritance of flower colour makes this characteristic predictable (Morris, 1990, Lotter, 1998, Tarr, 2000). Commercial tissue culture methods for clonal propagation have been developed (Smithers, 2000, Chapman, 1999) but these protocols have not been published. No reports could be found on commercial *Clivia* cut flower production and few reports exist on postharvest treatment of cut flowers (Nowak & Rudnicki, 1990, Zhang *et al,* 1991).

Biochemistry and physiology

Various biochemical and physiological studies have been conducted on *Clivia,* for example an investigation of the chemical composition of endodermal and hypodermal cell walls (Schreiber *et al.*, 1999) and water relations of the hypodermis (Casado & Heredia, 1998). The structure and function of leaf cuticles has also been studied (Dominguez & Heredia, 1999) and various secondary metabolites have been isolated (Evidente *et al,* 1999).

Aims

The aim of this project was to determine whether manipulation of growing temperature as used in Europe could be applied under local conditions to extend the short natural flowering period of C. *miniata.* It was then felt that if better control of the flowering period could be achieved, more attention might be given to the possibility of *Clivia* as a cut flower crop. Therefore, peduncle splitting and picking stage of *Clivia* cut flowers was investigated. Cut flower

cultivation or accurately programmed cultivation requires having large quantities of clonal material available. However, the success gained by following published sources of information on *Clivia* tissue culture is limited. No reports could be found on the use of paclobutrazol to stimulate *in vitro* shoot formation and this was investigated. Nevertheless, tissue culture is not always available to growers and *Clivia* collectors may be reluctant to sacrifice plant material of superior clones. As a result, another alternative was sought. The use of foliar sprays of plant growth regulators to promote shoot formation was seen as a feasible method which could be applied by individual growers.

EXTENDING FLOWERING PERIOD IN *CLIVIA MINIATA* REGEL USING A COLD TREATMENT

Summary

Clivia miniata can be forced to flower out of season by applying a cold treatment which brings about emergence and development of quiescent inflorescences. Plants growing outdoors were exposed to a cold treatment of *7.5* -10 °C for 14 days, commencing during the last week of April. This caused a significant number of the cold treated plants to flower earlier in the season. The implication was that the period during which *Clivia* in flower was available for sale could be extended. The difference in the number of cold treated and control plants in flower was most noticeable in the period from 12-19 weeks after commencement of the cold treatment. The 14 day period of cold treatment which was required for successful forcing under local conditions was shorter than a period of 60 days previously described.

Introduction

Flower forcing is undertaken in many species in order to prolong the period in which plants are in flower or to have plants in flower for specific occasions (De Hertogh *et al*, 1997). *Hippeastrum* sp. is an example of the Amaryllidaceae which can be successfully forced (Sandler-Ziv *et al*, 1997). It has been shown that *Clivia miniata* can be brought into flower outside its natural flowering period by manipulating growing temperature (Mori & Sakanishi, 1974, Vissers & Haleydt, 1994, De Smedt, Van Huylenbroeck & Debergh, 1996). *Clivia* has a modular, sympodial growth form and inflorescences form terminally on modules. Modules are produced as two or more recurrent flushes per growing season, depending on cultural conditions. Inflorescences remain quiescent until a cold stimulus is received which stimulates elongation of the peduncle and further development of the inflorescence. It appears that the inflorescence is only able to respond to the cold stimulus once it has reached a minimum size and it is known that flower initiation is linked to the production of a certain number of leaves (De Smedt et al., 1996). In local production of *Clivia*, there is often no control of growing temperature and flowering occurs mainly from August to September. The aim of this experiment was to determine whether a cold treatment could bring plants grown outdoors into flower earlier. It was hoped that this would extend the naturally short flowering period and ultimately increase sales and revenue to *Clivia* growers. In addition, the fruit wall is a source of explant which can be used in *in vitro* culture of *Clivia*, but the seasonality of flowering has been a limiting factor in the application of this technique (Finnie, 1998).

Materials and methods

The trial was conducted in the east of Pretoria at a nursery situated on the north facing slope of a hill where *Clivia* are grown under

70% black shade net. The experiment comprised 100 mature plants with at least 12 mature (fully elongated) leaves on each plant. Plants were growing in 6 liter plastic bags. Fifty randomly selected plants were removed from the nursery for the cold treatment and 50 plants remained as the control. The cold treatment comprised placing plants with plastic bags intact, in a dark, unventilated cold room for 14 days. The temperature was maintained between *7.5* and 10 °C and oscillated from minimum - maximum - minimum every 4 hours. The period of cold treatment was chosen after exploratory investigations indicated that 14 days was sufficient to bring plants into flower. This is in contrast to a period of 60 days at 10 °C previously described for successful forcing of *Clivia* (Mori & Sakanishi, 1974). After the cold treatment, plants were returned to the nursery. At weekly intervals, the number of plants whch had reached the marketable stage was recorded for both treatments. A plant was defined as marketable when it had a normally elongated peduncle with some orange colouration in the perianth, but before any flowers were open. The air temperature in the nursery, at leaf canopy level, was recorded for the duration of the experiment using a thermograph which had been calibrated with a mercury thermometer. A Chi square test was used for the statistical analysis and required data from weekly observations to be combined into fortnightly data. The number of observations at each fortnightly interval was large enough for analysis only from week 12 onwards. A two way table of the two treatments versus time for the four fortnightly periods (effective sample size = 87) was used to test the null hypothesis which proposed that there was no relationship between treatment and time.

Results and discussion

Figure 2.1 shows the weekly minimum and maximum air temperatures in the nursery for the duration of the experiment from 24 April 2000 (week 0) to 04 September 2000 (week 19). It is apparent that maximum temperatures fluctuated between 16 and 27°C and minimum temperatures between 2 and 11°C. Figure 2.2 shows on a weekly basis, over 19 weeks, the percentage of plants in each of the two treatments which had reached the marketable stage. Figure 2.3 (combined data) shows the percentage of plants in each treatment which had reached the marketable stage for the four fortnightly periods from week 12-19. The number of plants at marketable stage was equal to zero until and including week 6. After 19 weeks, 96% of cold treated plants and 94% of controls had flowered, but Figure 2.2 and 2.3 indicate the trend whereby cold treated plants flowered before controls. Table 2.1 is the two way table of treatment versus time and shows title observed and expected values from the Chi square test for cold treated and control plants ($P < 0.0001$). It indicates that for the first two fortnightly periods (week 12-13 & 14-15), the number of cold treated plants which were marketable, was significantly higher than expected while in the control treatment the number was significantly lower than expected. Conversely, during the last two periods (weekl6 -17 & 18-19), the number of plants at the marketable stage was significantly lower than expected for cold treated plants and significantly higher for controls. This result allowed rejection of the null hypothesis and it was concluded that the cold treatment was effective in increasing the number of plants available for sale early in the season when control plants were not marketable yet. It can therefore be deduced that one will be able to extend the period during which *Clivia* is available in flower by applying a cold treatment of relatively short duration, as described, to a portion of plants intended for sale in a specific season.

Prior to the abovementioned experiment, two exploratory investigations were carried out. In the first, a similar cold treatment was applied to outdoor grown plants at the beginning of February and flowering occurred in March and April.

In the second, flowering size plants were placed in a greenhouse which was heated from the beginning of April to the end of August so that exposure to winter cold was eliminated. These plants did not flower during the natural flowering period when plants outside were in flower. A cold treatment was then applied at the end of November and brought some of the plants into flower in January and February. Therefore, it is felt that it may be possible to even further extend the flowering period in *Clivia.* However, these results could not be statistically tested and will need to be verified. Further work could try to find out whether a cold treatment can be effectively applied earlier or later than the last week in April. The earliest and latest dates for successful forcing could also be determined. The phenomenon of negation of the effect of a cold treatment when followed by high growing temperature can also be investigated.

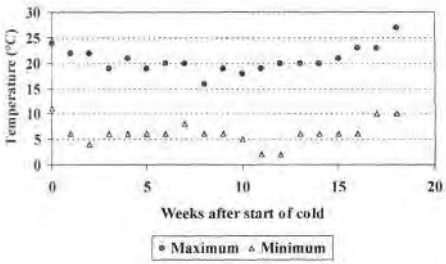


Figure 2.1 Weekly minimum and maximum air temperatures at leaf canopy level from week 0-19

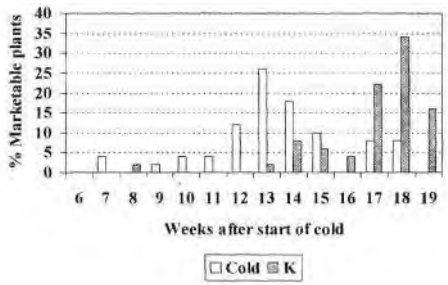


Figure 2.2 Percentage of plants at the marketable stage from week 6-19

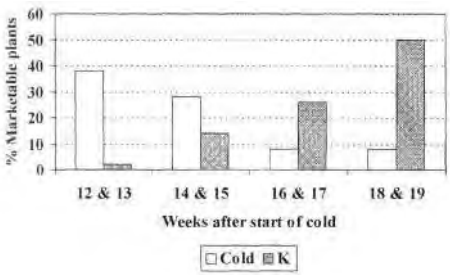


Figure 2.3 Percentage of plants at the marketable stage for the fortnightly periods from week 12 - 19

Treatment	Week			
	12 & 13	14 & 15	16 & 17	18 & 19
Cold	19 (9)	14 (10)	4 (8)	4 (14)
K	1 (11)	7 (11)	13 (9)	25 (15)

Table 2.1 Two way table of treatment versus time with observed and expected () values for cold treated (Cold) and control (K) plants. Expected values were btained from a Chi aquare test ($P<0.0001$) Effective sample size = 87

THE POTENTIAL OF *CLIVIA MINIATA* REGEL AS A CUT FLOWER

Summary

Clivia miniatA RegeL is widely cultivated as a garden ornamental and a pot plant. It occurs in many attractive shades of orange, red, yellow and pink but little information exists regarding its use as a cut flower. The possibility of picking cut flowers when all the flowers on the inflorescence were still closed and forcing flowers to open in distilled water and in Chrysal AKC™ (CHRYS) was examined. A forcing temperature of 21 ± 2°C and an irradiance of 22 ± 3.10^{-6} mol photons m^2S^{-1} was used. After 190 hours, in both distilled water and CHRYS, more than 90% of flowers had opened and developed normal colouration. However, after 96 hours, 90% of inflorescences held in distilled water and 10% of those in CHRYS had developed peduncle splitting. The mechanism involved in the prevention of splitting is unknown but it is suspected that sucrose may have caused this.

Introduction

Clivia miniata is widely cultivated as a garden plant in South Africa and has been cultivated as a pot plant in Europe for many years. Many attractive forms exist in shades of pink, orange, (Glover, 1985), yellow (Morris, 1990) and near white (McNeil, 1985) but few reports on *Clivia* cut flowers could be found (Drysdale, 1990, Nowak & Rudnicki, 1990). Furthermore, it appears that the flowering period of *Clivia miniata* can be manipulated to some extent by regulating growing temperature (Mori & Sakanishi 1974, De Smedt, Van Huylenbroeck & Debergh, 1996, Chapter 2 of this dissertation) and lighting (Vissers & Haleydt, 1994). Therefore, it was felt that the subject of *Clivia* cut flowers warranted further attention and that picking stage and the occurrence of peduncle splitting should be investigated.
The recommended cutting stage for *Clivia* (Nowak & Rudnicki, 1990) is when 25% of the flowers on the inflorescence have already opened. In order to facilitate handling, packaging and longer vase life it was felt that it was important to determine whether flowers could be picked at a more closed stage.

Materials and methods

Flowers were picked from a suburban garden during late afternoon and transported dry to the laboratory within an hour. It follows then that the effect of extended periods of dry storage of flowers such as may occur, for example, if flowers are transported by airfreight, was not investigated. The prevailing air temperature in the laboratory was 21 ± 2°C and the irradiance at a height of 25 cm above the inflorescences was 22 ± 3.10^{-6} mol photons m^2s, provided by Osram™ cool white fluorescent tubes. Figure 3.1 shows the developmental m^2s^{-1} of the inflorescences when picked; all flowers were closed but some colouration could be seen in the perianth. Ten inflorescences were placed in CHRYS (40g CHRYS/litre distilled water) and ten in distilled water. The Chrysal product was chosen because it is used to enhance opening of carnations and other flowers cut in the bud stage. The number of open flowers was recorded as a percentage of the total number of flowers on each inflorescence over a period of 190 hours. Furthermore, the number of split peduncles which occurred in each treatment was recorded. Longitudinal sections of split peduncles which had been embedded in paraffin wax were examined. A meaningful statistical analysis was not possible due to scarcity of material and the short natural flowering period.

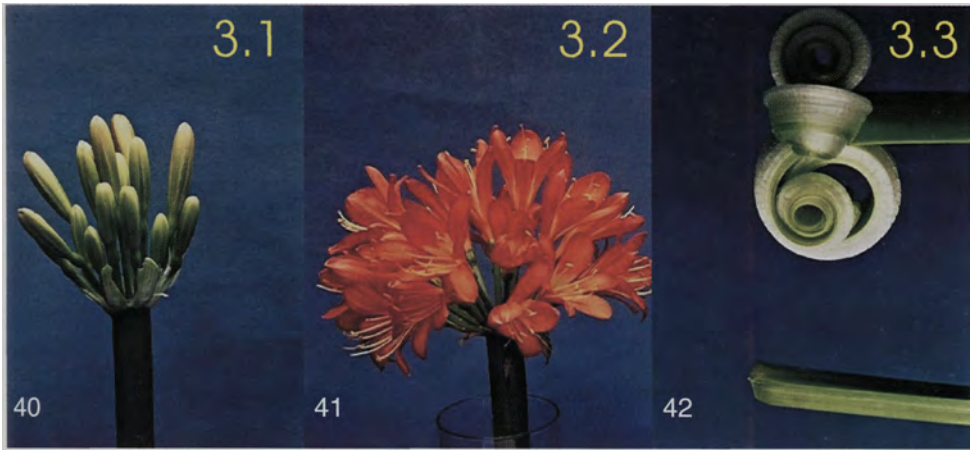


Figure 3.1 Development stage of *Clivia miniata* infloresences at picking.

Figure 3.2 Colour development in *Clivia miniata* flowers on an infloresence picked at the stage when all flowers were unopened and kept in distilled water for 6 days at 21 ± 2°C and an irradiance of 22 ± 3.10^{-6} mol photons m^{-2}s^{-1}.

Figure 3.3 Split (top) and unsplit (bottom) peduncles of *Clivia miniata* held in distilled water and 40g/l Chrysal AKC™, respectively

Results and discussion

After 190 hours (8 days), 99% of flowers kept in CHRYS and 95% of those in distilled water had opened (Table 3.1). In addition, colour development in the open flowers was normal (Figure 3.2). It was also observed that 90% of the inflorescences held in distilled water had developed peduncle splitting after 96 hours. This only occurred in 10% of stems held in CHRYS over the same period. In addition, the degree of splitting was much less severe when using CHRYS and was restricted to the tip of the peduncle. It appeared that equal numbers of flowers opened on inflorescences with split and unsplit peduncles. Figure 3.3 shows split and unsplit peduncles kept in distilled water and CHRYS, respectively. The mechanism by which splitting was prevented is unclear. However, the same problem occurs in *Hippeastrum* cut flowers due to extensive expansion of the inner parenchyma tissues. Splitting could be prevented by pulsing *Hippeastrum* stems in a 0.125 M sucrose or KNO_3 (potassium nitrate) solution which was thought to have conditioned the parenchyma in the basal portion of peduncles to withstand rapid expansion (Halevy & Kofranek, 1984). From sections of split *Clivia* peduncles, a difference in the size of inner and outer parenchyma cells could be seen (Figure 3.4). The chemical composition of CHRYS is a trade secret and is therefore not known. However, it is suspected that sucrose is an ingredient and that it may have reduced the incidence of splitting.

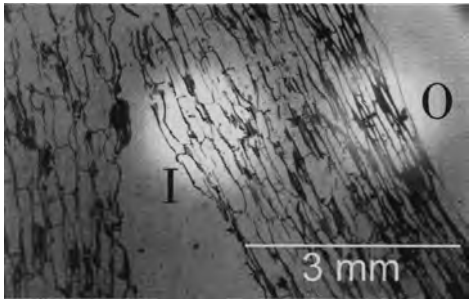


Figure 3.4 Longitudinal section of a split peduncle, showing inner (I) and outer (O) parenchyma tissues

Table 3.1 Mean number of open flowers (x) with standard deviation (s) on inflorescences held in 40g/l Chrysal AKC™ and distilled water (dH_20) over a period of 190 hours at 21 ± 2°C and an irradiance of 22 ± 3.10^{-6} mol photons m^2s^{-1}. The number of open flowers is expressed as a percentage of the total number of flowers on the inflorescence, n = 20

Hours		0	29	63	113	190
Chrysal	x	0	27	65	93	99
	s		7	15	8	1
dH_2O	x	0	23	48	78	95
	s		13	15	14	12

From the investigation it is concluded that it is possible to harvest *Clivia* cut flowers at a stage when all flowers are still closed and that a large proportion of the flowers will open with normal colour development under the conditions described. It seems that the problem of stem splitting can also be overcome by placing stems in CHRYS. Further work can be done to establish whether flowers will successfully open under conditions of lower irradiance than used in this experiment and to clarify the processes which cause and prevent stem splitting. The optimum treatment time and the possibility of using pulse treatments for prevention of stem splitting could also be determined. In addition, the effect of commercially available pretreatment products on the rate of flower opening and longevity could also be examined. Furthermore, the effect of dry storage of flowers on vase life, flower opening and stem splitting should be investigated.

PROMOTION OF SHOOT FORMATION IN *CLIVIA MINIATA* REGEL WITH PACLOBUTRAZOL AND PROMALIN™

Summary

Propagation of superior clones of *Clivia* occurs through division of basaly produced suckers which is relatively slow or by tissue culture which is not always readily available to growers. This study investigates the use of paclobutrazol (PAC) and Promalin™ (PRO) (benzyl adenine + GA_4 + GA_7) as a foliar spray to promote shoot formation. It was found that PAC promoted bud formation in the axils of older proximal leaf bases and the mean number of shoots produced at concentrations between 250 and 25 000 ppm PAC varied from 2.3 to 7.1 without any statistically significant difference among treatments, 7 months after application. However, at concentrations of 5 000 ppm and higher, growth inhibition was unacceptable and death of the parent plant occurred in some individuals due to abortion of the apical meristem. GA_3 applied 3 times, at 500 ppm, appeared to be useful in alleviating growth inhibition caused by PAC, but the effect could not be quantified. It was found that PRO also promoted branching, but from the axils of younger, distal leaf bases. PRO also resulted in dichotomous branching of apical meristems. When applied 10 times, at either 200 or 500 ppm a.L, PRO resulted in acrotonic branching of 50% of treated plants into 2 or 3 modules. However, the latter results could not be analysed statistically. The most significant benefit arising from the use of PRO was survival of the parent plant without any inhibition of growth.

Introduction

Clivia miniata can be vegetatively propagated by division of suckers. The rate at which suckers are produced varies from clone to clone and is often not satisfactory.

Published tissue culture methods are still imperfect, resulting in varying degrees of success (Wang, Li & Yang, 1995, Finnie, 1998, Chapman, 1999). In addition, tissue culture facilities are not available to many amateur growers who are in possession of desirable clones. This investigation was undertaken to determine whether the plant growth regulators paclobutrazol and Promalin™ could be used as a foliar spray to promote shoot formation and branching in *Clivia.*

Paclobutrazol (PAC) has been used in *in vitro* propagation to stimulate shoot formation in a range of plants such as *Nerine* sp. (Ziv, Kahany & Lilien-Kipnis, 1994), *Gladiolus* sp. (Nagaraju, Parthasarathy & Bhowmik, 1997) and *Tulipa* (Kuijpers & Langens-Gerrits, 1997). PAC applied as a foliar spray resulted in production of side shoots in *Cordyline* sp. (Higiladi & Watad, 1992) and when applied to *Clivia* to reduce plant size, caused the same effect (Van Huylenbroeck, 1998). However, in the latter work, a wide range of concentrations was not tested and the yield of shoots was relatively low. PAC is a plant growth regulator which inhibits the synthesis of gibberellic acid (Grossmann, 1990). However, in *in vitro* culture of potato, growth inhibition could be reversed by using GA_3 in the medium (Simko, 1993).

Benzyl adenine (BA) can also be used to stimulate shoot formation. This was achieved in *Cordyline* sp. (Maene & Debergh, 1982) and *Geranium* (Foley & Keever, 1992). In *Spathyphyllum* sp. grown *in vitro,* shoot induction by B A was dramatically enhanced in the presence of imidazole fungicides. As with PAC, the latter effect was obtained by inhibition of GA_3 production (Werbrouck & Debergh, 1995, Werbrouck *et al,* 1996). PRO (GA_4 + GA_7 + BA; 19g/l active ingredient) is registered in South Africa for the promotion of branching in apples (Vermeulen, Grobler & Van Zyl, 1997).

Materials and methods

PAC (Cultar™; 250g/l active ingredient) was applied to flowering size plants as a foliar spray until run off, at concentrations of 1, 2, 4,10, 20, 50 and 100ml Cultar™ /l, corresponding respectively to 250,500,1000, 2500, 5000,12500 and 25000 ppm a.i. Eight replicates per treatment were used. The number of shoots formed was then recorded and the statistical analysis comprised a regression analysis of the number of shoots formed as a function of concentration. An analysis of variance (ANOVA) using Tukey's least significant difference was done to determine whether the mean number of shoots differed significantly among the treatments (a = 0.05).

Alleviation of PAC induced growth inhibition by GA_3

A small number of plants (8) were used to determine if the growth retarding effect of PAC could be alleviated by GA_3. Ten months following a PAC spray at 25 000 ppm, GA_3 (Berelex™ 1OOg/kg a.i.), at a concentration of 500 ppm, was applied to 4 of the plants treated with PAC. Three applications were made; a single spray until runoff, every fortnight, for six weeks. The plants treated with PAC had produced a large number of stunted, basal shoot primordia.

Promalin™ application through the leaves

In a second set of flowering size plants, a foliar spray of PRO until runoff, was applied during April when plants were not in flower. Concentrations of 5.3,10.4 and 26.3 ml PRO/1 were used (corresponding respectively to 100, 200 & 500 ppm a.i.). Ten applications were made; one application every second day, for 20 days. Eight replicates of each treatment were used. The number of plants which reacted was then recorded.

After observation of the effects of the first PRO application, PRO was applied to a third set of plants for the purpose of an anatomical investigation (page 42). A concentration of 375ml PRO/1 (7125 ppm a.i.) was applied to a small number of seedlings at the six leaf

43

44

THE HABITAT

43 & 44 *Clivia miniata* from the same mutating population

45 *Clivia gardenii* from the same population as the yellow form shown in CLIVIA YEARBOOK 2 - photo 25

46 *Clivia caulescens* yellow form

stage. The solution was painted onto the crown and leaf axils of each plant with a paint brush, wetting the areas until runoff. Two application regimes were used; a single application per plant and three applications per plant. In the case of three applications, one application was given fortnightly, for six weeks. At various intervals, plants were harvested for anatomical investigation.

Promalin™ application through the roots

In a fourth set of plants, seedlings at the 6-8 leaf stage, an attempt was made to apply PRO via the root system. All soil was washed from the roots before plants were placed in an aerated water medium (hydroculture). The nutrient solution comprised Chemicult™ hydroponic nutrient powder at the rate of 0.5g /l. After 1 month, a PRO spray was applied to the roots at concentrations of 0,4 750 and 7 125 ppm a.i. comparing one and three applications. In the case of three applications, roots were sprayed once every evening, for three days. After removing plants from hydroculture in the early evening and allowing them to dry for 10 minutes, PRO was sprayed onto roots until runoff. After spraying, roots were covered in a plastic bag to prevent evaporation, left overnight and returned to hydroculture in the morning. After the last spray, plants were replanted in a decomposed bark medium. Each treatment was replicated eight times.

Anatomical investigation

An anatomical investigation was conducted to elucidate shoot architecture and to identify the origin of shoots produced after PRO and PAC treatments. Material was prepared by fixation in formalin acetic acid alcohol followed by dehydration in sequential alcohol and alcohol xylene mixtures. After embedding in paraffin wax, microtome sections were cut and stained with toluidine blue (O'Brien & McCully, 1981).

Results and discussion

The effect of paclobutrazol

Ten months after the application of a 2 500 ppm PAC foliar spray, a clearly visible reduction in plant height could be seen (Figure 4.1). This was accompanied by branching in the older proximal axils of leaf bases (basitonic branching) which was especially prolific at higher concentrations. At and above concentrations of 5 000 ppm PAC, complete and near complete disintegration of the parent plant and much of the root system occurred in some individuals (Figure 4.2). However, it follows that the viability and probability of survival of shoots on plants compromised to this extent would be much reduced. It was interesting to note that PAC caused the death of the apical meristem, but stimulated bud formation in the meristematic zones in the axils of basal leaves (Figure 4.10).

Seven months after PAC application, a relationship between PAC concentration and the number of shoots formed could be found and was given by $S = 2.799 + 0.179\ k - 0.001\ k^2$ where S and k represented the number of shoots and PAC concentration, in ml Cultar/l water, respectively (Figure 4.3). All three terms were highly significant ($Pr > t$; <0.0001, <0.0007 and <0.0044 respectively). A low value for R^2 (0.22) was obtained and indicates that there were other factors which also played a role in the number of shoots formed. Since the plants used were raised from seed, genetic variation is likely to have played a role. This was true for the response of different cultivars of *Gladiolus* to PAC (Nagaraju *et al*, 1997). The ANOVA indicated that the number of shoots formed at all PAC concentrations differed significantly from the control, but not from one another (Table 4.1). The effect of PAC on flowering was negative because of death of the apical meristem. Furthermore, existing inflorescences disintegrated completely at concentrations of 5 OOOppm and higher and where this did not occur, peduncles were unacceptably short.

Figure 4.1 Reduction in plant height 11 months after application of 2 500 ppm paclobutrazol (front) compared to the untreated control (back).

Figure 4.2 Disintegration of the parent plant and root system 13 months after application of 25 000 ppm paclobutrazol.

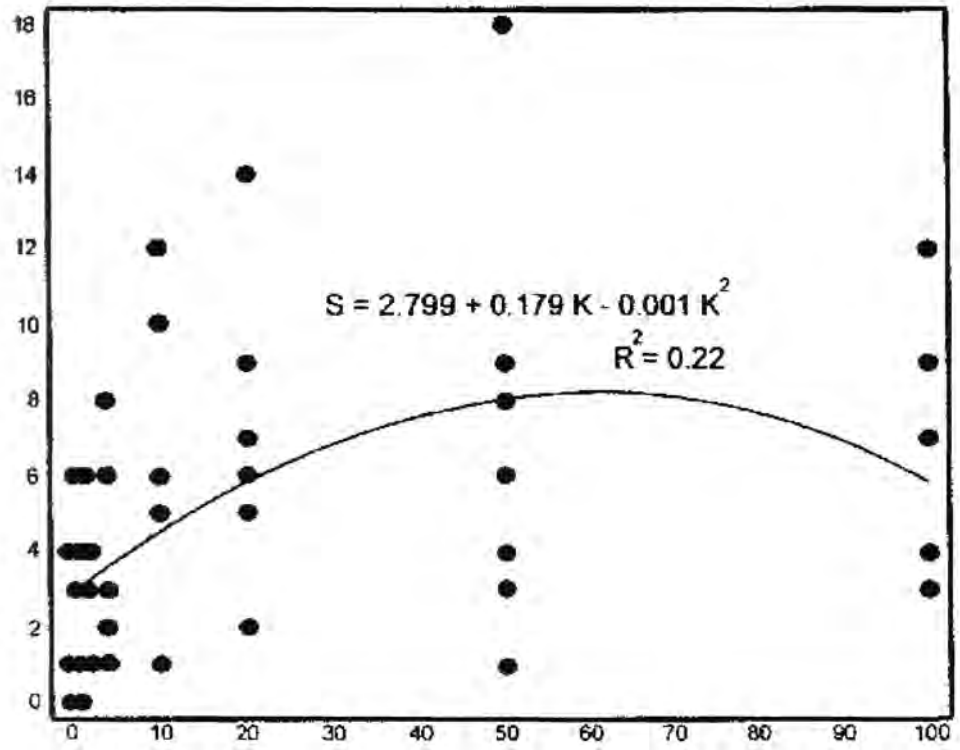


Figure 4.3 Regression analysis of number of shoots as a function of paclobutrazol concentration (ml Cultar™/l). $R^2 = 0.22$.

Table 4.1 Mean number of shoots as a function of paclobutrazol (PAC) concentration (ml Cultar™ /l), seven months after application. Means with the same letter do not differ significantly a = 0.05, Tukey, n = 64.

ml Cultar™ /l	0	1	2	4	10	20	50	100
Mean number of shoots	1	2.3[a]	3.3[a]	3.5[a]	7.1[a]	6.5[a]	6.6[a]	6.1[a]

Alleviation of PAC induced growth inhibition by GA3

It appeared that the 3 applications of GA_3 at 500 ppm alleviated the inhibition caused by PAC to some extent (Figure 4.4). It was felt that the use of GA_3 could have practical benefits but its effect could not be quantified or statistically analysed.

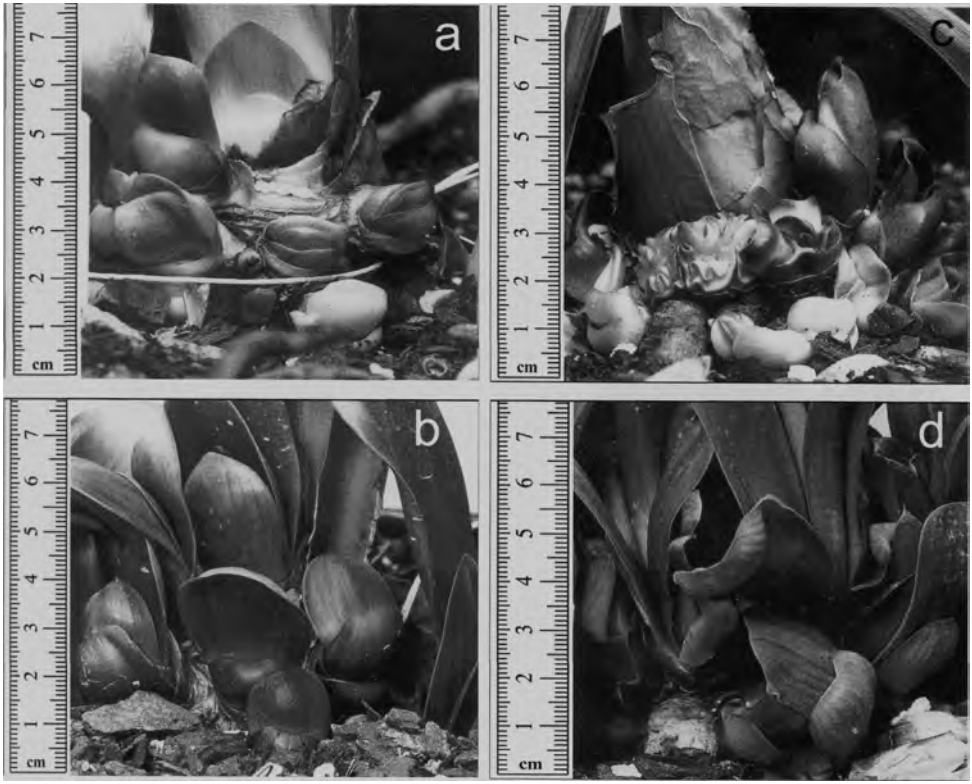


Figure 4.4 Alleviation of growth inhibition after application of 25 000 ppm paclobutrazol. Ten months after application of PAC, following formation of shoot primordia, 3 fortnightly applications of GA_3 at 500 ppm were made. Photo taken two months after the last application of GA.

a: Plant no. 1 before, without GA_3. c: Plant no. 2 before, with GA_3.
b: Plant no. 1 after, without GA_3. d: Plant no. 2 after, with GA_3.

Promalin™ application through the leaves

The result of PRO application was branching of treated plants in the region around the apical meristem. Shoots formed in this way were different in morphology to those formed by PAC in the sense that leaf size and shape were normal (Figure 4.5). One year following the 10 applications of PRO at 0,100, 200 and 500 ppm, the percentage of plants exhibiting formation of additional shoots was 0%, 25%, 50% and 50% respectively. However, these results could not be statistically analysed. The most significant benefit which arose from the use of PRO was that there was no inhibition of vegetative growth or destruction of the parent plant. However, flowering was negatively affected and deformed flowers could be observed when using 100, 200, 300 or 7 125 ppm PRO (Figure 4.6). The green tissue in the perianth probably occurred because cytokinins promote chloroplast development and chlorophyl synthesis (Salisbury & Ross, 1992) while the abnormal thickness of the tissue in the perianth could be due to cell proliferation and expansion caused respectively by BA and gibberellins in PRO.

Figure 4.5 New (1 & 3) and original (2) modules, 1 year following 10 applications of 500 ppm a.i. Promalin™.

Figure 4.6 Abnormal flower development (right) compared to control (left), after a single foliar application of 7 125 ppm a.i. Promalin™, before emergence of the infloresence.

Promalin™ application through the roots

PRO at 7 125 ppm a.i. proved to be phytotoxic when applied through the roots. When applied at 7 125 ppm a.i., 100% of individuals exhibited necrosis of the root system within two weeks, followed by gradual death of the entire plant. Phytotoxicity could also be observed, to a lesser extent, at 4 750 ppm a.i. Table 4.2 shows the number of plants surviving at the various application rates, 4 months after the last PRO application. From the first experiment in which PRO was applied through the leaves (page 39), it was apparent that visible branching could only be detected approximately 1 year after application. At the date of publication it was not possible to determine whether PRO application through the roots had achieved

Table 4.2 Percentage of plants surviving 4 months after application of PRO to the roots once (lx) and 3 times (3x) at concentrations of 4 750 and 7 125 ppm a.i.

PRO (ppm a.i.)	0	4 750; lx	4 750; 3x	7 125; lx	7 125; 3x
% survival	100	100	62.5	87.5	0

Anatomical investigation

In an untreated mature plant, Figure 4.7 depicts the development of a new module adjacent to the old one which has terminated in an inflorescence. This suggests a modular, sympodial plant architecture (page 51). Potentially meristematic zones are located in leaf axils, on the abaxial side of leaf bases, but no differentiated axillary buds are present (Figure 4.8). These meristematic zones are believed to be the source of new modules produced when a PAC treatment is applied. This would be consistent with the findings that PAC enhanced meristem formation on stem explants of *Tulipa* (Kuijpers & Langens-Gerrits, 1997). Figure 4.9 indicates these zones, accentuated in a seedling, 5 months after treatment with 5 000 ppm PAC while Figure 4.10 indicates a new bud forming in the most proximal axil of another seedling following the same treatment. It is evident that the bud is facing downwards and this is consistent with the 'U' shape which can be observed in suckers attached to the parent plant. At high PAC concentrations, it is believed that bud formation from proximal axillary meristems occurs continuously in subsequent modules and that this is responsible for the prolific regeneration of shoots not characterised by any distinguishable pattern (Figure 4.3). It is believed that the action of PRO is different to that of PAC. Modules formed in response to PRO also appear to arise from axillary meristems but from those directly adjacent to the apical meristem. This is illustrated in a seedling, 3 months after application of PRO at 7 125 p pm a.i., where axillary meristems have given rise to a new module on either side of the original apical meristem (Figure 4.11). In addition, it appears that following the application of PRO to seedlings, dichotomous branching of the apical meristem may occur (Figure 4.12). The occurrence of both dichotomous and axillary branching in the same individual has been observed in a seedling (Figure 4.13).

In mature plants, axillary branching would explain the formation of the shoots in Figure 4.5. It is thought that dichotomy also occurs in mature plants because leaf pairs, fused along the abaxial surface, were seen emerging from the apical meristem after treatment with PRO. These leaves were followed by the emergence of two new modules of similar size; one next to each adaxial surface of the fused leaf pair. Furthermore, it is proposed that in mature plants, pseudodichotomous branching may be the result of an early switch or reversion of the terminal bud from a reproductive to a vegetative stage. (In an untreated plant the reproductive bud would have given rise to the inflorescence.) Following reversion, the new vegetative bud and the axillary bud which was to form the new module after flowering, may then develop further, in the form of two vegetative buds of more or less equal size.

C. *miniata* var. *citrina* "Sarie 50'. Cape Clivia Club Best on Show 2000. Gert Wiese

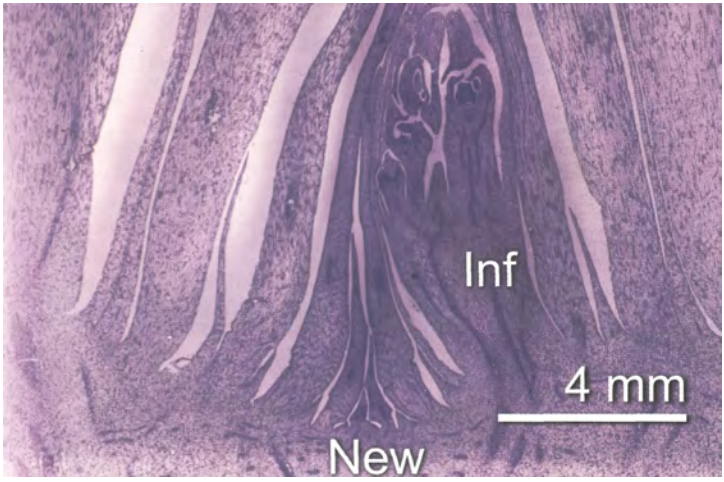
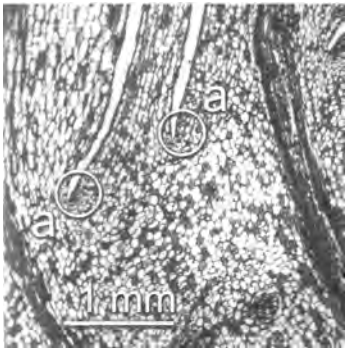


Figure 4.7 Longitudinal section of an untreated mature shoot showing termination of the old module in an infloresence (Inf) and formation of the new module (New).



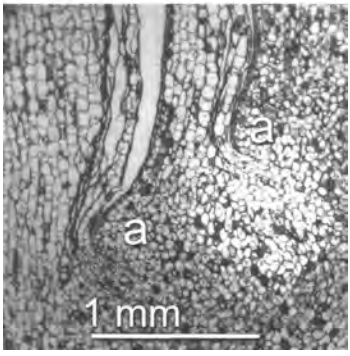


Figure 4.8 (Left) Longitudinal section of an untreated seedling at the 6 leaf stage, showing potentially meristematic zones (a) located on the abaxial side of leaf bases.

Figure 4.9 Longitudinal section of a seedling, 5 months after treatment at the 6 leaf stage, with 5 000 ppm paclobutrazol, indicating accentuated meristematic zones (a).

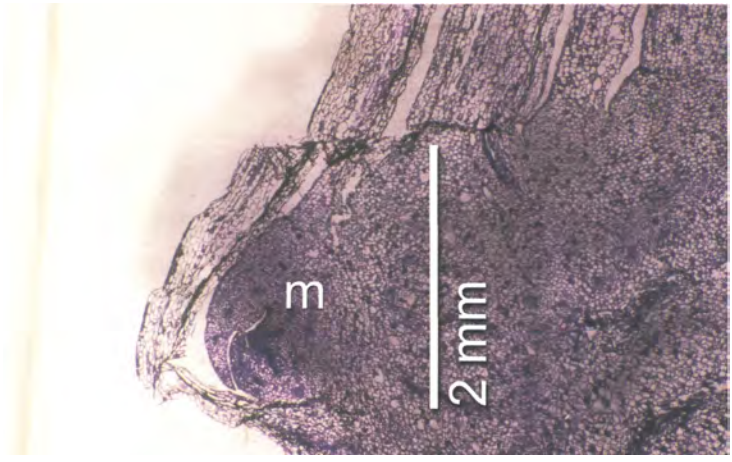


Figure 4.10 Longitudinal section of the most proximal axil of a seedling, 5 months after treatment at the six leaf stage, with 5 000 ppm paclobutrazol, indicating bud formation (m).

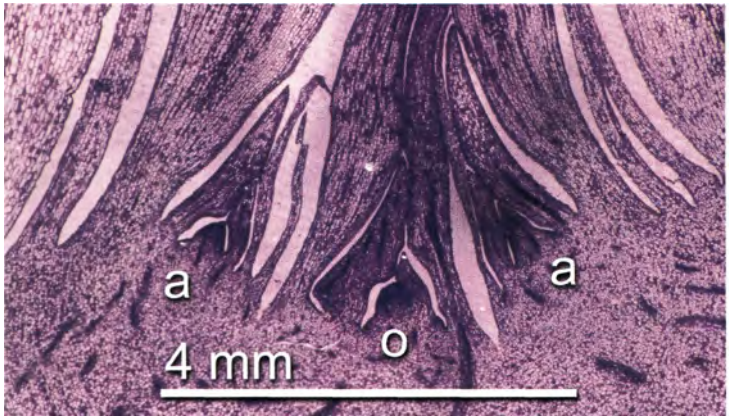


Figure 4.11 Longitudinal section of the apical meristem of a seedling, 3 months after treatment at the six leaf stage, with 7 125 ppm a.i. Promalin™, indicating new modules (a) adjacent to the original apical meristem (o). Note adnation of the buds (a) to the abaxial, basal part of the leaves.

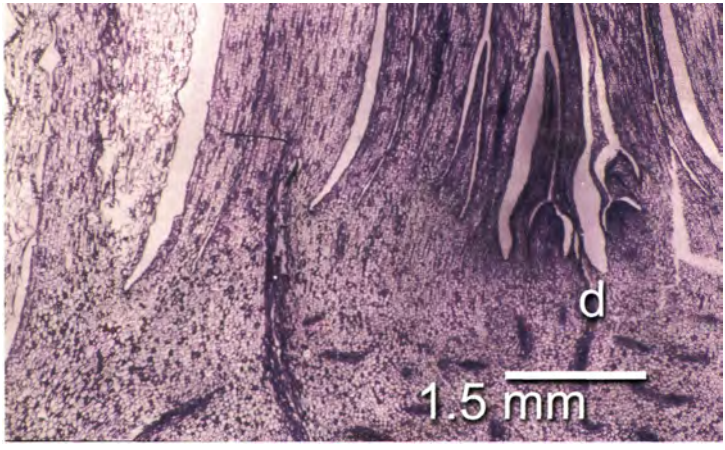


Figure 4.12 Longitudinal section of the apical meristem of a seedling, 2 months after treatment at the six leaf stage, with the first 3 fortnightly applications of 7 125 ppm a.i. Promalin™. Dichotomous branching (d) of an apical meristem is shown.

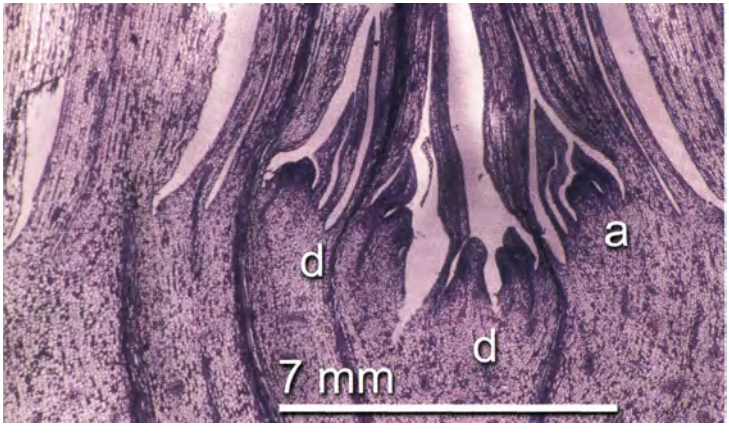


Figure 4.13 Longitudinal section of the apical meristem of a seedling, 3 months after treatment at the six leaf stage, with 7 125 ppm a.i. Promalin™, indicating dichotomous (d) and axillary (a) branching.

Costs of paclobutrazol and Promalin™ treatments

An estimate of the cost of treatment with PAC is based on a price of R480.00/1 for Cultar™. Assume that 10ml of the product is made up to 1 litre with water (2500 ppm a.i.) and that a volume of 10 - 20ml of this solution is applied per plant as a foliar spray. The cost per application, per plant is therefore R0.05 - R0.10. A price of Rl 018.00/l for Promalin™ is assumed. Assume that 375 ml of the product is made up to 1 litre with water (7125 ppm a.i.) and that a volume of 5 -10ml of this solution is applied per plant with a paint brush. The cost per plant, per application is therefore R2.03 - R4.05.

Conclusions and recommendations

From this investigation it is concluded that PRO and PAC can be used to increase shoot production in *Clivia* when applied to foliage but the action of the two agents seemed to differ. PAC stimulated formation of buds in the axils of older, proximal leaf bases while PRO stimulated dichotomous branching of the apical meristem or formation of buds in the axils of younger, distal leaf bases. The negative effect of PAC on flowering was attributable to disintegration of existing inflorescences and death of the apical meristem. In PRO, the negative effect on flowering was attributable to deformation of existing flowers and possible interference with progression of the apical meristem, in mature plants, from the vegetative to the reproductive phase. In addition, vegetative growth inhibition caused by PAC was unacceptable at and above concentrations of 5 000 ppm. PRO had no such effect at all concentrations which were applied to foliage. Further work should be carried out to optimise the use of these substances both in terms of yield and cost. A comparison should be made between the use of a large number of PRO applications at low concentration (approximately 500- 1 000 ppm a.i.) and a small number of applications at high concentration (approximately 5 000 - 7 000 ppm a.i.). It should furthermore be determined at which intervals PRO can be re-applied in order to stimulate successive cycles of branching. The possibility of combining the two agents, for example in a low dose of PAC followed some months later by a high dose of PRO, should be investigated. Other substances such as the imidazole fungicides, which promote shoot formation in the presence of BA could also be tested.

THE USE OF PACLO-BUTRAZOL TO STIMULATE MULTIPLE SHOOT FORMATION IN *CLIVIA MINIATA* REGEL *IN VITRO*

Summary

Clivia has been propagated *in vitro* with varying degrees of success using embryos and fruit wall material as explants but the methods are relatively slow. However, commercial protocols for propagation exist, but have not been published. After observing the stimulatory effect which paclobutrazol (PAC) had on shoot formation *in vivo,* the same technique was attempted *in vitro.* Seeds were germinated on a MS medium supplemented with 20g/l sucrose, 3g/l agar, 0.6g/l Gelrite™, 19/1 myo inositol, 1.4mg/l 2,4-D, 2mg/l benzyl adenine and 3mg/l kinetin. After seven months, the seedlings were dipped in paclobutrazol (PAC) at concentrations of 125 -1 000 ppm before being placed on fresh medium. Five months following application of PAC, there was no evidence of multiple shoot formation and mortality was approximately 70%.

Introduction

Moderate success has been achieved with the *in vitro* propagation of *Clivia.* Zygotic embryos from seeds could be used as the explant material for C. *miniata* (Wang, Li & Yang, 1995, Wang, 1998) and for C. *nobilis* (Min & Jmsheng, 1984). For purposes of propagating a mature plant, fruit wall material could be used (Finnie, 1998). However, seasonal availability of fruit walls at the right developmental stage together with slow plantlet regeneration hampered the development of a commercial protocol. The same conclusion was reached in another study (Chapman, 1999). Nevertheless, it appears that *Clivia* is successfully propagated *in vitro* on a commercial scale in Japan (Smithers, 2000) but the protocols used have not been published. The aim of this study was to examine whether paclobutrazol (PAC) could be used for generation of multiple shoots *in vitro.*

Materials and methods

Seeds were used as the explant material and were germinated *in vitro* following surface sterilisation. Disinfestation occurred in a 2.5% NaOCl solution (JIK™) for 10 minutes followed by rinsing 3 times in sterile distilled water. A Murashige & Skoog (MS) medium supplemented with 20g/l sucrose, 3g/l agar, 0.6g/l Gelrite™, 19/1 myoinositol, 1.4mg/l 2,4-D, 2mg/l benzyl adenine and 3mg/l kinetin, adjusted to pH 5.6, was used. The higher relative cytokinin concentration was chosen in order to promote development of shoots and to suppress root growth. After seven months, plants were dipped in autoclaved PAC solutions and placed on fresh medium. PAC concentrations of 0,125, 250,500 and 1000 ppm were used with 20 replicates of each treatment.

Results and discussion

After 5 months of culture there were no significant signs of new growth or any indication of formation of multiple shoots. Approximately 70 % of explants exhibited necrosis of the shoot in all treatments, including the control. The cause of the low survival rate was probably related to the medium composition, since much better growth was achieved when explants from the same batch were grown under the same conditions but with a different medium (Swanevelder, 2000). Furthermore, the formulation of PAC (Cultar™, 250g/l active ingredient) could not be filter sterilised and therefore necessitated autoclaving. The effect which this may have had on its efficacy is not known.

ILLUSTRATION OF THE NATURAL AND MANIPULATED PLANT ARCHITECTURE OF *CLIVIA MINIATA* REGEL.

Summary

Schematic representations of the natural and manipulated plant architecture of *Clivia* can be used to better understand its phenology and propagation. It is proposed that *Clivia* has a modular growth form in which inflorescences are borne terminally. Under natural conditions, sympodial branching occurs after flower initiation in a module. The number of inflorescences which are produced per season depends on the number of modules produced and this can be manipulated by modifying cultural conditions. The effect of paclobutrazol on architecture could be seen in highly repetitive, basitonic axillary branching while the effect of PRO was to stimulate less repetitive, acrotonic axillary branching and/or dichtomous division of the apical meristem.

Introduction

The juvenile period in *Clivia,* during which no inflorescences are initiated, ends after the production of 12 -13 leaves and may be as short as 12 months depending on growing

conditions and genotype. In general, initiated inflorescences develop up to a certain stage and then enter a dormant period before exposure to a low temperature causes their emergence. Emergence of the inflorescence follows about one year after initiation. Following initiation of the first inflorescence, further inflorescences are produced, on average, after every set of 4-5 leaves. (De Smedt, Van Huylenbroeck & Debergh, 1996). However, no mention is made of modules in the former work and this chapter describes the growth of *Clivia* in terms thereof.

Materials and methods

A thorough morphological study of *Clivia* is not discussed in this dissertation and results obtained in previous chapters were interpreted in terms of existing terminology (Halle, Oldeman & Tomlinson, 1978, Bell & Bryan, 1991).

Results and discussion

Natural architecture

It is proposed that *Clivia* has a modular growth form and that it exhibits sympodial branching under natural conditions. After the juvenile phase, a module consists of about four leaves and a terminal inflorescence. Following initiation of the inflorescence, growth of the flowering module ceases and a new module arises in the axil of a leaf base, adjacent to the inflorescence (Figure 6.1., corresponding to Figure 4.7). When the juvenile stage is ended at the 12-13 leaf stage (De Smedt *et al.*, 1996), it is not known whether the 12-13 leaves present are the product of 3 successive modules with aborted terminal buds or of a single module.

No axillary buds could be seen in *Clivia* and it is interesting to note that instead, meristematic zones which give rise to new buds and modules are situated on the abaxial surface of leaf bases (Figure 4.8 & 4.9). The position of the bud can be described as being displaced in an acropetal direction and adnation to the abaxial surface of the above leaf base occurs (Bell & Bryan, 1991).

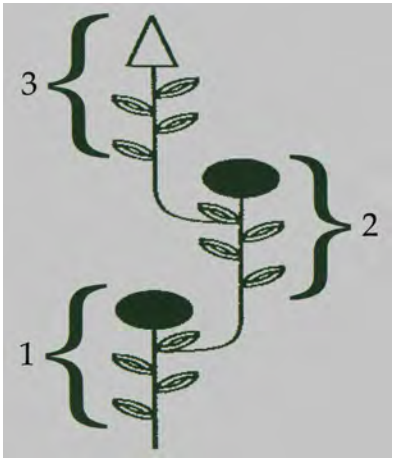


Figure 6.1 Schematic representation of sympodial branching of Clivia under natural conditions indicating a plant with 3 modules (1-3).

More than one module can be produced per year if cultural conditions are favourable, with the result tha.t there may be up to three inflorescences within a plant at a given moment. Two of these may be sufficiently developed to emerge together, or within close succession of each other, once exposed to either a natural or an artificial cold stimulus. Such plants have been referred to as 'twins'. However, if cultural conditions are not favourable, the production of leaves and therefore inflorescences may be slow and plants may not flower every year. Damage by pests or diseases may result in death of the inflorescence at an early stage with the result that not every inflorescence which has been initiated will emerge.
A specific temperature regime is important in the initiation of flowers in a wide range of plants and it seems likely that this may also be true for *Clivia.* From the information available, it appears that at a temperature

of 20 °C, both initiation of flowers and the rate of production of leaves is satisfactory (Mori & Sakanishi, 1974, De Smedt *et al*, 1996, De Koster, 1998). However, emergence of quiescent inflorescences relies on exposure to temperatures below 20°C. The effect of higher temperatures on flower initiation, as may occur under outdoor tropical or subtropical climates is not known.

Manipulated architecture

The effect of paclobutrazol could be seen in highly repetitive, basitonix axillary branching from leaf bases in the proximal, older axils. This is illustrated in Figure 6.2 (corresponding to Figures 4.2 & 4.10).

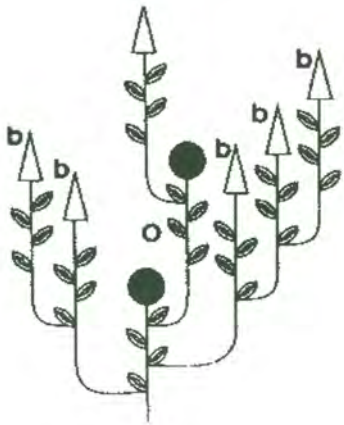


Figure 6.2 Schematic illustration of repetitive basitonic branching in *Clivia* caused by paclobutrazol. The original branch consisting of 3 modules (o) and new branches (b) are indicated.

By contrast, the effectof PRO sprays could be seen in less repetitive, acroronix axillary branching from leaf bases in the younger, distal axils (Figure 6.3A, corresponding to Figures 4.5 & 4.11).
PRO also caused dichotomous branching (a symmetrical split or division) of apical meristems (Figure 6.3B, corresponding to Figure 4.12). The fact that the response to PAC and PRO occurred in the specific regions could probably be explained by the different balance of plant hormones which occurs in the different locations of activity.

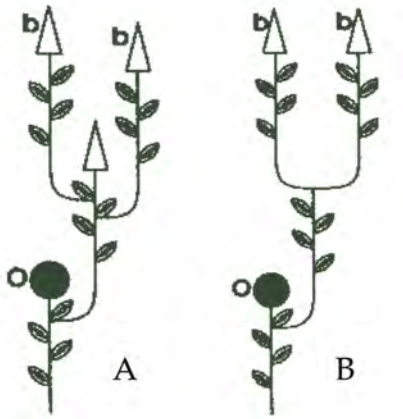


Figure 6.3 Acrotonic (A) and dichotomous (B) branching caused by Promalin™. The original module (o) and new branches (b) are indicated.

It follows from the above discussion that there is an interaction between the physiology, plant morphology and phenology of *Clivia* and that an understanding thereof will influence the success with which these can be manipulated.

'Pixy', an interspecific hybrid bred by Shigetaka Sasaki

General conclusions

From this study it is concluded that rich, diverse and 'underutilised' variation exists in the genus *Clivia.* Methods which will enable more rapid 'clonal' multiplication would enable propagation of plants with desirable characteristics. This would stimulate further research into cultural aspects such as the control of 'phenology ' in commercial production. Once further work has been conducted on the specific cultural requirements of particular clones, their 'commercialisation ' will lead to development of more new cultivars either through conventional breeding or the use of modern biotechnology. In combination, successful control of propagation and 'phenology ' will lead to increased popularity of *Clivia* in a market which constantly demands new and improved products which are attractive to consumers and profitable for producers.

Although the propagation techniques presented in this study may not be adequate for commercial scale propagation, it is felt that they will be useful in allowing wider distribution of desirable genotypes which are in the possession of individual collectors or a small number of growers.

Since significant advances have been made in the cultivation and breeding of *Clivia* in Japan and Europe, a concerted research effort will need to be applied locally in order to gain any competitive advantage. It is hoped that the results of this study will serve to illustrate what may be achieved if further work is conducted in the areas which were examined and where preliminary results were obtained.

APPENDIX

Statistical analyses

Two way table of treatment versus time (page 33)

Frequency	Expected	Cell Chi-Square	Percent	Row Pct	Col Pct
1	1	2	3	4	41
	19	14	4	4	
	9.4253	9.8966	8.0115	13.667	
	9.7625	1.7014	2.0086	6.8374	
	21.84	16.09	4.6	4.6	47.13
	46.34	34.15	9.76	9.76	
	95.00	66.67	23.53	13.79	
2	1	7	13	25	46
	10.575	11.103	8.9885	15.333	
	8.6693	1.5165	1.7903	6.0942	
	1.15	8.05	14.94	28.74	52.87
	2.17	15.22	28.26	54.32	
	5.00	33.33	76.47	86.21	
Total	20	21	17	29	87
	22.99	24.14	19.54	33.33	100.00

Statistic	DF	VALUE	PROB
Chi-square	3	38.3442	<.0001
Likelihood Ratio Chi-Square	3	43-8267	<0001
Mantel-Haenszel Chi-Square	I	36.3627	<.0001
Phi Coefficient		0.6639	
Contingency Coefficient		0.5531	
Cramer's V		0.6639	

Effective Sample size = 87
Frequency missing = 8

Regression analysis of number of shoots as a function of concentration paclobutrazol (page 39)

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	191.24356	95.62178	8.37	0.0006
Error	61	696.50644	11.41814		
Corrected Total	63	887.75000			

Root MSE	3.37907	R-Square	0.2154
Dependant Mean	4.56250	Adj R-Sq	0.1897
CoeffVar	74.06189		

Parameter Estimates

Variable	Label	DF	Parameter Estimate	Standard error	t Value	Pr>/(t)
Intercept	Intercept	1	2.79884	0.60343	4.64	<.0001
V4	Conc	1	0.17897	0.04993	3.58	0.0007
SQV4	Hormone	1	-0.00149	0.00050303	-2.96	0.0044

Analysis of variance (page 39)

The ANOVA Procedure	Tukey's Studentised Range (HSD)
Alpha	0.05
Error DF	56
Error Mean Square	0.066855
Critical Value of StudentisedRange	4.4523
Minimum Significant Difference	0.407

Means with the same letter are not significantly different

Tukey Grouping			Mean	N	V4
	A		0.8521	8	10
B	A		0.8200	8	20
B	A		0.8153	8	100
B	A		0.7974	8	50
B	A	C	0.6076	8	4
B	A	C	0.5935	8	2
B		C	0.4188	8	1
		C	0.2124	8	0

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Clivia miniata 'Imperial' - John Winter

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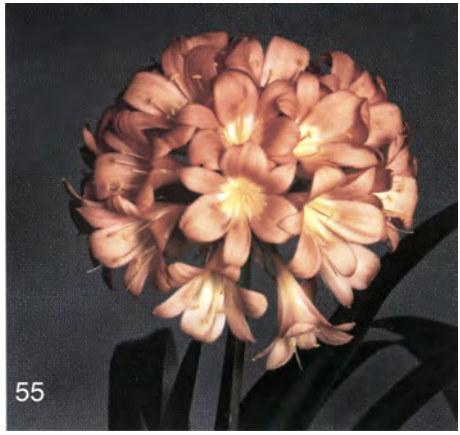
A DIFFERENT PERSPECTIVE ON CLIVIA

Elizabeth Andersson

Spring was always a beautiful season, mainly because of the splashes of orange under a large oak tree, viewed clearly from our bedroom window. The first *Clivia* to bloom each year made a clear announcement. It was always exciting waiting for the flowers to open for slowly hundreds joined in the declaration of spring and Des' *Clivia* were magnificent.He had started collecting them from the age of 15 years. We had moved from a rented property to our own newly built house in December, in the pouring rain, which seemed never to let up. There was no laid out garden, but a large 100 year old tree, which offered shelter to the dozens of *Clivia* which were part of the move. They were literally dumped on the ground. By the time their turn came for special attention,they had got on with establishing themselves. They grew and thrived and were enjoyed. For 20 years those *Clivia* lived where they had been put, increasing to hundreds. Occasionally one heard of yellow *Clivia*, but they were still scarce and had not taken on such a monetary flavour!

In the late 80's it was time to scale down and move to a town house. Again the new house had no garden and this time it was postage stamp size! As luck would have it, a huge avocado pear tree was there for the *Clivia* and they (the specially selected ones) were put under the tree. This time however, the moles moved in, and there was an urgency to pot the plants. This saved a lot of bad language usually reserved for the amaryllis worm.

The advent of the Clivia Club brought great changes to our lives. A variety of new names appeared and became part of the vocabulary. The plants were tagged, the dates noted and which type had been pollinated with which type. Playing the part of Mr Bee never changed over the years and it was perfected to a fine art! Lids, saucers, plates, cups are found all over the house with bits of paper identifying the seeds, while they await planting or distribution. The postage stamp garden now has six rather smart shade frames which protect the plants (and on occasion lodgers!). They grow and thrive, and this is purely because they are loved and appreciated, and they know it, I am



C. m*iniata* Teach' 1st in Class. Northern Club Show 2000. Koos Geldenhuys

I have grown used to all sorts of *Clivia* enthusiasts visiting our little garden and phone calls late at night *{Clivia* enthusiasts tend to forget the time and frequently phone at 10 o'clock at night!) There are a few draw-backs with this *Clivia* growing hobby, and one of them is the danger of small nieces, nephews and grandchildren.They have an absolute fascination with the lovely red berries, and before you know it, will present

you with a pot or tin full of berries, "look how busy I have been and helped you pick all the berries! " After a loving smile and a look of consternation its back to square one, for all the careful tabulating and noting is lost in a trice! We do tend to monitor small children in the garden but still have the occasional slip up. Rebekah, out from England, was the last berry gatherer. The dogs, by-and-large, cause no hassles. We do have one, a scotty who buries her bones in seedling trays if they are inadvertently left on the ground. This has now resulted in the trays being kept out of range, sometimes on the outside garden table if space is short, resulting in the grower's satisfaction, but not the grower's wife or scotty's acceptance. In the meantime I have become what I consider to be the best *Clivia* berry cleaner in the world! How lucky we are to be part of the *Clivia* enthusiasts club, for every spring brings a profusion of flowers in oranges, yellows and peach, all glorious and to be enjoyed, but never picked!

C. miniata 'Bertie's Bronze'. Bertie Guillaume

C. *miniata* "Bronze Green Girl'. Ian Vermaak

NATAL PEACHES

Terri & Sean Chubb

'GAIL'

Having an interest in *Clivia* is similar tothe expectations of the treasure hunters still seeking the Kruger Millions! We are looking for a pure white. Sean and I were invited to the Howick area to view a *Clivia* that had a different colour to the usual orange. We were in for a real surprise when we saw 'the' flower. The colour was in the range of peach to apricot (Kol skoot! Bulls eye! - something new). The owner Gail, told us she had found one plant on a newly rented property. She subsequently realised it was a *Clivia.* With care and attention, the plant duly flowered, suckered side shoots and self pollinated. In time, the seedlings also flowered true to type. With just one clone on the property, there was only a very remote possibility for colour pollination hybridisation.

Observation: The base of the adult plant is oval, approximately 150 mm on the larger axis. Outer overall height is 650 mm. The leaf tips are much less pointed than either the 'Natal Yellow' or 'Mare's Howick Yellow' with a very slight edge roughness at the end. The *Clivia miniata* 'Gail' was runner up selection on the 1999 Kwa-Zulu Natal Clivia Club show.

'NDWEDWE GAMMA PEACH'

This plant was found in the Ndwedwe area of Kwa-Zulu Natal on 26 September 1996. It was growing near the top of a very steep south facing cliff in the rock-face in very little soil and leaf compost.

It is spidery in appearance. The bloom opens a peach shade, slightly green down the centre initially, losing the green with age, darkening to peach in the centre of the petals, with the edges turning a whitish colour towards the end of the flowering period. There were two plants of similar size each with one bloom. The plant did not set seed the first season. There is plenty of pollen and the breeding parts are of good quality. The leaves are large and the plant is robust in appearance. No suckers have been produced to date.

The breeding performance of this plant is uncertain as so far it has only produced pigmented seedlings. Pollen from 'Chubb Peach', 'Alpha Thurston' and 'Beta Thurston' has been used on it and it was also self pollinated. A good seed crop was set with each crossing. It did not flower in 1999 but it had the usual two blooms in 2000, It has been crossed with pollen from 'Ndigi Pink Champagne' and 'Panache 2000' which are two pastel/pinks from the Ndwedwe area. It is thought to be an Orange showing peachy colourations.

C. *miniata* 'Gail'

C. *miniata* 'Ndwedwe Gamma Peach'

C. miniata 'Alpha Thurston'

'CHUBB PEACH'

The original plant was collected in the Ngwahumbe River Valley, in Eston, Kwa-Zulu Natal. It was found in a small patch of bush on the confluence of one of the tributaries and the Ngwahumbe River. The exact date of collection has not been accurately recorded but it was probably in the 1950's. No other plants of any colour variation have been collected from this area since. The *Clivia* population density in this area has also declined due to collection of plants by traditional healers.

'Chubb Peach' forms a well filled spherical umbel presented well above the foliage. The flowers are a deep peach colour with a distinct fragrance. Petals and tepals have slightly wavy edges and have a slight difference in width. The peach colour seems to intensify as the florets age. On ripening the seed pods turn a rich peach caramel colour. 'Chubb Peach' does produce offsets and mature plants may produce 2 or 3 per annum.

The initial breeding efforts with 'Chubb Peach' were not as successful as hoped. On realising that this plant was peach in colour and not being able to locate plants of a similar colour at the time, 'Chubb Peach' was self pollinated.

On average only 7 seeds were set per umbel flowered. These seed produced 30% peach flowering plants. This % was confusing and did not seem to conform to known genetic heritability patterns. In 1987 when the first peach flowering offspring flowered, this was

C. miniata 'Beta Thurston'

C. miniata 'Chubb Peach' F1

used to cross back onto the original 'Chubb Peach' clone, producing 100% peach offspring. This cross also had a remarkable improvement in seed set, on average 132 seed per umbel from 13 umbels. The orange flowering offspring were kept and crossed back with the original clone producing 50% peach flowering offspring.

These percentages conform to known genetic heritability patterns and it was confirmed that 'Chubb Peach' is in fact a homozygous recessive peach, group 1 peach. The original percentages recovered from self pollinating have been put down to foreign pollen producing the orange flowering plants and the low seed counts to the reluctance of 'Chubb Peach' to self pollinate. 'Chubb Peach' has also been crossed with group 1 or homozygous yellows producing 100% unpigmented seedlings which subsequently flower peach. 'Chubb Peach' is dominant over yellow but recessive to orange and red.

Since the first peach flowering in 1987 only the best of each years seedlings have been retained for breeding purposes. Up until 1999 flowering season only 5 plants have been used as pollen donors. The original selected plants have also been improved on and in 2000 only the very best, i.e. 2 plants, were used as pollen donors on the peach mother plants.

C. miniata 'Chubb Peach' F2

The intensity of peach pigment in the offspring seems to vary and some seedlings flower considerably darker than the original clone. Seedlings carrying green markings in the throat of the flowers seem to be the darkest peach.

A limited number of original clone offsets, flowering seedlings and seed, are made available for sale annually.

'NAUDE PEACH'

This magnificent plant belonging to Olive and Stoffel Naude came to the notice of *Clivia* enthusiasts in 1997 when it was entered in the Kwa-Zulu Natal *Clivia* Show.

Here it won the best 'any other colour' as well as Best on Show. It had at that time two umbels presented well above the foliage. The mature umbel was deep peach while the umbel still in the opening stage was buttercup yellow.

Mrs Olive Naude, on moving to Kloof, was very impressed by the display of both yellow and orange *Clivia miniata* in the neighbour's garden. The neighbour had a large number of yellows flowering in her garden and on her death, a single plant was obtained from the collection. Subsequent renovations to the property denuded the garden of *Clivia.* This single plant was carefully planted in a large concrete pot in about 1977. Here it remained on Mrs Naude's verandah producing two spikes of flowers every year, but never an offset. The plant remained in this pot for approximately 20 years. When repotted into a more practical container, it rotted leaving only 2 offsets.

The genetic make-up of 'Naude Peach' has not been accurately defined. The plant flowers open yellow, mature to peach and then produce red berries when the seeds ripen. Some results that do seem confusing have been obtained using 'Naude Peach':

'Naude Peach' (pod parent) x 'Chubb Peach' and also selfed resulted in only 5 unpigmented seedlings out of about 50 seed.

C. *miniata* Tanache 2000'

This cross was done in 1997. Some flowers had already been pollinated on arrival at the Show.

'Eshowe Yellow' (pod parent) group 1 yellow x 'Naude Peach' resulted in only four unpigmented seedlings out of 17 seed. Possible self pollination by 'Eshowe Yellow'. 'Natal Yellow' (pod parent) group 2 yellow x 'Naude Peach' resulted in 16 unpigmented seedlings out of 58 seed.

'Naude Peach' has not flowered since 1997 and an endeavour to do controlled crosses with it will be made as soon as it does flower.

C. miniata 'Ngidi Pink Champagne'

C. *miniata* 'Naude Peach'

C. *minata* - KwaZulu-Natal Club Best on Show 2000. Chris le Grange

A HYBRIDS STORY

Des Andersson

I have had an interest in *Clivia* from the time I first saw them as a teenager, being sold as wild cut flowers in our suburb by the local African women.

My early collection comprised a range from a light to dark orange collected from" Beauty Bush", a natural bush area below "World's View". Full of enthusiasm I made the acquaintance of Mr. Leighton, curator of the Pietermaritzburg Botanical Society (now Natal N.B.G.). I told him I had heard that there was a rare cream flowered plant, and, as an enthusiastic collector, could he please put me in touch with a grower. He graciously smiled and told me that I was fortunate as he happened to have a young unflowered plant for sale, and that I could purchase it, with the assurance that it would definitely be light yellow. The offer was snapped up in a trice and as a "bonsella" he gave me a young C. *gardenii*, which up to that time I had not even known existed.

The original C. *gardenii* parent

Time passed, and both carefully nurtured plants reached flowering stage together. (The *C. gardenii* was a late season flower, so the *C. miniata* var. *citrina*, was definitely early). The stage was set for Mr. Bee in the form of a small dry paint brush. Eagerly wanting more yellows, the C. *miniata* var. *citrina* was self pollinated. The C. *gardenii* was pollinated with C. *miniata* var. *citrina.*

Thinking back now, I am sure that the C. *miniata* var. *citrina* was a 'Natal Yellow' for it had the green trade mark. The C. *gardenii* was a good shade of red with a prominent green skirt. Only two seeds of the C. *gardenii* x *C. miniata* var. *citrina* reached flowering status, the better one being illustrated in photo 73.

None of the adult *C. miniata* var. *citrina* which were selfed flowered true to type, all shades of orange. This confirmed the advice from so called knowledgeable friends that the only possible route for propagation of a 'Natal Yellow' was an off-shoot plant.

Working totally as an amateur botanist, but a keen plantsman, I now waited for a repeat co-incidental flowering of the *C. miniata* var. *citrina* and my hybrid. About four or five years later my expectations materialized and the hybrid became the new berry bearing plant of a C. *miniata* var. *citrina* x 'C. Garmin'. Yet again, due to a variety of circumstances, only two seeds reached flowering stage.

The first one produced a tubular cream flower edged with a slight green tinge (photo 71).

The following year, to my great delight, the second plant flowered. The result was C. 'Garmin' 'Val' (right).

In the interim, with the input and association with members of the Clivia Club, I have acquired invaluable plant and breeding information such as deep freezing pollen, swapping pollen with other members, acquiring seeds and plants, either directly or indirectly from local or overseas members (Australia, Japan and Belgium for example) or purchasing seeds. I consider I have been able to extend the range of my collection. I still continue to give plants away to people who express an interest in *Clivia.* I am still keen to keep going for the exclusive "humdinger" but regret that I appear to be losing the race with old father time! (The above episode covered a period in excess of thirty years, believe it or not!)

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CLIVIA, WHAT IS ALL THE FUSS ABOUT?

Jim Holmes

A great many people in South Africa grew up with *Clivia* in the garden, and few people paid them any mind, they had been there for as long as anyone could remember, the *Clivia* were admired in flower and then forgotten about until the next spring.

The same was probably true for many people living in Australia, New Zealand and parts of the Southern U.S.A. "An old Victorian plant that lost its favour decades ago", suddenly becomes ever so popular.

My first yellow *Clivia* came from a friend in Howick, where I was living at the time. A retired farmer told me that his great grandfather had found it on the farm in the Karkloof area, back in 1907. They very carefully kept it in the family all those years, and he said I was the first person other than the family to be given one and I felt very honoured. When I moved to Cape Town a year later, the plant came with us.

Once a year when the Botanical Society held their spring flower show at Kirstenbosch, this single yellow *Clivia* plant was usually at its best and was displayed at the show, as far back as 1978. It was only then that it dawned on me, from the interest that it generated, that very few people knew that such a thing existed. With this plant being displayed on local flower shows for a number of consecutive years and as there were no plants available to the public for a very long time, at least a decade, this created a considerable demand and mystique of the rare and elusive plant. Though the National Botanical Institute at Kirstenbosch had a few yellow *Clivia* tucked away in the nursery area, they were never displayed to the public in those days.

Back about 1977 we had a visit from Dr. Hirao, a well known plant breeder from Japan. I met him when he visited Stellenbosch, and we spoke about his breeding of the *Iris kaempferi,* that he was doing, but I did not know at the time that he was a *Clivia* enthusiast. After his death a few years later, others took over his different breeding lines and his collection of *Clivia* was taken over by Yoshikazu Nakamura.

C. miniata var *citrina* - Second Prize. Cape Club Show 2000. Jim Holmes

Since then Mr Nakamura has been largely responsible (through his generosity) for making the *Clivia* so popular world wide, by distributing seeds of many of the selected forms in his collection, to people who took the time to write to him. It appears that he was eventually overwhelmed with requests and does not do this anymore.

During 1990 Nick Primich visited me several times to discuss his idea of starting the Clivia Club. He saw the passion with which many people were embracing the *Clivia.* Riding the crest of the wave was the rare yellow *Clivia.* At the time only a small handful of people were in posession of one of these plants. The Clivia Club was started by Nick in 1992.

One of the first people that I met who grew the yellow *Clivia,* was Cynthia Giddy, back in 1978. Although she grew a number of plants, she only propagated them by division.

C. *nobilis* - First Prize. Cape Club Show 2000. Ian Brown

I asked her at the time, why she did not go the seed route, as I was trying to do, and she explained that she had tried that and though she has flowered some 500 seedlings from her yellow stock, not one seedling had turned out to be yellow! She expressed the opinion that it was either not possible or practical and that seemed to be the general viewpoint at that time. The few propagations that Cynthia made during the 1970s and 1980s, went to a customer in Japan.

In line breeding

As no other material was available to me at the time, I started to inbreed with the plants I had. Using only the best forms, this resulted in a stable breeding population. The plants kept their vigor and characteristic of producing two flower stems at a time on each growth and carried a delicate vanilla fragrance on full flower heads. Others who have been out-breeding have encountered problems. One of these is a large percentage of throwbacks to orange.. The inbreeding quickly eliminates any recessive genes. Each season sees new and interesting selections emerging, from near whites to dark yellows, soft pastels in salmon and apricot, some with interesting variegations on the leaves and most of these have been bred from the original plants and have shown great variation in form.

Over the years, other *Clivia* forms and selections have come in from Europe and Japan. They have been bred in other directions with large orange and red flowers, tending towards the miniature and broad leaf types. Some truly beautiful hybrids have been developed at Cape Seed and Bulb, using C. *nobilis, C. caulescens* and C. *gardenii* crossed onto select forms of C. m*iniata.*

As we flower our new crosses and see the amazing variety of new forms and colours that are being produced by so many enthusiastic growers world wide, one begins to understand what the fuss is about!

SWAMP CL1VIA

Dr. Keith Hammett, Auckland, New Zealand

Dr Keith Hammett trained in botany and plant pathology and went to New Zealand 33 years ago. Gradually he changed his career and became a breeder. Today he is a private breeder but he retains his scientific link with a series of MSc and PhD students at Auckland and Massey Universities.

We live in a complex world and as we learn more about it the amount of information can become overwhelming. One way to cope is to break the information into smaller units and to establish a classification or indexing system.

We are so familiar with some classification systems that we do not really notice. When we go into a library we are conscious that a classification system operates which enables us to find books on specific topics. However when we go into a supermarket we are probably less aware that a comparable system is operating to enable us to find the items we require. In fact it is only when management decides to change where things are located that we really notice.

In general classification systems are arbitrary and only work by common consent. While we classify books most commonly on the basis of their content, we could equally well classify them on the basis of the colour of their covers, author name or even their size. Indeed most libraries have an oversize shelf for those books which will not fit the standard sized shelves.

So it is with plants. Classification systems have been developed so that we can more easily digest an often bewildering array of variation. Unlike man-made objects nature has created a continuum of variation and it is man who attempts to assign individual plants into the categories we have designated as genera, species and varieties.

As we learn more our paradigms change. With botanical classification ideas of what delimits a species depends on the opinions of individual botanists and these opinions reflect where they were trained and the plants with which they work. Over time botanical classification has attempted to reflect evolutionary relationships between species existing today. This is one of the reasons why botanists rearrange species and change names in an attempt to better reflect these relationships. However, at the end of the day, the measure of any classification system is whether it is useful or not.

The genus *Clivia* is a relatively small genus found only in Southern Africa.

The first species to be described was C. *nobilis* in 1828. This was followed in 1854 by C. *miniata* originally named Imantophyllum miniatum, but changed 10 years later. *Clivia gardenii* followed in 1856 while C. caulescens was named as recently as 1943. With the exception of C. *miniata* which has upright flowers, the other three species have pendulous flowers and have often been confused in cultivation.

Today wild populations of species occur in relatively small pockets often widely separated from each other and in reality the genus appears to be in retreat. As the plant is unable to tolerate full sunlight its current distribution reflects the progressive destruction of forest vegetation which was formerly much more extensive than it is today.

Traditionally botanical classification has been based on the morphology or shape of plants with particular emphasis on the flowers. It is also important to remember that a great deal of taxonomic work (classifying) has

been carried out on dried specimens mounted on sheets of paper (herbarium specimens) and that for many species the botanist will not have had the opportunity to see living plants. This came about because our ideas on botanical classification are European or Western in origin and much of the work was carried out at one or other of the great botanical institutes in Europe after specimens had been collected from around the world. For *Clivia* only *C. caulescens* was named in its country of origin.

Over time different pieces of information in addition to plant shape have been taken into consideration when delineating a species. For instance chromosome numbers and biochemical data have been used for various genera. Increasingly DNA data are being used.

Recently Dr Yidong Ran completed a cytogenetic analysis of the genus *Clivia* as a PhD. study here in Auckland jointly supervised by Professor Brian Murray and myself. This was made possible as I had brought together an extensive collection of both *Clivia* species and hybrids from around the world.

In this collection were some plants originally given to me as seed by Graham Duncan at Kirstenbosch following the inaugural Clivia Conference held in 1994. These plants were referred to as a robust form of C. *gardenii.*

Initially the seedlings looked pretty much like those of any other *Clivia* except C. *nobilis,* but as they became older the plants stood out from anything else.

They were very vigorous and with a tall stiff habit and rounded leaf tips quite distinct from the very pointed lax leaves of C. *gardenii,* although they did have the pale green almost white lower leaf surface that one associates with C. *gardenii.*

As shown in our scientific paper which was reprinted in the Clivia Yearbook 2, it is possible to identify the different named species of *Clivia* on the basis of banding patterns that develop when the chromosomes are stained in various ways.

When Yidong looked at the chromosomes of the 'Robust gardenii' he found that while the banding pattern was closer to C. *miniata* and C. *gardenii* than to C. *nobilis* or C. *caulescens,* it was distinguishable from either.

We hear much about DNA analyses and fingerprinting in connection with forensic work and criminal trials. Similar techniques are available to plant scientists and Yidong used two distinct methods, random amplified polymorphic DNA analysis (RAPD) and DNA sequencing. Two regions were sequenced, the internal transcribed spacers (ITS1 & ITS2) of nuclear ribosomal 45S DNA and the non transcribed spacers between the 5S RNA genes.

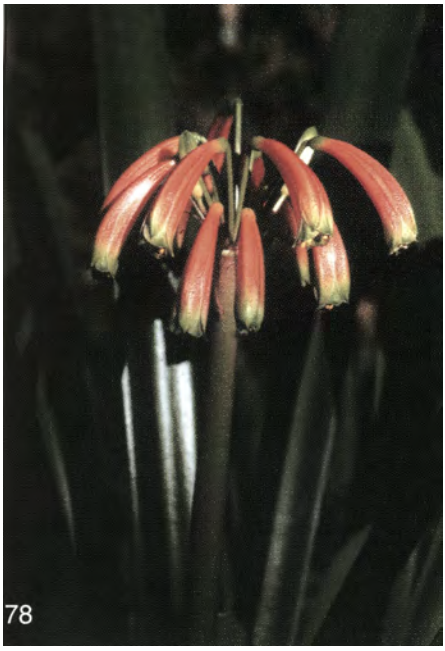
When these methods are combined with appropriate statistical models it is possible to estimate how closely related different species and varieties may be. Our DNA analyses showed that 'Robust gardenii' was distinct from the four species already named but most closely related to C. *gardenii* and C. *miniata.*

Correspondence with John Winter at Kirstenbosch established that the original accession of 'Robust gardenii' had been collected by Kobus Eloff from the Wild Coast. Dr John Rourke of the Compton Herbarium at Kirstenbosch in a letter dated 13 March 2000 indicated that he had recognised it as a distinct entity based both on its morphology and habitat and referred to it as the Swamp Forest *Clivia.*

John provided details of herbarium specimens held at the National Herbarium in Pretoria and at Kirstenbosch. He indicated that geographically its distribution fitted in between C. *nobilis* from the southern Transkei and Eastern Cape and C. *gardenii* in Natal.

He went on to say: "Most of the populations I am aware of are situated between Port St Johns and Umtamvuna at Port Edward. Ecologically it is very distinct and is mainly

found in swamp forest - those patches of *Syzigium* forest, like islands in the grassland which are situated in depressions and fill with water during summer. Thus the Swamp Forest *Clivia* is semi-aquatic standing in 15 - 22cm of water for several months. It also occurs along river banks in the area. Flowering takes place in June and July. This is the same species we collected at Mkambati in a swamp forest west of the Mtentu River (my no. 2145).



One of the swamp *Clivia gardenii*

The leaves tend to be pale green, rather fleshy and flaccid and the flowers tubular orange-red.

There are notes on the National Herbarium specimens written by Prof. Olive Hilliard indicating that it does not fit the C. *nobilis* or C. *gardenii* concepts, but she abandoned the problem at that point. Unfortunately, it was illustrated in colour in Flowering Plants of Africa plate 2094 in 1994 under the incorrect name *Clivia nobilis.* The plate is a very poor one confusing the matter even more".

This communication from John Rourke was especially valuable as it confirmed that a plant that Yidong had been able to identify at the genomic level had been recognised as being distinct in the field. It also explained why the description of *C. nobilis* published in 1994 differed so markedly from what most of us in the Clivia Club understand to be C. *nobilis.*

A coincidence with regard to the receipt of John's letter was that one of the herbarium specimens of the Swamp *Clivia* to which John referred was collected by Fanie Venter in 1976. Fanie now lives in New Zealand and happened to visit me on the very day that I received distinct material of a caulescent form of C. *gardenii* from South Africa and Fanie was able to examine it and discuss his knowledge of the Swamp *Clivia.*

John Rourke very wisely pointed out that while he felt sure the plant was a distinct taxon, before formally naming it more needed to be known about its distribution and ecology. I was very fortunate in June 2000 to be able to travel with John Rourke, John Winter and Brian Tarr to look at the Swamp *Clivia* in habitat and to collect seed from separate populations in the Transkei and KwaZulu-Natal.

Since returning to New Zealand I have been able to raise seedling populations of these collections and Yidong has been able to confirm that three of them have the same chromosome staining pattern as the original Eloff 'Robust gardenii'.

An important point to realise is that different populations of a species growing in the wild will vary from each other. The longer populations are separated from each other the greater the differences; eventually the

differences may be so great that they are considered to be different species.

All too often plants in cultivation have all been derived from a single collection or accession. That is why it is so important that the Clivia Society is based in South Africa and has access to a wide range of genetic material of each species.

Although I have not yet had time to grow the different accessions of Swamp *Clivia* to maturity and compare them side by side, it seems clear that there is appreciable variation between the various isolated populations.

Possibly the first record of the plant was that made by W.L. Chiazzari in 1943 who made notes on a plant which could not be fitted into one of the named species of *Clivia.* His story is recorded in the Clivia Club Newsletter Vol.4, No 2, April 1995 page 4 and was reprinted in Vol.9, No 2, Winter 2000 page 10. A good photograph of the plant appears on the front cover of this later edition.

More recently, 23 May 2001, James and Connie Abel reported in the email Clivia Group that Fred van Niekerk had known a similar plant since his childhood in the 1930s. Fred grew up in the Transkei and took a special interest in a vigorous form of *Clivia* which grew in his mother's garden.

"Later on he and his friends found them growing in the wild on the banks of the Umtentu River in the uMkambati Reserve, about 4 km from the sea and 25 km SW of the KwaZulu-Natal border. The umbel with over 40 flowers is indicative of a C. *nobilis* relationship, although the leaves are closer to those of C. *gardenii".*

James and Connie showed pictures taken by Fred Niekerk when he lived in the Cape of plants in cultivation. These have inflorescences more spectacular than any I have seen to date on Swamp *Clivia.*

Research is never fully complete and there is always more to learn.

However, here in Auckland we feel that on the basis of its distinct robust habit (up to 180cm), its ability to grow in running water, its distinct chromosome banding pattern and DNA fingerprint, that the Swamp *Clivia* can be clearly recognised as a fifth species.

Comment by Dr J.P. Rourke

Clivia gardenii *is a highly variable species with numerous local forms. One of these, the Swamp Forest* Clivia *is discussed in Keith Hammet's interesting article. There are other horticulturally desirable forms currently placed under* C. gardenii *such as the very robust pale lemon yellow form from Ngome forest, Zululand (Clivia Yearbook no.2 page 37), where orange and apricot colour variants also occur. Dwarf forms from around Eshowe with short scapes and rich orange perianths as well as numerous other variants crop up in different parts of KwaZulu-Natal. Thus as presently understood,* C. gardenii *is a mosaic of local races all grading into each other.*

One of the first steps to be faced in making some sort of taxonomic sense out of all this variation is determining which of these many forms Sir William Hooker used when he described C. gardenii *in 1856. The information given in the original description is singularly vague. "*C. gardenii *was discovered in the Natal Colony by our excellent friend Major Garden and by him introduced to the Royal Garden of Kew." Some historical research will be required to determine where Major Garden travelled in Natal, in order to narrow the field.*

It will be important to establish the type concept of the name, in other words, which of these many forms did Garden give to Hooker when the latter described the species. Careful examination of the type specimen at Kew will thus be essential. Natural variation in the C. gardenii *complex will hopefully form the subject of an article in a later edition of the yearbook.*

Dr Rourke is Curator of the Compton Herbarium at Kirstenbosch National Botanical Garden.

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CLIVIA

FOUR

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CLIVIA

FOUR

Mature flowerhead of *Clivia mirabilis*

EDITORS

Claude Felbert John van der Linde
John Winter Mick Dower

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EDITORIAL

In Clivia 3 we alluded to the discovery of *Clivia mirabilis,* which is the mainspring of this Yearbook. We have all experienced *Clivia's* toughness, its 'never say die' approach to life, which the D.N.A. research has shown would have been inherited from this grandmother of all the *Clivia* species. So the already remarkable genetic diversity and versatility of *Clivia* and its horticultural potential have suddenly expanded beyond belief. The Nature Conservation authorities have taken the steps necessary to protect this new species vigorously, but arrangements are being made by them to ensure that the public will be able to obtain seed and/or seedlings, so that the ideal of 'conservation by propagation' may be realised.

All of us must surely also want to know how it came to be that the other species which evolved from this species now grow over *800km* away in climatic conditions which are dramatically different. Why are they not found in the wild within that *800km* vacuum, say at Knysna where the climate and forest environment are ideal? And why is there so little overlap between C. *caulescens* and C. *nobilis* with C. *gardenii* and C. *miniata* where there is no dramatic difference in the environment in which all of these four species grow in nature?

The research by the National Botanical Institute at Kirstenbosch up to now shows how C. *mirabilis* and the other species evolved on the *Clivia* family tree. That research is continuing, to date the evolution of each of the five species. We expect that to be established before the next Yearbook is published so that it can include an article by a paleobotanist, which will deal with these intriguing questions.

Further research will include investigation into the increasing number of variations being discovered within the C. *gardenii* complex. Most populations which have been visited grow in wet or swamp like conditions. That probably also holds true for the type specimen which Major Garden sent to Kew and which bares his name. The starting point for a proper understanding of the relationship between the various forms must be to fingerprint that type specimen which is now in the Herbarium at Kew.

We also mentioned in Clivia 3 that the Cape Clivia Club had contributed financially to that research. We have seen in this Yearbook how rewarding that research has been. We urge the Clivia Society and all its constituent Clubs to contribute generously to that research so that its momentum will be maintained.

In an article written in the 1930's and republished in Clivia 2, the late Gladys Blackbeard, who is the doyenne of *Clivia* growing in South Africa, advises on nutrition of *Clivia* that '[t]he secret of flowering is to rather starve your plants than overfeed ...when buds show, sprinkle round each plant a little well-decayed horse or cow manure'. Modern experience has shown however that *Clivia* respond well to more sophisticated nutrition and growing media. Consequently we have included a number of articles to guide *Clivia* enthusiasts on nutrients and potting mediums.

Many of us grow *Clivia* in conditions which may encourage pests and diseases. Valuable plants have been lost as a result, and Henriette Stroh has taken a lot of care to obtain good illustrations of these problems and valuable guidance on how to deal with them. What must be emphasized however is that new problems, especially with fungi and bacteria, arise continuously, and safer and more effective or natural means of combating problems are being found every year. Henriette has emphasized therefore that hers is an open-ended invitation to all *Clivia* growers to make available continuously for publication in the Yearbooks illustrations of new problems and how they have been solved. This should

include good illustrations of virus infections on which an article is planned for the next Yearbook.

Bill Morris has guided us on the origins of peaches and pastels. Mendel has helped us to plan breeding programs, which will have predictably reliable results such as broad leaves or short leaves. However if, as we understand, it has been established that colour is inherited from genes found only in the pod parent, but that these genes can only express or show their colour under the control of nuclear genes inherited from both the pod and the pollen parent, how do we choose the right parents to produce the new colours we are all inspired to breed? We can select the broad-leaved plants which we planned to breed from year-old seelings, but is there any physical characteristic on which we can rely to predict the flower colour of year-old seedlings? For example, we now know that green stems can indicate not only yellow but also peach flower colour. And is there any relationship between the intensity of stem pigment and the flower colour as an indicator of pastel flower colour?

If colour is inherited from the pod parent, can we rely on this role of the pod parent to produce, for example, pink flowered offspring from a red flowered mother with a white throat if we use the right pollen? Are we wasting our time using red flowered pollen to produce red flowered offspring from an orange flowered pod parent? And why does a Group II Yellow such as 'Natal Yellow' pass on its yellow flower colour when crossed with 'Butter Yellow', but orange flower colour when crossed with virtually all other yellows? How does Mendel apply to the regulation of the colour genes inherited from the mother, which are not nuclear genes?

Most of us probably follow a hit and miss approach when breeding for colour and have to wait five years after pollination only to be disappointed too often by the flower colours produced. But we are sure that there are a few amongst us who can advise us on what guidelines to follow to be able to predict flower colours more reliably from our breeding. Won't they please come forward in the next Yearbook?

It is most appropriate that this Yearbook should deal primarily with the discovery of a new *Clivia* species just ten years after Nick Primich sought out those who shared his enthusiasm for *Clivia* and brought them together to found the Clivia Club. He stimulated a new interest in *Clivia,* particularly in South Africa. All of us who have benefited hugely from that initiative salute and thank him again. And we would also add our profound appreciation to the other honorary member of the Society, Yoshikazu Nakamura, for his most generous donations of seed, information and advice over these past ten years and in doing so, for opening our eyes to the potential of *Clivia.*

Finally we must thank all who have taken the time and trouble to prepare the articles which have made this publication possible. Please let no member feel that his or her contribution would be too small, so that we will have a wealth of knowledge and experience relating to *Clivia* for publication in the next Yearbook for the benefit of all of us.

An article on an old population of a C. m*iniata* x C. *caulescens* hybrid, found in the wild, has been deferred until next year for further research.

Cape Town, June 2002

The following abbreviations have been used, particularly in the captions to the photographs:

CC	Cape Clivia Club
KZN	KwaZulu-Natal Clivia Club
NC	Northern Clivia Club

THE MIRACULOUS CLIVIA

an astonishing new species from the arid Northern Cape

John Rourke

Dr Rourke is the Curator of the Compton Herbarium at Kirstenbosch National Botanical Garden.

Summary

The article discusses a new species of *Clivia* unlike any of the existing summer rainfall taxa in that it is a sun hardy winter growing species from the Northern Cape Province adapted to an arid mediterranean climate. It's tubular bicoloured flowers, orange and green tipped at first, becoming orange-red and yellow tipped later, are borne out on shiny orange-red pedicels. These coloured pedicels enhance the scape at flowering but abruptly change to green after pollination. The leaves have a prominent median white stripe on the upper surface.

Johannes Afrika, game guard at Oorlogskloof Nature Reserve who first drew attention to populations of C. *mirabilis* in the reserve.

Introduction

'John, you're interested in the systematics of Clivia, so I think you had better have a careful look at this/ said Dr Dee Snijman, a colleague of mine as she laid a pressed dried plant specimen on my lab workbench, one hot afternoon in January 2001. It was what appeared to be (and indeed was), a tubular-flowered *Clivia* but the locality given on the field ticket, 'Oorlogskloof, Nieuwoudtville', in the Northern Cape seemed totally absurd. We had become used to receiving unusual plant material for identification from Wessel Pretorius, Officer-in-Charge of the Oorlogskloof Nature Reserve, yet here was a specimen that defied logic. *Clivia* simply did not grow in the Northern Cape! Was this a diabolical hoax or a sensational discovery? To our delight the latter proved to be the

I showed the specimen to an equally dumbfounded John Winter, who has been building up a fine collection of wild-sourced Clivia material at Kirstenbosch. We both agreed: a personal site visit to view the plants *in situ* was essential, so as to establish the veracity of this record. By now it was February and even if the plants were in fruit and not yet in flower, we simply had to see them in their natural habitat.

After receiving a permit from the Northern Cape Department of Nature Conservation, to collect a few live specimens, we set off to meet Wessel Pretorius at Nieuwoudtville, popularly known as 'the bulb capital of the world'. February is not the best time to visit this delightful platteland dorp perched on the Bokkeveld escarpment between Van Rhynsdorp and Calvinia, renowned for the

world's most spectacularly speciose display of indigenous bulbs in late winter and spring. As we drove down the dusty main street, with the air temperature at about 35°C, the sun beating relentlessly on shimmering corrugated iron roofs, I could not help feeling that other than the centre of the Sahara desert there could hardly be a more unlikely place to find a new species of *Clivia*. But the environs of Nieuwoudtville contain such a mosaic of geological systems, such a diversity of landforms, habitats and sheltered refugia, that a huge range of plant species with different ecological requirements find niches for themselves in this area.

Nieuwoudtville by the now seasonal flow (May - November) of the Oorlogskloof River. About half a kilometre wide and 200m deep the canyon is edged by a resistant capping of Peninsula Formation Sandstone cliffs. Some 4700*ha* in extent, Oorlogskloof reserve was established as recently as 1983. There is no public vehicular access although an excellent network of hiking trails has recently opened this rugged stretch of countryside to keen hikers, some of whom in all probability must have seen *Clivia mirabilis* in previous years without realising that it had not been described in scientific literature.

Oorlogskloof canyon, natural habitat of C. *mirabilis*

Next morning, we were peering over the eastern rim of Oorlogskloof, one of these refugia that has enabled moisture-loving plants to survive in an otherwise hostile environment. Oorlogskloof is a spectacular canyon incised through the Bokkeveld escarpment just west of the town of

As the sandstone cliff faces have weathered and crumbled over the millenia, tallus screes have formed below them, creating a habitat for sparse patches of low, light woodland. It is here on the eastern margin of the canyon that *Clivia mirabilis* makes its home.

Wessel Pretorius with C. *mirabilis* in the natural habitat

Even as Wessel Pretorius guided us down the krans on the morning of 20th February 2001, I could see groups of *Clivia* plants among the huge boulders below. The first thing that struck me was that about half were in full sun, the remainder in very light shade under a sparse tree cover. Clearly this was not only a drought resistant species but one that could take a 6 month roasting under the brutal northern Cape sun with little if any sign of leaf damage.

The leaves of C. *mirabilis* showing median leaf striation and variation in range of leaf tips

The leaves were also unusual. Each possessed a prominent white stripe down the middle on the upper surface. (Some populations of *Clivia nobilis* also have a median white stripe on their leaves, but nothing as prominent as the Oorlogskloof plants). Moreover, the leaf bases were deeply pigmented in rich purple-carmine hues. Several plants bore fruiting heads. The berries were already turning from green through yellow to red, and would be ripe within a couple of weeks. Now there was no doubt in my mind. Although we had not yet seen flowering specimens, we were in the presence of a previously unknown species of *Clivia*, growing in a hitherto inaccessible almost virgin habitat, scarcely touched by the hand of man. Most surprising of all, nearly 800*km* of karroid semi-desert separated this species from its nearest relative in the Eastern Cape.

Later that year in mid-October we returned to Oorlogskloof to study flowering material, as well as collect a type specimen from which *Clivia mirabilis* was formally described (Rourke 2002). Its specific epithet *(astonishing, miraculous, to be wondered at)*, reflects an enduring amazement at the apparently endless surprises nature still has in store for us in this part of South Africa.

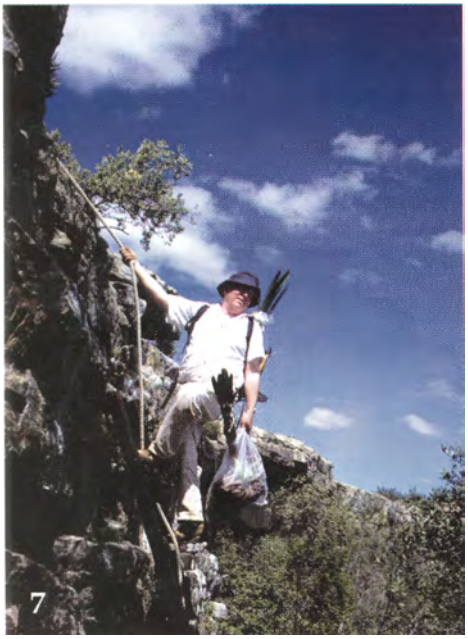
Diagnostic Characters

Clivia mirabilis is distinguished by its straight, actinomorphic, bicoloured (orange/yellow) tubular corolla, long drooping pedicels (25 to 40mm long) that are orange-red at flowering and green when fruiting; the distinctive single median white striation on the upper surface of the leaves which usually have smooth cartilaginous margins; and the irregularly shaped glebulose-gongyloid berries. The basal part of the leaves forming the leaf sheath is flushed a deep carmine maroon, unlike any other *Clivia* except C. *nobilis* which occasionally produces similarly coloured leaf bases. The orange-red colouration of the pedicels and ovaries in this species during flowering is a unique character in the genus *Clivia.*

Distribution and Habitat

Clivia mirabilis is apparently confined to the Oorlogskloof Nature Reserve in the Northern Cape.

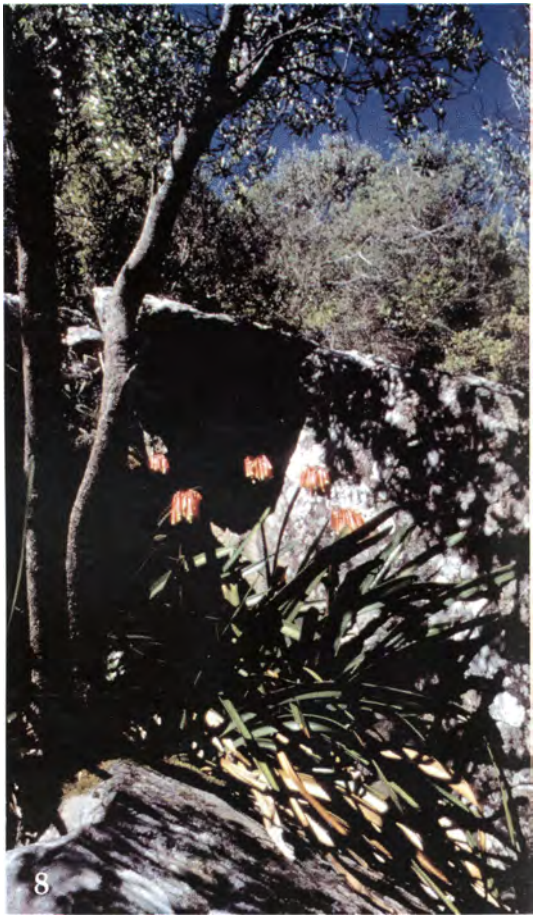
The margins of the Oorlogskloof canyon are capped with 30m cliffs of Peninsula Formation Sandstone. This has eroded to form coarse sandstone talus screes below the cliffs that are partly covered in a light woodland of relictual Afromontane evergreen forest elements, principally *Olea europaea* ssp. *africana, Maytenus acuminatus, Maytenus oleoides, Cassine schinoides, Halleria lucida* and *Podocarpus elongatus* with additional shade provided by outsize (4m tall) specimens of *Phylica oleoides.*



John Rourke climbing up the eastern wall of Oorlogskloof with the type plants of C. *mirabilis*

Small groups of *Olivia mirabilis* grow rooted in humus between cracks in the sandstone talus of the rock scree, either as solitary individuals or in small groups. Occasionally some clumps occur in full sun but these tend to have shorter leaves and often show signs of water stress (dried leaf tips). However, the remaining leaves show no signs of sunburn, despite the intense insolation experienced for several months each year.

The main population examined extends over several hectares and probably consists of well over 1,000 individuals. Due to the position of these two sites under the eastern cliffs of Oorlogskloof canyon, most plants experience shade until about midmorning after which they are in direct sun.



C. *mirabilis* in natural habitat amongst sandstone rocks

It is a matter of great surprise that a *Clivia* species is able to survive and thrive in the harsh climatic conditions prevailing in this part of the Northern Cape. The area is characterised by a semi-arid Mediterranean

climate with a strictly winter rainfall regime - exactly the opposite climatic conditions experienced by the other four species in this genus. The mean annual rainfall at this site is 414*mm*, falling mainly between May and September. Vegetative growth is thus restricted to a brief winter growing period. Situated at an average elevation of between 850 and 900*m* some 100*km* inland from the coast, these populations are subject to brief but light frost in winter.

Root system of C. *mirabilis* with a 1 *metre* measuring tape

Root System

On excavating several plants in the habitat for cultivation at Kirstenbosch, the enormous root system characteristic of this species was revealed. Large adult plants have a mass of fleshy, succulent roots between half and three quarters of a metre in diameter radiating from the base of the rhizome. Individually these roots are an average 20mm in diameter. This disproportionally large volume of subterranean biomass gives mature plants an extensive water storage capacity, allowing them to survive the prolonged rainless summers of the Oorlogskloof environment.

Flower colour, development & pollination

Each flower-head bears between 20 and 48 flowers on a purple to carmine flushed peduncle. The general impression of a fully open scape is of bicoloured flowers, orange-red at the base, yellow towards the mouth and with orange-red pedicels. During the development of the flower both perianth and ovary progress through a series of well-marked colour changes.

Immature flowerhead of C. *mirabilis* about a week before opening
The unopened bud is yellowish but prominently green-tipped and the ovary is also pale green.

Mature flowerhead of *C. mirabilis.* Note red pedicels and ovaries

At flowering the green colouration slowly disappears from the tips of the tepals, which take on the same yellow tones as the basal half of the perianth. The pedicels, ovaries and upper half of the perianth are deep orange-red at this stage. After pollination the yellow colouration disappears and the whole perianth including the ovary takes

on a uniform orange/red colour. As the perianth begins to wither, the ovary swells and undergoes an abrupt colour change from orange to bright green, as do the pedicels. No other *Clivia* has pedicels the same colour as the perianth when the flower is fully open.

The purpose of these colour changes is not yet understood but is probably related to pollinator cues. Pollination appears to be by sunbirds. A single sighting of a malachite sunbird probing the perianths was made at Oorlogskloof on 18 October 2001, suggesting that sunbirds could be involved in pollen transfer. However, like the other three tubular-flowered species, C. *mirabilis* may also be a 'selfer' as between 80 and 90% of the flowers in each umbel are pollinated and produce viable berries. Flowering extends over approximately six weeks, commencing in the first week of October, peaking in mid-October and continuing until about mid-November.

C. *mirabilis* immature berries

Fruiting

The berries mature more rapidly than in the other *Clivia* species. By the end of February, four months after flowering, the fully developed berries have begun to turn yellow and orange with a few having advanced to the final stages of ripeness in which the pericarp is pinkish and later red. Most berries contain two to three seeds, sometimes one. Occasionally a maximum of seven seeds per berry is produced. The berries have turned red by the end of March and are shed shortly thereafter, prior to the onset of the first winter rains in April/May. This rapid autumn maturation of berries is in sharp contrast to the summer rainfall area *Clivia* which mature slowly, usually 12 months for C.*miniata* and C. *gardenii*, about 9 months for C. *caulescens* and C. *nobilis* to coincide with the commencement of October / November summer rains.

Ripe berries of C. *mirabilis*. Note the green pedicels.

Seed Dispersal and Germination

Berries commence falling passively from the parent plant by late February. By early April the majority of berries have been shed. Germination appears to be rapid in response to the onset of autumn / early winter rains. At Kirstenbosch seeds sowed on 18 March 2001 had already developed a 10*mm* radicle by 10 April 2001.

On germinating, the primary root develops into a swollen, white, succulent cylinder up to 50*mm* long, 5 to 6*mm* thick. During the moist winter months (May to September), it swells, accumulating water in its succulent tissue. By October two short (5 to 10*mm* long) leaves have been produced where after further vegetative growth of the seedling slows or largely ceases with the onset of summer dormancy (November to April). This rainless phase persists for approximately six months, during which time the seedling survives on water reserves stored in the greatly enlarged primary root. Vegetative growth commences again in autumn. Thus the biology of a C. *mirabilis*

seedling in its first year is much akin to a winter rainfall area geophyte, with the swollen primary root being functionally equivalent to a corm or bulb.

Five month old seedlings of C. *mirabilis*. Note the prominent carmine pigmentation on the cotyledons and at the bases of the first pair of leaves

The phenology of the germinating seed described above is clearly an adaptation to a semi-arid mediterranean climatic regime - exactly the reverse of the summer rainfall region *Clivia* species.

Within a few months of germinating, the plumular bud (cotyledon plus first true leaf), becomes densely pigmented with anthocyanins. This prominent development of anthocyanins at the base of the leaves is later evident in the leaf sheaths of adult plants, which are heavily suffused with purple-carmine pigments. Why the seedlings of C. *mirabilis* are so densely pigmented with anthocyanins is not clear but it may be a response to the intense levels of sunlight experienced in the natural habitat thereby providing effective screening during the seedlings' critical establishment phase.

Relationships

The distribution ranges of all four previously known *Clivia* species are contiguous or overlap, while at many localities different pairs of species occur sympatrically. (C. *nobilis* with *C. miniata; C. gardenii* with C. *miniata;* and C. *caulescens* with C. *miniata.)* Geographically, populations of C. *nobilis* in the Eastern Cape, though more than 800*km* distant, are the closest spatially to C. *mirabilis.* Moreover, C. *nobilis* also appears to be the closest relative to C. *mirabilis* on morphological grounds. Among these are the tough stiffly erect coriaceous leaves with a median pale striation on the upper surface (some populations of C. *nobilis* occasionally have a faint median striation), and the small seeds.

Breeding Potential

Obviously, *Clivia mirabilis* will be of huge interest to breeders on account of its unusual characters. Biologically, its tolerance of intense sunlight should introduce a degree of sun-hardiness to the leaves of its offspring. Coupled with this is its adaptation to an arid winter rainfall climate. Perhaps a line of sun-hardy *Clivia* will eventually be bred that will grow in full sun in mediterranean climates, able to forego watering in summer!

The floral characters, especially the richly coloured pedicels and ovaries also offer breeding potential in combination with other species. Speculating any further is an almost hopeless exercise but we may be sure future hybrids will result in character combinations few of us can even imagine at this stage.

Phylogeographic questions

To those of us who have always seen *Clivia* as belonging to densely forested subtropical environments experiencing a summer rainfall/dry winter climatic regime, *Clivia mirabilis* seems a complete contradiction. Remote and isolated in the arid Northern Cape its very presence in this most unlikely of habitats is a paradox. How did it get there, how long has it been there, and how has it survived? These are obvious questions that at once spring to mind.

The heavy fleshy berries are not dispersed by wind. They may be carried short distances by fruit eating birds but in general the seeds

germinate within a metre or two of the parent plant. So, long-distance dispersal must be ruled out as a reasonable explanation.

It is more likely that *Clivia mirabilis* is relictual - a survivor of a past phase in the country's climatic history, when subtropical vegetation covered much of the interior of South Africa. From the Miocene period about 20 million years before the present, increasing aridification eliminated this vegetation type from much of central South Africa leaving survivors like the ancestors of C. *mirabilis* to adapt to the emergence of an increasingly dry climate in the western half of South Africa, as the 'proto' Benguela current brought a stream of cold water to the west coast of Africa which ultimately led to the development of a mediterranean type climate (Axelrod & Raven, 1978).

The afromontane forest elements in Oorlogskloof are, like *Clivia mirabilis*, only just surviving in the sheltered microclimate provided by this amazing protected habitat. At best we can only speculate on the past history of these plants, but one thing is certain: they are survivors and as such must command our profound admiration.

Conservation

There will inevitably be a demand from growers and breeders to obtain plants or seeds of *Clivia mirabilis.* At present all populations of this species that are currently known occur in a nature reserve controlled by Northern Cape Nature Conservation.

Collecting in Oorlogskloof is strictly controlled. In order to obtain a permit to collect live specimens the National Botanical Institute signed a memorandum of agreement with Northern Cape Conservation, which states 'The applicant may not transfer the material or any progeny or derivatives thereof to any third party without the prior informed consent in writing of the Director'. This places a responsibility on the NBI not to distribute any live material or seeds at this stage. Due to unprecedented public interested Northern Cape Nature Conservation has temporarily closed the Oorlogskloof Nature Reserve until it has formulated a policy on the distribution of plant material. In the mean time representations have been made to them to allow the distribution of seed through properly regulated channels.

Acknowledgements

I would like to acknowledge the invaluable field assistance of the staff of the Oorlogskloof Nature Reserve, especially Johannes Afrika who first noticed this species, and also Wessel Pretorius whose well-prepared herbarium specimens alerted us to the existence of *C. mirabilis.*

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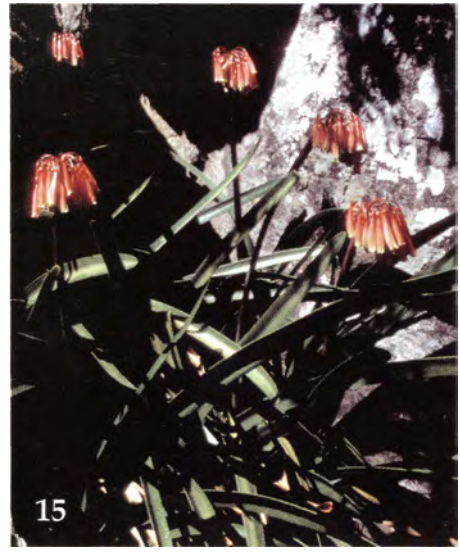


Clivia mirabilis in the natural habitat

GROWING AND PROPAGATING CLIVIA MIRABILIS

John Winter

The first *Clivia mirabilis* collected by Johannes Africa, a Senior Ranger in Oorlogskloof Nature Reserve, was sent for identification to Dr John Rourke, Curator of the Compton Herbarium at the National Botanical Institute, Kirstenbosch. This alerted Dr Rourke to this new species. For the purpose of describing and researching this *Clivia* a permit to collect a limited number of plants and seed was granted by the Department of Nature Conservation of the Northern Cape to Dr Rourke. The tremendous interest shown in this unexpected discovery in the Northern Cape has raised concern for the safety of the population of C. *mirabilis* and as a result the reserve has been closed.

The first impression I had of *Clivia mirabilis*, the latest addition to the genus *Clivia*, was its resemblance to *Clivia nobilis.* The thick rigid upright leaves resemble a C. *nobilis* growing in an exposed situation. However, the leaf has a pale green stripe running down the mid-rib. The seed is small and also similar in size to C. *nobilis.* C. *mirabilis* flowers in November and the berries are ready for harvesting four months later in March. It is unusual for *Clivia* seed to ripen so rapidly, the four other species all taking approximately seven to eight months before their berries are ready for harvesting.

The known population of C. *mirabilis* occurs in the Oorlogskloof Nature Reserve where they are protected. This reserve is situated in the Bokkeveld Mountains of the Northern Cape where the climate is Mediterranean with winter rainfall of only about 415*mm* per annum. Winter temperatures can fall to nearly 0°C. In summer the temperatures can rise to over 40°C and it is very dry but coastal mists relieve these conditions at times.

They have extensive thick *(20mm)* roots that penetrate the rocky scree and anchor the plant securely making it very difficult to remove a plant. More importantly the roots serve as a storage organ providing moisture and nutrients to the plant during the dry summer months, supplemented by moisture collected by the leaves from the sea mist. They grow in partial shade and also in full sun without any sign of sun damage to their leaves - some leaf die-back was noted but this had been caused by stress arising from lack of moisture. Leaf litter provides nutrients.

As with all *Clivia* species, C. m*irabilis* can be grown in a range of media from simply coarse sand to a mixture of well-matured compost, coarse sand and milled bark.

In their natural habitat their roots live in well-aerated rocky screes with leaf-mould, providing adequate oxygen, moisture and nutrient for the plants. To provide a similar growing medium I chose instead of coarse sand to use mainly seven parts of milled composted pine bark mixed with three parts of milled composted pine needles and one part organic fertilizer (Neutrog Bounce Back™).

Initially the plants were kept fairly dry taking into account that they are accustomed to a dry environment particularly in the summer. Under these conditions no growth occurred until watering was increased and the growing medium kept fairly moist. The plants responded immediately and have since produced steady growth, apparently faster than in the habitat and certainly a lot

faster than C. *nobilis*! Seedlings grown in a coarse sand medium have not responded as well.

One-year old seedlings grown from seed in composted medium

As mentioned earlier the seed of C. *mirabilis* is ready for sowing in March. Two methods of sowing were used. One method was to remove the seed from the berry and wash in water that had a liquid soap added. This acts as a fungicide and also helps to remove the membrane that covers the seed. Finally the seed was washed in clean water and placed in a clean transparent plastic bag, sealed and kept in a warm place. Germination occurred in three to four weeks. As the seeds germinated they were removed from the plastic bag and planted in 15*cm* pots containing a medium similar to that used for the larger plants. The other method of sowing the seed is the conventional way of placing cleaned seed in the growing medium at a depth of one and a half times the size of the seed and keeping it moist. The root develops first followed by a narrow leaf. This method turned out to be just as effective as using the sealed plastic bag.

The plants of C. *mirabilis* have been grown in a tunnel with a wet wall at the one end and an extractor fan at the other. The young seedlings have been placed close to the wet wall that keeps them perpetually moist but this does not appear to have a negative effect on the seedlings. The tunnel is shaded but this also does not appear to have an adverse effect on the plants. If grown in a conventional *Clivia* shade house I imagine C. *mirabilis* will do just as well although the growth rate will probably be slower. The young seedlings produce long thin leaves but as the plants develop each new leaf is broader than the previous one.

Although C. *mirabilis* is not the most spectacular species within the genus *Clivia* it offers many opportunities to those interested in breeding new cultivars by making use of the unusual characteristics the new species offers - for example, the red coloured pedicels and ovaries, sun hardiness, tolerance of hot summers, cold winters, flowering in November and a faster growth rate than C. *nobilis*.

In conclusion it appears that C. *mirabilis*, although originating from an arid winter rainfall region, responds well to the same growing methods used for the four summer rainfall species. It will be interesting to observe when they will flower and produce suckers.

Clivia nobilis from Olifantskop, the most westerly recorder population, 800*km* from Oorlogskloof Grower: Michael Jeans

CLIVIA MINIATA WITH GREEN THROATS

Above: Multipetal. Breeder and grower: Norman Weitz

Above, right: 'Mine'. Breeder and grower: Christo Lotter

Right: Grower: Clivia Unlimited

Below, left: Grower: Hein Grebe

Below, right: Winner any other colour Class NC 2001. Grower: Elda de Witt

THE STORY BEHIND THE COVER PICTURE

John van der Linde

The botanical convention is that a scientifically accurate line drawing, or better still, a watercolour painting should form part of the official description of any new plant species. The picture, in the form of a Botanical Plate, together with dried plant material and the full written description, is then stored under controlled conditions in an internationally recognized Herbarium.

The description, including the picture and any additional line drawings, is also published in an appropriate botanical journal, and the name then given to the new species becomes its official, name.

Why a painting and not a photograph? The work is done mainly for scientific purposes, so fine detail is important. Also special features can be highlighted; when comparing plants paintings are more useful for showing up distinctive identifying characteristics. Finally, surprising as it may seem, colours can be reproduced more accurately.

For the name of a new plant species to be validly published under the International Code of Botanical Nomenclature it must be accompanied by a Latin diagnosis or description or both. This is because Latin is the international common language of botany. The correct Latin name for a plant is the primary reference base for the storage, retrieval and use of the botanical knowledge. The description of *Olivia mirabilis* begins

'Clivia mirabilis. Rourke, sp. nov., a speciebus affinibus, corollis actinomorphis rectis tubularibus bicoloribus (miniatis/luteis); '.

The name 'Rourke' appears because Dr John Rourke is the author of the new species, and published the name and official description in Vol. 32,1 of *Bothalia*, the principal botanical journal of the National Botanical Institute of South Africa. The plant material, botanical plates and description are kept in the Compton Herbarium at Kirstenbosch National Botanical Garden, Cape Town, together with similar records for many hundreds of previously recorded South African plant species. The type specimen on which the original description was based is like the title deed of a species name.

The Botanical Plate of C. m*irabilis* was painted by Auriol Batten, and is reproduced with her kind permission. Auriol Batten is one of South Africa's best-known botanical artists, with artwork represented at the National Botanical Institute in Cape Town and Pretoria, the Royal Botanic Garden, Edinburgh and in numerous private collections. She has designed seven sets of South African postage stamps.

Her published artwork includes : *Wild Flowers of the Eastern Cape Province* (C.T. 1966); *Flowers of South Africa* (Sandton 1986). She painted illustrations for well-known books on *Dierama* and the *Gladiolus* species, and for *Curtis' Botanical Magazine*, which is an official publication of the world-famous Royal Botanic Garden, Kew.

The Clivia Society is greatly privileged to be allowed to use Auriol Batten's definitive Botanical Plate of this truly amazing new species, aptly named *Clivia mirabilis.*

Ciivia mirabilis

A LAYMAN'S COMMENTARY ON THE NEXT ARTICLE

Molecular systematics of the Genus Clivia

John van der Linde

When scientists publish their research they give full details of their methods, so that other scientists, working independently, can verify their results. The following article by Ferozah Conrad and Gail Reeves is written in that vein. Although these details are likely to be beyond most of us, this article is published here because of the importance of their results and conclusions. The purpose of this commentary is therefore to summarise, in everyday language, the processes that were followed.

Simply put, the authors had three aims : To confirm, by DNA analysis, the identification already made by other means, of *Clivia mirabilis* as a species in the genus *Clivia;* to investigate the relationship with the other species; and finally and most exciting to most of us *Clivia* lovers, to deduce a *Clivia 'fa*mily tree', showing how the genus *Clivia* developed to the present time, from the most recent common ancestors that existed millions of years ago.

The authors began by taking tiny samples of leaf tissues from plants collected from the wild. These plants are from the Living Plant Collection of the National Botanical Institute, maintained at Kirstenbosch National Botanical Garden in Cape Town.

Besides a sample from C. *mirabilis,* samples were taken from one plant each of C. nobilis, C. *gardenii, C. miniata* and C. *caulescens. A* sample was also taken from a *Cryptostephanus vansonii,* an amaryllid from Eastern Zimbabwe known to be closely related to the genus *Clivia* (and to *Tulbaghia,* incidentally).

Each one of these individual plants carries a message from its ancestors. That message is in the DNA, the genetic material in every cell, handed down from generation to generation. That DNA carries not only the histories of these six plants, but also the whole history of their ancestry. The authors, in matter-of-fact and unemotional prose, have now revealed the most likely version of that history to us - a fascinating DNA detective story.

They began by treating each sample with chemicals, to 'unzip' and then unwind the two strands of DNA from their normal double helix format. In a throw-away phrase, they casually mention that the amount of genetic material extracted varied in weight from twenty to fifty nanograms in each case. To the layman these figures are mind-boggling, because do you know what a nanogram is? A nanogram is one thousand-millionth of a gram! Heavy stuff!

Having applied further chemicals and several thermal cycles, the end result was, for each sample, a much magnified specifically targeted stretch of DNA, called a sequence. Each sequence is rather like an identifying bar-code which can be 'read' by special equipment, and which is directly comparable with the sequences similarly isolated from the samples from the other plants.

An important point is that the DNA in question was extracted from the genes from the chloroplast regions of the cells in each leaf sample. The significance of this is that, unlike genes in the nucleus of the cell - which are inherited from both pod and pollen parents, chloroplast genes are inherited from the mother plant only. This

means that the ancestors referred to above are the mother plants of the mother plants of the mother plants.... and so on, back generation by generation, tracing the maternal line from the present time, back into the long distant past - in effect, to the Great Grandmother of them all.

Because there is no genetic contribution from the pollen parent to the chloroplast genes to 'cloud the picture', the only source of change to genes inherited maternally can be mutations. These occur due to random errors in copying this particular genetic information.

For this reason the scientists focus on the chloroplast DNA sequences, and in particular on the differences between them, because they show the unclouded effects of the mutations accumulated over the millennia as the 'family tree' split into its various branches.

The number of differences presently observed is a measure of how far back the ancestors (or more correctly, the most recent common ancestors) of these six plants - now alive and flourishing at Kirstenbosch as you read this article - diverged from each other. For example, if there are few differences between the sequences for two plants, then their most recent common ancestor must have existed fewer years ago than if there were significantly more differences between the two DNA sequences.

The next step was to feed the sequence data into a computer, which then examined all the possible 'family trees' that could have given rise to the differences in sequences that were observed.

The computer, using an extremely sophisticated software program, then picked out the most likely 'family tree' from the range of 954 possible alternatives.

This 'tree', called a cladogram, is shown on page 21. The varying lengths of the branches of the cladogram illustrate the point mentioned above : If two plants have more similar DNA sequences, then they have a common ancestor which lived more recently in the past, and so are joined by shorter branches on the diagram. Plants with more differences in their DNA sequences share a more remote common ancestor, and are therefore linked by longer branches.

Once the scientists have estimated the rate at which chloroplast DNA changes with time, they can apply that rate to the number of observed changes in order to estimate how long ago the various branches diverged, and even the approximate date when the more recent common ancestor of the six plants must have existed. The authors have not made these calculations yet.

At this point I refer the reader to the Section 'Results and Conclusions' in the next article. This section makes for easier reading than the earlier, more technical sections. The conclusions are fascinating!

The work that the authors of that article have done is of major significance and they deserve to be recognized for their contribution to our knowledge of the genus *Clivia.* Their work was made possible by the generous donation by Mr Leslie Hill of the funds needed to equip the Molecular Systematics Laboratory at Kirstenbosch that has been named after him. The Cape Clivia Club contributed to the cost of the chemicals that were used.

Cryptostephanus vansonii

MOLECULAR SYSTEMATICS OF THE GENUS CLIVIA

Ferozah Conrad and Gail Reeves

Leslie Hill Molecular Systematics Laboratory, Kirstenbosch

INTRODUCTION

The genus *Clivia* (Amaryllidaceae) comprises five species of which C. *caulescens*, C. *miniata*, *C. gardenii* and C. *nobilis* are better known. The recent discovery of a fifth *Clivia* species - *Clivia mirabilis* (Rourke, 2002) in the Northern Cape has prompted questions regarding the relationship of this taxa to the other four *Clivia* species. Interesting questions also pertain to biogeography of the genus since the distributions of the other *Clivia* species are restricted to the east coast of South Africa, from the Eastern Cape northwards.

The most modern approach to phylogeny reconstruction involves the use of DNA sequence data as a source of phylogenetic information - a field of study known as molecular systematics. This involves the collection of DNA sequence data from targeted gene regions for all taxa of interest and the evaluation of this data to determine the extent to which nucleotide variation occurs among taxa. Other sources of characters for phylogenetic studies have been based in fields such as anatomy, cytology, palynology and morphology but DNA sequence data have become a valuable source of characters in recent years. In this study we utilised four non-coding chloroplast regions as a source of phylogenetic information: the rpoB-trnC intergenic spacer, the trnL intron, the trnL-F intergenic spacer, and the rps16 intron.

MATERIALS AND METHODS

DNA isolation and polymerase chain reaction (PCR)

Total genomic DNA was extracted from 1.0g fresh leaf using the 2X CTAB method of Doyle and Doyle (1987). Twenty to fifty nanograms of total genomic DNA were used as a template for Taq mediated amplification. One hundred microlitre reactions contained Promega magnesium free thermophilic buffer (50mM KC1, 10mM Tris-HCI, 01% Triton X100), 3mM MgC12, 0.004% BSA, 0.2mM each dNTP, 100ng of each primer and 2.5U Taq polymerase. Thirty cycles of DNA amplification were carried out in a Gene Amp PCR System 9700 (Applied Biosystems Inc) using the following programme for the rpoB-trnC spacer region: denaturation: 94°C for one minute; annealing: 52°C for one minute; extension: 72°C for one minute - five cycles and then the next 25 cycles: denaturation: 94°C for one minute; annealing: 48°C for one minute; extension: 72°C for one minute. For the trnL-F region and rpsl6 intron the following programme was used: denaturation: 94°C for one minute; annealing: 48°C for one minute; extension: 72°C for one minute. Presence of PCR products was verified on a one percent agarose gel.

Amplification of the rpoB-trnC intergenic spacer region was achieved using primers rpoB5' and trnC5' (Ohsaka and Ohnishi, 2000). Primers rpsl6F and rpsl62R (Oxelman et al., 1997) were used to amplify and

sequence the rps16 intron. Primers 'c' and 'f' (Taberlet et al., 1991) were used to amplify the adjacent trnL intron and trnL-F intergenic spacer between the trnL and trnF exons. For each of the above regions amplification primers were then used as sequencing primers.

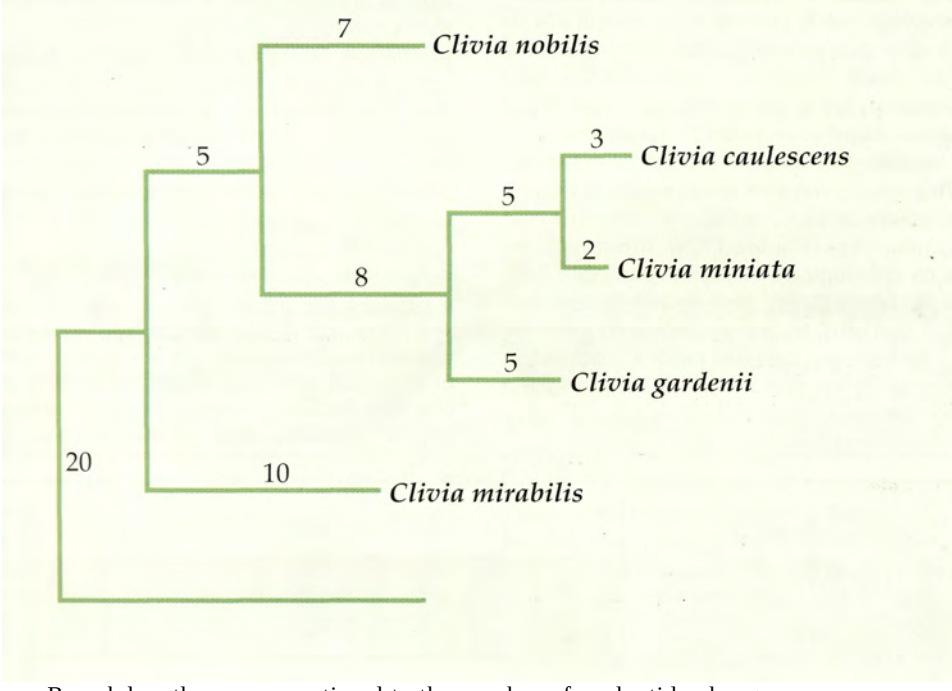
DNA SEQUENCING AND SEQUENCE ALIGNMENT

Amplification products were purified using Qiaquick (Qiagen) spin columns according to manufacturer's instructions and directly sequenced on an ABI 377 automated sequencer using standard dye-terminator chemistry following manufacturer's protocols (Applied Biosystems Inc). For assembly and editing of the complementary strands Sequencher (Gene Codes) was used.

A combined cladistic analysis of the four non-coding DNA regions was performed using the parsimony algorithm of the software package PAUP* for Macintosh (phylogenetic analysis using parsimony v.4.0b Swofford, 2001). Cryptostephanus vansonii was designated as the outgroup taxon based upon results of a larger analysis of DNA sequence data for the Amaryllidaceae (Meerow et al., 1999).

RESULTS AND DISCUSSION

Of the 2897 characters included in the combined analysis 17 were potentially parsimony informative. Branch and bound parsimony analysis gave a single tree with length 65, consistency index (CI) of 0.97, and retention index (RI) of 0.92.



Branch lengths are proportional to the number of nucleotide changes

Figure 1: The most parsimonious tree found from combined analysis of all four DNA sequence matrices

In the single most parsimonious tree shown in figure 1, *Clivia mirabilis* is placed as sister to a clade comprising the other four *Clivia* species. C. *nobilis* is placed as sister to the clade comprising C. *gardenii,* C. *miniata* and C. *caulescens,* and C. *gardenii* is in turn placed as a sister to the terminal clade comprising *C. miniata* and C. *caulescens.* This would therefore imply that *Clivia mirabilis* is representative of the most primitive lineage of the genus, and the terminal taxa, C. *miniata* and C. *caulescens,* are the most derived taxa.

In terms of biogeography this would imply an expansion of the lineage from the western Cape eastwards. *Clivia* mirabilis is the only species in this genus to be found in the winter rainfall region of South Africa (Rourke, 2002), and it is placed here as the sister to the remainder of the genus. *Clivia nobilis* is found in the Eastern Cape where its distribution overlaps with that of C. *gardenii. Clivia gardenii* then extends further north along the east coast. *Clivia caulescens* extends from Mpumalanga to the northern extreme of the genus' distribution in the Northern Province. The distribution of C. *miniata* is extensive throughout the east coast where its range overlaps with C. *nobilis, C. gardenii* and C. *caulescens* (Winter, 1999). Interpretation of morphological character evolution in light of the phylogenetic tree would suggest that the upright flowers demonstrated by C. *miniata* are derived since C. *miniata* is placed in the most terminal clade in the phylogenetic tree. All other taxa display pendulous flowers.

GLOSSARY

clade a group of organisms which include the most recent common ancestor of all its members and all the descendants of that most recent common ancestor

consistency index (CI) a measure of the amount of homeoplasy exhibited by a character or set of characters on a tree; defined as the sum of the minimum individual character ranges divided by the observed number of changes; if there is no homoplasy, these quantities will be equal, so that the consistency index achieves its maximum value of one

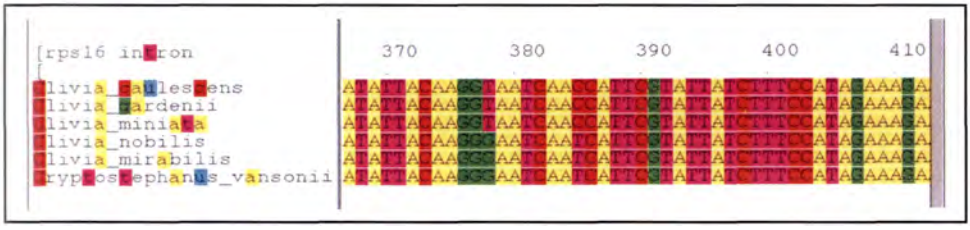
lineage any continuous line of descent; a series of organisms connected by reproduction by parent of offspring

outgroup one or more taxa used to help resolve the polarity of characters, and which is hypothesized to be less closely related to each taxa under consideration than any are to each other

parsimony refers to a rule used to choose among possible cladograms, which states that the cladogram implying the least number of changes in character states is the best

phylogeny the historical relationships among lineages of organisms or their parts (eg. genes)

polymerase chain reaction (PCR) a process for amplifying a target DNA sequence manyfold, in which a series of thermal cycles each result in denaturation of a double stranded target, annealing of oligonucleotide primers to the resulting single strands, and primer extention



A *Clivia* DNA string has approximately 2 800 characters in it. The above diagram is a snapshot of parts of some of those strings and shows two of the mutations.

catalyzed by a thermostable DNA polymerase

retention index(RI) the retention index measures the extent of character congruence at maximum parsimony

Taq polymerase a thermostable DNA polymerase from Thermus aquaticus, a thermophyllic bacterium; used for amplification of DNA via polymerase chain reaction.

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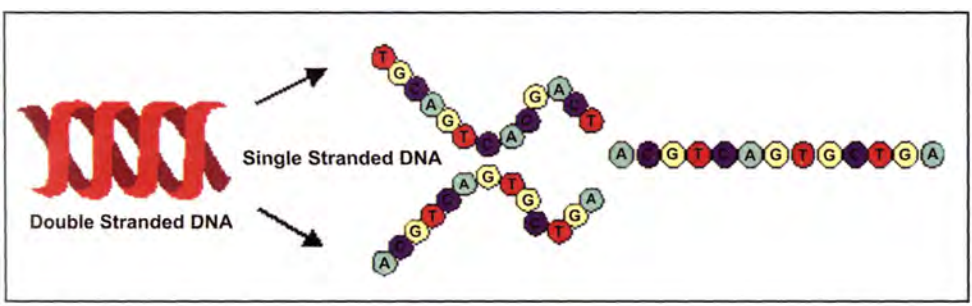


Reading DNA

Here you can see how the bases of a helix become a DNA sequence.

When you write a letter, you put together words using different letters of the alphabet. With twenty-six letters you can say anything you want. It is important that the letters go in the right order.

This sentence stops making sense when thaliekmviserhflker are in the wrong order.

When new cells are made, the organism is puttimg together different letters of the DNA alphabet. The order of the DNA bases is called the **sequence.** The DNA sequence codes for all the proteins that are ultimately made from DNA.

VEGETATIVE (ASEXUAL) PROPAGATION OF CLIVIA

Ammie Grobler and Lena van der Merwe

Clivia can be propagated in two ways:

Sexually: That is the conjugation of male and female sex cells after pollination. Pollination is the transfer of the pollen grain onto the female organ (pistil) so that fertilization can take place. Seed carrying the embryos then develop. (See detailed description in Clivia Yearbook 3.) Every one of these offspring inherits characteristics from each parent so that none of them will be identical to either parent or to one another.

Asexually (vegetative): This is the ability of a plant to produce offspring through its vegetative parts such as leaves, stems and roots. In asexual propagation all of the offspring are genetically identical, i.e. are clones of the mother plant. In the case of *Clivia* the natural method of cloning is through the rhizome.

Vegetative propagation can be achieved artificially, but before we cover the different methods, we must first ask an important question: *Why do I want to propagate a specific* Clivia *vegetatively?*

Remember that unlike sexual propagation vegetative propagation results in the production of a number of genetically identical plants. It is therefore the only way in which one can obtain exact replicas of a highly desirable *Clivia.* Many *Clivia* multiply asexually by way of suckers and grow into large clumps. This has an adverse influence on the quality of their flowers that can be remedied by dividing the clumps into individual identical plants, which will flower properly However some *Clivia* do not sucker readily and, especially if they are exceptional specimens, artificial means can be used to encourage them to produce exact replicas of themselves vegetatively.

DIVISION OF CLUMPS

This should be done only after flowering and till late summer - that is from October to the end of January, as follows: Carefully unpot or lift the clump and wash away the soil until all the parts are clearly visible.

Cut off all the suckers (daughter plants), which are attached to the mother plant by stolons (underground runners) but only if they have independent roots.

Offsets, which are attached directly to the rhizome of the mother plant so that they share a root system with the mother plant, must be carefully cut from the mother plant ensuring the offset retains its part of the rhizome and the roots attached to it. Underground runners which have grown out of the rhizome of the mother plant, but which have not yet developed their own roots, must not be removed.

The rhizome, out of which the suckers and offsets grow, is clearly discernable from the roots. It is thick and has nodes (the axillary buds) out of which offsets or suckers develop.

Cut the long roots short to about 10cm and place the plants for 24 to 48 hours (depending on the temperature) in a warm shady place to dry out.

After the drying out period, place the plants for 30 minutes in a KicStart™ solution (50m/ in 10/ water).

In all cases use only a sharp knife which is sterilized before every cut using an antiseptic agent such as Sporekill™, or bleach or by heating in a flame.

Submerge the plants for 20 seconds in a disinfectant solution such as Sporekill™ *(2ml* in 10/ water) and then plant the plants in a suitable potting soil or into the open ground.

When planting in a container, sterilize the soil with an insecticide and a fungicide. Water well and then water sparingly after 10 days.

SCORING

Scoring refers to different types of cuts made on the rhizome to stimulate vegetative propagation. First a clear distinction between the pseudo stem (above the ground) and the true stem (mainly under the ground) has to be made. The true stem (rhizome) is usually underground, is hard and slightly woody in older plants. It contains the axillary buds out of which offsets or suckers will develop.

The pseudo-stem above ground consists of leaf-sheaths covering the terminal part of the true stem (delicious nutrition for the lily borer!).

Scoring must be made into the rhizome. It disturbs the hormonal balance in the rhizome resulting in the development of offsets or suckers from the axillary buds.

When to resort to scoring?

Scoring is a drastic step, which carries the risk of losing the plant. It is resorted to only to reproduce clones of an exceptional plant with exceptional flowers, which does not form suckers naturally, and is in high demand.

Methods of scoring

Wedge scoring method *(Figure 1)*

Do not remove the plant from the soil. Remove just enough soil to expose the top roots.

Make 3 to 4 wedge-shaped incisions about *5mm* deep into the stem with a sharp sterile knife. Sterilize the wounds and soil with Sporekill™ solution *(2ml* in 10/ water). Repeat the sterilizing during watering with KicStart™ solution (50m/ in 10/ water).

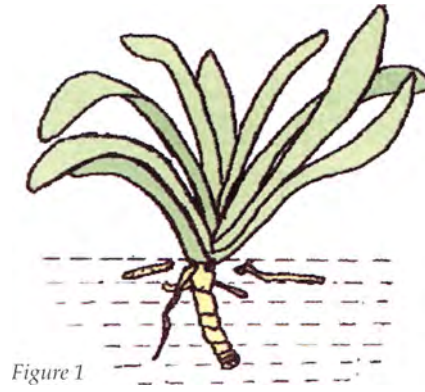


Figure 1

Heated small metal rod or metal knitting needle method *(Figure 2)*

Do not remove the plant from the soil. Take a *3.5mm* diameter metal knitting needle or metal rod and heat it in a flame. Press the hot needle right down the crown of the plant into the rhizome. The object is to destroy the growth point of the plant, thus stimulating auxiliary buds to sprout and form offsets.

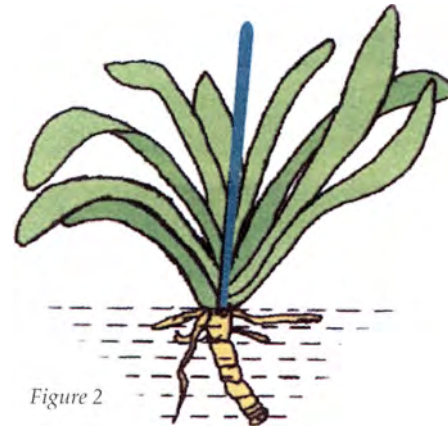


Figure 2

Scoring the rhizome *(Figure 3)*

This is a rather hazardous undertaking. Remove the plant from the soil. Wash the rhizome and roots clean. Prune the roots to about 10cm. Turn the plant upside down so that the bottom end of the rhizome points

upwards. Make a cross incision about 3 to 4*mm* deep into the bottom end of the rhizome and open the incisions as far as possible. Leave in a warm shady place for a day to dry off. Place for 30 minutes in a KicStart™ solution and disinfect when watering.

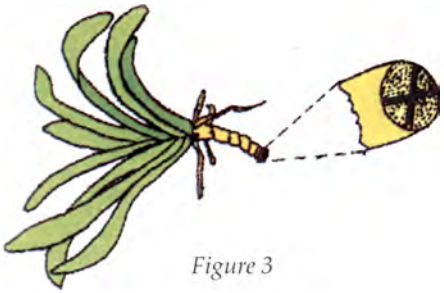


Figure 3

Removing a part of the rhizome *(Figure 4)*

Remove the plant from the soil. Wash the rhizome and roots until clean. Prune the roots to about 10cm.

Cut at a 45° angle about 5*mm* deep into the rhizome and then vertically downwards to cut away about 1/4 of the width of the rhizome. Treat the cut surface with fungicide. Allow it to dry off and replant as above.

Figure 4

Plant on a stone (adopted from Hennie Koekemoer)

This is a very safe method and can be used with exceptional seedlings or young plants which need repotting. Place a golf ball sized stone directly under the plant when planting. According to Hennie, this is a very effective way of stimulating the production of offsets.

GENERAL

The success of the above artificial methods depend upon:

- The vigour of the plant
- Climatic conditions at the time. Cool, dry conditions are ideal.
- Proper treatment and preparation of the plant. Sterilize the tools and equipment used and always work very cleanly when you make any incisions in a plant. Before and after each incision, sterilize your knife, your hands and everything in contact with the wound to prevent contamination - that is not only bacteria or fungi (they are treatable) but virus infections which are untreatable and must be prevented. Take the right precautions and you will succeed!

Good luck with your vegetative propagation of *Clivia.*

Division soon after flowering will have an adverse effect on seed set and seed development. Some growers also believe that new flower bud formation starts soon after flowering and that division should be done in May to avoid abortion of nascent flower buds and to protect seed.

Pruning roots can result in those roots dying back but some growers have treated cut root ends with Bravo™ neat to stimulate root growth from the cut surface.

Some growers have found that divisions need not be dried off. The leaves of the sucker should be tied together to protect them before it is severed from the mother plant. Treat the cut surfaces with fungicide, do not prune the roots, replant the sucker right away and water it with **KicStart**™ *and* **Sporekill**™. *That will reduce the shock of surgery! Then keep the divisions dry and the leaves tied for about 2 to 3 weeks until they have settled down.*

The growing medium itself can stimulate growth from cut surfaces and avoid disease. Use Bravo™ on the cut surfaces and plant in clean, sterilized filter sand - compare Henriette Stroh's article on Pests and Diseases under the heading Phytophthora.

Year round use of the fertilizer Peters Professional™ has been found to stimulate the production of offsets but it does have a negative affect on flowering unless it is used less often. Eds

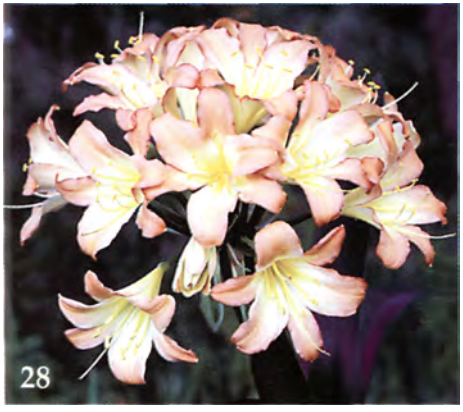
PEACH AND PASTEL CLIVIA and their origins

Bill Morris

I am interested in the variety of peach and pastel *Clivia* flowers and their origin.

I believe they may be of various types and origins. The following is an outline of my interpretation.

The normal orange *Clivia* in the wild is a variable plant in most of its characteristics. These characteristics are under the control of numerous genes. Generally, each individual gene is part of a set called a metabolic pathway. This produces certain chemicals by step-wise chemical transformation from simple chemicals to more complex ones. These pathways are interconnected in many ways as a chemical produced by one may be used by another at different times. It is sometimes in competition for the chemical at the same time. Such interrelationships are the reason many genes are said to be multi-functional. Not that the gene can do many things, but that the gene's chemical product can be part of many pathways.



In the case of colour in *Clivia* flowers (and other plants) the pigments of various different pathways of which chlorophyll, carotenoids (mainly yellow) and flavonoids (white, red, blue and purple) are the main groups.

In the wild *Clivia miniata* colour can vary from red to various shades of orange, then salmon, to even paler pastels, peach and yellow. All of these can then have white, yellow or green throats or background colours. Thus, at least three metabolic pathways are involved. This spectrum of colours (ignoring the throat or background colours) from red to yellow can be due to inefficient genes in the metabolic pathway. So, at each step less than the usual amount of chemical is turned into the next chemical. Each step therefore acts as a partial bottleneck along the manufacturing process. These multiple bottlenecks mean that at the end of the line, varying lesser amounts of the final product (anthocyanin pigment) are produced.

C. *miniata* pastel forms from the habitat (NBI)

C. *miniata* 'Ella van Zijl'.. Grower: Toy Jennings

Thus the whole series of colours from red to yellow can occur in what are really normal (orange) *C. miniata.* These inefficient genes are probably the product of different minor mutations, giving rise to various alleles (or forms) of each gene which are present in the wild population of *Clivia miniata.* It is the random or chance recombinations of these modified genes that give rise to the various colours. Because of these interconnections between all the metabolic pathways and the 'multiple functions' of the genes, the plants with very little colour in the flowers (peach and yellow) are very rare because most of them have other 'problems' in other pathways, due to the cumulative effects of inefficient genes. This makes them less vigorous or less fertile or their seeds less viable so they compete less well with other plants and only occasional ones are found.

Most of the yellow and peach variants that are known are not members of the continuous 'orange' spectrum caused by multiple ineffective genes. They are due to single gene mutation. In these plants a single gene has undergone a mutation which has made it totally ineffective, and this causes a total block of anthocyanin production giving a yellow flower. This is called a null mutation. In the case of peach flowers this null mutation can be described as 'leaky'. That is, just enough chemical is produced by the gene to give a trace of colour. It seems likely that some pastels could also be produced by a leaky 'null mutation'.

The important difference, however, is that one type of yellow, peach, pastel, etc. is produced by the cumulative effect of a number of genes, whereas the other type is produced by a major mutation (change) in just one gene.

Now, the question is, how can you differentiate between the two types? This is done by their different breeding behaviour.

C. *miniata* Peach. Grower: Clivia Unlimited

Lotter's Peach. Breeder and grower: Cristo Lotter

In the case of the multiple gene type, the plants when selfed or when two of the same type are crossed give varying results. Plants are obtained which can vary giving a wide spectrum of colours similar to the normal orange range but paler and there is no particular numerical relationship amongst the colours.

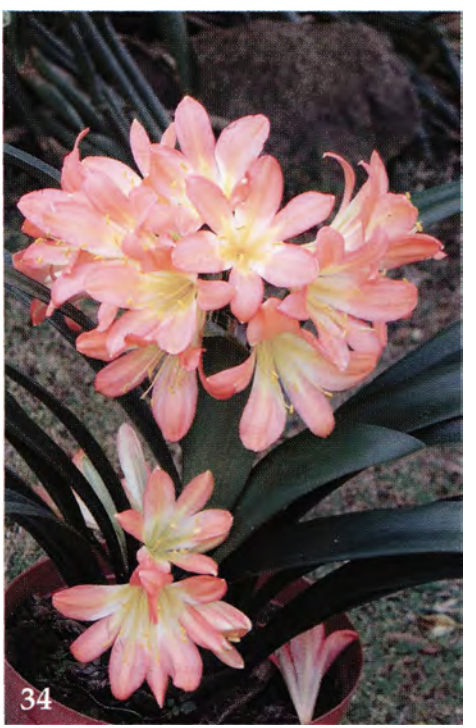
In the case of single gene mutations, crossing between the colours is predictable. That is, yellow x yellow gives yellow offspring, peach x peach gives peach, and so on. Also, in crossing these mutations with normal orange plants, the mutations are recessive, and in the second generation the mutations reappear in Mendelian ratios.

In cases where yellow x yellow or peach x peach give normal orange offspring, this is because the single gene, mutant plants are of two types (Group 1 and Group 2). These differ because a single gene null mutation has affected two different genes but each plant only has one affected gene (but present in a double dose).

The end result of this interpretation is that when a new yellow, peach, pastel, pink, etc. occurs, it may be a multiple gene type which will breed as an orange or it may be a single gene mutation which will breed according to Mendel.

There is one other source of pastel, peach or pink flowers and this comes from crossing an orange (multiple gene control) with a single gene mutant yellow. When a normal orange is used, most of the offspring are paler than the orange parent. When a paler orange is used the same result occurs and even paler flowers can be obtained. Pastels or peach flowers can occur. These plants will again breed differently but will give Mendelian ratios when crossed with appropriate single gene yellows.

C. m*iniata 'Chubb Peach' m*ultipetal. Breeder and grower: Sean Chubb



C. *miniata '* pastel. *Grower:* Clivia Unlimited

Winner C. *miniata* peach/apricot class and third Best on Show NC 2001. Grower: Sarel Naude

Winner *C. miniata* pastel class CC 2001. Breeder and grower: John Winter

Winner *C. miniata* pastel class KZN Interest Group 2001. Breeder: Nick Primich. Grower: Louise Swanepoel

THE NUTRITION SYSTEM OF CLIVIA

Hannes Robbertse

Profesor Robbertse is a former Director of the Margaretha Mes Institute of Seed Research, University of Pretoria but joined the Department of Plant Production and Soil Science in 1994.

In this paper, I am going to focus on those parts of the *Clivia* plant that are involved in the nutrition process.

Plant roots are responsible for the uptake of mineral nutrients by root hairs.These nutrients are then transported through the xylem vessels to the stem and leaves where they are utilized in metabolic processes. The leaves are the carbohydrate (sugars and starch) factories of the plant through the process of photosynthesis. Carbohydrates produced by the leaves are loaded into the phloem tubes (cells) and translocated to the different parts of the plant where they are utilized for energy production or stored as sugars or starch. In order to get a better understanding of the functioning of roots and leaves, it is necessary to know something about the origin and structure of these organs.

The root

Origin and structure

Apart from the primary root deriving from the radicle of the embryo in the seed during seed germination, most *Clivia* roots derive from deep inside the stem. The first sign of root formation is a small group of dividing cells, organising themselves into a root tip meristem *{Figure 1).* Unless damaged, these meristem cells will function as the 'cell factory' of the root and will continuously provide new cells required for the root growth. The newly formed cells are immature and have to grow and differentiate (mature) into specific functioning tissues like the root cap protecting the delicate meristem cells, epidermis, ground tissue and vascular system *{Figure 1).* The maturing epidermis cells form outgrowths, called **root hairs** *{Figures 2 and* 4). In actively growing roots the root hairs closer to the root tip are alive and thin-walled. Further away from the root tip the root hairs develop striations and die, but remain intact as a velvety layer around the root *{Figure 2).*

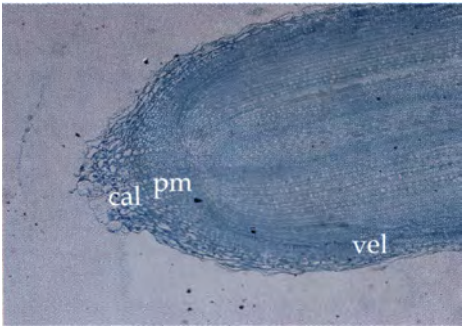


Figure 1. Longitudinal section of *Clivia* root tip. Cal = calyptra consisting of dead tissue, protecting the delicate promeristem (pm) cells. The promeristem cells initiates all other tissues of the root, including the velamen (vel)

Figure 2. Picture of *Clivia* root tip (rt) and outside of velamen (vel) covered with root hairs

Being a **semi-epiphyte** (a plant using another plant as a support to expose itself to the sunlight), the *Clivia* root structure also simulates epiphytic roots in the sense that it has a **velamen** *(Figures* 3 *and* 4), which is also formed by the root tip meristem as a separate tissue underlying the epidermis.

Closer to the tip of actively growing roots, all the cells, including the velamen cells are alive. The maturing velamen cells develop net-like striations on the inside of the cell walls before losing their protoplasts *(Figure* 4). The now dead velamen cells become filled with air that reflects light and gives the root an opaque or whitish colour. The first cell layer underneath the velamen is called the **exodermis** and consists of large cells *(Figure* 4) with thickened side (radial) walls impregnated with a corky substance (suberin) making them impenetrable to water, thus preventing water from moving through the cell wall from the velamen to the underlying cortex.

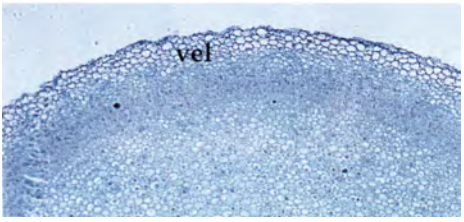


Figure 3. Cross section of *Clivia* root close to the root tip, showing young velamen cells

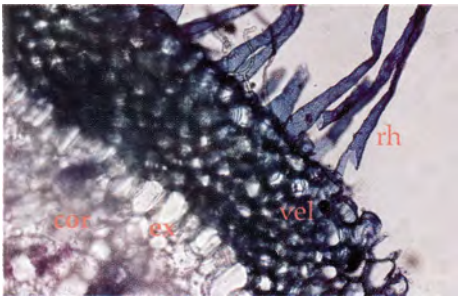


Figure 4. Cross section of *Clivia* root further away from the root tip, showing root hairs (rh), well differentiated velamen (vel), exodermis (ex) and cortex (cor)

Some of the exodermis cells, called **transfusion cells,** slightly intrude the velamen *(Figure* 5*)* and retain their dense cytoplasm in contrast to the surrounding ones that develop large vacuoles and die. Any solutes passing through the exodermis, therefore, have to pass through the cytoplasm of the transfusion cells. The outer walls of the transfusion cells are specially designed *(Figure* 5*)* for 'loading' substances into the cytoplasm of these cells for transfer to the cortex cells.

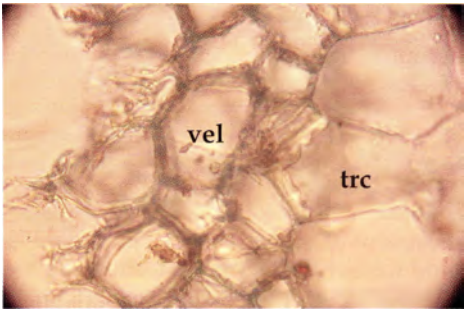


Figure 5. Section of *Clivia* root showing transfusion cell (trc) with thickened outer wall intruding into the velamen (vel)

Functioning of the root

The root hairs in the younger part of the root, closer to the root tip, are alive and responsible for the absorption of water and mineral nutrients from the growing medium. In the older part of the root, the root hairs and velamen cells have died *(Figure* 4). Water and nutrients now move into the root hairs and velamen cells by means of capillary action. The action of the velamen can be demonstrated by bringing the root in contact with a drop of stained water. The thick mass of dead root hairs together with the velamen act like blotting paper in absorbing the drop of water and staining the root hairs and velamen cell walls. Once in the walls of the velamen cells, the water and nutrients have to pass through the protoplasts (cell contents) of the transfusion cells to the cortex, due to the impermeability of the exodermis cell walls. Due to the semi-permeability of the

cell membranes and the cytoplasm, the exodermis acts as a 'filter' in preventing certain unwanted ions from entering the root.

Although not yet proven, it is possible that the velamen cells may also absorb water in the form of water vapor either from the atmosphere where the plants grow as epiphytes or from soil water vapor.

The way in which water and nutrients are taken up by the living root hairs directly from the substrate or indirectly by the transfusion cells from the velamen, can be explained as follows:

Fertilizers consist of mixtures of mineral salts. When mineral salts dissolve in water, they dissociate into positive and negative ions. For example, if a salt like potassium nitrate, KNO_3, dissolves in water, positively charged potassium ions, K^+, and negatively charged nitrate, NO_3", ions are formed. The mineral salts in applied fertilizers dissolve (dissociate) in the soil water, or water in the growing medium. The water together with the ions is then absorbed by the roots as explained above and transported through the xylem (wood) vessels *(Figure* 6) to the leaves. The vascular cylinder of the root is ensheathed by an **endodermis** *(Figure* 6*)* with similar structure and function as the exodermis, also acting as a selective filter for certain ions.

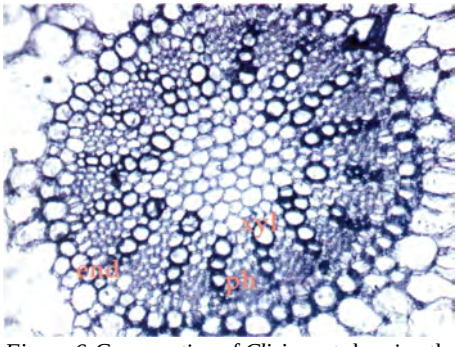


Figure 6. Cross section of *Clivia* root showing the central cylinder encircled by the endodermis (end) with alternating xylem (xyl) and phloem (ph) groups

Apart from its absorbing function, the velamen also has a protection function due to the layers of dead, air-filled cells surrounding the live cells of the cortex and vascular cylinder. *Clivia* roots are therefore more tolerant to desiccation than roots of most other plants. Due to their specific structure and functioning, *Clivia* roots will thrive best in a moist, but not wet, and well-aerated growing medium containing sufficient, but balanced amounts of all required mineral nutrients.

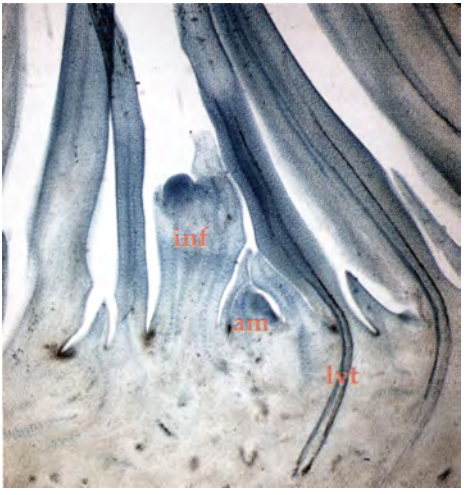


Figure 7. Longitudinal section of stem apex showing young inflorescence bud (inf), new apical meristem or bud (am) and leaf vascular tissue (lvt)

The leaf

Structure and function

Clivia leaves are produced by the apical meristem (bud) of the stem *(Figure* 7). Mature leaves are strap-like with parallel veins containing the vascular tissue responsible for transportation of water and nutrients to and from the leaves. In cross section *(Figure* 8a*)*, it can be seen that the outer layer of cells surrounding the leaf is the epidermis.

The outer cell walls of the epidermis cells are thick-walled and covered with a waxy layer, named the cuticle. The function of the

cuticle is to prevent excessive water loss from the leaf surface.

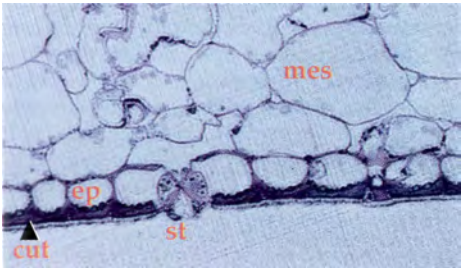


Figure 8a. Cross section of *Clivia* leaf showing cuticle (cut) covering the epidermis (ep), stomatal pore (st) surrounded by two guard cells and mesophyll cells (mes)

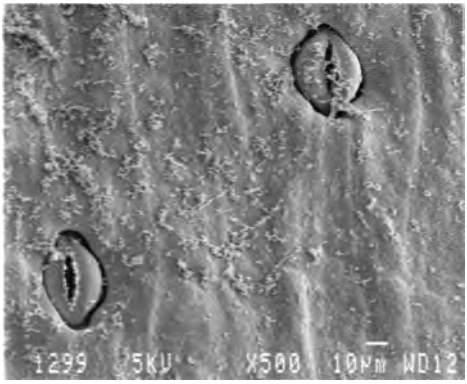


Figure 8b. Scanning electron micrograph of the lower epidermis of *Clivia miniata* leaf showing two stomata and wax deposits

Stomata occurring in the lower, but not in the upper epidermis, are small pores in the epidermis, each surrounded by two guard cells *(Figures* 8a *and* b*).* Changes in the shape of the guard cells allow the stomatal pores to open or close, allowing gasses, like carbon dioxide and oxygen, to pass into or out of the leaf.

The space between the upper and lower epidermis and traversing vascular bundle is filled with thin-walled ground tissue (mesophyll) cells containing **chloroplasts** *(Figure* 8a*).* The chloroplasts contain the green pigment, chlorophyll that can absorb the energy from sunlight and convert it into chemical energy. The latter is utilised by the leaf for synthesizing carbohydrates from carbon dioxide and water through the process of photosynthesis. Carbohydrates are the source of energy for the plant and are utilised for respiration, growth, flowering and fruiting. *Clivia* has a very effective photosynthetic system and can cope with relatively low light intensities.

Stomata play a major role in photosynthesis in the sense that if the stomata are closed, no carbon dioxide can move into the leaf, resulting in the cessation of photosynthesis.

Transpiration and Nutrition

Transpiration is the process of water loss in the form of water vapor through the stomata.

The rate of transpiration by the leaves is directly related to the rate of water and nutrient flow from the roots to the leaves, and to the opening status (aperture size) of the stomata. Factors affecting transpiration rate and the opening of stomata are, water content of the guard cells, relative humidity of the surrounding air, light, temperature, and wind. Due to transpiration or water loss through the stomata during the day when stomata are open, there is a flow of water from the substrate water solution, through the roots to the leaves and through the stomata to the atmosphere. This water flow, known as the 'transpiration stream', is also responsible for transporting the nutrient ions from the substrate to the leaves. The two processes of transpiration and photosynthesis and their relation with stomatal function, are crucial for the nutrition of *Clivia* plants.

Plant cells are live units and need oxygen to respire or 'breathe'. Leaves obtain their oxygen through the stomata, but roots get their oxygen from the substrate, either directly from the air-filled pores in the substrate or from the soil water containing dissolved oxygen. Roots therefore need a well-aerated growing medium to function

optimally. This is particularly so in the case of *Clivia* plants having roots with a velamen.

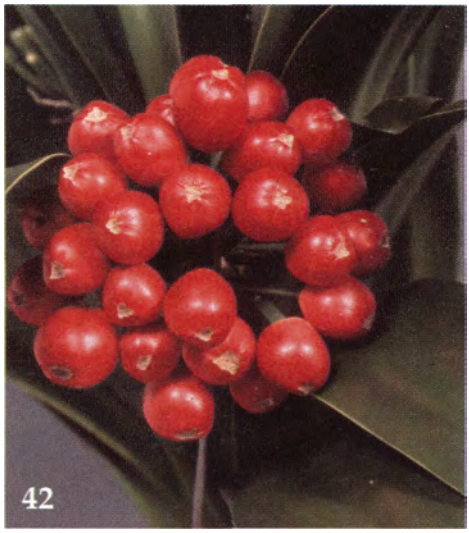
Foliar feeding

In addition to the uptake of nutrients by the roots, plants can also take up nutrients through the leaf cuticle. In younger leaves the cuticles are relatively thin, and nutrients applied as a leaf spray, can be taken up more readily than in older leaves with much thicker cuticles. Like any other living organism, leaves have a limited life span. As they become too old, the stomata are covered (blocked) by the thickening cuticle, resulting in loss of function, followed by senescence and death of the leaf.

[C. m*iniata x C. gardenii*] x [C. *caulescens* x C. *gardenii*] 'Golden Sunset'. Breeder: Y. Nakamura. Grower: Mick Dower

C. *nobilis*. Grower: Norman Weitz

C. *miniata* winner first flower section and runner up - Best on Show CC 2001. Breeder: Pen Henry. Grower: Ian Brown



C. *miniata* with berries section winner NC 2001 Grower: Dawie van Heerden

C. *miniata* ' Nico's Dream' first flower.
Breeder: Neels Carstens. Grower: Johan Botha

C. miniata winner short, broad leaf with flower section and runner-up Best on Show NC 2001.
Grower: Pikkie Strumpher

C. miniata winner any other colour section
CC 2001 Breeder: Y. Nakamura.
Grower: Charl Malan

C. *miniata* variegated yellow. Breeder: Christo Lotter. Grower: Norman Weitz

THE IDEAL pH AND NUTRITION FOR CLIVIA

Pierre de Coster, Belgium

The pH scale shows the acidity or alkalinity of the growing medium. The scale ranges from 0 to 14 with the neutral point at 7. The lower the number is below 7, the higher the acidity; conversely the higher the number is above 7, the higher the alkalinity.

Experience has taught us that Clivia can tolerate a wide scale of pH -let us say from 3.5 to 6.5.

Above 6 their growth becomes stunted and there is yellowing of their leaves.

I experienced that myself last year, and a fellow grower experienced major problems in the same year at 6.2.

It is important that the potting mix has the correct pH right from the inception of the plant's growth. Management of the pH is a problem because it is not easy to fix it for every individual pot.

We should aim for a pH of 4.3 to 5.5.

I estimate that for the average potting mix of pure peat and peat with pine needle compost 3.0 to 3.5 kg calcium carbonate is required per cubic metre of mix.

I no longer use pine needle compost but rather a mixture of coconut fibre and peat and compressed peat pieces.

Our calcium fertilizers in Belgium have varying compositions. They are all based on calcium carbonate but some contain in addition 3% to 30% of magnesium carbonate. These are to be preferred because not only do they provide essential magnesium, but magnesium carbonate is 5 to 6 times more soluble than calcium carbonate. Thus 1 kilogram of magnesium carbonate will neutralize more acid than 1 kilogram of calcium carbonate and is therefore more effective in raising the pH.

Nutrition

I referred the editors to the article written by Marc Vissers on the roles played by the various elements of nutrition in the life, growth and health of a plant, which was made available to them with his consent.

However, it has always been difficult to establish the ideal feeding program for *Clivia* because they respond slowly and not always clearly. My target figures are:

pH of H_2O 4.50 to 6.0
Conductivity 200 to 400

milligrams per litre potting mix	
N	30.00 to 140.00
P	min. 30.00
K	150.00 to 250.00
Ca	400.00 to 1200.00
Mg	150.00 to 250.00
Fe	min. 1.00

*C. miniata 'Sh*aja Moja'. Winner - pot plant section NC 2001 Grower: Dawie van Heerden

BEST ON SHOW

Winner *C. miniata* yellow section and Best on Show CC 2001 Breeder: Y. Nakamura Grower: Charl Malan

Winner C. *miniata* yellow section and Best on Show KZN 2001 'Watkins Yellow: Golden Glow' Breeder and grower: Natal National Botanical Garden

BEST ON SHOW

Winner C. *miniata* broad petal yellow section and Best on Show NC 2001. Breeder: Y. Nakamura. Grower: Bertie Guillaume

C. *miniata* Metro Interest Group Best on Show 2001. Grower: Tino Ferero

53

54

55

56

C. miniata. Grower: Clivia Unlimited

Winner broad leaf variegated *Clivia minata* in flower class NC2001 Grower: Ammie Grobler

C. *miniata* Meier Green'. Winner most unusual flower section NC 2001, Breeder: Hermann Meier. Grower: Peter Grey

C. *miniata* 'Harlequin' Breeder and grower: Roly Strachan

C. miniata yellow 'Akebono' class winner Northern KZN Interest Group. Growers: James and Connie Abel

C. *miniata* yellow broad leaf
Breeder and grower: Hein Grebe

Clivia caulescens Grower: Loukie Viljoen

Clivia nobilis section winner
NC 2001 Grower: Annetjie Holtzhauzen

C. m*iniata* 'Chiffon'
Breeder and grower: Roly Strachan

Clivia caulescens
Grower: Claude Felbert

THE ROLE PLAYED BY THE VARIOUS ELEMENTS OF NUTRITION IN THE LIFE, GROWTH AND HEALTH OF PLANTS

Marc Vissers, Belgium

[*This article is a summary by us of extracts from a more detailed technical paper, preparedly Marc Visserjor the Experimental Nursery Bloemisterij, Belguim, as the first part of a Manual for serious plant growers. We have left out the more advanced chemical and other technical data but a full copy of the translation of the paper into English is available on request. Readers who are not at all technically inclined will benefit particularly from the very handy and practical diagnostic tables setting out the symptoms of and a key to the recognition of nutritional problems. These will be found in sections four and five. In section six we have also added a key for the symbols of the chemical elements referred to. Eds.*]

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1. INTRODUCTION

Many symptoms of stress are seen in pot plants. While problems may arise due to spray damage, sunburn, desiccation, cold or frost, physiological effects etc., the most common cause is a surplus or deficiency of a specific nutrient.

Some understanding of the underlying theory is necessary for one to gain a better insight into nutrition and the problems that arise from a surplus or deficiency in specific nutrients.

2. THEORETICAL BACKGROUND TO THE VARIOUS ELEMENTS

IMPORTANT PLANT MATTER, MOLECULES AND ELEMENTS

Plants consist of 90% water and 10% dry matter.

The dry matter can be divided into organic and inorganic materials.

The greatest portion consists of complicated organic compounds which are formed from only C, H and O. These elements make up together 94% of the dry matter in plants. They are synthesized from water, H_2O (from the soil) and carbon dioxide, CO_2 (from the air.)

All the organic compounds are synthesized via the sugars that are formed during photosynthesis. These sugars are very soluble and are transported from the green parts of the plant throughout the whole plant. In various parts of the plant they are used in the synthesis of various organic molecules (complex sugars, proteins, fats, chlorophyll, ...).

The inorganic materials make up only 6% of the dry matter. The most important element of these is N that occurs *inter alia* in the living plant material (proteins). Sulphur is also an essential constituent of proteins. But after these, also Mg and Fe (leaf formation), Ca and K (cell membranes) and P (energy storing and release) are absolutely essential for complete plant development. These are the major elements.

All these elements must either be present in the soil or must be supplied through fertilization.

In order to appreciate the functions of the various elements it is important to know the structures of the important plant molecules in which they are incorporated.

C. *miniata* 'Inspiration' Grower: Keith Rose

The following plant constituents are discussed:

Protein molecules.
Polysaccharides or sugar molecules.
Fats.
Chlorophyll or leaf pigment.
ADP- and ATP-molecules.
RNA- and DNA-molecules.
Hormones.
Enzyme activators and Coenzymes.
Polyvalent elements.
The most important element in the cell sap: K.
The most important element in the cell structure: Ca.
Summary of components and composition of plants.

Protein molecules

Importance:

The dry matter of the living part of every cell consists especially of proteins. These proteins are essential components of the living organism. **They determine to a large degree the cell structure** and also **control all chemical reactions** in the cell: enzymes are indeed also proteins.
Absorbed nitrate, sulphate and carbon are converted to form amino acids which are joined together to form peptides. Various polypeptide chains together form a protein. The promoting elements are Mn and Mo.

Polysaccharides

Importance:

Polysaccharides or sugars are firstly

important energy sources for plants: they are produced during photosynthesis (trapping of photoenergy) and its consequence, all energy rich compounds which can be broken down (= oxidized) during respiration to make available chemical energy. This energy is necessary for all life processes in the plant, for heat production by the plant, for growth (mechanical energy: roots must thrust channels in the soil, leaves must develop from buds, ...).

Polysaccharides are essential to the plant for the construction of cell structures: cellulose chains give strength to cell membranes.

The sugar content of fruits is also determined by them.

Elements:

They are formed from C, H, and O and accordingly are also known as carbohydrates. The majority of sugars are very soluble and are thus readily distributed throughout the plant.

Promoting elements:

- Mg and Mn derive importance from being constituents of enzymes that regulate carbohydrate metabolism (eg. with Mn deficiency sugar deficiency occurs in roots).

- B not only is involved in sugar synthesis but also in phloem transport to the growth points, fruits and leaf nodes, ...

Since the formation of elementary sugars only takes place in the green parts of the plant, these must be transported throughout the plant to the non-green parts.

Fats

Importance:

Both fats (many single bonds) and oils (many unsaturated bonds, double bonds, ...) occur in the cytoplasm of plant cells. On one side they serve as an energy source when too few sugars are available while on the other they are important in cell walls as phospholipids.

Some lipids can also determine the colour of plant parts, e.g. carotenoids (the orange colour of carrots).

C.miniata Breeder and grower: Y. Nakamura

C. *miniata* variegated Breeder: Y. Nakamura

Chlorophyll, green leaf pigment

Importance:

This molecule belongs to the group of pigments and consequently results in the colour of plants; more specifically, **chlorophyll a** is responsible for the **green colour** of plants. Furthermore, chlorophyll is of crucial importance for photosynthesis. It can absorb light energy.

Composition:

The chlorophyll molecule is composed of C, H, O, N, and Mg. Mg is the central atom and a deficiency of Mg or N therefore manifests itself immediately as a lighter green plant colour.

Synthesis:

In the formation of chlorophyll, Fe is also important because Fe is a constituent of the enzymes that stimulate the formation of the pigment.

ADP- and ATP-molecules

Importance:

The molecule ATP is responsible for the trapping of light energy as chemical energy (photosynthesis) and for the energy transport in the plant (ATP is released during respiration). Without this molecule energy transport to the various parts of the plant would be endangered and the life processes and movements of the place could not take place.

Elements:

These molecules are composed of the elements C, H, O, N, and P and P plays a crucial role.

Synthesis:

ATP or adenosine triphosphate that is available for plant processes principally formed during respiration *(see p.* 50*)*. ATP is the molecule, which stores light energy in the form of chemical energy.

RNA- and DNA-molecules

= ribonucleic acid and desoxyribonucleic acid

Importance:

These molecules determine the genetic structure of every plant: every plant has a different DNA composition.

Elements:

There are five elements, C, H, O, N and P.

Promoting elements:

-Mg is a constituent of the enzyme RNA-polymerase that produces RNA.

-B is also important in the formation of nucleic acids.

C. *miniata.* Grower: Bertie Guillaume

Hormones

Importance

Various hormones function within the plant as growth and flowering regulators. They participate in various conversion processes within the plant such as protein synthesis, respiration, etc.

Elements:

Their elements are, C, H, O, N and CI.

Promoting elements:

-Zn is necessary for the formation of IAA (indoleacetic acid) and B drives the breakdown of IAA.

-Mo is necessary for the formation of ABA (abscisic acid)

Well known hormones:

N-containing:

-Indoleacetic acid (IAA) for the promotion of growth and root formation. Influence on cell stretching = auxine

N-free:

-Naphthylacetic acid (NAA): promotes root formation.

-Gibberellic acid (GA): promotes growth in height and flowering.

Interspecific *Clivia* 'Apricot Flush'. Breeder and grower: Brian Tarr

Interspecific *Clivia* 'Pink Sensation'. Breeder and grower: Wessel Lotter

Enzyme activators and Coenzymes

Activators: Many free metal ions (cations) can activate enzymes. Among these Mn^{++}, Co^{++}, Mg^{++}, Zn^{++}, Mo^{6+} and Ni^{++} fulfil this role.

Coenzymes: Many enzymes require for their activity the presence of coenzymes; these are mostly complicated organic compounds containing metal ions: Fe, Cu, Zn, Mo,....

Polyvalent elements

In photosynthesis elements having many valency states are very important:

-iron: Fe^{2+} and Fe^{3+}
-copper: Cu^{+} and Cu^{2+}
-manganese: Mn^{2+},. Mn^{3+}, Mn^{4+}, Mn^{6+}, Mn^{7+}
-molybdenum: Mo^{2+}, Mo^{6+}

These have the capacity to oxidise or reduce and thus transport electrons to other compounds. This electron transport is necessary for photosynthesis.

The most important element in the cell sap: K = not incorporated in plant molecules

By far the most important element in this connection is K, which is present as the K^{+} -ion. The potassium ions remain in solution or occur adsorbed on specific plant structures. It thus accounts for a great deal of the salt concentration and consequently the osmotic pressure of the cell sap (together with the other ions in solution), and it is hereby very important amongst other things for the water balance of plants. Nitrates and chlorides also play a major role in osmoregulation.

The most important element in the cell wall: Ca

Ca strengthens the cell wall by making bridges between the phospholipids and other cell wall materials. Furthermore this element, together with K, determines the distribution of load on the cell wall and the porosity.

In addition the carbohydrates are also important in membrane formation; only water soluble sugars are suitable for this, namely cellulose chains (one talks of cell material), The cell wall must not be subject to degradation. In contrast to reserve sugar chains such as starch, cellulose is very stable (does not react easily with other materials, does not dissolve).

K, Mg, and B also play an important role in the formation of the cell wall.

Clivia miniata 'Ramona'. Breeder: Dave Conway Grower: Hugh Bollinger

Clivia miniata 'Quin's Moon'. Class winner KZN 2001. Breeder: Y. Nakamura Grower: Pat Quin

Summary of components and composition of plants

Table 1 below presents a collective summary of the different plant molecules or elements discussed.

Important components and molecules	**Constituent elements**	**Anabolic elements (promote formation)**
1. Proteins, Enzymes	C, H, O, N, S, (P)	Mn, Mo
2. Polysaccharides, Sugars	C,H,0	Mg, Mn, B
3. Fats, Oils, Lipids	C, H, O, P	Fe
4. Chlorophyll, Green leaf pigment	Mg, C, H, O, N	Polyvalent elements
5. ATP	C H, O, N, P	Mg,B
6. DNA	C H, O, N, P	Zn,Mo
7. Hormones	C, H, O, (N, Cl)	
8. Enzyme activators and Coenzymes	Mn^{++}, Co^{++}, Mg^{++}, Zn^{++},Mo^{6+},Ni^{++} Fe, Cu, Mn, Mo	
9. Polyvalent elements	Fe, Cu, Mn, Mo	
10. Most important ion(s) in cell sap	K^{+}, ($N0_3$", Cl")	
11. Most important element(s) in cell wall	Ca (P, C, H, O, Mg, B)	

From the summary the enormous importance of the elements C, H and O that occur in all plant molecules is apparent. N also occurs in most of the important molecules.

IMPORTANT LIFE PROCESSES IN THE PLANT

General

The plant uses solar energy to synthesize sugars from primary materials, water and $C0_2$ (photosynthesis = trapping of solar energy and sugar synthesis).

Everything that lives must respire, also the plant. The synthesized sugars serve this purpose. During respiration they are broken down and the plant gains energy for its activities, such as plant development, chemical reactions in the plant, heat maintenance, etc.

(respiration = breakdown of photosynthesised sugars with the release of chemical energy).

Note: both unsuitable simple sugars, also complex sugar molecules and even synthesized fats are employed in respiration; in emergency situations even proteins can be respired.

Not all sugars formed during photosynthesis are consumed in respiration. The surplus sugars (residual sugar) can be used for increasing dry material and thus growth. During growth the plant produces more sugar than it uses (growth = conversion of residual sugar to new plant molecules

[= new plant dry matter], with the energy derived from respiration).

During growth various materials are formed: complex sugars (sugar synthesis), also other carbohydrates including acids and fats (fat synthesis), and also proteins; the protein synthesis is similarly indirectly linked to the sugar cycle.

For rapid growth a great deal of photosynthesis (sugar formation) and respiration (sugar breakdown but energy production) must occur. Photosynthesis occurs only in the presence of light (thus during the day) and only in the green parts of the plant. Respiration processes take place day and night in the whole of the plant.

Growth = Photosynthesis - Respiration

Consequently, for growth to occur there must be more photosynthesis than respiration. It is therefore important to accelerate photosynthesis by providing higher temperatures during the day (primarily for photosynthesis) than in the night (for only respiration).

Summary of various life processes in the plant.

Photosynthesis: Conversion of light energy into chemical energy, sugar formation

Basic reaction: coupling of carbon dioxide and water to form simple sugars.

The importance of polyvalent elements in photosynthesis:

The presence of various polyvalent elements promotes the light reactions in photosynthesis, e.g. Fe, Mo, Cu and Mn *(see p.* 48*)*. These function as intermediaries in the electron transport that takes place in the light reactions.

When and in what parts of the plant does photosynthesis occur:

Plants photosynthesise only by day or with artificial illumination.

Photosynthesis only occurs in the green parts of plants with large surfaces (especially leaves),

- to a lesser extent in green parts with a smaller surface (thick plant parts, or yellow / patchy leaves, growth points, ...)

- never in roots and other non-green parts: flowers.

Distribution of sugars to the roots and other non-green parts is consequently necessary.

Respiration:

Conversion of various energy rich compounds (sugars, fats, ...) to energy-poor compounds, with release chemical energy.

This energy can be used by the plant for:

chemical activity (reactions)

mechanical activity

heat regulation in the plant

When and in what parts does the plant respire:

Plants respire both by day and by night.

Respiration occurs in all parts of the plant. Both green and non-green sections use energy for their growth and consequently must respire (= energy release). Deficient sugar synthesis or transfer will result in much faster growth retardation or die-off in the non-green sections because, with disruption of the sugar reserves, these will not grow or life-critical proteins will be broken down.

Protein Synthesis:

That is conversion of absorbed nitrate/ sulphate / carbon to proteins, *(see p.*45*)*

Polysaccharide Synthesis:

Conversion of absorbed carbon / water to complex sugars, *(see p.* 45*)*

Fat Synthesis:

Conversion of simple sugars to fats, *(see p.* 46*)*

Clivia miniata runner up any other colour section CC 2001. Breeder: Y. Nakamura Grower: Charl Malan

Clivia miniata winner narrow variegated leaf in flower section NC 2001. Grower: Rory Niven

3. FUNCTIONS OF THE ELEMENTS (Table 2)

The majority of elements have multiple functions in the plant. Table 2 presents a condensed summary of the important functions by element.

ELEMENT	FUNCTION IN THE PLANT
Nitrogen (N)	quantitatively the most important element, especially important during the vegetative growth phase the most important constituent of living plant material, namely proteins and enzymes constituent of leaf green (chlorophyll molecule) and thereby responsible for the green plant colour and photosynthesis constituent of DNA (genetic material), vitamins, ATP (energy transport), ... Nitrates play a part in osmoregulation
Phosphorus (P)	especially important during rooting, also after flowering when more phosphorus is necessary P is a constituent of the most important energy transporter in the cell, namely the ATP molecule (without energy no life processes in the plant!) P forms strong bonds with C atoms (C-P-C bonds): these are important in the structure of the cell wall, and of the DNA molecules P is also a constituent of some proteins, and of importance for the formation of some enzymes
Potassium (K)	together with N quantitatively the most important element, especially important for flowering. K is the principal element that determines the strength and porosity of the cell wall, and gives resistance to adverse conditions K has a regulating function in maintenance of water balance: it controls the osmotic pressure of the cell sap and the opening and closing of the stomata K provides a better utilization of light energy during photosynthesis, and makes possible the transport of the synthesized sugars in the plant many enzymes function only in the presence of K

ELEMENT	FUNCTION IN THE PLANT
Magnesium (Mg)	Mg is the central atom in the chlorophyll molecule (leaf green), and thereby is essential for photosynthesis and therewith for the green leaf colour Mg is of importance for internal ion- and energy transport; it promotes the mobility of phosphates, so also that of the ATP molecule. Mg is part of enzymes acting as intermediaries in the carbohydrate cycle. A deficiency of Mg results in a sugar deficiency and this manifests itself in the non-green portions (such as roots and fruits, with consequent root inhibition)
Calcium (Ca)	Ca is very important for the structure and porosity of the cell walls Ca stimulates a limited number of enzymes, *inter alia* those functioning as intermediaries in respiration (= energy release)
Iron (Fe)	Fe stimulates some intermediary enzymes in the synthesis of chlorophyll, and is thereby indirectly of importance for photosynthesis Fe is one polyvalent ion that can switch valency (2^+ and 3^+). Thereby the element is involved in electron transport during photosynthesis Fe is important for root meristem growth
Manganese (Mn)	Mn is like Fe a polyvalent ion that can switch valency (2^+ and 3^+). Thereby it is involved in electron transport that occurs in photosynthesis Mn activates various intermediary enzymes in protein synthesis (it promotes nitrate reduction and the conversion of nitrites in amino acids Mn deficiency raises nitrate levels in the leaves just as Mg, Mn also forms part of enzymes that control carbohydrate metabolism; a Mn deficiency results in a sugar deficiency in the roots Mn also activates the enzyme that breaks down IAA

ELEMENT	FUNCTION IN THE PLANT
Boron (B)	B is directly involved in the synthesis of the enzyme that controls cell division, it inhibits the breakdown of the growth hormone IAA, and is thereby extremely important for root formation and the activity of the growth points B is essential for healthy cell walls; it stabilises cell wall structures, stimulates wood formation and thereby *inter alia* is responsible for increased resistance, e.g. frost resistance of fruit. B is responsible for starch as well as sugar synthesis in sugar transport (via phloem to the growth points *inter alia)'*, thereby it increases the sugar content of fruits and tubers. B stimulates the growth of tubers, flower- and pollen production, promotes the fertility of pollen, B is also important in the synthesis of nucleic acids (RNA, DNA)
Molybdenum (Mo)	Mo activates 2 enzymes that are responsible for nitrate incorporation (- nitrate reduction) in amino acids (lowers the nitrate concentration in the plant, raises the protein concentration). Mo is also of importance in N fixation Mo is a polyvalent ion that can switch valency (2^+ to 6^+). Just as Fe is the element involved in photosynthesis. Mo is a catalyst for various enzymes, and is *inter alia* also necessary for the formation of the hormone ABA
Sulphur (S)	S is the least known major element and is important in the young plant stage It is a component of proteins (disulphide bridges bind amino acids together) and is thus very important for protein synthesis In S deficiency the starch concentration is raised because the carbohydrate metabolism is slowed down (less breakdown of starch reserve)
Zinc (Zn)	Zn is necessary for the formation of the growth hormone IAA, indoleacetic acid, that is responsible for the stretching of the side- and middle veins of leaves Zn activates some intermediary enzymes in protein synthesis (peptidase, proteinase, ... = breakdown of proteins)

ELEMENT	FUNCTION IN THE PLANT
Copper (Cu)	Cu is thanks to its polyvalency (just as Fe, Mn and Mo) important for reactions in electron transport as in photosynthesis. Cu is necessary for lignification of plant parts (wood formation) and thereby improves the strength of plants Cu also functions as intermediary in hormone maintenance (auxin formation) and thereby stimulates germination and growth. further, Cu is of importance in the synthesis of vitamins, and as intermediary in carbohydrate- and N metabolism
Sodium (Na)	Na is of importance in tissues with a special photosynthesis system (C4, CAM).
Chlorine (Cl)	Cl is of importance in osmoregulation and in the maintenance of cell electrical neutrality in the plant Cl also plays a part in photosynthesis, in particular in the oxygen production reaction Cl is also a component of specific hormones

Clivia miniata orange broad tepal section NC 2001. Grower: Bertie Guillaume

Clivia miniata Topaz Dream'. Grower: Keith Rose

Clivia miniata x *denii.* Breeder and grower: Norman Weitz

Interspecific *Clivia* 'Orange Belle'. Breeder and grower: Brian Tarr

4. SYMPTOMS OF DEFICENCY AND SURPLUS, + RISK FACTORS (Table 3)

For the cultivator it is in the first place interesting and important to know whether he has either a deficiency or a surplus problem. Therefore we compiled a summary in which we present per element how the nutrition problems are manifested and where on the plant they occur. Together with this the risk factors are presented.

A possible rule-of-thumb for deficiency effects is the following:

- the major component elements N, P, K en Mg are very mobile in the plant and appear first in the older leaves! This applies also to Mn^{+}.

- the trace element deficiency as well as the calcium deficiency are seen mostly in the younger leaves.

- surplus effects are seen mostly in younger leaves; this is accompanied by a secondary calcium-, iron- or magnesium deficiency. Occasional B, Cl, Mn surplus is seen mostly in older leaves.

	DEFICIENCY		SURPLUS	
ELEMENT	SYMPTOMS	RISK ENVIRONMENT	SYMPTOMS	RISK ENVIRONMENT
Nitrogen (N)	•light green colour old leaf; later whole plant •much root growth	•winter: little fertilization mixing of organic matter in the soil	•dark leaf •less rooting •excessive plant growth	•too intense N fertilization
Phosphorus (P)	•less rooting •red colour in old leaf (sometimes blue-green)	•high pH, excessive liming • after cold or drought •beginning of cultivation: greatest necessity	• dwarf growth (short stem, small leaf (=Zn deficiency)	•Uncommon, only in soil cultivation
Potassium (K)	•yellowing of old leaf edge • incomplete / slow flowering	•winter: little fertilization •high N, Ca, Mg-fertilization •end of cultivation: greatest necessity	•yellowing of old leaf (Mg deficiency) •yellowing of young leaf (Ca deficiency) • fewer leaves	•excessive K fertilization
Calcium (Ca)	•leaf edge necrosis to yellowing of young leaves (beginning at tip) •transparency in leaf • die-back at growth points	•dark, low humidity weather •much K, NH4	•yellowing of young leaf (Fe deficiency)	•pH too high
Iron (Fe)	•yellowing of young leaf between veins (over whole leaf)	•high pH •much Ca, Cu, Mn, Zn •wet cold soil	•red leaf edges and veins	• excessive foliar Fe fertilization

	DEFICIENCY		SURPLUS	
ELEMENT	SYMPTOMS	RISK ENVIRONMENT	SYMPTOMS	RISK ENVIRONMENT
Manganese (Mn)	•yellowing of old leaves between veins (locally in leaf) •less root growth	•high pH •much Ca, K •wet cold soil	•purple brown spots in old leaf (later in leaf edges) •later yellowing of young leaf (Fe deficiency) •bushy growth	•very low pH
Boron (B)	• non-developing growth point •malformed leaves beginning at base in young leaf	•high pH •high Ca values •boron free cultivation	• leaf tip necrosis in old leaf (leaf edge necrosis)	•low Ph, little Ca •bad irrigation water / fertilizers
Molybdenum (Mo)	•light green colouration of young / old leaf =N deficiency •long small leaves, rank form •inhibited rooting	•low pH = the acid sickness		•does not occur
Sulphur (S)	• complete yellowing of young leaf (veins more transparent than leaf pulp	• only in soil culture	•dark colour •less root growth causes marked pH decline	•bad fertilizers or irrigation water
Copper (Cu)	•rigid growth yellowing to dark blue-green colour & curling of young leaf • die-off of buds •meristem necrosis - bushy growth	•high pH •too much Ca	• dwarf growth; •reduced root growth •yellowing of young leaf (Fe deficiency)	•low pH
Sodium (Na)			• growth inhibition	•bad fertilizers or irrigation water
Chlorine (Cl)			•rooting inhibition •leaf edge necrosis in old leaf •dark colour	•bad fertilizers or irrigation water

5. KEY FOR RECOGNITION OF NUTRITION ABERRATIONS (Table 4)

To simplify diagnosis we have compiled a recognition key that depicts stepwise each nutrition problem that may be encountered. We start in the first instance with the whole effect one sees (leaf edges or total leaf colour), and look thereafter in which leaves the effect occurs (young or old). As a third direction indicator we take the potting soil pH in the event that it explains the possible cause and in the event that the pH can be measured by the cultivator himself.

One then has an indication of the possible cause pending the results of laboratory analysis of the leaf.

APPEARANCE	LOCATION	pH POTTING SOIL	CAUSE	COMMENT
Leaf edges Leaf tips	young leaf	low pH	-Ca(+K+Mg) -Zn	low pH = little Ca, mostly in dark periods leaf edge necrosis + yellowing
	old leaf	low pH	+B	necrosis of the lower leaves proceeding upward
		low + high pH	-K	chlorosis of the leaf edge
Leaf bleaching (yellowing or light green colour)	young leaf	low pH	(-Mg) -Ca(+K+Mg)	(yellowing from underneath leaf edge between veins transparency: light patches in leaves
		high pH	Fe (+Ca) (+Mn+Zn+Cu) -S	yellowing over whole leaf (between veins) complete yellowing of leaf + veins (similar to N deficiency
	middle young leaf	low pH	-Mg(+K)	yellowing from underneath the leaf edge (between veins)
	old leaf	low pH	(-Mg)	yellowing from underneath the leaf edge (between veins)
		high pH	-Mn(+Ca) (+Mn+K+Fe)	localised yellowing (between veins)
		low + high pH	-N	light green leaf colour, extensive root system
	young and old leaf	low pH low + high pH	-Mo (-N)	light green leaf colour, poor roots (light green leaf colour, extensive root system)

APPEARANCE	LOCATION	pH POTTING SOIL	CAUSE	COMMENT
Other colorations	old leaf	low pH	+Mn (-Ca)	purple brown patches
		high pH	-P (+Ca)	red colouration (sometimes blue-green) old leaf, less rooting immediately after cold period
	young and old leaves	low pH	-S	dark coloured leaf, fewer roots, growth inhibition
		low + high pH	+N	dark coloured leaf, fewer roots, growth inhibition, weak luxuriant growth
Other effects	growth point	low pH	-Ca (+K +Mg)	die-off of growth point
		high pH	-B (+Ca) - Cu (+Ca)	die-off of growth point meristem necrosis
	young leaf	high pH	- B (+Ca)	leaf malformation, starts from the base
	young + old leaves	low pH	- Mo (+NO3)	small irregular leaves
	whole plant	low pH	+ Mn (-Ca) + Cu (-Ca)	bushy growth dwarf growth
		high pH	- Cu (+Ca)	bushy growth, premature spiking
		low + high pH	- Zn, +P	dwarf growth
	flowering	high pH	- P (+Ca) - Cu (+Ca)	irregular flowering bud die-off
		low+ high pH	- K (+N)	incomplete delayed flowering

6 TABLE OF CHEMICAL ELEMENTS REFERRED TO IN THIS ARTICLE

B	Boron	K	Potassium	O	Oxygen
C	Carbon	Mg	Magnesium	P	Phosphorus
Ca	Calcium	Mn	Manganese	S	Sulphur
Cl	Chlorine	Mo	Molybdenum	Si	Silicon
Cu	Copper	N	Nitrogen	Zn	Zinc
Fe	Iron	Na	Sodium		
H	Hydrogen	Ni	Nickel		

THE ROLE OF LIGHT (OR RADIATION) ON THE GROWING OF PLANTS

Dénis van Rensburg

Professor van Rensburg has a doctorate in Chemistry and retired as the Rector of Pretoria Technikon

Green plants possess the amazing ability to manufacture their own food through the process of photosynthesis. It is this basic process upon which the entire world of living creatures depends for its own food, either directly by eating plants, or indirectly, by feeding on other organisms that have fed on green plants. The process of photosynthesis, or the manufacture of food using the energy of sunlight, is often expressed by this simple chemical equation:

PHOTOSYNTHESIS

Sunlight

+

$CO_2 + H_2O \rightleftharpoons C_6H_{12}O_6 + O_2$

+

Chlorophyll (Glucose)+(Oxygen)

RESPIRATION

Green plants have the unique ability to utilize the gaseous carbon dioxide (CO_2) of the atmosphere, plus water (H_2O), in the presence of an energy source (sunlight) and chlorophyll (in the leaves of plants) to produce glucose ($C_6H_{12}O_6$), a kind of sugar that is a basic food for the plant) and give off oxygen (O_2) into the atmosphere as a by-product. The process of photosynthesis is much more complex than the equation would suggest, and a textbook published in 1992, telling the whole story required 21 pages to do so.

The important fact is that plants do not eat; we cannot 'feed' them. They **manufacture** their own food, beginning with the glucose produced during photosynthesis, and use the mineral salts in fertilizers (or the naturally occurring mineral salts in the environment) to complete the manufacture of food, to fabricate plant parts and to perform metabolic processes. A critical distinction between food and mineral nutrients, required by both plants and animals, is that food provides organisms with energy, minerals do not.

Carbon dioxide and water are the two **major** nutrients of plants and for plants to 'eat' or absorb these nutrients, **sunlight** (or the energy that is contained in sunlight) is absolutely necessary. But sunlight contains many different wavelengths or packets of energy. Just like a radio or TV set that only 'works' when it is tuned to a certain wavelength (or energy packet), so do plants only react to certain wavelengths and use that specific energy to manufacture food through photosynthesis. All the other light wavelengths are totally useless to the plant, and may even be harmful. In *Figure 1* all the wavelengths to be found in sunlight are shown. This wavelength range is commonly referred to as the 'electromagnetic spectrum'. From this figure it can be seen that the sunlight that reaches our plants or shade houses, apart from ordinary 'visible' light also contains X-rays, microwaves, radio waves, etc.

Because oxygen is produced when plants photosynthesise it is fairly easy to determine which wavelengths present in light are indeed preferred by the plant. All you need to do is to expose a plant to each different wavelength and measure the oxygen

produced. If no oxygen is produced that specific wavelength has no effect on the chemistry of the plant. *Figure 2* shows such an oxygen versus wavelength graph for the Visible' light region.

Photosynthesis seems to be very high in the 'blue' and 'red' wavelength ranges and much less effective in the 'green' region, and absent in **all** the other wavelength regions.

This effect of light on photosynthesis or plant growth could have been deduced from the green colour of the leaves. The colour of an object arises when the object **reflects** those wavelengths present in visible light that it does not want or cannot use. If we pass light from the visible part of the electromagnetic spectrum through a prism we can 'see' all the coloured components of so called 'white light'. The red component has slightly less energy than the green, while the blue and violet components have the highest energy (lowest wavelengths) in 'white' light. *(See figure* 3.) Hence an object such as an apple will appear to our eyes as yellow because it absorbs all the other colours and only reflects the light it does not want - the yellow *(see figure* 4). An object appears red to our eyes because it absorbs or 'likes' all the other colours of the spectrum but 'hates' red and hence reflects it. A white object reflects **all** the colours and hence appears white, while a black object appears black because it absorbs **all** the colours. Hence, strictly speaking, black is not a colour! *(See figure* 5.) By the same argument green plants hate green light, therefore they reflect the green light and appear green to the human eye.

This brings an interesting aspect to the fore when it comes to the choice of shade cloth for your plants - green would not be the ideal choice but rather blue or red, when we consider the information in the 'production of oxygen' curve *(see figure* 2).

Due to the fact that the energy of radiation is inversely proportional to **wavelength,** UV-light will have more energy than white or visible light and causes much more damage to plastics, human skin and other substances. There is also more energy in 'blue' than red' light and blue light or shade cloth should in theory produce a little more heating in plants and the shade house than similar red shade cloth. Infrared light has low energy but the energy is sufficient to cause heating if absorbed. Due to their water content most plants are effective **reflectors** of infrared and are not greatly heated by it. Where shade cloth with a low percentage shade is used the colour of the cloth is not very important because more than adequate white light will reach the plants for photosynthesis - with high percentage shade the colour of the shade cloth does come into play.

Klein, Edsall and Gentile (1965) published an interesting paper on the effects of near UV and green light on plant growth. The conclusions reached are that the **near UV and green wavelengths** are capable of **suppressing** the growth of plants which otherwise receive adequate levels of those wavelengths necessary for photosynthesis and normal development. Conversely the selective **removal** of near UV and green wavelengths from white light gave enhanced growth. From these scientific experiments it is evident that green shade cloth should as a matter of routine not be used as a covering in shade houses. Due to the total reflectance of white shade cloth varieties a **higher than normal** shade percentage should be used when the shade cloth is white.

The amount of pure sunlight needed by plants to manufacture their food has always been an unknown factor usually obtained by trial and error. What we usually observe when a plant is receiving too little light is that it may compensate by producing more light absorbing pigment - hence the leaves go darker green. It may also grow thin and leggy, trying to find light. It will probably not produce flowers or the flowers may be of poor quality. Conversely, if a plant is receiving too much light, it may try to adapt by reducing the amount of pigment - the

leaves grow paler. If the amount of light is really excessive, the leaf-tissue will be destroyed and leaves are scorched, especially in those areas where the leaf surface is at **right angles** to the incident light.

THE EFFECT OF TEMPERATURE ON PHOTOSYNTHESIS

The effect of **temperature** on **photosynthesis** is a very important consideration. Though the photochemical reaction is not dependent on temperature the rate of photosynthesis does increase with increasing temperature. *Figure* 6 shows this effect.

While gross photosynthesis rises with temperature so does respiration and whereas the photosynthetic rate tends to flatten at about 25°C respiration continues to rise rapidly above this temperature. Consequently the net photosynthesis (the production of energy compounds **minus** their use by respiration including photo respiration) must be considered continuously. It can be even better understood if we add a curve depicting respiration rate against temperature to the one shown in *figure* 6. (see *figure* 7.) Respiration increases strongly with temperature (same as with us humans) and at temperatures above about 35°C all the food manufactured is used to support respiration. At temperatures higher than 35°C plants therefore use more food than they produce to respirate, which leads to deterioration and ultimate death (if the condition is allowed to continue for too long, of course).

In their natural habitats plants are subjected to a day and night temperature differential, and it is important to imitate this as far as possible. Photosynthesis is affected by temperature as well as light intensity. As long as it does not become too hot, the rate of photosynthesis, and hence growth, increases with rising temperature, but only as long as there is sufficient light (and carbon dioxide). Not only is there no point in increasing the temperature of the greenhouse beyond 25°C if there is not sufficient light it is positively harmful as the rate of photosynthesis will, even at 25°C, fall below the rate of transpiration.

Technically speaking, when gains due to photosynthesis match losses due to respiration, this is termed the 'compensation point'. The practical value of appreciating this is that if night-time temperatures are too high, plants will gradually become depleted of their glucose and starch reserves, as losses due to respiration regularly exceed gains due to photosynthesis during the day.

DIFFUSE RADIATION AND ALBEDO VALUES

Diffuse or sky radiation is that radiation which reaches the earth's surface after being scattered from the direct beam by molecules in the atmosphere or reflected from clouds or other objects. On clear days it increases with solar elevation up to 30°C but after this it remains constant. It is diffuse radiation which gives the light in **shaded areas** and this is the main source of light for *Clivia.*

Diffuse radiation is very important for places of **high latitude** where low solar elevations reduce the direct solar energy due to **thicker** atmosphere passage, hence more absorption. For example, in England diffuse radiation may contribute from 50 to 100% of the total radiation used by plants. Hence the typical English glasshouse has the maximum amount of glass in walls and roof to catch this omni-directional radiation.

In South Africa our proportion of diffuse radiation is much lower but we still build English-European style glasshouses, then promptly cover them with shade cloth to reduce the intense direct radiation on to the glass. What makes it even worse is that we use green shade cloth!

Figure 8 shows the various light inputs to a typical horizontal leaf. These are

- Direct radiation from the sun (S_A)
- Diffuse radiation from the sky (S_D) - on overcast days this may be the main source of light

- Both direct and diffuse light reflected from the ground: R (S_A + S_D), where R is the reflectance from the ground, or the **albedo** value. These albedo values can be of great help when we have a problem with too much or too little light.

  In the case of *Clivia* we usually never have direct radiation falling on our plants, hence the light used by *Clivia* to photosynthesise mostly comes from diffuse radiation and reflected radiation (albedo) only.

Light reflectance (albedos) of certain surfaces

Surface	Reflectance
Dry soil : light colour	0.3
dark colour	0,15
Asphalt	0,05 to 0,2
Concrete	0,1 to 0,3
Brick	0,2 to 0,4
Glass - sun angle 60° +	0,08
- sun angle 10° - 60°	0,09 to 0,56
Whitewash	0,5 to 0,9

Table 1 indicates the albedos of certain common surfaces.

The higher the albedo value the better the reflectance of the surface.

Remember that the radiation energy (or light) we measure at our *Clivia* will be the 'combined effort' or **sum total** of all the diffuse and reflected radiation reaching the plants.

The correct unit to measure radiation energy is in watts per square metre (Wm^{-2}). Because foot candles make more sense to me and because my light metre is calibrated in foot candles, I will use this non-Si unit. Just to give some idea of the values involved on a clear day without too much smog, with a high sun angle (warm temperature or tropical) and little cloud we could have

S_A= 10,000 foot candles; S_D = 1,370 foot candles and albedo contribution = 1,580 foot candles.

The rate of photosynthesis is proportional to the light intensity received by a plant up to a maximum of about 5 000 foot candles. At 5 000 foot candles most plants are at 100% photosynthetic efficiency and light intensity levels above this value are of little or no benefit and can only cause heat exhaustion and undue drying of the plant. The light intensity of a full sun on a clear day is approximately 10 000 foot candles - where a foot candle is the amount of light cast by one candle at a distance of one foot. At 5 000 foot candles most common **outdoor** plants are at **100% efficiency** and light levels above that can only lead to heat increase, plant exhaustion and undue drying of the plant. This value will be considerably lower for shade growing plants.

As a general rule *Clivia* can grow happily in a light intensity as low as 650 foot candles of **quality** light! An error I frequently make when measuring the light intensity near my plants is to assume that the reading represents that of **quality useable** light. If there are many trees nearby or green shade cloth is used, a fair percentage of the light reading will be due to 'green' or useless radiation, giving one a false sense of confidence about the intensity quality of the light.

PHOTOPERIODISM

Plants of our temperate zone can be categorised into short-day neutral and long-day plants. The dividing line between day lengths favourable to vegetative growth and those to cause seed and flower formation is called the **critical light** period. For most species the critical light period is between 11 and 16 hours per day.

The intensity of the light and the duration of exposure combine to let us know the **quantity of light** received by the plant. As a general rule the intensity of 1 000 foot candles is the **minimum light intensity** for ordinary plants and the **minimum quantity** of light is 15 000 foot candle hours (light intensity multiplied by the duration of exposure in hours).

The relative length of the daily light and dark periods controls flowering of many kinds of plants. This phenomenon is called **photoperiodism.** Hence photo-periodism is the length of time a plant is exposed to light. Some plants, such as certain varieties of *Chrysanthemum, Poinsettia,* morning glory, are short-day plants and flower in nature only when the days are short and the nights are long. Certain varieties of spinach, beet, barley, and tuberous-rooted begonia are examples of long-day plants, which flower in nature only when the days are long and the nights are short. Flowering of many other kinds of plants is hastened but not absolutely controlled by the appropriate day length.

Bulbing and tuber formation are also controlled by day length. Tuberous-rooted begonia, which is a long-day plant for flowering, produces tubers on short days but not on long days. Onions, on the other hand, produce bulbs on long days but not when the days are short.

Dormancy, and thereby the preparation of woody plants for the coming winter is another plant response regulated by photo period. Even in a warm hothouse many plants can be stopped from becoming dormant by using artificial light to keep the days long.

Responses of many plants are regulated not by the length of the light period but actually by the length of the dark period. Thus, a long-day plant is really a short-night plant, and a short-day plant is really a long-night plant. Therefore, when a long dark period is broken into two short periods by a relatively brief exposure to light near the middle of the period, long-day plants bloom, dormancy in woody plants is prevented and onions produce bulbs. Under the same conditions short day plants remain vegetative.

This poses an interesting question : Is it not possible that the *Clivia* is also susceptible to photoperiodism? *Clivia miniata* flower in spring but many produce 'surprise' flowers in autumn at times when the days (and nights) are almost as long as in spring!

Quite an interesting thought to leave you with, isn't it?

Clivia miniata selection - Clivia Unlimited

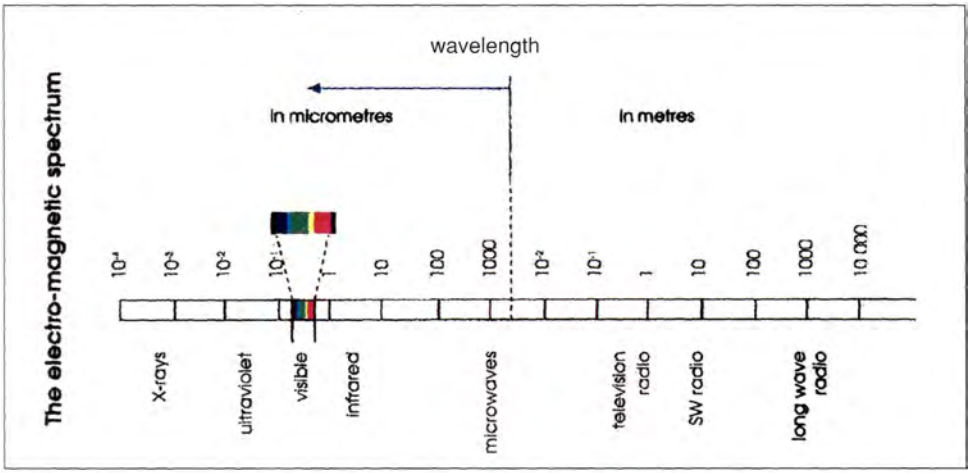


Figure 1: The electro-magnetic spectrum

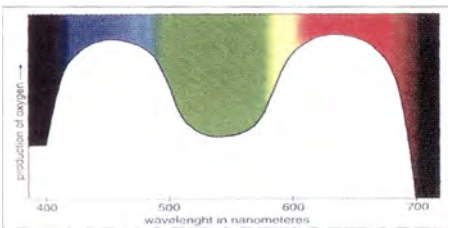


Figure 2: Photosynthesis *vs* colour (action spectrum of a typical leaf)

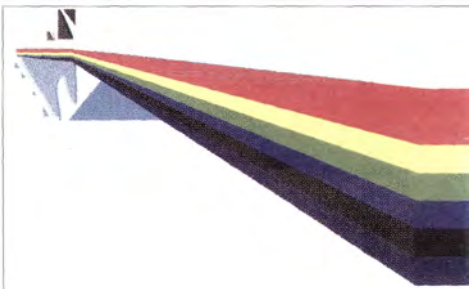


Figure 3: Reflection of 'white' light through a prism

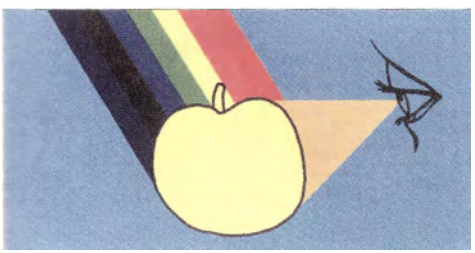


Figure 4: An apple appears yellow because it reflects the yellow wavelengths that it does not need for it's chemical reactions

Figure 5: Black is not a colour but only

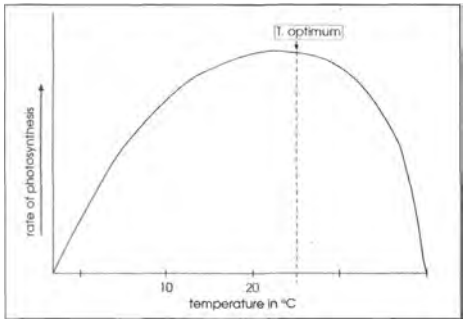


Figure 6: EFFECT OF TEMPERATURE ON PHOTOSYNTHESIS

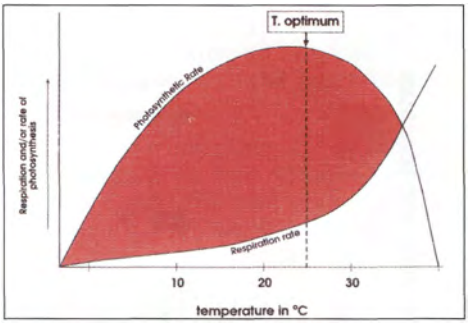
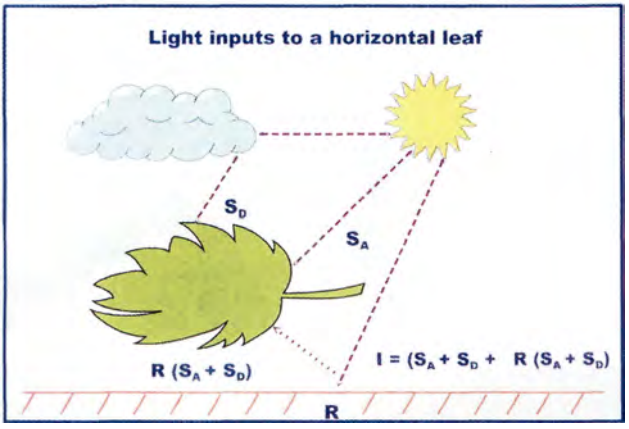


Figure 7: EFFECT OF TEMPERATURE ON PHOTOSYNTHESIS

Figure 8:



Interspecific *Clivia.* Grower: Bertie Guillaume

Clivia miniata var. *citrina.* Breeder and grower: Bing Wiese

PLANT DISEASES - NEMATODES

Sean Chubb

Leaf tip die back noticed in a large percentage of potted *Clivia* plants growing in a bark /sand mixed medium. Plants were taken for a diagnosis with Plant Aid Services.

Initially a bacterial infection was suspected but no significant bacteria (or fungi) in association with leaf lesions was found. On examination of the roots several parasitic nematodes were found. These were diagnosed as *Paratylenchus.* 83% of all nematodes found were of this species. The proportion of *Paratylenchus* sp. (common name = Pin Nematodes) was extremely high and was the major contributor to the symptoms. Nematodes are minute organisms not generally visible to the naked eye which feed on the sap contained within plant roots. The damage is seen as root knots. This damage can cause a drastic decrease in yield in commercially grown crops. All plants suffer to some extent if infested with nematodes.

The Pin Nematodes are a large group of external parasites of plant roots with a wide range of host plants. They are fairly common in South Africa, particularly from sugar cane fields in Natal. Thus the origin of the nematodes was probably the water source and the sand /soil mixed with the bark.

It was suggested that water used for irrigation might not be nematode free. The irrigation water should therefore be allowed to stand in a holding tank with minimum turbulence as Nematodes and their eggs have appreciable sedimentation rate and will sediment to the bottom of the tank. The outflow from the tank must be placed as high as possible so as to ensure minimum amounts of Nematodes in the water used.

According to Agrios (1997) chemical control is based on fumigants such as methyl bromide, cloropicrin, metam, sodium, dazomet, etc., broad spectrum nematicidal and insecticidal carbamates such as aldicarb (Temik™), carbofuran (Furadan™), etc., as well as organophosphate nematicides such as phorate (thimet), disulfoton (Disyston™), ethoprop (Mocap™), fenulfothion (Dasanit™), fenamiphos (Nemacur™) etc. Some organophosphate nematicides are available as water-soluble liquids or granules, have low volatility, can be applied before and after planting and are effective only against nematodes (Agrios 1997). Most nematicides are hazardous, broad spectrum and expensive.

This harmful nematode can also be controlled biologically with the fungi and other nemotodes which are its natural predators. These are found in natural organic matter which should therefore be added to the growing medium.

Recently a biological control product called Plplus™, has become available and the active ingredient is the fungus *Paecilnmyces lilacinus* strain 251. It may be tried in the soil around garden plants or in pots. Ensure that all *Clivia* are raised in previously unused growing medium.

Chemical control was administered on effected plants with little or no further leaf tip die back.

To avoid nematode(eelworm) infestation to Clivia *it is suggested that the following should be borne in mind:*

Use only organic material as a growing medium, such as composted milled pine bark and milled pine needles, which will reduce the prospect of nematode infestation.

Practise hygiene in growing areas by raising plants off the ground, providing efficient drainage and disinfecting areas where your plants stand.

Eds.

C. m*iniata* winner pink section NC 2001. Grower: Anna Meyer

C. *miniata* 'Oxblood' winner dark orange/red section NC 2001.
Breeder and grower: Louis Swanepoel

C. *miniata* yellow with persistent green throat.
Breeder and grower: Gerrit van Wyk

C. *miniata* best in red section CC 2001.
Grower: Gert Wiese

PESTS AND DISEASES AFFECTING CLIVIA IN SOUTH AFRICA

Henriëtte Ströh

We regard *Clivia* mostly as resilient, semi-hardy and drought resistant plants. Their ability to thrive under a variety of conditions, some most unlikely, is commendable, but eventually some will fall victim to a disfiguring or even fatal pest or disease. To aid our beloved plants, we need speedy and accurate identification of these pests and diseases. An immediate response is necessary in order to minimise severe setbacks in our growing program or even the tragic loss of a rare or unusual cultivar.

Although not always perceived as being environmentally friendly, the ruthless measures taken to ensure the future existence of exceptional clones can be justified when the loss of rare colour forms and multi-petal mutations is at stake in our diverse *Clivia* gene pool.

In this article some chemicals might be mentioned that are not available at your gardening shop - these are probably not registered for home use. As many growers are in need of both nursery and agricultural chemicals both types will be mentioned in relation to various factors such as economy and severity of the problem as applicable to the home or commercial grower. In the text the active ingredients are italicised and brand names highlighted. Search deeply for the academic in you and read, as well as comprehend, the instruction leaflets included with all the chemicals. By simply not applying them during the heat of the day and not concocting your own version of biological warfare, by boldly mixing different chemicals you can avoid the very real danger of burning your plants *{figure.* 1*)*.

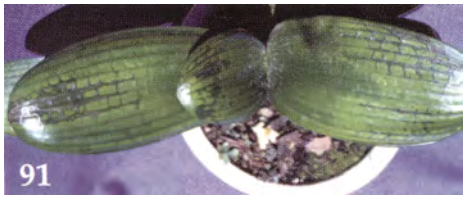


Figure 1 Chemical burn on Chinese raised tessellate surface leaves. At a recent lecture Prof. Hannes Robbertse mentioned the very thin wax layer found on the leaves of these plants

'Cocktails' are not recommended because the different chemical substances in the formulations might have a reaction and cause damage to plants or have no effect at all e.g. the particles of a wettable powder form an emulsion that precipitates, if mixed with a liquid chemical. Chemicals may only be mixed if the label indicates compatibility with certain other chemicals. The use of any other chemicals after a copper containing spray has been administered should not be attempted before at least 7 to 10 days have passed.

Be aware of the dangers of chemicals - most are toxic. The toxicity of a chemical is expressed as its LD50 mg/kg value. This simply means the amount of chemical needed (Lethal Dosage) in mg/kg body mass, which will kill off 50% of a population of test animals. The smaller the LD50 value in mg/kg the more toxic the chemical e.g. if a chemical has an LD50 value of 3mg/kg it means that only 3mg of chemical is needed for every kg of your body weight to kill you.

INSECTS AND PESTS

With the use of the naked eye, these can be identified and controlled in time to prevent

devastation. Although not daunting in their diversity, these pests may be numerous, but effective control makes them the least of the grower's problems. Of all the different insects only a few are troublesome as pests on plants. Only these have to be controlled in a corrective manner by treating affected plants with visible damage. The whole garden should not be sprayed because a lot of beneficial insects will also die in the process.

Insect pests are divided into biting, sucking and chewing insects, whereas the insecticides are divided into stomach, contact and systemic insecticides. The choice of the correct insecticide will depend on the size and eating habits (sucking or biting or chewing) of the insect, which needs to be controlled.

Insects, which are controlled by means of a contact or stomach insecticide, will have to come in contact with the insecticide before they are controlled. A systemic insecticide acts in a totally different way. The systemic insecticide is absorbed by the plant and transported to all plant tissues. The sucking and chewing insect, wherever it may start, will be poisoned. Remember that systemic insecticides are more concentrated than contact insecticides and only a small portion of the plant has to be sprayed not the whole plant.

The South African B*rithys pancratii* and it's Australian cousin *Brithys crini*, creatures unworthy of such eloquent Latin names, are also cursed bitterly as the lily borer or amaryllis caterpillar. The former are well known to most KwaZulu-Natal and inland *Clivia* growers. They have a larval stage characterised by transverse yellow and black stripes. In the case of *B. crini* larvae have white and black stripes and are 30-40mm long. The egg packages, which are laid on the underside of the targeted plant's leaf *(figure. 2),* bring forth small larvae, which immediately burrow into the leaf.

Figure 2 Egg package and hatching larvae of the lily borer

The eating marathon then courses downwards, the climax being the rhizome *{figure* 3).

Figure 3

Left unchecked the demise of the plant follows. Do not discard the remaining roots and rhizome, as they are sometimes robust enough to produce several side shoots in response to careful treatment.

A little grey moth *(figure* 4) of a centimetre in length is unnoticed by most gardeners during the nocturnal hours, but she is the true culprit in the lily borer crime. Meg Hart and James Haxton finally solved the mystery of this nasty creature's life cycle before it found its deserved place on the 'Compost heap' of our quarterly newsletter.

Indicator plants such as *Albuca, Crinum, Nerine, Cyrtanthus, Hippeastrum* and *Zephyranthus* planted in the garden can be of help in the early warning of their ominous presence. The lily borer is most active during the months of October to April, the summer growing season. During this time you can apply a full cover spray or drench by watering can with a broad-spectrum systemic chemical containing ***cypermethrin*** - **Garden Ripcord**™ (or **Polytrin 200 EC**™). Other fast acting but less effective contact insecticides may also be used *(figure* 5).

Figure 5 The lily borer's habit of eating between the upper and lower epidermal layers of the leaf dearly shows why little success is achieved with contact insecticides such as the Blue Death powder the grower has so liberally sprinkled on the plant by the grower

Dimethoate™ insecticide granules marketed by Efekto and Bayer are reported to be very convenient to use as well as effective against several sucking and chewing insects.

Young looper damage has been experienced only by a limited number of growers in Gauteng *(figure 6).* In Australia the Lily Caterpillar, *Spodoptera picta,* is found in eastern Queensland and NSW and can cause major damage to *Clivia.* Give them the lily borer treatment.

Figure 6 Young loopers eat the leaf from above, leaving only the bottom epidermal layer

Flies. These could be sciarid flies (fungus gnats) and other unidentified flies. These vary in the different growing regions of South Africa. Damage is caused by their larvae to the soft new inner and unexposed leaves. Wounds caused by larvae can be entered by fungi and bacteria causing severe secondary infection. We often see fungus gnats flying or their small reddish-brown pupae on our plants. They are attracted by rotting organic material but do not do serious harm to the plant itself but are secondary after being attracted by decay already present *(figure* 7). Contact insecticides containing *Mercaptothion* - **Malathion™** (or **Malasol™)** or *Chlorpyrifos* - **Chlorpyrifos™** (or **Dursban**™), can be used.

Figure 7 Fungus gnat pupae on rotten roots, most probably due to *Phytophthora* root rot

Snout Beetle. With their curious proboscises, these creatures have a healthy appetite for *Clivia.* They vary in colour from brown to charcoal and are 10-25*mm* in size. They are mainly creatures of the night, during which time they can erode away substantial areas of *Clivia* leaf, leaving a disfiguring lacy effect of circular lesions *(figure* 8*).* They are also not above gnawing

at flowers and fruit, thus also affecting your seed crop *(figure* 9).

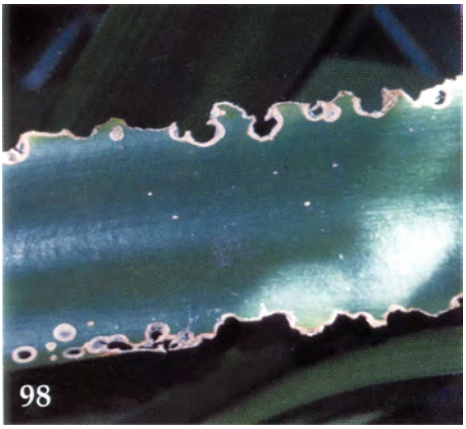


Figure 8 Circular lesions on *Clivia* leaf

Figue 9 Ripening and exposed seeds

Growers in the Western Cape and the eastern coastal regions of South Africa must be especially vigilant against this snouty foe. A retired entomologist friend of mine suggests that biocontrol, in the form of the little golden creeper mole, can substantially reduce its threat. Otherwise, control of this pest involves seeking it out with a strong hand-held light and great cunning and stealth, as they promptly drop off the leaf at the slightest threat.

A contact insecticide containing *Mercaptothion* - **Malathion™** (or **Malasol™)** or *Chlorpyrifos* - **Chlorpyrifos™** (or Dursban™), can be administered if an essential sticking agent such as **NuFilm** P™ is added. Systemic insecticides (such as **Garden Ripcord™** can also be used. *Fenitrothion* - **Folithion™,** (beta-cyfluthrin - **Bulldock™** insect granules and *dimethoate* - **Efekto Insect Granules** are also effective. A Port Elizabeth grower suggested spraying late in the afternoon to reduce the effect of the chemical breakdown of the toxin due to exposure to heat and light. This is important because the beetle, in his deviousness, also has a little built-in alarm clock, which goes off to announce his dinnertime at around 9pm.

Mealy Bug. These are small 3mm, flat and oval shaped insects, adorned with a flock of waxy, white, powder-like threads. Closer examination reveals filaments around the edge of the body, with two distinct filaments at the rear of the body. They excrete honey-dew and are therefore betrayed by the presence of ants. Mealy bugs cause severe damage during the warm summer months, targeting the tender new leaves (figures 10a & b).

Figure 10a Mealy bug infestation

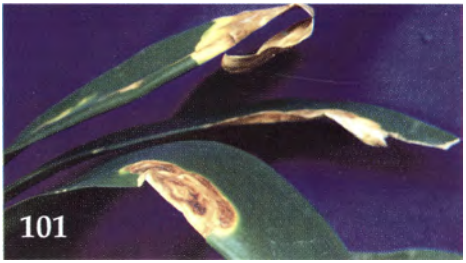


Figure 10b Mealy Bug Damage

They will also gather in masses like cottonwool underneath the leaves and into the upper roots if left unchecked. The best indicator plants are the *Agapanthus* species in your garden. Mealy bugs dislike strong air movement; therefore you will find them mainly in sheltered areas. They transmit serious viral diseases or cause wounds for fungi and bacteria to enter. Immediate action is important to combat this bothersome pest. You may use *Chlorpyrifos* - **Chlorpyrifos**™ or **Dursban**™ or *Mercaptothion* - **Malathion**™ or **Malasol**™ in controlling this infestation with full cover spray, using a wetting agent. Indoor plants need the use of methylated spirits and hand picking for control. Occasionally, the roots can become infected with **Root Mealy Bug** and this is more resistant. The pot will need to be submerged in a solution of proprietary insecticide and it is best to allow the plant to soak for at least 10 minutes. Several treatments may be necessary at intervals of 7 to 14 days if the infestation is particularly extensive.

Red spider mite. Red spider rarely causes many problems unless the atmosphere is excessively hot and dry. Sponging the leaves regularly will help prevent this pest becoming established, but should it become necessary, the plant will need to be sprayed thoroughly using a systemic insecticide. It is best to apply several treatments at 10 to 14 day intervals. Regular sponging of the leaves - particularly the undersides, will prevent recurrence.

Even badly affected plants clear rapidly once remedial action has been taken - it appears that *Red spider* is not an entirely successful pest on *Clivia* in South Africa but has been noticed in other parts of the world.

Scale is a well-known pest, but not necessarily on *Clivia*, although growers in China seem to have a problem with this. To remove scale, use **Oleum**™ (suspension spray or a systemic insecticide.

Slugs and snails, our arch enemies, love plants in well-watered areas *{figures 11a &b).* They rasp away from the underside of the leaves, leaving only some upper skin remaining, unlike the young loopers which eat the leaf from above. Snails and slugs find the buds on your show plants irresistible *(figure* 12*).*

Figure 11(a) Snails on *Clivia* leaf

Figure 11(b) *Clivia* bud damage

Fig. 12 Pustules on the leaf can be disfiguring

But they also love eating the bait that you leave out and respond appropriately to liquid killing spray. Anti-snail chemicals should contain *Carbaryl* and *Metaldehyde* in combination for the best results. Research has shown that the blue colour of the pellets is unattractive to birds.

Grasshoppers eat the edges of the leaf. When they eat at the sides of new growth it causes deformities as the plant grows and can cause the plant to fan only to one side if it was eaten on that side. It takes the plant several seasons to recover to a good-looking plant again. Catch them and kill them or spray with a *carbaryl*-containing insecticide.

The large **Dune Molerat,** another *Clivia* enthusiast, is likely to incense you with rage after making your magnificent *Clivia* plant disappear into his subterranean dining room. Remember that there are good moles (insectivorous) as well, before you embark on a 'molecide'.

Rodents, however, are a problem. *Clivia* fruit are a delicacy to them and although they do not eat the seed, they have no qualms about carrying the berry away for later consumption and thereby hiding your precious seed forever. Surprise the rodents in late winter when their normal food source is low, with rodent bait as a control. This is normally the time for berries to ripen as well. Recently, a grower from Kimberley found the outer leaves of the plants eaten off to between lto *5cm* above ground level.

DISEASES

Fungi, bacteria or viruses invading living plant tissue can cause plant disease. Plant tissues are damaged by the pathogen itself. To identify the type of pathogen is very difficult because the symptoms differ from plant to plant under different environmental conditions. Exact and reliable identification can only be made by a plant pathologist in a well-equipped laboratory.

In contrast to insect pests, fungus/bacterial infections are best controlled preventatively. This means that plants should be sprayed as soon as environmental conditions are favourable for disease development.

Unlike single applications for the control of insect pests, spraying for fungal /bacterial diseases follows a program. The reason for the spraying program is to chemically cover any new growth as well as replenishing chemical levels on older leaves, which may have washed off. If it rains within 3 days of spraying you will have to spray again, especially if the plants have waxy leaves, as in *Clivia.*

Contact fungicides / bactericides are usually sprayed every 7 to 10 days, whereas systemic chemicals are sprayed every 14 days.

Fungi. In *Clivia* there are two main groups, namely rusts and damp-off disease.

Rusts caused by many different fungi account for reddish-brown or yellow pustules above and below the leaves *(figure* 12*).* They begin slowly, but multiply rapidly during favourable weather conditions. Although sometimes seen as a cosmetic affliction and seldom fatal, they do reduce active growing area and thus photosynthesis. The plant, thus weakened, could be susceptible to aggressive rot-causing fungi and bacteria setting in as secondary and tertiary infections. At present rust-causing fungi are not well identified and preventative control measures are our best defence against them. In short, spray regularly with m*ancozeb* - **Dithane M45™,** *triforine* - **Funginex™**, *dithiocarbamate* - Zineb™ or chlorothalonil - Bravo™. Some larger growing concerns have tried the locally new systemic chemicals such as **Folicure 250EW™, Baycor 300EC™** and **Score 250™** with success, during the recent wet summer after heavy infections. The active ingredients in these are different *triazoles* claimed to be locally systemic. They are absorbed by the contact surface but not translocated to the roots or other untreated parts.

The new Chinese plants with tessellated or raised vein leaves are less than hardy and chemical burn is prevalent. Never experiment with new chemicals on rare plants. Instead, use reliable agents such as *mancozeb* - **Dithane M45™,** *captab* - **Captan™,** *chlorothalonil* - **Bravo™** or

Figure 13 Brownish smudge marks showing only on the weaker yellow parts of the leaf

Figure 14 *Amaryllis* stalk spot only appears in extremely humid conditions

Figure 15 Stem damage is linked to potassium deficiency by expert growers

dithiocarbamate - **Zineb**™. All of these are good broad-spectrum prophylactics that should suppress the disease. The rusts affecting our variegated *Clivia* leaves *(figure* 13*)* can be treated as above.

Leaf and stalk spot - Stagnospora curtisii. These form visible, bright red to brown, sunken lesions on members of the *Amaryllis* family *(figure. 14).* This fungus has been suspected on *Clivia* during extremely humid conditions. Do not confuse this with the tearing effect due to potassium deficiency *(figure* 15*).*

Leaf dieback. One of the first to be identified and best-documented fungi is *Macrophoma agapanthii.* Apart from *Clivia* others affected are *Haemanthus* and *Veltheimia* spp. The leaves die back from the tips leaving pale brown, parchment-like and scalloped remains. The whole leaf eventually dies down to the plant base if untreated *(figure* 16*).* Similar lesions were observed in illustrations of Chinese *Clivia* which were attributed to *Macrophoma* sp. It is possible that the visible symptoms among cultivars such as the 'ordinary narrow pointed leaf and the 'broad leaf could differ. The suggested action is to cut affected leaves back, well beyond the translucent area of infection. The wound must then be sealed using one of the following methods: application of *flowers of sulphur,* **Dithane M45™, Bravo™** or **Zineb**™ (undiluted). It is convenient to use **Mycota**™ foot powder and spray or **Merthiolate**™ spray.

Figure 19 depicts the extremely aggressive fungal infections experienced by several growers in Gauteng this past wet season. Early stages show small chlorotic spots, a red-brown area developing in their centres.

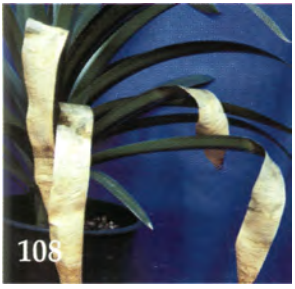


Fig. 16 *Macrophoma agapanthii* left untreated. Do not confuse with sunburn

Fig. 17 Possibly caused by *Rhizoctonia* or other unknown fungus

Fig. 18 Possibly caused by *Rhizoctonia* or other unknown fungus

Figure 19 Could be *Macrophoma* or a related *fungi imperfecti*

Figure 20 Plant fallen over with leaf base still intact

The infection begins at the side or middle of the leaf. These areas expand, coalesce and rapidly move to the leaf base. Without treatment the plant will die. Different chemicals were used by growers, such as **Bravo**™, **Zineb**™**, Dithane**™ and *Triforine* - **Funginex**™ and others, but only various degrees of suppression were achieved. Reasonable success was achieved when the affected area was cut away and the wound sealed, as described for *Macrophoma agapanthii* leaf dieback.

Damp-off disease. These are the most aggressive fungi for the *Clivia* grower that cause rot and 'dieback', and can lead to the loss of entire mature plants as well as seedlings. The quartet of the worst rot-causing fungi to attack plants consists of *Phytophthora*, *Pythium*, *Fusarium* and *Rhizoctonia.* All four of these pathogens have been positively identified during the past extremely wet and hot growing season. *Phytophthora* and *Pythium* are amongst the fastest and most destructive fungi known. They are soil-borne but can also spread via contaminated water through splashing when watering.

Pythium was very troublesome in *Clivia* seed and seedling trays during the past season. Infection starts initially slightly below the soil surface. Prevention is by sterilizing the seed, seedlings and growing medium with appropriate protective chemicals such as *mancozeb, captan, chlorothalonil* and *copper oxychloride.* I had no losses after I started to use *copper hydroxide* in **Kocide 2000**™ as a drench this year. This form of copper spray is claimed to cause less burn than previous copper compounds. It is also cost-effective. Do not plant too deep and do not drench or spray seedlings with *benomyl* - **Fundazol**™

Figure 21 Cleaned surface with Bravo™

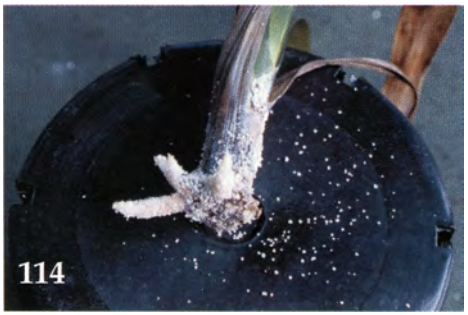


Figure 22 Recovering plant with new roots

as it has no curative effect for plants against *Pythium* or *Phytophtera* infections, although it works well for Rh*izoctonia, Fusarium, Botrytis* and flower spotting.

Phytophthora root rot is a slightly slower killer in adult plants. The leaves show slight symptoms of drought and starvation. Leaves turn a yellow green on outer leaves first in *Clivia* and then the plant falls over *(figure 20).* The roots are all soft due to root rot. It was very interesting that Mick Dower found a very small pupa on the roots. Unfortunately the insect that emerged could not be identified as it flew away when the entomologist opened the collecting bottle! This could have been a *Sciarid* (fungus gnat) that was attracted by the decay. *Phytophthora* is active in warm wet conditions and favours badly drained growth medium and poor aeration. Remember that *Clivia* have epiphytic roots that need good aeration in a light and well-drained growing medium. In this case the affected plant tissue is cut away and the clean surfaces treated with neat **Bravo**™ *(figure* 21*).* If what is left of the plant is then planted in clean sterilised filter sand new roots will soon emerge, resulting in a healthy plant again *(figure* 22*).*

Phytophthora and *Pythium* rot can be successfully treated with systemic fungicides such as *Furalaxyl* - **Fongarid**™, *propamocarb* - **Previcure N**™ **,Bravo**™ and *phosphoric acid* - **Phytex 200 SL**™ if it is detected at an early stage. Avoid planting in leaf mould collected under avocado trees. Open standing irrigation water could also be infected.

Rhizoctonia-infected plant tissue has a watery appearance with tan to reddish brown lesions that will finally girdle the stem *(figure* 24*)* and cause young plants to fall over *(figure* 23*).* Roots can still be firm. It is often found among newly transplanted plants. Avoid over-potting. Over-fertilising, a wet, heavy medium or an incompletely decomposed medium can all contribute to heavy plant loss. Although some visible symptoms could lead to confusion with the bacterial infection *Erwinia* it is not as fast, soft and mushy and lacks the characteristic foul odour. Preventative treatment with **Dithane M45**™ or **Bravo**™ or curative treatment with a systemic - **Fundazol**™, **Rhizolex**™ and **Topsin Flo**™ have been applied by growers with a good success rate.

Fusarium is a soil-borne pathogen causing root and basal stem rot in lilies. It is often recognised by its wilting effect, mainly in newly transplanted plants. It enters plants through wounds on injured roots or leaf bases. Avoid contaminated growing medium, soil compaction, excessive soil water because this is almost impossible to

Figure 23 *Rhizoctonia* infected plants

Figure 24 *Rhizoctonia* infected plants

cure. The only slightly curative chemical at this stage is *benomyl,* and as a preventative *zineb* or the new agricultural disinfectants containing *quaternary ammonium compounds* and referred to as QAC's. Manufacturers claim these chemicals destroy all fungi, algae, bacteria and viruses on exposed surfaces.

Sclerotium rolfsii, referred to as *collar rot,* has been identified in China and locally. This is a very serious infection with almost no control. It is spread by water and infected growing medium. High humidity and extremely high temperatures are preferred by this pathogen, which attacks plants near the soil level. The same treatment can be followed as that for *Phytophtera* root rot.

Bacteria. Bacteria multiply quickly and are intensely destructive rot-causing pathogens. Prof. Mark Laing's guide in Clivia Yearbook 2 on how to deal with them is to be well heeded. *Erwinia carotovora* is mostly secondary or tertiary in its occurrence and enters mostly through wounds or stomata - it is responsible for most crown and soft rots. The smell of putrefaction is rather obvious upon close examination. The past growing season has also revealed the first known reports of bacterial leaf spot caused by *Pseudomonas.* The grower must remember that general fungicides have no remedial effect on bacterial infections. *Kaptab* - **Kaptan B**™ was used in the past, but it does seem that we are left with only the newer *copper hydroxide* containing chemicals such as **Kocide 2000**™ to have a tentative grasp on the bacteria problem. *Tetracycline* is used in America for bacterial infection.

Good sanitation practice and sterilisation with the QAC's such as **Terminator**™ and **Sporekill**™ is the only alternative to the copper compounds. An interval of at least 7 days should follow between a copper treatment and another chemical treatment.

It is very important that a plant with a detected fungal or bacterial problem is kept dry during treatment.

Nematodes have been reported recently and secondary bacterial infection could have affected these growers as a result. Sean Chubb deals with this subject in a separate article.

PREVENTION

Accurate fungal and bacterial identification can only be achieved if a live sample is sent to a plant pathology laboratory. Hopefully, over the coming seasons, with input and feedback from growers, some useful answers will be forthcoming. Knowledge of the exact pathogen responsible is very important for without this the marketing personnel and manufacturers cannot give you accurate and cost-effective solutions to the cause of your nightmares. *Clivia* growers must now be observant and sensitive to the slightest disorder amongst their plants when trying to decipher the code in the many symptoms. Try to photograph diseased plants in order to extend the database of visible symptoms, as reliable laboratory results could take up to two months. In the meantime, do take your control measures and counter measures even if they could be likened to shotgun warfare.

There are other factors involved in the control and prevention strategy. Problems with growing conditions and culture disorders can perpetuate our bacteria and fungi situation.

The following preventative measures are recommended:

- Increasing the light intensity in order to grow stronger and more resistant plants.
- A decrease in nitrogen fertiliser and an increase of potassium, magnesium and calcium results in more balanced plant growth.
- Air movement is important - reducing air movement causes heat build-up e.g. 80% shade cloth is not conducive to good air movement if totally enclosed.

- Another factor is the general tendency to find a convenient sheltered spot between the house and boundary wall or between outbuildings etc., where the air can be quite stagnant. Above all don't overcrowd plants. Benching with air below is better than on the floor.
- Greenhouse hygiene is important: remove diseased plants immediately as well as dead leaves, as far away as possible is the rule, not outside the door or onto the compost heap.
- Isolate infected debris in plastic bags and place it in your municipal waste bin to let it have an honourable burial away from your growing area.
- Ensure that compost purchased is well 'composted' and aerated and be certain that it drains well enough. Sterilisation before you purchase is imperative. Raw sawdust and bark should be avoided. To speed up the composting process, add a handful of *magnesium carbonate* (agricultural lime) and a handful of *ammonium nitrate* a year in advance. In this way essential *magnesium* is also supplied. Unsuitable and raw medium is a major factor in plant loss.
- Avoid adding too much fertiliser to new medium. Fresh bone meal when transplanting can be disastrous.
- Avoid over-potting, the enormous effort of one more transplant is worth your while, as the large pot is only conducive to more moisture.
- Avoid 'water drip' from one plant above another.
- Environmentally stressful conditions to your plants should be avoided.
- Protect your plants against changes in their ideal growing environment brought about by weater conditions - for example, use QAC's to protect them against fungi and bacteria in hot and humid conditions; use sharply draining potting media which do not retain water if they are exposed to rain.
- Isolate all plants which are being treated for fungal or bacterial infections and ***keep them very dry***. This will accellerate their recovery from those infections, whereas it is very difficult to kill a *Clivia* by giving it too little water!
- Isolate newly acquired plants and treat with a QAC before placing in main growing area.
- The practice followed by Ammie Grobler of dipping all plants during transplantation in a QAC solution and leaving them to dry off before replanting in a new growing medium and pot can save a lot of tears later.
- All cuts made during the dividing process must be sealed with preventative chemicals mentioned in the text.

GENERAL

Prepared pesticides should never be stored for longer than a day, after which they start breaking down and losing their efficacy.

Pesticides should never be discarded down drains as they cannot be removed from wastewater at wastewater plants and can cause serious pollution. Rather dig a hole in your backyard and pour it in there. The bacteria in the soil will break the chemicals down within six weeks.

It is worthwhile investing in a good pressure sprayer.

Jeyes Fluid™ is not recommended for use on plants. It is a general disinfectant containing a number of chemical substances, which are harmful to plants. The Jeyes Fluid used in the horticultural industry in the UK has a different chemical composition to that sold in South Africa.

Only use chemicals which are marketed for the home gardener if living in an area demarcated as urban, this includes

smallholdings within an urban area as well. Insecticides and fungicides for the agricultural sphere are more concentrated and will damage plants if not correctly diluted. It is also illegal to buy and use these in an urban area.

At the time of going to press I still have numerous unidentified lesions like in *figures* 17 & 18. Hopefully this article is only a beginning for future contributions by *Clivia* growers. Any positive feedback or new information on pests and diseases including virus should be read about in the next Clivia Yearbook, because not all growers have access to the Internet enthusiasts' group. Internationally, if you 'read' through the Chinese Clivia book *Junzilan Zinpu* (ISBN 7-5281-3208-2) we gather they have similar problems. The Japanese book *My Green* (ISBN 4-07-929411-5) also clearly illustrates a common experience in *Clivia* growing problems. We also gather from the Internet that there are a number of other pests and diseases affecting *Clivia* everywhere. We welcome input and information from growers in the USA, Australia, China, the UK and all the other countries where *Clivia* are enjoyed, for inclusion in the next Yearbook.

Having become a *Clivia* fanatic with a special interest in pests and diseases, it occurs to me that my studies in Latin were of less use to me than Japanese or Chinese would have been!

LETHAL FACTOR

Although not a disease, the occurrence of the so-called lethal factor, which is a complete lack of chlorophyll and which results in the early death of seedlings among yellow and variegated *Clivia miniata*, is escalating and is now also reported from seedlings with pigmented bases. This is a genetic weakness and can be treated with a *2ml* magnesium sulphate solution dissolved in 1 *litre* of water and applied weekly for a few weeks. You should then experience a higher survival rate.

Acknowledgements

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figure 25 Could probably be linked to collar rot caused by *Sclerotium rolfsii.* This plant was saved and is developing new roots on the less affected parts

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Clivia gardenii from the habitat

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CLIVIA

FIVE

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CLIVIA

FIVE

Clivia miniata **'What a Peach'.** Breeder and grower: Brian Tarr.

EDITORS
Mick Dower Claude Felbert
John van der Linde John Winter

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EDITORIAL

Two events stand out in the period covered by this Yearbook. One is the third International Clivia Conference held at Pietermaritzburg; the other, the publication of Harold Koopowitz's outstanding and authoritative book, CLIVIAS. Both set standards that can only auger well for the future of the *genus*.

The first Yearbook was the product of a challenge to come up with something more than Newsletters to showcase the Clivia Club. The book was based on the proceedings at the second International Clivia Conference held at Kirstenbosch in 1998. At that time we had to rely on photographs of plants bred outside South Africa, mostly in Japan and Australia. Subsequent Yearbooks have increasingly brought forward photographs of outstanding plants bred in South Africa and at last we can see, in this Yearbook, what has been bred from the very small gene pool in the U.S.A.

This, the fifth Yearbook, covers primarily the proceedings at the Pietermaritzburg Conference, particularly for the benefit of the many who were unable to attend it. We have not published Dr John Rourke's keynote address on the discovery of *Clivia mirabilis* as it covered the same ground as his leading article in CLIVIA FOUR.

One of the highlights of that Conference was the 3-D slide show of spectacular Clivias presented by James Comstock, whose photographs illustrate Harold's book. Unfortunately, space allows us to include only a small selection of those slides.

Clivia miniata in full bloom provided a spectacular backdrop to this Conference. The Host Club, Kwa-Zulu Natal, excelled in their organisation and administration and provided wonderful opportunities to visit populations of *Clivia* in their natural habitat in relatively close proximity to the conference venue.

A notable feature was the honouring of Fred Gibello, Wessel Lötter and Bill Morris for their outstanding contributions to the spread of *Clivia* knowledge by awarding them Honorary Life Membership of the Clivia Society.

Another highlight of the Conference was the Auction, where rare and exceptionally magnificent *Clivia* realised excellent prices in Rand terms. But no amount of money could buy the single plant of *Clivia mirabilis* which was displayed by the National Botanical Institute. Identifiable in part by its characteristic white streak down the centre of its leaves, C. *mirabilis* attracted great interest. The discovery of this new species, growing in an isolated habitat in the North West Cape and in a harsh environment very different from that which other *Clivia* species thrive in, raises many questions and only time may produce some of the answers!

In this Yearbook Dr Dee Snijman, a senior researcher at the Compton Herbarium at Kirstenbosch, tells us why she believes C. *mirabilis* occurs where it does and why it is so isolated. Dr John Rourke also tells us about finding C. *mirabilis* with pedicels which had developed into secondary umbels, resulting in many more florets, and speculates on the breeding potential of this characteristic.

Clivia mirabilis seed is now being grown on at Kirstenbosch on behalf of the Northern Cape Nature Conservation Department and seedlings will be made available to the public towards the end of 2004.

With the proliferation of named *Clivia* it is of importance that growers read Ken Smith's article where, as the *Clivia* names Registrar, he advises on the naming procedure for *Clivia* hybrids that are constantly being introduced.

Once again the Yearbook has a number of articles on growing *Clivia* and covering the fascinating subject of genetics to promote a better understanding of breeding and to demonstrate the rich potential of this relatively small genus.

The Yearbook has become the showpiece of the Clivia Society which was formed in 1992 by Nick Primich as the Clivia Club. It held the

first International Conference in Pretoria in 1994. The Clivia Society is now the umbrella body which brings together and facilitates the common interests of regional Clivia Clubs as well as individual enthusiasts throughout the world. Within this overall 'Clivia fellowship' there are many people with multiple skills, knowledge and expertise and the Yearbook seeks to pass on such information to *Clivia* enthusiasts worldwide, stimulating interest and contributing to the conservation and development of the genus.

All enthusiasts are encouraged to share their knowledge and ideas by submitting articles and photographs to the Editorial Committee and the Editor of the Newsletter.

This Editorial Team has now produced five Yearbooks and the time has come for new blood and new ideas. Another Team will produce Yearbook Six. They will need your full support! We wish them every success and trust that they will gain as much pleasure, satisfaction and sense of achievement as we have, in rising to the challenge.

The Editors
CAPE TOWN. April, 2003

The following abbreviations have been used, particularly in the captions to the photographs:
CC Cape Clivia Club EC- Eastern Cape Clivia Club KZN - KwaZulu-Natal Clivia Club
Metro - Metro Interest Group NC- Northern Clivia Club

The International Clivia Show

COLLECTING CLIVIA IN THEIR NATURAL HABITAT

John Winter

As a horticulturist, I have always had a passion for plants. My interest has focused on a number of groups, such as *Erica, Disa* and *Drosera* which I have collected extensively through the years to build up the living plant collections at Kirstenbosch Botanic Garden where I was employed for 34 years.

My interest in *Clivia* grew after attending the First International *Clivia* Conference that Nick Primich organized in Pretoria in 1994. I investigated the herbarium records of the National Herbarium in Pretoria, the Natal Herbarium in Durban and the Selmar Schonland Herbarium at the University of Grahamstown. Rather surprisingly I discovered that *Clivia* were poorly represented in all three herbaria. It was obvious to me that no extensive study had ever been done on the genus.

The living collections of *Clivia* in all of the eight gardens of the National Botanical Institute, of which Kirstenbosch is one, were also a poor reflection of the genus. My natural reaction was to plan a collection programme to improve the living collections of *Clivia* in the National Botanical Institute (NBI) gardens, contribute towards improving the herbarium records and make selections of *Clivia* to be used in a breeding programme. What pleased me particularly was that there were only four species in the genus!

Although the NBI is charged by government decree to study, research, promote and conserve South Africa's indigenous flora, this does not give the staff the authority to collect plant material without obtaining permission from the local authority, i.e. the relevant Department of Nature Conservation as well as the owners of properties to be visited. All plant collecting undertaken by NBI staff has to be covered by a permit which stipulates certain conditions, such as the exact plants that may be taken out as well as the quantity. A permit is issued for a certain area and for a limited time period. After the collecting trip has taken place, a report has to be submitted detailing what plants have been collected and the permit has to be returned.

I have spent many hours in the field observing what pressures have been brought to bear on *Clivia* communities, many of which have long since disappeared. The reasons are many. The local indigenous people living in close proximity to Clivia populations, who use the plant for medicinal purposes, seek after *Clivia*. The horticultural industry and *Clivia* enthusiasts collect selected forms and many *Clivia* populations have been destroyed through the harvesting of timber for building, firewood and to establish arable land. This destroys the shade canopy and ultimately results in the death of the *Clivia* population which grew in the shade of these trees. And of course urban development has also played a part in the destruction of plant communities particularly along our East coast where *Clivia nobilis* used to be very common. In Kwazulu-Natal sugar cane farming has also contributed significantly to the destruction of our natural vegetation.

Fortunately *Clivia* are easy to grow and for this reason will certainly not be a candidate for the Rare and Endangered Species list. However

the recently described *Clivia mirabilis* is certainly not as common as the other four species and its well-being is a source of concern. I appeal to *Clivia* enthusiasts to be patient and not put pressure on the known population but to wait for this new species to be made available.

In the last five years numerous collections of *Clivia* have been made of all of the species - C. *mirabilis* had not yet been discovered. These collections have been grown on at Kirstenbosch and selections have been made of certain plants with particular characteristics, which will be used in a breeding programme. As *Clivia* are long lived and multiply vegetatively, they have grown in numbers and most of the plants in the collections have now been passed on to six of the botanic gardens within the National Botanical Institute for purposes of education, display and, most important of all, to retain and preserve this genetic material. Seed and seedlings have been made available to the general public through the Cape *Clivia* Club and vegetative material will also be made available of the selections as they multiply.

In 1996, as part of my five year collecting programme, I started collecting in the Eastern Cape and moved east into the Transkei visiting known populations of *Clivia*. Herbarium records were useful in locating populations. However what was even more useful, in fact essential, was the support and knowledge of local people. Without that help, it is like looking for a needle in a haystack!

As we all know *Clivia* are shade loving and grow in forests. *Clivia* are scattered throughout the forests in the Eastern Cape, Transkei, Kwazulu-Natal and Mpumalanga, occurring in deep valleys and along river banks which run down to the sea. The Transkei has many rivers and travelling from east to west complicates progress because one has to travel inland along the river to an appropriate crossing, and then return to the coast to continue the set course. Therefore, it can take the best part of a day just to reach one destination.

A typical Transkei River with C. *miniata* growing in forest on the eastern bank.

All Clivia grow in isolated populations. Not all forests have *Clivia* growing in them. Hence the need to have inside information if one is to be successful in locating a particular population. New populations of *Clivia* will continue to be discovered for many years hence, as vast areas of South Africa are botanically unknown.

Ecology

The ecology of *Clivia* includes a number of factors which are common to all of the five species:

- Shade loving
- Water wise, i.e. they survive on minimum water supply
- Growing medium - they prefer a well drained and aerated growing medium
- Roots - their roots are epiphytic.

Umtamvuna Gorge

Clivia nobilis This species occurs in a range of environments along the east coast growing on the coastal sand dunes where the roots run just below the surface of the sand. Shade is provided by the long living Milkwood tree (*Sideroxylon inerme*). In these areas which are exposed to the prevailing winds and where the canopy provides little shade at times, the leaves of C. *nobilis* are short and rigid. Inland populations occur in isolated forests which are sheltered. These heavily shaded areas produce plants with leaves of at least a metre in length. The soils in these areas are a heavy loam with abundant organic material on the surface.

In all conditions the roots of this species spread just below the surface with a great deal of organic material aerating the root area and creating drainage which can be described as sharp. Temperatures range on average from 6°C to 28°C on the coast and 3°C to 35°C in the inland areas.

C. ***miniata*** occurs in a wider range of environmental conditions than all of the other species. On occasion they are found growing as epiphytes in the forks of trees, or on decaying logs or even on rocks. However, generally C. *miniata* grows on rocky screes amongst abundant leaf litter or on steep or gradual slopes but their roots are always very shallow and spread amongst the organic matter which is deposited on the forest floor.

C. *miniata* growing in the Transkei

The *Clivia* populations that occur on the coast in the Transkei are virtually at sea level in places. Growing in forests and subject to the cool sea breeze their growing conditions are cool with not a very wide fluctuation in maximum and minimum temperatures. In Kwazulu-Natal and Eastern Cape, on the other hand, the populations of *Clivia* are situated inland and are subject to greater maximum and minimum temperatures. At the northern end of the distribution range of c. *miniata* altitude plays a role. At an altitude of over 1300 metres the mists and cloud which cover these mountains create conditions with a chill factor very close to freezing and at the same time the forest canopy collects much moisture from the clouds and mist which benefits the vegetation on the forest floor.

C. *miniata* from Entumeni Forest

Light has a strong influence on the flowering of all *Clivia* species. In forests where the shade is heavy only a small percentage of the *Clivia* will flower. On the forest verges or where there are breaks in the forest canopy which allow light to penetrate to the forest floor, one tends to find more flowering plants.

c. *gardenii* The environment in which c. *gardenii* is found growing differs from that of all of the other *Clivia* species. All of the populations that I have visited in the field have been growing in swamps or very wet conditions with the exception of one population. They occur in heavy to light shade but in the Transkei most of the populations were found growing under the canopy of the tree *Syzygium cordatum*, commonly known as the Waterbessie. These trees are always found growing in very wet areas - hence their common name. The canopy they provide is light shade. These swamps are not stagnant as the water drains away continually.

c. *caulescens* grow in a very similar environment to that of c. *miniata* in shade on the forest floor with plenty of leaf litter, and are often found growing on tree stumps or in the fork of a tree.

Swamp Forest in Grassland

The populations I have visited grow at an altitude of over 1300 metres and on occasions experience falls of snow in winter. The minimum ground temperatures are probably in the region of 5°C.

C. *mirabilis* I shall not dwell on these details as John Rourke has discussed in detail the ecology and climate in which this species has survived for centuries (See Clivia 4).

Variation

Variation exists within the various species of

Clivia in characteristics such as leaf width, length, height of plants, flower colour, size and shape and peduncle length and width.

My observations in the field indicate that the greatest variation exists particularly in C. *miniata* and C. *gardenii*. The following characteristics have been observed to vary from population to population but occasionally also just within a single population which makes that population unique. In most cases however populations are fairly uniform.

Flowers : Colour, size, petal width, pedicel length, number of flowers per inflorescence

Peduncle : Length, width

Leaf: Length, width, arrangement of leaf, spiral-wound round/coiled, distichous (arranged in two rows).

C. ***miniata*** is the most variable of all the species. Flower colour varies considerably; however this characteristic is not stable as it is influenced by other factors such as light. Size of flower, width of petal, pedicel length and the number of flowers per inflorescence can vary within a single population. The length and width of the peduncle was another noticeable characteristic but apart from the flowers the other most important characteristic is the foliage.

Generally the leaves of *Clivia* are long and strap-like which, to my mind, is unfortunate. Fortunately, however, there is variation in the natural populations which the European, Japanese and Chinese growers have focused on to develop the products that they grow today.

The characteristics of short, broad and a distichous arrangement of leaves is evident in some populations of C. *miniata.* Consequently the plants are a great deal shorter than the usual *Clivia* with it's strap-like leaf and coiled arrangement of the leaves.

C. ***gardenii*** is not as popular as a garden subject as C. *miniata* probably because it is not as freely available and not as well known.

The following variations in characteristics have been observed :

Flower ; Colour, size, fully and partly pendulous

Peduncle: Length, width

Leaf: Length, width

The flowers of C. *gardenii* are predominantly orange with green tips and yellow with green tips. The numbers of flowers per inflorescence range between 20 and 30 and the size of flower can also vary from population to population.

The length of peduncle and height of the plant varies depending on the locality. They range from 500mm in height to one metre. Generally the leaves are narrow (30mm wide) with one or two exceptions where the leaves are as broad as 60mm.

C. *nobilis* is the slowest growing of all the Clivia species. The variation observed in the characteristics of this species is as follows:

Flowers : Colour

Peduncle : Length

Leaf: Length

C. *nobilis* produces pendulous flowers with shades of red and green. The length of the peduncle and leaves are short in the coastal areas where the shade is light. Heavy shade produces plants with leaves of a metre in length and the flowers can also appear to be yellow due to the lack of light. The photograph of a yellow C. *nobilis* published in Yearbook 1998 (Photograph No. 6) is unfortunately not a true yellow as that particular plant was grown in reduced light with the result that the flowers were very pale and in the photograph appear to be yellow. Many populations have a distinct pale green stripe running down the centre of the leaf which is similar to the markings on the leaves of C. *mirabilis*. The leaves are usually notched at the tip.

I have not made many collections of C. ***caulescens*** and have not observed a great deal of variation in the characteristics of this species. I have, however, seen photographs

illustrating colour forms and received reports of a yellow form of this species.

Distribution

As many of us know the most westerly population of *Clivia* is C. *mirabilis* which has turned up in the winter rainfall region of the Northern Cape. About 800km east of the Oorlogskloof Nature Reserve Clivia *nobilis* occurs just north west of the Addo Game Reserve. The most easterly record of C. *nobilis* is in the region of the Dwesa Nature Reserve occurring in coastal forest. *Clivia miniata* is the most widespread of all of the *Clivia* species stretching from just west of the Kei River to the northern boundary of Swaziland. C. *miniata* does occur in Swaziland and reportedly also in Mozambique. I have a plant of C. *miniata* which was reportedly collected in Kenya but I have not been able to trace any herbarium records or publications on the flora of Kenya which list *Clivia miniata* as a species which occurs there naturally.

The distribution of C. *gardenii* stretches from Port St Johns eastwards as far as Vryheid in Kwazulu-Natal. The most northerly species is *Clivia caulescens* occurring in the mountains in the east and Gods Window in the west.

We have five species of *Clivia,* one of which occurs not far from our West coast. All of the other four species occur up the eastern side of Southern Africa and there is a certain amount of overlap. I have observed C. *nobilis* growing in populations of C. *miniata* in the Transkei but have not come across any natural hybrids of these two species. In Kwazulu-Natal I have seen C, *gardenii* and C, *miniata* grow together in a number of localities but here again I have not come across any natural hybrids. The fact that C. *gardenii* flowers in June and C. *miniata* in August and September very likely is the reason why natural hybrids do not occur. Finally in Mpumalanga at the most northern extent of C. *miniata* populations C. *caulescens* also grows. In the early 1970's Clivia *miniata* plants were collected from this population to plant in the Lowveld botanic garden. When they flowered hybrids were discovered which indicated that natural hybrids do exist of these two species.

For me collecting *Clivia* in their natural habitat has been a wonderful experience, observing the conditions under which they grow, their environment, the soils they grow in, their distribution and the range of variation which occurs within some of the species. Endless possibilities exist for the plant breeder and endless challenges. It is no wonder that there is so much enthusiasm for this diverse and remarkable genus.

See also Distribution Map on pp. 96-7. Eds.

C. *miniata* growing in the Umtamvuna Gorge.

CLIVIA IN AUSTRALIA

Kenneth R Smith

Thanks to Nick Primich starting the Clivia Club, now renamed the Clivia Society, *Clivia* have come a long way in Australia during the past ten years.

Early records show that *Clivia* were listed in nursery catalogues in 1866. The species listed was *Clivea* (sic) *nobilis*. Whether or not this was the true species remains a mystery, as there is still much confusion about C. *nobilis* today. The garden magazines have depicted *Clivia miniata* photographs captioned as C. *nobilis* for many years. It is still occurring.

By far the most widely planted and grown species is *Clivia miniata.* We in Australia know it as a narrow foliage plant, that produces narrow segment flowers of a pale apricot colour, or at least that is how it is most often described. This particular type is extensively planted in the Botanic Gardens and home gardens. It is first choice for planting in a shady garden. I, like most other Australians studying horticulture, was taught that it represented the species *miniata*, but I have come to realize that the variety to be found within *miniata* is still being uncovered. This pale flower, narrow leaf *miniata* plant, along with the so-called C. *nobilis*, are widespread right up the eastern seaboard of Australia, in South Australia, and also in the SW corner of Western Australia. At this stage I am unsure about the status in the Northern Territory.

A Cowlishaw C. *miniata* hybrid

Many people are aware of the 'common' *miniata* of gardens and the broad leaf 'improved' *miniata* that are available from nurseries. They have been part of the nursery marketplace in Australia for many years. When it comes to our *nobilis,* it is a bit more confusing. The plant is widespread but not often seen in nurseries. It is referred to as *Clivia nobilis* or *Clivia x cyrtanthiflora*, depending on who you speak to. It may well be a *cyrtanthiflora* type, but the origins are lying somewhere in the pages of a Botanic Gardens register. One nursery in Queensland offered *Clivia nobilis* 'Rubra'. I purchased a plant and when it flowered it was the same as the legion of plants growing in the parks and gardens of Sydney. Within the many garden plantings of *nobilis*, some slight variations are to be found. Some are paler some are darker.

Our 'common' *miniata* on the other hand is very consistent in form. I remember when Mr Yoshikazu Nakamura stayed with me and spent the day in Sydney Gardens. His comment after inspecting every flower was *'all same'*. I know his keen eye when it comes to *Clivia* would have picked up any variation. The situation is changing now that imported hybrids are being sold and planted amongst the more common *miniata*. Maybe we will get back to the diversity that is found in the wild? There is documented evidence that Arthur Yates & Co. imported the

'improved' Veitch's hybrids in 1923. They may have been used by one of our earlier *Clivia* breeders, Mr G K Cowlishaw. Every so often I come across anecdotal information about our early *Clivia* breeders, but the picture remains unclear as to the fate of their stock. We know that the Cowlishaw material is in the hands of a few enthusiasts. The two cultivars that we know of from Mr James Dearing, **'Ailsa Dearing'** and **'James Dearing',** are also safe in collections. It is questionable whether all the 'named' material from Mr Dearing is the actual clonal material, as some seedlings may have inadvertently been distributed. The cultivars developed by Mr Duncan Sinclair are in a couple of enthusiast's collections to my knowledge, and hopefully more are grown elsewhere, but the stock is certainly not well known. **'Salmon Queen'** and **'Giant No** 3' have been mentioned in past Yearbooks.

There are two gentlemen known to us that have done a lot to popularise *Clivia.* Mr Kevin Walters has produced an array of beautiful forms, many of them named, from his breeding work covering the past thirty odd years. Many collectors Australia wide covet the cultivars developed by Kevin; that is if they are lucky enough to secure an offset. His clone **'Relly Williams'** is well known in *Clivia* circles. Kevin is still developing and selecting choice plants today and the seedlings from some of Kevin's material hold the promise of exceptional flower forms. His broad petal yellows and rich oranges are truly beautiful. He is always ready to help promote *Clivia* in Toowoomba, along with the support of other Clivia Society members. There are more great *Clivia* to appear yet from Kevin Walters.

Mr Bill Morris is well known to Clivia Society members through his thoughtful articles in the newsletters. Bill's development of a yellow strain is documented in various journals and he is continually improving it through careful selection of breeding stock. It, too, has taken over thirty years of growing, selecting and learning about the plants to achieve the quality he has today. The many yellow seedlings on the market in recent years are probably from Bill's stock. As well as working on yellows, Bill also has a diverse collection of plants from breeders around the world. These are grown both for interest as well as development. There are many lines of improvement that come under the careful eye of Bill. He has grown variegates for many years. He has interspecific hybrids in various shapes and colours. His Australian hybrids show development of reds, pastels, bicolours, and a line that Bill refers to as sunset shades. Then there are the Daruma forms. Did I mention the *nobilis, gardenii* and *caulescens* hybrids? The Clivia Farm is the place to obtain quality stock.

The collection started by Mr Cliff Grove in Western Australia is now in the hands of Pen

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Left: C. *miniata* 'Relly Williams'
Below: Pale Australian C. *nobilis*

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Henry, trading as Clivia Gardens. Pen is well known to us in the *Clivia* fraternity and she is steadily producing choice material for both the enthusiast and the landscaper by using the material started by Cliff and also adding her own acquisitions and selections. Pen's collection represents material from breeders worldwide.

Kevin and Coral Larsen, from Queensland, have had their *Clivia* collection described in the Australian horticultural magazines. The *Clivia* of Mr, Don Barrett, of South Australia, have also been showcased in a magazine article. I am told about *Clivia* breeders in other states that wish to remain in the background. They are enjoying their breeding work, the flowering season being sufficient reward for them. I can't wait to see the deep yellow being developed by a South Australian gentleman. Other members of the Society are developing their own strains, perhaps to swap with other enthusiasts, perhaps with the view to commercial sales. Members that are nursery operators are growing *Clivia* now in the thousands, much of the seed stock being imported from RSA, Japan, China, Europe and the US.

C. *miniata* 'Aurea'

By far the majority of nursery-sold *Clivia* in Australia are the broad leaf hybrids. These are produced in the thousands, especially in Queensland nurseries. They have always been popular as potted specimens and they sell well in flower, to be enjoyed for the duration of the blooms and then perhaps to be planted in the shady garden. I have seen the impact of this within the Sydney Botanic Gardens, where the purchased plants are used to fill in the bare spaces in the garden beds, only to add to the 'cross pollination potential' of the *Clivia*. Whether they are Belgian Hybrids, European Hybrids, Sahin's Twins, or in more recent times, Japanese material, the result is the same, a complete mixing of forms. There is little consideration given to names, or flower colour, in fact, most are referred to as 'Belgian Hybrids' whether they are or not!

The situation in Australia of growing *Clivia* in shady gardens, irrespective of what name it has or where it came from, has been going on for over 100 years. The position in the last ten years or perhaps even five years has changed dramatically. The generosity of Mr Yoshikazu Nakamura has seen a wealth of forms flowering in the collections of some enthusiasts. Now the 'name' of the cultivar is all-important and the flower colour description has taken on a new meaning. Special clones like 'Vico Yellow' and **'Vico Gold'** are sought, and found, sometimes correctly named, other times, not. The rare yellows that were selling for hundreds of dollars several years ago are not so rare now. The clone that we know in Australia as **'Aurea'** has been on the market for many years. Now there are many nurseries offering yellow seedlings, but sales have flagged a bit in the last year or so. With so much interest in *Clivia,* the supply of yellows has increased and the high prices of a few years back have dropped significantly. The gardening public is questioning the origins of the material and they expect a certain flower shape and colour. They can afford to ask around. It appears that 'the rare cream *Clivia*' is not so rare anymore.

Red flower forms are in demand, but what is a red *Clivia*? Certainly selection for the deeper orange-red is warranted but I note that different people see the same *Clivia* flower as a different colour. Red can be orange and orange can be red. There are plants in the hands of enthusiasts that are from 'redder' stock, but most nurseries treat the 'Belgium Hybrids' as being the red *Clivia*, whether the plant for sale has flowered or not.

Variegated foliage *Clivia* are also part of 'the new range' being offered in Australia. It is not

uncommon to find a variegated specimen in a batch of green leaf plants at a nursery. These are purchased at the 'normal' price, if you are lucky enough to spot one. Now there are nurseries offering various variegated *Clivia* at prices that range from $120 to $1500. Not too many get sold unless it is to a serious collector. Some nurseries are even offering seedlings at high prices. Variegated plants are a very specialised part of the horticulture marketplace, be it *Clivia* or other plants. I know, I collect them.

Then there are the peaches. Anyone who has looked through the wonderful photographs in the Yearbooks will know what impact the peach forms have on them. Peaches and Pastels; very tempting indeed! There is confusion within Australia as enthusiasts want the peach forms and actively search them out. Unfortunately, some sellers use the term 'peach' or 'pastel' for a pale orange that has no link to the peach *Clivia* mutation found in South Africa. It is going to create disappointment down the track. Certainly many true peach seedlings are being grown, but it remains an area of much needed research in Australia. Plant importation is one answer, and one of our Society members, Mr. David Bearlin, has made a concerted effort to obtain selected material for the Australian enthusiast. He has imported batches of selected *Clivia* including '**Vico Yellow'** (tissue cultured stock), **'Fukurin', 'Akebono**' and peach seedling material from **'Chubb Peach'** breeding. He has brought in other stock from Japan, South Africa, Belgium and the US. It may be higher priced than other nursery *Clivia*, but the material is here. Other nurseries are investigating plant importation and tissue culture as a means to increase their stock, with varying success.

So, we have the well-accepted use of *Clivia* for the shady gardens and now the new found enthusiasm for special forms. How do we get those special forms if plant importation is too expensive? By seed. A noticeable appearance on the gardening scene in Australia over the past few years is the increase in Clivia specialists advertising plants in the gardening magazines. These newer nurseries are offering a vast array of material. The plants on sale are generally one or two year old seedlings with fantastic names, names that don't mean much unless you have seen a seed list from Japan or South Africa. Names that tempt the novice. Names like **Vico Gold**, **Peacherene** or **Golden Age**. Quite often the list just gives the seedling cross with no guarantee of flower colour. All of these plants hold promise but most won't be what is stated. For an enthusiast that might not matter much, but for the gardener, several years wait might end in disappointment. This is an area where the marketplace needs to do some reflection. It is pleasing to report that several enthusiasts have been importing very large numbers of seeds that they plant, grow and plan to evaluate when the flowering starts in years to come. It is a learning curve.

Which brings us to the cultivar name situation.

With such an increase in *Clivia* activity not only within Australia, but worldwide, the naming of plants is at a critical point. As part of my interest in the genus I have been researching the names given to *Clivia* in the past. It is noticeable that there is a major increase in named *Clivia* as a result of the formation of the Clivia Society. The Clivia Internet Group has also added to the ease of information dissemination. The 'Checklist' that I have produced is a start in the process of formalising the cultivar name situation. As expected, there are some duplicates, but not so many that we can't straighten the confusion out. Many of the people involved have contacted me with the assurance that they will help in any way. There has not been a formal registration of *Clivia* cultivars in the past, interested people have been naming *Clivia* and publishing articles and lists, but now we have a forum that will take the name situation forward. The increased development of newer types by the committed enthusiasts is going to see a greater naming of material. The Clivia Society has to regulate this in an orderly fashion. The committee set up by the Clivia Society will need the input from all enthusiasts to make this work. Please help us if you can.

But, whatever the name of your *Clivia*, I know you will enjoy it! Thank you.

THE GENUS CLIVIA IN ETHNOMEDICINE: USAGE, BIO ACTIVITY AND PHYTOCHEMISTRY

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Abstract

The herbaceous genus *Clivia* now comprises five species, four of which are employed in traditional medicine. Plants of this genus have been used by traditional healers in South Africa for the treatment of a range of ailments of both a physiological and spiritual origin, and have been implicated in human poisonings. The traditional use of the genus *Clivia* in southern Africa is overviewed, with attention focused on the important role of plants of this genus as protective charms, and as medicines taken internally. Interpretations of the Zulu name *umayime* are related to traditional applications. *Clivia* species form important components of *isihlambezo* and *inembe* mixtures, antenatal tonics administered to women with the aim of ensuring healthy foetal growth, or inducing and augmenting labour. Recent pharmacological studies have confirmed the uterotonic properties of plant extracts, so validating this aspect of traditional use. Consideration is also paid to unravelling confusion surrounding the identity of the species observed in trade at the various *muthi* markets located nationwide. *Clivia* species, like other amaryllids, possess a near-unique class of compounds known as isoquinoline alkaloids. The large range of such compounds isolated earlier from C. *miniata* and C. *nobilis* prompted our phytochemical investigation of the two lesser-known ethnomedicinal members C. *gardenii* and C. *caulescens*. From C. *caulescens*, hippeastrine, haemanthamine, 11 -(S)-hydroxyvittatine, lycorine and sternbergine were isolated, and from C. *gardenii* haemanthamine, haemanthidine in its free base and quaternary salt form, and the quaternary salt of tazettine. Although these studies were undertaken with a view to chemotaxonomically elucidating the 'C. *nobilis* complex' findings were unfortunately not definitive.

Introduction

Clivia of the tribe Haemantheae is a somewhat unusual amaryllid genus for most of its members are rhizome-bearing evergreen plants found within moist coastal and inland forests along the eastern seaboard of southern Africa. The exception of course is the recently-described C. *mirabilis* which in its Northern Cape habitat on the Bokkeveld Escarpment tolerates a much harsher climate than its close relatives found more than 800km away to the east (Rourke, 2002). In view of its highly endemic distribution in an area poorly populated by man, C. *mirabilis* has for long remained out of view of both taxonomists and 'Bossie Doktors' alike, and phytochemists for that matter. The Amaryllidaceae have long fascinated organic chemists who take an interest in a particular class of compounds known as isoquinoline alkaloids, which have long thought to be restricted to this particular

plant family. However, quite recently, Mulholland et al. (2001) recorded the first verifiable anomaly when they found crinamine one such constituent, in *Dioscorea dregeana* (Disocoreaceae) the well-known Zulu narcotic. Isoquinoline alkaloids, otherwise known as Amaryllidaceae alkaloids, are generally highly bioactive, and have been extensively investigated for possible development as new pharmaceutical drugs. In recent years galanthamine has been singled out for its promise in the treatment of Alzheimer's disease; this has stimulated further interest in the chemistry of the Amaryllidaceae, the world centre of diversity for which is South Africa. Elsewhere, pronounced but lesser centres of diversity are located in Andean South America and the Mediterranean. By the time of publication of the thorough chemical review of Viladomatetal. (1997) 110 different alkaloids had been identified from 62 South African species investigated, from a total Amaryllidaceae flora of about 18 genera and 280 species (Snijman 2000). Since the above review was printed, at least another ten South African species have been examined. Clearly though, much work is still to be done; such research is likely to reveal alkaloids new to science, with hitherto unknown potential as useful drugs.

The chemistry of both Clivia *miniata* and C. *nobilis* have been investigated previously and a wide range of isoquinoline alkaloids found (Table 1). Within this alkaloid class one can identify further sub-classes which on occasion help to define taxonomically, particular clusters of genera or species. In effect, chemistry can serve to confirm the relationships of particular plants: in this way isoquinoline alkaloids largely (with one exception!) define the whole Amaryllidaceae family. In similar fashion, within the 'homolycorine type' group of isoquinoline alkaloids one encounters a set of compounds with trivial names that reflect the history of their discovery: clivonine (Figure 1), clivatine, clivacetine, cliviamartine, clivonidine, cliviasine, clividine, nobelisine, cliviasyaline, miniatine and clivimine. These compounds, besides being isolated first from C. *miniata* and C. *nobilis,* have not yet been found in any other Amaryllidaceae taxa beyond *Clivia* (Viladomat *et al*., 1997), so providing us with good chemotaxonomic markers, at least to the level of genus. Further such chemical characters are also found within the lycorine type (cliviasindhine) and miscellaneous type (cliviahaksine, clivojuline and clivialine) alkaloid classes. We investigated the rhizome chemistry of C. *caulescens* and C. *gardenii* to determine whether there were further novel alkaloids to be found in these, and whether such finds were useful in elucidating the C. *nobilis* complex'. Nobilisine is a particularly unusual alkaloid and it was hoped to find variants of this type. Further taxonomic information can often be gleaned through careful consideration of the traditional uses of species. We thus offer an overview of the ethnobotany and known pharmacology of the genus, which further serves to explain its popularity in traditional medicine, and consequent decline in the wild.

Ethnobotany and bioactivity

Toxicity

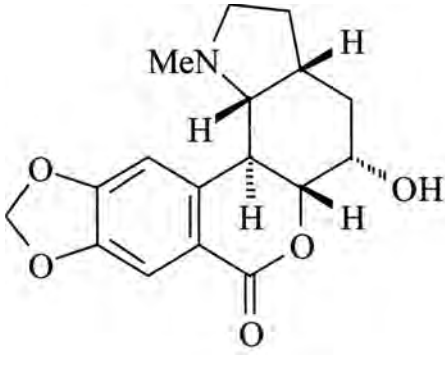
Plants of the *Clivia* genus are used by traditional healers in South Africa in the treatment of a number of ailments of a physiological or spiritual origin, and have been implicated in human poisonings. Juritz (1915) reported on the death in Willowvale in the southern Transkei of a sickly infant treated with *Clivia nobilis*. Further investigations by this author revealed that large quantities of a strong decoction of the plant produced only mildly emetic effects. Veale *et al*. (1992) considered ethnomedicines based on C. *miniata* to be potentially fatal if taken in large quantities, and noted vomiting, salivation, diarrhoea and depression of the CNS as the main poisoning features. All four north-eastern species are reportedly capable of causing dermatitis (Hutchings *et al*, 1996).

Table 1. Alkaloids isolated from four of the five species of *Clivia*

Class of isoquinoline alkaloid	alkaloid trivial name	*Clivia miniata**	*Clivia nobilis**	*Clivia caulescens*	*Clivia gardenii*
Lycorine	caranine	■			
	cliviasindhine	■			
	lycorine	■	■	■	
	sternbergine			■	
Homolycorine	clivacetine	■			
	clivatine	■	■		
	cliviamartine	■			
	cliviasine	■			
	cliviasyaline	■			
	clividine	■			
	clivimine	■			
	clivonidine	■			
	clivonine	■			
	hippeastrine	■		■	
	miniatine	■			
	nobilisine		■		
Haemanthamine	haemanthamine	■		■	■
	haemanthidine				**
	11-hydroxyvittatine			■	
Tazzetine	tazettine				**
Miscellaneous	cliviahaksine	■			
	clivialine	■			
	clivojuline	■			

* Vildomat *et al.* (1997); ** Isolated as an ammonium salt

Figure 1: The chemical structure of Clivonine, a compound only ever isolated from *Clivia miniata*. One of a number of unique *Clivia* alkaloids

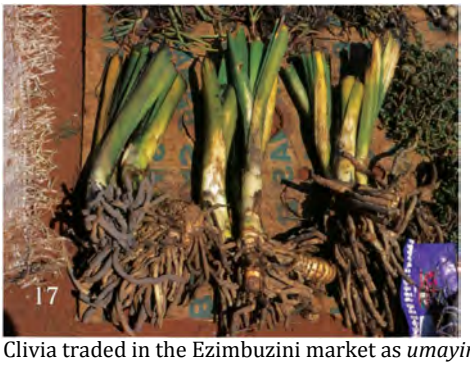


A trader in the Ezimbuzini mutfii market with her wares

Mutfii trade

Large medicinal plant or *mutfii* markets are found around South Africa, through which enormous volumes of about 700 plant species move each year. Based on an extrapolation of figures derived from the Durban markets Mander (1998) estimated that approximately 20 000 tonnes of fresh plants are sourced from the wild each year to meet demand.

Representatives of four *Clivia* species are included in this number. *Clivia nobilis* may be found in trade in the Grahamstown markets (Tony Dold, pers. comm.). However, reports of trade in C. *nobilis* plants in the medicinal plant markets of Kwazulu-Natal (Cunningham, 1988), Witwatersrand (Williams *et al*, 2000) and Mpumalanga (Mander, 1997) likely refer rather to C. *gardenii* in the former two markets and C. *caulescens* in the latter.



Clivia traded in the Ezimbuzini market as *umayime.* This Zulu name refers to the perceived action of the plant in 'stopping or of making to stay' both diseases and misfortune. Each bundle costs R2.

Clivia nobilis finds its northernmost distribution immediately to the north of the Kei River (extending south to Alexandria) and so is unlikely to have historically been used by the Zulu. In support of the identification of material as C. *gardenii is* the report by Williams *et al.* (2000) that the common name for genus members in the Witwatersrand trade is *umayime*, in the Zulu vernacular. Additionally, most species (42.1%) traded at this site are harvested from Kwazulu-Natal (Williams *et al,* 2000). These authors determined Clivia spp. to be among the most commonly available taxa in medicinal plant shops on the Witwatersrand, with over 70% of traders stocking them. In the Durban markets, *Clivia miniata* (probably including C. *gardenii*) was, according to market traders, amongst the top 15 species most frequently demanded by consumers (Mander, 1998).

Protective charms

Clivia plants play an important role as protective charms: Gerstner (1941a) reported that the Zulu use the roots as a sprinkling charm to ward off evil (*intelezi yokuchela*) and as a love-charm emetic. Species of *Clivia* are included as chopped components in *intelezi* mixes (Figure 4) traded in the Durban markets (Cunningham, 1988).

An *intelezi* mix sold pre-chopped and mixed for a Durban clientele. *Clivia* leaf sections can be seen as a component.

The Zulu name *umayime* for *Clivia* spp. has been variously interpreted as 'it should stand still' (Williams *et al*, 1996), or 'the young women may stay at home' (Gerstner, 1941a). In both cases the connotation is of the plant preventing evil, of halting the course of a disease, of stopping or of making to stay (Pujol, 1993), whether used as a charm or taken internally. An example of a multi-component protective charm that includes C. *miniata* is here detailed; to help explain the inclusion of particular species in the preparation, brief interpretations of the respective Zulu plant names are provided. *Clivia miniata* (umayime; meaning 'to stop') material is combined with *Rhipsalis baccifera* (Cactaceae; (*Figure 5*)(*ugebeleweni*; meaning 'hanging on the precipice', an allusion to the perceived dangerous qualities of this species), *Haworthia limifolia* (Aloaceae) (*umathithibala*; meaning 'to get stuck") and *Adenia gummifera* (Passifloraceae) (*impinda* or *impindamshaya;* meaning 'to return the strike'). Occasionally *Stapelia gigantea* (Asclepiadaceae) *{uzililo;* a reference to mourning) is included in cases where it is wished to actually kill the enemy.

Two preparation and administration procedures for this combination of plants are known. In the first, the dried plant materials are mixed and ashed (ash called *insizi* or *yezangoma*). After placing in the mouth, the ash is blown towards the sun, and the name of the enemy called out in order that any intended evil will befall them instead. Alternatively, the fresh materials are mixed and ground, and a decoction (*ukugoma*) prepared which is applied as a body wash to ensure protection against curses, which instead afflict the sender (Smith & Crouch 1999).

Rhipsalis baccifera, a component in a charm preparation which includes *Clivia*. The Zulu name *ugebeleweni* for R. *baccifera* means 'hanging on the precipice', an allusion to the perceived dangerous qualities of this species.

Internal use

The large range of isoquinoline alkaloids isolated from *Clivia* spp. are generally thought to be responsible for the observed bioactivity of the plant extracts. For example, extracts of C. *miniata* are active against Semliki forest, Coxsackie and measles viruses (Hutchings *et.al*, 1996). *Clivia miniata* rhizome preparations have been recorded as a remedy for snakebite (Bryant, 1909), specifically for the bite of the puff-adder (Smith, 1893), or associated pain (Pujol, 1993). Bryant (1909) further listed C. *miniata* as one of the Zulu emetic remedies for fevers known as *umkhuhlane*. To the south, the Xhosa use root decoctions of C. *miniata* for treating both barrenness and urinary complaints (Broster, 1982). *Clivia caulescens* has also been recorded as ethnomedicinally used by the Swazi, who know the plant as *hlakahla-wemahlatsi* (Dlamini 1981).

The leaves of C. *miniata* are included as a component of *isihlambezo* and *inembe* mixtures,

antenatal tonics administered with the aim of ensuring healthy foetal growth, or inducing or augmenting labour (Bryant, 1909, Veale *et al*, 1992, Varga & Veale, 1997). The preparations typically take the form of aqueous infusions of the leaves. In one *inembe* mixture detailed by Gerstner (1941b) 29 different plants (including C. *miniata*) were mixed together with dried *umhlapho wehhashi*. This last element comprises the placenta of the horse and some crocodile's skin, a little part burnt, a little not! Of the use of an *isihlambezo* mixture Gerstner (1941b) recorded: '*This infusion is kept covered up in a clay pot by a pregnant woman, and from it she drinks a spoonful now and then during the last three months of pregnancy, which the* isihlambezo *is supposed to make successful, with easy delivery. This medicine must not be drunk by any other women or be looked on by another person except the inyanga, otherwise the child will take the likeness of that person, the reflection of the person in the water being presumably swallowed by the women in the drinking and transferred to the child."*

The uterotonic (uterus stimulating) activity of aqueous extracts of C. *miniata* leaves has been evaluated in the laboratory using an isolated rat uterine system (Veale *et al,* 1989). Extracts were shown to possess uterine smooth muscle stimulant activity which augmented the effects of sub-threshold and threshold concentrations of oxytocin. This compound is a hormone produced in the brain, and has been identified as an important agent in stimulating contractions of the uterus. Additionally, the *Clivia* extract was found to elevate the frequency of spontaneous uterine contractions in the rat system. The inclusion of *Clivia* preparations in antenatal ethnomedications may thus be based on such stimulant effects (Veale *et al,* 1989). However, the use of such tonics can result in foetal distress (Veale *et al.*, 1992), and an increase in the need for caesarian sections to be undertaken (Mabina *et al,* 1997). Rather surprisingly, the active uterotonic compound has been found not to be an isoquinoline alkaloid but rather linolenic acid (Sewram *et al,* 2001).

Materials and Methods

Plant materials

Clivia caulescens R.A.Dyer rhizomes (2.4 kg) were obtained from near Long Tom Pass in Mpumalanga and a voucher lodged for verification purposes (*Crouch* 758, NH). This particular material had earlier been confiscated by Mpumalanga Parks Board from an illegal *muthi* harvester.

Fresh whole plant material of *Clivia gardenii* Hook. (1.08 kg) was collected from Ngome, KwaZulu-Natal *(Crouch* 809, NH).

Extraction, fractionation and structure identifications

The details for these procedures are provided by Crouch *et al*. (in press).

Results

From C. *caulescens,* hippeastrine, haemanthamine, 11-(S)-hydroxyvittatine, lycorine and sternbergine were isolated, and from C. *gardenii,* haemanthamine, haemanthidine, in the free base and quaternary salt form, and the quaternary salt of tazettine (Table 1). The free bases of haemanthidine and tazettine were obtained on treatment of the salts with NaOH (Crouch *et al*, in press). None of these compounds are unique to the genus *Clivia* (Viladomat et al, 1997).

Discussion

Toxicity links

Earlier reports of toxicity of *Clivia* likely relate to the presence of the alkaloid lycorine. This akaloid is the most widespread of the Amaryllidaceae alkaloids, and is highly toxic (in a trial, 50% of dogs died when subjected to lycorine at doses of 41 mg per kg body mass [LD50 (dog) of 41mg kg-l]). Lycorine is frequently the cause of accidental human poisoning, especially following the consumption of *Narcissus* plants in Europe. This alkaloid causes scurvy-like symptoms in experimental animals and acts as a respiratory

stimulant. However, from a positive medical perspective, this compound has also been shown to have moderate anti-tumour activity, anti-viral properties and to be a weak protozoicide (Hutchings *et al*., 1996, Dictionary of Natural Products 2001). Tazettine, the quarternary salt of which was isolated from C. *gardenii*, has been shown to have a LD50 (dog) of 71 mg kg-1 (Dictionary of Natural Products 2001).

Chemotaxonomic findings

From the homolycorine class of isoquinoline alkaloids only hippeastrine was isolated, and this only from C. *caulescens.* No alkaloids previously found only in C. *miniata* or C. *nobilis* were isolated and identified from C. *caulescens* or C. *gardenii* (Table 1). Further, no new compounds were isolated, precluding us from naming a 'caulescine' or 'gardenine' in honour of the sources! This rather disappointing outcome limits the chemotaxonomic value of the current work, so preventing us from being able to define authoritatively the components of the *'nobilis* complex'. It is noted though that within this 'complex', the following compounds appear uniquely produced: clivatine and nobelisine in C. *nobilis*; sternbergine, hippeastrine and 11-hydroxyvittatine in C. *caulescens;* and in C. *gardenii*, haemanthidine in its free base and quaternary salt form, and the quaternary salt of tazettine. Additionally, within the genus *Clivia*, the following alkaloids appear unique to C. *miniata*-, caranine, cliviasindhine, clivacetine, cliviamartine, cliviasine, cliviasyaline, clividine, clivimine, clivonidine, clivonine, miniatine, cliviahaksine, clivialine and clivojuline. This extensive list of constituents likely reflects the greater amount of phytochemical work conducted on C. *miniata*, on a greater mass of material of more widespread provenance and diverse physiological states.

Acknowledgements

This research was funded by the NRF and the University of Natal Research Fund. We gratefully acknowledge the Wellcome Trust Equipment grant number 052451 for the provision of the 400MHz NMR spectrometer. We are grateful to Mr Dilip Jagjivan and Mr Bret Parel for running NMR and mass spectra and to Professor Vincent Brandt of the University of the Free State for use of CD instrument. The DEAT is acknowledged for funding MEDBASE, the National Medicinal Plants Database for South Africa. The Mpumalanga Parks Board (Mr M. Lötter and Ms S. Krynauw) and DWAF are thanked for permission to collect samples for analysis.

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Second prize Yellow *Clivia miniata* grown from seed flowering for the first time Section, CCC 2002 Show. Breeder: Bill Morris. Grower: Mick Dower

Winner Orange *Clivia miniata* grown from seed flowering for the first time Section, CCC 2002 Show. Grower: Jaco Lötter

COLOR PIGMENTS IN CLIVIA

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Abstract

The anthocyanin flavonoids of *Clivia caulescens,* several specimens of C. *miniata* and one C. *nobilis* were examined in the flowers and the berries. Pigment in C. *miniata* seedling leaf bases were also analyzed. Different combinations of pigments were found in each of the examples investigated. The flower pigment in C. *caulescens* flowers was cyanidim 3-rutinoside. Pigments in C. *miniata* were pelargonidin-3-glucoside and pelargonidin-3' rutinoside. The proportions of the two pigments varied depending on the particular cultivar examined. In typical orange C. *miniata,* pelargonidin-3'glucoside predominated but in the peach colored flower pelargonidin-3' rutinoside was the main pigment. Both pigments occurred in almost similar quantities in the dark red cultivar **'Flame**™. Clivia *nobilis* flowers had both cyanidin and pelargonidin pigments. The berries of C. *caulescens* and C. *nobilis* contained both cyanidin and pelargonidin, while C. *miniata* berries only had cyanidins, irrespective of the cultivar examined. Clivia *miniata* seedling leaf bases had mainly cyanidin with very small amounts of pelargonidin.
Incorporating the pendent species genes into hybrids with C. *miniata* can be expected to widen the color pallet used for hybridizing.

Introduction

Although there is scant information in the scientific literature it is usually accepted that the color pigments in Clivia flowers and berries are reddish anthocyanins and yellow carotenoids. Detailed analyses of pigments in the various *Clivia* species and their locations in the plant do not seem to have been published previously except for a summary in Koopowitz (2002). Flavonoid pigments (anthocyanins) occur in three distinct regions of a Clivia plant. There is usually purple coloring at the bases of seedling leaves - the function of the pigment here is unknown although one might speculate that it helps camouflage seedlings growing amongst the leaf litter. Colors in flowers are obviously attractants to help guide pollinators to the flowers - why green tepal tips in species with pendant flowers? Colors in fruits are likewise deemed to be attractants for birds that might be involved in seed dispersal.

The chemistry of floral pigments is relatively well understood and most of the major genes underlying anthocyanin synthesis are known (Holton and Cornish, 1995). In this report we discuss some of the anthocyanin pigments found in Clivia *miniata*, C. *nobilis* and C. *caulescens*. We have not had the opportunity of investigating C. *gardenii* and C. *mirabilis.*

Methods and Materials

Microscopic Examination:

Microscopic examination of fresh flowers was carried out on free-hand sections of fresh living flower tepals. Sections were mounted on microscope slides in water and examined with an Olympus BH-2 compound microscope.

Antfiocyanin analysis-.

Pigments from seedling leaf bases, fresh fruits and fresh flowers were examined using HPLC. Three different cultivars of C. *miniata* were examined. *Clivia miniata* 'Flame™ has some of the most intensely red flowers currently known, C. *miniata* **'Morning Light'** a pastel peach cultivar and a "typical" orange-flowered form of the species were investigated. In addition, leaves fruits and flowers of C. *nobilis* and C. *caulescens* were also investigated. The flower colors in the last two species were typical of those species respectively.

Anthocyanins were characterized by HPLC and U.V. spectrophotometry (Griesbach *et al.,* 1991). Specific anthocyanins were isolated on a 7.8 x *300mm* column of 5µ Bondapak C18 using a 30 minute linear gradient of 0 to 10% (v/v) acetonitrile in aqueous 15% (v/v) acetic acid, followed by a 10 min linear increase to 20% (v/v) acetonitrile and finally held at 20% (v/v) acetonitrile for an additional 10 minutes. Flow rate was 1.0 ml min-1 and detection was by absorption at 540 nm. Isolated anthocyanins were then acid hydrolyzed at 100°C in 3 N HCl for 1 hour and the resulting anthocyanidins characterized by HPLC using a 20 minute linear gradient of 0 to 15% (v/v) acetonitrile in aqueous 1.5% (v/v) phosphoric acid and 15% (v/v) acetic acid and held at 15% (v/v) for an additional 20 minutes. Flow rate was 1.0 ml min-1 and detection was by absorption at 540 nm. Anthocyanins and anthocyanidins were characterized by co-elution with known standards and U.V. spectrophotometry. It was possible to distinguish anthocyanin 3-, 5-, and 3,5-glycosides by their absorption spectra in 1% (v/v) HCl in methanol (Jurd, 1962). A sugar at position 3 leads to a 12 nm hypsochromic shift in the λ_{max} A 7 nm hypsochromic shift occurs when a sugar is at position 5. A sugar at both positions leads to a 19 nm hypsochromic shift. In addition, anthocyanins without a sugar at position 5 have a distinct shoulder at 440 nm. Unacylated anthocyanins have a single peak in the ultraviolet; while acylated anthocyanins have two peaks. In the presence of aluminum chloride, anthocyanins with adjacent hydroxyl groups produce a 15-50 nm bathochromic shift in the λ_{max}.

The co-pigments were analyzed in a similar manner as the anthocyanins (Griesbach and Asen, 1990). The co-pigment analysis differs in the HPLC elution buffer (1% triethylamine at pH 3.0), gradient (0 to 20% in 20 minutes and held at 20% for 20 additional minutes), and detection wavelength (340 nm). The acyl groups (cinnamic acids) and sugars attached to the anthocyanin were removed during acid hydrolysis and were characterized by HPLC (Griesbach *et al.,* 1991). The acyl groups were further characterized by U.V. spectrophotometry (Jurd, 1962).

Proportions of pigments were compared by integrating areas under the curves after ignoring the initial surge of breakdown products.

Results

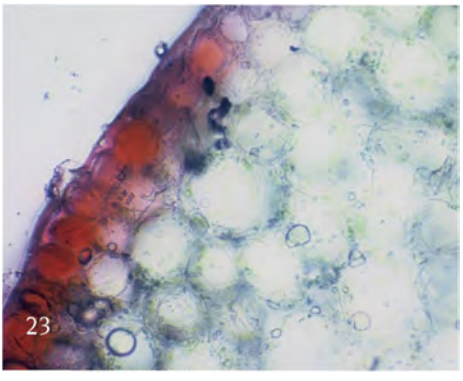
Microscopy

Clivia miniata **"typical".**

In common with many other flowers anthocyanins are found primarily in the surface epithelium of the tepals. There is a bounding cell layer where the central vacuoles are filled with anthocyanin. This is typically a single cell layer. Beneath this is a parenchymatious layer that can be many cells thick. The outer layers of parenchyma may contain either chloroplasts or carotenoid bearing plastids. These pigments are confined to granular organelles suspended in the cell cytoplasm. It is not possible to see carotenoid chromoplasts or chloroplasts in the outer epithelium. That might be due to the presence of the anthocyanins, but examination of yellow C. *miniata* cultivars show the presence of carotenoids in the underlying strata but the epithelium is devoid of them. Carotenoid bearing organelles do not appear within the surface epithelium.

Internal cells making up the tepal have very irregular shapes making many small spaces

for air pockets. These tiny air pockets may be reflecting and scattering light making a white background for the other pigments. Tests for the white leucoxanthin in *Clivia* have proven negative.



Section through the petal of an orange C. *miniata*. Note the anthocyanim - containing cells in the epithelium and the green chloroplasts in the underlying cells

Clivia *miniata* 'Flame' ™

This cultivar is sometimes called '**Merkins Flame'** and is among the most intense of the reddish C. *miniata* cultivars known to date. Microscopic sections through the tepals of this flower revealed that the anthocyanin layer extended inwards from the epithelium giving an additional 3-4 cell layers containing anthocyanin pigments.

Clivia *miniata* '**Morning Light**'

This is a pastel peach flower bred by James Comstock and is a potent parent for breeding peaches. Examination of the tepals revealed that anthocyanin was confined to the bounding epithelium as in normal orange C. *miniata*, but the concentration of anthocyanins appeared to be much more diluted.

Clivia miniata Bodnant Variety'

This creamy yellow flower lacks all pigment in the surface epithelium. No plastids were found in the epithelium either but chromoplasts were present in the deeper tissues.

Flower Pigments:

a. Anthocyanin

Clivia caulescens - see *Figure 1.*

This *Clivia caulescens* plant was grown from seed collected at God's Window, Mpumalanga. The flowers were of the normal orange color. The flowers contained only one anthocyanin component, *Fig. 1*, cyanidin-3-rutinoside (c-3-r).

Clivia miniata

"Typical" *Clivia miniata* - see *Figure 2a*. HPLC indicates two major anthocyanins in the flowers of typical orange clivias. These are both pelargonidins, pelargonidin-3-rutinoside (p-3-r) made up 27.89% and pelargonidin-3-glucoside (p-3-g) was 72.10%. A second plant with orange flowers yielded a similar pigment profile with p-3-r at 29.98% and p-3-g, 69.54%. In the second flowers there was a third unidentified peak of less than 0.5%.

C. miniata **'Flame** - see *Figure 2b.*

This is one of the most intensely red colored C. *miniata* selections to date. Pigments as in *Figure 2a* but here p-3-r makes up 56.59% and p-3-g 43.20% - ie, the concentrations are higher and both peaks are almost equal.

Clivia miniata **'Morning Light'** - see *Figure 2c*.

Bears peach colored flowers. Once again there were two pigments with the p-3-r making up 62.06% and the p-3-g being 37.94%. While we did not quantify the absolute amount of pigment present per weight of tepal, it was apparent during the initial extraction procedures that the peach colored flower had qualitatively much less pigment than either of the other types of C. *miniata* flowers.

Clivia nobilis - see *Figure 3*.

The coloration of this flower was a medium orange shade and similar to most of the C. *nobilis* in cultivation in the United States. This flower produced three distinct pigments. The major component p-3-r made up 73.13% of the pigment and c-3-r was 22.34%. A third unidentified peak accounted for 4.53%.

b. Copigments

These were only evaluated for two of the typical orange flowered C. *miniata*. They elicited a complex array of some 14 different co-pigments, see *Fig. 4*. Both flowers had similar arrays of co-pigments but these have not been analyzed further.

Fruit Pigments:

Anthocyanins in various *Clivia* fruits:

Clivia caulescens: The ripe berries of C. *caulescens* contained the same major pigments as found in the flowers. While c-3-r accounted for most of the pigment (83.21%) about 12.26% was p-3-r. See *Figure 5a*.

Clivia miniata: Fruits from several different cultivars of C. *miniata* were analysed.

Our earlier investigations utilized the fruit from C. *miniata* **'Flame'**™ and only c-3-r was found. A second set of fruits examined the following year also revealed only c-3-r.

Pigments were derived from the peach colored C. *miniata* **'Morning Light'** (See *Figure 5*(?) and the normal orange cultivar C. *miniata* **'Wide Body'** (see *Fig. 5c*). The latter appeared to have very small amounts of the two pelargonidin pigments.

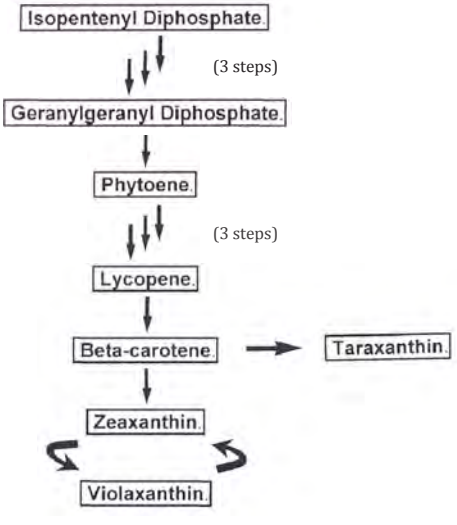
Clivia nobilis: The berries of C. *nobilis* contained mainly p-3-r (89.39%) and p-3-g (4.85%) with very small quantities of c-3-r (1.87% and c-3-g (3.88%). See *Figure 5d.*

Leaf Pigments:

Clivia miniata: At this time only a seedling from a normal orange C. *miniata* was investigated. The pattern of pigments found mimicked that of the fruit, (see *Figure 6)*, with c-3-r being the major component, and small amounts of the other pigments.

Discussion

There are several interesting points that arise from this work which are relevant for Clivia breeders who are striving to widen the color range. *Clivia miniata* carries two pelargonidins in its flowers and cyanidin in its berries while C. *nobilis* has lesser quantities of both cyanidin and pelargonidin in both its flowers and fruits. *Clivia caulescens* produced only cyanidin in its flowers and mainly cyanidin in its berries. The situation in C. *gardenii* and the newly described species, C. *mirabilis*, is not known but they should be investigated for floral pigments too. Differences in expression of pigments in fruits and flowers between and among C. *nobilis* and C. *caulescens* were unexpected. Perhaps the other species might also each do things differently.

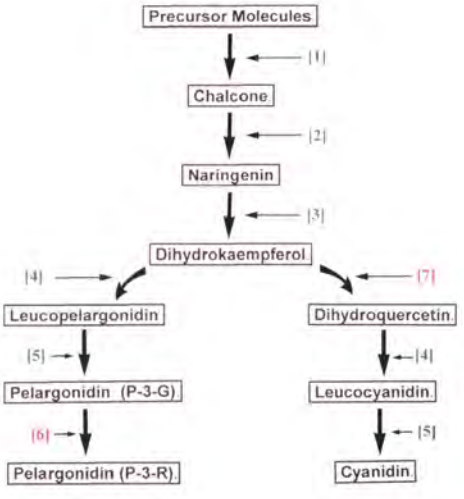


Pathway tor the major carotenoid pigments found in clivias. Lycopene is the first colored product produced and is pinkish. The three major carotenoids in both yellow and orange flowers are all yellow carotenoids; taraxanthin and violaxanthin can be interconverted to each other as indicated by the curved arrows.
(This plate from Koopowitz, H (2000) page 135)

Depth of red color depends on several factors, both the concentration of pigment in the central vacuoles of the tepal cells as well as the number of cell layers that contain pigment. The nature and concentration of the carotenoids also plays a major role. The greater the carotenoid concentration the more orange flower color should appear. The less the carotenoid content the pinker the flowers. A large number of carotenoids occur in *Clivia miniata* flowers (Matsuno & Hirao, 1980). Matsuno and Hirao found that the major yellow pigment was taraxanthin, but there were an additional six other carotenoids present with ≤-carotene, accounting for the second highest component. Taraxanthin is usually a rich yellow color but other pigments could account for the wide variation in cream, yellow and amber colors found in the yellow C. *miniata* hybrids.

In order to increase the color palette in Clivias it is important to incorporate the pendant species into the C. *miniata* hybrids and this should increase the range of pigments made in the flowers. The various pendulous species allow one to incorporate cyanidins into their tepals. It may be easier to get deeper red colors in this way. Several of the *cyrtanthiflora*-type hybrids I have seen have in fact had very deep red flowers. The array of co-pigments was unexpected. While some of these might represent breakdown products it is unlikely that all do. These products may open the door to additional colors. Investigation of the pigments in some of the new flowers with mauve - lavender tints in them would be very interesting.

There is a wider array of color in *Clivia miniata* fruits than in their flowers. It would be useful to compare the pigments in the various colored berries, *i.e.* pinkish berries and purplish berries to see what the differences are. But because these pigments are probably mainly cyanidins, perhaps those plants should be bred to species such as C. *caulescens* that express an appreciable amount of cyanidin in their flowers. As C. *caulescens* has more floral cyanidin than C. *nobilis* one might prefer to use the former for breeding.



Anthocyanin pathways. This a simplified anthocyanin pathway that ends in pelargonidin and cyanidin. Each number represents a specific enzyme (1 through 7) that catalyses the reaction to the next step. Only one additional enzyme (enzyme 7) is needed to make cyanidin instead of P-3-G. Enzyme 6 is unique to the P-3-R step.
(Taken from Koopowitz, H. (2000) page 130)

Because the pelargonidins and cyanidins are end points of a branching synthetic pathway it is not surprising that yellow flowered C. *miniata* always have yellow fruits. One might expect that there should be orange flowered C. *miniata* that have yellow fruit if the cyanidin pathway is blocked. Such plants are known. Some plants from a wild population of C. *miniata* from Centani, Transkei have normal orange flowers but produce yellow fruit (R. Ellis, personal communication). I examined these plants. The fruits are yellow but can sometimes have a slight blush to them. This blush may be due to spontaneous conversion of pigments in the pathway independent of the enzymes that normally catalyze them.

Seedling Clivias often have a variable amount of anthocyanin at their leaf bases and some seedlings are very heavily pigmented. Some seedlings lose this color rapidly while others do so more slowly at other stages of maturity. Seedlings under stress (e.g. those with poor root systems) are often heavily pigmented over the entire leaf. It should be possible to select and breed clivias with increasing amounts of pigmentation that is held for longer and longer periods of time. Such plants would be useful because they would make it possible to breed variegated clivias with pink stripes.

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Winner Clivia with fruit Section, NCC 2002 Show. Grower: Dawie van Heerden

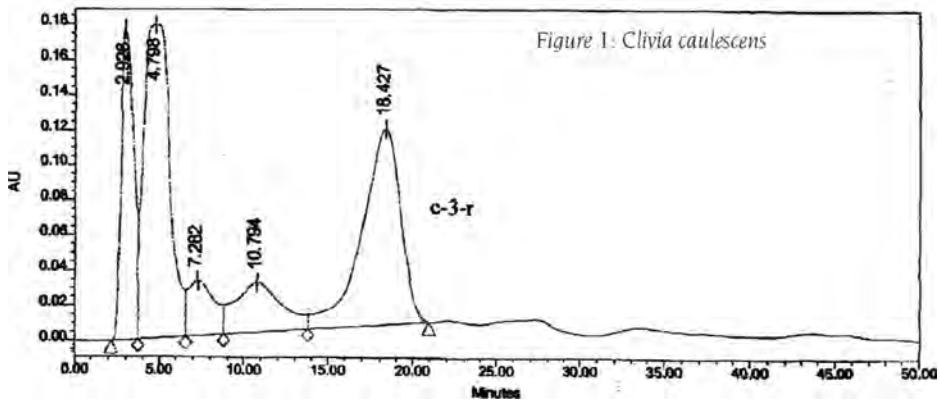

Figure 1: Pigments in Clivia caulescens flower. The peak between 1-6 and 20 minutes is cyanidin-3-rutihoside. Y-axis in this graph is pigment absorption in arbitrary units. X-axis is elution time in minutes. Initial 4 peaks represent breakdown products.

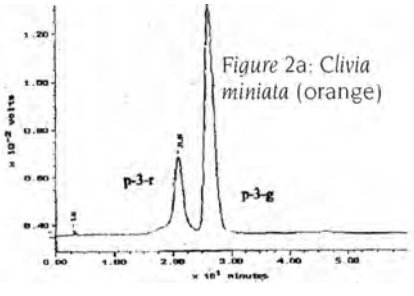

Figure 2a: Floral pigments in C. *miniata,* typical orange form. Initial peak is pelargonidin-3-rutinoside and second larger peak is pelargonidin-3-glucoside.

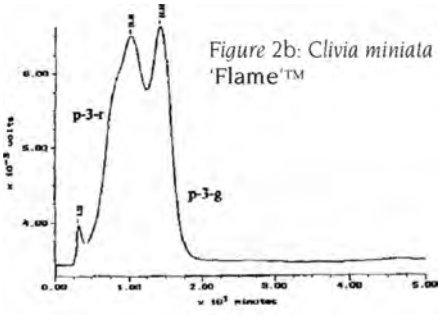

Figure 2b: Floral pigments in *Clivia miniata* '**Flame™**. Note that it contains the same two pelargonidins as in the typical orange Clivia *(**Figure 2a***), but the proportions are different.

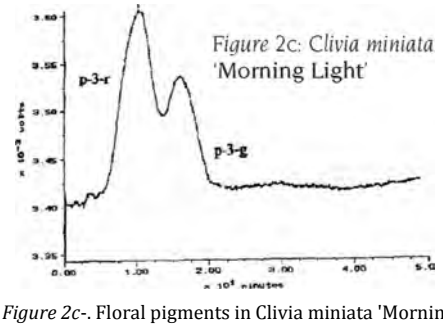

Figure 2c-. Floral pigments in Clivia miniata 'Morning Light'. Note that there is proportionately more p-3-r than p-3-g. Axes as in Figure 1.

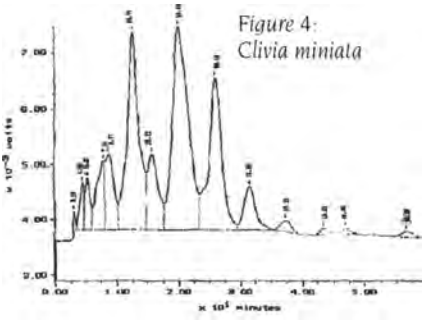

Figure 4. Unidentified co-pigments from a normal orange Clivia *miniata*. Axes as in *Figure 1*.

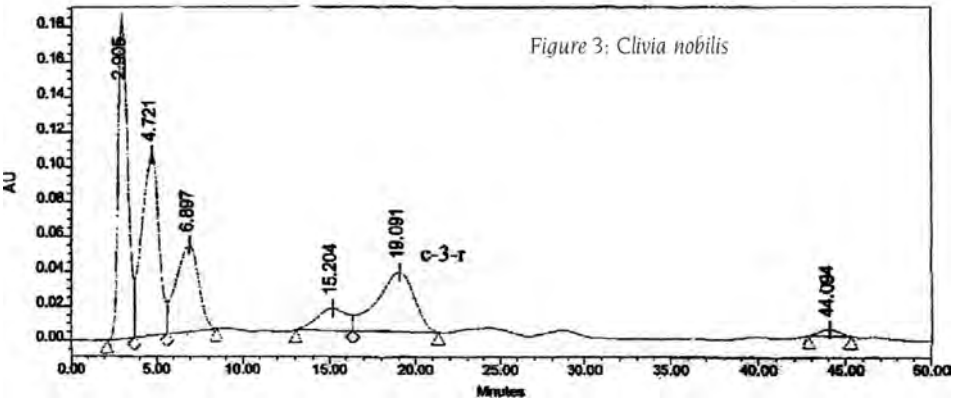

Figure 3: Floral pigments from a *Clivia nobilis* flower. Disregard the first three peaks, peak 4 is c-3-r and the 5th peak is p-3-r. Axes as in *Figure 1.*

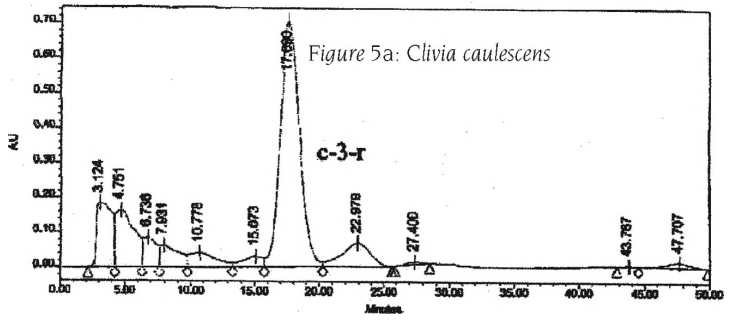

Figure 5a: *Clivia caulescens*, major peak is c-3-r.

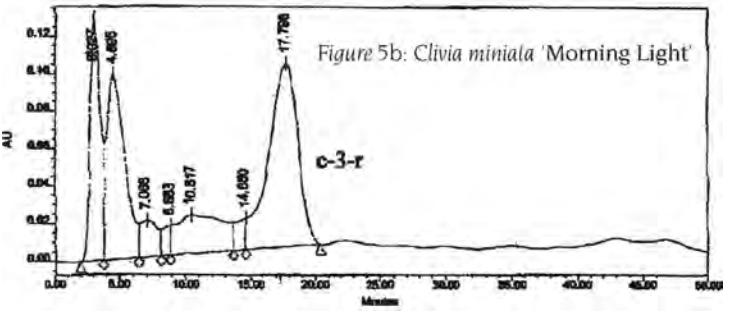

Figure 5b: Peach flowered C. *miniata* '**Morning Light**', major peak is c-3-r. Initial peaks are breakdown products.

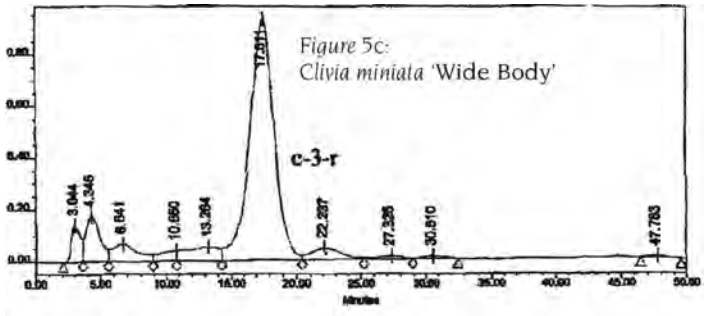

Figure 5c: Orange C. *miniata* 'Wide Body' major peak is c-3-r minor peaks are pelargonidins.

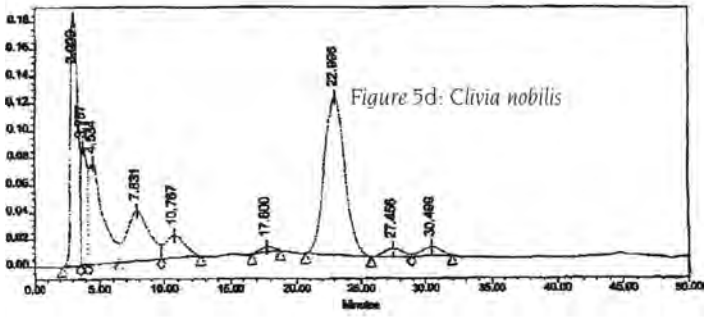

Figure 5d: *Clivia nobilis* fruit, major pigment here is p-3-r with minor amounts of c-3-r, c-3-g and p-3-g. Axes as in Figure 1.

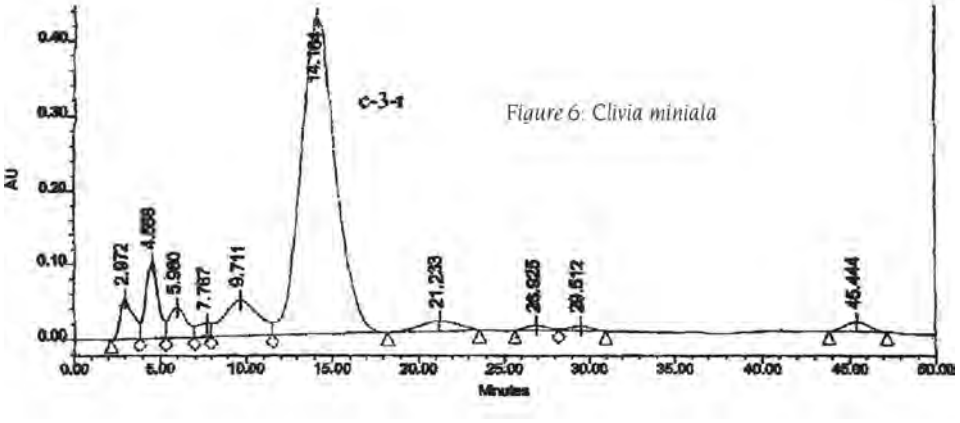

Figure 6. Anthocyanins from seedling leaf of a normal C. *miniata*. the major pigment here is c-3-r, with other pigments making up minor proportions. Axes as in *Figure 1* .

A NOTE ON C. *gardenii* STEM COLOUR

In this photograph are two C. *gardenii* offsets growing from the same rhizome. The stems of both are clearly pigmented. Yet the rhizome was cut from the rhizome of a yellow flowered C. *gardenii,* as illustrated in photograph 25 on page 37 of CLIVIA 2. It's flower is persistently yellow and does not change colour, even with age.

This bears out what Brian Tarr, Curator of the Natal National Botanical Garden, Pietermaritzburg, has always pointed out - unlike C. *miniata*, the stem colour of C. gardenii is not necessarily an indicator of the flower colour.

Eds.

Clivia nobilis with yellow fruit. Grower: Norman Weitz

INTRODUCTION TO POLYPLOIDY IN CLIVIA BREEDING

Aart van Voorst

Summary

miniata embryos were treated with colchicine *in vitro*. Tetraploid and mixoploid plants were regenerated. Crosses yielded tetraploid and triploid plants. Possibilities for polyploids in *Clivia* breeding are discussed.

Introduction

Clivia miniata hybrids are old, but loved pot plants in our homes in Northern Europe. I had one blooming for several years. Then Gordon McNeil raised my special interest in *Clivia* when I came across his article: Hybridising *Clivia* in Herbertia (McNeil, 1985). He wrote about his acquisition of the Gladys Blackbird collection. And what interested me most, was his claim of having material of intergeneretic crosses. *Clivia* crossed with *Hippeastrum*, *Eucharis grandiflora* and *Agapanthus*. That such crosses would be possible amazed me and I was tempted to repeat such unbelievable combinations.

In my professional life I had gained much experience with embryoculture of *AIstroemeria* and ***Lilium***, so I thought that if such crosses were possible under normal conditions in South Africa they also must be possible in Europe with the aid of laboratory methods. Well, I learned that it was not as simple as that, especially because those crosses do not exist (yet) in reality. The plantlets I got from the crosses proved to be selfings in the end. I still want to try crosses like that, but much more research should be done to see if certain combinations have a chance of success.

With my first so-called hybrids I did some research on propagation *in vitro*. And here again I learned that *Clivia* is not as easy as other Amaryllidaceae in *in vitro* culture. I could propagate the plantlets by dividing them into two and when I was lucky both parts formed a new plant. I also raised a plant from callus but it took about one year so a fast propagation method didn't come easily and my other work absorbed me at that time.

One day I got another *Clivia miniata* plant from a neighbor and I crossed it with my specimen. I was experimenting with methods of doubling the chromosome number in *AIstroemeria* and I considered the possibility of doubling the chromosome number in *Clivia* using the seeds from that cross.

Polyploids in horticulture

Polyploidy occurs naturally in many plant species. Cultivars of numerous horticultural crops are polyploids. The origin of these polyploids has for many years been a matter of discussion: are they the result of doubling of somatic chromosomes (the chromosomes normally present in every cell of the plant) or are they originated by the addition of an extra set of chromosomes through unreduced gametes (gametes: the sex cells that have normally half the chromosome number of the parent)? The latter explanation is nowadays generally accepted (Harlan and DeWet, 1975; Ramanna, 1992).

The positive aspects of polyploidy result in a selective advantage of polyploid plants when they occur by chance in the progenies of horticultural crops. The increased chromosome number results in most plant species in larger cell sizes and larger plant parts. Bigger flowers, stronger stems and other superior characteristics may appear. This makes up for the slower growth rate and the lower seed set and bud count that usually accompany these desired traits in the first generations of polyploids.

Breeders were not aware of their plants' polyploid status and in many cases it took years before more polyploids appeared. In a crop like Narcissus it took more than 100 years before the majority of hybrids consisted of tetraploids (Brandham, 1995 see figure 1). Kamemoto (1950) found another example of unintentional selection for polyploids. He thought it would be interesting to check the chromosome numbers of prize-winning hybrids in competitive orchid flower shows. Many of them proved to be triploids or tetraploids, which had appeared spontaneously in the breeding stocks of the prize winners. Evidently, these polyploids showed wanted characteristics.

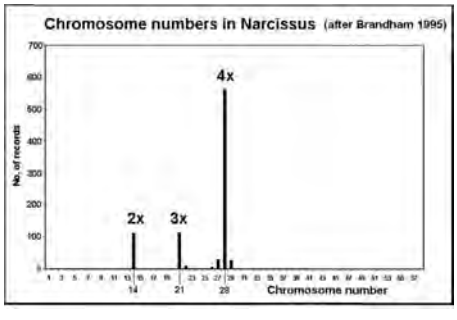

Figure 1.

Chemicals like colchicine and oryzaline were discovered that disturb the normal mitosis of plant cells and result in cells with a doubled chromosome number (Hancock, 1997). In many plant species man in the course of the last century has doubled the chromosome number with the aid of these chemicals.

Doubling the chromosome number can also restore the fertility of interspecific hybrids and this has been used in horticultural breeding programs for example with L*ilium* (van Tuyl *et al.* 2000)

In F*reesia* the first polyploid cultivar appeared in 1911 (Goemans, 1980). Here again we see an example of a crop where the first polyploids occurred spontaneously, but when the origin of their superior characteristics was recognized they were used in guided programs. To improve fertility tetraploid cultivars were selected and intercrossed with the help of natural pollinators (Sparnaaij, 1979). Later new diploid breeding lines were made tetraploid with colchicine and the same technique of intercrossing using bees was used. Today all major cultivars for cut-flower culture in F*reesia* are tetraploid.

Polyploidy in *Clivia*

The genus *Clivia* is small and consists of only six species if we include the not officially named 'Swamp *Clivia*' (Ran et al, 2001) and the newly discovered *Clivia mirabilis* (Rourke, 2002).

All *Clivia* species are diploid with a chromosome number of 22 (Ran *et al,* 2001 *figure* 2.) There are two literature references where a tetraploid number (4x = 44) is given for Clivia nobilis, both from Sato (1938, 1942). Other authors have not confirmed these chromosome numbers.

The first manmade polyploid clivias were reported by Niu *et al.* (1986). They treated seed and seedlings with colchicine. What has become of the results is not known. Doubling the chromosome number in *Clivia* can add to the tremendous progress in the breeding of *Clivia miniata,* and of the interspecific hybrids, that has taken place in recent years. The founding of the Clivia Club and then the Society, and the easy communication between people over the Internet, are important contributors to this phenomenon.

As stated before, polyploids can show wanted characteristics in floriculture. In *Clivia* we can think of bigger flowers, but also more extreme broad leaf types as appreciated by Chinese growers, and interspecific hybrids with unequal genome number (triploids).

If the tetraploid status in *Clivia* would be too extreme (Brandham, 1995), tetraploids could be used to breed triploids (three genomes: 3x=33) or aneuploid (normal genome plus or minus one or more chromosomes) material with superior characteristics.

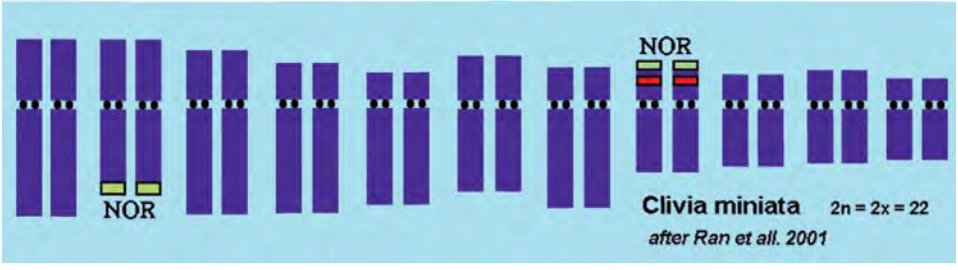

Figure 2. Genome of *Clivia miniata*

Materials and Methods

Berries from a cross between two Belgian hybrid type *Clivia miniata* plants were harvested when the color of the berries changed from green to orange/red.

The berries were dipped in 96% ethanol and flamed. This procedure was repeated and after that the seeds were removed from the berries under sterile conditions in an airflow cabinet.

The embryos were excised from the seeds and placed on a medium in 9*cm* petri dishes. The petri dishes were first filled with I5m! sterile MS- medium with 3% sucrose and solidified with agar (Murashige & Skoog, 1962). The petri dishes were supplemented with 2*m*l filter-sterilized colchicine. The total concentration of colchicine in the 17*ml* medium was calculated at 0,05%.

Each petri dish contained ten embryos and was placed in a culture room in the dark at 25°C.

After 66 hours the embryos were transplanted to test tubes with 15*ml* MS medium and placed in a culture room with fluorescent light (±2000 Lux) at 21°C.

Four months later the surviving plantlets were hardened under mist in the greenhouse.

Flow cytometer analysis (FCM) was performed on newly formed leaf parts.

Pollen grains were colored in a drop of aceto-carmine (Carmine in 45% acetic acid) and checked under 40x and 100x magnification.

Results

# embryos treated	#plants to greenhouse	# plants analyzed FCM	2n	**2n<x<4n** Chimera	4n	% embryos converted
78	55	37	24	ll	2	16,7

Table 1. Number of embryos treated with colchicine and the results from this treatment

Figure 3. Pollen grains of normal diploid *Clivia miniata* hybrid (left) and plant 94001-27 at the same magnification (Pictures taken at 100x magnification).

Figure 4. Two of the plants flowering grown from the colchicine treated embryos. The flower diameter in plant 94001-27 has increased by one third compared with the average flower diameter of the diploids from the same cross

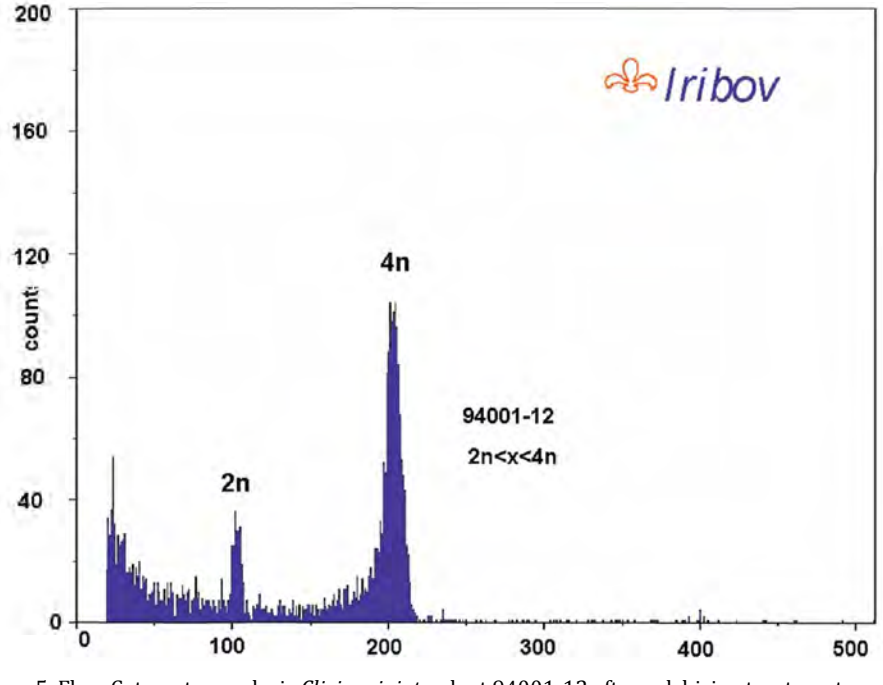

Figure 5. Flow Cytometer analysis *Clivia miniata* plant 94001-12 after colchicine treatment

Discussion

In general, the best procedure to raise the ploidy level in floriculture is to select several superior hybrids and treat a sufficient amount of individuals of each hybrid with the right chemical. After doubling the chromosome number you may have reached your goal and possess better hybrids or at least have good germplasm to start breeding on a higher ploidy level.

In *Clivia*, however, this procedure is very difficult to realize because of the slow propagation rate using divisions and the problems you will have to deal with in applying the chemical to the meristem of an adult plant, which is hidden deep in the heart of the plant.

Using embryos, seeds or young seedlings excludes a number of problems, but then you are not sure about the quality of the resulting polyploids, because your starting material is the result of a cross with unknown qualities. To have some influence on the result it is important to use good breeding parents that are both the result of crosses between parents that are genetically distant from each other. In this way you can make the best of a not ideal situation: you can start your polyploid breeding with material that can offer you a maximum of variation.

The method described to treat *Clivia* with colchicine is effective for several reasons. First exposing the naked embryo to colchicine *in vitro* gives a direct effect where it is needed. To work properly the colchicine has to reach fast dividing cells. Excised mature embryos will start to develop almost immediately after they are placed on the tissue culture medium and form a good source of quickly growing cells. There are two meristems in the young embryo: the shoot meristem and the root meristem. The shoot meristem is the one to be converted. If this meristem is made tetraploid in due time tetraploid new roots will be formed. If only the root meristem is changed to tetraploid, the plant that develops will still be diploid. Another benefit of *vitro* culture is that after the treatment the embryo can recover under ideal conditions and can even survive for example the situation where the root meristem is killed by colchicine.

To check if the colchicine treatment has been successful several methods can be used. The actual number of chromosomes can be counted in fast growing plant parts like root tips. The stomata size can be measured; the stomata are bigger at higher ploidy levels. The pollen size can be determined (*figure* 3). Another elegant method is flowcytometry, which estimates the nuclear DNA content of individual cells (Van Tuyl & Boon, 1997). Only a small piece of tissue is needed, so the ploidy level can be established at a very early stage of plant development.

The results show that two complete tetraploids were formed. One of them died in the greenhouse and the other one fell back to the diploid status. The chimaeric plants have a percentage of tetraploid cells; they are mixoploid (*figure* 5.). There is a possibility that some of those chimeras will become either diploid or tetraploid in the course of time. As diploid cells grow faster than tetraploid cells a diploid status will be favored. On the other hand, there are also stable forms of chimeras for example the so-called glove type. The outer layer of the plant is of another ploidy level to the inner layer(s). If the layer from which the sex cells originate is tetraploid, the plant will breed as a true tetraploid. Which type the 11 chimaeric plants represent is not known. The first plant of this group that flowered in 2000 gave almost 100% large pollen grains *(figure 3)*. Pollinating diploids gave three triploid plants (*vitro* culture). Selfing resulted in a tetraploid. In 2002 the same plant flowered for the second time. Crosses were made with other chimaeric plants to get complete tetraploids.

In 2001 crosses were made to determine if *vitro* culture is really needed for triploids in *Clivia*. The first crosses with plant 94001-27 gave a small number of well- developed seeds with almost normal looking endosperm. From these seeds, which were grown after chipping

in vitro, the first triploids were raised. A portion of the material from the 2002 crosses was chipped and placed *in vitro* and another portion of the seed was sown *in vivo*. The results are not clear yet because of the slow germination of the seeds *in vivo*.

What are the possibilities for polyploidy in *Clivia*? First the tetraploids. If we look at other floricultural crops we see that the number of tetraploids steadily grows after introduction (Brandham 1995). Seeds are the main source of commercial *Clivia miniata* propagation. Breeders are developing strains that show early flowering. For this purpose tetraploids are not well suited, because of their slow growing nature and low seed set. These characteristics can be improved, but this will take many generations of breeding. If superior tetraploid hybrids are produced, only division or tissue culture can be used for propagation. Propagation by division is a very slow process. Tissue culture in *Clivia* is difficult although there are several studies published (Min & Jinsheng.1984 ; Sato & Hasegawa, 1994 ; Finnie, 1998) Vico Yellow is the only hybrid propagated by tissue culture in larger quantities (Smithers, 1995). To increase the number of tetraploids more material can be made tetraploid, but another option is to cross tetraploids with hybrids that produce unreduced gametes. It is not known if there are many *Clivia* hybrids that produce unreduced gametes, but a survey revealed in any case one in my own small collection *(Figure 6.)*.

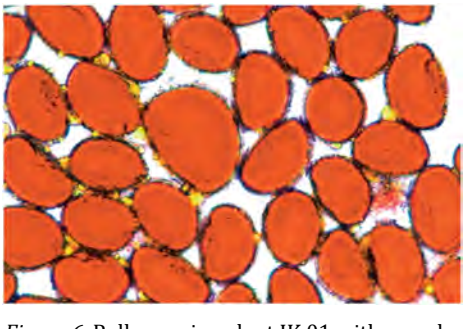

Figure 6. Pollen grains plant IK 01 with unreduced gamete.

Interspecific hybrids are another possible source for unreduced gametes (Ramanna, 1992).

In such interspecific hybrids unreduced gametes are in many cases the only functional gametes produced. In *Clivia,* interspecific hybrids can be produced by seed and are fertile. There are no records about the presence of unreduced gametes among their pollen grains.

When a tetraploid is crossed with a hybrid that produces unreduced gametes the normal reduced and the unreduced gametes can take part in the fertilization process resulting in triploid and tetraploid embryos. In most plant species endosperm formed after the fusion of n and 2n gametes is not functional or absent so no viable seeds are formed. The fusion of two 2n gametes however may result in a normal seed. So if seeds are formed as a result of a cross between a tetraploid and a hybrid producing 2n gametes the resulting plants will be tetraploid. As stated before it looks as though *Clivia,* as an exception, produces viable triploid seeds and if this is the case, all the progeny of a 2n x (n+2n) cross will have to be checked for ploidy level. Triploid breeding however will be much easier if normal seeds are formed and embryo culture is not necessary.

Triploids cannot be multiplied by seeds so only divisions and tissue culture can be used for propagation. Triploids are in most plant species sterile, but sometimes a small percentage of good pollen is formed and often one or more extra chromosomes are present. Used on diploids these gametes can give rise to aneuploids. In a number of plant species aneuploids are valued hybrids like in Japanese Garden Iris (Iris *ensulata-,* Yabuya *el al,* 1992) *Hyacinthus* and *Freesia* (Van Scheepen, 1991) and *Kalanchoe* (Van Voorst & Arends, 1982).

At this moment it is too early to predict as bright a future for *Clivia* polyploids as we see in *Narcissus (Figure* 1). But if there are positive elements in *Clivia* polyploids, they will surely be exploited by many *Clivia* lovers all over the world. Here I may add that I am working on a

method for inducing polyploidy that can be applied in the home, rather than in a laboratory. I hope to have an article on the method ready for publication in the next Yearbook in 2004.

Who knows what the ploidy status of *Clivia* hybrids will be in a hundred years.....

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Above: C. *miniata* CCC Runner-up to Best on Show and Winner Own Breeding Section, CCC 2002 Show. Beeder and grower: John Winter.
Below: Runner-up to Best on Show and Winner yellow C. *miniata* with one umbel Section, KZNCC 2002 Show. Grower: Bertie Guillaume.

RUNNERS-UP

Above: Runner-up to Best on Show and Winner broad petal cream to yellow C. *miniata* Section, Metro 2002 Show. Grower: Ernie Hobbs
Right: Runner-up to Best on Show and Winner C. *miniata* with two umbels at EPCC 2002 Show. Grower: Andre Calitz
Below: Runner-up to Best on Show and Winner C. *miniata* any other colour with green throat Section, NCC 2002 Show. Breeder and grower: Bertie Guillaume.

LEAF FORMATION AND ITS RELATION TO FLOWERING IN CLIVIA MINIATA

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C van der Merwe - Laboratory for Microscopy & Micro-analysis, University of Pretoria

Abstract

Leaves *of* Clivia miniata *are produced in succession on opposite sides of the plant apex. The apical mristem producing the leaves consists of a dome-shaped group of meristematic (dividing) cells. The 'roof of the dome consists of two distinct cell layers and new leaves originate from the second and deeper cell layers, forming a ridge around the dome. The base of the ridge forms the leaf sheath, and the tip of the leaf blade develops from the rim of the ridge. Widening of the leaf blade is the result of cell divisions parallel to the long axis of the blade and leaf elongation the result of cell divisions between the leaf sheath and the leaf tip, perpendicular to the long axis of the leaf. The leaf tip is therefore the first part of the leaf to mature and is 'pushed' out from below by the addition and enlarging of cells.*

After reaching sexual maturity (after about 12 leaves) the apical dome is 'converted' into an inflorescence bud and a new vegetative bud is formed next to the inflorescence bud. The new and consecutive vegetative buds will each form four leaves before they, in turn, will be converted into inflorescence buds. Inflorescence buds are, therefore, products of the modular growth of the plant with each module consisting of four leaves and an inflorescence bud. Further development of the inflorescence bud and ultimately flowering, depends on environmental factors and nutrition.

Leaves are the carbohydrate factories of the green plant and without healthy, functioning leaves, no plant can grow properly. In the case of *Clivia* the leaves also contribute to the beauty of the plant, especially if they have a specific shape or colour. Understanding how leaves develop will not only give the growers a better appreciation of their plants, but will also allow them to manipulate and improve the quality of the plants.

The arrangement of the leaves of all *Clivia* species is **distichous**, meaning that they appear one at a time with the succeeding leaf situated on the opposite side of the stem *(Figure* 1). The *Clivia* stem bearing the leaves is a constricted rhizome and each leaf base forms a sheath enveloping all the younger leaves and the stem apex *(Figures 2 and 3).* Due to the lack of stem elongation there are no visible internodes.

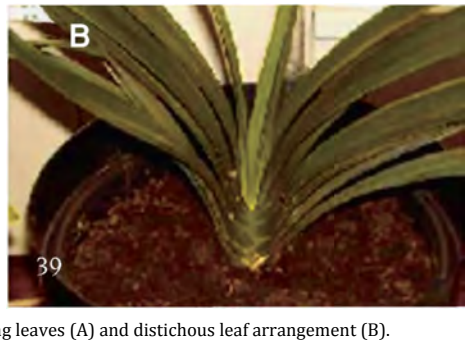

Figure 1: *Clivia* plant showing inflorescence with flush of young leaves (A) and distichous leaf arrangement (B).

If one would take a young *Clivia* plant and start removing the leaves from the base to the tip one would end up with a minute, dome-shaped structure known as the apical meristem (*Fig.* 2).

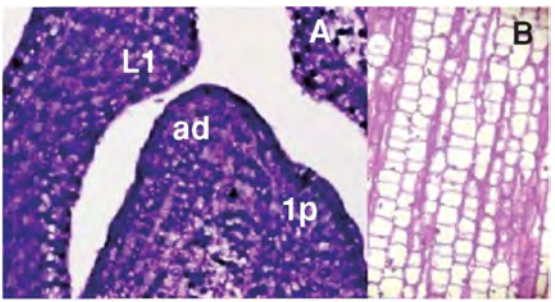

Figure 2A: Detail of *Clivia* apical dome (ad) in the process of producing a new leaf primordium (lp) and *Figure* 3B showing cell files after repeated cell division in the basal part of a young leaf

The cells of the apical meristem or apical dome are embryonic and their only function is to divide, and to give rise to new leaves *(Figure* 2A). The cells of the two outer layers of the apical dome normally divide perpendicular to the surface (anticlinal) and are therefore responsible for the increase of the surface area. During the formation of a new leaf by the apical dome, the first signs are periclinal cell divisions (parallel to the surface) in the second cell layer, followed by anticlinal divisions of the adjacent outer layer cells. The result is a small bulge or "outcrop" of cells that can now be designated as a leaf primordium. The outer cell layer of the leaf primordium will give rise to the epidermis of the new leaf, while the cells derived from the second and deeper cell layers will give rise to the central part of the leaf known as the mesophyll (*Figs*. 5 *and* 6). The vascular tissue derives from the third and deeper cell layers. During the formation of a leaf primordium, the greater part of the apical dome is 'consumed' and the remaining cells of the dome need a certain period of time to divide and restore the critical size of the dome before a new primordium can be formed on the opposite side.

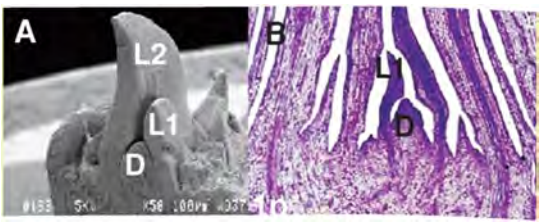

Figure 3: Sections of apical buds showing the apical dome (D) and youngest leaf primordia (LI & L2).
A was taken with a scanning electron microscope and B with a light microscope

Figure 4: Leaves that had to be removed to reach the apical dome in a seedling plant (A) and an older plant with an aborted inflorescence bud (B)

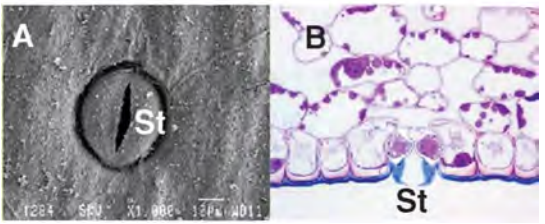

Figure 5A: Surface view of lower epidemis of *Clivia* leaf showing stomatal ledge (St) of sunken stoma.
Figure 5B: A subaxial cross section of the lower (abaxial) part of the leaf showing thick cuticle, structure of stoma and intercellular spaces between mesophyll cells

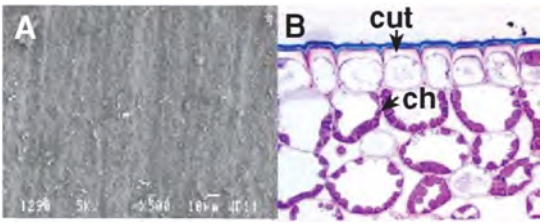

Figure 6: Surface view (A) & (B), cross section of upper surface of *Clivia* leaf, showing absence of stoma, thick cuticle (cut) and mesophyll cells packed with chloroplasts (ch)

Due to the distichous arrangement of the *Clivia* leaves the apical dome is "sandwiched" between the opposite sets of leaves and has the shape of a semi-disk, but for the sake of terminology, we will still call it a "dome". *Figure* 3A is a scanning electron microscopic view of one half of the apical dome of a young *Clivia miniata* plant, sandwiched between the two youngest leaf primordia. The outer leaves that had to be removed to get to the apical dome, are shown in *Figure* 4A. Each leaf consists of a leaf base (the leaf sheath) and the leaf blade. The sheath of every leaf had to be cut open before it could be removed. The sheath of the youngest primordium is already surrounding the apical dome which means that in three-dimensional view, the whole leaf primordium originates as an elliptical ridge around the flattened apical dome (*Fig*. 7), starting at the leaf blade end and progressing around the dome.

After initiation of a leaf primordium, cell divisions parallel and perpendicular to the long axis of the leaf causes the primordium to expand in width as well as in length. The tip of the lamina (leaf blade) develops as a result of rapid cell divisions and cell enlargement from the ridge of the sheath, concurrently with the elongation of the sheath. The leaf tip matures first while the formation and elongation of the leaf lamina is the result of actively dividing cells in a zone between the leaf tip and the leaf sheath (intercallary meristem). In this zone most cells divide perpendicular to the long axis of the leaf to form distinct longitudinally arranged cell files [*Fig*. 2B). In leaves still elongating this zone is visible as an etiolated (bleached) section covered by sheathes of the older leaves (*Fig*. 4).

The leaf lamina is therefore "pushed out" as a result of the activity of the intercalary meristem, and cell maturation takes place above this zone, progressing from the leaf tip downwards. The final length and width of the leaf depends on the rate and duration of cell multiplication and expansion, determined by the genetic composition of the plant as affected by the environment and nutrition.

Stomata develop from single embryonic epidermal cells in the zone of maturing epidermis cells, but are restricted to the lower epidermis in C. *miniata*. Each stoma consists of two guard cells surrounding the stomatal pore. The guard cells are sunken into the epidermis and are fitted with both inner and outer ledges, forming inner and outer 'lobbies' (*Fig*. 5) that play an important role in restricting transpiration. The function of the stomata is air exchange during photosynthesis and outlets for water vapour during transpiration and they are therefore linked to the inter-connected air spaces between the lower mesophyll cells. Mature epidermis cells have thick outer cell walls covered with a thick waxy layer known as the cuticle (*Figs* 5 *and* 6). The function of the cuticle is to restrict water loss through the leaf surface. The exceptionally thick cuticle covering the upper epidermis, together with the sunken stomata (guard cells positioned at a lower level than the ordinary epidermis cells) with prominent ledges on the outer walls of the guard cells, are typical characteristics of xerophytic plants (plants that are adapted to survive in dry areas). The mesophyll cells (cells between the upper and lower epidermis) particularly those adjacent to the upper epidermis, are packed with chloroplasts (*Fig*. 6B), rendering the leaves efficient carbohydrate factories.

It is impossible to talk about leaf formation in *Clivia* without considering the process of flowering. As already discussed by Honiball in *Clivia* Yearbook Three, the growth in *Clivia* that have reached the flowering stage is modular, with each module consisting of about four leaves and a terminal inflorescence. During the juvenile phase of the *Clivia* plant, the apical meristem (dome) gives rise to about twelve leaves before being transformed into an inflorescence bud. A new dome then develops next to the inflorescence bud (*Figs* 7, 8 *and* 9). Under optimal growing conditions, the new dome in turn produces about four leaves before giving rise to the next inflorescence bud. One module therefore consists of about four leaves and an inflorescence and as long as growing

conditions remain favourable, the plant will produce two or more such modules per growing season. After the formation of an inflorescence bud and the new dome, there is a time lapse required by the new dome to grow to a minimum size before starting to produce new leaves. This slight delay in leaf formation can often be observed indirectly when the youngest leaves are distinctly shorter and softer than the older leaves. They also often appear more or less at the same time as the spring inflorescence (*Figs* 1 *and* 10).

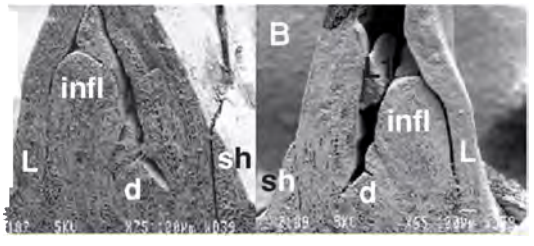

Figure 7: Mirror images of two halves of the same apical bud after dissection showing leaf primordium (L) and inflorescence bud (infl) of preceding module, and apical dome (d) of new module. Sh = sheath of leaf primordium marked L

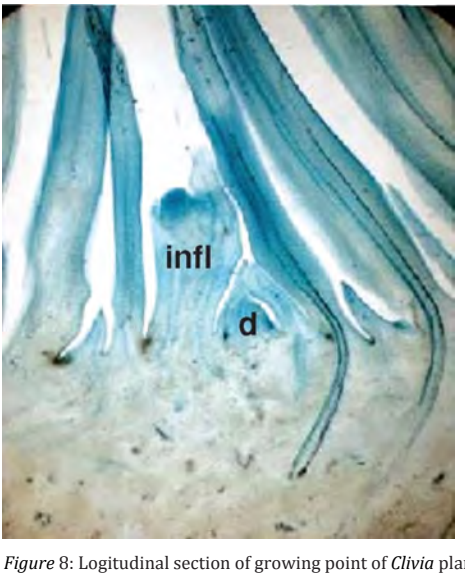

Figure 8: Logitudinal section of growing point of *Clivia* plant showing inflorescence bud (infll of previous module and apical dome (d) of new module.

The question now arises what happens to the inflorescence buds. This problem has not yet been solved, because many plants have to be sacrificed during the studying of inflorescence development. What follows is therefore partly a hypothesis based on a few observations. *Fig*. 4B shows an aborted inflorescence bud that was formed by a seedling plant after the 12th leaf (four leaves not shown). Before having been dissected, this plant was exposed to very unfavourable growing conditions (small container, water stress and some direct sun) indicating that favorable conditions are required for the survival of the inflorescence bud. A further sign of stress is that the same plant produced eight, instead of four leaves before the next inflorescence was formed. *Fig*. 2B also shows that after formation, the first inflorescence has grown to a stage where the scape (peduncle) as well as flower buds could be distinguished. *Figs*. 7, 8 *and* 9 clearly show that, after initiation, the inflorescence bud keeps on growing. Flower buds continue to develop but the scape remains relatively short. It seems as if most of the initial growth of the inflorescence is the result of cell division during the formation of the different parts.

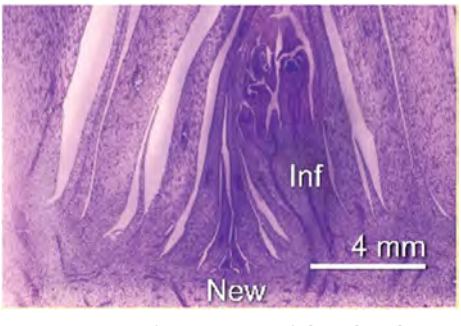

Figure 9: Section of growing point of *Clivia* plant showing inflorescence bud (inf) at a more advanced stage of development than the one in *Figure* 8.

Similar to leaf development the elongation of the scape is also the result of the activity of an intercalary meristem at its base, followed by cell elongation. Before starting to elongate however, the scape cells must be triggered by a period of low temperature.

Figure 10: *Clivia* plant showing reduced scape of older inflorescence and normal scape in younger inflorescence.

Cells may lose their capability to enlarge if they mature before expansion, that is, before the cold period that would trigger them to start elongating in a similar way as shown in *Figure* 2B.

'Untimely' inflorescences appearing amongst the leaves without scape elongation would be an illustration of the latter condition. Evidence supporting this statement is the fact that this condition is usually associated with inflorescences situated towards the base of the plant, between older leaves, like the spent inflorescence in *Figure* 10. The younger inflorescence in *Figure* 10, situated between the young leaves, produced a normal elongated scape probably because the young scape cells were triggered by the winter cold before they had lost their ability to elongate.

Other, more complicated factors are also involved in the process of scape elongation, but at this stage it seems as if the age of the scape cells play a very important part in the whole process. There are still many questions about flowering in *Clivia* and many more plants will still have to be dissected to provide the answers. The continuation of this research is therefore of the utmost importance.

Best on Show, Metro Interest Group 2001 Show, Grower: Tino Ferero, The incorrect photograph appeared in Yearbook Four on page 39,

A selection of the slides shown in 3-D by Jim Comstock at the International Clivia Conference.

Left: *Clivia* interspecific cross '**Juliette**'.

Below: C. *miniata* '**Red Mix**'.
Breeder: Joe Solomone.

Opposite page:

Top: *Clivia miniata* '**Lovely Rita**'.
Bottom: *Clivia miniata* tea party.

Top, left: C. *miniata* '**Antz**' spider form.
Above: Floret of C. *miniata* '**Affliction**' with some keeled petals.
Above, right: C. *miniata* '**Josh**'.
Below: C. *miniata* '**Blushing Bette**'.
Right: C. *miniata* '**Being Peach**'.

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C. *miniata* orange mix group. Breeder: Joe Solomone.

C. *miniata* '**Ruby**'

Above: C. *miniata* '**Box**' multipetal
Below: C. *miniata* '**Adam**'

C. *miniata* '**Flame**' group

C. *miniata* '**Dawn**'

Above: C. *miniata* **'Ramona'**

Below: C. *miniata* interspecific'Goodwill'

C. *miniata* interspecific **'Hunting'**

VARIEGATED CLIVIA IN JAPAN

Shigetaka Sasaki

Introduction

Mr. Nicholas Primich read a paper on variegated *Clivia* at the International Clivia Conference in 1998. I feel highly honoured to be able to publish this article on the same topic as he did. In his paper Mr Primich explained various aspects of variegation that are common in all plants. He tried to answer positively all the queries that we have when we try to understand variegation. If I had not read his article, I would not have known about the existence of air blisters that appear in the leaves of C. *nobilis*. I wonder whether this fact indicates the possibility of creating a new type of variegated *Clivia*.

As I wrote in Clivia Yearbook 3 (p. 24), we classify variegated *Clivia* into 7 types in Japan, namely, Shima-fu, Fukurin-fu, Akebono-fu, Negishi-fu, Naka-fu, Tora-fu and Genpei-fu. These are all illustrated on pages 24 and 25 of that Yearbook. Fu means variegation in Japanese. I would like to share more information about the 7 types of variegation and on which of their characteristics are inheritable. They are illustrated in the accompanying photographs.

C. *miniata* Naka-fu

Inheritable Characteristics

Within the 4 types of variegation, Fukurin-fu, Negishi-fu, Naka-fu and Genpei-fu, are variations of Shima-fu that are found in the seedlings. Sometimes, typical Shima-fu plants change their variegation into one of those 4 types. Akebono-fu and Tora-fu are not variations of Shima-fu. There is also a Tora-fu plant called "Taiho", but this is caused by a virus infection (*Figure*1).

Figure 1: C. *miniata* Tora-fu 'Taiho'

In breeding variegated Clivia, Shima-fu, Negishi-fu and Akebono-fu are inheritable characteristics, but other variegation types will not be inherited in the next generation. I have heard that Akebono-fu can also be inherited through the pollen parent, but I am not sure of this because there is no data available of the breeding results.

Breeding high quality variegated *Clivia*

I would like to explain how to breed good Shima-fu plants as an example of breeding high quality variegated clivias. A few months after the pollination of Shima-fu plants, you will find white stripes on the surface of the berries. But the variegation varies in every berry; some berries are totally white in colour, some berries have lots of stripes, and some berries have few stripes that look almost green.

According to what is reported by Clivia breeders in Japan, as well as Mr. Nakamura, I can say the following: you can take any variegated berry as an example, the seeds that are covered by the white portion of the berry peel tend to germinate with totally white leaves. Of course those seedlings will not grow and will die. On the other hand, the seeds that are covered by berry peel with lots of thin stripes will tend to show the same good leaf variegation after germination.

When Mr. Nakamura harvests the seeds named "best variegated", he chooses only the seeds that are covered by peel with lots of thin stripes. So, what plant is most suitable for getting good berries with lots of thin stripes? This is just my opinion, and it has not yet been proved, but I believe that plants with very thin stripes on the leaves in the flowering stage are most suitable for getting good berries.

Figure 2: Variegated Berries

You will notice that the variegation on the leaves runs through the flower stalk and reaches up through the berries. So I think that the variegation of the leaves and stalk influences the variegation of the berries. Refer to the picture of a variegated *Clivia* with variegated berries. (*Figure* 2). You can see that the white colour on the right side of the leaf runs through the stem and reaches up through the right side of the berries. On the other hand, the green colour on the left side of the leaf runs through the stem and reaches through the left side of the berries.

In keeping with this concept, you will notice that the berries of Fukurin plants tend to have white berries; also the seedlings tend to have no pigmentation (*Figure* 3).

Best variegated berries

Figure 3: Fukurin berries

It seems that the white parts of variegated leaves tend to get larger, as the plant ages. Therefore, when we try to breed the best variegated seedlings, I would recommend that you do not use plants with overly white leaves as maternal plants, but rather use plants with well balanced, striped leaves as the maternal plants. For example, the percentage of stripes should be 30 % of the total surface of the leaf.

In Japan, dwarf clivias are very popular. So we often use variegated Hime-daruma as a mother plant for breeding variegated Daruma, and use broad leaf Daruma as a pollen plant for getting broadleafed plants (*Figure* 4).

Figure 4: Best Shima-fu

Negishi-fu

The word "Negishi" comes from the name of a cultivar of *Rofidea japonica*, which is known as

a traditional pot plant in Japan. Japanese *Clivia* enthusiasts often use cultivar names of Rohdea for naming clivias. Negishi-fu was bred from crossing Shima-fu plants. When we see Negishi-fu plants, some plants have very small green points running on yellowish green leaves. Or some plants have very thin green stripes running on yellowish green leaves. We call both types "Negishi-fu". There are variations in Negishi-fu plants. Some plants show Negishi-fu only during the young leaf stage, and then the variegation and the yellowish-green leaves change into the usual darker green leaves as they get older. Some plants maintain the variegation and the greenish yellow leaves after they mature. There are various types of Negishi-fu plants, but the characteristics of flower stalks and berries are common to all the plants. Flower stalks and berries of Negishi-fu plants are yellowish-green, with rare green pigments (Figure 5). We can recognize the type easily when we check flower stalks and young berries. As the berries mature, the greenish-yellow colour changes into purplish-red. Negishi-fu plants are still rare in Japan. I think they will become more popular in the future.

Figure 5: Negishi-fu

Negishi-fu is an inheritable characteristic. The seedlings rarely show pigmentation on the leaves, and we cannot tell the difference from albino seedlings, but the leaves start to show a yellowish-green colour as they grow older. This fact is also common with Akebono-fu seedlings.

Akebono-fu

Akebono plants are a mutation in crossing the usual green plants. When *Clivia* breeders discovered Akebono variegation, it seemed to them like the image of the sun rising over the horizon. So this variegation is named after the classical word that means "sunrise" in Japanese. This word "Akebono" has been continuously used as a cultivar name for variegated plants like *Rohdea japonica* or *Neofinetia falcata* in the Japanese horticultural world since the Edo period (which was from the early 1600's till the late 1800's).

We will see some variation in Akebono plants. Some plants show Akebono variegation only in the young leaf stage, then the leaves become completely green, as they grow older. Other plants maintain Akebono variegation after the leaves age. Some plants show Akebono variegation only on the front of the leaves, and the back of the leaves look green.

As for the variegation pattern itself, there are also variations:

1. Plants with several white bands on each leaf.
2. Plants with a large white band in the middle of the leaf, while the tip and the base remain green.
3. Plants with white at the leaf tips.
4. Plants with a slightly white colour at the tip and base of the leaves.

C. *miniata* Akebono-fu

C .*miniata* Akebono-fu

C. *miniata* Akebono-Daruma

Unfortunately, we have not found plants with a stable variegation pattern. It seems that the variegation pattern sometimes changes on the same plant.

When we use Akebono plants as the maternal parent, the Akebono variegation will be inherited in 100% of the offspring.

Akebono seedlings are easily damaged because they rarely have green pigment (chlorophyll). We have to be careful when we grow them. One Japanese breeder told me how he grows Akebono seedlings. He keeps them in a humid place for 2 - 3 years. This keeps the leaves green. When they are big enough, he moves the plants to a drier place so that they will develop Akebono variegation.

I cannot tell you much more because the knowledge about Akebono breeding is very limited. But I am sure of one thing; it is better to grow them in a darker place than usual. Akebono variegation is very vulnerable to sunshine.

Akebono plants have the following characteristics in their flower stalks and berries: The berries do not show variegation at all (Figure 6). The flower stems have an unusual pigmentation. It seems that Akebono variegation totally covers the stems. This characteristic of the flower stems is similar to Negishi-fu plants. This makes me wonder if the Akebono variegation and the Negishi variegation have something in common.

Figure 6: Akebono-fu Berries

Figure 7: Daiohkan-nishiki

Strange variegations in *Clivia*

The flower (*Figure* 7) is called "Daiohkan-nishiki" and is owned by Mr. Tsuruya. This is a mutant Clivia found when breeding variegated Daruma plants. The petals also have variegation, a very rare thing. Only the flower tips look orange, and there are green stripes that are similar to the leaves. As you know, there are plants with "green flowers". I have heard that the "green flower" is a kind of temporary deterioration, and it seems that this type of plant has normal flowers under

normal conditions. However, the owner of "Daiohkan-nishiki" reports that it has the same type of flowers every year. I have heard that the ovary of green- flowered plants is wrinkled and not round shaped compared with that of normal flowers. However, "Daiohkan-nishiki" has round ovaries. It seems that this flower is not a temporary mutation. In addition, I have heard that the offsets of this plant also have the same type of flowers as the original plant.

Tora-fu owned by Mr. Mitsuhashi

This is a new type of variegated *Clivia* in Japan. There are lighter green bands on the leaves that are slightly raised. The breeder is not known. This variegation is inheritable. So if you use this plant as the maternal parent, the variegation will be inherited by the next generation. It may be possible to breed a new type of variegated *Clivia* by crossing this plant with other variegated clivias.

Finally, I am very interested in the white stripe on the leaves of *Clivia mirabilis* that was recently found as the fifth species of *Clivia*. This variegation has the potential to produce a new type of variegation beyond the 7 types of variegation in C. *miniata*. I have a request for Dr. John Rourke and the other people who are studying this new species. I would like to suggest that they try a breeding program of crossing C. *mirabilis* with various variegated C. *miniata*. I am willing to provide variegated plants as breeding material for such a breeding program.

C. *miniata*. Breeder: Margot McNeil. Grower: lohan Conradie.

VISITS TO SPECIAL CLIVIA PLACES
after the International Clivia Conference

Conrad Calitz, Stellenbosch, South Africa

"Good Heavens!", "Wonderful!", "My magtie - ongelooflik!", "Now ain't that something!", "Wow!". All around us echoed the surprised voices in several languages, in wonder at what lay a few yards in front and below us - the magnificent splendour of *Clivia miniata* in their natural habitat.

Amongst huge gray sandstone blocks, below a ragged canopy of riverine forest, someone had switched on these glowing candelabras. Some brightly gleaming in a shaft of sunlight, others less vivacious in the background. Large open trumpets in all the sunset hues - dark, glowing orange, light apricot, pink fringes, proudly high above the lush green foliage. The ground a rich gray-brown leaf litter, with green moss and little ferns unfurling their tiny fronds, their brown beards glistening with dew. High above, the forest birds twittered, catching the excitement below. An occasional butterfly fluttered its erratic course - perhaps undecided which of these beautiful flowers to visit first.

After falling in love with *Clivia* a few years ago, I had been looking forward to this conference, show and visits. But nothing really prepared me for the splendour of seeing my first *Clivia* in nature. We had traveled for two hours from Pietermaritzburg by bus, southward through the rolling hills of trees and sugar cane and through plantations to Umtamvuna Nature Reserve on the border between Kwazulu-Natal and the Eastern Cape. The river carved a deep canyon through the sandstone layers of the plateau and on the upper west-facing slopes this colony of healthy *Clivia* has survived the ravages of land clearing for agriculture, fires, muti gatherers and *Clivia* collectors.

From the gate in the secure fence at Clearwater Cottages, a faint path crosses an open field with dainty grasses dancing in the breeze. Some tiny creamy orchids shyly hugged the ground; a few bright purple *Agapanthus* and deep pink *Watsonia* led the eye onwards to the forested hills and the bright blue sea a few kilometers away. The path suddenly dropped past a ridge of deeply fissured rocks into the canyon.

The descent into Umtamvuna Gorge.

The descent frightened some, but the allure was too strong. Several older and less agile club members were able to easily do the walk, amongst them Gert Wiese, at almost 81 years. The path is stony and, especially under the trees, covered with thin moss, but is quite safe and easy. Just about 50 meters after entering the forest slopes you see the first clumps of *Clivia* - large, vigorous plants with long leaves, growing on the few flat spots, in nooks and crannies of rough tree trunks and leaning branches. Some even in a few centimeters of leaf litter on top of a rock or in partially rotted tree trunks.

I immediately understood the right conditions for *Clivia*. The forest was cool and fresh, with a lot of damp rocks, but no standing water.

Brian Tarr later told us, that in his experience, *Clivia miniata* only occurs on the west facing slopes, always associated with sandstone (which by the way, although much hotter and dryer, is also the environment in which the *Clivia mirabilis* grows in the Oorlogskloof). I have always believed in adding some sand to my growing medium and the natural habitat seems to confirm this.

C. *miniata* in the Umtamvuna Gorge.

The *Clivia* enthusiasts from several countries as well as us Capies and Valies, felt like children in a toyshop. Where to look first and "Oh, look at that!" but "hands off"! Instead the cameras clicked like a final at Wimbledon!

The Umtamvuna Nature Reserve of 3147 *ha* is about 8 *kms.* north-west of Port Edward. It has several walking trails and a wide river about 200 meters below the cliffs. According to tourism pamphlets, it is home to 259 species of birds and more rare and endangered trees than any other reserve in South Africa. Lots of accommodation is available at several places around the reserve.

C. *gardenii* growing in a swamp on Braemar Farm.

After Umtamvuna we travelled along back roads to several sites at Braemar Farm and at the Microlight landing strip where C. *gardenii* grow, also the Swamp C. *gardenii.* Many tall, healthy plants grow in black oozy mud (I remember it very well, - after a careless step it covered my foot and ankle for the rest of the day.) They were not in flower, but the meter long leaves and some green seed heads showed that they were thriving.

C. *gardenii* growing at the Microlight landing strip.

After some further travels along the back roads and another locality of C. *miniata* and C. *gardenii* as well as a beautiful waterfall showering over a very high cliff, we had a long sumptuous lunch at a Trafalgar Lodge. Later, the long drive back to Pietermaritzburg had many of us dozing off, but certainly dreaming of the real, natural *Clivia* we had seen for the first time. The visitors from Belgium, Holland, USA and Japan were all astounded, and all agreed on a heartfelt thanks to Andy Forbes-Harding for taking us to see these treasures.

Narrow petal *Clivia miniata* from Umtamvuna

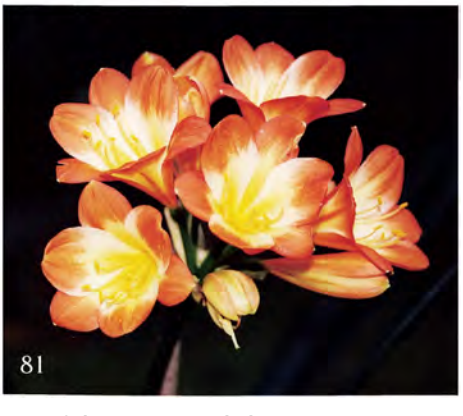
OTHER LOCALITIES:

Day visits to these natural areas and farms were organized for the 3 days following the Conference. The first day, two hours South was the absolute highlight. The second day took us about 2 hours North and the third an hour South from Pietermaritzburg.

That first night some very heavy rains fell with loud thunderclaps making the Capetonians very jittery. There was also some local political unrest, so the next day's visit to Kranskop could not go through completely.

We therefore had more time for the visit to Pieter van Rooyens' farm (aptly called 'Gem'), an amphitheatre set in smooth emerald green hills. As the bus could not traverse the muddy road, Pieter and his daughters ferried us in the backs of bakkies (LDVs) into the valley where the neat farm buildings nestled under huge trees, flanked by old sheds and kraals built from warm brown sandstone blocks. Some of the younger and fitter visitors walked in, with frequent stops at a variety of other flowers in the veld.

The farm garden, developed over decades, houses some beautiful shrubs and climbers, but the 'gems' are the multitude of flowering *Clivia*. They are everywhere, packed in terraced shade houses, growing in every corner, patio, stoep, passage and room of his large house, as well as in the lush garden under the large trees and beautifully tended flowering shrubs. Even the large catering room was lined with dozens of show quality plants in flower, to the envy of the visitors. The seedlings even had their own porcelain baths! . Pieter's 'red' strains are particularly beautiful.



Two of the C. *miniata* which grow near Pieter van Rooyen's farm

The hospitable van Rooyen family all jumped in to serve a very tasty tea and lunch. Pieter also showed us *Clivia* in habitat on another part of his property, again in a beautiful indigenous forest on the sandstone bouldered slopes of a high hill.

On the way back we called in at Otto's Bluff, one of the ridges surrounding Pietermaritzburg. A long, winding driveway under tall trees has been planted with thousands of *Clivia*, and many were in flower. This creates a beautiful river of green and orange. (In the Botanical Gardens, an old winding furrow has also been shored with *Clivia* and other shaded plants, creating a delightful feeling of being close to and walking with the plants.)

Our heartfelt thanks to Brian Tarr for his excellent informative, humorous and knowledgeable commentary during the whole day, not only on the flowers, but also the ecology, history, culture and personalities. If he tires of his good work at the NBI and growing beautiful *Clivia*, he should become a tour guide. (How about an annual *Clivia* route, Brian?) He brought to our attention the *Clivia* for sale at the *muthi* stalls in the main street of Greytown, but warned the avid collectors amongst us to please not buy any of this kind anywhere. Buying this would enlarge the pressure on the natural populations, as the vendor's stocks are replaced with even more plants.

On the third day the bus and several cars again travelled south, calling first at the Chubb's farm. The variety and quality of plants were amazing, I noticed a pile of **Chubb Peach** plants with bare roots being packed into a large, hard suitcase for transport to Japan. In a few years we shall surely find superior peach, apricot and pink strains returning from Japan. But it is also a compliment to the quality of Sean's plants.

We travelled further south to Roly Strachan's farm at High Flats near Ixopo, where a sight reminiscent of the Dutch bulb fields greeted us - a field of flowering *Clivia* stretching on both sides of the road right up to and around the farmhouse. We estimated that the two, 20 x 400 meter strips contained some 100,000 heads of *Clivia*! Later, the afternoon sun shining under the clouds and flowing under the trees created an ethereal glow of peach and orange. My wife and I were fortunate to spend the evening and night with Roly and Barbara before continuing our journey back home. We walked down to the main road through the sea of *Clivia* several times, each time noticing new unusual specimens, even several multipetals and multicoloured tepals. The variety in his plants was as amazing as the sheer numbers. No wonder Roly can sell seeds by the *kilogram* and amongst them you are sure to find some of nature's wonderful crosses and selections.

Roly Strachan's sea of *Clivia*

Driving away the next day and even now, thinking back, we agreed that the three days visiting these special places, with these special people, being guided and entertained by these special hosts was indeed ... well, SPECIAL!

Dear reader, please pardon the 'flowery' language used above. If, through the words, you can feel and share something of the majestic beauty and serenity of this area with its many little pieces of Clivia *paradise, your patience is rewarded. Better still, go and visit these places and also the other floral wonders of South Africa, preferably in the company of the local experts. Even better, would it not be possible for Brian Tarr, Sean Chubb, Andy Forbes-Harding and the other experts to conduct regular tours to these localities? We have wine, art, cheese and many other routes, why not a* Clivia *route?*

THE CAULESCENS TOUR
SEPTEMBER 2002

Ken Smith

During my trip to South Africa for the Conference at Pietermaritzburg, I had the opportunity to be part of the Caulescens Tour organised by Connie and James Abel. It was a valuable experience.

I had been in South Africa for a week visiting the Cape and had seen a lot of clivias and had met many of my clivia friends. The tour was set to depart from the Abel's residence early on Monday morning, September 2nd. The trailer was loaded with the luggage and the bus was loaded with the group of clivia enthusiasts from around the world. The bus headed off from Pretoria at approximately 8am on its way to Magoebaskloof. We travelled through some very dry country and to me the scenery was not unlike Australia, except for the Aloes.

We reached the Motel at 2.30pm so that the trailer could be left and we were on our way again through some Afromontane forest vegetation on route to the first C. *caulescens* habitat. I was intrigued to see some very mature specimens of *Quercus, Fagus* and *Malus*, and a large stand of *Sasa palmata*. Upon reaching the site the bus was parked and we had a walk of several kilometres to view the clivia in habitat. What we saw was *Clivia caulescens* carpeting the forest floor as well as the odd specimen growing epiphytically on the moss covered tree branches. The view of the valleys was spectacular. With Illie Gaceui I ventured into the forest to photograph some flowering specimens, and then it was back along the track to the bus. The drive out of the forest as the light faded was a very interesting one. Well done Justin. Once back at the Magoebaskloof Motel we were able to rest and revive ourselves with pre-dinner drinks. The meal was fantastic.

Day two was a planned trip to see the McNeil Collection at Ofcolaco. It was a warm, sunny day that became warmer as the morning progressed. Margot McNeil met the bus at the entrance to the Legalameetse Nature Reserve. Several four-wheel drive vehicles had been organised to take the tour party through the scrub to the clivia planting, almost all *Clivia miniata*. For me, this part of the tour was extremely satisfying. I had researched the McNeil collection when I was doing my university studies and now to actually be in the midst of this important *Clivia* collection was special indeed. The whole party had a guided tour of the collection. We listened intently to Margot and soaked up the spectacle of the mass planted *Clivia* that changed with every turn of the pathway.

While some took refreshments, those that wanted to purchase plants were able to select out the plant in flower, negotiate a price, and providing a suitable piece could be dug, ended up with some choice clivias. For those readers that have enjoyed the images of the 'Four Mary's' *Clivia*, you should see it *in situ*! I am so glad I was part of this tour. I know some of us stayed too long with Margot, but the time wasn't enough for me. James had a schedule to keep so it was time to go back down the rutted track through the thick scrub. We joined the others on the bus and headed for Mariepskop, our next C. *caulescens* habitat site.

By mid afternoon we had arrived at the offices of the Mpumalanga Reserve where the trailer was to stay while we took the bus up to the top of the area. Our host for this visit, Mr. Winners Mashego, joined the bus and

explained about the redevelopment of this pine and eucalypt forest back to indigenous forest trees. He also helped in getting clearance through the Air Force site on our way up. The drive to the top was steep but well worth it for the view once there. *Clivia caulescens* was seen growing under vegetation along either side of the roadway. I was surprised to see it growing in fairly exposed conditions, under shrubs and on rocky outcrops, at the top of the site. Cleaned seeds of *Clivia caulescens* were scattered all along the concrete roadway and the group discussed at length as to how they got there. (Probably rodents - see Connie and James Abel article, page 67, penultimate paragraph. Eds). It was a very relaxing time. After a slow descent to pick up the trailer, it was off to Graskop, which was to be the starting point for day three of the tour.

We set out for God's Window after breakfast, stopping along the way at several places to see more C. *caulescens*. The Pinnacle was amazing. Fantastic scenery was to be the order of the day. The C. *caulescens* habitat was different here to that of the forest on day one. The habitat was most surprising and to see the C. *caulescens* growing in the leaf mould on top of the rocks was an eye opener indeed. Huge plants with long stems. We also ventured into the thicker vegetation to view C. *caulescens*, still with the large stems, growing under the shrubbery. Lunch was at Bourke's Luck Potholes, on the Blyde River, where we were able to marvel at nature's handiwork. Quite a bit of shopping was done at the various stops during the day, as well as at the curio shops back at Graskop.

Day four, the day we were to leave Graskop for Pretoria, started out cool and overcast. We stopped at several scenic viewing points during the return trip. Our stop at Sabie gave me a chance to compare the horticultural planting at an old church with those that I am familiar with in Australia. I was aware of a lot of similarities. After the drive back to Pretoria the tour finished at the Abel's where we all had a meal and viewed the *Clivia* collection of Connie and James. A great way to finish the tour.

I was pleased I had joined the Caulescens Tour. So many things to see and learn: the C. *caulescens* in habitat of course, but also the countryside and the places we visited. A special part of being on the tour was the opportunity to interact with the other participants and to learn a little more about each of them. Even helped celebrate a wedding anniversary! James discussed suggestions for improving future tours, so if any of you were planning a trip to South Africa for the 2006 Conference, I would recommend you consider being part of a habitat tour like the Caulescens Tour.

The Caulescens Tour group.

C. *caulescens* growing lithophytically.

POOR MAN'S PEACH

Nick Primich

When I first started with clivias in the early 1980's I obtained three orange *Clivia miniata* from the wild. These three plants came from three different farms, and unfortunately I did not take care to note which plant came from where.

The one plant that I had named "**Wild Type I**" was the least prepossessing of the three. It had 20*mm* wide leaves or even less. The flower was small and insignificant, yet the other two plants passed into oblivion and this one gave me much of interest. It did not take long to grab my attention. When I selfed it, I noticed that one seedling had a light green leaf base. I was aware at this stage that this was the sign of a yellow flower, so carefully put the plant to one side. When it flowered it was indeed a yellow. Alas, even in those days of few and far between yellows, this one was a calamity. A small, pale insipid flower, with almost grass-like leaves. However, I selfed it and put it aside.

I duly planted the seeds and was most surprised when they all turned out with brown leaf bases. Over the years we had become aware that there were different types of yellows insofar as breeding goes. I always avoided "**Natal Yellow**", as there was a big mix-up there, and even today the picture is not quite clear.

I had obtained yellows from as many backgrounds as I could, but none of the pollen that I tried could produce a yellow seedling from this plant. It was a vigorous plant and soon produced offsets which I handed out to various breeders. Not one of these people ever informed me of success in producing a yellow seedling.

My next surprise from **'Wild Type I**' was when I crossed it with a yellow. I noticed the seedlings' bases had quite a variation from a good brown to a pale green. I discarded the dark bases and carefully tended the paler ones. I noticed some of the green ones took on a pale shade of brown as they aged.

The time came for them to flower, and they all opened yellow. Some of them had much improved flowers to those of the mother, but the surprise came when some of them started to suffuse with a pale orange. Gradually at first, and some even became a normal looking orange. Strong light accelerated the process. As we all know, the anthocyanin does not develop properly in the dark.

I had another plant, as far as I knew unrelated to this one, which opened pale orange, and the colour would gradually darken. One or two members told me they also had similar plants. Again light would speed up the process, and darkness would stop it.

As I no longer breed clivias I am not able to find out if a true-breeding line can be established from the peaches from '**Wild Type I**'. These are the plants that I called "**Poor Man's Peach**". They had quite a variation among them, but some were very lovely plants. Perhaps the new owners will do something with them.

Top, left: F2 caulescens Top, right: Fl '**Swamp**'

Above, left: '**Yoshi**' Above: '**Cinderella**'

Left: '**Warmheart**'

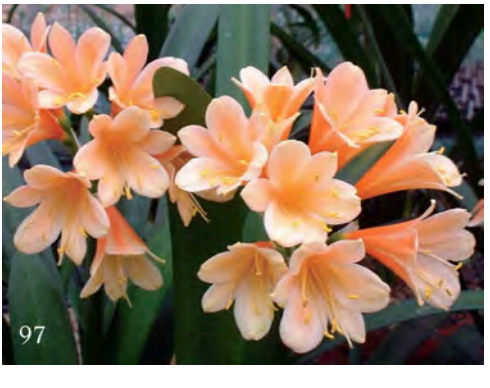
Below, left: F3 '**Moon**' Below right: '**Dainty**'

A selection of Interspecific *Clivia* bred by Wessel and Rudo Lötter

Above, left: **Pink Sensation**'.
(The incorrect photograph was published on page 48 of *Clivia Four*.)
Above, right: **'Ballerina'**

Right: **'Virna'**

Below, left: **'Rosy Cheeks'**
Below, right: **' Chandelier'**



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SOME OBSERVATIONS ON CLIVIA CAULESCENS

Connie and James Abel

The range of *Clivia* from the southernmost C. *nobilis* to the northernmost C. *caulescens* spans nearly 10 degrees of latitude and from sea level rises to about 2000m on the peaks of the eastern escarpment. C. *caulescens* occurs between 23°S and 27°S, overlapping with C. *miniata* in the south. However, this apparent inverse correlation between degrees S and altitude is almost certainly a temperature effect, with the Eastern Cape Province being temperate at the coast and the Limpopo Province being generally warm to hot, with the sub-tropical forest (and its C. *caulescens* with it) found at high altitude in the mountains for coolness. In the photo of Marieps Kop the C. *caulescens* are found on the top and sides of the distant peak, on eastern and southern aspects.

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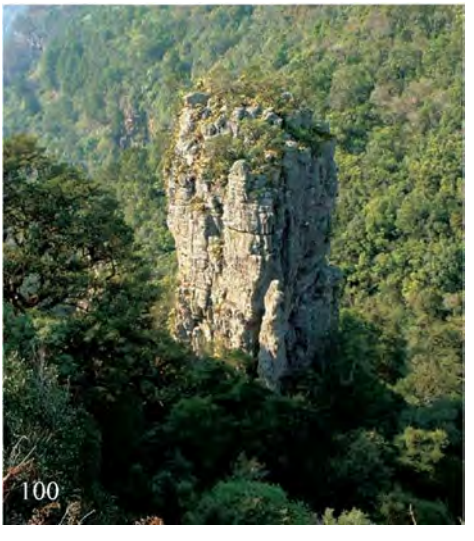
Rondavels and Mariep's Kop

C. *caulescens* are surprisingly tolerant of direct sun - there are many plants without shade at the top of the Pinnacle.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The Pinnacle

As with all the habitats that we have seen, C. *caulescens* populations occupy small areas of only a few hectares at most. Millenia ago the sub-tropical forests of southern Africa were very much more extensive, and one can assume that clivias would have had a similar distribution. As the climate has changed the forests have shrunk, and so have the habitats of C. *caulescens.* The individual populations are now isolated along the escarpment, from one to many kilometers apart. This may help explain differences in the plants in the various habitats, with each population having developed in isolation.

From a conservation viewpoint, C. *caulescens* do not seem to be valued for traditional (medicinal or spiritual) purposes by the indigenous folk. Another reason why many C. *caulescens* populations must be totally safe from human depredation is their inaccessibility on the high cliffs. The most striking feature of

C. *caulescens* is, naturally, the stem. The populations that we have seen show a wide variation in this respect, with the longest stems being at God's Window. On the habitat tour in September 2002 we were fortunate to find a stem of 2.2*m.* Several enthusiasts have commented that this must surely be a sign of extreme age. Within C. *caulescens* perhaps, but we do not believe that the stem in any way indicates that C. *caulescens* grows to a greater age than the other species - it simply elongates to a greater degree, so that one can have a gap of 20*mm*+ between leaf scars. We have seen bare stems in all three of the other common species, but in those cases the leaf scars are very close together and the stem has been short. It is likely that all species 'grow' at about 4 to 8 leaves a year and one would need to count leaf scars to judge the age.

All species can grow epiphytically on tall trees or lithophytically on rocks, and C. *caulescens* particularly so. In those positions they are subject to dry spells, but they are drought resistant due to the root structure with its thick outer layer of velamen cells, which act like blotting paper in soaking up and storing every bit of available moisture.

Clivia caulescens at God's Window

In this respect they are similar to orchid roots, which also have velamen. However, they seem to us to be purely opportunistic epiphytes. The seed is heavy, unlike the extremely fine seed of orchids which can be blown large distances by slight breezes. No *Clivia* seed was ever transported into a tree by the wind. They have been seen to be taken by monkeys (samango and vervet) and birds (Knysna loerie in particular), but it is unclear whether they are simply dropped during feeding or pass through and are later deposited with a nice kick-start nutrient mix. If they fall on a nice flat branch they thrive with the roots securing themselves in moss and ferns. We have only once seen an epiphytic *Clivia* (a C. *gardenii* near Kranskop) with roots clinging to the bare side of a branch as orchid roots do.

Why are *Clivia* not more prolific? We have visited a number of C. *caulescens* habitats in October/November, which is the main flowering time, and at maximum there have been 15% of mature stems with flowers. We would have thought that all stems would try to produce a flower each season, and have no idea why they do not.

And rodents are also important in distributing seed. During the recent C. *caulescens* trip to Marieps Kop |mountain] we were puzzled to see many nicely cleaned seeds lying on the hardened road surface, and assumed that they had rolled there from the verges. We then spotted a seed on top of a flat rock with no possible parent plant within metres. We decided that the berry must have been taken by a rat or a mouse which found a nice open eating spot, ate off the berry skin and left the seed. This theft of seed has been seen frequently in Pretoria gardens - if berries are suddenly missing a bit of searching will reveal a neat pile of seed under the leaves, with the rats having done the work and the undamaged seed ready for planting.

With C. *caulescens* habitats being on the escarpment the bonus in visiting them is that one travels through some of the most scenic parts of the country.

Above: Winner pastel C. *miniata* Section KZNCC 2002 Show. Grower: Pat Gore.

Above, right: C. *miniata* '**Salmon Sensation**'. Breeder and grower: Michael Jeans.

Right: C. *miniata* '**Golden Amber**'. Grower: Elroy Janse van Rensburg.

Below: Winner Interspecific *Clivia* Section KZNCC 2002 Show. Grower: Natal National Botanical Garden.

PROMOTING EARLY FLOWERING OF CLIVIA MINIATA SEEDLINGS

Ian Brown

Too many growers are waiting patiently for five years and more for their *Clivia miniata* seedlings to flower from seed.

One cannot know before a seedling flowers whether it's breeding has produced the desired flower colour or shape or whether it should be kept for further breeding. The advantages of getting it to flower as soon as possible are obvious.

Some growers use stratagems such as confining the roots in too small a pot or keeping the plants very dry for four months before the Spring flowering time, in the belief that the plant will 'feel' threatened and flower to ensure that its kind will at least survive by producing seed!

This is a myth. In fact Robbertse and van der Merwe point out in another article in this volume that stress caused by pot bound roots can cause the plant to abort its dormant floral buds. Dehydration can also cause bud abortion and will do no more than slow the growth of the plant. In fact here in Cape Town our *Clivia* are exposed to heavy rains before the flowering season, yet they flower well.

Honiball has pointed out (in the *Clivia Yearbook* 3, p.30) that the plant must develop through a juvenile stage before it will be sufficiently mature to produce a floral bud which can develop into an umbel. That juvenile stage encompasses development of its first 12 leaves.

It struck me, therefore, that the key to successful growing of early flowering C. *miniata* lay in promoting sustained, rapid, but healthy, growth during the juvenile stage to achieve production of those first leaves as soon as possible.

I set about achieving this and here are a few of my experiences.

For a few years I monitored selected seedlings and recorded the date when each new leaf appeared. I found that I could achieve 3 or 4 leaf growth in year one and another 5 or 6 in each of years two and three. I also found that good, strong root growth is essential for leaf development.

This was achieved by ensuring that the seedlings were grown in containers which did not restrict their root development. However, the container must not be so big that the roots will probably not fill it in that season. Rather transplant it into a larger container as soon as the roots fill the container.

Figure 1: One year old seedlings with four leaves each.

Figure 2: Seedlings left for one year in seed tray. In this cramped space only two leaves have formed.

The growing medium should always drain well and be well aerated and rich in vegetable matter. This must be kept barely damp (test it from time to time by pushing your finger into the pot) and not so wet that this could cause root rot. There must also always be sufficient light to promote growth without exposure to sunburn. Warmth is also required to promote growth. This is not usually a problem in the Southern Hemisphere but may require artificial aids in greenhouse culture. However, too much light or heat seems to retard the growth of small seedlings. James Abel has commented that both minimum and maximum temperatures are important as they limit or stop growth. Heating in winter to 18 degrees is considered to be too expensive for South African enthusiasts, but evaporative cooling to limit summer temperatures to 30 degrees is inexpensive if a tunnel with a wet pad is available.

The first two years are critical. If a plant has not grown 9 or 10 leaves after two years, it is unlikely to flower in year three.

Figure 3: Two-year-old plant in 20*cm* pot

Trial and error has led me to use the following growing program:

1.Seeds are sown in August/September. Before then it is often too cold and wet in Cape Town.

2. Use a fairly deep seed tray or pot. I find a depth of about 10*cm* is ideal.

3. Always use a well drained medium. A mix of two-thirds milled bark to one-third coarse compost (with no manure) works well. I use this for all sized plants.

4. As soon as the seed starts to wither away, start fertilising. I alternate **Kelpak™** (seaweed concentrate) and **Supranure™** 3N:2P:1K(22) i.e. (11 %N; 7,3%P; 3,7%K) weekly with occasional doses of **Chemicult™** (6,5%N; 2,7%P; 13%K). All are watered on. This would be too rich in nitrogen for flowering sized plants but gets small plants to produce good leaves and roots.

5. In April I transplant the seedlings (1 to 2 leaf size). These go two at a time into plastic bags of about the size of a 17cm pot.

6. I don't do much fertilising between May and July as it's too wet! From 1 August I use the same fertiliser progam as for the seed trays.

7. In April (18 months) I put the seedlings individually into 17*cm* or 20*cm* pots and leave them in these until they flower.

8. These plants are now treated like all my mature ones and are fed **Phostrogen™** (14:10:27) (an oxide formulation - see footnote. *Eds)* fortnightly from August with a very occasional dose of **Chemicult™**. I cut back on fertilising in December and January (often away on holiday!).

9. Of late I've put a little **BounceBack™** into my pots. This is an organic fertilizer made from steam sterilised chicken manure with 30*gm/kg* N :15*gm/kg* P:1 *gm/kg* K. (an Australian formulation - see footnote. E*ds*.)

(Note: All the fertilisers mentioned also contain varying amounts of micro and trace elements).

Generally one needs to produce as many leaves and roots as possible in the first two years. At flowering time each year one can check progress: hopefully 4 leaves in the first year, 9 to 10 in the second year and 14 to 16 when they flower in year three. Whatever you do, allow plenty of root space. Plants that are pot bound in their first three years will not be strong and vigorous enough to flower.

Seed that is imported from the Northern Hemisphere can well flower here after 2½ years and should flower after 3½ years. I had my first flower in September 2002 from seed sown in this millenium. This was seed from Mike leans sown in April 2000.

These C. *miniata* have been selectively bred in Europe for early flowering. We also have plants, however, which have better flowers or colours but mature more slowly, often taking 5 or 6 years to flower from seed. I have found that, whether my seedlings are from early or late maturing strains, they invariably mature more quickly when their growth is promoted in this way during their juvenile stage. The late maturers may not flower in 3 years but they can flower in 4 instead of 5 or 6 years.

You will find that, even when seedlings from the same parents are given exactly the same treatment, some grow better or faster than others. This is because even siblings have different genetic make-ups. You can thus identify the genetically weak seedlings bred from the same parents by their weak growth and cull them, unless they are promising for other reasons - for example unexpected green stemmed seedlings from champion parents which do not have yellow flowers.

A parent which produces vigorous seedlings when crossed with one plant, can produce weak seedlings when crossed with another plant. This again is a matter of how genes inherited from each parent are rearranged in their offspring. Some plants are also better pod parents than pollen parents, and vice versa.

Encouraging seedling growth in this way enables you, therefore, to find out far more quickly what the breeding characteristics of your individual plants are, and facilitates selective breeding.

Footnote: Fertliser Formulations

In a 1996 Newsletter Bill Morris commented on a fertilisation recommendation by Gerhard Reyneke at the first Clivia Conference in 1994. Among other points he noted the use of a 1.0.1(36), which in international terminology would indicate only 2% plant food. James Abel explained that in a typical formulation in South Africa *e.g*. 4:3:4(33), the first three numbers refer to the ratio of elemental N:P:K and the fourth to the total percentage by weight of N.P.K in the product. Thus that product would have 12% by weight N (i.e. 4x33/(4+3+4), 9%P and 12%K.

However, most countries specify their fomulations on the oxide equivalent forms of P - Phosphorus pentoxide (P_20_5) and of K - Potassium oxide (K_20).

To convert the elemental specification used in South Africa to the oxide based specification divide the P percent by 0.43 and the K percent by 0.83.

To convert oxide based specifications imported into South Africa to the South African elemental equivalent multiply the P number by 0.43 and the K number by 0.83.

The international use of the oxide contents is historic, but misguided (in the South African view) in that the 'oxygen' is not a plant food and may in fact not even exist - on the international basis Potassium chloride would be 0.0.60 (it contains 60% K_20 or 50% K), giving an impossible 110% chemical content since it contains 50% Cl.

We record our appreciation of James Abel's guidance in the preparation of this note.

E*ds*.

Clivia miniata bicolour. Breeder: Y. Nakamura

BEST ON SHOW

Left: Best on Show and Winner broad petal Orange *Clivia miniata* Section CCC 2002 Show. Grower: Felicity Weeden.

Below: Best on Show and Winner broad petal Yellow *Clivia miniata* Section EPCC 2002 Show. Breeder: Yoshi Nakamura. Grower: Charl Malan.

Right & above: Best on Show and Winner dark orange to red broad petal Section Metro 2002 Show. Grower: Pikkie Strumpher.

Below: Best on Show and Winner long broad leaf *Clivia miniata* in flower Section NCC 2002 Show. Grower: Dawie van Heerden.

A CLEAN SLATE

Keith Hammett, Auckland, New Zealand

I came to horticulture as a teenager via competitive flower shows in England. In the immediate post-World War II era ornamental horticulture enjoyed great popularity and specialist societies were strong in terms of both membership and the level of competition offered at flower shows, national and local.

The training and encouragement offered to me by top exhibitors of various flowers led me to obtain degrees in botany and plant pathology, and subsequently to travel to many parts of the world to study diverse aspects of horticulture.

I have continued to exhibit competitively and to judge flower shows in a variety of countries.

As I write, the *Dahlia* show season in New Zealand is less than a week away and I have blooms developing which are destined for the show bench.

However, despite my continuing enjoyment of exhibiting I have from time to time had cause to question what exhibiting does to the plants being exhibited. It is well known that congenital defects have developed in various breeds of cats and dogs where undue emphasis has been placed on certain cosmetic attributes.

During 2002 I had the privilege of being involved in the formation of the New Zealand Clivia Club and to stage the first specialist *Clivia* exhibition in this country. This was reported on pages 24 and 25 of *Clivia Society Newsletter* Vol. 11 No. 4 Summer 2002, and a picture of our non-competitive show is presented here.

A display at the New Zealand Clivia Club Show 2002

As yet the club has to hold an inaugural meeting and the members will need to determine what form the club should take and what to do. To this extent we have a clean slate. It is therefore perhaps worthwhile to pause and look at the track record of similar organizations to see what they have achieved. This is especially important at this time, as many long established specialist plant societies worldwide are in decline in the face of competition from many new recreational activities and changes in lifestyle.

In my experience there are two broad types of plant society, collector and exhibitor. For example in clubs and societies devoted to broadly defined interests such as Cacti and Succulents, Alpine plants or to genera that contain many species the emphasis is often on bringing together large collections. Much effort is put into discussing the variation that exists in the plant or group and on the growing conditions needed by each. It is useful to think of such societies as collector societies.

In contrast, for other plants the predominant focus of the enthusiasts is almost exclusively on holding competitive shows. Here the interest is to determine how closely growers can produce blooms to match a commonly agreed set of ideals. Such societies are closer to sports clubs and the real interest is on how well individuals are able to manipulate the plant.

Of course different plants are better suited to manipulation than others. Dahlias are supreme sports plants as there is a great potential to manipulate the bloom, both with regard to quality and timing. In contrast there is relatively little that can be done with a *Rhododendron*.

The *Clivia* has the potential to cover both areas of interest and more, provided that we keep sight of what we are doing. It is important for all organizations to regularly review what they are achieving and to beware of what is happening to kindred organizations. If this is done we may just avoid some of the pitfalls.

For me diversity is essential. Different approaches to a subject reflect local climate, culture and aspirations. Standardization is important to the extent that we need to communicate with each other. For example, it is useful to have a commonly accepted definition within C. *miniata* to distinguish a peach from a pastel or a picotee from a bicolour. Beyond this it is healthy for people to explore areas of development which appeal to them.

Classification

We could probably devise a broad classification which took into account characters like leaf width, broad/narrow, ratio of length to width, tepal shape etc., which could be agreed upon to facilitate communication worldwide.

Such a framework is useful in staging an exhibition, competitive or otherwise. However, what we must guard against is the unwitting imposition of arbitrary value judgments e.g. broad tepals are superior to narrow, trumpet shaped blooms are preferred to tulip shaped blooms per se. It is here where I start to have a crisis of conscience with regard to competitive exhibition.

So often once exhibitions of plants and flowers become competitive people lose sight of where they are taking the subject of their interest. Exhibition, like commerce, does influence breeding direction.

In essence an exhibition is an opportunity for people to compare plants side by side [collector motivation]. It can also be a means to encourage good husbandry and presentation of well-grown specimens (skill in growing motivation). The problem arises in balancing these two elements.

As an example, *Dahlia* shows in Britain are essentially elitist and are organized so that requirements for each class are demanding (*e.g.* 6 cultivars, five blooms of each, 6 vases). In this environment the comparative growing skills of each exhibitor are of more importance than the flower. In contrast American *Dahlia*

shows tend to be inclusive and attempt to encourage maximum participation at the same time displaying the range that the *Dahlia* offers. There are lots of classes calling for just single blooms; this enables the less committed or people with more modest means to participate.

Show Schedule

The classification defines the different types of plant and allows essentially similar plants to be compared. This is comparable to the weight divisions in boxing that ensure the combatants are matched for size.

It is however the schedule that is all-important in determining the direction and emphasis that a society adopts with regard to competitive exhibition. This in turn influences the breeding and longer-term development of those plants that attract a specialist following.

C. *miniata* 'Sir John Thouron'

In Britain the form of *Dahlia* blooms and the strength of their stems are the dominant features, while colour is of little consequence. Because of this, schedules are framed almost entirely in terms of form and size. As a consequence white and yellow blooms predominate at British shows, as they are easier to match in multi bloom exhibits. In contrast American schedules organize classes to cover the colour spectrum as well as size and shape of blooms. This has done much to retain the colour range and diversity of the cultivated *Dahlia*.

In the *Clivia* world there is similarly a clear difference in emphasis between Eastern and Western cultures. In China the focus of interest is on the leaf and plant shape, seemingly to the exclusion of the flower, whereas in the West flowers are important.

Judging criteria

Once shows become competitive it is necessary to establish judging criteria. Such criteria ideally define the elements that make a bloom or plant aesthetically pleasing. The problem is that it is difficult to frame such guidelines without at the same time unwittingly imposing a straight jacket. Again using Dahlias as an example, with the exception of Collerette and Waterlily types most other groups, irrespective of floret form or size, have become spheres on sticks.

It would be all too easy for C. *miniata* used for exhibition to become footballs on sticks. While such blooms can be undeniably beautiful in their own right they are less useful in floral arrangements and the problems of transporting such blooms would limit their potential as a commercial cut flower.

The other thing to remember with judging rules is that they come into play most consciously when judging plants or blooms that have obvious faults. A truly aesthetically pleasing exhibit tells you, you do not have to go and look for it.

The organization of competitive shows is a fine balancing act between classification, schedule writing and judging criteria as together they influence the long-term development of the plant. Once an exhibition culture is established it can be difficult to change direction or introduce new ideas. It is important that new forms can be displayed so that breeders can determine whether their developments have arrived at an appropriate time or place to be accepted.

In the same way that discussion of competitive shows has already taken up much of this article, exhibition based societies most

frequently lose sight of any other area of activity. Publications are dominated by show reports and names of exhibitors, while discussion of the plant rarely gets past how to produce prize-winning blooms or plants. Other aspects are marginalized.

Show plants often become bad or inappropriate garden plants. While a good Daruma specimen can be a great pot plant it will not match something like the inter-specific hybrid C. *caulescens* x C. *gardenii* as a landscape plant, either aesthetically or functionally. Exhibition based societies frequently equate a good garden plant with a failed exhibition plant and pay scant if any attention to the use of their plant in a garden setting.

While the concept of perfection is an illusion, plants under intense breeding pressure can start to approach the contemporary paradigm of perfection. When this happens, there is nowhere much for breeders to go. This can be discouraging, especially for newcomers. Interest wanes and societies fossilize, becoming little more than social clubs for the old timers.

There are many facets of interest to be covered in a plant like the *Clivia*. At this time many plants are under threat in the habitats where they have evolved. Custodianship of specific wild sourced accessions of the various species is an important role for any club devoted to a genus. We have a responsibility to pass on species, unsullied, to future generations. The curation of collections is not easy and certainly not short term. Responsibility needs to be widely spread both between individuals and countries. There are many cases where a small collection in another country has acted as a Noah's Ark for various plants and animals.

Interestingly, while societies devoted to ornamental plants are dealing at their core with aesthetics, very seldom is there any discussion as to the beauty of individual cultivars, or the components that contribute to that beauty. This lack is especially noticeable at a time when a plethora of magazines are devoted to the connoisseurship of food, wine, interior decoration and comparable areas of aesthetic interest. Fortunately the *Clivia* has the very exciting area of inter-specific hybrids for discussion.

So far, the *Clivia* movement in South Africa has done very well in not allowing competitive exhibition to dominate its activities and in being outward looking. It is healthy that different ideas prevail in the North, South and East. Publications have been of a high standard, covering a broad sweep of activity and the daily exchange of ideas worldwide on the e-group initiated in South Africa has been a healthy adjunct.

However, we should not become complacent, the teenage years are ahead in South Africa, while in New Zealand we are just starting, so it is a good time to pause and assess what we wish to achieve in the years ahead.

Winner narrow petal *Clivia miniata* Section CCC 2002 Show. Grower: Riël Lötter

NATURAL INTERSPECIFIC HYBRIDS IN CLIVIA

C. *miniata* X C. *caulescens* hybrids from Mpumalanga

John Rourke, Compton Herbarium, Kirstenbosch

Hybridization through man's deliberate intervention has played a pivotal role in Clivia breeding during the past one hundred and fifty years. Now there are not only first generation interspecific hybrids but a whole series of back crossings, resulting in plants of complex parentage, using the four species that have until recently been available to growers.

However, natural hybrids, that is, hybrids found in the natural habitat where two species grow sympatrically, flower simultaneously, and have by chance been cross-pollinated by birds or insects, have not yet been reported in *Clivia* literature as far as I am aware. I was first alerted to the presence of naturally occurring *Clivia* hybrids by Willem Froneman, horticulturist at the Lowveld National Botanical Garden in Nelspruit in the eastern Transvaal province of Mpumalanga.

When the Lowveld Garden was established in 1969 some *Clivia miniata* plants collected in the wild on The Bearded Man were planted out in the garden. (The Bearded Man is a 1455*m* high peak on the Swaziland-Mpumalanga border, capped by a patch of Afromontane evergreen forest, inhabited by both C. *caulescens* and C. *miniata*). At the time the plants were collected all were in a vegetative state and were assumed to be C. *miniata* but on flowering one or two hybrids appeared bearing flared tubular flowers. Clearly, they were natural hybrids taken unsuspectingly from nature when not in flower. Could there be any more of these natural hybrids still growing in their natural habitat?

I made several trips to The Bearded Man to examine the *Clivia* populations there, but never succeeded in finding any hybrids. An interesting form of *Clivia miniata* predominates at this site. Growing at nearly 5000 ft (1455*m*) above sea level this form presumably has a higher degree of cold tolerance than the Transkei or Natal forms that occur in coastal forest at sea level. Individually the flowers are much larger than Transkei *Clivia miniata*, but the umbels are usually fewer flowered and flowering occurs much later, usually from mid October to November. In part this is a response to a cool, elevated habitat but it is also genetically fixed as plants brought back to Kirstenbosch have continued to be late flowering. These features alone make The Bearded Man populations of C. *miniata* particularly interesting.

Figure 1: Pale, blush pink form of C. *caulescens* from The Bearded Man, Mpumalanga.

On the moister southeast facing side of The Bearded Man summit, C. *caulescens* can also be found, growing on steep rock faces. It too flowers in late spring and early summer. A most unusual, arresting colour form - a pale blush-pink, occurs at this site (*Figure* 1). Both species were observed flowering in late spring but despite a careful search no hybrids could be detected.

Then, an opportunity arose to make a winter visit to The Bearded Man. Neither C. *caulescens* nor C. *miniata* were in flower in late July but to my great surprise several obvious natural hybrids were in full bloom. They were a delicate pale blush apricot, clearly betraying the pale blush-pink genes of the adjacent C. *caulescens* in their parentage.

Most significantly, the examples I saw were all very old plants with well developed rhizomes just over 50cm long - another legacy of C. *caulescens* in their parentage. They had probably been growing there undisturbed for well over 50 years, if not longer.

Two hybrid plants were selected from the wild population for cultivation at Kirstenbosch, both with pastel flowers. These have been grown on for several years and have flowered annually at different times between May and July and on one occasion in November. Both are exceptionally robust and vigorous with showy umbels carrying between 27 and 29 flowers (*Figure* 2).

The presence of such hybrids in nature immediately raises the question of pollinators. Orange-red tubular flowers like the normal colour form of *Clivia caulescens* are almost invariably pollinated by sunbirds although reliable confirmed sightings have not been reported in this particular case. Would sunbirds be attracted to pale pink forms? The best we can do is to assume that the likely pollen vectors in bringing about a C. *miniata* x C. *caulescens* cross (or *vice versa*), at this particular locality, would have been sunbirds.

Figure 2. Natural hybrid (C. *miniata* x C. *caulescens*), from The Bearded Man, Mpumalanga.

Another interesting feature of these hybrids is the shift in flowering time from late spring (both parent species) to early or mid winter (hybrids). Precisely why these hybrids should flower several months earlier than either parent is not clear but it certainly provides a useful extension to the flowering season. Willem Froneman tells me that some of his wild-sourced natural hybrids from the same locality flower several times a year but that there is no predicting as to when flowering spikes will be produced.

One might also expect to find natural hybrids between other species although I have not personally observed any and to the best of my knowledge none have been reported. *Clivia miniata* and C. *gardenii* grow together at numerous sites in Natal and the Transkei but their significantly different flowering times virtually preclude naturally occurring cross pollination from taking place. The only other possible combination is C. *nobilis* and C. *miniata*. These do have flowering times that overlap. I have observed these species growing sympatrically at just two sites; one, at Qora mouth in the Transkei, the other in the lower Kei River valley at the confluence of the Gaguga River and an unnamed stream. In both instances no obvious natural hybrids could be found. It is of course entirely possible that like the C. *caulescens* x C. *miniata* hybrids from The Bearded Man these would bloom outside the main September flowering period and would therefore not have been evident at the time of my visit. But this is mere conjecture until field observations prove otherwise.

Observations on naturally occurring *Clivia* hybrids in wild populations are woefully scarce as are reliable data on pollinators. This is an open field where sound observations and photographs of pollinators in action by naturalists and wildlife photographers can contribute much to our knowledge of Clivias in the wild.

Interspecific *Clivia:* Grower: Mick Dower.

NOTES ON POLLINATION AND POLLEN TUBE GROWTH IN *CLIVIA* MINIATA

Hannes Robbertse and Mariné Pienaar

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Some information about the structure and function of the *Clivia miniata* pistil (stigma, style and ovary) is supplied in an article in the *Clivia Yearbook* No 3. *Figure* 4A in that article shows the stigma papillae (hairs) on one of the three lobes of the stigma and *Figure* 4B shows pollen grains adhering to the stigma papillae after hand pollination. In the present communication, we provide illustrated notes on pollination, germination and pollen tube growth in the stigma and style and also include a revised concept of the *Clivia* stigma.

In discussions amongst Clivia Society members, questions like when and how frequently to pollinate are often raised. During the past flowering season (September 2002), Marine, one of the students in our Department spent a day in my garden pollinating freshly opened flowers. Before pollinating a flower, the stigma was inspected to make sure that three stigmas had separated (stigmas with style lobes not yet separated are not receptive) and that 'natural' pollination has not happened. Since there was no insect activity on the flowers, no steps were taken to cover the pollinated stigmas. Pollinated flowers were collected one hour, two hours, five hours, twelve hours and twenty-four hours after pollination in an attempt to determine the rate of pollen germination and pollen tube growth. The style and stigma of each flower was carefully removed from the flower and preserved in a solution containing acetic acid, chloroform and alcohol for a few days. They were then softened in concentrated solution of Potassium hydroxide and cleared in commercial **Jik** (liquid chlorine solution). The cleared styles were then stained with Aniline Blue and observed with a fluorescent microscope fitted with a digital camera.

On the day the pollination was done, Pretoria experienced a cold spell, with the day temperature plummeting to 15°C. In spite of the cold weather, all stigmas collected one hour after pollination, except those that were not yet fully receptive at the time of pollination, contained germinated pollen grains with pollen tubes well established within the stigma.

Figure 1: One style lobe penetrated by pollen tubes coming from pollen grains on the stigma

Five hours after pollination the pollen tubes had already reached one third of the length of the style on their way to the ovary (*Figure* 1) and had reached the ovary after 24 hours.

In the previous article it was mentioned that the *Clivia* stigma is three-lobed. In this investigation it became clear that it is actually

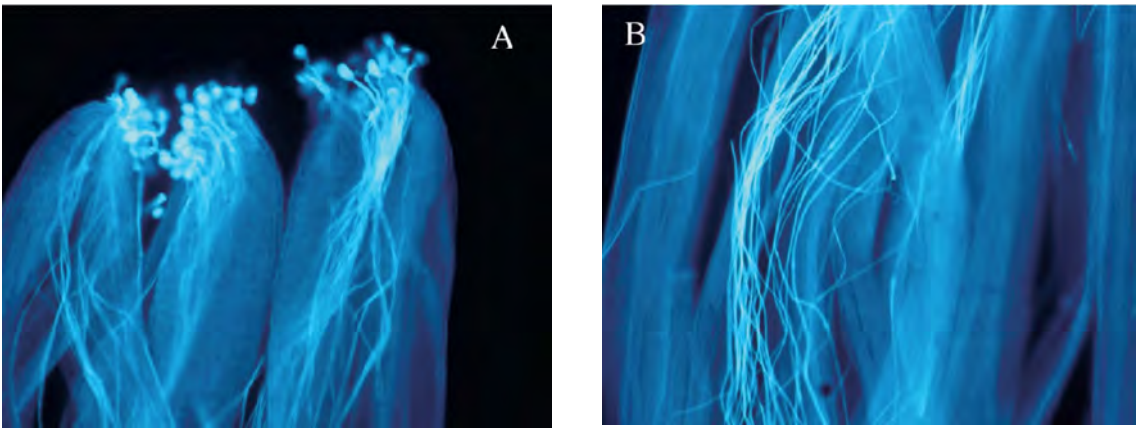


Figure 2. Fluorescing pollen tubes in *Clivia miniata* stigmas and style. Material collected 12 hours after pollination. A showing germinated pollen grains on stigmas and in style lobes. B showing pollen tubes one-third the length of the style down to the ovary.

the terminal end of the style that divides into three units, each terminating in a separate stigma. The *Clivia* flower, therefore, has three separate stigmas, each operating independently from the others (*Figure* 2A). The implication of this is that each stigma can be pollinated with a different kind of pollen. In the style the three bundles of pollen tubes coming from the three independent styles, remain separate. Although not yet confirmed in this study, it could be possible that the pollen tubes from one stigma will serve the ovules in the corresponding ovary locule. (See *figure* 2 page 17 in *Yearbook* 3)

Looking at the number of pollen tubes growing down each style lobe (*Figure* 2) and considering the number of ovules to be fertilized per locule, one single pollination operation should be quite sufficient for a good seed set, provided viable pollen is used and receptive stigmas are pollinated.

C. *miniata* '**Floradale Apricot**'. Breeder: Gerald Muller. Grower: Mick Dower

A VISIT TO MR. YOSHIKAZU NAKAMURA IN JAPAN

Charl Malan

I left Grahamstown on Friday 15 March 2002 in great anticipation of my long overdue visit to my *Clivia* friend, Mr Yoshikazu Nakamura. The journey by air took me via Johannesburg and Hong Kong to Tokyo where I arrived 20 hours later on Saturday.

The plants which I took with me as gifts were cleared very efficiently by the Plant Quarantine Office at Narita Airport and an hour later I was met by two friends of Mr. Nakamura's, namely Masashi Yamaguchi and Shigetaka Sasaki. Masashi had handled all English /Japanese translation in my preparations for the trip and had most kindly offered to put me up in his home in Yokahama City He also accompanied me and interpreted for me during most of my visit.

Shige likewise provided all transport during my stay and is an excellent driver. Both of them are fervent *Clivia* enthusiasts and from the moment they met me we went on a *Clivia* roller coaster!

From the airport we drove straight to Shige's flat to see his *Clivia* collection. The route took us around the sweep of Tokyo Bay and on this clear night, the dazzling display of lights was wonderful. Shige stays in a suburb of Tokyo and keeps an astonishing number and variety of *Clivia* in his flat. As he is unmarried, no one seemed to mind!

Shige and Masashi run the 'Clivian' website and Shige in particular is planning to breed *Clivia* at some stage in the future. He has a most impressive collection and makes use of Mr. Nakamura's expertise in his breeding programme.

Shige dropped Masashi and myself at 01:00 at Yokohama City and after a shower I got to bed at 01:30 on the Sunday.

Masashi stays with his parents in a beautiful three-story house, I was allocated a comfortable room on the ground floor where I found the following:

A futon bed in the middle

A Buddhist temple set in one wall

Two Clivias in full flower on the floor

Wonderful artworks throughout.

Needless to say, I did not fall asleep for some time as a result of the 20-hour flights and excited anticipation of the next day"s visit to the *Clivia* Breeding Plantation. I woke up early and went for a walk in the neighbourhood. Other early risers were walking dogs, going to work, preparing the park for baseball practice, and so on. Window boxes, both in and outside were in full flower and it was obvious that Spring was in the air! All over the neighbourhood, I saw small container gardens at entrances to houses and the most common denominators were - guess - *Pelargonium* and *Aloe!*

The cherry blossom spectacle was only just beginning and during my stay I only saw one tree in full bloom: what a sight!

The weather was wonderful throughout my stay and the heavy jacket that I carried wherever I went, was totally unnecessary. By the way, I only met Masashi's parents then as we had come in too late the previous evening.

Shige arrived, and at 09:30 we were on our way to Chiba. We grabbed breakfast at a takeaway - cold tinned coffee is very popular and a supply is always available.

Once again we drove through Tokyo, which is one endless metropolis. Once we crossed into Chiba Prefecture, the city began giving way to countryside. The peninsula consists of rolling hills with rice paddies in the valleys (dry in March), and indigenous forests on higher ground. Bamboo of all sizes and descriptions abound in these forests. I saw beautiful golf courses, Olympic training facilities used by athletes from all over the world and the Japanese enjoying a wonderful sunny and warm day in the open.

Charl Malan at *Clivia* Breeding Plantation

We finally arrived at the *Clivia* Breeding Plantation, where Mr, Nakamura and his father met us. Yoshi was very excited and couldn't wait to show us all the *Clivia* in flower. For the next two hours we examined virtually every *Clivia* in the collection. He had moved several plants into a special warm tunnel to open their flowers in anticipation of my visit. Particularly impressive were the Vico hybrids - large yellows and oranges with the latter in wonderful varied colours. It is obvious that this strain is his favourite for breeding top quality flowers, and the range produced is amazing.

Apart from the flowering plants, the popularity of variegated plants in Japan is reflected in the huge breeding stock and many seedlings on display.

I made some interesting observations and picked up handy tips. Plants in Mr. Nakamura's large glass house are kept under a very dry regime, to combat the inevitable problem of disease associated with overwatering, excess humidity, etc. The temperature in winter is manipulated by the use of a coal fired heating plant.

We exchanged gifts and I took many photographs. Next we departed for the coast with Mr. Nakamura who was going to host us to lunch and show us some *Clivia* sights on the way. We meandered through a beautifully forested district until we reached the sea. The coastline is quite steep and in many places on the coastal road we drove through tunnels. The sea was a beautiful turquoise colour with small fishing harbours in every cove.

Mr. Nakamura hosted us to lunch in a traditional Japanese seafood restaurant. Most of the fare on the menu was swimming in a large aquarium in the foyer and as dishes were ordered the chef would net what he needed: a fish, crayfish, clam, etc.

We took off our shoes and were seated at a low table in one of the rooms in the restaurant. The menu was exclusively Japanese and my hosts offered to order for me. We were immediately served hot green tea and also ordered beer. My food on a tray consisted of the following:

A small bowl of fish soup

A large dish containing savoury rice on top of which were two large fillets of white fish grilled in a puffed out batter (tempura). Around this dish were arranged smaller dishes with dried fish sauce, small blocks of turnips, various other sauces and condiments such as sliced tomato

A side dish of two grilled maasbankers (horse mackerel).

I could immediately see that it was far too much for me to handle but I battled through it with a small teaspoon and cake fork, which were the only Western utensils available. The fish was delicious.

Mr Nakamura, Shige and Masashi ordered dishes, the main ingredients of which

consisted of raw fish of different descriptions. They are super deft with the chopsticks and finished their meal before I was halfway through mine!

Through all this we had discussions about my family origins. They were absolutely fascinated with the Huguenot history and the fact that the Malan family has been in South Africa for 11 generations.

At a neighbouring table a family of father, mother and daughter consumed copious quantities of beer with trays of food similar to those of my hosts, but they were also served a fish dish arranged on a large platter placed in the centre of the table. The centre of the arrangement was a rock cod, which I had seen in the aquarium earlier. Its fillets had been sliced into thin slivers and replaced on the fish and were now being picked out with chopsticks.

The name of the restaurant is Funayoshi 'good ship', and is situated in a village with the name of Arnatsukorninato - 'Small Port of Heavenly Seaside'.

The coast around there is popular with the Japanese for watching the sun rise at New Year.

From there we proceeded further East until we reached the flower market which Mr Nakamura had promised to show us.

The shopping centre is situated at the waters edge and had a large number of *Clivia* on display (not for sale), but also a large number of plants for sale. Many of the plants were in full bloom and ranged from large multipetals, through akebono variegated to seedlings of all descriptions.

I purchased a broadleaf Akebono seedling (±18 months) for 3 000 yen, i.e. all of U.S$23.00. There were many more expensive plants, way beyond my means. Akebono variegation is extremely popular in Japan and for the uninformed it refers to horizontal, instead of the more common vertical, variegation in the plant leaves. Mr. Nakamura bought quite a few multipetal plants.

There were many South African plants on sale including a *Gloriosa* hybrid with cerise pink and yellow flower petals, the whole colour range of *Zantedeschia* and beautiful zonal Pelargoniums of all descriptions.

All too soon we had to leave. Outside a cool wind had sprung up and we were greeted by a wonderful sight - large numbers of small brown kites were hanging in the sky. This must be a marine bird species, which I think I've seen in books on Japan.

Although it was 5 pm, Mr Nakamura decided that we must visit a *Clivia* friend of his in the nearby hills. We eventually turned off the main road onto a narrow elevated concrete road onto which our car barely fitted and it took all of Shige's skill to negotiate this road, which meanders through rice paddies and ends on a farm up in the hills.

Mr. Nakamura found his friends, husband and wife, still at work in their tunnels of *Clivia*. Mr.Nakajarria is probably Japan's largest grower of multipetal *Clivia* and has a huge collection - we toured only 4 of the larger tunnels! The quality and size of the flowers are impressive and we were able to buy a few seedlings.

By the time we bade them goodbye, it was almost dark, and it took another hour's driving to get back to the *Clivia* Breeding Plantation. There we washed and packed my plants under spotlights rigged up by Mr. Nakamura. He then took us to dinner in nearby Yokohama City in a Spur style restaurant where we did not have to take off our shoes! The menu was a huge laminated plastic book with a photograph of every dish. I chose a pork schnitzel and my hosts again had traditional meals with varieties of Sushi / fish, eggs, etc.

Mr Nakamura insisted that Shige and I visit him again on the next day. We finally bade goodbye to Mr. Nakamura who had followed us in his bakkie (LDV), and headed for home. Shige dropped Masashi and myself at home at 02:00. After showering, I climbed into bed at 02:30. My head was still spinning from the flights and sleeping was difficult. I woke at

Masashi, Yoshi, and Shige

06:00 and again spent a while outside. It was my 47th birthday and a glorious, warm and sunny day.

Masashi could not accompany us on the Monday, as he had to work. His mother cooked us breakfast, after which we bade our farewells. Shige picked me up at 08:30 and again we headed out to Chiba. At the *Clivia* Breeding Plantation we did another detailed tour of the Glasshouse and discussed the merits of many plants in some detail. I was most fortunate to receive some wonderful plants as gifts.

We said our final goodbyes and Shige and I proceeded to Narita Airport where we had lunch and he saw me off at 15:00. I arrived back in Port Elizabeth the next afternoon.

A mad, exhausting but wonderful 5 day trip!

Thumbnail photograph 119, p. 83: Winner Miniature *Clivia* not in flower Section KZNCC 2002 Show. Grower: Yoshikazu Nakamura.

Below: Winner C. *miniata* any other colour with a green throat Section. Metro 2002 Show. Grower: Pikkie Strumpher.

CLIVIA MUTATIONS AND MODIFICATIONS

Wessel Lötter

Colour

In my article on *Clivia* mutations and colour variations, (*Clivia Yearbook* 1998), I explained flower colour to be the combined effect of anthocyanin in the epithelium (upper layer) and carotenoids in the mesophyll underneath.

Further information has now revealed that:

a. The anthocyanin in *Clivia* is synthesized in to two end products, namely pelargonidin in the flowers of C. *miniata* and cyanidin in the berries and seedling bases. Some of the tubular species however contain both pelargonidin and cyanidin in the flowers.

b. Colour of the flowers is also influenced by the pH of the cell. A lower pH (acidic) produces darker shades and a higher pH (alkaline) paler shades.

By extracting the pigments from the cells, one can make a solution that changes colour according to the pH. When experimenting with *Clivia* pigments, a solution with pastel flower pigments changed to red by adding acid. Yellow flowers showed no change because they do not contain any anthocyanin.

There are 6 genes that influence the pH in the cell. To find out what role intracellular pH plays in the expression of flower colour, scientists inserted a jumping gene on the pH-6 gene. This abolished the function of the pH-6 gene and resulted in very pale flowers. When the jumping gene jumps out of the pH-6 gene's position the function of the gene is restored and spots appeared. It was concluded that paler flowers could be the result of a mutation on one of the 6-pH controller genes.

Griesbach, who has been working for 15 years to solve the flower colour puzzle, states that the colour is influenced by the interaction of pigments, cell pH, light and temperature. The slightest fluctuation in any of these factors will cause the colour to alter. Griesbach used petunias for his research, proving that specific shades of colour resulted as the combined inheritance of pigments and cell acidity.

When Griesbach and Koopowitz did specific work on the genus *Clivia*, they confirmed that the colour is drastically influenced by the pH in the vacuole. They have also found that there may be more than ten co-factors influencing the colour in a single *Clivia* flower and that the pelargonidin in a *Clivia* flower can be divided into two types: Pelargonidin-3-glucoside and pelargonidin-3-rutinoside. The ratio of these two in the cells can also influence the colour.

Pastel coloured flowers are therefore not necessarily the result of a single factor, but may vary genetically from one pastel to another. They remain scarce and are not easy to breed in numbers. The exception is Chubb Peach, which is a single gene mutation on the same locus (position on the chromosome) as group 1 yellows. As it is dominant over group 1 yellow, it is now being bred in significant numbers.

Attempts to breed pastels by crossing Chubb Peach to other pastels such as Naude's Peach and Wittig's Pink resulted in mostly orange flowers. Another example of how different these pastels may be was demonstrated by crossing Natal Yellow as pod parent to two different pastels. All the crosses with Naude's Peach were very pale, about midway between Naude's Peach and orange. In vast contrast the Meyer's Peach crosses with Natal Yellow were dark orange-red. The inheritance suggests that Naude's Peach is co-dominant and Meyer's Peach recessive.

The green in the throats of some flowers is not an additional pigment but is due to the

C. *miniata* '**Naude's Peach**'.

C. *miniata* '**Meyer's Peach**'. Note the dark orange-reds in the background from which it originated.

C. *miniata* '**Natal Yellow**' x '**Naude's Peach**' (left) and '**Natal Yellow**' x '**Meyer's Peach**' (right)

presence of chlorophyll. Chlorophyll can appear in any parts of a plant that is in contact with light. Chlorophyll is present in many developing flowers and is usually broken down as the flower matures. In the throats of *Clivia* flowers, chlorophyll appears as green stripes that contrast well with yellow, pastels, orange and even reds. Many modern day lilies have large green throats and are very popular. We still have a long way to go to increase the green in the throats of *Clivia* and a lot to learn about the inheritance of chlorophyll in the flower.

Chlorophyll is present in plastids within the cytoplasm of the plant cells. Plastids possess their own DNA and this is inherited independently of the nucleus genes. As very little or no plastids are transmitted by pollen to the progeny, the inheritance of green throats maybe maternal.

An apparent problem with green in the throat is that it is not always persistent. In many of these phenotypes it tends to disappear with aging. Others do not always flower green throats every year, indicating possible environmental influence e.g. fluctuations in temperature or light intensity.

The green throats, which the late Gordon McNeil bred, he named **Green Girl**. Bill Morris obtained seed from these in the early 80's. These seedlings flowered with a green throat every year and it is persistent. Bill wrote that the seedlings from a green throat pod parent also flowered with a green throat. This confirms maternal inheritance.

Yellow *Clivia* (group 1) have yellow berries, except for the Howick yellow, which has peach coloured berries. Howick yellow might be a very pale peach, which appears yellow, as a seedling from Howick x yellow flowered peach. Natal Yellow (group 2) sometimes shows red spots on some of its tepals. The berries are always heavily spotted when left on the plant, indicating an incomplete mutation or a 'leaky' gene.

This defective gene at the beginning of the anthocyanin pathway seems to have a different effect on the final products: pelargonidin and cyanidin, as the berries are always heavily spotted and the flowers mostly yellow.

We know that yellow flowers with red berries exist and also orange flowers with yellow berries. This is caused by a differentiation in the anthocyanin pathway to produce either cyanidin or pelargonidin as end products. The first few steps in the anthocyanin pathway for these two pigments are the same. A mutation at the beginning will cause yellow flowers and berries. Further in the pathway genes alter the pathway to produce pelargonidin in the flowers and cyanidin in the berries. The pathway now becomes two pathways. If a gene becomes non-functional in the cyanidin pathway the berries will be yellow but the flowers will still be orange. Likewise if a gene mutates in the pelargonidin pathway the flowers will be yellow and the berries red.

Modifications

Every living organism possesses modifying genes, these enable it to adapt to environmental changes through natural selection. Man has always exploited these genes to alter living things to his own taste e.g. domesticated animals and agricultural crops. *Clivia* is no exception, for instance the **Daruma** cultivar has been selected for short broad leaves. Modifying genes enabled Clivia breeders to select for broad leaves, multipetals and many more unusual strains.

Regulatory genes can also cause some modifications. These regulatory genes are responsible for the structural differentiation of the different parts of the plant for instance sepals, petals, stamens and the ovary with its pistil. Many double flowers are the cause of modified regulatory genes, where the stamens have become petaloids. The so-called green flowers, which are more leaf like in appearance, may well be the result of such a modification. These green flowers usually fail to open properly and persist on the ovary after pollination.

Multipetals are possible because of modifying genes, note that the stamens also increased (photo by Yoshikazu Nakamura).

This double flower appears to be a combination of multipetals and a modification of some of the many stamens into petaloids. Note the anthers at the tips of some of the petaloids.

In many cases the inheritance of modifying genes is co-dominant. Further breeding with unusual phenotypes such as green flowers and multipetals will teach us more about their breeding behaviour. What the future holds for *Clivia* depends on the breeder's ability to recognise and select for appealing traits. There is no doubt that many more modifications will appear.

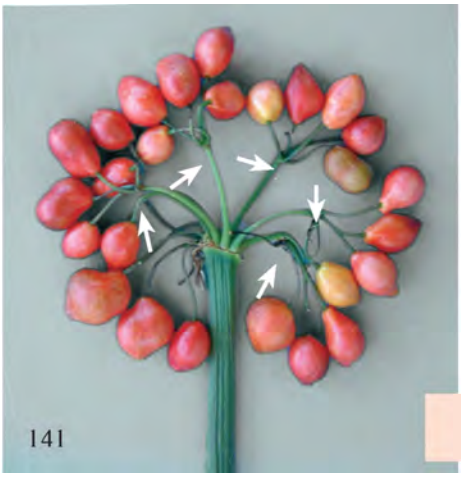
Winner C. *miniata* Peach with two umbels Section KZNCC 2002 Show. Grower: Bertie Guillaume.

C. *miniata* pastel. Breeder and grower: Roly Strachan.

Winner orange C. *miniata* Section KZNCC 2002 Show. Grower: Coenraad Vermaak.

Above: Winner yellow C. *miniata* with broad petals Section NCC 2002 Show. Grower: Pat Gore.

Left: Winner C. *miniata* peach Section KZNCC 2002 Show. Grower: Marie van der Merwe.



SECONDARY PSEUDO-UMBELS IN CLIVIA MIRABILIS INFLORESCENCES

John Rourke,
Compton Herbarium, Kirstenbosch

Clivia mirabilis fruiting inflorescence showing five secondary branches (pseudo-umbellula) each bearing four to five berries.

The occurrence of secondary flower heads in the inflorescences of certain petaloid monocotyledons is an unusual and quite rare condition. *Agapanthus* does occasionally produce secondary structures but this phenomenon has not yet been reported in *Clivia* as far as I am aware. The inflorescence in *Agapanthus* is technically a pseudo-umbel while the secondary branches are referred to as pseudo-umbellula (Muller-Doblies, 1980). Precisely the same terminology applies to *Clivia*.

Fruiting inflorescences of C. *mirabilis* were collected at Oorlogskloof by Northern Cape Nature Conservation staff in February 2003. The seed was then sent to Kirstenbosch as part of a newly initiated programme to cultivate and distribute this species to growers world wide. Among the fruiting heads received were five berry bearing heads that were found to have small secondary pseudo-umbellula branching from the main umbel.

Normally in *Clivia* the umbellate inflorescence contains a number of flowers borne individually on flower stalks (pedicels) arising at the apex of the inflorescence stalk (peduncle). In the aberrant examples between three and five small secondary peduncles were produced at the apex of the main peduncle, carrying between four and eight flowers. The secondary peduncles ranged from 25-30*mm* in length, while the pedicels were usually between 15 and 20*mm* long, rather shorter than the pedicels in a normal inflorescence.

These secondarily branched inflorescences were apparently collected from different parts of Oorlogskloof, so this curious morphological character is not unique in the population. It remains to be seen whether the characteristic of producing secondary pseudo-umbellula is an inheritable one or whether it is merely the result of a developmental abnormality that crops up randomly. We propose to keep the seeds from these inflorescences separate in order to observe their future development so as to monitor the possible inheritance of this character.

Reference

Muller-Doblies, D. 1980. Notes on the inflorescence of *Agapanthus*. Plantlife. *Amaryllis Year Book* Vol. 36: 72 - 76.

C. *miniata* '**Westonbirt Perfection**'. Grower: Mike Jeans.

WAS THE PLANT NAMED CLIVIA NOBILIS IN 1828 'SURREPTITIOUSLY OBTAINED' FROM KEW?

John van der Linde

The late Amelia Obermeyer (Mrs. Mauve), who was a botanist at the National Botanical Institute in Pretoria, wrote the following in the August 1972 issue of *Flowering Plants of Africa:*

"By a curious coincidence two English botanists, Lindley and Hooker, separately published on the same day in October, 1828, a new genus based on the same plant. Lindley named this new genus Clivia *and Hooker called it* Imantophyllum. *In* 1830 *Roemer and Schultes (Syst. Meg.* 7:892*) chose the name* Clivia *and reduced* Imantophyllum *to synonymy. The plant in question was an introduction from the eastern Cape by Bowie and it grew in the hot houses at Kew and at Syon House, the residence of the Duchess of Northumberland. Lindley named the plant* Clivia nobilis *saying that such a compliment had long been overdue to the noble family of Clive. It is said that the plant described by Lindley 'had been surreptitiously obtained from Kew'."*

The final sentence, with its strong hint of ***Clivia*** theft and the receiving of stolen property back in the early 1800s, intrigued me. I set out to examine the evidence. I began by reading what the two botanists *closest to the action* had said. Were there any clues there? I then spread the net wider to other writers, looking for evidence of any crime. Finally, I set out to track the allegation to its source.

Lindley, in naming the plant *Clivia Nobilis*, said "*This noble plant is supposed to have been one of the discoveries of Mr Bowie at the Cape of Good Hope, from some of the inner districts of which colony it was probably procured. The plant from which our drawing was made, flowered for the second time in July last, in the princely Garden of his Grace the Duke of Northumberland, at Syon house, and was communicated to us by* Mr. Forrest*, to whom we are indebted for several observations upon its habit and characters."* Lindley also says *"We have named this genus in compliment to her Grace the Duchess of Northumberland, to whom we are greatly indebted for our opportunity of publishing it."* (1)

The plant flowered for the second time in July, more or less the time one would expect a ***nobilis*** to flower in the Northern summer. This suggests that the plant was well-acclimatized to the Northern Hemisphere, and was probably imported before 1827 .

The noble couple would almost certainly not have been directly involved in buying the plant; the Head Gardener would normally have dealt with suppliers. The said Mr. Forrest became Gardener to the Duke at Syon House in 1826. If the plant had been bought by his predecessor, Forrest may not have known its source. Lindley refers to Bowie as having discovered the plant but the words he uses do not actually say that the plant at Syon came from those introduced by Bowie to Kew.

Bowie is certainly credited in the records of Kew as having introduced ***Clivia nobilis*** to Kew. He must have done this when, or before, he was recalled to England in 1823, after his contract to collect plants in South Africa for Kew had been terminated. All ***nobilis*** plants he may have collected then would all have belonged to Kew. There was of course nothing to stop Bowie legitimately importing plants

to England on his own account, but only after his recall in 1823, as speculated below.

In naming the plant *Imantophyllum aitonii* (after William Townsend Aiton) in the October 1828 issue of *Curtis's Botanical Magazine* Hooker gives considerably more detail than did Lindley: *"Mr. Bowie..... in the summer of last year, immediately previous to his return to the Cape, mentioned to me a* Cyrtanthus *- like plant, which he had there found and imported, and which if it blossomed in this country, he desired might bear the specific name of his patron,* Mr. Aiton. *At the same time the letter enclosed one or two wild specimens of the flowers, and a small piece of the leaf....".* Does the use of the word 'imported' imply that Bowie was already in England, *i.e.*, between 1823 and 1827, the year he returned to South Africa?

Hooker, then goes on to say that a specimen of the plant had flowered in October 1827 *"in the noble gardens of Syon House"*, and that "*Mr. Forrest ... kindly reguested His Grace the Duke of Northumberland's permission for a drawing to be made of the plant..."* Clearly a plant had also flowered at Kew, because W.T. Aiton, Director-General of all the Royal Gardens, including Kew, *"has likewise been so obliging to send me a drawing and specimens of the fruit...."* Aiton also consulted Bowie's notes, stored at Kew, to tell Hooker that the plant(s) at Kew had been found *"on shaded spots, near Quagga flats, and more common in the Albany tracts, near the great Fish River".*

Forrest would hardly be likely to have knowingly drawn attention to a plant that had been 'nicked' from Kew; similarly if Aiton had known that a plant 'surreptitiously acquired from Kew' had flowered anywhere else he is hardly likely to have co-operated in supplying further information on the plant, especially if it were to be named for him! This would have made him an accomplice to theft.

There had in fact been thefts from Kew; plants that were exclusively Kew's were appearing for sale in nurseries, probably smuggled out with the assistance of garden staff, bribed by middle-men who could make a profit, on-selling to eager customers. In 1824 it was found that the keys to the Royal Gardens at Kew had been counterfeited and all the locks had to be changed.

Robert Sweet, the manager of Colvill's nursery (which incidentally had a large collection of Cape bulbs) in Kings Road, Chelsea, was accused of receiving some choice Australian plants stolen from Kew. Aiton was determined to make an example of him and the case was heard at the Old Bailey in February 1824. *"Sweet's unblemished reputation, vouched for by other nurserymen, secured his acquittal on technical grounds".*

So, going on what I had discovered to date there did not seem to be any evidence that the plant at Syon House had been 'surreptitiously obtained from Kew', even though other thefts from Kew had indeed taken place. So where did the plant come from? From Hookers' account which ties in with Lindley's in this regard, one could perhaps, at a stretch, conclude that it came from an importation by Bowie some time after 1823, when he was no longer under contract to Kew. Important to the story is the wording of Bowie's contract to collect for Kew. Exclusive supply to Kew was demanded: *"Should a plant sent by you to Kew appear in any other garden, an enquiry will immediately be set...."*

Then along comes the very well-connected Rev. William Herbert, the multi-talented bulb expert and younger son of the Earl of Carnarvon, with a more conclusive explanation. I repeat in full his account, given in his classic monograph *Amaryllidaceae* published in 1837:

"This beautiful plant was first discovered by Dr. Burchell, in whose herbarium, soon after his return from Africa, I saw a fine specimen, which not having been carefully examined, had been mistaken for an Agapanthus, *to which its root and leaves have a striking affinity. I soon after became possessed of a plant of this species, brought over by an officer who had been employed on the Caffre frontier, and I recognized it to be the plant I had seen in Dr. Burchett's herbarium, but concluded it to be an* Agapanthus*. Not long after, I obtained for* Mr. Tate*, from the kindness of Dr. Burchell, a precise account of the spot where he had seen this plant; the result of which was a large importation of the roots;*

but after they had vegetated, Mr. Tate mistook them for the common Agapanthus*, and was about to dispose of them as such, when I saw them accidentally, and immediately recognized them. One of the plants flowered for the first time in this country in the collection of the Duchess of Northumberland, after whom it was named. By a singular accident it appeared on the same day in the* Bot. Reg. and Mag.*, being named in the latter work* Imatophyllum aytonii, *but the name* Clivia nobilis *has been generally preferred. Sir W. Hooker was mistaken in supposing Mr. Bowie to have been the first discoverer of this plant. Indeed, roots of it were in my hands before he had seen it in Africa. If is a plant of perfectly easy culture, requiring no particular care but to shelter it from frost, and it flowers freely in the greenhouse if placed near a front light, and ripens its seeds; but the seedlings are of very slow growth. The reason of its not having flowered in my collection earlier was that from the slowness of its growth I had been induced to put it in the stove, hoping that it might grow there more freely; but the heat increased its sulkiness."*

'Stove' was the word used in those days for a hothouse with artificial heat. Herbert says he saw the plant (a dried specimen?) soon after Burchell returned to England, which was in 1815. He says that there was a *"large importation of roots"* which subsequently *"vegetated"*. This would have taken several years - Herbert refers to very slow growth - and then one or more plants were sold, prior to flowering.

Tate imported the plants directly, maybe even before Bowie returned to England in 1823. lames Charles Tate had a nursery in Sloane Street, Chelsea, close to Burchell, who had collected in South Africa from 1810 to 1815, and who was then living in Fulham. Four other horticultural Tates are listed as having been born in Alnwick, Northumberland. What is significant about that is that Alnwick was the 'home territory' of the Duke of Northumberland, owner of Syon House.

If James Tate had a family connection with Alnwick then this may have given him an entree to supply plants to the garden at Syon.

Herbert says that his own plant was acquired from an army officer before 1823, the year Bowie returned to England. Tate may have used a similar contact in South Africa - Bowie complains about having to compete with officers who sent their troops out on plant-hunting expeditions!

So neither Hooker nor Lindley appear to have known of Burchell's dried specimen, or of Tate's importation. Were they both in so much of a hurry to publish that they missed this information? Hooker does not even seem to have seen the plant at Syon. (This did not stop him from ingeniously putting together the picture which accompanies this article - his *Imantophyllum aitonii,* from *Curtis's Botanical Magazine*, Vol. 55 of 1828. It is a collage based on a drawing of the plant at Syon House, on a *'drawing and specimens of the fruit'* of a plant at Kew, supplied by Aiton, and possibly also on a *'small piece of the leaf* given to Hooker by Bowie!)

With this additional evidence all three accounts seem to hang together, without significant contradictions, so where on earth did the *"surreptitiously obtained from* Kew" allegations originate? Robert Archer at the National Botanic Institute in Pretoria put me on a track which led back over the years from one source to another, each saying more or less the same thing, in more or less the same words; back to Saturday 29th October 1881.(2)

This was the date on which the weekly newspaper for the serious gardener, *The Gardeners Chronicle* of London, published the latest in a series of articles on earlier plant collectors. This issue was about James Bowie. No author is named and no references were given. The relevant section of the article, dealing with events nearly 60 years before, reads: *"In the country of the Orange River State he discovered the beautiful Amaryllidaceous plant which was received at Kew in* 1823*, and having flowered, was in* 1826 *figured and named in the Botanical magazine by Dr. Hooker (afterwards Sir William) under the name* Imantophyllum aitonii*; at the same time a plant which had been surreptitiously obtained from Kew flowered in the Duke of Northumberland's garden at Syon House, was figured and described by Dr. Lindley under the name* Clivia

nobilis, *both names appearing in their respective journals of the same date. Dr Lindley was reguested to forego the name* Clivia*, but refused to do so, and ultimately it became the popular name"*.

And there the trail goes cold. Who wrote that article and who were his informants? Perhaps we will never know. But what I can say is that he did not read Hooker (writing in 1828, not 1826), who set out exactly where Bowie found the plants growing - certainly nowhere near the Orange River State! Also, I find it hard to believe that any specialist writer at that time would not have known of Herbert's classic book and his version of events. Was that anonymous author simply doing what others did after him *i.e.* repeating without checking what had been written even earlier by someone else?

I did not let the matter rest there. To make sure this was indeed the end of the trail, I looked at other sources including the 465-page long very detailed *Kew: The History of the Royal Botanic Gardens* by Ray Desmond, former Chief Librarian and Archivist at Kew. Nowhere could I find any reference to the theft from Kew of a plant, subsequently to flower "*in the princely garden*" of the Duke of Northumberland, and to be published on the same day in October 1828 by two of the most prominent botanists in two leading botanical magazines in England. This must have been a high-profile event in horticultural circles. Surely there would have been some comment, if the plant had in fact been "*surreptitiously obtained from Kew"?*

My account contains speculations, but they - I submit - are logical, though they may not be conclusive. I would welcome any reader of this article to throw further light on this interesting episode in *Clivia* history.

Until then, case dismissed..... or should it only be adjourned?

I would like to thank Victoria Herriott of Syon House, and Topher Martyn, currently the Head Gardener there, for examining Forrest's"Alphabetical Catalogue of Plants of Syon garden", which he put together in 1831. I thought that might tell us where the plant came from. Yes, one *Clivia nobilis* appears on the list, but unfortunately there are no details of where it was obtained...

At an early stage in my research John Rourke drew my attention to Herbert's book and to his explanation for how the plant came to be at Syon House. When Harold Koopowitz's book *Clivia* was published I was interested to see his interpretation of this episode.

Michael Jeans and Drs. Robert Archer, Keith Hammett, Harold Koopowitz and)ohn Rourke helped me, also Prof. Donal McCracken, who is researching the life of lames Bowie. I thank them all.

Finally, you may have seen the Duke of Northumberland's two ancestral homes without knowing it; they have recently featured in three movies:

Syon House, Middlesex, in *Gosford Park,*

Alnwick Castle, Northumberland, in two *Harry Potter* films.

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In addition to the sources specifically mentioned above, I also referred to:

Edwards' Botanical Register, Oct. 1828 (1 182)

Gardeners Chronicle, 29 Oct. 1881 (568), which I traced back through

Kew Bulletin,1891 (309)

Journal of Botany, 1889

Transactions of the Philosophical Society of South Africa, vol. 4, xlii, 1887, the 1886 Presidential Address of P. MacOwan, Director of the Cape Town Botanical Garden, entitled *Personalia of Botanical Collectors at the Cape.*

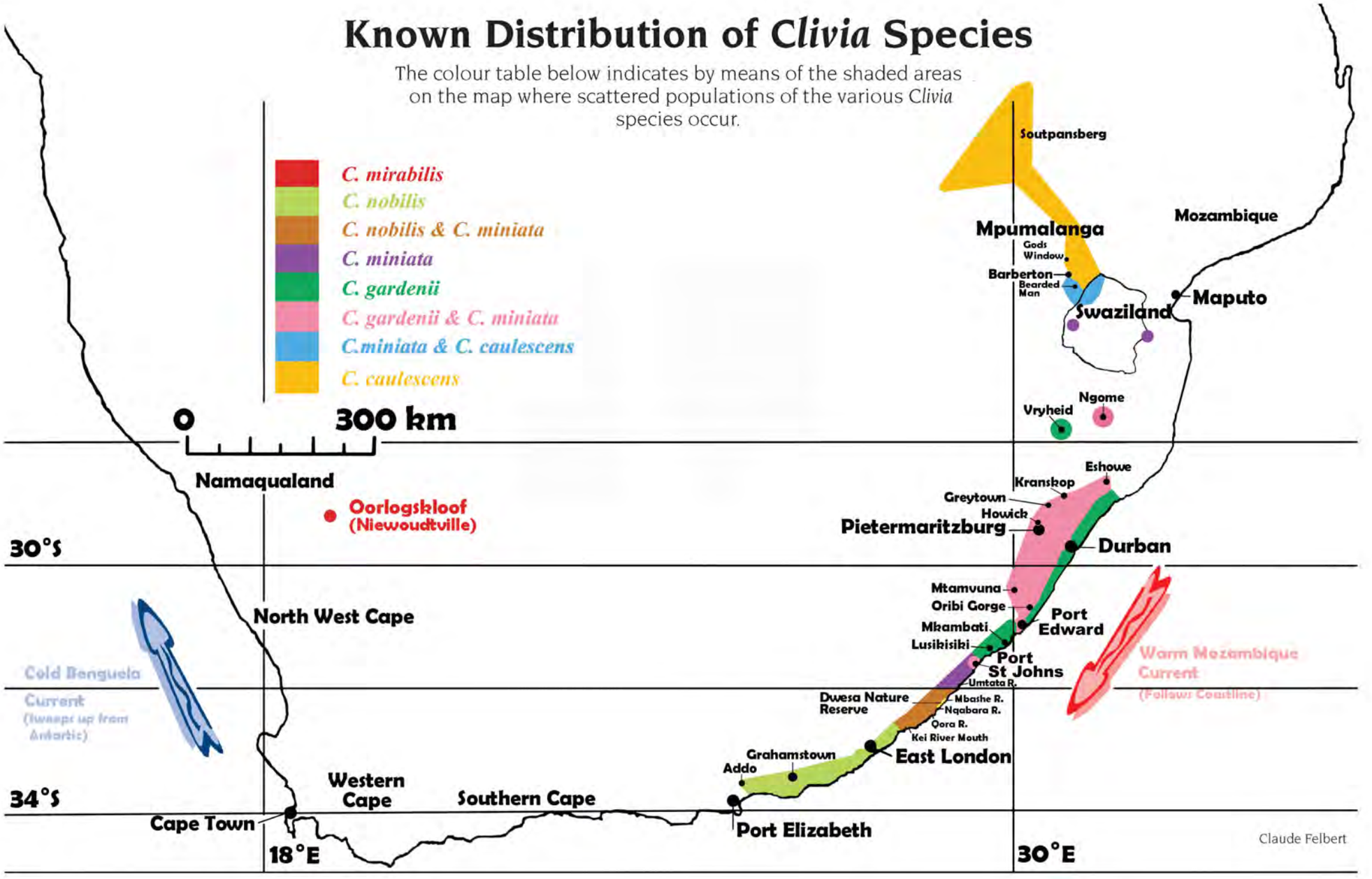
I also looked, without success, for some mention of this episode in a number of books on Hooker and Lindley.

The British National Dictionary of Biography, and two further books by Ray Desmond, his *British and Irish Botanists and Horticulturalists,* and *A celebration of flowers:* 200 *years of* Curtis's Botanical Magazine, helped me get a feel for the times.

I also referred back to my earlier articles, 'James Bowie' and *The noble family of Clive*, William Ait on, William Hooker and John Lindley', in Newsletters of the Clivia Society (Vol. 11, nos. 3 and 4 of 2002).

Known Distribution of *Clivia* Species

The colour table below indicates by means of the shaded areas on the map where scattered populations of the various *Clivia* species occur.



FIRE AND THE DISTRIBUTION OF CLIVIA IN SOUTHERN AFRICA

Dee Snijman

Dr. Snijman is a senior researcher in plant systematics at the Compton Herbarium, National Botanical Institute, Kirstenbosch

Introduction

The very recent discovery in the north western Cape of *Clivia mirabilis*, occupying a habitat quite unlike those of the other four species of *Clivia* from equable eastern regions of southern Africa, has generated considerable interest since it first became widely known in May 2002. The nearest populations of any of these clivias are those of C. *nobilis* some 800km to the east of Nieuwoudtville, near Grahamstown. What makes this discovery so remarkable is that despite more than a century of botanical exploration in the Cape, no records of wild clivias have yet been found in the southern Cape (see distibution map on pages 96 & 97), even though the warm-temperate evergreen forests there appear to offer suitable habitats for their growth.

In his description of the species, John Rourke ruled out the possibility that the Oorlogskloof clivia had become established in the north western Cape relatively recently through long distance dispersal of seed. Instead, he speculated that the north western Cape clivia was probably a survivor of the warm and moist climate that prevailed widely some 20 million years ago, when much of the interior of southern Africa was covered by subtropical vegetation (Rourke 2002a, 2002b). About 13 million years ago, the cold Benguela Current, however, developed along the West Coast. The climate became more arid and the subtropical forests retreated eastwards, whereas in the west C. *mirabilis* withdrew to well-protected, sparsely wooded patches of vegetation.

Using DNA sequence information from the chloroplasts of all five *Clivia* species, Ferozah Conrad and Gail Reeves (2002) analysed the pattern of relationships within the genus. Their work showed that C. *mirabilis* is the closest genealogical relative of the ancestor of *Clivia* and as such appears to be a remnant of a once more widespread ancestral species.

The Puzzle of the Southern Cape

To understand more fully how C. *mirabilis* came to be isolated in the north western Cape it is interesting to ask why clivias are unknown in the southern Cape. What conditions have prevailed in the past - and still prevail - that may have led to the extinction of an ancestral clivia from the southern region and why were the plants themselves unable to cope with these conditions? I propose that the impact of fire on the Cape forests since the development of a mediterranean-type climate in the south western Cape and the inability of clivias to cope with fire have been the major factors that have led to the natural distribution of clivias today (Snijman In press).

Struggling with Fire

My study of other genera of southern African Amaryllidaceae has made me appreciate how important the bulbous habit has been to their success in the harsh environments of the north western Cape and Namaqualand. For instance *Haemanthus*, a close relative of *Clivia*, and *Cyrtanthus* both occur in the northern western Cape, yet they are also richly represented in the western and southern Cape. They are typical geophytes and possess an underground bulb that becomes dormant during the unfavourable dry months when the aerial parts of the plant die back to ground level. In this way the buds are insulated below ground from environmental extremes and particularly against fire, which is such an important feature of the Cape Region. In several amaryllids, the commonly called fire-lilies, this adaptation

has become so finely tuned that they actually depend on fire for flowering - a response that may allow them to exploit pollinators and set seed before other plants have begun to recover from the fire. With their evergreen habit, however, clivias are not at all equipped to survive fire - if exposed to the sun and heat their leaves are damaged and the short rhizome offers few reserves for vegetative regeneration. In effect, clivias share none of the benefits of dormancy by which their bulbous relatives manage to survive intense, dry season fires.

In addition, the seeds of *Clivia* are recalcitrant, which means they fail to dry off and enter dormancy and thus cannot be stored. In nature the inability to build up seed stores over time makes plants like clivias, which are unable to regenerate rapidly by vegetative means, especially susceptible to unfavourable conditions and may ultimately lead to the local extinction of isolated populations. In short, the morphology of clivias at every stage of their life suggests that they lack any specialised features that are tolerant of fire.

C. *mirabilis*.

Forest Fires

Modern evidence shows that most vegetation types in South Africa have burned at one time or another. The frequency with which this takes place, however, differs greatly among different veld types (Edwards 1984). In general, the greater the interval between fires, the greater the fuel load and the more intense the fire will be (Frost 1984).

The Oorlogskloof Canyon in the semiarid north western Cape has probably seldom burned, since the fuel loads in the scrub forest, where C. *mirabilis* grows, are too low to sustain fire. Furthermore, the sheer 30 metre cliffs that cap the canyon provide an unbroken barrier to the occasional fires that break out in the arid fynbos on the Bokkeveld plateau above. Moreover, the slopes on the opposite side of the Oorlogskloof River are covered by widely spaced, succulent shrubs that are non-flammable, hence the potential for fire in the kloof itself is negligible.

In the east, summer-rainfall grasslands surround the evergreen forests along the coast and Great Escarpment. Here the intensity and duration of the dry winter season and frost period determine how inflammable the grasslands are during autumn, winter and spring. The narrow coastal strip from the eastern Cape to Kwazulu-Natal, which is home to four *Clivia* species, has no severe dry season, however, and the absence of frost results in the grasslands here being less flammable than those further inland (Edwards 1967). When coastal grasslands burn, the fires are cool and make little impact on the adjacent forests. Clivias are slow-growing, long-lived plants and the dense stands of clivias that flourish in the lightly shaded gaps of these forests suggest that they have persisted here for hundreds of generations, undisturbed by fire.

Unlike elsewhere, the fynbos in the southern Cape becomes extremely dense and tall and forms extensive corridors between the forest patches. From historical records it is known that fires driven by bergwinds have devastated large areas in the southern Cape. The greatest

forest fires on record occurred in the southern Cape in February 1869 and burnt along the coastal areas from Swellendam to Uitenhage (Edwards 1984), This event provided graphic evidence of the extensive spread of fynbos fires under particularly hot dry weather conditions following several wet seasons of fuel accumulation and the impact they have on forest patches. Other evidence of the occurrence of fire has come from fossil charcoal deposits found in seemingly mature forest throughout the southern Cape. Carbon dating of these deposits indicated that they came from trees burnt approximately 8 500 to 1 400 years ago (Scholtz 1983). There is also good evidence that the incidence of recurring high intensity fires has led to the extinction of many tree species that used to occur in the forests of the Cape (Cowling *et al* 1996). Furthermore, studies using recent data on the species composition at the forest margin and core also indicate that fire is important in influencing the diversity in the southern Cape forests, particularly in their understoreys (Watson & Cameron 2001). Altogether these findings suggest that fires have had a major impact on the floristic and structural composition of forests in the Cape Region.

Conclusion

Finally, until someone finds populations of clivias growing naturally in the southern Cape, I suggest that recurring intense fires in the fynbos have served to isolate clivias in the north western Cape from those along the eastern coast of southern Africa. In this scenario it seems that C. *mirabilis* has persisted at Oorlogskloof for hundreds of generations, untouched by fires that probably destroyed its ancestor which once occupied the southern Cape during more favourable times.

Acknowledgements

Wessel Pretorius and the Northern Cape Directorate for Environment Conservation are thanked for help when visiting the Oorlogskloof Nature Reserve. Colin Paterson-Jones kindly improved the manuscript.

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Winner narrow petal orange C. *miniata* Section, EPCC 2002 Show. Grower: Willie le Roux.

INSECT CONTROL ON CLIVIA

THE ORGANIC AND CHEMICALLY FRIENDLY WAY

Johan Gerber

Johan Gerber is the Manager: Chemical Product Development of Straathoffs

Insect populations hardly ever kill plants, but some species can be very destructive to the general performance of plants, and more specifically affecting leaf and flower production adversely. Most of these insects have natural enemies that can keep them under control if they are present in low numbers. Many of them are very important sources of food for wild life, *e.g.* caterpillar larvae for bird species. However, when insect numbers increase dramatically, it is time to act to safeguard plants.

Gardeners have many products to select from that they can use to combat pests. There are organic or biological and chemical insecticides. Select those products which have the lowest, or no impact on non-target organisms.

Chemical insecticides often have the disadvantage that they are harmful to beneficial insects, wildlife, birds, fish, etc., and can also harm humans when inhaled or ingested or when absorbed through the skin. Furthermore, insects can develop a resistance to chemical insecticides. This results in a temptation to use even more toxic chemicals, some of which are not registered for use in the garden, which puts the public at risk of air and water pollution in the urban environment. These chemicals can also cause secondary poisoning of mammals when crops and foodstuffs absorb them.

The aim of organic and biological pest controls is therefore primarily to make the plant unattractive to insects or to kill insects by smothering rather than poisoning them or, when poisoning is necessary, to use natural ingredients which biodegrade (break down) and become harmless a short time after achieving their objective.

Products that are pest specific or those which are very unlikely to cause secondary poisoning and are not persistent in the environment are normally more environmentally friendly.

Red spider mite, mealy bug, and various other insects:

Margaret Roberts Organic Insecticide is an organic broad-spectrum insecticide for the control of very small-bodied insects. It has a preventative and controlling effect and can be used on all ornamentals, herbs and edible crops. Its active ingredients are garlic juice and canola oil. Garlic has a repelling effect, preventing insects from landing on host plants, whereas the canola oil kills small-bodied insects and insect eggs on contact by suffocation. The formulation is completely non-toxic to humans, wild life, birds, fish and beneficials (frogs, lizards, chameleons etc.).

Small-bodied beneficial insects can be killed on contact, but no poisoning through the skin or secondary poisoning is possible. Edible crops can be harvested 24 hours after the last application.

This product is officially registered for the control of **aphids, red spider mite** and **whitefly**, but will also kill insects like **mealy bug** and **scale** on contact. It has no killing action on the bigger leaf and flower eating insects like **chafer beetles**, but the garlic will assist in preventing adult moths of caterpillar species from laying their eggs on host plants

Ludwigs Insect Spray is available as a more 'toxic' organic broad-spectrum insecticide. It also contains not only garlic and canola oil but also natural pyrethrum. *Pyretfirum* in the formulation extends the insect spectrum from mainly small-bodied insects like **aphids** to bigger leaf and flower eating insects like **chafer**

beetles. The pyrethrum comes from the chrysanthemum flower and adds to the toxicity of the organic formulation. The main advantage of pyrethrum is that it biodegrades completely within 24 hours, leaving no poisonous residues on crops sprayed.

Pyrethrum has an effective stomach poisoning action for 12 hours after application, which means that it can kill bigger bodied chewing insects when they feed on the plant within that time. It kills on contact and therefore it can be hazardous to beneficial insects, including ladybirds and bees. Secondary poisoning is very unlikely, however, because the active ingredient breaks down completely within a very short period. Thus it is non-persistent in the environment and target insect cannot build up any resistance to it.

Biological control of Lilyborer:

By far the most environmentally friendly way of controlling leaf-eating caterpillars is with ***Margaret Roberts Biological Caterpillar Insecticide***. This is a daughter registration of the world's leading biological insecticide ***Dipel*** **DFTM**, a product of the Valent Biosciences Corporation. Its active ingredient is a bacterium, which causes the active feeding larvae to stop feeding directly after ingestion. It is completely harmless to birds, fish, wild life, beneficial insects, humans and pets.

You can protect your precious *Clivia* plants against the destructive larvae of **lilyborers** by spraying your plants with this insecticide every 7 to 14 days using 5*g* (10 *ml*) per 10 *litre* water. It is highly effective against young larvae that are actively feeding, but does not control larvae that have stopped moulting.

Edible crops can be harvested directly after the last application. It will also control active feeding larvae of **orange-dog caterpillar** on citrus, **American bollworm** on tomatoes and cabbage, **diamond-back moth** larvae on cabbage, **semi-looper** worm on green peppers (all present from September to March), as well as **lawn caterpillar** on lawns (present from January to April).

Ludwigi's Rose Spider Mite is very effective in controlling **red spider mite**. It's active ingredient Etoxazole and is one of the safest chemical miticides. The toxicity towards humans and non-target organisms like birds fish and wild life is very low. It is harmless to bees as well as natural enemies of red spider mite. One to two applications per month are sufficient for optimum control of red spider mite. It kills the eggs and immature stages of red spider mite and various other mite species like **European red mite** as well as **Bryobia mite**.

It is ideally used at an early stage of infestation *i.e.* when small numbers of adult males and high numbers of eggs are present.

Organic feeding:

For general feeding of *Clivia* in your garden or containers, use **Margaret Roberts Organic Supercharger**. It contains all the macro- as well as the micronutrients together with a growth stimulant.

Its formulation is virtually identical to that of **Nitrosol™**, a leading brand of organic plant food, the main difference being the addition of a comfrey extract to increase the organic content and to improve the odour.

Dilute 10*m*l (a bottle cap full) in 3 *litres* water. It can be applied with a fine rose watering can or a pressure garden sprayer. For feeding of all plants, apply the diluted mixture to the soil surface as a drench. Wet the soil and plants thoroughly. Repeat every two to four weeks for optimum results. Regular feeding results in stronger healthier plants that are less susceptible to disease. More frequent use is sometimes desirable and will not harm the plants or damage the roots if used as directed.

Before sowing seeds, soak the seeds overnight in a diluted mixture of Organic Supercharger to boost germination.

Ludwig's Spray Stay. Rain or irrigation can wash away the expense incurred and the trouble taken to prepare and apply sprays before they

have done their job. ***Ludwig's Spray Stay*** prolongs the adhesion and overall period of effectiveness of insecticide, fungicide and nutrient sprays by ensuring that they stick onto the plant and that their erosion by rain, irrigation or the weather is reduced. It is based on an organic extract from pine trees, which is emulsified and therefore mixes easily and stays mixed. It is compatible with all horticultural and agricultural sprays that have been tested by the manufacturers.

Such a sticker is also essential for best results when spraying onto wet leaves or onto smooth, waxy, hard leaves such as those of *Clivia*. Therefore you should always add Spray Stay to your sprays (12.5*ml* per 10 *litre* spray mixture). Only one hour of no rain or irrigation is needed after spraying to ensure the protection.

This article covers only products manufactured in South Africa by Straathoffs. We would like to extend it in the next Yearbook to cover organic and biological insecticides manufactured elsewhere, including their natural active ingredients. To that end we have provided the active natural ingredients of the South African products, both to enable the South African members to compare them with overseas products available here, and to encourage overseas members to provide us with information on other such products available, for publication in the next Yearbook.

E*ds.*

PERSISTENT MEALYBUGS

John Winter

Mealybugs are soft bodied flattened oval insects which are greyish white or pink and up to 4*mm* long. A white fluffy wax is secreted from the insect's body which also conceals the eggs. They live on the underside of leaves, in inaccessible places, such as in leaf axils and some species of Mealybugs attack the roots as well. They breed continuously in the warmer months of the year.

These sapfeeding insects excrete honeydew which make the leaves of infested plants sticky. Being sapfeeding, Mealybugs can transmit virus diseases. Heavy infestations cause a loss in vigour and plants may eventually die. Mealybugs tend to be more troublesome when plants are grown in a dry growing medium and closed environment.

Broad spectrum insecticides for the control of small bodied insects, applied thoroughly to the entire *Clivia* plant, are effective in controlling light infestations of Mealybugs. However once Mealybugs have established themselves on a *Clivia* plant, particularly in all the inaccessible places such as in leaf axils and on roots, repeated application of these insecticides never seems to successfully eradicate the infestation completely.

An application of **Confidor**[R] (1ml/ **1** *l.*), applied as a drench, will then be 100% effective for a year. It becomes effective within a month of application, ie as soon as the plant has absorbed the active ingredient. Confidor[R] is a systemic suspension concentrate insecticide, manufactured by Bayer, and the active ingredient is Imidacloprid (chloronicotinyl).

Mealybugs must also be sought and destroyed under pot rims, where they hide!

Winner C. *miniata* medium broad leaf in flower Section, KZNCC 2002 Show.
Grower: Geoff Meyer.

Third prize yellow C. *miniata* first flowering from seed Class, CCC 2002 Show. Grower: Johan Botha.

INFLORESCENCE BUD ABORTION

AND THE IMPORTANCE OF GROWTH MODULES WHEN DIVIDING AND FEEDING CLIVIA MINIATA

Mick Dower in consultation with Hannes Robbertse

It is necessary to divide well-developed suckers from mature *Clivia*, not only to provide clones of a desirable plant, but also to ensure that the plant continues to produce high quality flowers. (Grobler and van der Merwe p.24)

However, experienced growers hold quite divergent views on when clumps of C .*miniata* should be divided. Some growers believe that this can be done at any time. This seems to be the most generally held view - provided only that the weather conditions are favourable, particularly as raw cut surfaces are vulnerable to fungi and bacteria. Fungicides and anti-bacterial cleansers are not always effective in hot humid weather.

Others believe strongly, however, that clumps should be divided only in May, to ensure that the divisions will flower in that season.

One grower found that the divisions of a newly acquired clump, which he divided in December 2001, did flower in 2002. I found that, whereas none of the divisions of a clump of the Floradale Transkei Yellow which I divided in December 2001 flowered in 2002, all the mature divisions of a polychrome pastel, which I divided in April 2002 and of a Kirstenbosch Supreme, which I divided in June 2002, did flower in September/October 2002

At the International Clivia Symposium held at Pietermaritzburg in September 2002 Professor Hannes Robbertse read a paper prepared by himself and Chris van der Merwe on growth modules and mentioned that severe stress caused flower bud abortion. That paper is published elsewhere in this volume.

I consulted Hannes on whether stress caused by dividing suckers from C. *miniata* could also result in abortion of newly formed flower buds in that plant. He advised that *'it is true that any severe stress would cause abortion of the inflorescence bud, and the younger the bud the more sensitive it would be to stress conditions. I have seen many aborted buds in plants I have dissected'.*

He explained what Honiball (p.52, referring to research done by De Smiedt *et al* 1996 and by Bell and Bryan 1991) had reported, namely that the growth of C. *miniata,* like many other bulbous plants, is sympodial - *i.e.* by successive development of lateral leaf buds behind the apex, as more fully described by Hannes in his article on leaf growth and illustrated in *Figure* 6 on page 52 of Honiball. In the juvenile stage 1 2 - 1 3 leaves are produced, usually at shorter intervals than the growth modules in the mature plant. Honiball tells us that it has not yet been established whether any flower buds are produced then, but Ian Brown has noted that a first flower can be produced after the fourteenth leaf (including leaves which have died off). This seems to indicate that at least the last growth spell in the juvenile stage does produce a flower bud.

When that stage ends growth occurs in modules. Such a growth module comprises four leaves followed by a terminal bud - *i.e.* a bud at the top of that growth spell which ends that growth spell. That bud remains quiescent (dormant) until it is stimulated by a favourable environment (more particularly a sufficient difference in day and night temperature) to develop into an inflorescence .

Following that inflorescence bud formation the growth of that module ceases, but in favourable cultural conditions, it may be followed in the same season by another and even a third growth module, each from below the apex and on the other side of the previous module and each ending in a quiescent terminal flower bud. More than one of these

quiescent buds, if sufficiently developed, can be stimulated by drop in temperature to develop into umbels within close succession, resulting in two or even three umbels flowering from the same crown in the same season.

Honiball goes on to point out that unfavourable climatic (particularly temperature) conditions may inhibit the development of such a growth module and in particular, for the purposes of this article, that damage caused by diseases or pests may result in the death of dormant buds so that the plant does not flower. In their article, Hannes and Chris point to sunburn, severe dehydration and root restriction in too small pots as other causes of stress which will cause bud abortion. This may explain why suckers in big clumps do not flower satisfactorily - when a mature sucker is freed and repotted it will probably flower in the same season. It is important to remember, though, that suckers are in fact young plants and can revert to the juvenile stage for some time before they will be ready for flowering.

Regarding pot size, conservatory growers in the Northern Hemisphere may have a different experience because I have seen C. *miniata* with suckers thriving and flowering well in small pots in Mike Jeans' greenhouses in England. It may be that these plants have adapted to chemiculture in small pots.

Hannes has observed in Pretoria that C. *miniata* normally have two growth flushes per season - one in spring during flowering and the second in late summer to autumn. He advises that '*the development stage of the leaves that are formed during the flush should give you an indication of the development of the inflorescence bud. That would mean that when dividing the plants in Spring, it would be better to wait until the youngest of the four new leaves has reached a 'reasonable' size. Too early division may cause flower bud abortion. The same would apply to late summer division'.*

While most C. *miniata* may have growth flushes in spring and autumn, I have noted that there are some which regularly have growth flushes in mid-summer. One of these is the **Floradale Transkei Yellow**. This could explain why its buds were aborted when I divided it in December 2001. In some plants, therefore, untimely division may affect all dormant inflorescence buds, not only the bud being formed in the growth module taking place at the time when the plant is divided.

Other plants divided during a growth spell may abort only the inflorescence bud then being formed and not the further developed dormant bud(s) from previous growth spells I have also noted some C. *miniata* growth flushes in May so that the advice to divide in May only may not be correct for every plant.

The conclusion would therefore be to follow Hannes's advice if you do not want to put the dormant buds at risk - do not divide any plant during a growth flush but only after the fourth leaf of that flush is well developed. However because these growth flushes take place in different plants at different times, every plant should be treated as an individual - you should not do all your dividing at the same time. And if the plant is carrying seed, it could be advisable to delay division until May/June when the seed will be mature.

Since stress can cause inflorescence bud abortion, it also follows that the stress caused by division should be kept to a minimum. Letting the divisions 'dry out' before potting them up must surely add to that stress. One should not divide in hot humid weather, and always treat the cut surfaces with fungicide. The divisions should be potted up right away **I add Sporekill™**(as a cleanser) and **KicStar**™ (as a growth stimulant to counter the transplant shock) when watering them in.

Remember also that, while too severe root restriction can cause stress, excessive root development can delay the production of flower spikes. Take care, therefore, to use pot sizes which restrict excessive root development, and use **KicStart**™ sparingly because it stimulates root development.

These growth modules may also be a guide for nutrition programs. In an accompanying

article Ian Brown advises on the nutrition and environment which will promote the growth of C. *miniata* in the first 1 2 - 1 3 leaf stage. I have also found that during that stage regular feeding (whenever new leaves appear) of Calcium nitrate (2 level teaspoons in 10 litres water used as a drench) promotes stronger leaf growth than the Ammonium nitrates found in most fertilizers.

Feeding programs for mature plants (*i.e.* those which have reached or passed the 1 2 - 1 3 leaf juvenile stage) must ensure that the plant has the right nutrition available:

- Firstly at every growth module, to promote strong leaf growth followed by the full development of an inflorescence bud;
- Secondly, when changes in ambient temperature during winter stimulate inflorescence buds to develop into umbels, to optimise the quality of the umbels which will be produced; and
- Thirdly, to improve seed production after pollination.

Dr. Piet Vorster has cautioned on the Internet that well-balanced nutrients should be used. That is the case where C. *miniata* grow in nature - in well-drained and well-aerated mediums rich in vegetable matter.

A plant will only take up the nutrition which it requires and over-feeding can result in a build-up of chemicals in the growing medium, which can poison the plant.

References:

Grobler & van der Merwe: Vegetative Propagation of *Clivia-. Clivia Yearbook* 4, page 24.

Honiball: Manipulation of Flowering Period and Shoot Multiplication in *Clivia miniata* Regel: Clivia *Yearbook* 3, page 30.

Third prize C. *miniata* multipetal Section CCC 2002 Show. Breeder: Y. Nakamura. Grower: Toy Jennings.

C. *nobilis* from Featherstone Kloof. Winner species other than C. *miniata* Section CCC 2002 Show. Grower: John van der Linde

THE NAME GAME

Kenneth R Smith

Most of you would be well aware of the cultivar name situation with Clivias. Many of the articles produced in the newsletters and the Yearbooks list both obscure and well-known forms. It was Nick Primich who started the idea of a list being compiled, to which I added any names I had in my files. Nick pushed for the Clivia Club to become the International Cultivar Registration Authority (ICRA) for the *genus Clivia* in 2000. Not much happened in the way of registration, even though the Clivia Club was evolving into the Clivia Society. It was in June 2002 that I was appointed International Registrar. The name gathering continued to the point of being able to compile a 'Checklist of named Clivias' in August 2002. When the draft publication was printed it contained 542 names. I made copies available to the various Clubs in South Africa during my trip in September 2002. The international delegates were able to take copies with them and I sent some copies to other interested parties. The idea being that everyone was able to provide feedback on names and details. This has been happening. So much so that I have an extra 100 names to put into the revised Checklist. Herein lies the problem.

The purpose of the ICRA (*i.e.* the Clivia Society) and the Registrar, is to make available a register of known material. A list of names. Okay, we are getting there on that front, but also what is occurring is the increased 'naming' of Clivias, quite often without regard for what might already exist in the market place. No real problem when you consider that they may be totally different names and easily recognisable cultivars. Just add them to the list, I hear you say. This can certainly be done. The real problem is when two different *Clivia* people name their respective plants the same name. Now we have a potential problem. This has occurred already based on my findings, and I am certain it will continue. So, I ask, how can we avoid this happening in the future?

Several avenues are open to us. If members of the various Clubs liaise with their committees, all information will be forwarded to me. Updates can be made and the naming of new plants can be kept in check. This is all very well for people working within the *Clivia* fraternity, but the need is greater than that. We have to ensure that the worldwide horticulture industry knows what is happening with *Clivia*. The Society needs to produce a more informative 'Checklist and Register'. Very preliminary discussion has been held regarding this and the idea is acceptable. The compilation of information and images for each cultivar or strain is harder, but will be done. Which leads us to the problem of how much information is required. Ideally, lots of detail needs to be gathered about the cultivars to make the Checklist valid and useful. In some instances the name is all we have, yet for other plants, a lot is known about them. Now that we have people actively developing hybrid Clivias, the time is right for getting this information into a published format. The more information known about a named *Clivia*, the better the Checklist will be.

The sort of detail in a book like 'Clivias' by Harold Koopowitz is just what we need. Letters and anecdotal material are also useful as they help piece the puzzle together. Nursery catalogues, old or new, are one of the best ways to map the history of a plant, especially as they can give dates of introduction to the marketplace. Whilst the internet is not considered a valid publication for a cultivar name as far as the International Society for Horticultural Science (ISHS) is concerned, it is certainly a quick and efficient means of disseminating information. The Society's

committee dealing with Registration will rely on email communication to discuss ideas and send information back and forth. The ISHS has made the point that a registration system must be user friendly and this will dictate what sections are included on a registration form. What form, you ask?

For us to put in place a workable registration system, we have to get as much information at the one time as we can. This allows us to 'register' the *Clivia* name, issue a certificate, and most importantly, ensure that the name is not duplicated when others apply to register their *Clivia* name. All sorts of ideas come to mind when this is mentioned, things like what do you do about the existing named Clivias, how quickly will an application be processed, what costs might be involved? There are other questions, and I hope that this article prompts you, the reader, to share the questions or ideas that you have with us. I am thankful that many friends have been sending me information and I encourage the flow of information. I am just asking that we formalise the process.

The quality spin off to the registration of named Clivias is in the value of providing a description of a plant that will aid enthusiasts, and hopefully reduce confusion in the marketplace. Yes, I know, all we have is a list of names, but it will provide a basis for breeders to select material to work with, knowing that the information given relates to a certain plant or strain. It may also serve to educate the horticultural community interested in Clivias by providing valuable information on the plant. I am sure it won't stop the practice of calling a seed grown *Clivia* the name of the parent plant, but it may help reduce the incidence.

Making information available to the Registration Committee will help our cause. Please send any details you have about old 'lost' cultivars, existing cultivars, or potential cultivars and cultivar-groups to:
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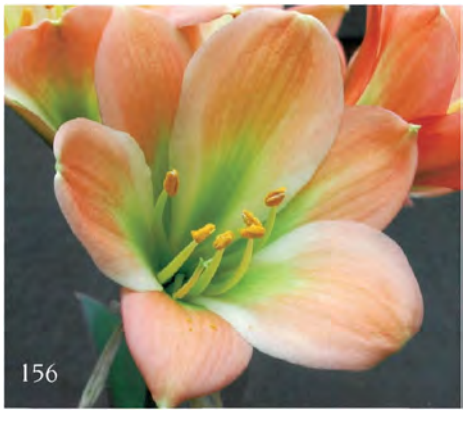
C. *miniata* named '**Doris**' by David Conway

C. *miniata* named '**Doris**' by Jim Holmes

By way of explaining how the naming of cultivars can become confusing, I have included information and pictures of some cultivars. The first two are cultivars from David Conway and Jim Holmes. Perhaps many readers know of the Conway clone **"Doris'?**

It is a deep red form, named by David for his mother, Doris Wells Haviland, in 1992. Listed on Jim Holmes' Cape Seed and Bulb website is another Clivia named '**Doris**', this time a yellow selection from Jim's New Dawn breeding programme. Both fine Clivias, but with the same name. Another example is the Clivia from Conway called '**Julia**', named after his wife's Great Grandmother, Julia Ann Cole, in 1999. It is a variegated foliage yellow flowered selection. Loukie Viljoen has named a beautiful green throated pastel after his wife Julia. Again, both fine Clivias but with the same name.

C. *miniata* named 'Julia' by David Conway.



C. *miniata* named 'Julia' by Loukie Viljoen.

I must say that I have had a lot of support from the *Clivia* fraternity about the name issue. The three gentlemen just mentioned have given their permission to both list their plants as well as providing suggestions to reduce the naming confusion. Most of the issues are being addressed and will be corrected. My thanks to those people who have given me valuable information already. We have to move past the checklist stage and into the Registration of cultivars. I have included information from the ISHS website to give you an idea of the information required for registration. You can see the amount of detail required to get the registration correct. We need your help.

Registration form

All registration forms should request at least the following information and material:

A The ***names and addresses*** of:

1 the **ORIGINATOR** (it may be necessary to distinguish the HYBRIDISER and the person who grew a plant on to its first flowering from the Originator)

2 the *NOMINANT* who invented or coined the name (may be the same as Registrant).

3 the **INTRODUCER** (to help distinguish private distribution from commercial introduction)

4 the **REGISTRANT** (person completing the form).

In each case the relevant ***date***(s) should also be requested (the year is usually sufficient).

B If the **cultiva***r* or cultivar-group has been previously established but not registered, the name of the person who originally published the name, together with details of the publication or full reference to its date and place of publication. A copy of the printed page(s) should be requested which might be added to a PORTFOLIO of the cultivar.

C If the ***name*** to be registered is a transliteration from a language not using the Latin alphabet, the original form (characters) of the name or epithet should also be requested.

D For hybrids, the ***parentage***, when known should be listed or, for sports, the identity of the parent plant or cultivar on which the sport occurred.

E The ***location*** of the original find, if the cultivar results from a plant or plants found growing in the wild.

F Particulars of any associated ***trade marks***, plant ***patents***, or ***Plant Breeders Rights.***

G ***Awards*** received, with dates and the name of the awarding body.

H A **full description** including, where applicable, details of colour - a reading from an RHS Colour Chart is now a widely used standard and is strongly recommended. The precise edition of a colour chart should always be stated in publications of an ICRA.

I The registrant should give an account of the likely ***diagnostic characters*** that differentiate the cultivar or cultivar-group from any closely related cultivars or cultivar-groups known.

J A ***photograph*** of the plant and flowers should be requested to be stored in a portfolio of the cultivar.

K The preferred ***method***(s) by which the new cultivar will be ***propagated***.

L An explanation of the ***etymology,*** derivation or meaning of the cultivar name, especially if this is not immediately apparent from other information given on the form.

Registration forms should stress that although the ICRA will ensure eventual establishment for all registered names, their precedence is not fixed until establishment, at which point the name will have a date. Registrants may thus wish to publish new names themselves following registration, to ensure that precedence of their cultivar name is not affected by any delay in publication by the ICRA.

Ken Smith is the International Registrar for the genus *Clivia*. His appointment in June 2002 was through the Clivia Society. The Society is the International Cultivar Registration Authority (ICRA). It was appointed by the International Society for Horticultural Science (ISHS).

The purpose of the ICRA is to promote fixity and stability in the nomenclature of cultivars and cultivar-groups within designated plant groups and to produce and promote authoritative checklists and registers of all names known to have been in use in such groups.

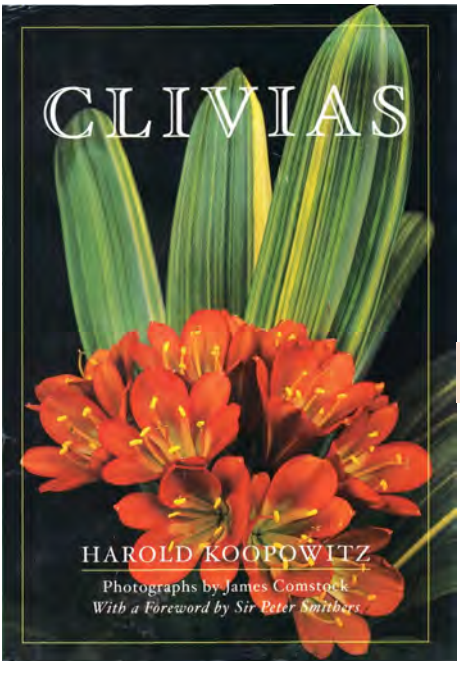
The primary functions of an ICRA are:

1 to register cultivar and cultivar-group names in the genus and to ensure their publication and establishment.

2 to record, publish and make available full lists of cultivars and cultivar-groups, whether they are in common use or are part of the historical record so as to provide the world community with authoritative listings of names.

3 to maintain records in as great a detail as is practical, of the origin, characteristics and history of each cultivar and cultivar-group in the genus.

Winner 2nd prize C. *miniata* any other colour with green throat Section, NCC 2002 Show. Grower: Johannes Smith



REVIEW : CLIVIAS

by Harold Koopowitz,
with photographs by James Comstock
and a Foreword by Sir Peter Smithers.
Timber Press, Oregon

Nick Primich

Every once in a while comes one of those golden moments when one really enjoys something that one is doing. That happened to me when I first read through Harold's book. I had known of him for a long time when I was a collector of all and sundry forms of bulbs. I had heard he was a South African who lived at Irvine. I actually met him a year or two back at Pietermaritzburg Clivia Show where he asked me to read through a paragraph or two concerning my doings in the Clivia Club. He had a proof copy of his book that we had all heard a lot about. I think I sat down right away and read for about an hour or so. There were no photographs in the proof copy, and I was not too sure at that stage how I felt about his writing.

The other day I was handed a gleaming copy of the newly released book flown out by airmail, and I fell upon it like a starving lion. THIS TIME I KNEW EXACTLY HOW I FELT ABOUT IT. This was great, this is what a *Clivia* collector needs. Look, one never ever agrees 100% with anyone about anything, but what I disagree with Harold about in here is really small potatoes. He has aimed his book at the middle of the target. Not too much technical detail, but just enough to fill some explanations out. The layman need have no qualms that he will be assaulted with a ton of technical Hooha just because the book is written by a professor at a university.

A goodly selection of excellent photographs, lames Comstock impressed me with his photographs of clivias many years back. When he came out here to the International Clivia Conference in 1998 I got a hold of him, and elicited some detail on the techniques involved in such photography. He promised to send me an article, which he duly did and it appeared in your Clivia Club Newsletter a couple of years back.

Harold covers just about everything I could imagine, but of course he had to leave out many names of important people in the *Clivia* world. His space is limited, and he also had to leave out many great *Clivia* photographs as the publisher put a strict limit on these. This book fills a great need as a primer for one starting out with clivias. It will also satisfy many desires and longings in the hearts of established *aficionados.* I will note one small criticism, and that is the index could have included people and places, and suchlike. He has an easy relaxed style of writing that puts the message across clearly and succinctly.

If I were you and I had not yet ordered my copy, I would hasten to rectify the omission, as I am sure they will sell out. There will, I am certain, be other *Clivia* books in time, some more technical, some more illustrative, but until then this book will be more than a stop gap, it will be the standard by which the others will be judged.

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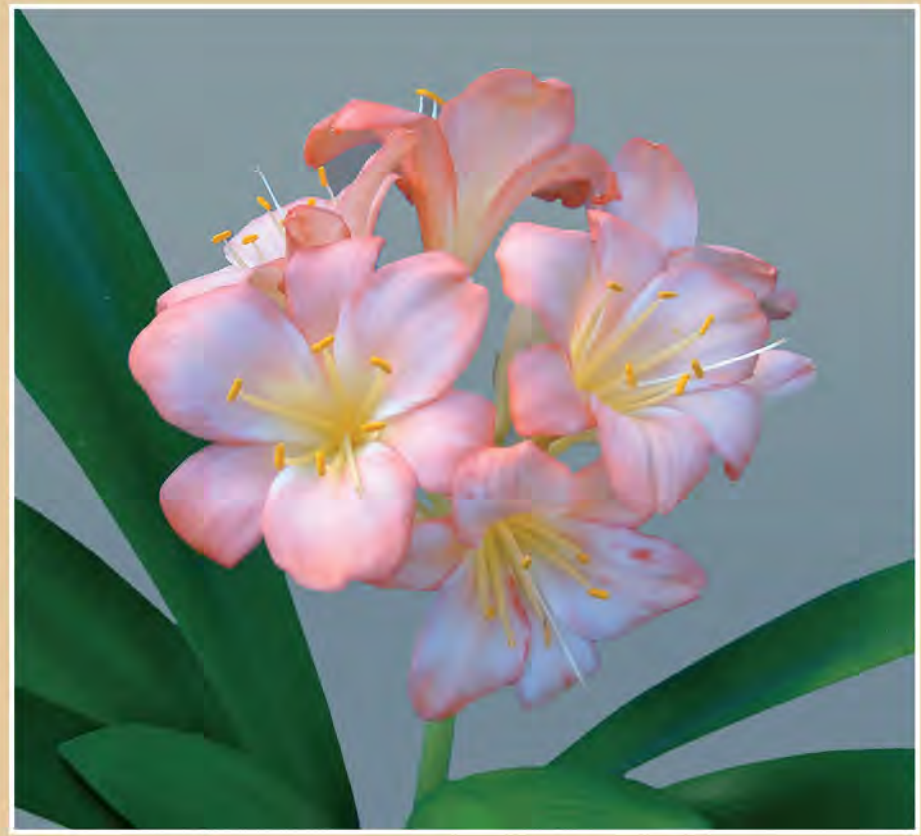

Clivia miniata '**Emma Leslie**'. Breeder and grower: Mick Dower

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CLIVIA

6

Photo: Keith Barlow

Clivia miniata from the Metro Show

Front cover: C. *miniata* "Deklan" Breeder and grower Bossie de Kock. Photo: Chris Vlok
Back Cover: Winner Photographic Competition Photo: Tony Barnes, New Zealand

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C. miniata of the "Roly's Chiffon" strain. Breeder and grower Roly Strachan

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Editorial

'Art is exploration,
To breed a flower is Art'

The words of this haiku, written by Keith Hammett, provide an ideal theme for Clivia 6.

Clivia growing, in all its aspects, affords one of the most satisfying of gardening interests, not least because it is a perfect outlet for our artistic and creative instincts. We become partners with nature in the design of new plant forms and colours. We access her paint box and so become close to the very miracle of creation. Nature may reward us with the most beautiful of plants and flowers - or it may not!

As with any worthwhile interest, serious *Clivia* growing and breeding is a learning experience that can be both challenging and frustrating. Achievements do not come easily, and they certainly don't come quickly. Time is not on our side, so it is all the more important that we save time by building on foundations that have already been laid down for us. Clivia Society yearbooks not only provide the opportunity to learn from the experience of others but also are a forum for *Clivia* enthusiasts to share their knowledge and skills with everyone. As growers and breeders we can use their input to point us in directions that hold the promise of pleasant surprises - and to steer us away from pitfalls, blind alleys and disappointments. Time is far too precious to be wasted.

We trust that CLIVIA 6 will add to the library of *Clivia* knowledge that is steadily being accumulated for the benefit of all. It contains articles by authors from Australia, England, Netherlands, Japan, New Zealand, South Africa and the United States. The topics covered range over most of the *Clivia* A to Z, from Akebono and Anshan, China through to Peach, Perceptions and Polyploids.

The quality and range of photos available to us improves year by year. This issue features the winning pictures in the Clivia Society Photographic Competition and it is our hope that these will encourage novices and experts alike to submit entries for the next Competition.

The editors wish to thank our contributors and hope that readers will be encouraged to share their knowledge, experience and photographs with us. We welcome contributions, not only from Clivia Society members, but also from a far wider field, including members of the new Clubs and Societies in Australia, New Zealand and USA. Our members would also like to know more about all aspects of *Clivia* in China and Japan.

This new editorial team pays tribute to our predecessors, who produced five Yearbooks, each an improvement on the last. They are enjoying their break - working with their clivias, you can be sure!

Finally, a gentle warning: it can be tempting to convert prices of seeds and plants quoted by authors into one's own currency. Interpret price conversions with caution, for exchange rates at the time of reading may have changed significantly from those ruling when transactions referred to in articles actually took place.

The Editors
July 2004

C. gardenii "Ngome Yellow"

Perceptions

Keith Hammett, New Zealand

The period 2002 - 2003 was an important one for people with a common interest in the genus *Clivia.* I specifically stopped myself from using the term "Clivia Movement" as I think it important to remind ourselves that we form clubs and societies because we have a common interest in something, whether it be domestic cats, salt and pepper pots or model trains. It is nothing more and nothing less, yet there is an inherent tendency to start to think that we have been chosen to look after the subject of our interest. In reality, the *Clivia* has got on really well without mankind's help for millions of years and if it is in trouble in the wild now, it is because of man's activities.

As soon as we see ourselves as guardians of an interest we become evangelical and the interest runs the risk of becoming a quasi religion or doctrine. The organisation of religions and major political movements is by nature hierarchical, where edicts are handed down from on high and people are expected to adhere to such edicts. This system works quite well for small groups operating in local areas. The problems arise when efforts are made to get agreement between groups working in different areas. This is especially so with a plant interest where people operate within different social structures and climates.

Currently I see a clear dichotomy of thought amongst those interested in *Clivia.* On one hand efforts are being made to establish a grand coalition of clubs and societies worldwide. This is the hierarchical approach. At the same time a highly successful Clivia e-group is operating. This is the best e-group that I know. A tremendous amount of good information and images are posted daily and the needs of both newcomers and the more experienced are met. This is an example of the grassroots approach where individuals making their own observations in their own specific climates contribute to our collective knowledge.

I intimated in my article, "A Clean Slate", published in CLIVIA 5, that as a young interest we have the luxury of being able to chart our future without the inherited baggage of a traditional way of doing things. With established interests newcomers are taught how things are done and once people are so programmed it is much more difficult to stand back and be able to see the "wood for the trees".

Communication

The current era is often referred to as the information age. With the Internet, communication can be virtually instantaneous and available twenty-four hours a day. It is important that *Clivia* enthusiasts working in different places are able to communicate accurately. Currently an internationally based group is drawing up a classification scheme so that we can categorize and have a common understanding of the different flower shapes, colours and plant habits already found in the genus plus those being created by hybridization. It is essential that by defining categories of plants with certain characteristics in common we create something which is both robust and useful. In reality we are simply attempting to erect fences at points along a continuum of variation. If a classification is seen to be useful it will be adopted widely. However, like respect, such usage will need to be earned.

Aesthetics

I guess that people are drawn to a particular interest by circumstance and some interaction between their personality and the topic. I make the assumption, rightly or wrongly, that those of us interested in flowering plants

are primarily drawn to a particular plant because of its beauty. I am therefore constantly bemused by the almost total lack of discussion of aesthetics in connection with ornamental plants. In other comparable areas of endeavour whether they be music, visual arts or dance one expects and receives discussion on the inherent merits of a work and the interpretation by the performers. Such discussion is almost totally lacking in ornamental horticulture. Quite apart from the problem of the divide between garden or landscape design, where plants are seen simply as components of a bigger picture and plantsmanship, information on individual cultivars seldom gets past being told the colour of the flowers and the height of the plant.

In other areas of connoisseurship such as appreciation of wine, there is discussion of how the components contribute to the whole experience and how well a particular wine might complement a particular food. I would really value discussion on the relationship between flower size, flower shape and leaf width in a particular cultivar and the number of flowers in an inflorescence and their presentation. This latter consideration is especially pertinent to some of the elegant interspecific hybrids now being produced.

Art is exploration,
To breed a flower is art.

Judging

I acknowledge that fundamentally the concept of establishing judging criteria is an attempt to define aesthetic appeal. Basically we are trying to determine which is the most beautiful exhibit. However, in practice they are a very blunt instrument and equate more closely to the rules governing a sport or game than aesthetic appreciation.

At best, judging rules help us simplify the exercise by considering component elements in turn. However, in my experience, when there is a truly beautiful or champion exhibit, it tells you. One does not need to go and look for it. In practice, judging rules come into play most obviously when a judge is attempting to determine the relative position of exhibits, all of which have differing faults.

Some time ago a judging panel was nominated by the Clivia Society based in South Africa to frame judging criteria. This panel consists of people in various countries. It is interesting to note that at this time, while it is only Clivia Clubs in South Africa that hold competitive shows, to date almost all the active responses have been made from outside South Africa. Life is full of little ironies.

Photo: Sharon Booth

C. miniata "Lemon Glow" from New Zealand

Ownership/Custodianship

During the last couple of months there has been much lively debate concerning the recently named C. *mirabilis* and its availability or otherwise to *Clivia* enthusiasts for breeding. I have specifically not engaged in this debate and do not intend to do so. However, I do have some observations to make from the sidelines concerning the alternate paradigms of ownership and custodianship.

I am a full-time professional plant breeder. My personal belief is that in our very short lifetimes we have the privilege to run a leg in a relay race. We may pick up the baton in the form of elaborated hybrids from earlier breeders or we may run the first leg with wild species not previously used. In either case we only have a pitiful fragment of genetic diversity available to us for a short time.

With wild plants we are dealing with what seems to us to be the end point of millions of years of evolution in essentially the areas where they now occur. As mankind has evolved definable groups have constantly migrated. Even the oldest recognizable groups have probably not been associated with an area for more than 10,000 years and most groups have been associated with an area for no longer than a few centuries. No individual human has been associated with an area for longer than their lifetime. It is therefore very difficult to understand how any group can claim to have contributed to the development of wild plants that they happen to live alongside right now, let alone have ownership.

For several decades I have been involved in Plant Variety/Plant Breeders' Rights, Plant Patents and Industrial Patents. The essence of Patent and Copyright Laws is that if someone invents something or writes something, in return for full disclosure, they may be granted monopoly rights of exploitation for a finite period. Such legislation was intended to encourage creative activity.

The alternative to patenting is to have a secret formula such as the recipe for Coca Cola or Colonel Sanders Kentucky Fried Chicken. In such cases disclosure of the formula is not made, you just have to protect your secret.

Inherent in Plant Variety/Breeders' Rights and Copyright Law is the concept that it is the

Photo: Sharon Booth

C. miniata from NewZealand

juxtaposition of the genes, words or musical notes that is protected, not the individual genes, words or notes themselves. An important feature of Plant Variety Rights has been that other plant breeders may use a protected cultivar for further breeding. It is only propagation and selling of the protected cultivar that is controllable. Any new cultivar bred from a protected cultivar must have sufficient distance. In other words it is the effort and creativity of arranging genes, words or notes that is rewarded and then only for a specified time.

Photo: Sharon Booth

C. miniata "Cup of Fire" from New Zealand

With the advent of genetic manipulation and the employment of industrial patent law, especially in the USA, large corporations and some universities are claiming ownership of specific genes. This is comparable to an individual claiming ownership of a C-sharp note so that they may demand a royalty payment from anyone else who may wish to use that note when writing a piece of music.

In parallel with this concept is the idea that ethnic groups, organisations or countries can claim ownership of fauna and flora. It would be far healthier if we were to realise that we live on a very isolated planet with a fragile biosphere and that none of us has long-term ownership of anything.

At best we have the privilege of short-term custodianship. Wild species are our inheritance; they must also be our legacy.

Photo: Courtisy Shigetaka Sasaki

Opposite: A delicate Pink

Below: “Hirao” bred by Toshio Koike

Horticultural Significance of *Clivia miniata*

Dirk Swanevelder, South Africa

This article has been abridged from a chapter in the author's MSc thesis; "Diversity and population structure of Clivia miniata *Lindl. (Amaryllidaceae): Evidence from molecular genetics and ecology.'' He has given copious references in the original work but these have been omitted here for brevity.* **Eds**.

Introduction

The horticultural history of this genus started when the first specimen, namely *Clivia nobilis,* arrived in Britain for identification during the early 19th century. The subsequent introduction of *Clivia miniata* launched this genus into the horticultural markets of Europe. Today *Clivia* can truly be regarded as a cosmopolitan genus, far removed from its humble origins in its native countries, South Africa and Swaziland.

The variety found in flower form and colour is one of the reasons for the horticultural success of the species. The ease with which *Clivia* is grown and hybridised, together with the big showy flowers and a high tolerance for abuse, makes it an ideal plant for amateur botanists, landscape designers and gardening hobbyists. The long 'seedling stage' and lengthy waiting period for sucker production, in conjunction with human impatience, facilitates the trade of this species.

The *Clivia* industry is dominated by *Clivia miniata.* With no international monitoring institutions there are no official estimates available to determine the extent of the industry. No comprehensive worldwide studies on the *Clivia miniata* industry, covering such aspects as annual production, monetary value and breeding aims, are known. This type of study is complicated by the fact that a large part of the industry is owned by the private sector. The present study has shown that private growers are responsible for a significant share of the total income generated by the industry.

Clivia are grown world-wide, and information presented here covers the larger markets and was gathered through an extensive survey of the literature, the World Wide Web—including a related news group http://groups.yahoo.com/group/clivia-enthusiast/ and websites of mail-order nurseries — and personal communications with various *Clivia* growers. Where possible, estimates are supplied to highlight the horticultural significance of C. *miniata* internationally.

Photo: Reinhardt Hartzenberg

Clivia miniata. Grower Jack Walters NCC

South Africa

South Africa is the chief producer of commercial *Clivia* hybrids in Africa. Surprisingly, South Africa only became a role player in *Clivia* cultivation in and around 1998. The growth of the *Clivia* industry in the region is largely due to the formation of the Clivia Club in 1992. Rare clones that were in the hands of a select few were now being actively promoted and marketed to a wider audience. The increase in public awareness and knowledge, promoted largely by the Clivia Clubs and their shows, led to a boom in the local *Clivia* industry, with plants being actively propagated to satisfy the increasing demand. Shows, newsletters and discussion sessions organized by these

Clubs and Groups, as well as the Society's annual publication (Clivia Yearbook), are contributing to the success of the industry in South Africa.

The South African market focuses on a broad range of plant characters, which include flower form, flower colour, leaf width, leaf variegation and interspecific hybrids. With material becoming readily available and a large natural genetic pool, new hybrids are actively being produced. Weather conditions that prevail virtually throughout the country are ideal for the promotion of *Clivia miniata* as a garden shade plant. The other species of *Clivia*, however, enjoy limited interest in South Africa. In recent years, the local demand for rare hybrid lines, produced in other countries like Japan and China, has increased considerably.

Private growers dominate the South African market, which makes it difficult to obtain reliable estimates of the actual number of plants being produced annually. Income generated by seed and plant sales is virtually impossible to calculate without production figures. Annual production is estimated to be anything from one to five million plants. Supposing plant production figures are around one million, with plants sold for an average of R30 per plant; the revenue generated at the producer level would be in the vicinity of R30 million.

The demand for South African material is strong. Seeds and plants are exported to, amongst others, the USA, Australia, Canada, UK, Sweden, Netherlands, Japan, France, New Zealand, Denmark, Malta, Peoples Republic of China, Finland, Spain, Belgium, Portugal, Israel, Germany, Puerto Rico (USA), South Korea, Costa Rica, Brazil and Mexico.

The market still appears to be unsaturated—even though prices have decreased over recent years for certain varieties. High prices are still being paid for top quality and rare specimens—clearly evident from the auction held by the KwaZulu-Natal Clivia Club in September 2002, in conjunction with the 3rd International Clivia Conference. At the auction 81 plants were sold for a staggering R91 695. A C. *miniata* plant was sold for R13 600 and a yellow *Clivia caulescens* for R8 600, implying an average price per plant of R880 for the remainder.

Photo: Coen Calitz

Brush pollenation at the nusery where Dirk Lootens works in Belgium

Europe

The debut of *Clivia miniata* into Europe's horticultural markets during the 1850s launched the genus into instant stardom. Increasing popularity made C. *miniata* a very successful indoor plant during the Victorian era when it was one of the most highly prized plant varieties. The popularity of *Clivia miniata* has been maintained, largely due to numerous new cultivars being produced, the most popular being broad-leaved, compact types—though types with high flower counts are also popular. The market briefly lost interest in this pot plant after World War II (1960s), mainly because

of its long production period (less profitable in a market looking for inexpensive plants) and an old image sentiment.

Clivia miniata is currently being grown throughout Europe, especially in Belgium, Denmark, Finland, France, Germany, Italy, Netherlands, Portugal, Spain, Sweden and the United Kingdom. Compact plants flowering within three years, with umbels above the foliage, have been the latest market trend in the northern European countries. Southern European countries appear to prefer the larger varieties.

Belgium's annual production for 1997 is estimated at 700 000 flowering plants, making it the largest producer in Europe at that time. A large portion of Belgian plants (278 000 plants) was sold during 1997 at the Dutch auctions for a then average price of US$3.90 per plant. The Netherlands produced around 200 000 plants for the corresponding period. Production figures for Italy, Germany and France were substantial. Europe therefore produced more than 1 million plants in the 1997 season. In 2003 at Dutch auctions, orange-flowered cultivars were sold for €4 a plant and the yellow-flowered cultivars for €6. Retail prices are usually two to three times the auction price for the same cultivar.

If the 1997 production figures are used, the wholesale income is estimated to be €4-6 million for the 2002 season. The retail income is therefore in the vicinity of €4-12 million per annum, depending on the number of yellow-flowered cultivars sold. With these estimates, the gross revenue generated by the industry is calculated at between €8-18 million for 2002.

Japan

Clivia was introduced into Japan during 1854, probably C. *nobilis*. *Clivia miniata* was most probably introduced to Japan from Europe in the 1870s. The general trend in Japanese horticulture to produce dwarf hybrids, with broad leaves or

Photo: Courtesy Shigetaka Sasaki

Shima-fu variegated Daruma and a Japanese decorative pot with a dragon design

variegated foliage, stems from the Edo Period in Japanese history (1603-1867). During this period various wild mutations of highly prized plants were collected and the Japanese model for *Clivia* is based on two such plants, the Nippon lily or omoto, *Rohdea japonica* (Thunb.) Roth (Convallariaceae or Liliaceae s.l.) and the Japanese wind orchid, *Neofinetia falcata* (Thunb.) Hu (Orchidaceae). The Daruma cultivar-group corresponds to these species in leaf shape and variegation form—commercial Daruma names even correspond to these species' cultivar names.

Clivia miniata is highly commercialised in Japan. The other species are not well known. In Japan, the emphasis is placed on the plant rather than its flowers. *Clivia miniata* plants with symmetric, fanlike appearance, half round leaf apexes, visible contrasts between leaf veins and blades as well as the overall shape of the leaves, are all highly desirable. Japanese horticulturists focus their breeding programs on the production of short and broad-leaved plants. Selections with the correct leaf width to leaf length ratio have the cultivar-group name Daruma. Subtle differences

in leaf shape and variegation are used to distinguish between the various commercial cultivars. The Daruma cultivar-group name is generally accepted to have its origin in Buddhism—either from a small doll named Daruma sold at temples (as a symbol of happy fortunes), or from a monk named Daruma.

Clivia purchase prices in Japan range from US $10-30 for orange-flowered plants, to US $80 for a yellow or selected hybrid. Precise statistics regarding the Japanese *Clivia* industry are unavailable, but production and sales are estimated to be considerable.

China

The main introduction of *Clivia* into China only occurred in the 20th century when Japan invaded China, although legends in the southern region of Liaoning Province claim that a German brought some plants from the Drakensberg in South Africa to Qing Dao after the Opium War (1840). A Danish missionary is said to have brought plants to Liaonan around the same time. These plants were called "German-lan" and "Danish-lan", respectively. Denmark is pronounced in this region as 'Darma, therefore, the Chinese term "Darma-lan" is sometimes used for *Clivia.*

A glasshouse in Anshan with 10 cm broad-leafed seedlings. Note the clay pots used.

It has been said that the Japanese policy of 'opening the country and learning from books' was largely responsible for the introduction of *Clivia* into China during the Japanese occupation of Manchuria in the 1930s. A Japanese named Tamura brought plants to the Manzhou Royal Palace in Changchun, the capital of the Japanese puppet state. The Japanese emperor also gave rare *Clivias* to the last Chinese emperor of the Qing Dynasty, Aixin Jue Luo Pu-yi, whom they had set up as "ruler" in Changchun. At this time, *Clivia* was regarded as a noble plant and was only publicly displayed at state functions. Just a small number of Japanese, royals, courtiers and high-ranking government officials could enjoy them, with the ordinary people not even knowing of their existence.

In 1942, Pu-yi, while mourning the death of his wife, the Empress Tan Yu Ling, ordered a pot of *Clivia* to be displayed "before her spirit" at the temple Hu Quo Bo Ye Ji (Guardian Wisdom Temple). The *Clivia* was not returned to the palace after the 49-day funeral. P'u Ming, a monk at the temple, kept the plant and started to cultivate it. This plant eventually gave rise to the cultivar Monk ("He Shong") when it reappeared in 1963. It was the end of World War II in 1945 that was responsible for the release of *Clivia* to the general populace. It is reported that there were only "two *Clivia* pots" preserved after the collapse of the government. An old florist (gardener) of the court, Chang Yu T'i, preserved a specimen that was subsequently presented to Changchun Park (Zhang Chun Sheng Li Park). In celebration of the victory

of “Peoples’ Liberation” against Japan; this specimen was named “Sheng Li”, i.e. “Great Victory’” The other specimen was taken by the royal chef and presented to the manager of the Changchun Tung Hsing Dyeing Factory (Dong Xing Dyeing Factory), Chen Kuo Hsing—a cultivar today named “Dyer” or “Dyeing Factory”.

In the 1960s it was realised that *Clivia* could be produced from seed. This led to intensive breeding programs and the development of various new, highly desirable cultivars, i.e. “Engineer Huang” and “Painter”. Then the Cultural Revolution came about (1966 to 1976). With *Clivia* regarded as a mark of distinction, i.e. elitist, many prominent growers faced prosecution and even death in Changchun. During this time many rare *Clivia* were destroyed.

The current Chinese name used for *Clivia,* “Junzi-lan” (noble orchid), originates from a Japanese publication in “Horticulture Illustrated 1931” in which *Clivia* was referred to as “Kunshi-ron Orchid”, which refers to the original Latin meaning of *Clivia,* namely noble, good and strong, but was later modified to “Kunshi-ran”. The Chinese later adopted these ideographs, but pronounced them as “Jun-zi-lan”. In Chinese, “Jun-zi” means noble or “those with ability & morality” and “lan” means orchid. “Kun” in Japanese, similarly as “Jun” in Chinese, would be added to the end of a persons name to express respect .

Flower cultivation became a fashionable trend after the Cultural Revolution—breathing new life into *Clivia* cultivation. This eventually caused an outbreak of “Clivia-fever” all over the country in the mid 1980s. In October 1984 *Clivia* was named the official flower of the city of Changchun by the “Changchun People’s Congress”. Large-scale cultivation projects by nationalised companies, private groups and individuals—all coming together in the search of commercialised companies and *Clivia* enhancing activities, were started. This was probably the beginning of Chinese institutions like the Clivia Business Association (Changchun, Anshan), the Clivia Union (Beijing), the Clivia Study Society (Shenyang), the Clivia Project Association (Harbin) and the China Clivia Association (Jilin, Liaoyang, Daliang).

The Chinese *Clivia* industry is essentially situated in the northeastern part of China, in the Jilin Province. Changchun, the capital, is regarded as the cradle of the Chinese *Clivia* industry. A 5-day competition held in 2003 in Changchun, attracted 50 000 Clivia entries from more than 3 000 participants and was visited by 100 000 people. Only ten plants regarded as “superior” won the title “the king of flowers”.

In the mid 1980s the *Clivia* industry reached its peak. Prior to this a 5-leaved sucker from the Monk cultivar-group sold for 100 yuan—approximately 3 months wages of an ordinary worker. In the mid 1980s, top quality plants were sold for anything from 60 000 to 200 000 yuan per plant (60 000 yuan equalled about US $20 000 at that time). The prices dropped dramatically during the latter part of 1985, some by as much as 99%. Today ordinary mature *Clivia* plants can be bought for as little as 30-100 yuan, but rare cultivars still demand high prices, i.e. a top quality plant can reach anything from 10 000-200 000 yuan (US $2500-50000).

Annual production of mature Chinese C. *miniata* cultivars is estimated to exceed a million, excluding one to two year old seedlings. This assessment is a rough figure of the total volume traded. The Chinese market is believed to be one of the largest, if not the largest, market for *Clivia* cultivars. The true value of this market is probably in the vicinity of US $200 million annually.

Photo: Ken Smith

A pale "Cowlishaw" (See pg 24 for the dark strain)

Australia

The first introduction of *Clivia* into Australia occurred in 1844 when J.C. Bidwill, an early director of the Sydney Botanical Gardens, brought some C. *nobilis* on board the Arachne to Sydney. More introductions followed, with imports of new hybrids and C. *miniata* occurring regularly.

Clivia miniata are very popular in Australia. The similarity between the Australian and South African climates makes it possible for *Clivia* growers to grow plants in shade houses or in shady spots in the garden. Hence, the plants are a favourite of landscapers and gardeners alike. *Clivia miniata* is the most widely cultivated *Clivia* species.

The *Clivia* industry in Australia focuses on the broad-leaved cultivars. In Queensland nurseries, these are produced in their thousands. Red, variegated and peach cultivars are currently in demand. *Clivia miniata* plants are sold as pot plants during the flowering season, but unlike in Europe, these plants are planted in the garden.

Market prices for *Clivia* in Australia have dropped in recent years. Mature yellow-flowered plants that were sold in the past for AUS $100-150 are now difficult to sell at retail stores, even though prices are reduced. Plants over AUS $50 are hard to sell. The price drop could be attributed to an increase in producers: during 1995 there were only 2 or 3 mail order nurseries offering *Clivia,* but in 2002 this number more than doubled to 7 or 8. Growing imports (from USA, South Africa, Europe, China, Japan and especially from New Zealand), an increase in maturing plants produced from previously imported/produced seeds and higher local production, all contribute to this drop in prices.

Collectors, however, are still prepared to pay high prices (>AUS $150) for guaranteed cultivars. Variegated plants are priced from AUS $150 to AUS $1500. It is therefore the known producers and collectors in select sectors of the market that are profiting. The exact production figures and total income of the industry in Australia are unknown.

Photo: Di Smith

A New Zealand Peach. Grower Di Smith

New Zealand

New Zealand is one of the emerging markets of the *Clivia* industry. Seed and plants are currently being produced for both the local and the Australian market, with focus on yellow-, cream-, red- and orange-flowered plants. Internal production of seed/plants and a growing interest among the local population, is currently driving the market. Seeds have for several years been imported from countries such as Japan, South Africa and Europe, raised and sold to the local market.

Photo: Jim Comstock

A collectors dream from the USA

The Americas

Clivia have increased in importance on commercial markets during the last few years. *Clivia miniata* is grown from Canada to Brazil, including several states in the United States of America, Mexico and Puerto Rico.

Clivia material is being imported from South Africa, Japan and China. Californian growers specialize in flower varieties that seem to be more colourful than those in South Africa and China. American customers seek *C. miniata* plants with both attractive foliage and flowers, with no special preference for either. *Clivia* prices are still relatively high due to sustained demand. A mature orange-flowered variegated plant sells for US $100-150 and a yellow-flowered variegated plant for US $400-450.

Various companies sell plants in the USA, with prices ranging from US $50 for mature orange-flowered plants to hundreds of US $ for mature yellow-flowered plants. In 1998, yellow *C. miniata* plants were on offer for US $950 by White Flower Farms (Pennsylvania). Seed prices range from US $0.60-20.00 a seed, depending on the demand. There are no figures available for any of the American markets to date. Considering initial tendencies of other countries that grow *Clivia*, prospects for the US market look very promising.

Conclusion

Clivia miniata is currently grown worldwide and the *Clivia* industry has reached a considerable size. The number of mature *C. miniata* hybrids produced annually is estimated to be around 6-10 million plants. Income generated by the trade in these plants, excluding seedling sales, is conservatively estimated to be US $200 million

to US $400 million annually. The Chinese *Clivia* market is the largest in the world. However, figures obtained from USA growers indicate that there is a substantial market in the USA waiting to be developed. In Table 1 estimates are given for the different regions where C. *miniata* is grown on a substantial scale. These estimates are calculated from a small percentage of the market and could be distorted, most likely towards the conservative side.

Production Area	Breeding Trends & Markets	Estimated Annual Production & Revenue
South Africa	Broad & variegated leaves, intra- & interspecific hybrids, flower forms & colours, pot- & bedding plants	1 - 5 million plants US$ 1- 5 million
Europe	Compact, small, broad-leafed plants, fast flowering, greenhouse & pot plants	>1 million plants US$ 8 - 15 million
The Far East (China, Japan, Korea, etc.)	Foliage: broad-leafed, variegated plants with symmetrical fan-like appearance, greenhouse & pot plants	2 million plants >US$200 million
Australia & New Zealand	Broad &variegated leaves, intra- & interspecific hybrids, flower colour variations, pot- & bedding plants.	<1 million plants US$ 1 - 5 million
USA	Broad &variegated leaves, intra- & interspecific hybrids, flower form & colours, greenhouse & pot plants	1 - 5 million plants US$ 50 - 100 million

Table 1. Horticulturally important production regions for Clivia miniata: estimated production figures and revenues, including breeding trends and markets.

Clivia economics is firmly based on supply and demand. The possibility of high returns on investment stimulates production to meet demand. The market may become saturated and prices may decline. In trying to counter this trend, producers develop new cultivars or hybrids. This forces the buyers to become knowledgeable about cultivars and their monetary value, resulting in an educated clientele with specific needs and demands.

Another way of countering the drop in price of cultivars is through exports. The local clients' demand for new and improved cultivars is the driving-force behind imports. This puts pressure on local producers to have the latest cultivars on offer. Only those producers with good reputations and products are able to stay in business.

Better communication between growers stimulates the market. That is, with new hybrids becoming more rapidly known, the demand for them increases. The market is therefore driven by the latest cultivars. Older cultivars rapidly become outdated as new cultivars are produced. The serious collector is prepared to pay high prices, usually for the new and improved cultivars. What is important is that the market has become knowledgeable, demanding breeding records, genetically identical material and improved cultivars of known origin.

The development of a sustainable and stable industry depends on growers identifying their

target markets, for example pot plant market, collectors, general public, landscapers, etc. In Europe, for example, *Clivia* is mainly grown as a pot plant. It is enjoyed for a season and a new plant is bought the next year. This market is limited in size, with too high a production forcing prices down and making it commercially non-viable. This markets' profitability is directly linked to quality and the markets' trends—both contributing to the sustainability of the market. In China, where Clivia is part of the people's culture and enjoyed by both serious collectors and the general public an opportunity exists for producers to exploit both of these market sectors. The future of the C. *miniata* industry is very promising. There are still substantial new markets to develop such as the Americas. Also, Clivia growers have not yet explored the cut flower markets of the world. This sector could be highly profitable for those who are first to venture into it. To date it is still more profitable to produce and sell seed than to produce cut flowers. Intraspecific and interspecific hybrids have yet to reach their full potential. Biotechnological manipulation of floral colour holds considerable potential. The industry is still growing, and with new hybrids being produced worldwide, the future looks prosperous indeed.

Acknowledgements

I would like to thank all those who responded to my request for information which has been most helpful. Special thanks to Pen Henry, who is not only a well know Clivia breeder but is also one of the moderators of the Clivia e-group.

C. miniata "Show Stopper".
Breeder & Grower: Sean Chubb. Best yellow KZNCC Pietermaritzburg Show

Photo: Courtesy Sean Chubb

Design Your Own Clivia

John van der Linde, South Africa

This article has primarily been written for the "clivia man in the street". This is the enthusiastic but random pollinator, one might say, who crosses two good-looking plants and hopes for a winner. (I am a dedicated random pollinator by the way, so I am writing this article for myself too!) Our chances of success are probably a lot less than the chances of winning the First Prize *Clivia* in a raffle at our local Clivia Show. What is more, we will have to wait in suspense for years for the results of our breeding efforts. "It is then that hopes and aspirations are either fulfilled or shattered."

Would you like to know about another way to achieve success in your *Clivia* breeding? A methodical way, which can give you a lot of satisfaction? A method by which you can design your own *Clivia* to meet your own requirements?

You need to begin with an objective you wish to achieve. Then you need to know your plants, and have a basic understanding of some simple genetic principles - "the rules of the game". You also need those scarce commodities, time and space. Let me describe my own real-life application of the method. This "case study" illustrates the general principles you can apply - to design the *Clivia* that until now you have only dreamed about.

The objective:

I want to have plants that will bloom from April or May onwards, thus bringing forward the start of my flowering season - I am of course talking Southern Hemisphere here. My reason already extends in the other direction. I have plants based on breeding with Group 2 yellows, which regularly flower late, from October through to November. I have decided to begin my project by breeding an early-blooming yellow *Clivia miniata*. Why a yellow? Well, firstly, I have not yet come across such a plant. Secondly, I am halfway there already, as will become clearer later.

The benefits to me would include: (i) the pleasure of achieving what I had set out to do,
(ii) beauty to be enjoyed and shared, at a time when there are no other yellows in flower, and
(iii) maybe some pocket money from seed and plant sales to feed my insatiable clivia habits! The costs would largely be my investment in time, and the opportunity cost of devoting scarce space to this particular project at the expense of others.

The plants needed to achieve my objective:

Fortunately I already have one early blooming plant, even though it is not a yellow. It is a very attractive light apricot, as measured on the Cape Clivia Club colour chart. It is an offshoot of "Gladys Blackbeard", a plant named by the late Gordon McNeil for Miss Blackbeard, a pioneering South African *Clivia* breeder (see CLIVIA 2 page 44, for Charl Malan's article about her). This plant may flower at any time from April onwards.

Mick Dower, the owner of the mother-plant, who gave me the offshoot, made a cross between "Gladys" and a Lötter C1C2 Group 1 yellow and put some of the seedlings on sale in 2000. I bought two of them, both with heavily pigmented stems. One of these plants bloomed in September 2003, as did one of Mick's plants, and also a sibling owned by another grower. In all three cases the flower colour was light apricot, very similar to the colour of the mother plant.

The Lötter yellow, the pollen-parent of these seedlings, is a handsome plant that meets my colour requirement but not my requirement for early flowering, since it does not bloom until Spring.

My plan is to use these two plants, with their different colours and flowering habits, to produce the plant that meets my objectives set out above. But I am not going to start from scratch, which might take ten years or more. Rather, I plan to work with the first generation plant that I already have, to build on what Mick Dower has begun. This will cut development time in half. But first I need to make sure that my plan will work.

The next step: Knowing my plants

I know, from the light apricot colour of the first generation (F1) crosses that have already flowered, that "Gladys" colour characteristic is dominant over that of the yellow. Also, that "Gladys" does not itself have any hidden yellow in its makeup. How do I know that? Because if it did carry this recessive characteristic, then the cross with a yellow would have yielded some seedlings with green stems and possibly also yellow flowers. Mick Dower has however said that all the seedlings from this cross had heavily pigmented stems.

Another useful observation is that the two parents did not combine to "fix up" whatever genetic mutation had given rise to each plant's unique colour, by producing orange-flowering seedlings, as is the case when Group 1 and Group 2 yellows are crossed.

Thirdly, because the three seedlings all bloomed at the "normal" September flowering time, and not months earlier like the mother plant, I can deduce that "Gladys' " early-flowering habit is a recessive trait, which is "overridden" by the dominant September-flowering trait of the yellow pollen parent.

Also - and this is a key conclusion, vital to me in my breeding plan - I can deduce that "light apricot colour" and "early flowering" are characteristics which are inherited independently. This is because the seedlings that flowered in September 2003 were all light apricot, like their "mother", yet they flowered at the usual time when their "father" flowered.

Stage three: September 2003

First, I isolated my first-generation (F1) "Gladys x yellow" plant to prevent any accidental unwanted pollination by stray pollen. Next, I self-pollinated it, in order to bring to light, in the next (F2) generation, those hidden recessive characteristics which I know are there in the genetic mix. By the way, there are other hidden traits I don't even know about, and they could surprise me when they are brought to light at the same time.

I have drawn up a "checkerboard" to show all sixteen possible combinations of the two independent characteristics, colour and flowering time, that will be generated and displayed in the next (F2) generation of plants. Of course, there are many more than just two traits that could be taken into account. However, the number of possible combinations increase rapidly if more than two characters at a time are considered.

A convenient shorthand, in drawing up a checkerboard like this, is to use capital letters for dominant observable characteristics, and lower case for recessive hidden ones:

A = Dominant Apricot

a = Recessive Yellow Colour

S = Dominant Spring Flowering

s = Recessive Early Flowering

		AS	As	aS	as
Dominant apricot Dominant spring flowering	A S	1 A S A S	2 A s A S	3 aS A S	4 a s A S
Dominant apricot Recessive early flowering	A s	5 A S A s	6 A s A s	7 aS A s	8 a s A s
Recessive yellow colour Dominant spring flowering	a S	9 A S aS	10 A s aS	11 aS aS	12 a s aS
Recessive yellow colour Recessive early flowering	a s	13 A S a s	14 A s a s	15 a S a s	16 a s a s

Possible Combinations of Desired Genetic Characteristics

In this shorthand, and with respect only to the two traits I am working on, my plant can be coded as AaSs. The capital letters show what is dominant and thus observable, the apricot colour (A) and normal flowering time (S). These dominant characteristics mask the hidden traits (a) and (s) also carried in the genetic makeup of the plant, the "s" having come from the mother and the "a" from the father.

Self-pollination (or cross-pollination with a sibling, had one been available to me at the time) gives rise in the next (F2) generation, to the above sixteen possible combinations of the two characteristics (colour and flowering time) that I am working on.

Across the top, in heavy type, I have set out the four possible mixes of my two chosen characteristics: AS, As, aS, and as. These represent the contributions from the F1 pollen parent ("self" in this case). Down the side, also in heavy type, are the corresponding contributions from the F1 mother plant (again "self").

So what is in heavy type relates to the genetic traits brought to the party by each parent, from "pollen parent (father)"in one case, and from "pod parent (mother)"in the other. Now we look at what is inside the checkerboard, all in normal type. This all relates to the next (F2) generation, the one I am really concerned with.

The squares are all numbered in sequence for easy identification. Look at square 1 for a start, containing A and S from the pollen parent, which are the two characteristics shown immediately above, in heavy type along the top of the checkerboard. The square also contains another A and S, contributed by the mother plant alongside. The combination AASS in the square tells us that the seedling produced from this particular combination of pollen and egg will have a light apricot flower (as shown by

the dominant A), and will bloom in September (because of the presence of the dominant S).

Now look at square 2; there we have A and s from the pollen parent, from what is immediately above, in heavy type along the top of the checkerboard. The square also contains A and S from the mother, from what is to the left, also in heavy type. The seedling from this mix AASs will also flower light apricot, also in September, because of the presence of both A and S. It will look just like the first seedling, but genetically it will be subtly different, because it will carry the hidden trait for early flowering - the (s) in the mix.

You should have the idea by now, but let us look at another one, say square 10. This has the combination A and s from pollen (above), and a and S from egg (to the left). The F2 plant with this genetic mix (AaSs) will look just like the first two we have examined, because of the presence of dominant A and dominant S, but will differ from each of the first two because it carries the hidden recessive traits for both yellow colour (a) and early flowering (s).

However, let's not go into too much detail at this stage. Now that you have the hang of it let us look at the big picture. The nine squares with the numbers 1, 2, 3, 4, 5, 7, 9, 10 and 13 are those combinations with both dominant characteristics, A and S. This result implies that 9 out of every 16 seedlings will be light apricot coloured, like "grandmother Gladys", but will flower in Spring like "grandfather Lötter yellow".

The combination that I am looking for, however, is in the one remaining square, which has neither the dominant A nor the dominant S, but only the double recessive aass. So I can expect one in every sixteen seedlings to be my precious early-flowering yellow. I will have achieved my objective: to unmask both hidden characteristics in the same plant.

Action plan for 2004:

Having self-pollinated my "Gladys x yellow" F1 plant in September 2003, I will harvest and then sow the resultant seeds in 2004. For every 16 seeds I plant I can expect just one early-flowering yellow (the "double recessive"). In fact, I plan to plant 48, from which I can expect - if all survive to maturity:

3 early-flowering yellows
(my target plants)
9 Spring flowering yellows
9 early-flowering light apricots
27 Spring flowering light apricots.

Note that 12 out of 48 (25%) seedlings will be yellows, the result one would expect from the self-pollination of a (non-yellow x yellow), according to one of the basic laws of genetics.

You can now see why I have said that space can be a limiting factor! However, the problem is not as big as it may seem because in 2005, if I want to, I will be able to substantially reduce the number of plants that I grow on from there.

Action plan for 2005

Around April 2005, or when most of the seedlings have at least two leaves and are strong enough, I will be able to separate out the twelve yellows, which of course will all have clearly visible unpigmented stems. I have to keep them all, since at this stage, I will not know which of the twelve are the three early-blooming ones.

At this point, depending on how much space I have available, I will have to decide what to do with the thirty-six seedlings with pigmented stems, all of which will eventually bloom with light apricot flowers. They will be a by-product of my plan to breed an early-blooming yellow, and so can be discarded as

being surplus to my immediate requirements. However, they could be a useful input, were I (or a successor) to take my breeding plan further, as discussed below.

Fast-forward.....2008:

My F2 plants have all flowered!?

This is when I should be able to observe the flowering times of my 12 yellows, the ones selected in 2004 because of their unpigmented stems. I should at long last, when they bloom, be able to isolate my 3 early-flowering yellows, the plants I set out to design, back in 2003. A long time to wait? Yes, but no longer than the waiting time for the results of a "random pollination" in 2003. Think about that....

Note that, apart from the uniform yellow colour, these three early-flowering plants could differ considerably from each other with regard to other features, like form, flower shape, petal width, etc. Such variation is to be expected in the F2 (second) generation.

End of the story - or the start of the next phase?

Yes, I can choose to end my project at this point, since I will have achieved what I had set out to do. But look at the options available to me, or to a successor, for using the plants I have now reared to maturity, to further develop a range of early-blooming *Clivia* by breeding within the line that I have now begun to establish.

I can sibling-cross between my three early-flowering yellows, I will be able to guarantee that the seeds will all yield yellows, all early blooming, because of their parents' double-recessive traits. These two traits are now "fixed", with the advantage that the plants will breed true for these traits from generation to generation. I can now concentrate on selecting the most desirable F3 plants with regard to other features, like flower shape, petal width, vigorous growth, etc.

Photo: Shawn Benjamin

C. *miniata "Cl C2"* grower Riel Lötter

I can back cross my three yellows with "Gladys", and will be able to guarantee all early-blooming light apricot flowers in the next generation, though the plants will have the hidden yellow in their genetic mix. Back crosses can be repeated several times - here I am talking about a really long-term breeding program- and variations will decrease accordingly. By using at each stage the seedling parent with the most desirable features (which means, in effect, selecting out the less attractive) such back crosses will, in the long run, perpetuate the features I prefer and eliminate those I don't.

Let us assume that I also grew some of the F2 seedlings with pigmented stems on to maturity and was able, at the flowering stage, to select out one or more of the nine that were early flowering - refer back to squares 6, 8 and 14. I could use them in my breeding programme as well, for example, by sibling-crossing between them, or with their three yellow siblings, or indeed again back to "Gladys". I will still be able to guarantee that the resultant seeds will produce early-blooming F3 plants, though some will be yellow and some light apricot.

I would probably not self-cross any of my

F2 plants on a large scale, since they themselves were the product of a selfing, because I suspect that this could lead to a loss of vigour in subsequent generations. To find out if this was in fact the case I could always experiment with one or two flowers, and then keep records of what happens.

I could also out cross with a plant outside the early blooming line that I have worked so hard to establish. I would be reluctant to do this, unless such a plant also came from a known line of early flowering plants. I might consider, as an experiment, for example, pollinating a few flowers with pollen from a winter flowering interspecific hybrid, say a C. *miniata* x C. *gardenii*, with characteristics I liked. The purpose would be to bring desirable characteristics into my early flowering line, but there would also be a risk of bringing in unwanted features. Normally, in line breeding like this, outcrossing is used only when really necessary, to bring in new vigour and fertility.

Of course, there is nothing to stop me from using pollen from my plants to out-cross to plants outside the line I am establishing.

Conclusion:

I have gone somewhat beyond my original purpose when I began this article, in order to illustrate the range of possibilities opened up to the enthusiastic amateur, once one has learned "the rules of the game" and begun to apply them. The process is made so much easier if you can begin with F1 plants, building on work already done.

This is certainly a practical and exciting working method, well worth the effort for the amateur wanting to achieve planned results. I say 'exciting' because remember that, by controlling for only two characteristics, you will not be removing all uncertainty, for the plants resulting from the self-pollination of an F1 plant may still vary in every other conceivable characteristic.

Photo: Mick Dower

C. miniata "Gladys Blackbeard," grower Toy Jennings

The general principles can be applied to breed a dark red with a large flat open flower. Such plants are rare and are highly desirable. You could begin by crossing a plant with dark red funnel-shaped flowers, which are not as rare, with one with large open, flat but orange flowers. Or, better still, you may already have an F1 seedling from such a cross, or be able to acquire one. Provided the traits "dark red" and "flat open flower" are independently inheritable - you can check this by asking experienced breeders or by learning from your own experience as you go along - you can follow the steps outlined above to design your own *Clivia*.

The unlocking of hidden variation in ones plants remains one of the most fascinating - and most rewarding - aspects of Clivia breeding. The article "Multitepal breeding" by Shigetaka Sasaki on page 57 gives further breeding possibilities that you may care to try, using the method set out above. Eds.

More on mirabilis

John van der Linde, South Africa

The story of the discovery of the new species, *Clivia mirabilis*, was told in CLIVIA FOUR. Several of the plants collected under permit at the Oorlogskloof Nature Reserve flowered at Kirstenbosch Botanical Gardens in November 2003, unseen by the public.

The terms of the memorandum of agreement with the Northern Cape Nature Conservation Department (NCNCD) governing this permit state that no material or any progeny or derivatives thereof may be transferred to any third party without the written consent of the Director of the NCN CD, so the tight security surrounding these plants is understandable.

We are therefore privileged to publish these "behind the scenes" pictures, showing two of the plants in flower. The third picture shows John Winter at work at Kirstenbosch, surrounded by plants he is potting up.

In terms of the agreement, the NBI will market C. *mirabilis* seedlings to the public, on behalf of the NCNCD. By early 2005 most of the seedlings should be ready for sale, once permission to release the plants is received.

The NCNCD has been asked to consider making seeds available to growers in countries where plant importation procedures could be fatal to young plants.

The "candy-stripe" effect is thought to be caused by the lack of direct sunlight

Photo: Claude Felbert

Photo: Claude Felbert

John Winter working amongst *C. mirabilis* seedlings

Photo: Graham Duncan

C. mirabilis flowering at Kirstenbosch in November 2003

The Photographic

Competition Winners

Above Left: Winner Best Photograph
Also shown on back cover
A selection of *C. miniata,*
Grower & Photo: Tony Barnes,
New Zealand. Sigma 35mm
on slide

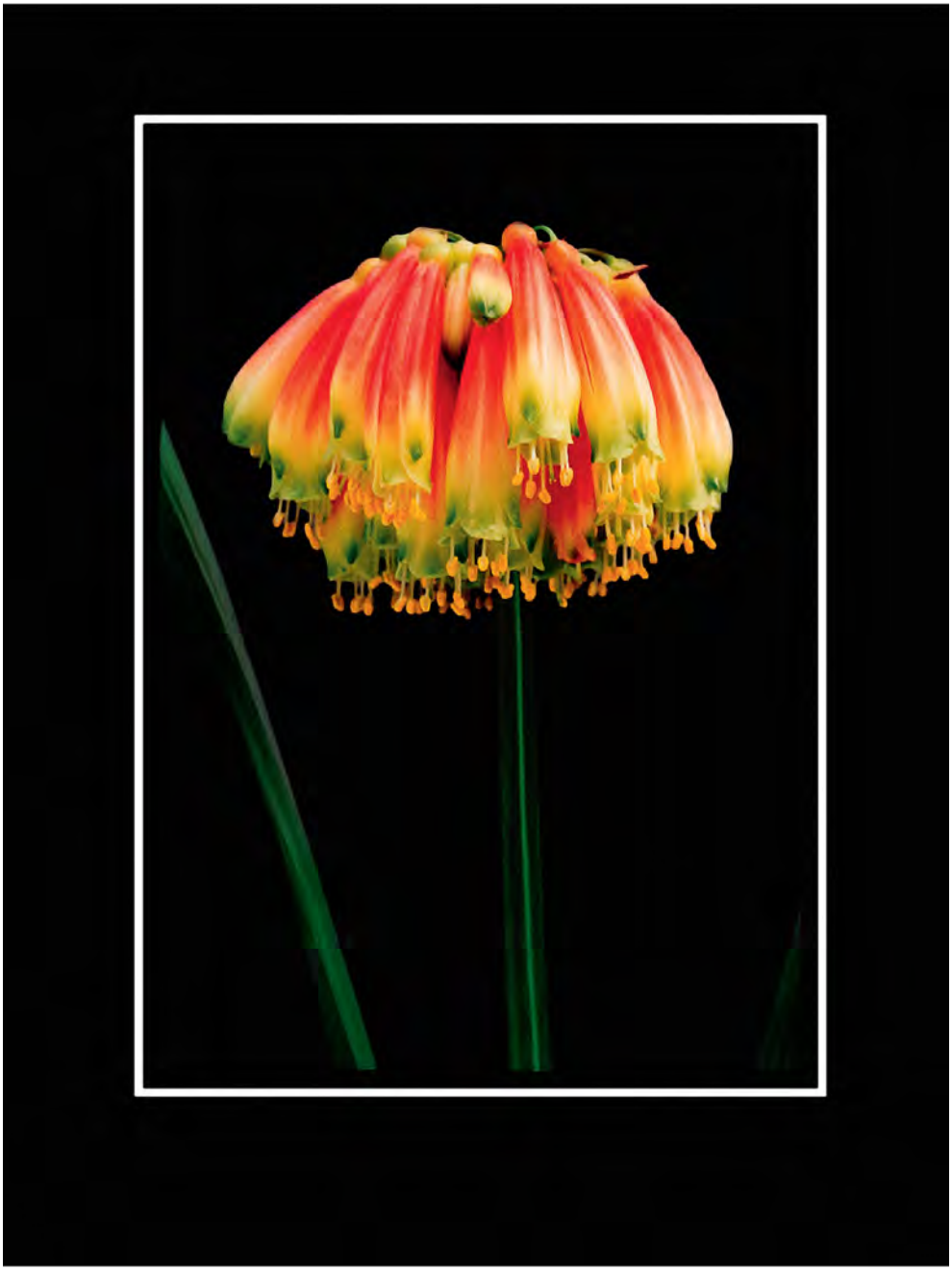
Above: Runner-up to best Photograph
C. miniata, Breeder G Cowlishaw
Grower & Photo: Ken Smith,
Australia. Canon Power Shot A30

Below Left: Winner Best *C. miniata*
Grower & Photo: Tony Barnes

Right: An Ian Coates Interspecific entry

Winner *C. Caulescens*, Grower & Photo: Ken Smith, Australia

Winner Interspecific, Grower & Photo: Ian Coates, UK



Winner *C. Gardenii,* Grower & Photo: Ian Coates, UK

Location, Location, Location

Jerry Charpentier, U.S.A.

I reside in Orlando, Florida, U.S.A. and no, I'm not in property sales. I am a *Clivia* collector and have all of my *Clivia* growing outdoors exclusively. The land is basically white 'sugar' sand rich in phosphate and not much else. It is further enriched by live oak leaves which I utilize as a year-round mulch. Earthworms play a major role in further breaking down the leaves and turning the sand into an appropriate organically rich 'soil' for the Clivia. The sand is of course very free-draining and apparently allows for enough air to reach the roots providing optimum growth. The Live Oak trees *(Quercus virginiana)* are ideal to grow *Clivia* under since they provide the necessary shade and protection from the settling frost. The trees are essentially evergreen, losing their leaves in a flush during very early Spring and immediately replacing them in a flash with the new ones.

Orlando is located in lower USDA and is in Zone 9*. Subtropicals are at home here and the *Clivia* thrive. The winter months are cool to occasionally cold and dry and the summers are hot and very humid with daily afternoon thunderstorms prevailing from early July through early September. These hot and humid conditions don't especially appeal to *Clivia* which leads me to the first 'Location' reference.

Firstly, locate your *Clivia* where they will receive adequate air circulation, especially if they subjected to the heat and humidity prevalent here and along the U.S. eastern and gulf coasts, among innumerable other locales in this great big world. Generally if I'm going to lose any *Clivia* plants, it will be in August when they run this test gauntlet. I don't spray any fungicides or pesticides since I only want to to be associated with cultivars which have the genetic propensity to be utilized as landscape plants requiring no pampering, only reasonable care. Surprisingly, without spraying I have lost very few to soft rot in the last 16+ years and most of those were from a seed lot of indigenous types from South Africa. I also lost a few named cultivars bred on the U.S. west coast to various vulnerabilities to this Florida climate, although a high percentage of seedlings from these same cultivars actually show no ill effects from the climate.

Secondly, locate *Clivia* where they receive adequate light. Experience has shown me that if you want blooming, give them all the light they can take, short of sun-bleached leaves and scorching. I have clivia clones which produced immense heads of flowers in one bright south-facing location which even subjected the plants to many hours of winter sun. I broke the clump into segments and put some of them in a shadier spot which received just a couple of hours of morning sun and dappled shade for the rest of the day. ..those haven't bloomed in the three years they've been there. Out of curiosity I set my hand-held photographic exposure meter for 100 speed film and used a 30 shutter speed exclusively, allowing for the lens opening reading as the only variable. The reading in the more desirable south-facing area called for a lens opening of f-16 whereas the lens opening reading for the least desirable shaded area was f-8. (A reduction of two full stops.) The reading was taken October 26 at 3:00 p.m., I hope this quasi-scientific effort will be of assistance to others.

Thirdly, locate your *Clivia* so that they can get the chilling they need to set blooms. I leave my plants in the ground throughout the year but I know not everyone has that luxury. My plants have survived temperatures below freezing without trauma and they actually

seem to luxuriate in the very cool temperatures. What has been most damaging to the plants is frost settling on the leaves and burning them to a crisp. The plants are generally unscathed but the appearance is unsightly for the whole of the next year. To avoid this burning, place the plants inside or under the eaves of the house, under evergreen trees or a frost cover of any contrivance and they'll reward you handsomely.

I hope this mini-treatise will help some of you with your *Clivia* growing problems.

Additional comments

**Climatic Regions of the USA are split into 10 Zones. Each zone may be categorised by the average range of minimum annual temperature, which each zone receives. Parts of Zone 6 and Zones 7, 8 and 9 are the areas where* Clivia *may be grown in shaded ground without protection from ambient temperatures.*

If you do not live where it is convenient to keep your Clivia *in the ground then like most* Clivia *enthusiasts you will probably grow your* Clivia *in pots. This portability means that they can be grown anywhere as long as they receive protection from extremes.* Clivia *are hardy plants and adapt to many climate, temperature and moisture extremes. They will grow best in temperatures that range from between 8° to 28° C. By placing* Clivia *in shade houses to protect from sunlight or glasshouses to protect from cold we are creating a controlled microclimate.*

Factors to consider when creating a protected environment for* Clivia*;

1. Solar Radiation, Sunlight / Shade; The degree to which your plants receive light and heat radiation from the sun is largely a function of the angle at which solar rays strike the earth's surface. This depends on the time of year and the latitude at which you are situated as well as the time of day. The amount of sunlight and heat that your plants receive at various times will determine whether you need to protect them from heat or cold. In some climates only one protection is required while in others you need to protect from both.

2. Temperature; The temperature to which plants are exposed determines the protection required. With high temperatures a greater amount of moisture will be needed. Air circulation will also help to reduce the temperature and remember that evaporation causes cooling. Lower temperatures are required to initiate scape elongation, but frost and ice with their below freezing temperatures have the potential to cause the most damage. Combat with warmth or continuous water sprayed on leaves until the temperature rises above freezing and any ice or frost has melted.

3. Moisture; The amount of water that your Clivia *need will depend on the drainage characteristics of your potting medium and the ambient temperature.*

4. Air Circulation; This helps to reduce fungal growth and keep temperatures from rising too high. Pests like mealy bug do not thrive in good air circulation.

5. Feeding; This depends on the time of year and the stage of development at which the plant is.

Seedling	*-Nitrogen for vegetative growth & Phosphorus for rooting*
Pre-Flowering	*-High Potassium*
Post-Flowering	*-Phosphorus*

(see Clivia *4 pgs 52 & 53)*

6. Control of Insects and Fungal Diseases; Air circulation is an important factor. Fungicides and insecticides can play a role. Eds

Maternal Inheritance: Some Observations About Variegated Clivia

Kenneth R Smith, Australia

When I first started to research *Clivia,* it was the knowledge that yellow-flowered and variegated foliage forms of *Clivia* existed that prompted my selection of the genus. Now a lot more is known of the breeding of the yellow flower forms, but the variegated types continue to amaze us. As a long-time collector of all variegated plants I have learned that plant variegation has many aspects. I am still learning new things.

The term maternal inheritance, or cytoplasmic inheritance, or extrachromosomal inheritance, is used to describe the mechanism by which foliage variegation is transmitted. The material contained in the plasma that surrounds the egg cell holds the genetic material that influences the phenotype, or appearance, of the resulting seedlings. More and more, we are learning about the role that the mother plant, or seed-bearing plant, plays in the transmission of the variegated foliage character in *Clivia.*

Photo: Hein Grebe

Variegated seedlings from China

Whilst it is said that an evenly-striped plant, that has good form and flowers, gives the best chance of producing striped offspring, it must also be remembered that chance plays a role.

Variegation in *Clivia*, as well as in other plants, can be a very personal choice. What looks good to one grower may be considered unworthy of cultivation by another grower. I gave up trying to explain my fascination with plant variegation to others a long time ago. I like all types of variegation and that is all that matters. The striata type of variegation can have many combinations of stripes. *Clivias* that appear totally green may have just a few fine stripes, and, of course, can produce variegated seedlings. *Clivias* with evenly spaced stripes of green and white or green and yellow tend to be showier and can produce seedlings of variable stripe patterns, some weaker and some better than the mother plant. *Clivia* that have very bold stripes of white or yellow on the green leaves certainly stand out in a collection. These plants can also produce striped seedlings. But here's the catch — these bold plants have a greater tendency to produce albino seedlings, which of course will ultimately die due to lack of chlorophyll.

I found it very interesting to read an account of the propagation of the beautiful margin variegated form of *Clivia* called 'Demeteri'. It was stated that the plant originated as a seedling and that it grew well and was shown to the public for the first time at the Ghent Floralies of 1905! That it originated as a chance seedling, I can believe, but the article then goes on to say: "Offsets were rarely formed and although seed from self pollinated plants produced practically 100 per cent variegated plants, only one or two seedlings raised during the last sixty years have approached the parent plant in beauty"

That was written in 1971, and although a few seeds would have resulted from the self pollinating, the comment that 100% variegated

offspring resulted is surprising to me. The margin variegation is chimeral in origin and it has been my experience that all seedlings from the margined form turn out to be albino. I don't spend any of my time pollinating the flowers of the margined form. I must note here that I have raised some seedlings that turned out variegated where the margined form was the pollen parent. They are very weakly striped plants and I am not sure what to make of that.

I think we have had the spotlight put on the variegated *Clivias* lately with all the attention that the Chinese forms have received. The images we are shown show exceptional plants that have been cultivated for precise stripe patterns. The variegated Sparrow *Clivia* is one of the most elegant variegated plants I have seen, and the nature of variegation means that anyone growing *Clivias* from seed of the Chinese variegated forms can end up with a plant like that. The breeding recommendations in the translation of Zhu Jifu's book, "Appreciation of Chinese *Clivias"* page 5, state:

1. green pollen + green female = green seedlings
2. variegated pollen* + green female = green seedlings *
3. green pollen + variegated female = the 3 colours (green, variegated and white offspring)
4. variegated pollen + variegated female = the 3 colours."

The asterisk in point 2, states:

"The pollen from a variegated pollen X green female can be used in your (sic) crosses with a variegated mother plant. The pollen contains the recessive gene."

Another form of the striata type of variegation that commands attention is the half-green half-yellow leaf. Several forms have been named, such as 'Miss Perfect' and 'Hamboon Hamboon'. The Chinese refer to this form as Mandarin Duck variegation. The elusive nature of variegation means that this form is difficult to propagate both vegetatively and by seed. Offsets can be either all green, all yellow or variously striped, and I imagine, rarely as a half-green half-yellow offset. One of my variegated Belgian Hybrid *Clivia* has decided to make one side of the plant a half-and-half variegated leaf, whilst the other side is typical striata. I am watching it with interest and await the first flowers.

Photo: Claude Felbert

Narrow-leafed centre variegation from Mike Christie

Like the margin-variegated types, the centre-variegation forms cannot be reproduced from seed. This chimeral type of variegation will produce all green seedlings, or at least that has been my experience so far. Yet, on occasion, a centre-variegated seedling will crop up unexpectedly in a batch of seedlings. Well, I suppose they have to start somewhere. When variegation appears in a plant, either as a new growth or as a seedling, the pattern can change in time as the cells sort themselves out. The centre stripe and the margin tend to be stable, whilst the striata type is variable. Mr Nakamura has sent me a photo showing a striata form *Clivia* that developed the prized margin variegated leaf as the new leaves were produced. I have had this happen on one of my variegated *Clivia*. As I previously mentioned the nature of variegation is unpredictable.

Akebono variegation is another form that has caught our attention recently. Here we have cross banding on the *Clivia* foliage. The good thing about this mutation is that it is able to be reproduced by seed, that is, it is maternally inherited. Add the fact that the pattern appearance is influenced by temperature as the seasons change and you have a very interesting *Clivia.* This is proving to be a very variable character, as some seedlings will display the banding very early, yet others will start with typical green foliage, only developing the banded leaves as the plant matures. Crossing a striata form with an akebono form will produce some very interesting checkerboard pattern plants. But wait a minute, how will you get the seedlings to show both variegation characters if each type is only maternally inherited?

There are many types of variegated plants that can be grown from seed. As the research states, there are many ways that different variegations are reproduced. The more you research variegation the more detailed it becomes. In *Clivia* we have striped leaves and banded leaves that can be grown from seed. The margin and the centre variegations have to be grown by offsets. I feel that the more you deal with variegated *Clivia* the more you will understand how it works. It is necessary to keep an open mind about it, as anything can happen. Yes, there are clear indications that certain types reproduce from seed. The trouble is that the percentages vary unless you are growing lots of seedlings. The one seed that you buy could hold the genes to produce the best patterned plant in your collection. On the other hand you could grow hundreds of seedlings and only get mediocre patterned plants. It really is the luck of the draw. I would encourage all *Clivia* growers to try different crosses because there is always a chance of creating a new pattern.

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Photo's: Hein Grebe & Claude Felbert

Different forms of variegation — courtesy Mike Christie's "The Clivia Collection" and Hein Grebe

Breeding Broad Leaf Clivia

Theoretical Genetic Considerations

Johan Spies, South Africa

Introduction

Although the genus *Clivia* is endemic to South Africa, this phenomenal plant has been exported to many countries, where breeding programmes were subsequently initiated. 'Beauty is in the eye of the beholder'. This expression is especially applicable to various breeding programmes. I do not know whether cultural differences or fashion preferences in different countries were responsible for the extremely diverse breeding aims in the different countries.

Breeding for broad leaves started in Belgium and has been carried to the extreme in the Far East. When comparing these products of human intervention with *Clivia* in nature, they appear to represent almost different species (See Fig. 5 *for selection of leaf shapes and widths*). Many breeders are now trying to combine plants selected for beautiful flower production with plants selected for extremely broad leaves. The ultimate aim is to combine the beautiful flowers with yearlong beautiful foliage. During this process the inheritance of certain traits should be known, for example, how does the inheritance of broad leaves work. Are the ultra broad leaf *Clivia* plants the product of combining the correct combination of genes during breeding or the result of a new mutation (change of a gene) that occurred?

One of the major problems with *Clivia* breeding is the lack of knowledge of the inheritance of many characters, such as broad leaves. This process is being studied and the final results will, hopefully, be available in about 15 year's time. Some people are anxious to see the results and are not willing to wait. Therefore I decided to write this purely academic exercise and present a totally theoretical putative explanation of how this phenomenon may have occurred.

Photo: Hein Grebe

You have to play your cards right to get the perfect fan shaped broad leaf.

Polygenic inheritance

When a pure breeding yellow and pure breeding orange *Clivia* are crossed, the offspring will all be orange. When an offspring is self-pollinated, a ratio of 3 to 1 (orange to yellow) will be observed. This type of inheritance is called Mendelian inheritance.

Many variations of Mendelian inheritance exist. Some characters in plants and animals are controlled by more than one gene pair. Usually quantitative traits (height, length, weight, etc.) are controlled by various gene pairs. This phenomenon, where more than one gene pair determines the inheritance of a single character, is called polygenic ("many genes") inheritance. With polygenic inheritance the genes work additively; the more genes present the more or greater the effect will be. For example, with no dominant gene for leaf width present, the leaves may be extra narrow, with one gene the leaves may be narrow, with two genes they may be semi broad, and so on till six dominant genes may produce an ultra broad leaf plant. Let us assume that the genes responsible for broad leaves are present in nature and we name these the "broad leaf genes" (abbreviated as BL1, BL2, BL3, etc.). This assumption immediately gets the response "but why are there no plants with very broad leaves observed in nature"?

Population 1

We start with a theoretical *Clivia* population with a bit of variance in the width of their leaves. The majority of the population have narrow leaves (N) and occasionally an extra narrow (EN) or semi broad leaf (SB) is observed. This normal variation is caused by a single gene pair, Broad Leaf 1 gene (BL1). Genetically the majority of the population will be BL1bl1 (in other words heterozygous[1] for the broad leaf (BL1) gene - or they can be described as splitting for EN and SB as often described in the *Clivia* literature). If this narrow leaf *Clivia* is self pollinated, a quarter of the offspring will be EN, another quarter will be SB and half the offspring will be N (Fig. 1). This form of inheritance differs from the normal inheritance where we will get a 3:1 ratio in the offspring (for example when you self-pollinate an orange *Clivia* plant which had a yellow parent). The reason for this is that the dominant genes (written with capital letters) act additively to the width. This theoretical situation corresponds with observations in nature where a bit of variation in leaf width is observed.

	BL1	bl1
BL1	**BL1 BL1 SB**	**BL1 bl1 N**
bl1	**BL1 bl1 N**	**bl1 bl1 EN**

Fig. 1 Genotypes and Phenotypes following the self-pollination from an N plant in population 1

Population 2

Assume that a second *Clivia* population exists with a similar variance in leaf width. However, this second population contains a different broad

[1]*The term heterozygous implies that the individual will have the appearance (or in genetic terms the phenotype) of the dominant gene but it will also carry a recessive gene. The genotype (the genetic constitution of the plant) of this plant consists consequently of a dominant and a recessive gene (eg. Aa). In* Clivia *literature this phenomenon (heterozygosity) is often described as a plant that will split for a certain character. A heterozygous orange will, if self-pollinated, split to form three orange and one yellow plant.*

	BL1BL2	BL1bl2	bl1BL2	bl1bl2
BL1BL2	BL1BL1BL2BL2 VB	BL1BL1BL2bl2 B	BL1bl1BL2BL2 B	BL1bl1BL2bl2 SB
BL1bl2	BL1BL1BL2bl2 B	BL1BL1bl2bl2 SB	BL1bl1BL2bl2 SB	BL1bl1bl2bl2 N
bl1BL2	BL1bl1BL2BL2 B	BL1bl1BL2bl2 SB	bl1bl1BL2BL2 SB	bl1bl1BL2bl2 N
b1bl2	BL1bl1BL2bl2 SB	BL1bl1bl2bl2 N	bl1bl1BL2bl2 N	bl1bl1bl2bl2 EN

Figure 2 : Genotypes and phenotypes following the crossing of two SB plants from populations 1 and 2.

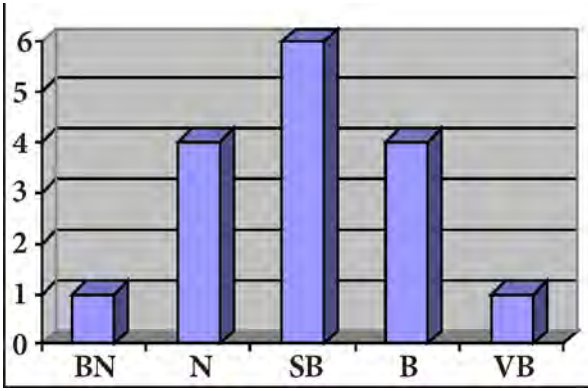


Fig. 3. Ratios of different leaf widths following the crossing of two SB plants from populations 1 and 2.

leaf gene, BL2. This second population may be bllbll or the bl1 gene may be absent, especially if this population is from a different locality or is a different species from the first population. In nature these populations will usually be geographically isolated. Our keen *Clivia* breeder collects SB plants from both these populations and crosses them. To his/her dismay all the offspring (Fl) are still classified as SB.

He/she self-pollinates these inter-population hybrids and observes quite a variation in the offspring (Fig. 2) where leaf width varies from EN to VB with the majority of F2 plants being SB (Fig. 3).

BL1BL1bl2bl2 (SB - Pop. 1)
X
bl1bl1BL2BL2 (SB - Pop. 2)
results in
BL1bl1BL2bl2 (SB - hybrid)

With no dominant genes a certain basic width will still exist (EN). Each dominant gene will add to the total width (in this case approximately 20-30 mm). The number of classes involved is directly correlated with the number of genes playing a role in this whole process.

These results indicate an important breeding principle: self-pollination of the F1. People often hear about the negative effects of inbreeding and they try to avoid it at all times. Self-pollination is needed to determine whether genes like these putative broad leaf genes are present. If self-pollination was skipped the whole breeding effort would have been stopped when the F1 did not show any response.

Population 3

In an attempt to get even broader leaves, a population with a third broad leaf gene (BL3) should be found. The success of the next cross is dependent on the genetic composition of the parent containing the BL1 and BL2 genes.

The parent should contain both dominant genes. If the VB plant is selected from the cross between populations 1 and 2, you will ensure the presence of both dominant genes. So in your next cross you use the VB plant (BL1BL1BL2BL2bl3bl3) and cross it with the plant from the third theoretical population (bl1bl1bl2bl2BL3BL3):

BL1BL1BL2BL2bl3bl3 (VB)
X
bl1bl1bl2bl2BL3BL3 (SB)
results in
BL1bl1BL2bl2BL3bl3 (B)

Self-pollination of this hybrid will result in the ratios presented in Fig. 4.

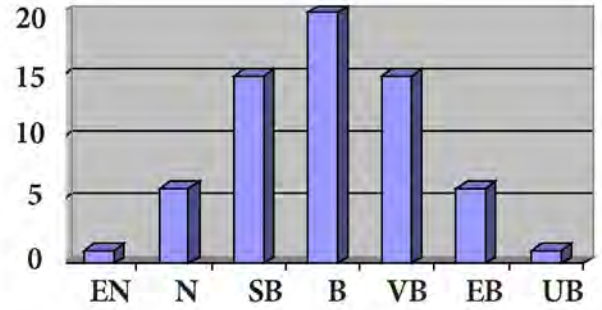


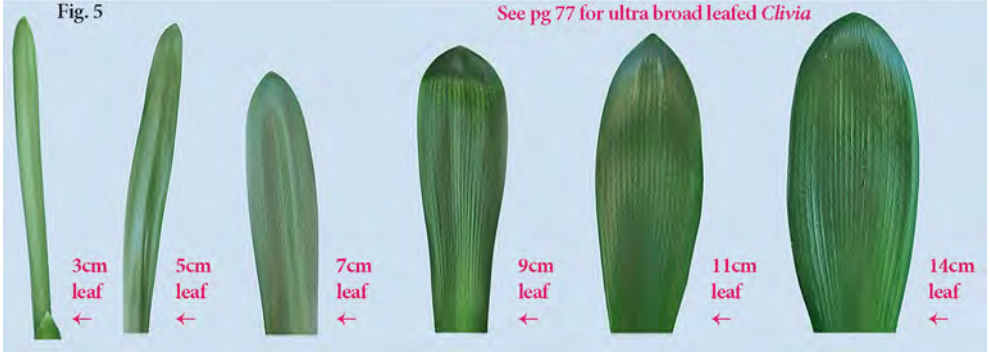
Fig. 4. Ratios of different leaf widths following the crossing of a VB hybrid from populations 1 and 2 and a SB plant from population 3.

In summary it can be said that each dominant gene adds a certain width to a basic width.

# Dominant Genes	0	1	2	3	4	5	6
Width	EN	N	SB	B	VB	EB	UB

Fig. 5

See pg 77 for ultra broad leafed *Clivia*



Discussion

These results indicate that it is theoretically possible to breed an ultra broad leaf *Clivia* if plants containing different broad leaf genes are used. Any of these theoretical natural populations can be substituted by a mutated population in a breeding programme. The major problem remains our lack of genetic knowledge regarding our breeding material.

A lot of factors complicate this simple demonstration of the inheritance of broad leaves in *Clivia*. The width of a leaf is not only the product of the genes present, but the interaction between these genes and the environment will play a role. If we compare this situation with humans, you may inherit the potential to develop an IQ of 120 but if all stimulation is withdrawn from you during your childhood, your IQ will be much lower than 120. Similarly a *Clivia* may inherit the potential to reach a leaf width of 150 mm, but stress at any stage of development will decrease that figure.

All genes may not contribute to the same extent. BL1 may contribute more, the same as, or less than either BL2 or BL3. These genes may influence one another so that BL1 and BL2 in combination produce a different width than would be predicted from crosses involving only one of them. Any one of these genes may be linked to another gene that will almost always be inherited together with it, that may influence the outcome. If a short leaf gene is inherited with a broad leaf gene, the leaf may, for example, be broader than predicted to compensate for photosynthesis.

Breeding broad leaf yellow *Clivia*

An example of this complexity may be the extreme rarity of broad leaved yellows. Two possible explanations exist; either (i) the yellow mutation suppresses the formation of broad leaves on a physiological/bio chemical level, or (ii) the yellow mutation gene is linked to a recessive bl gene or to a broad leaf suppressor gene. The fact that broad leaved yellows have been obtained in the USA and in the East suggests that hypothesis (ii) is likely to be correct.

Linked genes indicated that these genes are situated close to one another on a chromosome and that they will be inherited together. The closer these genes are together the more often they will be transferred together to the next generation. Since two yellow genes are needed to form a yellow plant, gene linkage will ensure that two "narrow leaf genes" are inherited with them. Consequently the broadest leaf possible will be very broad (VB) and the extra (EB) and ultra broad (UB) leaves will not be obtained by conventional breeding. However, with linked genes a cross-over occurs occasionally between the genes involved. These very rare events may have occurred in the American and Asian cases.

It may also be possible that the yellow mutation is linked to a "broad leaf suppressor" gene. If such a gene is inherited it suppresses the working of the BL genes and they cannot be expressed. In the case of humans this can be illustrated by the inheritance of albinism. Two black people (having many expressed 'colour' genes and both being carriers for the albino gene) may produce an albino child. This child may have inherited many 'colour' genes but these genes cannot be expressed because the albino genes stop the production of melanin (the colour forming substance).

To test this hypothesis the following should be done: try to breed a broad leaf yellow group 2 *Clivia.* If this aim is achieved we know that we are dealing with linked genes. The chance of both yellow mutations being linked to the same "broad leaf controlling gene" is very low.

Clivia breeding

The strategy for the development of broader leaves should be to try crossing as many populations of *Clivia* as possible in an attempt to find new BL genes. In *Clivia* this is a very

difficult process because breeders continuously cross different populations and almost no 'pure' population exists. If the populations were pure, a cross between a Belgian broad leaf and a Chinese broad leaf should be an excellent source to increase the width. However, it appears as if these populations contain the same broad leaf genes and no additional width is obtained. This 'contamination' of the different gene pools (populations) of *Clivia* makes it very difficult to make progress with the breeding process. Breeding becomes a haphazard event - where you are looking for a needle in the haystack - rather than the predictive science it should be.

In a previous Clivia Newsletter Keith Hammett and Ken Smith pleaded for the preservation of the natural variation in *Clivia,* or in other words, for the preservation of as large a gene pool as possible. I want to end this in the same way. That insignificant *Clivia* that started your *Clivia* obsession may look worthless to you now that you have obtained some hybrids and have improved your own material, but it may contain some novel genes that you are unaware of. It may contain an, as yet, unknown broad leaf gene that will, in the right cross, give you the ultimate broad leaf plant. Take care not to destroy an ugly looking genius. If you selected humans, would you have kept Einstein as a child?

Photo: Hein Grebe

A fan-shaped short broad leaf *C. miniata* from China

Photo: Claude Felbert

C. miniata "Ella van Zyl". Grower: Toy Jennings

Miniata : In Favour of Seed Grown Strains

Michael Jeans, United Kingdom

For the majority of popular plants, those most desired are the named cultivars or hybrids, and divisions or cuttings from the award winning clones. There is considerable current discussion on possible commercial methods of propagating the most desirable clones of *Clivia miniata* and *Clivia* Cyrtanthiflora. In this article, I am setting out my reasons for suggesting that, in general, seed grown strains of C. *miniata* are the way forward, both for large scale commercial production and for amateur growers. Cyrtanthiflora, being a hybrid between two species, may well have problems in maintaining the quality of plants if grown from seed - it is outside my experience as I restrict my efforts to C. *miniata*.

Photo: Michael Jeans

Fig. 1 - Attractive fruits setting the tone

Seed grown plants avoid the very real genetic pitfalls of propagation by tissue culture, and also the long term problems resulting from continued vegetative propagation. In Europe, where the latter has been carried out over many successive generations of some bulbs and corms, it is now impossible to find them un-infected by virus. Continued vegetative propagation will, in any case, lead to a slow but gradual decline in the quality of the genetic make-up of the plant. However, a division from an early generation of an exceptional plant makes a worthwhile addition to any gene pool. Its good qualities are still there to be passed on, and any genetic deterioration is subsequently lost in the seed process. Virus is seldom transferred by seed, and the genetic make-up is totally renewed in a seed grown plant.

Absolute uniformity, usually the desired end point in line-breeding, is best avoided. There are several reasons for this - not least because the added interest of variation would encourage growers to produce ever better plants. However, a degree of uniformity in the size and appearance of the plant is essential for commercial production. In my strains, I am aiming for moderately broad leaves, 5 - 7 cm across, and very roughly 45 - 60 cm long. In my experience, broad-leaved plants produce flowers with broad petals and a good degree of petal overlap. Narrow-leaved plants tend to produce flowers with narrow petals and very little, if any overlap, which I feel should be avoided. Again, my experience suggests that well shaped plants usually have broad leaves while narrow-leaved plants are more likely to have the leaves sticking out at all angles and look untidy.

My own seed grown strains of C. *miniata* are divided into 4 groups:

Clear orange, dark orange and red

Pale oranges, sometimes suffused with other colours and sometimes pure, are put in the pastel group, leaving this group with strong,

vivid colours. Fig.2 shows a seedling, flowering for the first time, which will be incorporated into my gene pool for this group. Amongst other core plants, I am also using an Ixopo C. *miniata* which has a 25cm head and flowers with 9cm long petals, which are larger than flowers usually found on Ixopo C. *miniata.*

Photo: Michael Jeans

Fig. 2

Photo: Michael Jeans

Fig. 3

Yellow flowers, including peach

The yellow in this group is limited to strong, medium saturation yellow, and the cream coloured flower with a faint yellow stripe down the centre, which is described (commercially) as yellow is moved to the pastel group. Again it is intended that the group has only flowers with strong, vivid colours. Fig. 3 shows a yellow seedling which I feel has many of the characteristics for which I am looking. Its only real weakness is that the flowers are only 7 - 9 cm across. I feel that, ideally the flowers should be about 10 cm across, and that they would then look in balance with a large round head carried on a strong stem well clear of the leaves.

Pastel flowers

This group is intended to have the full range of pastel colours, amongst which the (commercial) yellow and pale orange can earn their keep in extending the range. Photographs taken at *Clivia* Shows, capturing different classes and a range of colours in the same picture, illustrate how much more impact is made than with a display of a single colour. One has only to see a large display of orange C. *miniata* in a garden centre to realise the difference; they may look attractive, but are hardly likely to stop every passer-by in their tracks! The pastel group is probably the most exciting commercially, and also that most likely to appeal to enthusiastic growers. Figs. 4, 5, 6, 7 and 8 show various pastels that are typical of my gene pool at its current stage of development.

Photo: Michael Jeans

Fig. 4

Photo: Michael Jeans

Fig. 5

Photo: Michael Jeans

Fig. 6

Photo: Michael Jeans

Fig. 7

Variegated leaves

For me this is by far the most difficult group, and consequently I have had to lower my sights and settle for a strain that produces seed with a good chance that the seedlings will have attractively variegated leaves. Parent plants with spectacular variegation can easily produce seedlings that suffer sufficiently severe chlorosis as to be unable to survive. It is also desirable that the plants should have flower heads that are the equal of other C. *miniata.* Figs. 1 and 7 show a plant with attractive variegation, a good flower head and a spectacular seed head which adds considerable interest to the plant. My target is that 50% of seed should produce variegated leaf seedlings, mostly with orange flowers, but some with yellow flowers.

In order to aim for top quality, it is essential that the plants are hand pollinated to a carefully controlled plan and the seed from the various crosses kept separate and labelled. Cross-pollination tends to produce very much larger seed heads than self-pollination, and consequently yields a much larger crop. Typically, I would expect 10 - 12 seeds a berry from cross pollination. Whilst in the course of writing this article, I have harvested and sown two berries from the plant shown in Fig. 3, one contained 13 seeds and the other 17 seeds. One exception to this is any cross with considerable Vico Yellow blood in it, where one would be lucky to see even half that number of seeds in a berry. The small green and white berry at the bottom of the head in the photo on the first page of this article is likely to be a self-pollinated berry, and the other much larger berries to be cross-pollinated.

Hand-pollinated seed that is labelled so that it can be traced to its parents is far more time-consuming and expensive to produce than "bulk" unlabelled seed, but the production cost per seed is minimised if nearly every flower in the head produces a large berry filled with a good quantity of seed. It also means that the number of stock

plants needed to produce a given quantity of seed is much reduced. High seed yield, all other things being equal, is an extremely valuable characteristic for those retained as stock plants.

My aversion to keeping records manifests itself in the labels which I tie to flower heads once I have cross-pollinated them. Each label records the parent plants and the date of the cross. The latter is of interest as it tells me the earliest time that I can sow the seed and expect it to be viable. Sowing the seed as early as possible is important since the few months between the seed becoming viable and the berry changing colour can, in some instances allow the plant to flower a year earlier than would otherwise be the case.

In England, C. *miniata* flowers in the period mid-Febuary to the end of May. If a plant has not flowered during that period, it will wait until the following year, and that particular program will be delayed by a year. Typically, a complete cycle for my C. *miniata* is usually 4 years, one year for the seed to ripen followed by 3 years for the seedlings to flower. Only very occasionally, does a seedling manage to flower in two years from seed. To reduce the complete cycle to 3 years would pay great dividends as it would mean that a 12-year period contains a total of 4 cycles rather than 3.

As I mentioned earlier, I am keen that all the plants should be relatively broad-leaved and tidily shaped. Such plants can be selected when they are about 18 months old, and grown on to flowering in the hope that they will at least match, if not improve, on the previous generation. Without doubt my greatest disadvantage in growing *Clivia* in England is the cold winter that demands that the plants are grown under glass, thus limiting the space available and the quantity of seedlings that I can grow on to flowering. However, I also have a great advantage in the availability of broad leaved orange flowered plants. Some of these plants are the product of selective breeding through many decades in the late nineteenth and early twentieth centuries, and combine good flower form with a well shaped plant. Fig. 9 shows a seedling with excellent shape and only average or below average flower form. It is still worth adding to the gene pool as few plants are that well-shaped, and the shape is all that there is to see for those of the 52 weeks in the year when the plant is not in flower.

Seed sown strains should only be the starting point for enthusiastic growers who, having bought a packet of mixed pastel shades, can then add their own favourite plants into that gene pool, giving a unique but completely up-to-date gene pool. Not only would the availability of seed enable all growers to maintain high-quality gene pools, but also, hopefully ensure that much better quality plants find their way onto the general marketplace.

Photo: Michael Jeans

Fig. 8

Photo: Michael Jeans

Fig. 9

Polyploidy in Clivia : A Laymans Guide

Aart van Voorst, Netherlands

Introduction

After my first research on polyploidy in *Clivia* and the successful production of polyploid *Clivia* plants using the in-vitro method (see CLIVIA 5), the question arose: how to continue? If polyploidy should be a success in *Clivia*, working alone on this subject will not speed up polyploid breeding very much. Among the many *Clivia* enthusiasts around the world, working on the improvement of all kinds of characteristics, there must be others who would also like to work on this subject. The hobby breeder doesn't normally have a laboratory at his or her disposal, so the method to induce polyploids should be simple and easy to apply at home "at the kitchen table".

Preliminary results with germinating seeds immersed in a colchicine solution, presented at the 2002 Clivia Conference, showed great loss of material due to the toxicity of the colchicine to the root meristem. Normally you also get losses because in many cases the shoot meristem dies, but loss because of a destroyed root meristem reduces the effectiveness of the method without any possible advantage. The first root(s) of a colchicine treated *Clivia* seedling may be diploid even when the shoot is converted to tetraploid. Roots that appear later from the tetraploid shoot will also be tetraploid. A method that will save the root meristem would be welcome. Harold Koopowitz suggested putting the germinating seed upside down in the liquid with the root meristem above the colchicine solution. In this case the chemical is not in direct contact with the root meristem and will reach it only when transported within the plant. With this in mind I returned to Europe and at home I started experimenting with seeds people at the conference had donated to me and with some material collected from the wild.

Material and Methods

Two of the chemicals most widely used to double chromosome numbers are oryzalin and colchicine. Although oryzalin is more effective in several plant species (van Tuyl *et al.*, 1992; Vainola, 2000), colchicine is easy to use and maybe more easy to purchase in different parts of the world. I use colchicine in all my experiments. Colchicine can be purchased at several chemical firms. A website illustrating the use of colchicine where Wouter Addink uses *Fuschia* as an example is: www.geocities.com/RainForest/Vines/2259/colchicine.htm.

To be effective colchicine should be in contact with an active meristem. Why germinating seeds are the best starting material for chromosome doubling in *Clivia* has been explained before (van Voorst, 2003). It is important to state that colchicine is highly toxic and should be used with great care, especially the pure powder form. Inhaling the powder should be completely avoided. When diluted with water to the working concentration of 0.05 - 0.1% (0.5 - 1 g/l; some firms sell solutions) the risk of getting poisoned is very small. Take the same precautions you would when using any other household chemicals like bleach or poisonous substances.

Starting off with dormant seeds and a clean method of germination should increase your success rate. Putting the seeds in soil would complicate the procedure due to the substrate particles sticking onto the developing plantlet. Place the seeds on moist tissue paper in a small container which is then kept in a warm spot. Treating the seeds with a diluted solution of household bleach (one to one hundred) for one hour should prevent fungal infection.

Within the seeds of a cross there is normally a variation in germination speed. For convenience it would be preferable to treat all within a batch simultaneously. This can be achieved by "chipping" the seeds: taking the seed coat away above the embryo with a sharp sterilized knife or razor. Extra care should be taken so as not to damage the embryo.

Colchicine application method

After the seeds have been chipped they can be placed in moist rather warm surroundings (a little above 20° C). For example in a petri-dish on a piece of moist paper towel (Fig. 1.)

Colchicine can be applied when the seeds have germinated and the radicle is about 1-1.5 cm long. Terminology of reproductive parts of *Clivia* is explained by Robbertse (2001).

The meristem of the primary root should be visible and just above the meristem the first circle of root hairs can be seen. The sheath from which the first leaf will emerge should also be visible. It is around this sheath from which the first leaf emerges that the colchicine solution should be applied in order to reach the shoot meristem. To make the procedure easy, it is best to mount the seed on a piece of clay (Fig. 2).

You can use ordinary children's playing clay that comes in different colours. Using the different colours of clay will help in keeping the seeds from different crossings within an experiment separated (Fig. 5).

A small oblong piece of (Kleenex) tissue is then wrapped around the radicle containing the sheath and shoot meristem, (Fig. 3). This piece of tissue can be pre-wetted with a small amount of colchicine solution to make it easier to manipulate. From this stage the tissue should not be touched, so working with sterilized tweezers is recommended.

When the tissue is placed in several layers on the shoot meristem, as much extra colchicine solution as possible should be added (Fig. 4). I use a standard 0.05% solution.

The seeds, still mounted on clay, are then kept in the dark in a humid container (colchicine breaks down in light) at a temperature above 20° C for 1-2 days (Fig. 5). If a period of two days is chosen (recommended), after one day an additional drop of colchicine solution should be applied to the piece of tissue on the shoot meristem. After the induction period of the colchicine, the seeds are then rinsed in tap-water and planted in soil or other medium.

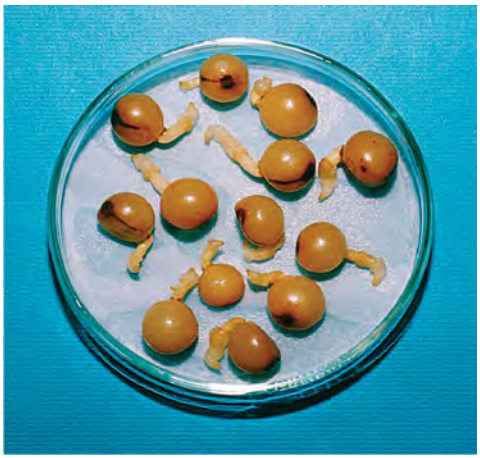


Fig.1

Fig-2

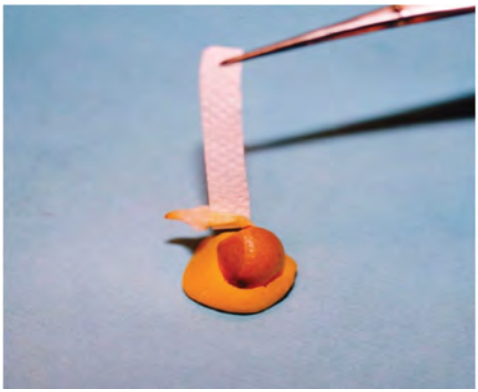


Fig. 3

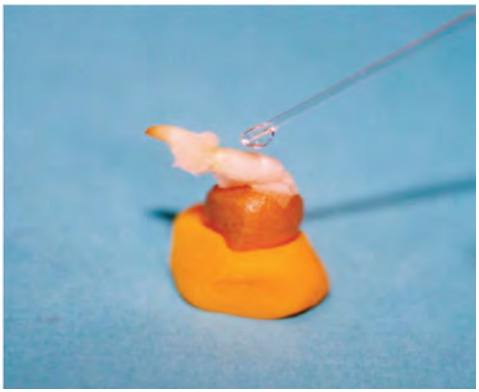


Fig. 4

Fig. 5

Fig. 6

To minimise chances of fungal infection, I remove the outer seed coat (the thin transparent outer layer of the seed) and dust the seed with a fungicide. Unfortunately in Western Europe seeds are at their best for germination in winter, which is not the best growing season for seedlings. I put my seeds in test tubes on vermiculite in a growing cabinet with artificial light. Fig. 6 shows a number of test tubes with seedlings that show a positive reaction to the colchicine treatment.

Discussion

The effectiveness of the abovementioned method has yet to be checked. What can be seen at present is that the results of the colchicine treatment vary from distorted growth to complete death of the plantlet. The reason for developing this new approach was the high death rate of the root meristem after immersion in a colchicine solution. The procedure described in this article results in a reduced number of plant deaths. It is not possible to give exact figures on this because of the great difference in treated seeds. I have used seeds from (very) different crosses and sources, which are of interest to my tetraploid breeding program. I did not intend to get scientific proven results.

The described procedure is very time consuming and therefore rough methods like immersing great numbers of germinating seeds

in colchicine can also be successful, and used in cases when many seeds are available. My approach is specially designed for relatively small numbers of seed from precious crosses. Every seedling is individually treated with colchicine and receives special after-care.

To determine whether an experiment is a success, you have to wait until the treated seedling flowers. Indications of success are a thicker leaf and flower structure than normal. Pollen grains of tetraploids are bigger than those from normal diploids. Also measuring the DNA level of the individual cells with flow cytometry is a good method or counting the chromosome numbers. In CLIVIA 5 these methods are discussed more thoroughly.

It is maybe a good idea to recap on the possible benefits of polyploidy in *Clivia*. Polyploids can give bigger flowers, broader leaves and more intense colours. Disadvantages could be slower growth and lower flower count per umbel and reduced fertility. These disadvantages can be overcome by selective breeding. An interesting possibility would be the incorporation of genes from several species in a polyploid plant. Developing triploid hybrids was one of the reasons I started colchicine treatments in *Clivia*. First attempts to get triploids between tetraploid C. *miniata* and diploid species like C. *gardenii* and C. *caulescens* in a cooperative project with several *Clivia* lovers in South Africa and Australia failed. This year I've made my own crosses between tetraploid C. *miniata* and diploid C. *caulescens* and they look successful. I've germinated some seeds from the cross with C. *caulescens* as a mother in-vitro and found two of the plantlets to be different from "caulescens-type" seedlings. Triploids between tetra C. *miniata* and diploid (yellow) C. *miniata* are now two years old and need at least one more growing season to flower.

In many plant species crosses between different ploidy levels require embryo culture to be successful: there is no or insufficient endosperm development. In *Clivia* normal triploid seeds do arise, but also many shrivelled seeds are found in ripe berries. Embryo culture in an early stage could give more triploid plants from a cross, but this has not yet been tried. The number of triploids from a cross seems to depend very much on the combination of parent material used. Till now the most successful combination was a cross between tetra C. *miniata* as a father and a yellow C. *miniata* as a mother. More than ten plants have been grown from seven developed berries. In most other combinations till now, only one or two triploid plantlets have been found.

The number of tetraploids produced from seed is low. I only have a couple of tetraploid or cytochimeric plants that are old enough to flower. As a result of reduced fertility in the colchicine treated material and the resulting slow growth (a flower is not always produced every year), I only have five proven tetraploids from seed in my collection. It will take many years of patience to see if the fertility in future generations of these treated plants will increase as the theory dictates.

I hope the above results will not scare people from trying to produce polyploids of their own. To make tetraploid breeding a success it is important that every type of *Clivia* is available in a tetraploid form. Peach, Akebono or variegated types, broad leaf Chinese plants and interspecifics, there is still a lot of work to be done!

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2003 Show Sellection

Photo: Peter Lambert

Above: *C. miniata,* Best on Show KZNCC, Grower Gem Wild Flowers

Below: *C. miniata*, Runner-up to Best on Show KZNCC, Grower Gem Wild Flowers

Photo: Peter Lambert

Photo: Reinhardt Hartzenberg

Above: *C. miniata,* Best on Show NCC, Grower Pine Pienaar

Below: *C. miniata,* Best on Show PECC, Grower Ian Vermaak

Photo: Pine Pienaar

Photo: Reinhardt Hartzenberg

Above: *C. miniata,* Runner-up to Best on Show NCC, Growers Pikkie & Elize Strumpher

Below: *C. miniata,* Runner-up to Best on Show CCC, Grower Felicity Weeden

Photo: Claude Felbert

Photo: Pine Pienaar

Photo: Claude Felbert

Above: Runner-up to Best on Show PECC, miniature with variegated leaf, Grower Charl Coetzee
Right: *C. miniata*, Best on Show CCC, Grower Eric Heine
Below: *C. miniata*, Winner Yellow / Cream narrow tepal, NCC, Grower Gert Esterhuizen

Photo: Reinhardt Hartzenberg

Photo: Keith Barlow

Above: *C. miniata,* Best on Show Metro Group, Grower Johannes Smith

Below: *C. miniata*, Third Placed on Show Metro Group, Grower Bertie Guillaume

Photo: Keith Barlow

Clivia: Food and Drink

Ian Coates, United Kingdom

It is not possible to give advice on the upkeep of any plants without some qualification, as there are so many variables. There are now five accepted species of *Clivia* and each resides naturally in a different environment. Some by a stony water's edge, some deep in forests or a dry gorge and some are partially epiphytic. Each location has its own characteristics and each species has developed to suit. Darwin would be proud of them! Some people live in areas where they are able to grow *Clivia* in their natural habitat, others around the world can grow them in their garden beds if temperatures are compatible, but, mostly, it is *C. miniata* which are grown and kept in pots. I will therefore concentrate on this scenario.

I am located in central England where winter day temperatures are around 4^{0}C and nights can drop to -10^{0}C so plants are kept indoors. In summer, temperatures rise to around 20 - 25^{0}C and plants are outside in their pots. In hotter climes, more water will be required than I give — but only slightly more food to compensate for the extra growth.

In the ever warm Canary Islands where the plants grow mostly in free draining volcanic rock, they are watered daily. In cooler climes, less water will be necessary.

In the Northern Hemisphere, January is part way through the plant's rest period. Watering is very minimal according to its retention in your potting medium. The number one problem with *Clivia* in pots appears to be rotting of their roots. However little they are watered, they must have excellent drainage. Coarse sand, granules or bark allow for this whereas a fine water retentive compost does not.

The only change in February is a slight increase in temperature. By March one would hope that flower scapes are starting to grow, so watering is slowly increased. I usually wait until the stems are about 9" (22 cm) high before I begin to add feed. By the time the majority have reached this height I feed them all, as some may not be going to flower this year anyway.

In April I pot on any plants which are too heavily pot bound. If you do this into a ready-made commercial medium, be sure to add extra drainage. Such mediums probably already contain nutrients so your fertilising should be delayed a month or so as it should

Photo: Ian Coates

A well cared for *C. miniata*

not be overdone. I water heavily and let the medium dry out before repeating. With good drainage in the British climate, this usually means about once a week during the summer. To keep things simple, I feed at every watering. Since this would give too much fertiliser, I double the recommended rate of dilution. It is never good to over fertilise, as some of the chemicals are retained in the potting medium and can become toxic.

The three main constituents of proprietary fertilisers are Nitrogen (N), Phosphorus (P) and Potassium (K). Each has a different function and the proportion of each in a fertiliser mix will vary. Nitrogen is responsible for leaf growth. A shortage of it will see older leaves yellowing. Phosphorus looks after the roots and therefore the overall growth of the plant including the seeds. Potassium particularly affects the flowers. The proportion of each will vary but this should be shown on the package. This could typically read: Nitrogen - 4%; Phosphorus (pentoxide*) - 4%; and Potassium (oxide*) - 2%. This is usually shown as a ratio - N:P:K. 4:4:2*. It shows that there is twice as much Nitrogen and Phosphorus as there is Potassium. It is therefore most suitable for leaf and root growth and is used on younger plants. It may be notated differently according to your country but you should still be given the percentages. If the figures are higher i.e. N:P:K 8:8:4, this would indicate that it is twice as strong and will need more dilution. This will be shown on the mixing instructions.

Since most *C. miniata* in the Western world are grown for their flowers, a higher proportion of Potassium is desirable once the plant has matured. I consider my *Clivia* have reached maturity when they have a total of twelve leaves. They are then mature enough to bear flowers so a fertiliser richer in Potassium is used. A readily available mix for this is a specialist tomato fertiliser where the fruit is more important than the foliage. This mix is nearer 1:1:2 (or 4:4:8 etc) and is just right for flowering plants.

In May my plants are moved outdoors and, during the hotter months of June, July and August I will also spray the leaves occasionally with water to increase humidity. Annually in July I give the plants one special feed. This contains elements including Magnesium, Calcium, Iron, Manganese, etc. which are vital for healthy growth but only required in small quantities. Commercially, this is known as a 'trace' element fertiliser. Some basic fertilisers will also contain these trace elements so this special mix will not be needed. In summer, I will also test the growing medium for acidity. *Clivia* generally seem to prefer a pH level around 5.5 and simple test kits are available in most areas. Levels of pH 4 to 7 have been reported but I aim between 5 and 6.

Watering with feed is carried on until September. Most seeds will now be ripe and are sown immediately onto a water retentive gel. The plants are brought indoors and plain watering without fertiliser is continued for a month through October. *C. gardenii* and *C. nobilis* and interspecific crosses mostly flower at this time. In November, resting begins with minimal watering again and the temperature is kept down to between 5C and 15C to trigger the dormant flower spikes for the next year. Resting continues through December and so to January again.....

** In South Africa and a few other countries, NPK content in fertilisers is specified in elemental form. It is given on the container in terms of the ratio of NPK to each other with the total percent NPK in brackets. For example, South African 4:3:4 (33) has 12% N, 9% P and 12% K. For approximate conversion from the oxides multiply the P by 0.43 and the K by 0.84. The 4:4:2 that the author uses as an example will be approximately 4:1.7:1.7 NPK elemental*. Eds

Observations on Akebono

Connie & James Abel, South Africa

Variegation in *Clivia* leaves fascinates many enthusiasts. As we have added different types to our collection we have gained a little (perhaps dangerously so) understanding of the types and their origin, from observation and available literature. A highlight was the realisation that Akebono variegation is seasonal - something that we have seen no reference to elsewhere. This seasonality is short term in effect and not overall, as with autumn (fall) colours for example.

Plants with variegated leaves are slower growing, proportionately to the amount of non-green leaf surface, since that area does not contain chlorophyll and does not contribute to the energy needs of the plant that are derived from photosynthesis. Variegation is the result of dysfunctional chloroplasts. According to Ben Zonneveld of Leiden University, about 1000 genes are involved with the formation of the chloroplast of which 900 are located in the nucleus.

Variegated leaf *Clivia* have had their greatest development in Asia, particularly Japan and China, where *Clivia* enthusiasm has been concentrated on leaf forms and patterns, based on the principle that they can be enjoyed all year round, while flowers offer only short term pleasure. A few basic aspects will first be discussed. The three best known forms of variegation in clivias are:

1) Regular or longitudinal stripes (Fig. 1), further subdivided into a number of recognised patterns such as Fukurin (green centre with broad lateral white stripes).
2) Akebono or transverse banding (Fig. 2)
3) Light of Buddha (LOB, Fig. 3 with blotchy patches of lighter colour. We have little experience with LOB and will not discuss them further.

Photo: Hein Grebe

Fig. 1. Longitudinal variegation

Most plant characteristics, with the genes on the chromosomes, are inherited in predictable Mendelian ratios. Regular variegation, with attractive and even startling colour contrasts,results from the presence of a mix of normal and dysfunctional chloroplasts in varying proportions in the cells in the apical meristem. The genes controlling regular variegation are in the chloroplasts in the cytoplasm and, since the cytoplasm separates at random as the cells divide (for growth or for reproduction), variegation

Photo: Courtesy Connie & James Abel

Fig. 2. Akebono variegation

gene distribution between the new cells is unpredictable. As the meristem divides and grows upwards, it leaves vertical bands of less or more highly striped stem and leaf below it, around the circumference of the plant. The leaf meristems continue this division, so that individual stripes can be traced down the full length of the plant. But since the cytoplasm split between the cells in the meristem is unpredictable the patterns do change and are seldom the same between seedling siblings, between parent and offsets and between leaves on the same plant.

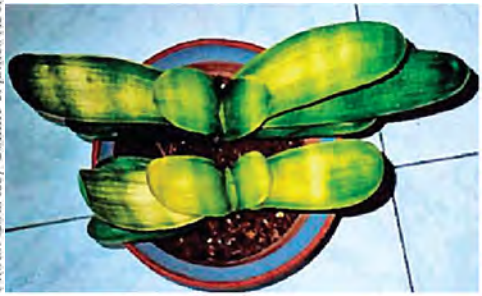

Fig. 3 — Light of Buddha

Pollen, necessarily very light so as to enable distribution by wind or insect, brings no or very little cytoplasm to the new seedling. Therefore variegation is inherited from the fruit parent. For this reason, green leaf pollen parents can be used on variegated plants to improve flower or leaf characteristics, without affecting the variegation of the seedlings.

Fig. 4 — Akebono with yellow flowers

Akebono variegation

Our interest in Akebono started from the first Clivia Conference and Show in Pretoria in September 1994 with the visit of the well known *Clivia* breeder Yoshikazu Nakamura, who stayed with us. We obtained some seed from him — seed which was not only Akebono and rare,

Fig. 5 — Akebono radiation (see a & b next page)

but which had been bred for yellow flowers, a combination which had not previously flowered. Ours flowered in September 2000 (Fig. 4) and again in 2001, to the good natured frustration of Yoshikazu who flowered his first yellow Akebono in January 2002. He has used his yellow Vico strains to give the excellent flower quality.

Apart from their flower and leaf beauty, our interest in the Akebono has been increased with our observation that the pattern is seasonally determined. We have seen no record of this from elsewhere, but there can be no doubts about the correlation and our hypothesis follows.

The genes for Akebono variegation are also carried in the chloroplasts and inherited from the berry parent. These plants do not have a mix of functional or dysfunctional chloroplasts in their cells - for most of the year ALL new chloroplasts in the new cells dividing off the meristem are able to form chlorophyll. However, for perhaps 6 - 8 weeks in

late winter/spring a seasonal trigger, which may be increasing light and/or temperature, causes all new cells to be chlorophyll-incapable.

After this period the effect is cancelled out and new cells are again chlorophyll-capable. As the new leaves emerge from the centre of the plant the emerging cream bands are clearly visible at a uniform height above the centre of the plant, as can be seen in the photo. The leaves grow about 8 - 10 cm during this period and that is the width of the band. There are several interesting observations that follow:

a) The band appears in a chevron shape, which is the pattern of the intercalary meristem between the leaf sheath and the leaf blade, from which the leaf elongates.

b) The growing leaves are at different stages of elongation when the Akebono tissue is formed, and as they elongate to their final length through the summer and autumn, so the bands in older leaves remain close to the centre of the plant while younger ones are pushed out to the periphery of the plant. In the photo the three new leaves show this season's greenish/yellow recent stripes while the previous years have off-white bands having lost the green colour.

c) Since leaves develop fully in less than a year, normally there will be a maximum of one stripe per leaf.

Fig. 6 — Akebono plant flowering

d) The peduncle elongates fully in about three weeks, and since this occurs fully within the Akebono period it is cream for as compared to 8 - 10 cm for slower growing leaves.

Fig. 7 — Akebono seedling

e) Seeds are also subject to the Akebono effect. The original seed was germinated late, in December '94, and the new leaves were green. We germinated our first seedlings in September '01 and the leaves emerged without chlorophyll. We assumed that they were all albino and would soon die. There was much relief when the Akebono period was over and the new leaf tissue started to emerge green.

f) As with regular variegation, Akebono plants can be pollinated from green leaf plants to improve flowers or leaf form, without affecting the inheritance of Akebono in the seedlings.

Multitepal Breeding

Shigetaka Sasaki, Japan

In recent years the breeding of *Clivia* has advanced thanks to the efforts of enthusiastic breeders, and it is now evident that there are a number of characteristics of *Clivia* species that will be important in future breeding. In particular, the following characteristics should be of interest:

- Flowers with green striped petals that are found in interspecific hybrids subsequent to the F2 generation (e.g., Nakamura hybrid shown in CLIVIA 3, p.29)
- Hybrids based on *C. nobilis*, such as Rudo Lötter's interspecific "Chanel"
- Bicolour flowers with contrasting sepals and petals, such as the *C. miniata* bred by Yoshikazu Nakamura (CLIVIA 5, p.71)
- *Haemanthus*-like flowers with about 20 stamens;
- Flowers like Connie Abel's "Frats Odd Petal", without any petals or with deformed petals but with stamens and pistils
- Flowers with keeled petals
- Flowers with bleached petals like "Kabuki", bred by Yoshikazu Nakamura using cobalt 60
- Flowers with peach, pink or green petals

In relation to breeding developments with regards to the leaves of *Clivia*, Chinese and Japanese breeders have had a long interest in breeding beautiful variegated and broad-leafed *Clivia*. Future breeders could try crossing *C. nobilis* with *C. miniata* to breed broad-leafed and variegated *Clivia* incorporating the rigid leaf of *C. nobilis*.

In comparison with other garden plants, it appears that *Clivia* breeding is still in its development stage. However, I believe that we will be able to see a special hybrid in the future that incorporates a number of the above interesting characteristics.

What will be the most important factor to dramatically influence *Clivia* breeding? I think the answer lies in the breeding of multitepals. We can see two kinds of multitepals: a double flower type, and a type that bears many tepals. Since we have not produced many beautiful flowers of a double flower type to date, I think it is desirable to concentrate our breeding on this objective. If we can breed *Clivia* with some of the above-listed characteristics in conjunction with a combination of green-tipped tepals, such as *C. nobilis*, *C. gardenii* and *C. caulescens*, and, with double flowers, we will certainly change the impression of a *Clivia* flower. It should even be possible for us to breed *Clivia* even more rose-like in the future.

Here I would like to introduce two tips for breeding multitepals. These are not based on my own breeding results, but I think these points will be useful and of interest to *Clivia* enthusiasts.

Rose-like *Clivia* multitepal

***Hippeastrum* Multitepal**

The following comments are extracts from a letter from my friend, Nobuyuki Katsuyama. He has used the methods described below to breed *Hippeastrum* double flowers.

"If you want to breed double flowers, you have to select good plants with the potential for breeding this feature. For example, use a flower with eight petals or a flower of which the stamens and stigma are partly changed into petals. Of course the plants should be fertile. If you cannot find such plants, you have to at least select plants that show such signs.

Nerine and *Hippeastrum* which have eight petals have a tendency to produce eight-petalled flowers in the next generation. However, I have been unable to breed double flowers from crossing eight petals x eight petals. Therefore, I selected only those plants with flowers where the stamens and stigma were partly changed into petals as the parent plants for my double flower breeding.

In the case of *Hippeastrum,* I was able to create a high percentage of double flowers from crossing plants with flowers where the stamens and stigma were partly changed into petals. It seems that the changing of stamens and stigmas into petals can be inherited through either the mother plant or pollen plant.

Plants where the stamens and stigmas are changed into petals in alternate years (rather than every year) will be more fertile and are recommended for use in breeding double flowers. This feature will be masked through a reduction of water and fertilizer but the plant will become more fertile. Accordingly, it's better to select good fertile plants showing even a slight disposition rather than selection based on the number of the petals themselves.

In order to build up my stock for breeding *Hippeastrum* with double-flowers or different colours, I tried pollinating double-flowered plants with pollen from regular flowers with six petals, or else pollinating plants possessing regular flowers with pollen from double-flowers. The result was that almost 100% of the F1 plants had regular flowers. However, the F2 plants that were bred from crossing these F1 plants together showed a high percentage of double-flowers. I then selected the most fertile plants from the F2 generation and crossed them with each other. An even higher percentage of double-flowers resulted. This is the method that I have used to breed *Hippeastrum* cultivars with double flowers up until now.

If you want to create double-flowers based on your favorite flower shapes, you will need to select good parent plants carefully before crossing the F1 plants together."

When I consider Nobuyuki Katsuyama's results in breeding doubled-flower *Hippeastrum* cultivars, the most important thing is that the characteristic for showing double flowers will be inherited from the pollen as well as from the mother plant.

Photo: Courtesy Shigetaka Sasaki

Another fine multitepal. Breeder Yoshikazu Nakamura

Photo: Courtesy Shigetaka Sasaki

A good multitepal bred by Yoshikazu Nakamura

There are not many common features between *Clivia* and *Hippeastrum,* apart from the fact that both belong to the *Amaryllidaceae* family. However, I think that it is worthwhile applying Nobuyuki Katsuyamas breeding results to the creation of double flowers in *Clivia.* I have already tried using this breeding method, but I will have to wait for some years before I can see the result.

My goal for breeding *Clivia* is to create double flowers with the unique characteristics that are found in interspecific hybrids. My idea is based on the fact that Nobuyuki Katsuyama was able to get *Hippeastrum* with a high percentage of double flowers in the F2 generation and also because I can find very unique interspecific hybrids in the F2 generation of *Clivia.*

Crossing F1 hybrids is a kind of self-breeding in genetic science. This fact reminds me that we can bring out hidden inferior (recessive) genes as a result of crossing F1 hybrids with each other.

Clivia Multitepal Breeding

Another tip for multitepal breeding comes from a story that I heard from a Japanese *Clivia* breeder of daruma. Once he found a regular flower (six tetals) with its stigma split into four on the top, and he placed pollen from a normal daruma *Clivia* on top of this stigma.

As a result, he was able to obtain plants with eight-tetalled flowers in the F1 hybrids of this cross. He also pollinated other flowers on the same plant at the time, but the seedlings grew to show regular flowers. When I reflect upon his breeding results, I wonder whether the genetic information might vary within each flower of the same plant. Multitepal flowers can be seen as an abnormality compared with regular *Clivia* flowers, but we do not care about this because the flowers are beautiful. Nobuyuki Katsuyama has succeeded in creating beautiful double flowers in *Hippeastrum.* I think that *Clivia* display signs to us for creating something new. We should recognize these signs and engage in continuous breeding in order to create the *Clivia* of our dreams.

I would like to thank Masashi Yamaguchi for translating this article into English, and Helen Marriott for her assistance in producing the final version.

Multipetal is a layman's term and is used by Clivia *enthusiasts to describe flower forms that have more than the normal six segments. The correct descriptive word is multitepal as used in this article. In some cases the term polytepal should be used.* Clivia *flowers are often incorrectly called florets. When a flower is in multitepal form the tepals are normal in size, shape and position in the flower, but there are more of them. They vary in their consistency and will usually produce some six tepal flowers among the eight tepal or even double flowers within the crown.*

***Polytepal** — this term is used where the flower has as many extra stamens as there are extra tepals.*

***Double** — Stamens have been converted to petaloids and the centre of the flower can sometimes be filled with them. Doubles in the other sense have extra tepals (petals) and petaloids. The picture at the beginning of this article is a good example.* Eds.

Photo: Courtesy Shigetaka Sasaki

Radiation type multitepal bred by James Comstock

Photo: Courtesy Shigetaka Sasaki

Chrysanthemum-like — bred by Yoshikazu Nakamura

Photo: Johan Schoombee

An attractive green throat with the centre flower wide open with overlapping tepals. Grower Gerrit van Wyk

Diagnosing Plant Disease: What the grower needs to know

Wijnand J. Swart, South Africa

Introduction

When growers of any agricultural crop or ornamental plant observe physical abnormalities on their plants, the typical reaction is usually one of immediate concern followed by the rapid application of a chemical pesticide obtained from the local hardware store. Very few growers resort to the logical route which is, firstly to determine the exact cause of the specific abnormality and then to treat it accordingly with a therapeutic compound.

Often, the observed "abnormality" may not be an abnormality at all but simply a normal expression of the plant's growth habit or reproduction. In other instances the cause may be insect-related or a soil nutrient deficiency, in which case a fungicide will not help at all.

It is also possible that there is more than one problem present, and in some cases there may be more than one pathogen infecting a plant. Symptoms associated with these infected plants may be significantly different from the symptoms expressed in response to each of the different pathogens acting separately.

These scenarios illustrate the importance of correctly diagnosing the cause of a plant abnormality before attempting to rectify it by chemical application or other means. Incorrect diagnosis can lead to control failure and it is therefore important that an expert is consulted before control measures are applied.

The main objective of this article will therefore be to inform growers of the correct procedure to follow when encountering sick plant/s.

Plant disease: Understanding the causes

It is important to have a basic concept of what plant disease is and how it occurs as a background to understanding the procedures involved in plant disease diagnosis. Plant disease occurs when there is the slightest alteration or deviation in the physiology and/or structure of a plant due to interference by living entities (biotic factors) or the environment (abiotic factors).

As seen from this definition, a plant's health is subject to factors that influence its growth and development, either positively or negatively (Table 1). It is important to understand that although a single biotic or abiotic factor can lead to stress which will eventually affect the plant's health, it is usually an interaction between one or more biotic and abiotic agents that results in plant disease.

Abiotic factors may be physical, mechanical or chemical and whereas the first two are usually easily observed and identified, chemical factors may require extensive laboratory analysis (e.g. soil testing) to identify the exact qualitative and quantitative nature thereof.

Biotic agents are divided into infectious and non-infectious agents. Infectious agents are mostly microorganisms that have the capacity to grow and reproduce very quickly and to be spread from one host plant to another over wide areas and even entire continents. Of these, the fungi are particularly important in that they cause most plant diseases.

Non-infectious disease occurs when abiotic factors (chemical and physical) occur at levels above or below a certain range tolerated by plants, for example, temperatures that are too low or too high, air pollution, lack of oxygen, nutrient deficiencies, drought or waterlogging (drowning). The organisms which cause infectious diseases are called parasites or

pathogens and are spread by means of **inoculum**. A parasite is an organism that lives on or in some other organism (e.g. plant) and obtains its food from the latter (i.e. parasitism). **Parasitism** is not always detrimental to the host, for example the root nodule bacteria of legumes and my corrhizal fungi of most flowering plants, a phenomenon known as **symbiosis**. Parasites that are detrimental to the plant's health are termed pathogens. This phenomenon is referred to as **pathogenicity**.

Photo :: Claude Felbert

Fruits eaten by rodents or insects

TABLE 1: Factors that can negatively affect plant health:

BIOTIC	ABIOTIC (non-infectious) (non-infectious)	
BIOLOGICAL	**CHEMICAL**	**PHYSICAL**
Infectious agents:	Soil acidity / alkalinity	Compacted soil
Fungi	Air pollution	Day length
Bacteria	Mineral toxicities	Drought
Viruses / viroids	Growth hormones	Waterlogging
Phytoplasmas	Nutrient deficiencies	Fire
Parasitic plants	Pesticides	Frost
Nematodes	Soil salinity	Heat stress
Protozoa		Lightning
		Light intensity
Non-infectious agents:		UV radiation
Insects		Wind
Mammals		
Mites		
Birds		
Slugs and Snails		
Weeds		

Determining the causes of plant disease

To determine what factors caused plant abnormality or disease requires an inquisitive, investigative approach combined with careful observation and the ability to put all the pieces together to reconstruct the event(s) that produced the disease. In diagnosing plant damage a series of deductive steps can be followed to gather information and clues from the big, general situation down to the specific, individual plant

or plant part. Through this systematic, diagnostic process of deduction and elimination, the most probable cause of the plant abnormality can be determined (Fig. 1). When samples of diseased plants are taken to a diagnostic plant pathology laboratory it is crucial that as much information as possible is supplied by the grower. The diagnostitian will then have as much information as possible on which to base his / her diagnosis and thereby recommend the correct control measures. This information usually includes the soil media used, watering and fertilization regime and light availability, etc. However, by having a through knowledge of the particular type of plant involved and its normal appearance it is often possible for a grower to circumvent the cost and effort of consulting a plant disease diagnostician. The bottom line is that that there are many instances of plant disease where no plant diagnostician, no matter how experienced, can accurately diagnose the true cause of the disease without the aid of additional information which only the grower with an experienced eye can provide..

Photo: Courtesy NBI

Photos : Claude Felbert

Top of page - sun damage.
Above - fungal disease.

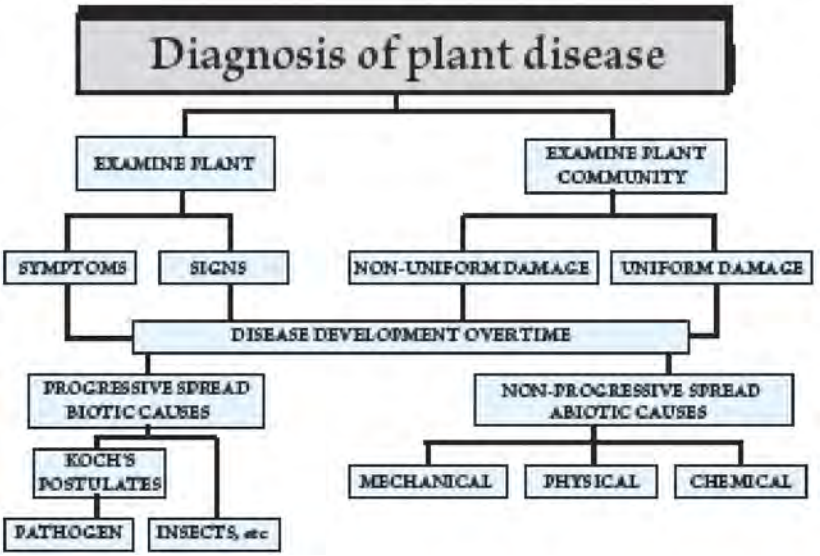

Fig. 1. A flow model for diagnosing plant disease

A. Defining the problem

The first stage in diagnosis is ascertaining that a "real" problem exists. It is important to note that the plant species must firstly be identified and then examined in isolation as well as within the context of its community. Secondly, it is important to know the normal appearance of the plant species under observation. Each species of plant has special growth habits, colours and growth rates and if the grower does not know what to expect of the plant he/she cannot recognize when something is wrong. It is also important to know that appearance can vary between hybrids or cultivars. Some plant cultivars have naturally pale to yellow leaves, or sparse foliage which at first glance appear to have symptoms of under-fertilization, root stress or soil pH problems.

Once the "normal" appearance of the specific plant is determined, several comparisons can be made between the problem plants and healthy plants. Compare characteristics such as overall size, shape and colouration; leaf shape, size, colouration and distribution; and root distribution and colouration. It is also important to take note of events such as leaf drop or senescence (ageing), which may occur in a healthy plant. The affected parts of the plant should also be noted. Are there symptoms on the leaves, stems, roots, flowers or fruit?

Examination of a single plant must take note of abnormalities such as "signs" and "symptoms" which are the physical effects of disease and the most important clues as to the presence of a possible pathogen. Not all signs and symptoms are visible to the unaided eye and finding all symptoms of a disease may require microscopic examination, possibly with a scanning electron microscope.

Signs are an indication of the actual pathogen, or part of the pathogen, or the products of the pathogen on a diseased plant. They are usually the best indication of the presence of a pathogen except when they belong to a micro-organism that may be of secondary concern (e.g. a saprophytic fungus or bacteria). Typical signs of plant disease are usually:

- Bacterial ooze. Sticky liquid produced by some bacteria.
- Mycelium. The mass of interwoven strands of a fungus (hyphae).
- Fruiting bodies. Structures which produce spores (in fungi) and can appear as anything from small black specks to large mushrooms for others.
- Cysts. Nematode body tissue protruding from roots.

Symptoms are more difficult to describe and in most cases require an expert that has a knowledge of plant anatomy and physiology in order to accurately describe the plant parts affected and how they are affected using the correct terminology. Variation in symptoms expressed by diseased plants may lead to an incorrect diagnosis by an untrained eye and it is important to know exactly what kinds of symptoms are usually associated with plant disease. Symptoms are usually grouped as follows:

Underdevelopment of tissues or organs.

Examples include such symptoms as stunting of plants, shortened internodes, inadequate development of roots, malformation of leaves, inadequate production of chlorophyll and other pigments, and failure of fruits and flowers to develop.

Overdevelopment of tissues or organs.

Examples include: galls on roots, stems or leaves, witches' brooms, and profuse flowering.

Necrosis or death of plant parts.

These may be some of the most noticeable symptoms, especially when they affect the entire plant, such as wilts or diebacks. Other examples include shoot or leaf blights, leaf spots, and fruit rots. (Figs. 2 & 3)

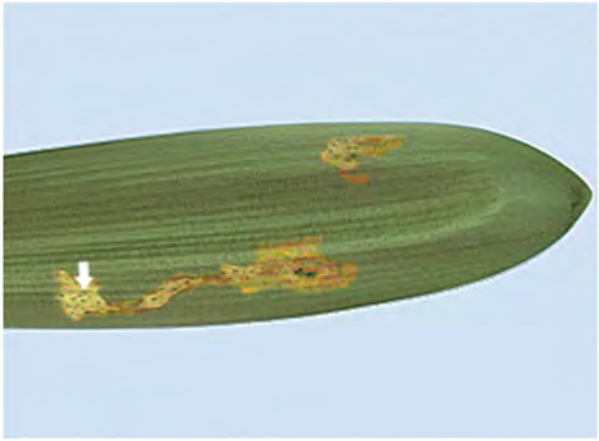

Fig. 2. *Clivia* leaf with necrotic tissue (symptoms) and small black fungal fruiting structures (signs)(see arrow).

Alteration of normal appearance. Examples include mosaic patterns of light and dark green on leaves, and altered colouration in leaves and flowers.

B. *Look for patterns in distribution*

Diseases, whether caused by biotic or abiotic factors, are usually characterized by trends in terms of the distribution of sick plants within a specific location. This information is critical in making a correct diagnosis but more often than not growers cannot supply a diagnostician with any specific details in this regard. It is therefore important to note whether sick plants are distributed uniformly across an area or localized in one or more parts. For example, do the sick plants occur only along the edges of a greenhouse near open windows or lights, next to roadways or driveways, in low spots of a field or garden, along a planted row, or are they randomly spread.

Distribution patterns can be especially important in looking at the possibility of non-infectious problems, such as improper herbicide use or various soil factors. A non-uniform damage pattern on individual plants or in a community of related plants (e.g. a bed of *Clivia*) is usually indicative of biotic causal factors whereas a uniform pattern over a large area and on individual plants indicates abiotic factors.

C. Determine the development of damage over time

Progressive spread of symptoms on a single plant or over an area of plants, indicates damage caused by living organisms. When damage does not spread to other plants or parts of the affected plant over time and when there is a clear distinction between damaged and undamaged tissues, abiotic factors are usually indicated. Such factors may be related to an episodic event such as a change in temperature, lighting, hail damage, or possibly improper chemical usage.

Fig. 3. Basal stem rot of *Clivia* caused by *Fusarium oxysporum*

D. Review cultural practices and growing environment

As was previously mentioned, it is vital that a diagnostician be made aware of all the activities that have been conducted around the affected plants. Information pertaining to the growing environment of the affected plants is often a vital piece of the puzzle and can usually only be supplied by the grower. Changes in the environment are especially important, for example, extreme temperatures, rainfall, hail, temperature inversions (important in possible air pollutant damage and pesticide drift) and prevailing winds. All these abiotic factors can be related either directly or indirectly to the problem. Site factors such a soil type, drainage and soil pH should also be evaluated.

E. Analysis and understanding of the problem

After having systematically worked through the steps shown in Fig. 1, the diagnostician will know whether the primary cause is abiotic or biotic. If biotic, and the organisms are phytophagous (plant-eating) insects, they may be linked directly to the observed damage by virtue of their presence and actual activities (e.g. feeding or oviposition) on the plant. If they are micro-organisms (e.g. bacteria or fungi) then rules developed by the microbiologist, Robert Koch, in 1876 and known as "Koch's Postulates" have to be followed in order to determine whether they are the true cause of the problem. Although not always necessary in routine diagnosis, Koch's Postulates must be followed when the disease symptoms have not previously been reported on a specific host.

Photo: Courtesy of NBI

Snout beetle damage to C. *miniata* flowers.

These rules involve five steps and are outlined in the table below:

1. A suspected pathogen must be consistently associated with same symptoms.
2. Suspected pathogen must then be isolated and grown in pure culture on nutrient agar away from host and its characteristics described.
3. Organism from pure culture must be re-inoculated into a healthy host plant of same species.
4. Symptoms identical to original disease should then develop.
5. Organism should be re-isolated from test host to pure culture and must be identical to the organism initially isolated.

Once a diagnostician is certain that a specific pathogen is the cause of a plant disease, the organism must be identified to species level. There are estimated to be some 1.6 million fungal species, most of which are not infectious pathogens. Many fungi and bacteria have never been isolated and identified and the characteristics upon which their identification is based are very complex and require specialized training.

Conclusion

As is evident from the foregoing, correct identification of a pathogen is crucial for effective plant disease control. For this reason, growers should always resort to consulting an experienced plant disease diagnostician before attempting to rid their plants of disease. As long as the grower can provide the diagnostician with as much background information as possible, an accurate diagnosis and sound recommendation for controlling the disease will follow.

A Call for a Peach Standard

James Comstock, U.S.A.

I have heard that "a rose is a rose is a rose". But over the years, I have realized that a "peach" *Clivia* is a creature of many colours. Or more precisely, they are creatures of many colours, all given the same name. I have found it both amusing and frustrating to visit other *Clivia* growers, both in the U.S. and South Africa, and find *Clivia* flowers of admittedly similar yet distinctly different colours all referred to as "peach". I think the time has come when these differences are recognized and standardized for accurate and internationally consistent reference. Certainly, I don't claim to be an "expert" on *Clivia* or peach *Clivia* in particular. And I am not going to propose a standard here. But I will share my observations and call for further discussion.

Back in 1984, I discovered at a local nursery, the first "peach" *Clivia* I had ever seen or heard of. It was growing on the edge of a shade house where it and its companions were getting far too much sun. Their leaves and their flowers were burned and faded. At first, I considered that the colour of this peach *Clivia* was due to sun bleaching. But I kept returning to this flower and kept comparing it to the other normally-coloured, but also sun bleached flowers around it. I just knew something was different about it. I bought it and took it home. As all the buds had opened already, there was no way to find out what its true colour was. I would have to wait until it bloomed again. Hopefully, that would be the following year. And sure enough, the following March, I was delighted by a *Clivia* flower with a colour unlike any I had seen before. And the additional year of kinder growing conditions resulted in a much improved umbel as well. I named it "Morning Light" and, at the time, described it as apricot coloured, not peach. But back then, that description was a term I only used for myself. I knew no one else who cared for *Clivia* or would appreciate its uniqueness. With the discovery that same year of a huge, magnificent orange that I named "Grandmere" I decided I finally had something worth breeding with. After obtaining a yellow to throw in the mix, I began my breeding program that today is light years beyond that simple beginning.

In the late 1980's, I heard rumours of another *Clivia* breeder in Santa Barbara, California. Up until then, I had never heard of anyone else breeding *Clivia*. I tracked down this "Dave Conway" and was graciously invited

Photo: James Comstock

Clivia miniata "Morning Light"

to visit him and his plants. Among a glorious and impressive array of yellows, reds, and his first "parti-colours", I was introduced to "Tessa". It had the same glowing, warm colour as my "Morning Light". This was probably my first exposure to the term "peach".

In the late 1990's, while traveling with Harold Koopowitz in South Africa and attending the International Clivia Conference, I had the pleasure of meeting Sean Chubb and

Photo: Sean Chubb

Clivia miniata "Chubb Peach", Breeder: Sean Chubb. **Best on Show at the KZNCC show at Kloof in 2004.**

getting to see, first hand, his famous "Chubb's Peach". The mind often convinces us to see what we expect to see; and my first impression of "Chubb's Peach" was that it was the same colour as "Morning Light" and "Tessa". That's what I expected to see; that's what I saw. But with subsequent visits, I decided it was distinctly different. Its colour, to me, is much lighter and paler with the colour concentrated in the center of the petal.

This was when I sensed we might have a problem. Here were two different colour forms being called by the same name. Then I became aware of a growing group of *Clivia* called "pastels". These are pale forms of orange, some nearing pink. My preference is to reserve the term pink for flowers with no yellow in them. I find the standards for pastel descriptions very difficult and I won't approach them here, but I have seen many plants I would classify as pastel being called peach. One way I differentiate between peaches and pastels is that peaches seem to breed true when crossed with other peaches, and produce green-based seedlings. Pastels give a wide range of results when selfed or crossed to other pastels. I have done much breeding with many different peaches over the years and I have hundreds of seedlings of various F1, F2, and F3 generations. Unfortunately, few have bloomed. So I cannot give detailed results or percentages for particular breeding scenarios. But so far, the deep peaches like "Morning Light" and "Tessa" seem to breed true. I have read similar reports of peach breeding in South Africa giving the same results. My question is, "what peach are they using?" I've assumed it is "Chubb's Peach".

As a photographer, I have realized a major factor contributing to the confusion over peaches is that this colour is extremely difficult to photograph. The slightest inaccuracy in the ratio of orange, pink and yellow results in either a pink-looking *Clivia* or one that just looks like a pale orange. In doing the photography for Harold Koopowitz's book "Clivias", I was further frustrated by the additional inaccuracies of the printing process. Trying to compare supposed peach clones through pictures shot by different people, with different equipment, under different lighting conditions, and then reproduced in different formats is, shall we say, challenging. That is why I reserve judgment until I see a plant in flower personally. Being of particular interest to me and my breeding, I have searched out these peaches here in California and in South Africa. I can't think of anyone else who has seen as many peach clones in person.

In my opinion, the deep peach colour that is represented by my "Morning Light" and Conway's "Tessa" is a particular colour variation that is a simple genetic mutation, like the yellow mutation is, and breeds like a recessive trait as yellow does. They also produce green-based seedlings. I also think it is a mutation that occurs much more frequently than the yellow mutation does. In addition to "Morning Light". I myself have found three or four other peach sports occurring in various, unrelated, normal-orange populations. I know of at least six other peach clones that have been discovered by other collectors in California. By contrast, I can't think of anyone here that has found a yellow sport that couldn't be traced back to an original yellow from Africa. On my last trip to South Africa in September 2003, I saw a peach of the same colour as "Tessa". I think its name is "Cameron Peach".

Photo: Courtesy of Mike Christie's "The Clivia Collection"

Clivia miniata "Cameron Peach"

There have been determined to be at least two types of yellow, Type A and Type B. A third type is suspected. I have a feeling there are probably several types of true breeding peaches. "Tessa" might be an example of one type, while "Chubb's Peach" might be an example of another. Both types appear to breed true. Both types produce green based seedlings. The colour of "Tessa" is a rich, warm peachy-apricot colour with pink highlights and a yellow throat. "Chubb's Peach" is paler in colour with less yellow, and the peachy-to-almost-caramel colour concentrated in the throat. Only time and careful breeding records will identify and verify the existence of different peach types.

One of the problems with the pastels is that many of them are what people would call peach, partly because we don't have enough names to describe colours. As an art student, I became aware of the small vocabulary most people have for describing colours. And until the specific peach mutations, that I am hoping people will recognize as distinct, are widely known or given a completely new name, we will continue to see any *Clivia* that is between yellow and pale orange being called peach.

Considerably more of my seedlings need to bloom before I can make any theories about how peaches breed, especially when crossed with yellows. Of course, I have my suspicions and these guide my breeding program. But I won't discuss them until I have numbers to back them up. I have read many reports from the Lötters of South Africa regarding peach breeding and, again, I assume they are using "Chubb's Peach". One example I do have regarding peach and yellow breeding is the work of Victor Murillo who has brought us the "Victorian Peach"' strain. There is a considerable range of colours displayed under the name "Victorian Peach". I have seen plants that appear close to "Tessa" in colour, yet others are nearly yellow with just the slightest pink revealed. Some are nearly pale cream, while others are darker than "Tessa". I have seen the original peach plant

that Victor started with. It appears to me to be "Tessa"-like in colour. It was crossed with a yellow that I did not see. The resulting F1 progeny are the parents of the plants sold as "Victorian Peach" (F2 and F3). The resulting colours segregate into 3 or 4 ranges. Victor is able to predict which colour range a particular plant will exhibit depending on its parents.

I am sure there are what I call peach in Australia. Unfortunately, I have only seen what look like pastels that, for lack of another term, get the peach name. Again, pictures are just so frustratingly deceptive. Until I go there myself and see them personally, I probably won't be satisfied.

There is a warmth and a glow to this peach colour that impresses everyone who sees it. One of my goals in my breeding program is to expand the range of flower forms and plant shapes available with a peach colour. It is important to me that the different types of peach colours are recognized as distinct within themselves and especially from the pastels. This to facilitate communication and the exchange of knowledge and appreciation among *Clivia* lovers worldwide. There are several directions we could take. We could find a way to categorize the different types of peach such as "type A peach" and "type B peach". Or we could drop the term "peach" altogether, find some other term, and let "peach" be used in a more vague sense which would allow its use for some pastels. Horticulturally, I know that a name can be a powerful thing. The right name can enchant the mind to see the virtues of a flower that a more pedestrian title might discourage.

But ultimately I know, what's in a name. A peach *Clivia* by any other name is still a glorious sight!

Photo: James Comstock

Seedlings "split" for peach - 4 of 9 are green stem

Addendum, April 2004

This article was written in August, 2003. As we in California wrap up our Spring 2004 bloom season, I quickly compiled some results related to peach and yellow crosses. Of approximately 280 plants that bloomed for the first time this season, 42 were peach X yellow crosses, or yellow X peach crosses. All 42 produced orange coloured flowers. These 42 crosses represent 15 different combinations. They also involve 5 different peaches and 12 different yellows. Of approximately 10 other crosses that involved a peach X a peach, all produced peaches. All these crosses were done, of course, several years ago. I rarely do a straight peach X peach

Photo: James Comstock

Clivia miniata "Being Peach"

cross now. Or a peach X yellow cross. Most of my work involves using an orange that is "split" for peach (meaning it is an orange X peach cross, thus having a recessive peach trait.) When the orange/split peach is crossed with a peach, the results are typically 50% orange, 50% peach.

I have done very little work with "Chubb's Peach". Those crosses I have done have yet to bloom. The breeding habits of "Chubb's Peach" have been well documented and obviously demonstrate a difference between that form of peach, and the peach forms I have discussed here in California. The exception being "Victorian Peach" which, according to its breeder, Victor Murillo, reportedly breeds more like, if not identically to, "Chubb's Peach". Although breeding techniques, I'm sure, are common knowledge, perhaps for clarity I should briefly explain my breeding strategy. When I crossed an orange X a peach which gave me orange flowering progeny, or I crossed an orange X a yellow which also produced orange flowered progeny, that was exactly what I expected and wanted to happen. This F1 generation would be the parent, when crossed with siblings or back crossed to a peach or yellow, of an F2 generation producing the yellow or peach colors but, hopefully, with the desirable traits of the original orange. That is why when I started my breeding program in 1986, when I was given my first yellow and then found a peach and an orange of exceptional form, I knew I had something substantial worth breeding with. If, for example, I wanted to "improve" my yellow (and by "improve" I mean simply to produce an alternate form), the strategy is to cross it with an orange that has the desirable traits, and eventually the F2 and F3 generations will yield something approaching the goal. To simply cross 2 yellows and hope something better will be produced, and doing that over and over, will only move one towards one's goal in small, incremental steps. In the short term, it might seem more emotionally satisfying to look at a bed of yellow-blooming seedlings and say,"yes, I'm breeding for yellows", than it is to look at a bed of oranges/split for yellow and say, "look at the potential!" But this is how I've worked since my very first three crosses. The third cross being peach X yellow because I did not know what would happen. This kind of experiment is also very important. Please remember that when I started in 1986, I didn't know anyone else in the world was breeding *Clivia,* and had no way of benefitting from their experience as we all are so fortunate to do now.

The purpose of this whole article is to bring an awareness to the different forms of peaches. And one of the important differences is in their breeding habits.

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Photo: Johann Schoombee

Clivia miniata A peach owned by Gert Wiese

Single

Flowers

Opposite Page: Flowers from the Metro Show
Photos: Keith Barlow

Above: A double headed multitepal from Ken Smith

Above Right: An almost white flower from Ken Fargher

Right: A cream flower. Photo by Johan Schoombee

Below: Olive striped pink flower. Breeder Ken Fargher

Below Right: A delicate pink flower.
Breeder Yoshikazu Nakamura

In Search of a "Light of Buddha"

Hein Grebe, South Africa

About 2 years ago I saw pictures, on the Clivia Enthusiasts e-mail group, of a *Clivia* grower in Anshan, China, photographed with what looked like a Light of Buddha (LOB) *Clivia*. These broad leafed plants fascinated me so much that I immediately started to make plans to visit Anshan. My first step was to locate this city on a map. I was glad to see that it did not look too far to the north-east of Beijing, as I have a very good friend, Tracy Qi, living in Beijing. I showed the photos to *Clivia* friends and they also became excited about these new - to us anyway - plants. Wu Jin, who has posted many LOB photos on the e-mail group, satisfied our hunger for more photos and information on these plants. In early 2003 I ordered LOB seed from Wu Jin for friends and myself. It was the very first time that I held LOB material in my hands.

I asked my friend Tracy to look out for LOB plants at flower markets in Beijing, but she had no success. The story she was told was that these plants do not exist, but that growers fastened aluminium foil around the leaves of ordinary plants so that they become yellow over a period of time.

October 2003 was my first chance to travel to Anshan. This was after I had spent nearly 6 weeks traveling in China and Tibet, covering a distance of almost 10 000 kms. During that time I had visited many Buddhist temples in the West of China. I found *Clivia* growing in pots at all of them, including the temple above the Grand Buddha in Leshan, Sichuan, which at 71m, is the largest Buddha in the world. Here I found a type of cyrtanthiflora, similar to that in Australia, in flower. At all the other temples I saw ordinary *C. miniata.*

I learned from my tour in China and around Tibet that Buddha and *Clivia* have something in common. Where there is a Buddhist temple you are sure to find some clivias growing in the beautiful landscaped gardens. Another plant that you will find at the temples is *Gingko biloba* - trees that are hundreds of years old and some that are even more than a thousand years old.

In the back of my head Anshan was a magic place where the most beautiful plants were to be found. In Beijing's flower markets and on the internet, I made contact with a number of growers, including the secretary of the China Clivia Association (CCA), Mr Meng Zhou, who invited me to visit their glasshouses, which they call 'sheds', in Anshan.

My friends' father, Mr Yonghe Qi, is well known in plant circles in China and he even arranged for us to be accompanied by Yuanhau Liu, the daughter of a well known *Clivia* growing family in Anshan. Her job is to

Photo: Hein Grebe

The view of Mr Meng Zhou's plants from his home

sell the family's plants in Beijing at the flower markets. When Yuanhau told me that they had LOBs in their glasshouse, I became even more excited. Our departure day from Beijing was a rainy one. After a long shopping spree, we ate a meal together as a family in a restaurant, an old Chinese tradition before a family member goes away on a long trip. As a result, we left quite late that afternoon and got lost along the way. Luckily lone taxi drivers here and there put us on the right track again. We arrived between 02:00 and 03:00 in the morning in Anshan. Members of Yuanhau's family were waiting for us. We got to bed after an hour's chat, very tired indeed after the 10 hour drive of more than 650 kms in pouring rain.

Later that morning we were woken up by what sounded like machine guns. Our host, Qingxiang Guo, informed us it was a bride and bridegroom coming home from a wedding ceremony and that it is a tradition to shoot crackers and fireworks. It was Saturday and many Chinese couples get married on weekends. A big surprise was waiting for me at the breakfast table. The main dish was the one in the centre of the table, fat silkworm larvae grilled in garlic. My host said I must try some as they are very tasty and nutritious.
Not to disappoint him I began eating, pretending that I liked them. This was a big mistake, as when he saw my 'enjoyment, he said he would arrange more for the next day! After breakfast we all set off to the family's glasshouses.
They do not work at weekends, unless there is urgent work to be done, like repotting in the glasshouse.

After all the rain, the dirt road to the commercial *Clivia* growers was not in good condition. I saw discarded *Clivia* lying along the road between heaps of leaf litter used as growing medium. Some nice broad leaf plants as well. I was thinking that you could pick up a fortune of *Clivia* by just checking out what the growers throw away!

Anshan growers repot their *Clivia* twice a year. This is hard work as all the growing medium must be removed and replaced with new rotted oak leaves, which must be made fine at the same time. It looks like this keeps them busy for the whole month and the whole family helps with this operation.

When we finally arrived at the family's home we had to look for dry ground. A big iron gate was opened to let us into the courtyard with two glasshouses of approximately 650m^2 each. Yuanhua's parents still live in the house area attached to the glasshouse. As you enter their house you look through a window into where the *Clivia* are housed. What a wonderful sight and what an excellent idea! I had never thought of having my *Clivia* shade house next to my home so that I could watch them from my kitchen or bedroom!

Photo: Hein Grebe

All plants face north / south to facilitate short broad leaves

The *Clivia* all stood like soldiers on guard. Not a single one out of line, with their arms stretched out in a north-south direction. I had never seen anything like this and could not take my eyes off them. We were invited in for tea. Despite the cold outside, it was warm and

cosy inside the two roomed house. The first room serves as the kitchen and entrance and the second one as a dining room, lounge and TV room during day time and doubles as a bedroom at night. There is a raised section along the wall of the lounge. I was invited to sit there. It is warm there, they say. The stove in the kitchen is connected with pipes that transfer the heat underneath the raised area. This is so that they can sleep warmly during the icy winters.

Photo: Hein Grebe

Broad leafed "Light of Buddha"

Finally, I was invited into the glasshouse. For the first time I saw full grown LOBs. They are even more beautiful than on the photos. I also saw variegated LOBs - something I never thought existed.

Later we were taken to our host's glasshouse or shed just opposite his parents. Each year he grows a few plants with 15cm broad leaves. He said he gets several thousand rands for each. His plants are of a higher quality and I can see why he can live in a big modern apartment.

We were then taken to other glasshouses. It was ice cold outside and our shoes and socks were wet. We were tired as well, after only 4 hours sleep. After a family meal, with lots of wonderful spicy dishes, we returned to our host's apartment and slept. In the evening we chatted and watched TV.

The next morning we were woken up again by what sounded like machine gun shots. I did not worry to get up as I knew it was a happy occasion being celebrated - someone getting married. So many dishes for breakfast, including my new-found 'favourite, silkworm larvae, which I had actually begun to enjoy. Tracy noticed it was snowing and everyone got excited, except me. I had recently had a bad experience driving back from George to Cape Town on snowy, slippery roads. They say the snow is a good omen, as it never snows in October.

Today we were to visit the Anshan growers we had met in Beijing. To find a place in a big city in China is not that easy. You can easily get lost even if you know the place well. I thought back to our experience in Beijing, when we were looking for a clivia grower there that Tracy and her brother, Biao, had visited in 2002. After a long search we had to give up. I hoped that we would be luckier this time in Anshan. To me the snow looked like a bad, rather than a good, omen. It forced everyone inside and to close their gates. We found a house with an open gate and asked if they knew the CCA Secretary. Yes, we were lucky. We saw some stunning *Clivia* through the entrance window and asked if we could look. The lady was a tough negotiator and her prices were high. I explained that I was not an American but an African and that, relatively, we are not as well-off and cannot afford American prices. She did not believe that I came from Africa.

Above: Rare “Starlight Light of Buddha”

Left: Anshan grower with 15cm broad-leafed plants — note leaves wrapped to maintain alignment

All Photos: Hein Grebe

Above: The unusual markings of the "X-Ray Light of Buddha"

Right: 12cm variegated leaves in one of Mr Zhu's heated glasshouses.

Below: Seedlings reminiscent of hungry fledglings — their leaves like open beaks

All Photos: Hein Grebe

Maybe my skin was not dark enough for her!

After a long fight I bought a couple of plants, one with leaves almost 15cm wide. It is the first time I had seen a plant with leaves this wide and I had to get it. I had with me my picture of the LOB grower I had seen on the e-mail group. Maybe she knew of him as she looked almost 70 years old and must have known most growers. No success, but she did refer us to someone that grows LOBs.

We visited the house of the secretary of the 23000 member strong CCA, Mr Meng Zhou, whose plants have won several awards including a gold medal at the Kunming International Horticultural Exposition in 1999. He invited us into the glasshouse to look at the *Clivia* growing there. Everyone was so friendly. It looked like they specialized in 'crinkle face' plants. These plants are the most expensive in China at the moment. He showed me a plant with a price tag of R800 000. A sucker of this plant would set you back a mere R30 000. The surface of the leaves looks like a honeycomb. He explains that the idea of this plant comes from the civil building industry. The ridged areas represent the reinforcement, the areas in between the concrete or bricks. I would love to have plants like this.... but not this year! I was shown a very thick hard cover book with beautiful photos, priced at the equivalent of R450. I decided to rather buy a book.

At long last we were taken to the house of the LOB grower. I thought that maybe this would be the man in the photo. Only his wife was present. From the size of the house, and the luxuries inside, I could see that he was successful and made a good living, like the previous grower we had visited.

I have never imagined so many LOBs - thousands of them. All the different types, even "painted face" LOBs.. We took photos and shots with the digital video camera. After a few minutes the owner arrived. No more shooting and no more pictures. I showed him the photo I had been carrying all this time. He recognized the person and showed me the place where the photo was taken. He explained that the person in the photo, although pictured with LOB plants, was not a *Clivia* grower but a publisher, who did not even have any *Clivia*! He showed me his second glasshouse, also full of LOBs. He told me that in the past he got R50 a seed, exporting to the USA. Now prices had reduced, and though for very good quality plants he still got R50 a seed, he now got only R20 a seed for the rest.

During the following days we visited as many growers as we could, all with magnificent plants. To everyone I visited I gave a couple of hundred special *Agapanthus* seeds. This South African plant is as yet not well-known in China. They liked the blue flowers and said that they wanted to create blue flowering *Clivia*. I wondered how wide their *Agapanthus* leaves would be in 10 years time! At least I have a running start - back home I have an *Agapanthus* with 9cm wide leaves.

We visited growers with *Clivia*

Photo: Courtesy Hein Grebe

Mr Zhu & the author

with leaves 15, 16 and 17cm wide, and a grower with X-ray LOBs and a new type of LOB called Starlight. The dots on the leaves look like stars in the sky. He explained that Japanese *Clivia* lovers bought most of his plants, paying up to R10 000 for a good Starlight LOB. I bought two 12cm broad leaf LOBs from him, the widest leaves I could find. We also visited a grower who specializes in variegated LOBs. I was stunned. Later this grower entertained us with some songs, while playing his guitar. I bought another 12cm BL LOB from him.

I asked around if anyone had an 18cm or wider BL (broad leaf) *Clivia*, as I had read a message on the e-mail group of someone who has a plant with such broad leaves. One evening we were taken to a grower who has such a plant. I was warned not to touch his plants as he is very precise; also that his plants start at R10 000 each. If I were to offer a lower price I might insult him. This grower told me that he had a friend with a 19cm BL and showed us a hundred or so plants resulting from a crossing between the 18cm BL and the 19cm BL plants. They looked around 2 years old and should flower early next year, in April 2005. We also admired beautiful variegated BLs of 12 cm and wider. Then suddenly I was given a beautiful gift - a variegated double whale, i.e. a *Clivia* with white or yellow rimmed leaves with green in the middle.

After Anshan we traveled about 150kms north to our last stop in Shenyang to visit China's most famous *Clivia* grower, Mr Jifu Zhu, who is the Deputy President of the China Clivia Association as well as the author of 2 *Clivia* books. After a short meeting at his home, where we discussed photos, we were taken to his glasshouses. He has the biggest collection of variegated plants I have seen. In China they are called "coloured leaf" *Clivia* and I can see why. The range of colours on the leaves is amazing. The leaves of the adult plants are thick and wide, many of them 12cm and wider.

Mr Zhu let me choose a plant and later on he gave me another seedling and some seed heads. His wife gave me an offshoot of a beautiful plant, another 'coloured leaf' *Clivia*. The gifts did not end there as I was also given copies of his books. Photos were taken. Mr Zhu had arranged his own photographer, one of the top ones in the country. I could see that Mr Zhu is a professional, and a perfectionist. He explained that he was planning his third book, which will be in English and Chinese, and that he wanted to visit South Africa to see Clivia in their natural habitat. Finally Mr Zhu showed us a beautiful poster of one of his very best plants and then took us for lunch at a top restaurant. The food was excellent, as in the restaurants we had visited in Anshan and Beijing, food that I miss now that I am home in South Africa.

Back in Beijing, we prepared for inspection the almost 200 plants I had collected. Two permits were necessary, a phytosanitary certificate and a CITES certificate to say that *Clivia* were not protected indigenous Chinese plants. I left with a sad heart as I had fallen in love with China and its friendly people. Also, there is so much I still have to see and enjoy. I had been showered with so many gifts —something I had never imagined — by my new *Clivia* friends, and I had found, not one Light of Buddha, but many.

Photo: Hein Grebe

Variegated & "Light of Buddha" plants together

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Winner Photographic Competition

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CLIVIA

7

Photo: Helen Marriott

Winner of the Interspecific Section Photo Competition. *C. miniata* x *C. caulescens*, Owner: Laurens Rijke.

Front cover: *C. miniata* var. *citrina*. Overall and Single Flower Section Winner, Photo Competition. Photographer: Gordon Fraser.

Back Cover: *C. miniata* 'Hirao'. Bred by Toshio Koike. Photographer: Shigetaka Sasaki.

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CLIVIA
7

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Clivia nobilis — Winner *nobilis* Section of the Photographic Competition

Editors

Roger Dixon

Claude Felbert

John van der Linde

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Editorial

This Yearbook is mainly about the various *Clivia* species as they are found in the wild. The reason for this will become apparent to you as you read this Editorial.

A wide range of topics is covered. For the first time we have some clarity on the nature of the pollinators of the various species and on how the plants so artfully attract them to visit their flowers. Articles about *Clivia* breeding, the main interest of many of us, feature again, though less prominently than last year. There are also photographs of Show winners, and the best of the entries in the Clivia Society Photographic competition.

Speaking of photographs, we are delighted to be able to provide a forum for the publication of pictures, not only of plants in the wild, but also of some of the wonderful plants that are increasingly being bred by enthusiasts around the world. Please continue to share them with us. The old saying that a picture is worth a thousand words has much validity for many of our readers, especially where photos provide them a neat balance to the more scientific or technical articles that are meat and drink to others.

Several articles, and the photographs which illustrate them, highlight the diversity of the gene pools in the wild, diversity that is increasingly under threat. Indeed, habitat destruction and the relentlessly growing demand for *Clivia* for traditional medicine ('muti') purposes may lead to some local populations becoming highly endangered or even extinct, as Vivienne Williams warns in her article, "*Clivia* Under Threat".

Even where cultivated plants have been made available to traditional medicine practitioners, their wild cousins are regarded as more potent in medicinal and magic properties, the slow-growing *C. nobilis* being highly sought-after. The problem with this indiscriminate harvesting of *Clivia* – the whole plant is pulled out by the roots, which are usually chopped off for easier transportation of the parts – is its total and utter unsustainability. Possibly as many as 30 000 to 40 000 plants a year of all the species, except *C. mirabilis*, are being taken from their natural habitats in the Eastern Province, KwaZulu-Natal, Mpumalanga, and even the neighbouring country of Swaziland, for sale in traditional medicine markets throughout South Africa. *Clivia* grow in isolated stands, and whole populations, with bewildering genetic diversity that has arisen over thousands or even millions of years, can be wiped out quite easily. A rare population of naturally occurring hybrids is a case in point, as described for us by Allan Tait in his article, "The *Clivia* at Mbashe". Indeed, many populations of *Clivia* in many parts of the country have long since disappeared.

The largest known population of yellow-flowering *C. gardenii* is in the news. The plants grow in the protected Ngome Forest in northern KwaZulu-Natal, some 120 km north of where the first yellow-flowering *C. miniata* was found. This variety has recently been described and named *C. gardenii* var. *citrina*. The article "*Clivia gardenii* – Autumn's Delight" by Brian Tarr places this variety in the context of the entire *C. gardenii* complex. Their relative inaccessibility should have provided them with some protection against illegal plant collecting, but unfortunately even they are not safe –some of the best populations have already been removed.

South Africa has laws to protect the most endangered species within its borders. Penalties for violating these laws include

heavy fines and imprisonment. But, as so often happens, there is a discrepancy between law and practice, and *Clivia* parts are freely transported from where they are collected to where they are displayed and sold. It would appear that the reason the authorities are not prepared to enforce the laws to protect *Clivia* is because of their importance as powerful 'muti' and because the 'industry' provides at least some employment for thousands of otherwise poverty-stricken people.

Also, as John Winter said in his paper "Collecting *Clivia* in their natural habitat", delivered in 2002 at the Third International Clivia Conference, "....many *Clivia* populations have been destroyed through the harvesting of timber for building, firewood, and to establish arable land. This destroys the shade canopy and ultimately results in the death of the *Clivia* population which grew in the shade of these trees". In addition, some members of the horticultural trade and some *Clivia* enthusiasts have collected selected forms from the wild.

The world-renowned Pondoland centre of plant endemism, the habitat of the recently named *C. robusta*, which is described for us in an article by Keith Hammett, is also at risk, but for another reason. There is a proposal for a major new toll-road to be built through the area.

So, dear readers, we trust that you will enjoy reading about *Clivia* in the wild. May these articles and the accompanying pictures inspire you to join the tours to *Clivia* habitats that are being arranged as part of the 2006 International Clivia Conference. This occasion may well provide one of the last opportunities to see *Clivia* in their habitat, other than on privately-owned land.

There is of course an intimate relationship between naturally occurring diversity and *Clivia* breeding. Plant breeding has often been described as 'the management of evolution', with selection by man replacing natural selection. As we raise more highly-bred 'domesticated' plants it becomes all the more important that a wide pool of genetic diversity is preserved in nature, in national botanical gardens and in the collections of private individuals – let 'Conservation by propagation' be our motto. Unless this is done, we the current generation of *Clivia* breeders, with our ever-increasing emphasis on the creation of highly-specialized plants with a narrow genetic base are, in effect, working against the interests of future generations of breeders.

There has been much comment and also heated exchanges in the *Clivia* world for many years now, mainly about a taxon which had not been clearly and categorically placed, due to its somewhat variable nature and appearance. We are referring to the saga of the 'Swamp *Clivia*', now formally described as *C. robusta*. This taxon has been variously identified and misidentified on the basis of its size, its leaf shape, its habit and its habitat. A number of papers in this Yearbook pertinently address the issue in looking at what exactly is a species and how does one circumscribe it, and also consider the variation to be found within such a species.

The evolution of the genus itself is also looked at, and Ben Zonneveld's contribution on DNA content supports the progressive evolution of *Clivia* from the most primitive form *C. mirabilis* through *C. nobilis*, *C. robusta*, *C. gardenii* and *C. caulescens*. Previous work has shown that *C. miniata* is closer to either *C. gardenii* or *C. caulescens*. The difference between these pendulous species and the open-flowered *C. miniata* is very noticeable, but genetically small. Is it not possible that the mutation that gave rise to the open flower arose at various places within the distribution of the pendulous species, thus explaining the very wide range of *C. miniata* when compared to the very distinct ranges of the pendulous

species? This would also explain the very great variation found in *C. miniata*, both physically and genetically. The DNA-based research published to date does not always give locations for the plants included in the analyses. It would be interesting to see where the plants used in the different phylogenetic analyses came from - maybe the location plays a much bigger role than previously thought.

A recent highlight for many of us has been the release of *C. mirabilis* seedlings to *Clivia* enthusiasts all over the world. These were grown on by John Winter at the Kirstenbosch National Botanical Gardens in Cape Town from seed collected in the habitat at the Oorlogskloof Nature Reserve in the Northern Cape – a real labour of love by John and his small team of helpers. The reserve is managed by the Northern Cape Nature Conservation Department and the proceeds from the sale of these plants will be used to benefit the local people.

This is an excellent example of enlightened authorities cooperating with *Clivia* enthusiasts to put into practice the dictum of 'conservation by propagation' for the preservation in private collections of specimens of a rare and endangered species. As a matter of interest, we understand that plants were distributed throughout South Africa, and also to enthusiasts in Germany, U.S.A, Australia, U.K, Netherlands, Japan, Switzerland, Hungary, Portugal, Sweden Denmark, France and Belgium. Also, plants are being grown on for possible future importation into New Zealand, when the laws of that country permit.

With this exciting species in mind, we trust that you will especially appreciate Hein Grebe's stimulating article about his visits to *C. mirabilis* habitat, and enjoy the photos that illustrate it.

Clivia in the wild appear to be hardier than many of the pampered highly-bred plants in our collections. The Clivia Society is sponsoring research into the diseases that affect our home-grown plants. The article by Wijnand Swart sets out some of the early results that have so far been obtained.

Finally, we thank all those who have prepared the articles and sent the photographs that have made this publication possible. There is a large and growing body of knowledge and experience within our world-wide '*Clivia* fellowship'. We encourage more of you to share what you know, and to show off the beauty of your plants, by submitting articles and photos for publication in the next Yearbook.

The Editors, July 2005

Roger Dixon

Claude Felbert

John van der Linde

Photos: Claude Felbert

Genetic Variation in Clivia

Johan Spies, South Africa

Without genetic variation in *Clivia* no breeders, no collectors and no Clivia Society would have existed! All plants would have been exactly the same and the interest of the majority of us would have dwindled. However, genetic variation exists and we have a common hobby or, in some cases, even whole enterprises, which have been built on this phenomenal plant. This paper will try to determine the source(s) of the genetic variation and give a few guidelines on exploiting this variation.

Genetic variation in wild populations

The early issues of the Clivia Newsletter were filled with debates on the correct "cultivar" name for plants collected in the wild. Are 'Howick Yellow', 'Karkloof Yellow', 'Mare's Yellow' and 'Watkins Yellow' the same "cultivar"?[1] Every collector and breeder argued that their material represented the true cultivar since other collectors' material deviated slightly from their concept of "the real thing". One specimen may have a fragrance or the sepals may be slightly more recurved but no differences (genetic variation) were recognised!

A common mistake made with a genus like *Clivia* is that we forget that we are dealing with an evolving organism. Although the rate of evolution is very slow, it happened and continues to happen. Initially, *Clivia* consisted of a single plant. This plant found a niche and propagated. Seeds were distributed and gradually this plant (new species or even new genus) covered a larger geographical area. Almost no variation occurred in individual plants. Eventually mutations occurred. Most of these mutations disappeared again, as the majority of plants did not contain it, and during out-crossing (i.e. cross-pollination with other plants) the mutation was "outnumbered" and so it disappeared. But some mutations were more persistent. Because our new plant genus/species covered a large geographical area, different selection pressures were applied to these plants in different areas and mutations persisted. In due course this led to the formation of morphologically different populations in different areas and eventually new species were thus formed.

Now, thousands of years and many mutations later, we see a *Clivia* population in a "kloof" and start collecting and expecting all these plants to be similar! These plants will vary genetically. Although this population may appear very similar, individuals within the population will contain many different genotypic combinations. Use inbreeding (i.e. self-pollination) to test this hypothesis on a plant collected from the wild.

In an out-breeding (i.e. cross-pollinating) population we would expect the figures in Table 1. If 1% of the plants in a population show a certain trait (for example yellow flowers), 81% will represent true breeding orange flowers and 18% will split for yellow (i.e. carry the gene responsible for yellow flowers without showing signs of the gene) if self-pollinated[2]. If the trait we are interested in occurs at an even lower frequency, let us say 1 in 10000 individuals, approximately 2% of the population will split

[1] See page 67 for article on naturally occuring yellow clones.

[2] These values are calculated in the following way: the frequency of occurrence of the rare (recessive) phenomenon equals q^2. The square root of that frequency will give the frequency of the gene in the population (q). The frequency of the other gene (the dominant gene) is represented by p and $p = 1 - q$. The frequency of true breeding dominant plants is p^2 and the frequency of the population that will split for the trait when selfed, is $2pq$. These ratios and the rules governing them can be studied in textbooks under the heading "Hardy-Weinberg equilibrium".

for that specific trait. Many such traits are present in *Clivia*. Therefore we should expect to see some minor differences within a wild population, but their actual genetic variation will be revealed only by self-pollination of these plants. Even then you will have to self-pollinate a large number of individuals to reveal all the "hidden" attributes, because the rarer the occurrence of a trait, the smaller the chance of collecting an individual that will exhibit (split for) that trait.

Thus, there are differences within any wild population but these differences are less frequently observed than the differences between different populations. This variation in the genetic composition of each population is vital for the survival of the population. If the whole population were genetically similar, a single catastrophic event could destroy the whole population. Due to genetic variation different plants in the population would react differently to such an event and the survival rate would be higher. Such a catastrophic event may be a certain disease, insect infestation, drought, excessive rains, a heat wave or a sudden cold. Some plants (with the "wrong" genetic constitution) would die, but others would be able to cope with the situation due to their genetic make-up and would survive.

Genetic variation in cultivated *Clivia*

When we compare the variation between natural populations of *Clivia* with the variation present in breeding programs, the cultivated plants seem to possess more variation than the plants in their natural habitat. Do not be fooled by this apparent increase in diversity! Mankind selected for features that suited him; so variation in flower and leaf morphology was emphasised by man. In this way plants were produced with an enormous variation that will not help them to survive in nature. During cultivation the plants are nursed and many growers use pre-emptive dosages of fungicides and other pesticides. The need for resistance genes disappeared.

Where plants are grown in greenhouses there is no need for plants to survive low temperatures. I have seen different responses to cold in an unprotected tray filled with young seedlings: at -1°C a seedling died, at -4°C more seedlings died (approximately 40%), at -6°C almost all seedlings died and -8°C proved to be fatal for the last survivors. This unscientific observation was made on one tray with approximately 80 seedlings from one specific cross. However, this clearly indicates differences in cold tolerance in this genetically relatively similar group. If more seedlings from various crosses could be compared I am convinced that greater cold tolerance could be obtained. But why waste good seed/seedlings on such a breeding program?

In protected areas variegated *Clivia* plants flourish, but will they be able to survive in nature? When transplanting seedlings in October 2004 (the seeds were sown in 2003) from a variegated mother, the expected quotas of

Table 1: Genotype frequency in a population for different frequencies of recessive individuals

	% of recessive individuals in a population		
	1%	0.1%	0.001%
True breeding dominant individuals (p^2)	0.81	0.938	0.98
Heterozygous (splitting) individuals (2pq)	0.18	0.061	0.0198
Recessive individuals (q^2)	0.01	0.001	0.0001

for that specific trait. Many such traits are present in *Clivia*. Therefore we should expect to see some minor differences within a wild population, but their actual genetic variation will be revealed only by self-pollination of these plants. Even then you will have to self-pollinate a large number of individuals to reveal all the "hidden" attributes, because the rarer the occurrence of a trait, the smaller the chance of collecting an individual that will exhibit (split for) that trait.

Thus, there are differences within any wild population but these differences are less frequently observed than the differences between different populations. This variation in the genetic composition of each population is vital for the survival of the population. If the whole population were genetically similar, a single catastrophic event could destroy the whole population. Due to genetic variation different plants in the population would react differently to such an event and the survival rate would be higher. Such a catastrophic event may be a certain disease, insect infestation, drought, excessive rains, a heat wave or a sudden cold. Some plants (with the "wrong" genetic constitution) would die, but others would be able to cope with the situation due to their genetic make-up and would survive.

Genetic variation in cultivated *Clivia*

When we compare the variation between natural populations of *Clivia* with the variation present in breeding programs, the cultivated plants seem to possess more variation than the plants in their natural habitat. Do not be fooled by this apparent increase in diversity! Mankind selected for features that suited him; so variation in flower and leaf morphology was emphasised by man. In this way plants were produced with an enormous variation that will not help them to survive in nature. During cultivation the plants are nursed and many growers use pre-emptive dosages of fungicides and other pesticides. The need for resistance genes disappeared.

Where plants are grown in greenhouses there is no need for plants to survive low temperatures. I have seen different responses to cold in an unprotected tray filled with young seedlings: at -1°C a seedling died, at -4°C more seedlings died (approximately 40%), at -6°C almost all seedlings died and -8°C proved to be fatal for the last survivors. This unscientific observation was made on one tray with approximately 80 seedlings from one specific cross. However, this clearly indicates differences in cold tolerance in this genetically relatively similar group. If more seedlings from various crosses could be compared I am convinced that greater cold tolerance could be obtained. But why waste good seed/seedlings on such a breeding program?

In protected areas variegated *Clivia* plants flourish, but will they be able to survive in nature? When transplanting seedlings in October 2004 (the seeds were sown in 2003) from a variegated mother, the expected quotas of

Table 1: Genotype frequency in a population for different frequencies of recessive individuals

	% of recessive individuals in a population		
	1%	0.1%	0.001%
True breeding dominant individuals (p^2)	0.81	0.938	0.98
Heterozygous (splitting) individuals (2pq)	0.18	0.061	0.0198
Recessive individuals (q^2)	0.01	0.001	0.0001

albinos, variegated and non-variegated (green) seedlings were observed. The non-variegated seedlings were placed among seedlings from various other crosses (all covered with 80% shade cloth). Last week I observed sun damage to some seedlings. All the sun-damaged seedlings were non-variegated siblings from a variegated mother. They received the same light intensity as the non-damaged seedlings. This indicates that although these seedlings appeared normal, there was something wrong with their chlorophyll. Is variegation really only influenced by the chloroplasts (inherited from the mother plant) or is it the result of genes (in the nucleus, inherited from both parents) combined with a chloroplast action? Personally I think that variegation is the delayed result of nuclear gene action - where the genes influence the cytoplasmic factor that, in turn, influences the leaf colouration of the next generation.

The yellows and pastels are collectors' items in greenhouses, but what happened to the ultraviolet patterns that are recognised by pollinating insects? Are they still present in these human selected specimens? If not, these specimens will disappear if released into nature. So how do we exploit the genetic variability of *Clivia* in our attempts to breed a show-winner?

Breeding *Clivia* – genetic considerations

What do you want to get from your breeding program? Do you want broader leaves, brighter colours, more flowers, another shape of the petals, should the petals be curved inward or outward, etc.? Remember that you often have to sacrifice something to reach another goal. If you are interested in variegated leaves and eventually obtain the ultimate variegation, remember that you are actually dealing with a "sick" plant. Do not expect that plant to be as vigorous as plants with normal chlorophyll. Be realistic with your goals!

The process of making crosses seems simple. However, it needs careful planning. Before you do any crosses you should know the genetic background of your material. This means that you should know whether a plant is true-breeding for a certain character. In many instances *Clivia* breeders cross two F_1 siblings (first generation hybrids from the same parents). In this way it is impossible to predict the outcome of your cross. In annuals you produce true-breeding plants by line breeding, i.e. by selfing two sets of siblings selected for the desired characteristic in every generation for at least seven generations and then you produce a hybrid between the end result of two such lines. Only then can you predict exactly how the hybrid (F_1) will look. It is also possible to predict what will happen when that hybrid is self-fertilised – when dealing with only one character you will get a ratio of 3:1 (for example 3 orange to 1 yellow); with two characters you will get a ratio of 9:3:3:1 (for example 9 orange bugle (recurved), 3 orange tulip (incurved), 3 yellow bugle, 1 yellow tulip), etc. However, it is impossible to follow this 'traditional' way of breeding in a slow propagating plant like *Clivia*, which takes not one, but three to five years to flower and thus show the results of your breeding. But, if you establish the genetic background of your plants you will be able to estimate the probability of obtaining your desired result.

By keeping a record of all your breeding material and using this material in test crosses you will be able to determine each plant's genetic make-up. Use 2-3 flowers for self-pollination to determine for which traits your plant is true breeding and for which one it is still segregating. Do test crosses (again 2-3 flowers) with plants with a known genetic background (for example group 1 or 2 yellow) to determine to which group your yellows belong. Keep in

mind that the more characters you are looking for, the slimmer your chances of obtaining all those characters at once. A formula, $¼^n$, can be used to calculate the number of true breeding recessive stock you will get from a cross involving n different characters. So when two characters are involved the chance for a true breeding recessive offspring is 1/16. If you try to get a true breeding plant for 5 recessive characters, you will have to produce at least 1024 F_2 offspring to get one desired plant.

The moral of the story is that the more characters you want to improve, the more offspring should be produced and the more vigorous the selection process will be. Starting with material containing most of the desired traits can accelerate the process.

In a breeding program certain genetic principles must be acknowledged. Most of us know about "normal" (or Mendelian) inheritance [i.e. where a recessive trait is caused by a single gene, for example yellow colour in *Clivia*, and this trait will be inherited in a fixed ratio in the second generation (F_2) if the hybrid or first generation (F_1) siblings are crossed]. Few of us know that many factors may influence Mendelian inheritance. Firstly, genes may be linked and will be inherited together. This may be the case with narrow leaves and the "group 1 yellow gene". If two genes are linked, thousands of offspring are needed to find a few plants where the genes have segregated.

If we start looking at the genes responsible for flower colour in *Clivia* we find no information in a database like Genbank (a worldwide database where all sequences of DNA are stored). However, genes responsible for similar chemical substances are found in other plants. It is interesting to note that the majority of genes responsible for the 'red' colouring in *Clivia*, the anthocyanins, are located on one chromosome (chromosome 10) in rice. Similarly the 'yellow genes' (carotenoids) are clustered on chromosome 2 in rice. So the 'red' genes are linked as well as the 'yellow genes'. Is this also the case in *Clivia*? Are the genes in *Clivia* similar to those described in rice and other plants[3]? Linkage of these genes may explain the rarity of pastels in *Clivia*.

The next deviation from Mendelian inheritance is called epistasis. With epistasis one gene influences or masks the expression of another gene. Unfortunately for us epistasis may be a major force of colour inheritance in *Clivia*. Many genes contribute to the formation of anthocyanin (red) and carotene (yellow). What causes these pigments not to be formed? Is it a defect in one of the genes along the way, or is it a different gene that inhibits the pigment formation? In humans many genes form pigment; the more genes you have the more pigment will be formed. A totally different gene exists that can stop the formation of all pigment, regardless of the number of pigmentation genes you have. When you have this albino gene you will be an albino. In maize a similar gene exists. If present, different genes may produce purple, red or yellow seeds. Otherwise all seeds will be colourless (white). The absence of inbred pure-breeding *Clivia* makes it almost impossible to determine the mode of colour inheritance.

Another contributing problem to colour inheritance in *Clivia* is the throat. What regulates the inheritance of throat colour and the size of the throat? In Holstein cattle a gene determines whether the animal will have the well-known black and white pattern or a brown and white pattern. A totally different set of genes regulates the form of the pattern. Are we dealing with genes controlling the "normal colour genes" in various degrees in

[3] A molecular study on the different genes controlling the inheritance of colour in *Clivia* has been started at the University of the Free State. If everything goes well, results should be available in a few years time.

different parts of the flower or are we dealing with a totally different set of genes controlling the size of the throat?

Polygenic inheritance (where many genes influence the same trait) also contributes to the problems in understanding the genetics of *Clivia*. Polygenic traits are usually associated with patterns of inheritance where you observe a continuum rather than a specific class. Probable polygenic traits in *Clivia* include leaf width and length (these two may also be linked or may influence one another), number of flowers, length of tepals, etc.

Inheritance may also be influenced by a phenomenon called genomic imprinting. This means that the working of the genes is dependent on the environment (the cytoplasmic constitution) in which they operate. Only certain genes are affected and it will usually be genes responsible for disease resistance or other factors where the chloroplasts play a role. Genomic imprinting is the reason why reciprocal crosses may differ from one another: it is not cytoplasmic (maternal) inheritance but the genes may operate differently depending on the cytoplasm present. In extreme cases a trait inherited from one parent will be more strongly expressed than when that same trait is inherited from the other parent.

During the last part of 2004 Mick Dower shared his results on "De Villiers variegated peach" with us on the Internet. When crossed with a group 1 yellow, "De Villiers variegated peach" will produce peach offspring when used as pod-parent and yellow offspring when used as pollen-parent. Since low numbers of offspring were obtained, these results may be fortuitous. However, if larger numbers of offspring confirm the initial results, this may clearly be a case of genomic imprinting. Something in the cytoplasm influences the colour 'prescribed' by the genes. It will be very interesting to see what happens when he self-pollinates the yellows and peaches from this cross: will the imprinting last in the offspring from the yellow plants or will it change in the next generation? How many generations will be needed to determine whether the genomic imprinting lasts? How many other cases of genomic imprinting exist in *Clivia*? The lifespan of a human being is too short to solve all these problems. To truly understand *Clivia* we must share information. Even then we should keep the Biblical text in mind: "For now we see through a glass, darkly, but then face-to-face, now I know in part, but then shall I know even as also I am known."

Breeding *Clivia* – practical considerations

At this point you may become discouraged. You want to breed with *Clivia* and now I am telling you that we know almost nothing about the inheritance of most traits in *Clivia*. Many of you may tell me that you have used your green fingers and plantsman instincts to achieve good breeding results with little, if any, genetic knowledge. However, an understanding of the underlying genetics will undoubtedly improve those successes. We therefore have a magnificent opportunity: if all of us share[4] our practical knowledge gained over many years, we may be able to build up a genetic interpretation of those results for the benefit of all of us, so breeding *Clivia* will become a lot more predictable and we will have to rely less on a "hit and miss" approach!

Polyploidy

Much has been written on polyploidy in *Clivia*. Do we really want polyploid plants? Usually a polyploid will be a larger plant with

[4] If you are willing to share your knowledge please contact the author at spiesj.sci@mail.unvi.ac.za. Information needed includes a description (or photo) of the parents and the offspring, the number of offspring with each trait, and if possible the numbers of second generation offspring with each trait. The direction of each cross should also be supplied.

bigger flowers. The majority of us stopped after reading that introductory part and did not read the negative aspects. Polyploids usually develop more slowly than diploids. Polyploidy is the doubling of the chromosomes of an individual and the larger number of chromosomes slows down cell division. In some plants the growth rate is so inhibited that the plant cannot produce flowers during the growing season. I don't know the effect in *Clivia*, but with *Clivia's* large genome size, growth may be inhibited substantially.

If a tetraploid (a tetraploid contains four sets of chromosomes instead of the usual two) is crossed with a normal plant (diploid), a sterile triploid (three sets of chromosomes) is produced. If two tetraploids are crossed, you will not get a ¼ offspring with the recessive trait, but the figure drops to 1/36. Breeding with polyploids will further complicate this already very intricate issue.

Hybrid vigour

Lastly I would like to address the issue of hybrid vigour. It is a well-known fact that hybrids are often stronger and grow more vigorously than their parents. This effect is known as hybrid vigour and is especially pronounced in organisms where two highly inbred lines are crossed, for example in maize. It is also known that the combination of certain lines provides more hybrid vigour than others. Hybrid vigour is probably the result of the combination of as many genes in the heterozygous (split format) condition as possible.

The majority of *Clivia* plants we use can be classified as hybrids and inbred lines do not exist. Even the widespread strains are products of the pollination of similar individuals, rather than the self-pollination of an individual for at least seven generations to produce an inbred line as with annuals. Therefore no hybrid vigour will be observed, not even if we produce interspecifics.

Conclusion

Clivia is a wonderful plant with a very high degree of genetic variability. This variability makes it ideally suited for a breeding program. Keep records of your crosses and count the number of offspring that have each particular trait. In the long run this will be the only way to determine the mode of inheritance of traits and make it possible to predict the outcome of a specific cross. This means that, ideally you should monitor all the seedlings of the cross you have made. For most of us this is not physically possible, but the more who monitor and report on even samples of the seed they have bred, the more information will become available for genetic interpretation of those results.

Photo Claude Febert

C. mirabilis the oldest *Clivia* species.

Photo Ken Smith

C. caulescens a younger genetic variation.

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C. caulescens a younger genetic variation.

Clivia Under Threat

Vivienne Williams, South Africa

The use of the *Clivia* species

Five of the six *Clivia* species found in South Africa are harvested for the traditional medicine ('muti') trade. Known as *umayime*, the whole plant (except for the flowers) is utilized and the tops of the leaves are typically cut off, hence making it difficult to tell the species apart in the *muti* markets and shops.

Photo: Vivienne Williams

Clivia with leaf tops and roots removed.

The genus is used by traditional healers to treat a range of ailments of both physiological and spiritual origin. The name *umayime* means 'let it stop' and the plant is reportedly sprinkled around homesteads to stop people from damaging property. *Clivia* rhizomes are reported to be extremely toxic to humans due to the presence of numerous Amaryllidaceae alkaloids. Root infusions of *Clivia miniata* are taken orally to treat fevers, snake bites, infertility, urinary tract disorders and *inembe* - a childbirth therapy to ensure successful confinement and the birth of a healthy child. Additionally, leaf infusions are used in *isihlambezo* ('that which cleanses'). Despite their toxicity, species of *Clivia* remain the most popular of the Amaryllidaceae sold for traditional medicine.

The author conducted two surveys of the medicinal plant trade on the Witwatersrand. In 1994, plants sold in 50 *muti* shops were investigated and in 2001, 101 street vendors in the informal Faraday Street *muti* market were surveyed on behalf of DACEL (Department of Agriculture, Conservation, Environment & Land Affairs). Described as a multi-million rand 'hidden economy', the trade in indigenous plant medicines employs and supports hundreds of thousands of people in the capacity of plant gatherer, street vendor, shop trader and traditional healer. The annual volume of plants in trade in Faraday is in excess of 800 tonnes per annum. *Clivia* is one of at least 300 genera sold to consumers of traditional medicine on the Witwatersrand, and this article discusses aspects of this trade.

The species used

Except for *Clivia mirabilis*, which occurs in the Northern Cape, the remaining five *Clivia* species are all used for traditional medicine. Species of *Clivia* are sold in all the major medicinal plant markets of South Africa, namely KwaZulu-Natal (KZN), Witwatersrand, Mpumalanga and Grahamstown/Eastern Cape.

The trade in traditional medicines on the Witwatersrand is multicultural and reflects historical processes (related to labour and urbanisation) working in different ethnic groups, which shaped the development of migrancy. These same historical processes also shaped the preponderance of different ethnic and language groups in various sectors of the emerging South African capitalist economy from the late 1800s when the medicinal plant trade was being established

Table 1

Probable Species		Faraday 2001	Muti shops 2004
C. gardenii / *C. miniata*	Bought from traders from KZN	8	11
	Gathered self in KZN	4	4
C. nobilis / *C. miniata*	Bought from Harvesters from the Transkei	-	1
?	Collected in Johannesburg †	2	1
?	Location not Specified *	7	6
C. caulescens	Bought from Harvesters from Polokwane	-	4
C. caulescens / *C. miniata*	Gathered self or bought from harvesters from MP and Swaziland	2	7
C. gardenii	Gathered self in KZN	4	1

The species of *Clivia* likely to have been sold by traders in muti shops (in 1994) and the Faraday market (in 2001). The information was extracted from citations by the owners of the shops/stalls regarding from whom purchased, and where the plants were harvested. The information was then compared with the *Clivia* distribution map on pages 96 and 97 of CLIVIA 5 to determine the likely species. ('Gathered self' means that the trader personally harvested the plants from the cited location) (LMP = Limpopo Province; MP = Mpumalanga Province; KZN = KwaZulu-Natal Province).

* The plants could have originated from the provinces of Mpumalanga, Limpopo, Eastern Cape and KwaZulu-Natal as well as from Swaziland. The plants therefore belong to any one of the four species of *Clivia*.

† Likely to be cultivated.

on the Witwatersrand. While the Zulus dominate the present medicinal plant trade in the region, and at least two-thirds of the plants are harvested from KZN, traders in the Faraday market have extensive trade and family links with gatherers from all over the country, including the Eastern Cape and Mpumalanga. These links are reflected in the plant supply network to Faraday. There are more than 15 buses operating between collecting areas in KZN, Mpumalanga, Limpopo, Free State and the Eastern Cape that transport gatherers and plants to the market.

As a result, all *Clivia* species (except for *C. mirabilis*), regardless of whether or not the plant was historically used by the local ethnic group in its area of occupancy, are potentially vulnerable to being harvested by gatherers for the medicinal plant trade. That all the *Clivia* species are given the name *umayime* when sold in the market reflects the similarity of the plants, especially when the flowers and leaf tips are removed. While traders may acknowledge the different regional origins of the plants, and may have preferences for plants harvested in certain parts of the country, customers don't differentiate between the species of *Clivia* when requesting *umayime*.

Photo: Vivienne Williams

Bus with luggage compartments packed with *Clivia* and other plants.

Distinguishing between the species sold

The intra-species variation in characteristics such as leaf width and length, depending on the habitat conditions, confounds the ability to distinguish between species, particularly since the leaf tips and flowers are often absent in plants sold in medicinal plant markets.

Given these difficulties, a way of determining which species are traded in the *muti* markets is to compare the known distribution of *Clivia* species with the harvesting localities reported by the vendors selling the plants (Table 1). *C. miniata* and *C. gardenii* appear, from harvesting records, to be the most prevalent species sold by both *muti* shops and street vendors in 1994 and 2001. Records further indicate that *C. caulescens* is also available, but not with the same incidence. There was one specific reference to *Clivia* having been harvested from a locality in the former Transkei that would indicate that *C. nobilis* is also present in the Witwatersrand markets. However, interviews with traders from Faraday revealed the likelihood of *C. nobilis* being more prevalent than the trade records suggest.

Several traders were unable to recall where plants they sold originated (Table 1). As a result, these plants could potentially represent any one or all of the five *Clivia* species. Further, three traders cited that the plants they sold had been harvested in Johannesburg, suggesting that cultivated plants are also being targeted by harvesters. According to one siSwati traditional healer in Faraday the "best" Clivias for *muti* (in terms of efficacy) are from Mpumalanga (likely to be *C. caulescens*) followed, interestingly, by plants harvested from Pretoria.

Red Data listing

Based on their distribution and extinction risk, the Threatened Species Programme of the South African National Biodiversity Institute (SANBI) categorises the threat status of *Clivia* in the following way: *C. miniata*, the most likely species in trade, is considered *LR-nt* (Low Risk-Near Threatened) or *LC* (Least Concern) in both Swaziland and South Africa respectively. However, the species is noted to be 'declining' in South Africa in terms of the "Orange List"[1]. One author, writing in 1999, said that *C. miniata* is *LR-nt* in KZN, and was becoming very rare as accessible colonies were decimated and that there was a continuous threat of exploitation by the medicinal plant trade. The species was then considered to be medium priority for conservation action, and it was recommended that its conservation status should be reassessed in eight years.

C. gardenii is probably the next most popular *Clivia* species in trade and, while endemic to KZN, is considered to be *LC* in South Africa. The legal status of *C. gardenii* in KZN (in terms of the as yet unenacted KwaZulu-Natal Nature Conservation Bill) is described as 'protected', i.e. a species that may be purchased from any person legally entitled to sell them (i.e. the seller has the relevant permit).

Trade records indicated the presence of *C. caulescens* in the Witwatersrand markets. While collection threats are an acknowledged risk for the species, it is classified as NT (Near Threatened) in South Africa and DD (Data Deficient) in Swaziland.

[1] It is generally accepted that species on a Red List are a conservation priority. Conversely, it is an assumption that species that do not qualify for Red Listing need not be subject to conservation efforts. Some taxa that qualify as Least Concern (LC), e.g. *C. miniata* in South Africa, do not meet the criteria for a category of threat in the Red Listing process. However, this does not mean that these taxa are not worthy of consideration for conservation. As a result, the 'Orange List' was proposed. It comprises taxa that require anticipatory conservation planning to avoid future Red Listing. In terms of the Orange List, *C. miniata* is classed as 'declining'. In terms of this categorisation, species generally have large population numbers or distributional areas, but are threatened by commercial harvesting, horticultural acquisitions or are declining for other reasons.

Just before sending this article off for publication, a paper appeared that describes a new species of *Clivia* from the Pondoland Centre of Endemism, Transkei, South Africa. *Clivia robusta* was previously known as the 'robust form' of *C. gardenii*.

In terms of the species' conservation status, it has been proposed in that paper that *C. robusta* be categorised as EN B1a + 2a, i.e. Endangered and facing a very high risk of extinction in the wild because the extent of occurrence and area of occupancy is estimated to be less than 5000 km^2 and 500 km^2 respectively, and the populations are severely fragmented or known to exist in no more than five locations. This categorisation was based on the 2001 IUCN Red List Categories.

C. nobilis is the most threatened of the *Clivia* species. Originally listed as *LR-nt*, its conservation status has been upgraded to *VU B1b(v)*, i.e. Vulnerable owing to its extent of occurrence being less than 20,000km^2 and estimates indicating that there is a continuing decline in the number of mature individuals. As long ago as 1999 it was felt that there were pointers to local scale extinctions of the species in its area of occupancy.

Red List assessments of species are aided by information on observed, estimated or suspected population size reduction based on actual or potential levels of exploitation. The *muti* trade is an example of how exploitation has caused serious declines in population size for several species. The threats faced by *Clivia* species are further exacerbated by habitat degradation and habitat reduction caused by development. However, sustained harvesting for the *muti* trade will impact on the population size in the long term if current levels of exploitation persist in conjunction with other threats to its habitat. In 1988 in one of the first assessments of threats to plants used for *muti*, the *Clivia* sp. were listed and classified as 'rare and vulnerable', i.e. "*a species with relatively small populations that are vulnerable to over-exploitation if exploitation for medicinal purposes increases*". One author, writing in1988, considered vulnerability to over-exploitation to be partly a function of demand. Demand was deemed to be a direct representation of the number of bags sold annually by 54 traders, which probably represented ¼ of the total quantity sold in the region. In the 1988 assessment, 397 50kg-size maize bags were sold annually by 54 traders.

Trade records

No other records of the volume traded annually appear to exist until the Faraday street trader survey in 2001 by the current author.

Photo: Neil Crouch

A Muti Market.

Twenty-six percent of the traders sold *Clivia* and 11 50kg-size sacks were present during the inventory. This does not represent the quantity traded annually. Conservatively, however, it is estimated that at least 200 50kg-size bags are

sold to the Faraday market annually. Not much is known about the annual volume and value of the *Clivia* trade in the other medicinal plant markets around the country.

Based on its popularity and the volume known to be traded, *Clivia* ranked within the top ten plants for conservation action according to the 2001 Faraday survey. Over-harvesting is clearly a real threat to the species.

On a visit to Faraday in early November 2004, none of the traders had any *Clivia* in stock and were awaiting delivery later in the week. Amongst the traders, opinion was that *umayime* was now "*very, very scarce*". This is the first time the author has not encountered *Clivia* in the market, and its current availability does not represent its popularity. Clearly, more traders would sell the plants if they could obtain the stock, and this current scarcity is of concern. By late November, the traders had taken delivery of a consignment of mature *Clivia* harvested in Swaziland (either *C. caulescens* or *C. miniata*). Observations made it clear that no more than 7 traders were able to purchase the plants that arrived, and each trader had a volume equivalent to two plastic supermarket bags or less. Given the shape of the leaf tip and the rough margins, the species was probably *C. caulescens* (Figure 1).

In 1988, it was reported that the standard price for a 50kg maize bag filled with *Clivia* was R10 in KZN. In Faraday in November 2004, the cost of a 50kg-size bag was R60-R70 for smaller plants and up to R80 per bag for more mature individuals. The resale price in the market was R5 for 3-4 individual stems, whereas in 2003 it was reported that bundles cost R2 in KZN.

Conclusions

Clivia spp. (especially *C. miniata*) are widely traded and are at risk of being over-harvested. They have been reported as scarce in several regional medicinal plant markets, and are sold in large volumes. There is clearly a need to monitor and manage wild populations of the species before they become eligible for Red Listing. Propagation of *C. miniata* has been recommended. It is extremely difficult to identify the species sold in the markets, but knowing where the plant originated allows a preliminary judgment to be made. Thereafter, some macroscopic leaf features, such as margin and apex shape on immature leaves, could be used for inter-species differentiations. However, intra-species variations in leaf morphology do not guarantee that a correct identification will be made.

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This article has been abridged from a paper supported by 28, mainly academic, references. The full article, including detailed references, is available from the author: Vivienne L. Williams, School of Animal, Plant & Environmental Sciences, University of the Witwatersrand. vivwill@planetac.co.za **Eds.**

Photo: Charl Coetzee

***C. nobilis* the most sort after 'muti' *Clivia*.**

Pollination in Clivia

John Manning, South Africa

Introduction

Very little is known about the pollination biology of Amaryllidaceae although it is evidently diverse, judging from the variety of flower forms found within the family. The first documented record of moth-pollination in a southern African representative of the family, *Crinum variabile*, for instance, is just a few years old (Manning & Snijman, 2002). Observed or inferred pollinating agents include sunbirds, butterflies and moths, bees, and long-proboscid flies (Meerow & Snijman, 1998) – in fact most of the common pollinating agents. Actual observations based on wild plants are in the minority. This is not unusual, however, and it is only Iridaceae among the geophytes that have been at all intensively studied. Observations on cultivated plants are of little use since the natural pollinators are unlikely to be present in such situations, and in the majority of instances we must infer the pollination systems from the form of the flower. This can, however, often be done with a high degree of certainty because of the close relationship between pollinator type and floral form. The close correlation between pollinator needs (in the form of floral rewards) and floral attractants (shape, colour, and odour) led to the recognition of the existence of distinct floral syndromes (Faegri & van der Pijl, 1979). These are associations of floral characteristics that correlate with specific pollinator groups. As a consequence it is often possible to predict with some degree of certainty the pollinator group for which a particular plant species is adapted from the appearance of the flowers alone. Nectar is by far the most common floral reward, valuable to many insects as an energy-rich carbohydrate source, but other species are visited for the proteins in pollen, or for floral oils, or even for the shelter offered by certain flowers. Plant species differ in the degree to which they are specialised for a particular group of pollinator. Some are generalists that attract a wide variety of pollinating agents, while others are specialists, attracting just a single group (or even species) of pollinator. The more specialised, or exclusive, the pollination system, the easier it is to infer the pollinator. Even the specialised pollination systems, however, are seldom exclusive, showing some degree of 'leakiness', by which we mean that other groups of floral visitors may also act as pollinators, although always to a lesser extent.

Photo: Roger Fisher

Moths on *Clivia miniata*

Photo: Roger Fisher

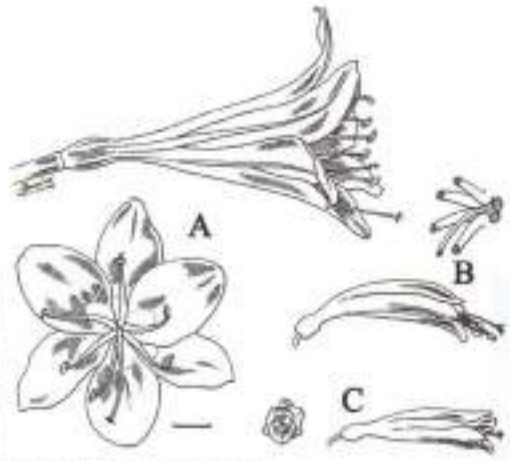
Specialised pollination systems are frequent in the southern African flora (Johnson & Steiner, 2000) and may in fact be the norm in many parts of the world. Certainly the extensive studies on the pollination of Iridaceae have confirmed their existence and predominance

in this family. With this background, therefore, let us look at what is known and what can be inferred about the pollination systems in *Clivia*.

Floral Morphology

Two distinct floral types are evident in *Clivia*:

Tubular: Flowers nodding; perianth sub-cylindrical, 35–50 mm long and 8–10 mm in diameter, the tepals not or scarcely flaring at the mouth, orange with green tips; stamens erect, the anthers close together, protruding up to 8 mm beyond the tepals or hidden in the mouth of the flower; style central; unscented. (See Fig. 1A).



Drawing : John Manning

Fig. 1: Distinct Flower Shapes

Funnel-shaped: Flowers spreading; perianth funnel-shaped, 70–80 mm long and 50–60 mm in diameter, the tepals flaring widely at the mouth, orange with a paler, yellowish throat; stamens slightly spreading, the anthers well-spaced in a ring at the mouth of the flower; style declinate and lying on the bottom tepal; usually unscented but sometimes reported to have a sweet-floral fragrance. (See Fig. 1B & C).

In both types the nectar accumulates in a reservoir in the lower 5–10 mm of the perianth, within the floral tube below the level of filament insertion. The base of the filaments presses against the style and act as a valve to close the mouth of the floral tube, preventing the nectar from exuding out of the tube.

Floral Longevity

Individual flowers of *Clivia* are long-lasting, with unpollinated flowers remaining fresh for 2–3 weeks. There does not appear to be a significant difference in longevity between the two floral types but further observations are required.

Nectar

Clivia flowers produce large amounts of moderately concentrated nectar (Table 2). Volumes secreted per day range between 13–36 microlitres (one microlitre is equivalent to one thousandth of a millilitre, or one millionth of a litre), and there does not appear to be a difference in nectar volumes between the two floral types. Nectar concentration ranges between 13–27% sucrose equivalents. Species with tubular flowers appear to secrete slightly more dilute nectar (13–18 %) than the species with funnel-shaped flowers (22–27%) but further observations are required to confirm this.

Photo: Rob Drake

Bees — Secondary pollinators?

Table 1: Floral and nectar characteristics of *Clivia*. (— indicates no observations)

Species	Flower Shape	Scent	Longevity (Days)	Nectar Volume (Microlitres)	Nectar Concentration (% Sucrose Equivalents)
C. caulescens	Tube	x	—	13	18
C. gardenii	Tube	x	—	36	13-14
C. miniata	Funnel	x/✓	18 - 20	24-26	22-27
C. mirabilis	Tube	x	±14	—	—
C. nobilis	Tube	x	—	—	—
C. robusta	Tube	x	—	—	—

Floral visitors

Wild plants: Observations have been made on single populations of four species of *Clivia*. These indicate that the species with tubular flowers are visited by various species of sunbirds, while *C. miniata*, with funnel-shaped flowers, is visited by swallowtail butterflies. Sunbirds alight on the stout peduncle and reach into the nodding flowers with their beaks. Pollen is deposited at the base of the beak. The butterflies, in contrast, alight directly on the flowers, brushing the anthers with their bodies and wings.

Cultivated plants: Various observations have been made of insects visiting cultivated plants of *C. miniata*. These mostly involve honeybees, *Apis mellifera* (Hymenoptera: Anthophoridae) and hoverflies (Diptera: Syrphidae) (Abel *pers. comm.)* but also noctuid moths (Fisher, 2004). The flies and bees alight on the anthers only, where they gather pollen (Fig. 2), while the moths settled within the flowers.

Conclusions

Species of *Clivia* produce two floral types that accord with two different specialised floral syndromes. The tubular flowers that characterise the majority of species are typical of other southern African bird-pollinated plants of the gullet-type, both in shape and coloration (Rebelo, 1987; Goldblatt *et al.*, 1999). The long beaks of sunbirds are adapted to probing for nectar in narrow, tubular flowers, from which visitors with shorter mouthparts are denied access to the nectar. The division of the flower into two sections: a tubular, nectar-containing portion at the base that is more or less blocked by the insertion of the filaments; and a cylindrical upper portion is

Table 2: Pollinator observations in wild populations of *Clivia*. (— indicates no observations)

Species	Visitor	Locality data
C. caulescens	Black Sunbird	God's Window (Manning pers. obs.)
C. gardenii	Sunbird species	KZN coast (Val Thurston pers. obs.)
C. miniata	Citrus Swallowtail	Morgan's Bay (Colin Paterson-Jones pers. obs.)
C. mirabilis	Malachite Sunbird	Oorlogskloof (Manning pers. obs.)
C. nobilis	—	—

Photo Peter Steyn

Sunbird on an *Erica*

Photo Graham Duncan

Cyrtanthus obliquus

Photo: Piet Theron

Sunbird pollinator on pendulous *Clivia*

Note the similarity of the flowers above in order to attract the same pollinators

consistent with many bird-pollinated Iridaceae (Goldblatt *et al.*, 1999). In such flowers the bird is able to insert its beak into the upper portion of the tube but can only reach the nectar in the lower reservoir by extending its slender tongue through the valve formed by the filaments and the style. This valve has an obvious function in preventing the nectar from flowing out of the pendant flowers but may also serve to protect the ovary tissue from damage by the birds' beak. The upper cylindrical portion of the tube in bird-pollinated *Clivia* species measures between 25–28 mm, which accords with the dimensions recorded for Iridaceae of this type. The nodding or drooping presentation of the flowers is also commonly encountered among bird-pollinated species, including *Aloe*, *Gasteria*, *Kniphofia* (Asphodelaceae), *Agapanthus inapertus* (Amaryllidaceae) and *Watsonia aletroides* (Iridaceae). Orange and red are the dominant colours among bird-pollinated flowers, largely because these colours are invisible to insects and not because birds have an intrinsic preference for these colours (Raven, 1973), and bicoloured flowers tipped with green or black are essentially restricted to bird-pollinated species. The resemblance between the flowers of these species of *Clivia* and other bird-pollinated species such as *Cyrtanthus obliquus* (Amaryllidaceae) is a striking example of convergent evolution. It is likely that the tubular-flowered species are visited and pollinated by a variety of sunbirds, depending on the local avifauna.

The strategy of swallowtail (Papilionidae) pollination has not been studied among the South African flora but is undoubtedly an important one. Several plant species from subtropical South Africa, among them *Bauhinia galpinii* (Fabaceae), *Crossandra* (Acanthaceae), *Freesia grandiflora* and *F. laxa* (Iridaceae), and *Gloriosa* (Colchicaceae), conform to the floral syndrome displayed by *Clivia miniata* and are apparently also adapted to pollination by swallowtail butterflies. The large, funnel-shaped flowers of *Clivia miniata* also match the brush-type flowers of several plant species that are adapted to pollination by another butterfly species, *Aeropetes tulbaghia* (Johnson & Bond, 1994), bearing an especially close resemblance to those of *Cyrtanthus elatus*. This syndrome has been well-studied in the Western Cape, and involves several plant species of montane habitats. Butterflies are one of the few insect groups that are able to distinguish red or orange. Although the plant species adapted to pollination by *Aeropetes* in the Western Cape have converged on a very precise shade of red (Johnson & Bond, 1994), this is not the case further north, where this butterfly species

visits flowers in a range of hues between orange and red. Orange or red flowers are also highly attractive to swallowtail butterflies, including *Papilio nireus*, which are also attracted to the pale blue of *Plumbago* (personal observation). The exposed anthers in *C. miniata* are well-placed to brush the body and wings of visiting butterflies and the position of the stigma along the circumference of the ring of anthers ensures that it is best positioned to brush pollen off the insect. The Citrus Swallowtail, *Papilio demodocus*, is widespread through Africa, and although it favours more open, wooded country (Van Son, 1949) it is often seen patrolling the edges of forest patches and bush clumps, where its larval food plants grow. These are mainly forest trees in the Citrus family, such as *Calodendron*, *Clausena* and *Toddalia*. It is highly probable that other species of *Papilio* also visit *Clivia miniata*.

The large amounts of more dilute nectar secreted by the bird-pollinated species of *Clivia* are typical of other bird-pollinated plants. Nectar of bird-pollinated Iridaceae typically ranges between 15–40 microlitres (as much as 119 microlitres in large-flowered *Watsonia* species), at a concentration of 10–25% (rarely up to 35%) sucrose equivalents (Goldblatt *et al.*, 1999). Plants adapted to pollination by *Aeropetes*, in contrast, typically secrete smaller quantities, ranging between 2–27 microlitres, of moderately concentrated nectar in the range 15–35% sucrose equivalents (Johnson & Bond, 1994) but there is substantial overlap between the two. The more concentrated nectar secreted by *Clivia miniata* is consistent with pollination by large butterflies, as is the development of fragrance in some forms. Fragrance is an important attractant in several butterfly-pollinated species (Andersson *et al.*, 2002) but is not part of the floral syndrome in bird-pollinated species.

The short mouthparts of the honeybees and hoverflies observed visiting cultivated plants of *C. miniata* preclude them from reaching the nectar and it is also evident that these insects were concerned respectively with gathering and eating pollen. It is not inconceivable, however, that the bees in particular (hoverflies are far more accomplished fliers), may accidentally brush against the stigma and succeed in transferring pollen to it. Noctuid moths, however, may be more successful as pollinators. During field studies around Nieuwoudtville I have frequently observed that noctuid moths become active during the late afternoon, when they visit a variety of flowers that are adapted to pollination by other agents. The extent of their involvement as such secondary pollinators has not been assessed but may be significant. There is no doubt, however, that these insects are incidental pollinators of *Clivia* at best, and their role in wild populations remains to be assessed.

Photo Claude Folbert

Though frequent floral visitors, ants are unlikely *Clivia* pollinators.

Both groups of primary pollinators in *Clivia*, sunbirds and swallowtail butterflies, are polylectic foragers that visit a wide variety of flowers for nectar. They are thus not dependent on *Clivia* as a food source. In contrast, *Clivia* species have evolved specialised pollination systems that rely on a single group of pollinators. Further observations are likely to reveal that each *Clivia* species is pollinated by several different species of sunbird or swallowtail that comprise local suites of species present at the different localities.

Evolutionary considerations

The cladistic analysis of *Clivia* (Conrad & Reeves, 2002) is consistent with the hypothesis that bird-pollination is ancestral in the genus and that the switch to butterfly pollination is a subsequent, derived characteristic. In this context it is highly significant that the divergence among the bird-pollinated taxa in the genus has taken place along a geographical cline, with little or no overlap between each. It is only *C. miniata*, that is adapted to pollination by butterflies, which occurs across the range of any other species (in this case across the ranges of three different species). Fertile hybrids can be produced between all of the species of *Clivia* and it is presumably this adaptation to different pollinators that made it possible for *C. miniata* to expand its range in this way. The substantial overlap in floral coloration and nectar quality between bird and large butterfly pollination makes the shift between them an easy evolutionary event.

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Photo: Peter Lambert

Northern Club Show, Owner: Dawie van Heerden

Photo: Gordon Fraser

A moth on a light coloured *Clivia*.

The Significance of Colour and Ultraviolet Patterning in *Clivia miniata*

John Manning, South Africa

Light is the term used to describe that segment of electromagnetic radiation that is visible to living organisms, more particularly humans. Our visual spectrum includes light with wavelengths between 400–750 nm, covering the range of colours from blue, through blue-green, green and yellow to red. Not all organisms have the same spectral range as us, however. The visual spectrum of bees, for example, extends from 300–650 nm. The colour vision of bees, although sensitive to a similarly wide range of wavelengths as ours, is shifted towards the blue end of the spectrum. Thus bees are unable to see red, which has a wavelength of 650–750 nm and is therefore beyond their range of vision, but they are able to perceive ultraviolet light as a distinct colour, with a wavelength of 300–390 nm. Humans, in contrast, cannot. We owe much of what we know about colour vision in bees to the remarkable work done by the German scientist Daumer (1958), and Table 1, which compares the colours seen by humans with those perceived by bees, is drawn from his work.

Most insect groups are able to perceive ultraviolet light and it is not surprising, therefore, that the colours and patterns of many insect-pollinated flowers include ultraviolet components that are visible to pollinating insects but not to humans. The patterns on these flowers may appear very different to the insect than they do to us. Several surveys of ultraviolet reflectance and patterning in flowers have been published but these cover just a few species and the UV characteristics of the great majority of flowers are unknown.

Flowers that appear white to the human eye normally absorb UV light strongly below about 400 nm and it is now clear that the class of water-soluble floral pigments known as flavones and flavonols, which occur dissolved in the cell sap, are largely responsible for

Table 1: Flower colours as seen by bees and humans (Daumer, 1958)

Reflected light	Colour to Bees	Colour to Humans
Yellow + UV	Bee Purple	Yellow
Yellow	Yellow	Yellow
Green	Yellow	Green
Green + Blue + Red	Blue-Green	White
Blue	Blue	Blue
Blue + Red	Blue	Purple
Blue + UV	Violet	Blue
Blue + UV + Red	Violet	Purple
UV + Red	UV	Red
Red	Black	Red

UV absorption. The orange pigmentation in typical *Clivia miniata* is due to a special class of flavonoids, known as anthocyanins, that are not UV-absorbing. A second class of floral pigments, the carotenoids, which are oil-soluble and occur in discrete bodies within the cells, do not absorb UV. They are responsible for many of the yellow colours in flowers. In many yellow flowers, however, the carotenoids occur along with certain flavonoids, which also appear yellow but are able to absorb UV light as well. It is these flavonoids that are responsible for the UV-absorbing nectar-guides that are found in many yellow flowers, including evening primroses (*Oenothera*) and sunflowers (*Helianthus*) (Kay, 1987). Contrastingly, flowers that are adapted to pollination by birds, which have a similar visual spectrum to ours, lack UV patterns. Three important colours have been recognised that are differentiated only by insects with vision extending into the near UV. These are "insect-yellow" for UV-absorbing white, "insect-red" for UV-absorbing yellow, and "insect-purple" for UV-reflecting yellow.

Photographs of the flowers of *Clivia miniata* that visualise UV light, taken by Ian Coates (Fig. 1) show that the stamens and style are strongly UV-absorbing, whereas the perianth is not. Note that the pale central star in the mouth of the tube does not reflect UV any differently than the rest of the perianth. The stamens in *Clivia miniata*, although not distinctively coloured to us, are therefore highly visible to insects as "insect-yellow". This may explain why honeybees are strongly drawn to the anthers of this species, where they collect pollen and may occasionally effect pollination, although the available evidence indicates that *Clivia miniata* is actually adapted to pollination by swallowtail butterflies (Manning, 2005).

Colour vision is widespread in butterflies, which have a wide visual spectral range, 300–700 nm, from ultraviolet to red (Silberglied, 1984). Within this range, different species show distinct preferences for certain colours. Studies on colour discrimination in swallowtails (*Papilionidae*) carried out by Ilse (1941) have shown that they, like whites (*Pieridae*), have advanced trichromatic colour vision, enabling them to distinguish at least 3 groups of colours: red-to-yellow; green-to-blue green; and blue-to-violet. The orange and yellow flowers of *Clivia miniata* are thus quite visible to these insects, as well as the UV reflectance of the stamens and anthers. The significance of this, however, is difficult to explain since the butterflies do not visit the flowers in search of pollen. Possibly the UV reflectance plays a role in guiding the butterflies towards the source of nectar at the centre of the flower, analagous to the role of nectar guides on the petals of many bee-pollinated flowers.

Different butterfly species vary in the way in which they locate food, with some species guided principally by scent and others by sight. Whites, which have the same advanced eyesight as swallowtails, are guided by sight and evince a full feeding response in the complete absence of scent (Ilse, 1928). Swallowtails are thus also likely to respond to visual cues, following them to nectar and responding to them in their feeding behaviour.

Interestingly, learning can be important in some butterfly species. Newly hatched adults of the White Admiral, for instance, are directed by scent in their first visits to flowers but are guided visually in later visits. The inconsistent presence of scent in the flowers of *Clivia miniata* may, therefore, indicate that it is less important for attracting butterflies in some populations than in others. Even

colour preferences can change as a result of experience. The swallowtail *Papilio troilus* shows a strong spontaneous preference for blue and is only weakly attracted to orange but after training showed an increased response to this colour.

Finally, studies on the effects of size and form of coloured objects carried out by Ilse (1932) found that larger objects were more attractive to butterflies, most particularly the extent of the outline of the object as opposed to the surface area *per se*. This is an obvious reason for the greater size of the flowers of *Clivia miniata* in relation to bird-pollinated species, an effect that is heightened by the aggregation of these flowers into large heads.

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Photo: Kevin Mansfield

Selected from the KwaZulu-Natal Garden Show.

Photographing Clivia in the Ultraviolet

Ian Coates, United Kingdom

An insect with good eyesight and a well marked plant seemed destined to survive. However, an insect's vision is strong in ultraviolet, so successful plants which rely on such insects for pollination must be attractive to them in that region of the spectrum as they are competing with all the other flowers in the area. For this reason, *Clivia* put out markers, rather like runway lights, to make it easy for their nectar seeking pollinators to target them.

Since these markings can only be seen beyond the violet end of our visible spectrum, we cannot see them with the naked eye. Of further inconvenience is the fact that ever since the invention of photography the manufacturers of equipment and materials have all strived to match their results to those seen by our eyes and have therefore eliminated ultraviolet sensitivity.

Photo: Ian Coates

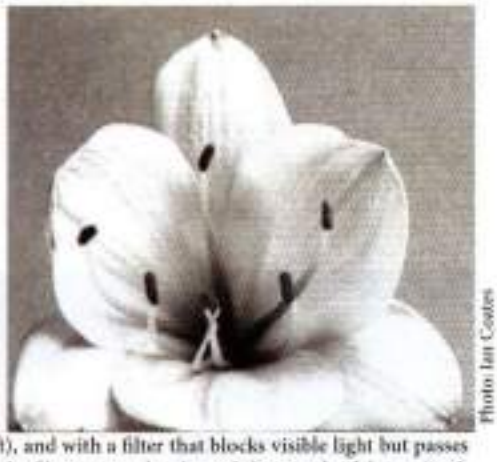

Photo: Ian Coates

***Clivia miniata* flower photographed in visible light (left), and with a filter that blocks visible light but passes UV (right), showing that the anthers, lower portions of the filaments and style, and the mouth of the perianth tube absorb UV light.**

I hope in CLIVIA 8 to show you how to overcome these and the many other associated problems so that you can photograph your *Clivia* in ultraviolet for just a small outlay. Results from a wide range of varieties across the species, including interspecifics, can only help our understanding of the genus.

Photo: Charl Coetzee

Runner-up to Best on 2003 E.P. Show. Owner: Charl Coetzee

Photo: Charl Coetzee

Charl Malan's pastel class winner at the E.P. Show

Why do Clivia Flower when they do?

John van der Linde, South Africa

The quick answer to the question above is: Because that is when their pollinators are around. But how do the plants know when it is time to get ready and dress up in their very best flower colours and switch on their ultraviolet "come hither" looks to attract the wandering eyes of the pollinators flitting by?

Clivia have to cope with the conditions in which they find themselves - they can't change or avoid them; their evolutionary success totally depends on their ability to get their timing just right. Blossoming, and then pollination, fertilization, and nursing of their seeds all follow on logically from the timing of one key decision: when to flower?

Plants, as well as other organisms, respond to temperature change and also to night length to control certain functions, like flowering, dormancy, general growth, etc. This latter ability is called photoperiodism, and it, in turn, is regulated by special proteins called photoreceptors, molecules that respond to different wave lengths of light. Plants also have internal clocks which control daily rhythms. They can actually detect that nights are growing shorter as days grow longer, and that summer is on its way.

This day/night rhythm occurs in every plant and animal. This is hardly surprising since life arose under the influence of the earth's rotation, which has dictated exposure to solar and lunar cycles over many millions of years. One of the more obvious photoperiodic responses of plants is flowering. Many plants, including *C. miniata*, have evolved a mechanism to delay flowering until nights are shorter and days longer and the weather begins to warm up. The very same climatic factors operate to cue the pupae of Swallowtail butterflies to hatch, and for the adult butterflies to emerge to begin patrolling their habitat, the outskirts and glades of the relic patches of Afromontane forests up the eastern parts of South Africa, where *C. miniata* have been growing and evolving for thousands or even millions of years. In summary, the same circumstances independently affecting both plant and pollinator ensure the happy "coincidence" that the *C.miniata* bloom at the very time that their chief pollinating insects can be expected to be present.

Clivia adapted to growing in the most heavily shaded parts of the forests are unlikely to be visited by butterflies, who avoid the very darkest areas and prefer to flit around where there is enough light for them to see. These plants may multiply vegetatively without ever flowering. It would be tempting to conclude that they are saving valuable energy by not flowering, because they somehow sense that no pollinators will visit them. It is more likely however that the common factor affecting both plant and pollinator is the lack of the necessary daylight to spur them to "do what is necessary to do what comes naturally".

A wild mustard called *Arabidopsis thaliana* is a laboratory favourite, often used by scientists studying the inner workings of plants – the plant equivalent of the fruit fly or the mouse. Researchers have found that two of this plant's genes, involved in their internal clocks, make receptors for glutamate. This is interesting because in the human brain glutamate plays a part in acquiring and storing memories. Do plants also "remember", and maybe even "learn", as they react to their external environments?

It has been known for a long time that flowering is activated by light. But only in the last few years have scientists been able

to establish how the process works: Through their work with *Arabidopsis* they have found that its internal clock controls the activity of a gene called CONSTANS. This gene's protein is influenced by light, but only starts to be produced about 12 hours after dawn. In the late afternoon/evening, one kind of photoreceptor stabilizes the CONSTANS protein if it senses blue light, which scatters more than the other components of sunlight, leaving the dominant yellow-orange that we see in sunsets. Blue light has a very short wave length and is a good sensor because it is not absorbed by plant chlorophyll as other types of light are. In the morning another photoreceptor starts to break down any unstabilised protein.

On short days, there is not enough light later in the day for much stabilization to occur and flowering is delayed. But as spring approaches and the days grow longer, with more afternoon sun, the balance shifts in favour of a build-up of protein. When the protein reaches a high enough level, the genes that cause flowering are switched on.

Because flowering is so vital to their survival, plants apparently also have back up systems in place. For example, there is also a gene that suppresses flowering but which is switched off by cold. This may well explain why *C. miniata* needs a cold spell in early to middle winter, not for flower initiation *per se*, but for the "bodyclock" genes to then begin the countdown for bud development and scape elongation, for when the plants deem it safe enough to bloom in the spring, when activated by CONSTANS.

Also, each *C.miniata* cleverly gets its flowers to bloom sequentially, rather than all at once, to give the plant the best possible chance of being visited by pollinators over an extended flowering period .There is another good reason for this timing strategy: upward facing flowers are always at risk of pollen getting wet and being ruined by occasional spring rains, so all the more important to spread flowering over a period.

Even the experts don't know all the answers to how plants organize themselves so well. There seems to be a delicate interaction of pathways to promote and suppress flowering. What are the triggers for *C. gardenii* and *C.robusta*, which flower in late autumn, instead of early spring, like the other species? Is the CONSTANS mechanism somehow reversed, with flowering being triggered in effect by the days growing shorter, as has been shown to happen with rice? Why do interspecific hybrids, even those between species like *C. miniata* and *C. nobilis*, which both flower in spring, often flower in early to mid winter?

It is quite possible that CONSTANS is only one way that plants regulate flowering by day (or night) length, and that there are other factors involved. There may be hundreds of genes working together to get the timing of flowering just right. The pace of scientific progress is such that we may well know far more about this subject within the next few years.

But what I want to know, now rather than later, is why some of my best *C.miniata* plants don't obey the rules. Why don't they flower when they are supposed to?

I found most of the information above about CONSTANS by searching the Internet, but my interpretations of the possible effects on *Clivia* are my own. Please read what I have written in that light.

This single flower view is of an Interspecific, owned by John van der Linde and bred by Mick Dower.

Photo: Mick Dower

Odd Umbels

Roger Dixon, South Africa

The normal inflorescence of a *Clivia* is an umbel, which is a raceme where the axis is not elongated, so that the flower stalks arise at the same point. The flowers are in a head with the oldest on the outside.

Fairly often, a plant will produce an inflorescence which consists of a normal umbel but with a smaller stalk with a few flowers on it sticking out of the top. This does not usually repeat the next season. It may also produce several branched stalks such as in *C. mirabilis* (Rourke, 2003). In this case, all branched stalks, or pseudo-umbellulae, arise from the same point.

Photo: Bill Dyk

Clivia caulescens.

However, in extreme cases, the plant can revert to an ancestral inflorescence such as the one illustrated here. This is a *C. miniata* from near Greytown in KwaZulu-Natal belonging to Pieter van Rooyen which always flowers in the same fashion. Brian Tarr has a *C. caulescens* that behaves similarly.

These 'throwback' inflorescences show two distinct features, which when combined would probably produce a cyme, which is an inflorescence in which the terminal bud is a flower-bud and other flowers are formed at the ends of lateral branches. The small tubular red flowers in such an open inflorescence would not present a particularly striking target for pollinators, and I suggest that evolutionary pressures caused the flowers to become closer spaced, both vertically and laterally, leading to the umbel that is typical of *Clivia* today.

Photo: Pieter van Rooyen

Clivia miniata with a candelabra-like crown.

Photo: Pieter van Rooyen

Clivia miniata with elongated pedicels. Here the peduncle is greatly reduced.

Rourke, J. (2003). Secondary pseudo-umbels in *Clivia mirabilis* inflorescences. *CLIVIA* 5:91.

The Photographic

Winning *C. gardenii*:
Awarded second place — best of four entries.
Caption: Praise and Prayer.
Breeder: Dr. M. Barker. Grower: Gordon Fraser.
Photo: Gordon Fraser.

BEST PHOTO:
Winning – Single Flower. Best of 33 entries.
Caption: Lemon and Lime.
(See Front Cover)
Owner: Edgar Fevrier. Photo: Gordon Fraser.

Winning Habitat Photo: *C. caulescens*
Best of 16 entries. Photographed at
Orighstadrivier on the Farm Breytenbachskraal.
Photo: Eli van der Merwe.

Winning Interspecific: *C. miniata* x *C. caulescens*
Best of 14 entries.
(See Inside Front Cover)
Owner: Laurens Rijke. Photo: Helen Marriott.

Competition Winners

Winning *C. miniata*: Best of 64 entries. Owner: Laurens Rijke. Photo: Helen Marriott.

Winning *C. caulescens*: Best of two entries.
Owner: Laurens Rijke. Photo: Helen Marriott.

Winning *C. nobilis*: Best of five entries.
(See Frontispiece) Photo: Tony Barnes.

What's in a Name?

Johan Spies, South Africa

With the publication of a sixth *Clivia* species, *C. robusta*, some *Clivia* lovers wanted to know how many differences are needed to form a new species. To answer this question we will have to look at the way in which taxonomists describe new species.

Usually a taxonomist will look at all herbarium specimens and decide that a certain group forms a separate species. This is normally followed by field investigations in which the differences between populations, and the natural range of morphological variation within each population, are further assessed. The taxonomist will then describe the variation within the species in a valid taxonomic way and use one specimen as the type specimen for the species name. According to the *International Code of Botanical Nomenclature*, the type specimen is a specimen to which the name of a species is permanently attached and need not necessarily be typical of the species, though obviously it should fall within the range of variation accepted for that species. It will be housed in a separate cover in a special place in the herbarium. The type specimen will be available for restricted viewing and is usually considered as one of the important reference sources of the herbarium.

In the time before the 18th century no taxonomists lived in South Africa. Plants were collected in a haphazard way, mostly by laymen. These specimens were transported to Europe where they were named without the luxury of field investigations. The early taxonomists often had only one specimen per species and no variation was accounted for in the species description. It may have happened that two extreme forms of a species were collected and described as different species, or even as different genera, i.e. *Imanthophyllum aitoni* (=*Clivia nobilis*) and *Vallota miniata* (=*Clivia miniata*). At a later stage with more specimens available a taxonomist might see that the two taxa should represent one taxon and another valid publication follows. The oldest name is usually retained as the correct name for the taxon and the other names are considered to be synonyms. This whole process is ruled by the international code for nomenclature.

Species concepts

Another point that may be of interest to *Clivia* lovers is that there is no consensus on the definition of a species. Hundreds of definitions (or species concepts) exist but in this paper we will cluster them in three different groups, i.e. the classical (or morphological), biological and evolutionary species concepts.

The **morphological species concept** states that a species consists of a population or populations that are morphologically similar but differ from other such populations in several morphological characters. If populations are linked by continuous variation in their morphological characters then there is no justification for separating the extreme forms into different species. The main problem with this species concept is that different people interpret those "allowable" differences between different populations differently. Taxonomists are often classified themselves as being either "splitters" or "lumpers". A splitter will use the slightest difference between two populations to describe a new species. If we use this approach in *Clivia* we could end up with at least 15-20 species. On the other extreme a lumper will describe only two *Clivia* species, the trumpet shaped *C. miniata* and the tubular flowered *C. nobilis*. As the oldest described name in the tubular flowered group, *C. nobilis* would be the

valid name. Included in the latter species will be the subspecies *caulescens*, *gardenii*, *minabilis* and *nobilis*. The lumper will further describe different varieties or forma (different forms) in each subspecies, for example *C. nobilis* subsp. *gardenii* f. *robusta*.

According to the **biological species concept** a species is a population or populations than can freely interbreed but are reproductively isolated from other such populations. This species concept was developed to get a more objective way to delimit species. Since all *Clivia* species can be crossed and produce fertile offspring, only one species should be described. However, even this "objective" species concept proved to be subjective. Should the reproductive isolation exist in nature or in the laboratory? In the case of *Clivia*, should the different flowering times of the different species and their geographical separation act as isolation mechanisms to justify the description of the current species?

The **evolutionary species concept** states that a new species is a divergence from the ancestor-offspring lineage, where no gene flow exists between the new species and the original lineage. This species concept is very popular among molecular scientists. A closer examination of this concept indicates that it contains elements of the first two concepts and adds a new dimension. A deviation from a lineage implies a mutation (a novel-looking individual implying the morphological species concept) that does not exchange genes (reproductive isolation as in the biological species concept). Unfortunately even this latest concept can be interpreted in different ways; how many mutations are necessary for a new species and under what circumstances should gene flow be restricted?

To be "a new species" or not to be "a new species", that is the question.

The foregoing part indicates that taxonomy or the classification of plants is not the exact science we believed it to be. However, the majority of taxonomists will try to achieve the same goal: a realistic classification of plants.
Will it be realistic to use only one character to separate species? If we use humans as an example: should blue-eyed people form a separate species from brown-eyed people? Everybody will agree that it would be absurd. Yet we consider yellow flowering *C. miniata* to be a separate variety (*C. miniata* var. *citrina*) to orange flowering ones (var. *miniata*). We should therefore keep in mind that a certain amount of variation within a species is quite normal.

If we look at another practical example: I received a number of *C. nobilis* specimens from different localities. The Nahoon specimens are much more robust than the Kei River Mouth specimens. In comparison with specimens from Grahamstown, both coastal strains/cultivars/species appear to be gigantic. In addition the Grahamstown form has a light median line along all leaves, absent from the coastal forms. These three forms can easily be identified at a glance and they were originally geographically isolated. Should these three forms be described as different species, subspecies, varieties, cultivars, forms, strains or some other taxonomic unit? They all share a rough leaf edge, the same leaf texture and blunt leaf tips. These shared characters indicate to me that these plants should be grouped together in a separate group to the other *Clivia* species. So I will not describe them as new species, but consider them as entities at a taxonomic level below that of species. A splitter will disagree and describe them as three separate species.
What characters should be used to decide at what taxonomic level different collections should be placed? Is there any sense in using obscure characters that cannot be seen in a

classification? In my opinion anything that cannot easily be seen should not be used to classify taxa. These characters may help to study the evolution of a group or the genetic variation but are not proper taxonomic characters. If you need an electron microscope to see whether a certain form of gland is present or a certain structure is present in the cells of an organism, it is taxonomically impractical to use such characters to separate species. In a similar way if you have to test for the presence of a certain chemical in a plant to decide to which species a specimen belongs, this impractical character should not be used to separate them. The same principle applies to DNA sequences and chromosomal characters.

If we study the DNA sequences available in Genbank (an international database where DNA or protein sequences are stored for all organisms) and the approximately 30 sequences produced in my own laboratory, we observe differences in the same species. This can be expected. If the DNA did not differ, all specimens would have been exactly the same with no genetic variation. We all know that a lot of genetic variation is present in *Clivia*. Is a single difference in one gene sufficient to give the deviating form 'species' status? In my opinion it is not.

Very little genetic work has been done in any plant species when compared to humans. In humans satellites (a little knob at the end of a chromosome) may be present on certain chromosomes. These satellites are inherited in a Mendelian fashion. If you study a certain family you will, for example, observe satellites on both number 13 chromosomes. In an unrelated family no satellites may be present. Should these two families be considered as separate species? This phenomenon has not been observed in plants. I think it is just because of our insufficient knowledge of plant chromosomes. We are always limited by funds and so the number of specimens studied per population and per species is limited. With humans literally millions of specimens are studied around the world. This overwhelming number of studies offers much more information than the few studies conducted on a particular plant species.

Should something like the "fragile X-syndrome" in humans (with a specific staining procedure the X-chromosome will stain differently) be considered as a separate species (this deviation is also linked to a number of morphological and mental characters)? Definitely not. Why should a similar phenomenon in a plant be considered to indicate a separate species?

In conclusion it is certain that different people will consider the delimitation of species in different ways. As a natural lumper my view will differ from that of a splitter. To remain the practical, useful and workable tool that it is, taxonomy should be based on easily observable characters. My plea to the *Clivia* taxonomists: please do not split more species. The more species we have the more difficult it becomes to classify your plants. Ask yourself whether the "new species" will really contribute to our handling of this wonderful genus.

Photo: Keith Barlow

The beauty of a single flower.

Nuclear DNA Content in Clivia

Ben Zonneveld, The Netherlands

Summary

Genome size was investigated in all six published species. The species of *Clivia* have the same chromosome number (2n = 2x = 22) but the nuclear DNA contents ranged from 31.2 to 39.2 picogram. (1 pg is 10 to the minus twelve gram). *C. miniata* and *C. caulescens* have nearly the same nuclear DNA content and the same is true for *C. gardenii* and *C. robusta*. *C. mirabilis*, having the lowest DNA content, could be the most primitive species. A difference of 8 pg in nuclear DNA content implies that the largest genome has chromosomes that are on average 30% larger. Flow cytometry can be used with non-flowering plants, and therefore has applications in conservation monitoring and the determination of the results of interspecific crosses.

Introduction

The genus *Clivia* Lindl. (*Amaryllidaceae*) comprises six described species and occurs naturally in South Africa and Swaziland.

Clivia nobilis Lindl. was the first to be described in 1828. The next one, *C. miniata* (Lindl.) Regel was described in 1853 differing in its open, not tubular, flowers. It is the species most often encountered in culture. Several cultivars are described, including one with yellow instead of orange-red flowers. In 1856 another species with tubular flowers, *C. gardenii* Hook. was described, followed in 1943 by *C. caulescens* R.A. Dyer. Ran *et al.* (2001) point to a possible fifth species (colloquially known as 'Robust *gardenii*', or 'Swamp *Clivia*') also having tubular flowers, but differing e.g. in DNA sequence. It also grows in wet places contrary to the others that grow in shady, rocky places. It was described as *C. robusta* by Murray *et al.* (2004). Great was the surprise when in 2001 another species was found 800 km to the west. It is not only far removed from the other species but grows at least part of the day in full sun (Rourke, 2002).

Clivia are popular plants both for indoors or outside in the more favourable climates. All species are in cultivation, and several cultivars have been described, mainly of *C. miniata*. The tubular flowered taxa that are in culture are often confused. All species counted have the same chromosome number, 2n = 2x = 22.

By doing DNA analysis Ran *et al.* (1999; 2001a; 2001b) and Conrad & Reeves (2002) have substantially clarified systematic relationships within *Clivia*. However, *C. mirabilis* was not available to Ran *et al.* and Conrad & Reeves did not investigate *C. robusta*. To elucidate the relationships between all *Clivia* species, a character was investigated that was not used earlier in the systematic study of *Clivia*. Nuclear DNA content was measured in all species by flow cytometry with propidium iodide. The classical taxonomic traits based on morphology and the available molecular data are here supplemented with data on nuclear DNA content.

Nuclear DNA content

Nuclear DNA content can conveniently be measured by flow cytometry using propidium iodide, a stain for DNA. Species in a genus can have the same chromosome numbers, but still differ up to 3 times in nuclear DNA content. Genome size has been demonstrated to vary between taxa with identical chromosome numbers (Zonneveld & van Iren, 2001; Zonneveld, 2001).

Plant material was obtained from the collection of K.R.W. Hammett via B.G. Murray and the recently described *C. mirabilis* Rourke was obtained from the author of that species, J.P. Rourke. Where possible, we used material

of known wild origin. For the isolation of nuclei, about 0.5 cm^2 of leaf was chopped together with a piece of *Agave americana* L. with 15.9 pg as an internal standard. After adding propidium iodide solution the suspension with nuclei was filtered and the fluorescence of at least 5000 nuclei was measured. The more DNA in the nucleus the higher the fluorescence.

Genome size

All known *Clivia* species were investigated and if they clearly differ in nuclear DNA amount they are considered to be good species. This does not mean that taxa with identical DNA amounts, must always be considered as constituting a single species. The nuclear DNA amounts should always be evaluated in combination with morphological/molecular data, just as any other taxonomic characters. The species are listed according to a decreasing nuclear DNA content. The genome size in *Clivia* varies between 31.2 and 39.2 pg (Table 1). The DNA values are close suggesting that they are strongly related. This is also indicated by the fact that most species are cross-compatible and produce fertile progeny (Hammett, 2002). The DNA contents of *C. gardenii* and *C. robusta* with 35.7 and 36.4 pg are nearly identical. This suggests that they may be the same species and that *C. robusta* is at most a variety of *C. gardenii*. However, *C. caulescens* and *C. miniata* with 38.7 and 39.2 pg respectively are also nearly identical in DNA content.

The difference between the highest and lowest DNA contents is about 8 pg or 8 x 10^9 base pairs. This should be compared with the change from orange to a yellow flower colour that could be due to a single base pair, something that this method is not able to detect.

It is shown here that *C. mirabilis* has the lowest DNA content, suggesting that *C. mirabilis* can be considered as the most primitive species.The close relationship between *C. miniata* and *C. caulescens* fits with the results of Conrad & Reeves (2002) based on analysis of chloroplast DNA, but not with the results based on analysis of nuclear DNA sequences of Ran *et al.* (2001b).

Grime and Mowforth (1982) suggested that in dry and growth-limited situations species adapt over evolutionary times with an increase in DNA content and a decrease in permanently wet situations. This was confirmed for *Hosta* (Zonneveld & van Iren, 2001), but is not found here in *Clivia*. *C. mirabilis*, growing in the most dry conditions, does not have the highest nuclear DNA content nor has *C. robusta* the lowest DNA content.

Photo: Claude Felbert

Cape Clivia Club Show, Winner Multitepal Class. Owner Eric Heine.

Application

Flow cytometry is a cheap and fast method, up to 25 plants can easily be done in a day. Now the amounts of nuclear DNA are known the species can be distinguished up to a degree.

This makes it useful as a tool for identifying the vulnerable species *C. mirabilis*. Moreover, hybrids of crosses between species can be checked soon after germination, provided the parents are different in their nuclear DNA content. The hybrid will be intermediate between the parents. So one does not have to wait until flowering to know if a cross was successful. Alternatively if the values of the seed parent and the hybrid are known the nuclear DNA content of the other parent can be calculated. Even a single seed can be measured but in that case the plant is lost. I have started now to measure the nuclear DNA content of the *Clivia* relative *Cryptostephanus*. So if anyone has a single fresh leaf available, I would be most grateful.

Table 1: Nuclear DNA Content in *Clivia*

	DNA in pg
C. miniata	39.2
C. caulescens	38.7
C. gardenii	36.4
C. robusta	35.7
C. nobilis	34.7
C. mirabilis	31.2

Acknowledgements
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Photo: Peter Lambert

Northern Club Show Selection.
Owner: Fritz van Schalkwyk

In Search of *Clivia mirabilis* —some Observations from the Wild

Hein Grebe, South Africa

Some two years ago my work involved me in a building project in Clanwilliam, some 185 km due north of Cape Town. This project gave me the opportunity to visit the southern part of Namaqualand, and to do so at least once a month. The country around Clanwilliam is known for its indigenous Rooibos (*Aspalathus linearis*). The farmers deep in the hills harvest the bushes for their leaves, which are dried and used to make a herbal tea which is now sold all over the world. Several hours north of the town, and accessible only by four-wheel drive vehicles, is a mountainous area in which I hoped one might be able to find *C. mirabilis*.

Whenever I was able to get away from my business commitments I took the difficult drive into the mountains to look for suitable *mirabilis* habitat. I soon realised that it would not be easy to trace *mirabilis* on my own. It took hours to climb a mountain and even longer to look for the plants, and my time on each trip was very limited.

One day while lunching with Pieter, a friend and colleague also involved in the building project, I told him about the plant and how important and rare it was. His involvement in the expansion of the Rooibos tea factory in Clanwilliam had brought him into contact with several local business people and farmers. He promised to contact some farmers from the outlying areas if I gave him photos and a description of the plant.

Months later, I received the exciting news that Pieter, through a contact, Johan, who was a farmer as well as an engineer like us, had found people who had recognised the photos and descriptions; yes, they had *mirabilis* on their farms.

I visited Johan one weekend in September 2004. I left Cape Town at 05:00 in the morning to arrive early. He had told me that it gets extremely hot where the plants grow. After speeding like a madman to Clanwilliam I still could not make it to his farm in less than 4 hours. There we met up with his friend Mias, who was to guide us to a farm where *mirabilis* grew. We travelled in a convoy of three four-wheel drive vehicles over some really difficult "off-the-map" dirt roads.

When we finally arrived, the farmer, Izak, was in a hurry to get moving as the temperature was rising steadily to an almost unbearable heat. We worked our way up a hill almost the size of Lions Head, but steeper, to get to the plants. When we got ¾ of the way to the top he led us sideways and then told us to look down through the tangle of bushes. Even at a distance I immediately recognised the *mirabilis*. Upwards through the trees and bushes we saw more plants. We suddenly seemed to be surrounded by *mirabilis*.

Photo: Hein Grebe

C. mirabilis in flower, red / orange form.

Photo: Claude Telbert

Oorlogskloof *C. mirabilis* habitat.

My heart jumped with joy. After almost two years' search I had found what I was looking for. And do you know what? This was the very first time that I had seen *Clivia* of **any** kind in their natural habitat!

We looked for more plants between the rocks and thick bushes. I found some that were coming into flower. From my experience with other *Clivia*, I judged that the flowers would open in one or two' weeks time. Izak told me that he also knew of other populations. Well, I thought, eventually I had met the right person! I had wanted to spend more time with the plants and take photos but we had to leave to escape the heat and prepare for a braaivleis (barbeque) that had been arranged.

Back at the farmhouse I asked Izak as many questions as I could without irritating him. He had discovered the plants way back in 1961, the year I was born. He had removed some plants years ago and planted them at his beach house but they had all died. Does this mean *mirabilis* does not tolerate sea air, or was the soil type not right?

While helping him with the fire he casually mentioned that he had *mirabilis* here at his home as well. When he showed me the plants I realised that I had walked right past them without noticing! One had been planted in a pot more than 15 years ago and another one was planted in the ground approximately 10 years ago. I did not notice at the time that both were single plants, without suckers.

Photo: Hein Grebe

Hein Grebe with a fifteen year old plant.

I told Izak more about *Clivia* in general, showed him photos in the Clivia Yearbooks, and gave him a copy of the article in Clivia 4 by John Rourke about the then newly discovered *C. mirabilis* populations in the Oorlogskloof Nature Reserve, to the north of where we were. I told him that, in my view, there was a huge interest in *mirabilis*, and that I would like to sell his seeds and pollen if possible. I offered to show him how to pollinate the flowers so that more seed would be formed. He showed interest and promised to let me know when the flowers opened.

On my next visit I was able to spend more time with the plants, some of which were in flower. I had expected to come across thinnish red pendulous flowers, similar to the pictures I had seen of the Oorlogskloof populations. But, in fact, I got the surprise of my life. There was so much diversity in flower colour and shape as well as in leaf size. The flowers came in exciting neon-like colours. With the help of my Clivia Colour Chart I identified the darker colours as dark red, red, orange red and watermelon, and the inside as peach. Then there were lighter colours like orange, papaya, salmon and

apricot with peach inside and with green tips. I looked for a yellow, but without luck. However, with this wide colour range I think it is not impossible to find a yellow.

I noticed that they self-pollinate very easily. Numerous small insects were crawling up and down the flowers. I found very few flowers which had not already been pollinated.

Because of the tangled bush it was difficult to get close to the plants. In the process I tore my clothes while trying to protect my camera and other belongings. I carefully pollinated several plants with pollen I had brought with me: variegated yellow, Starlight Light of Budha and pollen from my own and other people's show plants.

Snakes lying in the sun on the rocks were always on my mind, and there were many hiding places for them between the rocks. What makes it more dangerous is that one has to jump from rock to rock to get to the plants. Sometimes the rocks give way under you and then you have to grab the nearest tree while in the same time protecting your camera and other valuables from damage. Away from the rocks it must already have been at least 35°C in the shade, but it seemed cool deep inside the cracks where the *mirabilis* grew. I noticed that they shared the same space with arum lilies (the common calla, *Zantedeschia aethiopica*), which means there must be sufficient moisture there for their needs.

Photo: Hein Grebe

A *Zantedeschia* alongside a barely visible *C. mirabilis*.

Photo: Hein Grebe

C. mirabilis, with a darker flower form.

Photo: Hein Grebe

An unopened *mirabilis*.

I could not help thinking that an arum was not a good companion plant as it is one of the porcupines' favourites, and there are plenty of those spiny creatures in this part of the world. The *mirabilis* could be disturbed in the process of a porcupine looking for an arum lily dish, but I could not find any lying around uprooted. Maybe the porcupines also respected these very special plants!

We examined the plants closely, counted and measured the flowers, leaves, etc. Scapes bore between 38 and 54 flowers. The flower length varied, some were longer than *nobilis*, most were the same length as my *gardenii*, and some were longer. Some plants had short leaves, others had long leaves and it looked as though only 60% or so had the median white stripe in the centre. But what struck me the most was that I could not find a single plant that had made an offshoot.

I remembered that the plants at the farmhouse had not suckered, though they were 10 and 15 years old. Does this mean *mirabilis*

has only one life? At least I knew they could survive longer than 15 years as the plant in the pot looked very healthy indeed.

Here, out in the mountains, there were single plants to be found, but most plants were growing close together, almost in clumps. The next thing that struck me was that I could not find any flowering plants that had also flowered the previous year. It was very easy to see which plants had previously flowered as the old scape was still greenish and intact. In fact, the majority of plants did not even have a current flower scape. Yet, Izak told me that he made a trip into the mountains to see the flowers every year, and that he had not seen so many in flower as this year.

This suggested to me that *mirabilis* is a poor flowerer. I reckon that, at best, it flowers only every third year in the wild. If it flowers, on average, only every 5th year say, then that means it can flower only 2 or 3 times in 15 years. Can this be the reason why it is on the verge of extinction? Its reproduction rate seems to be inferior to that of other *Clivia*.

Nevertheless, all the plants looked very healthy. I could not find any plant with a sign of a fungal disease or of any insect attacks. But the plants were clearly in danger from fire since there seemed to be so much dead dry wood next to them and inside the crevices where they hide. A fire could destroy everything - that's for sure. Another feature that struck me was that I was in a pristine wilderness area. I had not seen a single plant that I recognised as an alien species. Not many farmers in South Africa can say that their farms are alien free.

While we were looking for more plants in flower, I asked Izak and his wife to keep their eyes open for any plants that looked a little different. I think it was the farmers' wife who made the discovery. She called me to look at some lovely flowers but then I noticed something different about the plant's foliage. Yes, it was a *mirabilis* in flower, but the leaves looked like those of a *nobilis* with its typically indented tips. I understand that in some *Clivia* growing areas in the wild, overlapping takes place. *Nobilis* and *miniata*, *miniata* and *gardenii*, *miniata* and *caulescens*, and, I believe, *miniata* and *robusta*. But where were the other *nobilis* plants? I looked again to make quite sure I was right. Yes, the flower definitely looked like that of a *mirabilis*, but the leaves were like those of a *nobilis*. We searched for similar plants, but in vain. Only that one could be found.

That afternoon I was taken to other populations. At one place I saw the most beautiful *mirabilis* - a superior form with large, big tubular flowers that looks like the *C. robusta* 'Maxima'. It was much bigger than the average *mirabilis* and was very vigorous, with leaves 7cm wide. I spent some time pollinating the flowers and then removed as much pollen as I could from this plant.

While on the issue of pollen, I was disappointed time and time again. No matter how early I got up in the mornings to get to the plants, most of the pollen bags were dry and it was extremely difficult to harvest any pollen. One day I started climbing a hill with a flowering population early in the morning, an hour before sunrise, just to find, yet again, most of the pollen dried

Photo: Hein Grebe

A superior plant form.

Photo: Hein Grebe

Photo: Hein Grebe

Variation in flower colour found amongst the populations of *C. mirabilis*.

Photo: Claude Felbert

Photo: Hein Grebe

out. I found usable pollen on only a few plants, placed it immediately in a special cooler bag with plastic ice blocks in it, which I then kept cold until I reached home. I am holding thumbs that this pollen will be viable when I come to use it on some of my best plants when they flower this September.

I left the *mirabilis* populations a happy man, all the time thinking of the *mirabilis* that looked like a *nobilis*, and of the superior 'Maxima'- like plant with the semi-broad leaves.

What I also learned from my visits was that *mirabilis* grows only in selected cool spots on certain sides of a mountain or hill, at around 800-1000 m above sea level. One thing that I picked up was the growth of moss on the rocks and trees, as well as arum lilies sharing the same growing spots. This to me was an indication that at least at certain times of the year there was plenty of water available.

My plan was to re-visit the plants around the end of November/beginning December to see and photograph the development of the berries. However, on short notice I had to go to Cuba on business, and when I returned home on 24th December the holiday season and other obligations made it impossible for me to visit the plants. In March I made appointments with the farmers as I thought that the seed might be ready to be harvested, using the information in Clivia 4 as a guideline. However, my visit took place only on 9th April 2005.

As I drove, I had the vision of full heads of fruit in my mind, and thought about harvesting at least 1 000 seeds. On the other hand, I had read that berries drop from the pedicels as early as mid March. I was indeed glad that I had obtained a permit to sell the seeds I intended collecting.

When we arrived at the farmhouse we wasted no time and, with Izak, headed straight for the first *mirabilis* population. I looked for my special "*nobilis*-like" *mirabilis*. I was disappointed when I saw the plant - only two berries with one seed each. One was a greenish colour, and the other watermelon red. I noticed that the seed heads changed colour from green to yellow, then to yellow with red spots and finally to red. The second discovery I made was that I had pollinated this plant with a Broadleaf Daruma. I should have selfed it. I removed the seed heads and we then decided to split up and collect seeds on our own. It was a perfect autumn day, around 25°C.

It did not take us long to realise that we had arrived too late. Either the heavy rains had washed the berries away, or mice and rats had carried them away after eating the fleshy parts. The berries that we found between the rocks and leaves were fresh and undamaged. Here and there we found a berry still on a flower stalk. The berries looked similar to those of *miniata* or especially *gardenii*. We found only a maximum of 3 seeds per berry, with most fruit containing only one seed. The seed distribution was good with some seeds at least 2 metres away from the nearest mother plant. Other seeds could be found within 60 cm from the adult plant, but the majority of the seeds had disappeared. According to the Izak there were lots of berries on the scapes only two weeks ago. I could have kicked myself for not having come earlier.

While the seed search was on, I discovered plants I had not seen previously, plants with a wide white median stripe of at least 6mm in the centre of the leaves, with two thinner white lines on both sides of the centre white line. After looking around I found a few more. I noticed the difference in leaf length, with some plants with leaves as short as 25 cm and others as long as 60 cm. The width of the leaves varied between 2 cm and 7 cm.

After two hours of searching for seed we decided to visit another population, hoping to have better luck. There we experienced the same problem, we had again arrived too late. We collected seeds for another hour or so while inspecting the plants for diversity, and then called it a day as the sun was almost setting. In all, we collected fewer than 100 seeds. I told them it would not be worthwhile to sell so few seeds and advised them to rather plant the seeds themselves.

I left the *mirabilis* populations with mixed feelings – and with the two seeds of the special "*nobilis*" *mirabilis*. Maybe I should have left them there out on the mountainside as it looked as though the survival rate of small seedlings there must be close to 100%. On the other hand, I hope my *Clivia*-growing skills will pull them through and that they will become big plants one day, like their special mother parent.

Note:
Aliases have been used to protect the identity of the farmers, and hence the *mirabilis* populations. The plants may well be in danger of extinction, but even so it would be unwise to remove them from the habitat as they are in good condition. Strict measures will have to be put in place to protect the *C. mirabilis* in the Western Cape. This is not a simple process and only time will tell whether *mirabilis* will continue to survive on its own in its natural habitat.

Photo Claude Felbert

A distinct single white stripe showing on this leaf.

Photo: Hein Grobe

What a view!

Competition or protection – perhaps both? This is typical of where *C. mirabilis* grows.

Photo: Claude Fibert

Clivia nobilis —Cinderella of the Clivia World

Charl Malan, South Africa

The distribution and ecology of *Clivia nobilis* is well documented and a number of articles on the subject have appeared in previous Society publications. I am going to look at this species, which I regard as the Cinderella of the genus, from a different perspective.

C. nobilis is normally poorly represented at Clivia Shows as well as in the collections of Society members. The reasons for this may be ascribed to the following factors:-

- As it grows very slowly from seed, most collectors probably do not have the patience or time to see through a propagation programme.
- *C. nobilis* is not a particularly attractive plant from a horticultural perspective. Plants removed from the natural habitat have the tendency to die back and may take years to recover, particularly if injured in the process of removal.
- *C. nobilis* is not readily available in the market, even in the Eastern Cape, where it originates.

Photo: Courtesy Mike Christie

A red form of *C. nobilis*

How then do we solve the dilemma of popularising this Cinderella of the *Clivia* world. There may be several ways, one of which is to involve *C. nobilis* in hybridisation programmes. *C. nobilis* has unique features which makes it an ideal candidate for such programmes, particularly with *C. miniata* as a participant. These features are:-

- The number of flowers in the inflorescence. I have recorded 51 flowers in a specimen from a population at Riet River near Port Alfred!
- The leaf structure – A tough, rigid and leathery leaf which is well adapted to variable climates.
- A range of flower colours – from dark red to very light pastel.

From my own experience, crossing *C. nobilis* (pod parent) with *C. miniata* (pollen parent) produces the typical *Clivia cyrtanthiflora* hybrids which most knowledgeable members can recognize at a glance. See Photos 53 and 54 in CLIVIA 2. Conversely, however, hybrids comprising *C. miniata* (pod parent) and *C. nobilis* (pollen parent) result in much more varied forms, colours and shapes.

Although my own breeding programme is in its infancy and is awaiting flowering of an F_2 generation, I have no doubt that there are exciting times ahead and the advantages to be derived will be many. These include:-

- Flowering outside the normal spring season which could open up a totally new flowering window.
- A wonderful colour range.
- Large inflorescences with many flowers of all shapes and sizes.
- Attractive variegated leaves with a different

form to the usual *C. miniata* and Daruma types.

- Hybrid vigour which is often the result of interpecific hybridisation.

The first two characteristics mentioned above were first observed by Miss Gladys Blackbeard during her early hybridisation attempts at Scott's Farm in Grahamstown (see CLIVIA 2: 42).

While the purists amongst us may not like all this talk about hybridisation, such work opens up new horizons, and if in the process it can turn a Cinderella into a pretty and desirable Princess, let us enjoy it.

Photo: Charl Malan

C. miniata 'Vico Yellow' x *C. nobilis*

Two examples of *C. miniata* 'Shima Fu' x *C. nobilis*

Photo: John van der Linde

F_2 *C. miniata* x *C. nobilis* cross. Breeder: Jim Holmes; Owner: John van der Linde.

The Clivia at Mbashe

Allan Tait, South Africa

From my earliest days, South Africa's flora has interested me. I started my horticultural career in the Eastern Cape where I met the botanical artist Auriol Batten, who fostered my interest in exploring the indigenous flora of this region.

After leaving this beautiful part of the world I went back to Pretoria and in 1996 I was awarded the Kirstenbosch scholarship. Here I was introduced to the finer details of botany, as opposed to horticulture, by Ernst van Jaarsveld and John Winter. John, the then curator, aroused my interest in the genus *Clivia*.

It became my mission to visit as many field localities of *Clivia* as possible and it was on one of these expeditions to the Transkei/ Border region that I came across the interesting plants at Mbashe. The Mbashe river feeds into the sea at The Haven on the Wild Coast, about half-way between Port St Johns in the north and East London in the south. I stayed across the river, in a traditional rondavel with minimum luxuries. This entailed carting drinking water from a couple of kilometres away!

Photo: Allan Tait

Vegetation on the banks of the Mbashe River.

On my first day in the forest, I approached from the river side and immediately realized what a spectacular place it was, with the beautiful forest form of *Stangeria eriopus* abounding and it was not long before I found the first stands of *Clivia* occurring in great profusion. The plants, however, did not look like the usual plants that I have encountered in similar areas along the Wild Coast, including the Kei River.

Photo: Allan Tait

A broad-leafed *Clivia* from the same population as the narrow-leafed *Clivia* below.

Photo: Allan Tait

I started investigating and the difference soon became apparent. The foliage of the plants in general was far more robust. Some specimens had long, narrow leaves, in sharp contrast other plants, where the leaves were also long but broad. The margins of the leaves were also variable and some were sharply serrated and the apices were often emarginate. In many, there was a small acute apex within the dent of an emarginated apex. Flower

colour was very variable, unlike the very uniform colour of the plants in the stands that I encountered on the Kei. However the most profound differences were to be found in the fruit. The berries displayed a wide variety of colour, from yellowish orange to deep crimson red. Even more remarkable was the fact that despite their size they each contained only one, to a maximum of three, very large seeds!

Photo: Allan Tait

A natural hybrid?

The picture at once became clear to me. Natural hybridization has taken place between *C. miniata* and *C. nobilis*. To prove this, I had to find *C. nobilis*. I climbed higher and the vegetation changed, with the forest becoming less dense and drier. *C. miniata* were still to be found but in smaller numbers. Suddenly I found the first *C. nobilis* plants of a declining population growing amongst *C. miniata*. This was a great find because, although the flowering times of the species overlap, they are rarely found growing together like this.

The mystery now deepened and I decided to revisit the site in June / July to see if I could find any natural F_1 hybrids (*Cyrtanthiflora*-type) in bloom. I returned in June but to my great disappointment, there were none.

I now had to rethink whether these were indeed hybrids or not. With no visible evidence of hybrids present I re-formulated my theory. After finding the first *C. nobilis* plant, I discovered that it was part of a population that was declining due to excessive collection of material for traditional herbal medicine "muti". After the initial F1 cross, could not hybridizing in many successive generations have produced plants with flowers that resemble *C. miniata*, with great variation of colour in the same stand, and also with distinctive foliage and fruit?

Further research in this population could well lead to the finding of F_1 hybrids. Material of these plants was forwarded to Kirstenbosch, where with advanced genetic technology the true state of affairs might well be revealed.

I would like to thank Dr. Auriol Batten and Dianne Batten for reviewing my text.

Interspecific hybrids often flower in winter, so a return visit to Mbashe in June to look for F_1 hybrids showing signs of flowering makes good sense. John Rourke found natural hybrids between *C. miniata* and *C. caulescens* in flower on his mid-winter visit to the Bearded Man mountains, as he described in his article in CLIVIA 3. The collectors may well have taken any pendulous flowering plants as *C. nobilis* is prefered to *C. miniata* since nobilis is perceived to be the "more powerful muti". **Eds.**

Photo: Mark dorset

Apple Blossom complex, first time flowering from seed. Owner: Ian Brown

Clivia miniata 'Bella Donna Oprah'

A rose by any other name smells as sweet, but nothing can be sweeter than when an unusually beautiful, rare flower is named after you. One such flower, a *Clivia miniata*, was recently named after Oprah Winfrey, to commemorate her 50th birthday. The name given to a special cultivar of this species, endemic to South Africa and Swaziland, is 'Bella Donna Oprah'.

Bred by Bertie Guillaume from Makhado (previously known as Louis Trichardt) in the Limpopo Province, the plant was chosen by a panel of judges consisting of the editor of the Oprah magazine, South African edition, and representatives of the Clivia Society.

Photo: Courtesy Bertie Guillaume

Clivia miniata 'Bella Donna Oprah'.

Although several breathtaking entries were received, the judges were unanimous that Bella Donna, which means "beautiful lady" in Italian, was the winning plant.

"In fact, when we chose this specific clivia, we did not know that Mr.Guillaume's unofficial name for his plant was Bella Donna. Adding Oprah's name to Bella Donna made perfect sense for this stunning flower," said O Magazine SA editor Kgomotso Matsunyane.

"It would have been inappropriate to name a clivia after Oprah without being able to present her with a specimen of the winning entry," said Chris Vlok, chairperson of the Clivia Society.

It was therefore a requirement of the competition that all entries have an offshoot that could be presented to Oprah. Another rule was that the owner of the winning entry should start a breeding programme to develop a "Bella Donna Oprah" *Clivia* strain.

During a recent visit to a taping of the Oprah Winfrey Show in Chicago, Matsunyane presented Winfrey with a photo of the Clivia Miniata named for her. An offshoot has been sent to her home in California, as a birthday gift from O Magazine SA.

"The meeting with Oprah meant a lot to me because it was my first opportunity to meet Oprah in person. I got the opportunity to tap into her energetic spirit and share ideas on how to enhance O in South Africa. We also announced to Oprah the naming of a *Clivia*, endemic to South Africa and Swaziland, after her in celebration of her 50th birthday," said Matsunyane.

"We had an absolutely amazing time at the show and were completely blown away in true Oprah style. Watching the taping of the show was definitely the highlight, and we were all very surprised when Oprah welcomed and introduced our South African delegation to the studio audience – a memorable moment indeed," Matsunyane said.

Adapted from an article "Flower for a beautiful lady" by Kashiefa Ajam in the Johannesburg "Star", Saturday 6 November 2004.

2004 Show

Photo: Peter Lambert

Best on Show, Northern Clivia Club. Owner: Norman Weitz.

Runner-up, Norther Clivia Club. 'Pat's Peach', Owner: Pat Gore.

Photo: Peter Lambert

Selection

Photo: Clive Graham

Best on Show, KwaZulu-Natal Clivia Club. Owners: Edsel & Brenda Nuss.

Runner-up, Northern KwaZulu-Natal Clivia Show. Owners: Clive & Ebb Graham.

Photo: Clive Graham

Photo: Charl Coetzee

Best on Show, Eastern Cape Clivia Club. Owner Charl Malan

Photo: Clive Graham

Runner-up, KwaZulu-Natal Show.
Owner: Conrad Vermaak.

Photo: Claude Felbert

Runner-up, CCC Show. Owner Mick Dower.

Runner-up, JCC Show. Owner: Chris Viljoen

Photo: Kevin Mansfield

Runner-up, ECCC Show. Owner: L. De Beer

Photo: Charl Coetzee

Photo: Clive Graham

Best on Show, KwaZulu-Natal Garden Show. Owner: Sean Chubb.

Photo: Courtesy NZCC

From the New Zealand Show, a varie gated Daruma
Owner: Keith Hammett.

Photo: Courtesy NZCC

From the NZCC Show an F_2 Hybrid.
Owner: Terry Hatch.

Photo: Courtesy NZCC

From the New Zealand Show, a Variegated Red.
Owner: Tony Barnes.

Photo: Kevin Mansfield

Best on Show, Jo'burg Clivia Club. Owner: Dawie Strydom

Photo: Courtesy GRCC.

Runner-up, Garden Route Clivia Club Show, 'Charls Green'. Owner: Charl Coetzee.

Photo: Claude Felbert

Best on Show, Cape Clivia Club. Owner: Coen & Diné Calitz.

Photo: Courtesy GRCC.

Best on Show, Garden Route Clivia Club. Owner: Gerrit van Coppenhagen.

Clivia robusta — the "Swamp Clivia"

Keith Hammett, New Zealand

Every person on earth has an individual view or paradigm of the world. Such paradigms are influenced by the culture in which we are raised, our education and by individual experiences as we pass through life. Problems often arise when discussing a topic if we do not check out the other person's understanding, or we do not clearly explain our own.

It is clear to me that there are several quite different concepts of what constitutes a species. This was brought home to me when I posed the question "what is a species" to a meeting of a Rhododendron Society. The consensus answer was "a weedy version of the nice hybrids we grow".

As a botanist / plant breeder, this was an eye-opener for me as I realised that had I not asked the question I would have talked right past my audience. Similarly, if we are to discuss *Clivia* species, we must first establish some common ground.

Clivia is a small genus confined to Southern Africa. I feel that there is sufficient evidence to believe that the species that constitute the genus have evolved over time from ancestral types, rather than having been created at a single point in time by a supernatural force.

This distinction is critically important. If someone happens to believe in Creation, it is likely that they will see species as entities waiting around for us to discover and to give them a name. This is rather like a sculptor who sees his role as liberating a form that already exists within a block of stone or wood. Such a view is essentially static and species are likely to be seen as being well defined and capable of being fitted into neat pigeonholes. In contrast, the evolutionary view is fluid and in consequence defining the limits of a species is seen to be more a matter of opinion based on an accumulated body of information.

If we take *Clivia miniata* as an example, the work of John Winter and others, who have spent much time looking at populations in the wild, has shown us that there is a lot of naturally occurring variation within this species. I chose *C. miniata* deliberately because, as it has the single trait of having upright flowers, there is seldom much dispute about its identity, despite exhibiting considerable variability in floral and leaf characteristics.

Variability is extremely important as it encompasses many physiological traits in addition to morphological and pigment variation. Without adequate inherent variation, plants and animals are unable to survive and adapt as the climate changes. This same variability is equally important to the plant breeder.

Often the term **gene pool**[1] is used to describe the range of variability that we have gathered together in our collections. In using this term it will be seen that there has been a shift in focus from whole plants to the genes or chemical entities that code for the characters we see. A breeder's gene pool is akin to a painter's box of paints.

An extension of this train of thought is the paradigm encapsulated by the term **germ plasm**. Here the genetic material is seen as a river flowing through time and all the plants and animals that exist at any point in time are simply manifestations of this. The idea was first put forward by the German, August Weismann, towards the end of the Nineteenth Century.

[1] I note a tendency in commercial circles for people to talk about a breeder's **genetics** rather than gene pool. This is a misuse of the term.

Conceptually this idea is very helpful to plant breeders and evolutionary botanists alike. I like to think of a genus as a bank of cumulus clouds moving across the sky. **The act of a cloud breaking into two separate clouds is analogous to speciation in nature. Similarly, when clouds aggregate together this is analogous to species being crossed in cultivation to form hybrids.** With this model, you will realise that the clouds making up the genus have many characters in common, and whether clouds are seen to still be connected or are separate will depend to a large extent on viewpoint.

Hopefully having established some common ground, it is now appropriate to discuss the recent establishment of the taxon *Clivia robusta* (Murray *et al.*, 2004). Most of the background to this was discussed in CLIVIA 3. Little has changed since that time except that a few additional accessions have been positively identified as being *C. robusta*, while South African botanists Truter and Swanevelder have added to our understanding of the natural distribution of this taxon.

Over time different pieces of information in addition to plant shape have been taken into consideration when delineating a species. For instance, chromosome numbers and biochemical data have been used for various genera. Increasingly DNA data are being used.

Between 1996 and 2000 Dr Yidong Ran completed a cytogenetic analysis of the genus *Clivia* as a PhD study here in Auckland jointly supervised by Professor Brian Murray and myself. This was made possible as I had brought together an extensive collection of both *Clivia* species and hybrids from around the world.

In this collection were some plants originally given to me as seed by Graham Duncan at Kirstenbosch following the inaugural Clivia Conference held in 1994. These plants were referred to as a robust form of *C. gardenii*. Initially the seedlings looked pretty much like those of any other *Clivia* except *C. nobilis*, but as they became older the plants stood out from anything else. They were very vigorous and with a tall stiff habit and rounded leaf tips quite distinct from the very pointed lax leaves of *C. gardenii*, although they did have the pale green almost white lower leaf surface that one associates with *C. gardenii*.

As shown in our scientific paper which was reprinted in CLIVIA 2, it is possible to identify the different named species of *Clivia* on the basis of banding patterns that develop when the chromosomes are stained in various ways.

When Yidong looked at the chromosomes of the "Robust *gardenii*" he found that while the banding pattern was closer to *C. miniata* and *C. gardenii* than to *C. nobilis* or *C. caulescens*, it was distinguishable from both.

We hear much about DNA analyses and fingerprinting in connection with forensic work and criminal trials. Similar techniques are available to plant scientists and Yidong used two distinct methods, random amplified polymorphic DNA analysis (RAPD) and DNA sequencing. Two regions were sequenced, the internal transcribed spacers (ITS1 & ITS2) of nuclear ribosomal 45S DNA and the non-transcribed spacers between the 5S RNA genes. When these methods are combined with appropriate statistical models it is possible to estimate how closely related different species and varieties may be. Our DNA analyses showed that "Robust *gardenii*" was distinct from the four species already named but was most closely related to *C. gardenii* and *C. miniata*.

Correspondence with John Winter at Kirstenbosch established that the original accession of "Robust *gardenii*" had been collected by Kobus Eloff from the Wild Coast. Dr John Rourke of the Compton Herbarium at Kirstenbosch, in a letter dated 13 March 2000,

Photo: Courtesy Sean Chubb

C. robusta

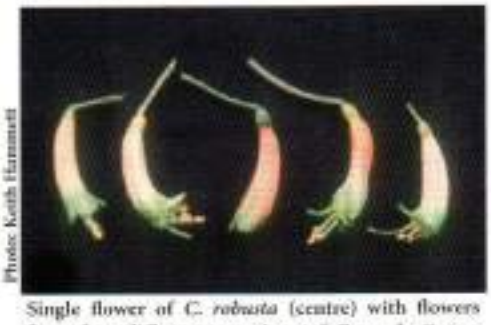

Photo: Keith Hammett

Single flower of *C. robusta* (centre) with flowers from four different accessions of *C. gardenii*, two on each side, showing the clear difference in stamen exsertion between the two species

Courtesy SANBI collection

Plate 2094 from Flowering Plants of Africa, 53 (1994) incorrectly identified as *Clivia nobilis*. Artist Claire Smith.

indicated that he had recognised it as a distinct entity based both on its morphology and habitat and referred to it as the "Swamp Forest *Clivia*". He provided details of herbarium specimens held at the National Herbarium in Pretoria and at Kirstenbosch and he indicated that geographically its distribution fitted in between *C. nobilis* from the southern Kwazulu-Natal and the Eastern Cape and *C. gardenii* in Natal. He went on to say, "Most of the populations I am aware of are situated between Port St Johns and Umtamvuna at Port Edward. Ecologically it is very distinct and is mainly found in swamp forest - those patches of *Syzigium* forest, like islands in the grassland which are situated in depressions and fill with water during summer. Thus the Swamp Forest *Clivia* is semi-aquatic standing in 6-9 inches of water for several months. It also occurs along river banks in the area. Flowering takes place in June and July. This is the same species we collected at Mkambati in a swamp forest west of the Mtentu River (my no. 2145).

The leaves tend to be pale green, rather fleshy and flaccid and the flowers tubular orange-red. There are notes on the National Herbarium specimens written by Prof. Olive Hilliard indicating that it does not fit the *nobilis* or *gardenii* concepts, but she abandoned the problem at that point. Unfortunately, it was illustrated in colour in Flowering Plants of Africa plate 2094 in 1994 under the incorrect name *Clivia nobilis*. The plate is a very poor one confusing the matter even more".

This communication from John Rourke was especially valuable as it confirmed that a plant that Yidong had been able to identify at the genomic level had been recognised as being distinct in the field. It also explained why the description of *C. nobilis* published in 1994 differed so markedly from what most of us in the Clivia Society understand to be *C. nobilis*.

A coincidence with regard to the receipt of John's letter was that one of the herbarium specimens of the "Swamp *Clivia*" to which John referred was collected by Fanie Venter in 1976. Fanie now lives in New Zealand and happened to visit me on the very day that I received distinct material of a caulescent form of *C. gardenii* from South Africa and Fanie was able to examine it and discuss his knowledge of the "Swamp *Clivia*".

John Rourke pointed out that while he felt sure the plant was a distinct taxon, before formally naming it more needed to be known about its distribution and ecology. I was fortunate in June 2000 to be able to travel with John Rourke, John Winter and Brian Tarr to look at the "Swamp *Clivia*" in habitat and to collect seed from separate populations in KwaZulu-Natal.

After returning to New Zealand I was able to raise seedling populations of these collections and Yidong was able to confirm that three of them have the same chromosome staining pattern as the original Eloff "Robust *gardenii*".

Possibly the first record of the plant was that made by W.L. Chiazzari in 1943 who made notes on a plant which could not be fitted into one of the named species of *Clivia*. While visiting South Africa for the Second International Clivia Conference in 1998 Nick Primich showed me a plant owned by Pat Gore. This was a very large plant which could not be assigned to any of the then recognised species, but was informally being called "robust *nobilis*". After sterling efforts by James Abel and many subsequent trials and tribulations, I was able to get an offset of Pat's plant as far as quarantine confinement here in New Zealand. Yidong was able to determine the chromosome staining pattern of the plant which enabled us to identify it as what we now call *C. robusta*.

It has been demonstrated that all the named species except *C. mirabilis* (because that was not available to us) can be recognized both by gross morphology of the whole plant and by chromosome and DNA characters. In the case of *C. robusta*, the most obvious feature is the sheer size of the mature plants and their ability to grow in both running and stagnant water as well as in better-drained situations. When grown in damp conditions prominent prop or stilt roots are developed. Leaves are broad with rounded tips and contrast markedly with the narrow tapering leaves of *C. gardenii*. Like the other pendulous species except *C. gardenii* the stigma and stamens are essentially retained within the flower tube. Accessions of *C. gardenii* are notable for the protrusion of these organs.

The distribution of *C. robusta* has been shown to be endemic to Pondoland and to be separate from that of *C. gardenii*, which is recorded only from the Durban area northwards.

I have been asked why we did not try to locate the type herbarium specimen of *C. gardenii* as described by Hooker in 1856 and compare the DNA of this with living material of *C. robusta*. All our work was done with living plants. An adequate number of distinct living accessions for each species was used and these were identifiable both by concurrence with accepted morphological descriptions for each species and their karyotypes.

In the course of the work, the "Swamp *Clivia*" was seen to be distinct, both morphologically and by karyotype from the other taxa. I went to considerable personal expense to ensure that an adequate number of different accessions was obtained and tested. Four different DNA/phylogenetic tests confirmed that the "Swamp

Clivia" was distinct from the then known species. *C. mirabilis*, which was described subsequently, is based only on morphological and geographic criteria.

C. gardenii was described 149 years ago. Presumably a herbarium specimen was prepared somewhat earlier than this. As the plant was first grown at Kew, this presumably would be the place to look. Whether it would be possible to get permission to borrow and to make DNA samples from a type specimen is a moot point. It is also a moot point whether after 150 years the DNA had degraded or not and whether a comparison between fresh and long dried material would be valid.

Hooker's original description and illustration closely match the accessions that we have determined to be *C. gardenii* and are quite distinct from *C. robusta*.

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Table 1. Summary of the key differences between *Clivia gardenii* and *C. robusta*

Morphology	*Clivia gardenii*	*Clivia robusta*
Habit	Gracile plant, strongly clump-forming, ±1 m in height	Massive plant with stout rhizome, often with prop roots, ± 2 m in height
Leaves	Linear-acuminate, strongly sulcate in cross-section	Broad, strap-shaped with with obtuse-apiculate apex, planar in cross section
Flowers	Stigma and stamens strongly exserted	Stigma barely protrudes and stamens usually retained within corolla tube
Karyology	45S rDNA site + C-band on chromosome 2 45S rDNA site but no C-band on chromosome 2 No 45S rDNA site or associated C-band chromosome 8	45S rDNA site or associated C-band chromosome 2 45S rDNA site + C-band on chromosome 8
Distribution	Widespread in KwaZulu-Natal	Confined to Pondoland Centre of Endemism

Notes on the sketch of *C. robusta* by W.L. Chiazzari .

We are indebted to Mr W. L Chiazzari for permission to reproduce his sketch, shown here. An extract from a letter that he wrote from Pietermaritzburg on 14 July 1965 to the National Herbarium, Pretoria, is set out below:

"The Clivia was taken from a small patch of isolated swamp forest growing in dense masses beneath the trees. I first located this same group of Clivia in 1943 when I was serving with the S.A.A.F. during the last war and had been sent with No. 29 Squadron to a landing strip named Lombazi approximately 1 mile from this patch of forest. A coloured sketch was prepared from a flowering head at the time, and is still in my possession. However about four years ago, I again visited the areas and brought back a number of plants, one of which I took to the Herbarium, Botanic Gardens, Durban, from where it was consigned to your Department in Pretoria for identification by a Miss Johnson. To this date I have not heard as to the identity of this species.

The main characteristic of this species is the procumbent or semi-procumbent stem more than 18" long and with leaves strap shaped, forming a plant on an average of well grown plants 4'9" - 5'0" height. The heads contained between 22-35 flowers each. From available literature, it does not appear to be C. gardenii which has from 10-14 flowers in an umbel nor is procumbent, as far as I am aware. This also applies to C. nobilis which is also diminutive by comparison. The description of C. caulescens nearest meets the description except for its locality and fewer flowers.

I have successfully grown and flowered plants in my plant houses at Richmond. I should be pleased to forward another plant to your Department should the original be mislaid or the species be of interest?" Eds.

Courtesy W.L. Chiazzari

C. robusta by W.L. Chiazzari, 1943.

C. robusta seed.

Photos: Courtesy Sean Clubb

A Red form of *C. robusta*

Photo: Keith Hammett

A *C. robusta* inflorescence.

Clivia robusta 'Maxima'

Roger Dixon, South Africa

A plant which catches the eye is Fred van Niekerk's 'Maxima'. Known to him from his mother's garden from the early 1930's, he collected this form of *C. robusta* from the Umtentu River Valley, near the sea, in the Bizana District of Pondoland in the Eastern Cape Province in 1989. This stunning geographical variant has up to 49 flowers per umbel which can be up to 20 cm across, and appears to be at the one end of the *C. robusta* spectrum.

The southernmost populations of *C. robusta* occur in the Lusikisiki, Flagstaff and Bizana areas and are differentiated from the plants to the north near Port Edward by having many short broad flowers, a light stripe down the middle of the leaf and a slightly serrated leaf edge. Those from Port Edward northwards look more like *C. gardenii* with fewer, long narrow flowers. It appears that although they are genetically distinct from *C. gardenii* and *C. nobilis*, where they grow closer to *C. gardenii*, they tend to look more like them and similarly at the southern end of their distribution they are more like *C. nobilis*. *C. robusta* generally are bigger plants with higher flower counts, broader, longer and lighter green leaves than *C. gardenii*, with leaf tips which are more rounded and in the south sometimes notched as in *C. nobilis*.

Photo: Roger Dixon

One of Fred van Niekerk's 'Maxima' plants.

An unusual feature of Fred's 'Maxima' plants is that when selfed they produce up to 10% albino progeny, and none of the parent plants are variegated. A possible reason for this is that many populations of *Clivia* in the Pondoland area are fragmented and isolated into narrow gorges, and this geographic constraint might act as a barrier to cross-pollination with other populations, eventually leading to a preponderance of recessive genes, such as albinism. One of Fred's plants puts forth a split peduncle each year with two umbels, one below the other.

Photo: Roger Dixon

This 'Maxima' plant produces split peduncles each year. Each peduncle produces two umbels, one below the other.

Clivia gardenii – Autumn's Delight

Brian Tarr, South Africa

History

Clivia gardenii was discovered and collected by Major Robert J. Garden of the 45th Regiment. He collected specimens while stationed in the Colony of Natal and sent them to the Royal Botanic Gardens at Kew. It was here that Sir W. Hooker named the new species *Clivia gardenii* when it flowered in 1856, in honour of the collector.

Distribution

Clivia gardenii occurs in the forests and forest patches of Pondoland and KwaZulu-Natal from near the coast to an altitude of 1200 m on south- and southeast-facing slopes in shale or sandstone-derived soils. From personal observation, it is possible to identify four main areas where *C. gardenii* occurs:

- Durban / Pietermaritzburg / Stanger
- Southern KwaZulu-Natal and Northern Pondoland
- Eshowe
- Vryheid / Louwsberg

C. gardenii is one of six species of *Clivia* found in South Africa, the others being: *C. miniata*, *C. nobilis*, *C. caulescens*, *C. mirabilis* and the most recently described *C. robusta*, previously known as the 'Swamp *gardenii*'.

C. gardenii is concurrent with *C. miniata* in all regions. It is often confused with (and sometimes sold as) its more southern sister, *C. nobilis*, the main differences being in the arching, soft, pointed leaves in *C. gardenii* as opposed to semi-erect leathery, notched leaves in *C. nobilis*.

Flowering time for *C. gardenii* is from early to mid winter when heads of 10-25 pendulous or semi pendulous green- or, infrequently, yellow-tipped flowers appear. The overall colour is variable, ranging from pale yellow to deep red.

Courtesy SANBI collection

Clivia gardenii from Ngome Forest by Cythna Letty from *Flowering Plants of Africa* 42, (1972).

Durban/Pietermaritzburg/Stanger

This region comprises Stanger, Hillcrest, Pietermaritzburg, Karkloof, Greytown and and is generally referred to as the 'Midlands'. The plants here are 900mm – 1200mm tall with lax, deep-green pointed leaves loosely clasping

Photo: Brian Tarr

'Green Ivory' from KZN Midlands.

the base. They seldom develop significant, taller, stems and can occur in large colonies in moist as well as dry habitats. Flower colour is variable in this region from red with green tips in the Greytown area, blush yellow and green around Harburg and pale red and green in the Hillcrest area. The flowers are held semi-erect on the umbel and are well spaced with between 15-25 per head.

Photo: Brian Tarr

'Green Blush' from Ngome Forest, Northern KZN.

Southern KwaZulu-Natal and Northern Pondoland

Two pendulous forms are found in this area, both flowering in early to mid-winter. Both were previously regarded as being forms of *C. gardenii*. Their habitats are quite different.

One form, known for many years as the 'Swamp *gardenii*', is significantly the larger and has recently been named *C. robusta*, the sixth *Clivia* species. It is always found in or near swamp forests, certainly not far from water. Its flowers come in a range of colours from cream to red.

The other form is smaller, and is found in drier areas, usually amongst rocks. Unlike *C. robusta*, with its range of colours, the flowers of these

Photo: Brian Tarr

Pink form from Southern KZN.

plants are generally only a brick red with green tips. No other colour forms have been found.

They also differ in several respects from the geographically closest *C. gardenii* form, the 'Midlands' form. The leaves have a rounded tip as opposed to the acutely pointed tip of the 'Midlands' plants. A plant collected in the Port St Johns area has leaf tips with a distinct indentation, similar to those of *C. nobilis*. The leaf colour tends towards a grey-green to light green and tightly clasps the stem. Also, the flowers do not have the flared tepal tips found in the Midlands form, nor do they have the range of colours.

Photo: Brian Tarr

'Boogie' from Southern KZN.

On the face of it, these plants seem to me more like a form of *C. gardenii* than a form of *C. robusta*, though Hammett *et al.* state that *C. gardenii* occur only to the north of the Durban area, and that

Photo: Brian Tarr

Leaf tips from Southern KZN.

the plants in southern KwaZulu-Natal and N. Pondoland are all *C. robusta*. In my view, more field work in this area could prove rewarding.

Photo: Brian Tarr

'Harburg Blush' from KZN Midlands.

Photo: Brian Tarr

A good colour form from KZN Midlands.

Eshowe

Plants from this region tend to be somewhat smaller than the 'Midlands' form, ranging in size from 300mm-500mm and averaging 10-15 flowers per umbel. The flowers are held sub-erect and are brick red with flared green tips. With further exploration of the region it is likely that populations of *C. gardenii* could be found in the Lebombo Mountains.

Vryheid / Louwsberg

Plants from this region are distinct in that they have a growth form which differs from the norm in that a well defined 'stem' is formed by the leaf bases tightly clasping the rhizome, giving the young plant an "onion-like" appearance. The plant develops a stem similar to *C. caulescens*. The leaves are 700mm-900mm long, with a pointed tip, less acute than the 'Midlands' form. Flower colour is predominantly a yellow/rose pink with green tips although green tipped

Photo: Brian Tarr

C. gardenii var. *citrina*.

pink/red flowered plants have been found. The plant bears large umbels of between 20-35 sub-erect flowers. The umbel is held well above the

Photo: Brian Tarr

'Jade Ivory' from KZN Midlands.

Photo: Brian Tarr

Red form from Ngome Forest.

leaves. Yellow-flowered plants from this region have recently been described and published as *Clivia gardenii* var. *citrina*.

Conclusion

C. gardenii, rather like *C. nobilis*, is viewed as very much the poor relation behind its more flamboyant sister *C. miniata*. Undoubtedly there are poor forms of *C. gardenii* but nevertheless it has much to offer both the enthusiast and the gardener in that it flowers at a time when colour in the garden and shade house is in short supply, there are a number of colours and forms to add variety, and it is not as susceptible to lilyborer attacks. It is a plant that deserves a place or two in every collection and garden and we look forward to a time when *C. gardenii* shows are held throughout South Africa.

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Photo: Brian Tarr

'Greeney' – from Ngome Forest

Yellow *Clivia miniata* from the Habitat

Fred van Niekerk, South Africa

There has been much confusion over the last century or more as to the status of the yellow-flowering *C. miniata*. The first record of a yellow *C. miniata* was in a note in a German gardening journal in 1888, reporting a novel yellow form displayed at a show. The first recorded example from habitat was discovered that same year. Subsequently, a number of yellow-flowering wild plants have been found and more have arisen in cultivation. Many of these clones have been passed along from one person to another, and along the way have acquired different names, which has given rise to much confusion, especially when directed breeding using these yellow plants has been attempted. The existence of different mutations, each resulting in yellow flowers, has been identified (e.g. Group 1 and Group 2, although there are more), and therefore when breeding is attempted, it is important to be able to identify similar plants.

I have personally visited many of the people and locations from where the various habitat yellows have been found in an attempt to unravel the name confusion, and to ascertain which plants were in fact from habitat and which have arisen in cultivation. Where this has not been possible I have consulted with a number of knowledgeable *Clivia* enthusiasts and the result of this investigation is presented below. I have not included all the details, but have provided a brief summary describing where each plant originated from, who found it and when it was collected, together, where possible, with a photograph. All the information, to my knowledge, is accurate – many stories were found to be either confused or inconsistent and where such information was not able to be confirmed, it was not used.

Painting of *Clivia miniata* var. *citrina* Katharine Saunders (Bayer, 1979).

Clivia miniata was already well-known in cultivation in England, Belgium and elsewhere in Europe, having been discovered in the early 1850's. The first yellow came to light in Eshowe, KwaZulu-Natal, around 1888. It was found by a Zulu cook of Sir Melmoth Osborne (the Resident Commissioner at Eshowe) while collecting firewood in the Hlinza Forest, Eshowe. Plants were given to Sir Charles Saunders, who in turn sent a plant and an inflorescence to his mother, Katharine Saunders. She made a watercolour painting of the inflorescence, which in turn was sent, together with a plant, to Kew Gardens.

An extract from the book "Flower Paintings of Katharine Saunders" reads: "Yellow *Imantophyllum* from Eshowe, flower withering after being two days in post bag. Most lovely,

delicate, peculiar shade of yellow, not orange, but like straw-colour mixed with pink, quite inimitable by me. October 8th, 1893. This drawing has been sent to Kew with the bulb by Maud." (Katharine's daughter.). *Imantophyllum* was an earlier name for *Clivia*. *Clivia miniata* is one of the most striking and best known of all Natal flowering plants, occurring in all forests from Port St. Johns to Zululand and from the coast to the Midlands. The flower colour varies from cream through various shades of yellow and red to dark red. Some of the yellow flowering heads are truly magnificent. It is little wonder, therefore, that Katharine Saunders was delighted with what was apparently her first view of these flowers. The plant sent to Kew by Maud Saunders was successfully established and flowered under glass in one of the greenhouses (Bayer,1979). The plant was later described and published as *C. miniata* Regel var. *citrina*.W. Watson 1899.

Mrs. M.M.R. Robinson, the daughter of Sir Charles Saunders, inherited his plants and continued growing them in Pietermaritzburg until the mid 1960's. Sir Melmoth Osborne's plant was grown by Mrs. Essie Osborne, whose husband was a nephew of Sir Melmoth. One of these plants was given to Mrs. Joyce de Villiers of Manderston outside Pietermaritzburg by her father Mr William E. Marriott, curator of the Pietermaritzburg Botanical Gardens from 1906 to1910.

'Mare's Yellow'

This well-documented yellow clone was grown and sold by Miss Grace Mare from her home, "Silver Oak", Mare Street, Howick. The original plant was collected from the foot of the Howick Falls in 1891. When Miss Mare left Howick, she gave her plants to Mrs. A. D. Tanner who grew them at her home in Blackridge, Pietermaritzburg. She described these plants as having dark green narrow leaves and the flowers a clear, deep, butter

Photos: Sean & Terri Clubb

'Mare's Yellow'

yellow with no trace of orange (or green). She tried self-pollinating them but the resulting plants were all orange with more yellow in the throat than her other plants. Clones of this plant can be found in many gardens in Howick and Karkloof.

'Dwesa Yellow'

This plant was collected from the Mbashe River mouth prior to 1939 by the Wood family who owned a trading post in the Transkei (Eastern Province). The plant has been in the family for some seventy years. These details were given to Dr Bing Wiese of Pretoria some fifteen years ago when he obtained a piece of the plant from the Wood family. Robert Moss (son-in-law of the late Eric Dodd of Pioneer Nursery, East London.) states that a piece of this clone was given to Eric by a trader's wife in the early 1980's and is still being grown at the Pioneer Nursery. The plant has an extremely beautiful, small light-

Photos: Sean & Terri Clubb

'Dwesa Yellow'

cream full bloom. Upon self-pollination the plant produces berries each with a single large seed. Despite their large size the seeds germinate poorly, grow very slowly and only orange-flowering plants are produced.

'King Hamelin Yellow'

This clone was collected by Mr. King Hamelin on his farm in the Darnell area of KwaZulu-Natal approximately thirty years ago. King Hamelin was a conservationist and arranged walking tours through the natural bush occurring on his farm. The highlight of these tours was to view the clump of yellow *Clivia* growing in the bush. This *Clivia* clone has been distributed to a fair number of people but is still little-known. The plant offsets fairly well, has medium to broad leaves that are pale green and is fairly susceptible to stem rot. The good flower with overlapping petals has an attractive deep yellow colour.

'Byrne Valley Yellow'

Photo: Sean & Terri Chubb

'Byrne Valley Yellow'

Mrs. Mary Hosking collected this plant in the Byrne Valley between 1925 and 1935, and planted it in her garden at Etterby. After her death the plant was moved to the garden of Mrs. Pam Pottow, her daughter. The plant is considered a family heirloom and is thus undistributed. It has an attractive bright, star-shaped yellow flower.

Photo: Fred van Niekerk

'Natal Yellow'

'Natal Yellow'

The late Cynthia Giddy collected this plant on a farm in the Bainesfield area near Richmond, in KwaZulu-Natal. This plant, which is the true 'Natal Yellow' as named by her, was **not** the plant described and recorded by Kirstenbosch as 'Natal Yellow' - that was 'Cynthia's Best', described below. The spread of the 'Natal Yellow' throughout South Africa was partly due to a friend of Cynthia's, Anna Höll, who bought a plant from her at the end of September 1978, and grew it in her garden in Swellendam to where she and her husband had retired. It suckered profusely (a characteristic of the clone) and she gave away or sold many of these offsets which can be found in collections around the country under a number of different names. It is very easily distinguished from other yellows due to the tips of the older leaves that are inclined to die back. From correspondence between Cynthia and the late Prof. Christo Pienaar it is apparent that Yoshikazu Nakamura bought all the yellow plants that she could produce. 'Natal Yellow' is a wonderful horticultural subject - it is a robust plant that suckers well and has very attractive butter-yellow flowers on well-presented umbels.

(See Shigetaka Sasaki's article for insight to the value of this clone in a breeding programme.) **Eds.**

'Blinkwater Yellow'

Dr. Bing Wiese of Pretoria obtained a clone of this yellow *Clivia* from a Mr. Koch of Wartburg, KwaZulu-Natal. The plant had been collected during the 1960's from the Blinkwater stream that flows into the Sterkrivier that in turn flows into the Umgeni River below the Albert Falls Dam in KwaZulu-Natal. The 'Blinkwater Yellow' is light creamy yellow in colour with an average sized open trumpet flower. Its most distinctive feature is the semi-pendulous disposition of the flowers. The plant is receptive to its own pollen and produces 100% yellow progeny. This is the reason why Dr. Wiese included this clone in the gene pool of his yellow *miniata* breeding program. After six generations of line breeding the progeny of this program still segregate within a wide range as far as shape and size of the flowers is concerned.

'Crookes Yellow'

A little-known plant collected by Mr. Vernon Crookes on the farm Mgai of Mrs. Molly Reynolds in the Umzinto district of KwaZulu-Natal in the early sixties. He grew the plant in the Orchid House at Selbourne Estate. This plant has not been distributed at all.

Photo: Sean & Terri Chubb

'Mpumulo Yellow'

'Mpumulo Yellow'

The plant was collected by Darrel and Marrion Bignoux at Mpumulo in KwaZulu-Natal during the late fifties. A new road was being built in the area destroying many *Clivia* populations: Darrell and Marrion were on a motorcycle trip and collected the yellow plant as well as seed. The plants in habitat are said to be growing in clumps on top of a cliff above a waterfall, where at one stage 20 to 30 plants were seen flowering around late December or early January. The medium yellow flower is star-shaped and offsets fairly well. It is at this stage undistributed.

Photo: Sean & Terri Chubb

'Whyte Yellow'

'Whyte Yellow'

This plant was found about 20 years ago on a farm in the Upper Tongaat area of KwaZulu-Natal, along the Umhlali River. When self-pollinated it produces green base seedlings. The berries ripen yellow and the plant produces 12 to 14 flowers that hang in a very open pendulous umbel at the end of long pedicles.

'Mvuma Yellow'

This plant was collected by Ian and Colleen Goble on their farm Mvuma, upper Tongaat, KwaZulu-Natal, during September 1978. The flower opens with a green tinge and changes to a beautiful yellow that fades to a creamy yellow

'Mvuma Yellow'

with age. This robust, upright plant has full flowers with rather broad petals. It is not a true-breeding yellow. It has not been distributed.

'Oribi Yellow'

Mrs. Nilssen was a Primary School teacher on the KwaZulu-Natal South Coast and she owned the farm Gibraltar in the Oribi Gorge where wild *Clivia* grew. She informed Mick Dower that this plant had come up amongst orange plants that she had grown from seed collected from the habitat. It has leaves approximately 6 cm wide. It has no green colouring in the flower but as it ages these very beautifully shaped flowers take on a distinct pink blush. Mrs. Nilssen died a couple of years ago and Mick mentions that the mother plant has not been traced and nobody else has a piece of this clone except him.

'Oribi Yellow'

Photo: Sean & Terri Chubb

'Ndwedwe Alpha Thurston'

'Ndwedwe Beta Thurston' (see overleaf)

Photo: Sean & Terri Chubb

'Ndwedwe Alpha Thurston'

This plant was found in August 1985 in the Upper Tongaat area of Indwedwe growing high up on the rock face above the Mona River. A robust plant, it has rich cream coloured flowers which are closely bunched together giving the umbel a good shape. There are up to 29 flowers in an umbel and they have a faint scent. When Sean Chubb crossed this plant with a range of yellows from other groups the stems of the resulting seedlings were all pigmented. However, seedlings with unpigmented stems were produced when it was self-pollinated. They flowered yellow, as do the seedlings that are produced when the F1s are sibling-crossed or back-crossed to the mother plant. Sean has defined this group of yellows as "Alpha Group", because of their distinctive breeding behaviour.

'Ndwedwe Beta Thurston'

This yellow was found September 1986 in the same area as the 'Ndwedwe AlphaThurston' lower down on the same krantz. Again there were no suckers and no fruit from a previous flowering. The plant is not as robust as 'Alpha' and has only produced one sucker since discovery. It produces up to 15 flowers per umbel. The flowers are not as closely bunched as 'Alpha'. When selfed or crossed with Group 1 or Group 2 it produces pigmented seedlings.

'Port St Johns Yellow'

The original 'Port St Johns Yellow' plant was collected in the mountains near the Umzimvubu River mouth at Port St Johns by Mr. Bill Strachan of Umtata in the Eastern Cape. In 1964 Neville Wylie obtained an offset of the plant from Mrs. Mona Heard of the farm Hluleka, near Port St Johns, who had received a plant from Bill Strachan some time previously. Mrs. Heard's plant consisted of about a dozen mature growths in a large clump. The plant has narrow leaves and produces offsets regularly. About seven flowers are borne in each umbel, and the individual flowers have narrow petals with no gap between petals and sepals. Old or rain-damaged blooms show small orange spots. The seed is large with one to three seeds per berry and mostly up to three berries per umbel. The flowers are self-fertile and produce about 50% yellow offspring. When crossed with other Group 2 yellows nearly 100% yellows result.

'Centani Yellow'

This plant was found by Rodney Ellis of East London in about 1985 in a typically small forest approximately 5 km east of Centani village in the Eastern Cape. The plant is of medium size, offsets freely and needs to be repotted every 3 to 4 years. The forest where the plant was found no longer exists. It was apparently razed by the local populace and has reverted to grassland. This clone is fertile but the progeny are orange.

'Qora Yellow'

This plant was also found by Rodney Ellis during September 2003 in a forest in the Qora River valley close to the coast. Other plants in the area were predominantly orange although there were also pastels. The plant is sterile but very little else is known about it and it has as yet not been distributed.

I have been unable to prove that 'Noyce's Yellow' (the so-called 2nd Eshowe Yellow'), 'Watkins Yellow' and 'Cynthia's Best' are out of habitat. However, because there is confusion concerning the origin of these strains I felt it fitting to treat them as well.

'Noyce's Yellow' Strain

This plant was first grown by an Eshowe doctor (name unknown) who had received it from a grateful patient. It was also grown at the Eshowe Hotel over the period 1920 /1925 by a Mrs. Russell. Mrs Russell gave a plant to Mrs. Gladice Munroe and her son John Munroe. This plant was passed down to all the Munroe family members. It is from this source that Sean Chubb acquired his clone.

During April 1955 Mr. and Mrs. Faircliffe of Hilton, KwaZulu-Natal, bought a clump of *Clivia* grown in a half drum from the retired widow of an Eshowe doctor then living in Pietermaritzburg. The plants were advertised in the Farmer's Weekly as "Rare plants for Sale". In turn, Michael Noyce purchased the clone from the Faircliffes. This magnificent robust plant with well-proportioned flowers on a tight umbel has the added characteristic of breeding true yellows when selfed.

Table 1: Yellow clones and their synonyms

Clones	Group	Synonyms
Eshowe Yellow	1	Saunders Yellow
Mare's Yellow	1	Howick Yellow
Dwesa Yellow	2	Bashee Yellow, Transkei Yellow, Smith's Yellow, Tsolo Yellow, Floradale Yellow
King Hamelin Yellow	1	
Byrne Valley Yellow	**Unknown**	
Natal Yellow	2	Giddy Yellow, Fred Gibello Yellow, Jardine Yellow, Swellendam Yellow, Höll Yellow, Stella Parish Yellow
Blinkwater Yellow	1	Kaekloof yellow
Crookes Yellow	**Unknown**	
Mpumulo Yellow	1	
Whyte Yellow	**Unknown**	
Mvuma Yellow	**Unknown**	
Oribi Yellow	**Unknown**	
Ndwedwe Alpha Thurston	**"Alpha"**	
Ndwedwe Beta Thurston	**Unknown**	
Port St Johns Yellow	2	Very similar to Dwesa Yellow
Centani Yellow	2	Very similar to Natal Yellow
Qora Yellow	**Unknown**	

'Watkin's Yellow' Strain

Hal Watkins of Hilton had both Mare's Yellow and Noyce's Yellow and from these two clones bred Watkin's Yellow. This is a robust, free-flowering plant, which has a compact umbel of well-formed flowers carried well above the leaves. When selfed, the Watkins Yellow produces yellow-flowering plants. Therefore 'Watkins Yellow', which is an F2 plant, is a Group 1 clone. In view of the fact that both these clones have been available for more than a century, this cross must have been made in the past in South Africa as well as in other countries.

'Cynthia's Best'

Photo: Sean & Terri Chubb

'Cynthia's Best' Strain

Another Giddy yellow that deserves mention is 'Cynthia's Best', which she bred and named, and is still to be found in her collection, maintained by her daughter Caitlin Leach at Bathurst in the Eastern Cape. A plant of this F2

Strain was bought from Cynthia by Norman Weitz on 14th April 1984. Wessel Lötter noticed that this plant was a Group 2 as it had a red streak on one of its tepals and the berries were yellow and pink. Cross-pollination with 'Natal Yellow' proved that this was a second clone of the 'Natal Yellow' genotype, which is a Group 2. All seedlings were unpigmented and when some flowered during 2002 they were indeed yellow. This strain of yellow with its exceptionally pretty flower has been named 'Cynthia's Dream'.

Acknowledgements

I would like to thank the following persons and *Clivia* enthusiasts for their willing and kind co-operation with this undertaking: Mick Dower, Roger Dixon, Rodney Ellis, Claude Keytel, Rudo Lötter, Robert Moss, Chris Saunders, Gerald Schoßeld, Brian Tarr, Val Thurston, Dr Bing Wiese, Norman Weitz and Neville Wylie. In particular I must make particular mention of Sean and Terri Chubb, without whose knowledge and unselfish devotion to the task of timeously preserving naturally occurring *Clivia* out of habitat the task of recording the provenance of these plants, and indeed their identity, would have been very difficult.

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Photo: Claude Felbert

A Light Orange / Apricot where the flowers get paler as they age. Note the distinct difference between the colour of the two inflorescenses. John Winter has bred this F_1 from a Jim Holmes Yellow crossed with a Kirstenbosch Garden Plant which has a compact crown and short leaves. The F_2 generation will flower in 2005.

Clivia miniata — Colour Mutations and their Breeding

Sean Chubb, South Africa

I don't profess to be a geneticist or to know very much about the way in which colour is inherited in *Clivia*, but by taking the very simple approach of line breeding and a lot of trial and error over many years I have managed to produce true-breeding lines of *Clivia*. I have decided to share what I have learnt with others, in the best interests of *Clivia*. I trust that breeders wishing to perpetuate a particular colour mutation will find it of value.

It is my opinion that, for a particular colour mutation to be inherited by sexual reproduction a pathway has to occur – i.e. the genes or other factors influencing the colour have to line up. A simple way in which to view the chromosomes, and the loci on which these chromosomes have mutated, is by taking two rulers and placing them side by side, each representing different plants with similar colour mutations. Only if both plants have mutated on the same point of the chromosomes, that is they line up at the same place on the rulers, would the mutation be transferred to the offspring by sexual reproduction.

Some plants are relatively easy to line-breed / inbreed because of the fact that they can be self-pollinated. Unfortunately with others, mechanisms seem to be in place that inhibit self-pollination. More effort is required to perpetuate these colour mutations.

The best-known colour mutation in *Clivia* is the yellow mutation occurring in *Clivia miniata*. Even here just because two plants are yellow doesn't necessarily mean they have mutated at the same locus on the chromosome. If they haven't, they will not produce yellow-flowering offspring if bred together.

Bill Morris classified the two best known yellow mutations as Group 1 and Group 2 yellows. These groups produce homozygous yellow flowering offspring if bred within their group but revert to orange when bred across the groups – i.e. where the groups have mutated at different points/loci on the chromosomes. Phenotypically (externally) these yellows are very similar but genotypically (in their genes) they are very different. Any yellow flowering *Clivia miniata* mutation should not be presumed to belong to one group or another, since many groups exist. These yellows should be tested by controlled breeding with plants from known groups before they can be classified into a group. Probably 99%+ of all yellow *miniata* available worldwide would be Group 1, the remaining 1% made up of 0.9% Group 2 yellow, with the remaining 0.1% falling into numerous other groups.

Examples of these other groups are:

- A group which I call Group 3: The plants display yellow flowers but develop red berries and show maroon stem pigmentation in both seedlings and adult plants. Work is still in progress to classify which and how many clones belong to this group.
- A further group is named in my breeding programme as "Alpha group". This group consists of plants which have mutated on the same point as Ndwedwe Alpha, a wild collected clone. All known plants in "Alpha group" thus far are direct descendants of 'Ndwedwe Alpha'. When bred together these plants give rise to unpigmented seedlings and resulting yellow flowering plants.

Even yellow plants wild collected in the same area do not necessarily belong to the same group. Examples of this feature are: 'Ndwedwe Alpha' belongs to "Alpha group" but 'Ndwedwe Beta' and 'Ndwedwe Echo', both wild originated from the same area don't belong to the same groups.

There are other wild collected yellow clones which do not seem to be part of any of the known groups and will have to be trial-bred with other yellows to be classified into groups. Perhaps many of them will be a group on their own, but time and carefully controlled trial breeding will prove this.

My approach to a yellow-flowering plant with unknown genealogy is to self-pollinate the plant, and to use it's pollen on known groups of plants, for example Group 1 and Group 2 (the two most common groups of yellows). The results of these crosses will then guide the breeding programme in the direction which would best perpetuate the colour mutation. Self-seedlings flowering the same colour as the parent should be selected and the breeding programme continued. Even if the offspring don't flower the same as the parent, the best seedlings should be selected and line bred back to the mother plant. This would give more desirable results. Remember, not all yellow-flowering groups produce unpigmented seedlings. A clue to this would be berry colour on the flowering plant. Red berries on yellow flowering plants can give rise to pigmented seedlings, which eventually flower yellow. If pigmented seedlings are produced when the unknown yellow is crossed with both Group 1 and Group 2 yellows, it can safely be assumed that the plant belongs to another yellow pigmentation group.

Not all naturally occurring clones of whatever group are worth perpetuating in any numbers, since they may be inferior to the existing yellow clones and hybrids already available. 'Ndwedwe Alpha' is spectacular and is a first class plant; thus the "Alpha group" line breeding is being continued in an attempt to perpetuate the excellent qualities in 'Ndwedwe Alpha'.

Colour mutations occur naturally in *Clivia miniata* populations, although very rarely. Mutations have been found in wild populations as well as in "chance" seedlings in commercially grown *Clivia* populations. These mutations include a large variety of colours including Peach, Pink and Apricot, as well as colour-related features such as Bicolour, Picotees, and many more.

The approach I take with plants with these colour mutations is to self-pollinate them and also to cross them with as many similarly coloured plants as possible, in the hope that some may have mutated on the same locus on the chromosome and will thus result in seedlings with a similar colour to the original parents.

'Emmie Wittig Pink'

What follows is an example of successful line breeding. Over the past nine years I have had the pleasure of being able to work with the plant 'Emmie Wittig Pink'. Described by Harold Koopowitz in his book Clivia as "the clearest and truest pink I have ever seen", this plant has delicate pink flowers, maroon berries and it's offspring seem to revert to orange. I first acquired a plant in 1996 from Mrs Emmie Wittig. My plant was self-pollinated and also crossed with other known groups of yellow mutation *Clivia miniata*.

All resulting offspring were pigmented as seedlings and produced orange-flowering plants (cross-pollination and selfing may have occurred as the pollination was not completely controlled). The best of the orange seedlings were selected and 'Emmie Wittig Pink' was used as a pollen parent onto these plants. The resulting offspring were interesting from the start, producing ⅓ unpigmented, ⅓ lightly pigmented and ⅓ heavily pigmented seedlings. These were grown to maturity, with all unpigmented seedlings producing pink-flowering plants. Some are similar to the original 'Emmie Wittig Pink', some are better, and a good percentage poorer. The pigmented seedlings, dark and light, produced normal orange flowering plants. The pink offspring were then crossed back to their mother, and also to siblings. Resulting seedlings are all unpigmented and it can be said that they will flower pink. A true-breeding line of pink *Clivia miniata* has thus been produced by breeding amongst related plants carrying the 'Emmie Wittig Pink' gene.

It is important, when using line breeding as a tool, to select seedlings carefully, to keep good records, and to note loss of vigour and other recessive undesirable genes which may occur in seedlings. Breed plenty but select only the best for further breeding. The more selection pressure placed on the seedlings the quicker the desired results will be achieved.

I first used line breeding/inbreeding to produce my line of true-breeding 'Chubb Peach' plants and have subsequently used it in many other lines with good results. Using these line breeding practices, it could be said that any *Clivia miniata* mutation or colour form can be reproduced as a true-breeding line within 5-9 years.

Photo: Courtesy NZCC.

'Chubb Peach' from New Zealand. Owner: Keith Hammett.

Have Genes, Will Travel — on the Trail of 'Vico Yellow'

Roger Dixon, South Africa

The first record of yellow-flowered *Clivia miniata* was in 1888 when a plant was displayed in Ghent at a show and was referred to as *Clivia sulphurea* (Anon., 1888). The report (in German) reads "In Ghent a colour novelty was praised – *Clivia sulphurea* Laing & Sons. We believe, however, that lasting success can only be expected from either a pronounced red or a pure white variety. All intermediate varieties which are yellowish or reddish in colour will disappear as fast as they pop up." As this was an informal description, the name is not officially recognised. At around the same time, a yellow-flowered plant was discovered in habitat in Eshowe in KwaZulu-Natal, and was subsequently formally described as *Clivia miniata* var. *citrina* in 1899 (Watson, 1899). This plant had been sent to Kew Gardens around 1893 (Bayer, 1979) and had also been distributed around Pietermaritzburg at the same time, where it has been in cultivation ever since (Gooding, 1964; Smithers, 1995) as 'Eshowe Yellow' (Van Niekerk, 2005).

Most probably due to the fact that journals dealing with botanical taxonomy were not widespread at the time, and an article published in one magazine might not be available to all botanists, another yellow-flowering plant from Eshowe was described in 1931 as *Clivia miniata* var. *flava* (Phillips, 1931). According to Phillips 'Mr Saunders informs us that one or two plants were found in the Eshowe Forest, Zululand,

'Eshowe Yellow' by Mairn Hulme (Hulme, 1954).

Clivia miniata var. *citrina* by H.G. Moon, from the original description from Watson (1899).

Clivia miniata var. *flava* by Cythna Letty from Phillips (1931).

Courtesy SANBI Collection

about the year 1888, and a number of plants have been propagated from these originals. Plants were propagated from seed, but took many years before they flowered. Mr. Saunders also informs us that two or three years ago a plant flowered at the Royal Botanic Gardens, Kew, but as far as we are aware has not been figured. The fact that all plants raised from seed have yellow flowers indicates that we are dealing with a pure strain; but except for the colour of the flowers we have not been able to detect any tangible characters which would separate it from *C. miniata* and have therefore kept it as a yellow variety.'

The plant described by Phillips was received from Mr B Nicholson of Swaziland, who had obtained it from Mr C R Saunders, the source of the original '*citrina*'. The plant that flowered at Kew had also been received from Saunders in October 1925 by The Hon. Lewis Palmer of the Royal Horticultural Society, who gave it to his father-in-law Lord Wakehurst who exhibited it at an RHS meeting in 1927 or 1928 under the epithet of '*citrina*'. Apparently this plant flowered, amongst orange-flowering plants, set seed and then died. The seeds flowered orange, but Charles Raffill of Kew started a program to breed back the yellow flowers. After some years he succeeded, and the resulting yellow-flowering plant was named *Clivia x Kewensis* 'Cream'. It, and others of the same breeding, had significantly larger flowers than the normal *C. miniata*, and much larger umbels. This is most probably due to the fact that Raffill would have used the best available orange plants in order to produce a better yellow that the original, and since *C. miniata* had been in Europe since the 1850's the original wild-collected material had been much improved upon.

The improvement of *C. miniata* was avidly pursued from the 1870's through until the early 1900's, and a number of excellent quality clones were bred, named and illustrated in this period. The most outstanding of these was 'Lindeni', the seedlings of which were highly sought after and gave rise to numerous new clones with large umbels, large flowers and broad leaves (De Coster, 1998). Its genes are thought to be widespread in the background of most modern *Clivia miniata* of European breeding (Koopowitz, 2002). One such clone

Clivia miniata 'Prince Albert'. A cross between C. 'Madame Donner' and C. 'Chevalier Heynderycx', exhibited by M. Charles Vermeire, horticulturalist in Gendbrugge, at the Exposition Internationale of Ledeberg (from *L'Illustration Horticole*, 1896).

might have been 'Prince Albert', which was originally figured in the Belgian publication *L'Illustration Horticole*.

Photo: David Brundell

Sir Peter Smithers pollinating 'Vico Yellow' at Vico Morcote in 1986.

In 1971 Sir Peter Smithers obtained a plant of *Clivia x Kewensis* 'Cream' and two of its orange siblings, *Clivia x Kewensis* 'A' and *Clivia x Kewensis* 'B'. He cross-pollinated these plants and raised a number of seedlings, most of which flowered orange. However, a later seedling flowered yellow. This was of much better quality than the original 'Esbowe Yellow' and he sent a plant to Dr Shuichi Hirao in Japan. This plant was of such superior quality that it became quite famous in Japan, and was referred to as 'Smithers' Yellow' (Smithers, 1995; Koopowitz, 2002).

In July 1986 David Brundell, a horticulturalist from New Zealand, visited Sir Peter at his home in Vico Morcote, Switzerland, and was given a piece of this yellow-flowering plant. After arriving back in New Zealand, David wrote to Sir Peter informing him that the plant had been placed in quarantine for a year. In reply, Sir Peter said:

"I am glad the yellow Clivia made it and hope they won't kill it in quarantine. We ought to name it, and in my opinion a name ought to tell us as much as possible about the plant: The Hon. Mrs. George Bumbleshutz tells us very little except that the lady was

'Vico Yellow' flowering in New Zealand in 1988.

probably gratified, as I was when a Magnolia was called for me in the U.S.A.! What about 'Vico Yellow'? This gives us a clue as to its colour and where it originated."

David replied:

"I agree, your Clivia should be named 'Vico Yellow'. It is most suitable and will be used henceforth. Last week a researcher from a Japanese seed company sent me an original copy of the Journal of the Japanese Horticultural Society that had 'Vic Yellow' on the cover. For your information, the Japanese actually refer to it as 'Smithers Yellow'"

'Honey Moon', an F1 'Vico Yellow' hybrid. This was runner-up Peoples Choice at the New Zealand Clivia Club Show in 2004.

Yoshikazu Nakamura, who took over Hirao's *Clivia* plants, requested permission from Sir Peter to breed from the plant " 'Smithers' Yellow', world's best yellow *Clivia*, the one to beat". As 'Vico Yellow' the plant was micro-propagated by Miyoshi & Co. and the tissue-cultured plants were widely distributed. However, some growers have noted quite a variation in the flowers of the tissue-cultured plants and it would be interesting to find out which particular part of the plant was used in the propagation. In 1989 another yellow seedling of Sir Peter's breeding flowered, which he said was "a better plant than the original 'Vico Yellow'. He named it 'Vico Gold' and sent a piece to Nakamura, who used it in his breeding program. The influence of 'Vico Yellow' and its progeny emanating out of Japan has been enormous, and many modern clivias today include 'Vico Yellow' in their ancestry.

David's plant of 'Vico Yellow' flowered for him in 1988 for the first time, and he then started breeding with it. One of the important aspects of 'Vico Yellow' is that it imparts its robust character to most of its offspring, and this is a dominant characteristic which results in a great improvement in flowers, when used as either pod or pollen parent. The leaves of the clone are long and broad. Another characteristic is that it produces offsets fairly freely, just like the original 'Eshowe Yellow' plant.

Nakamura has used 'Vico Yellow' as a pollen parent because:

- its hybrids produce large flowers with good shapes
- its hybrids produce a well reflexed tepal
- its pollen is very compatible and results in a good seed set with large seeds.

According to him using 'Vico Yellow' as a pod parent with self-pollination does not result in a good seed set.

Acknowledgements

I would like to thank Fred van Niekerk for stimulating my interest in yellow *Clivia*, which I used to consider boring, and providing me with obscure information; David Brundell for his enthusiasm and information, including access to his personal archives; John van der Linde for his support and help in locating references; Alberto Grossi for sourcing and providing the illustration of 'Prince Albert', and Roger Fisher for his assistance in sourcing and providing the illustration of *flava*.

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Accent on

Photo: Helen Marriott

Photo: Keith Barlow

Photo: Helen Marriott

Single Flowers

Photo: Keith Barlow

Photo: Sharron Booth

Photo: Keith Barlow

Photo: Helen Marriott

Photo: Karen de Jager

Photo: Gordon Fraser

Photo: Karen de Jager

Photo: Keith Barlow

Photo: Keith Barlow

Photo: Gordon Fraser

Photo: Kevin Mansfield

Photo: Keith Barlow

Photo: Keith Barlow

Photo: Keith Barlow

Photo: Gordon Fraser

Photo: Keith Barlow

Photo: Chris Welgemoed

Photo: Chris Welgemoed

New Developments in Clivia Breeding in Japan

Shigetaka Sasaki, Japan

New *Clivia* in Japan

Yoshikazu Nakamura has bred numerous *Clivia* hybrids that have enchanted us with their beautiful flowers. This time, I would like to introduce you to another significant *Clivia* breeder, Toshio Koike, who has also bred brilliant flowers by using different materials in his breeding program. I will also inform you about Nakamura's latest breeding results.

Green flower 'Hirao'

Koike owns a nursery in Gifu prefecture that sells many pot plants other than *Clivia*. For his *Clivia* sales, he mainly sells his original cultivar called 'TK Original'.

Photo : Shigetaka Sasaki

Clivia miniata - 'TK Original'.

The above *Clivia* belongs to Group 2 yellow and sometimes shows the typical red spots on its flowers and berries. He has not used any Group 1 yellows like Vico Yellow that Nakamura has often used in his own breeding program. On the contrary, Koike has only used a Group 2 yellow that he bought from a Japanese flower company for his breeding program and from the F_2 hybrids has bred his original yellow *Clivia*.

Photo courtesy of Shigetaka Sasaki

The author and Ryuko Hirao, widow of Dr. Hirao.

I think that the most beautiful flower bred by Toshio Koike is the green flower 'Hirao' which appears on the back cover of this Yearbook. The cultivar name 'Hirao' comes from the first name of the late Dr. Shuichi Hirao, who was a great gardener and introduced Vico Yellow to Japan. His *Clivia* collection was subsequently taken over by Nakamura, but that is another story.

The cultivar 'Hirao' can be described as a green type of yellow flower which was bred from Group 2 yellows. According to Koike, this flower keeps a beautiful green colour until the middle stage of its bloom. After the pollen sacs burst open on the anthers, the green colour on its tepals disappears gradually and finally becomes cream. In addition, he said that the plant displayed cream flowers several times when its nutritional status was compromised. He indicated that green flowers such as 'Hirao' probably need plenty of nitrogenous fertiliser to promote the growth of chlorophyll.

Koike had bred his Group 2 yellow hybrids for the purpose of getting green flowers for a few years before his first green flower actually

appeared. When he was young, he crossed orange flowers with green centres several times and obtained quite a lot of dark orange (so-called bronze colour) *miniata* plants with strong green centers in the F_2 or F_3 generations. In his green flower breeding, he used these dark orange *miniata* as the mother plants. He pollinated these dark orange *miniata* with the pollen of Group 2 yellow, which he had obtained for his breeding. Then, he crossed the F_1 siblings and from this has bred 'Hirao'. Toshio Koike says that the reason why he was able to breed a green flower like 'Hirao' is that he could obtain many bronze-colored miniata and he used them as the mother plants in his breeding.

Photo : Shigetaka Suzuki

Picotee *Clivia miniata* 'Green Impact'

In Japan, there is another green flower called 'Green Impact' that was bred by Toshiyuki Hosoya. He claims to have bred this green flower using a yellow cultivar called 'Ohgonkaku', a Group 2 yellow that gives unpigmented seedlings when selfed. Green flowers might emerge in the future through crossing Group 1 yellows. However, according to the two breeding results reported above, I suggest that crossing Groups 2 yellows might be an effective way to create such green flowers.

Koike also paid attention to the red margins that sometimes appeared on the tepals of his 'TK Original' yellows. He crossed yellows which had these vivid red margins and has bred the flower shown below.

He reported as follows: "I could obtain yellows with more vivid red margins by crossing those yellows with red margins. However, I wonder if this red color might be caused by the tepals being wounded since they graze each other when they open."

Koike hypothesizes that Group 2 yellow flowers might have pre-pigments for anthocyanins in their tepals. Accordingly, Group 2 yellow flowers might show red on the margins of the tepals when the margins are damaged because these pre-pigments react to oxygen and become anthocyanins. He thinks that flowers with thin tepals can be easily damaged, and so he might have bred yellows with thinner margins and these yellows might appear to have redder margins on their tepals. Once when he deliberately injured the tepals of his 'TK Original' yellows, some plants revealed red spots on their tepals while others did not. Thus he concluded that the coloration of red spots might vary among the plants belonging to Group 2 yellows.

Peach interspecific hybrids

Using his 'TK Original' yellow, Koike has bred interspecific hybrids, such as those shown in the photos, which are peach or apricot coloured.

The hybrids shown (**See photos 4 - 5**) emerged from {(*C. miniata* orange x *C. gardenii*) x *C. miniata* orange} x Group 2 yellow. It is very interesting that this peach colour hybrid emerged without the use of 'Chubb Peach' or a peach from the USA. I have the impression that the colouring of Koike's peach and apricot interspecifics is very similar to those peaches that I previously saw in California, bred by James Comstock and Dave Conway.

Nakamura has also bred two peach-coloured hybrids to date in his interspecific crosses but he did not use any peach parent either. Furthermore, both of these peach interspecific hybrids arose

Photo : Shigetaka Sasaki

A peach interspecific.

Photo : Shigetaka Sasaki

'Orchid' a spectacular peach and green interspecific.

An apricot interspecific.

Photo : Shigetaka Sasaki

'Candoll' a peach interspecific with a yellow throat.

Photo : Shigetaka Sasaki

out of *C. miniata* x *C. gardenii* crosses (**See photo 6 - 7**). I feel that the colouring of Nakamura's two peach interspecific hybrids is closer to the delicate peach colour of 'Chubb Peach' that I saw in South Africa three years ago, in comparison with Koike's peach interspecific hybrid or the peaches from California.

According to Nakamura, both of these flowers came from the crosses that he calls 'Candoll'. We do not have the exact breeding records of these plants, but the breeding combination was one of the following three possibilities:

1. *C. miniata* orange x *C. gardenii*
2. *(C. miniata* orange x *C. gardenii)* x self
3. *(C. miniata* orange x *C. miniata* yellow (Group 1 yellow)) x *C. gardenii* x *C. miniata* yellow (Group 1 yellow)

In relation to the potential of *Clivia*, it is very noteworthy that both Nakamura's and Koike's peach flowers came from interspecific crosses using *C. gardenii*. This is a good example demonstrating the potential of *C. gardenii*. I think that this peach interspecific hybrid bred by Nakamura that has the open tepals of *C. gardenii*, just like the shape of an orchid flower, shows us the unlimited potential of *Clivia*.

Furthermore, by breeding a dark coloured peach from a Group 2 yellow and *C. gardenii*, Koike has further opened up the potential in relation to interspecific breeding of both *C. gardenii* and Group 2 yellows. In addition, another different Japanese breeder has bred a peach interspecific hybrid, shown **above**, from Group 2 yellow x *C. gardenii*.

Broad and short-leafed yellows

Lastly, I would like to introduce the broad and short-leafed yellow that Koike has bred using Group 2 yellow and Japanese Daruma. One of the *Clivia* that enthusiasts not only in Japan but throughout the world have been waiting for is the broad and short-leafed yellow. Recently, Chinese *Clivia* have become popular internationally, and many people want *Clivia* with good broad and short leaves. Koike has certainly bred a broad and short-leafed yellow but some more improvements will be necessary before we can actually call it a Daruma. Here I am using my own definition of "Best Daruma". Accordingly, "Best Daruma" applies where the width of the leaf is one, and the length is three, in other words, for Daruma the most beautiful leaf form is where the length of the leaf is three times its width. In summary, then, leaf width 1: leaf length 3 = "Best Daruma". The "daruma percentage" of Koike's broad and short-leafed yellow is leaf width 1: leaf length 4-5, with the best that I have seen having a leaf width of 8 cm and a leaf length of 33 cm.

Koike bred his broad and short-leafed yellow using Japanese Daruma x Group 2 yellow = F_1 orange hybrid.

The length of the leaf of the F_1 orange hybrid from this crossing was clearly shorter than that of the Group 2 yellow pollen parent and the width of the leaf was also definitely wider. However, in comparison with the F_1 orange hybrid, a broader and shorter leaf was evident in the F_2 hybrid made from a sibling cross of this F_1. **(See photos 8 -10)**

Besides these, I have also seen a broad and short-leafed yellow with variegation that was an F_1 hybrid bred by Nakamura's mother, as well as a rather big broad and short-leafed yellow in the greenhouse of the Californian King of *Clivia*, Joe Solomone. According to Nakamura, when he used 'Vico Yellow' (Group 1 yellow) pollen on this short-leafed yellow with variegation (bred by his mother), all of the seedlings were pigmented. I think we can say from this result that there is a high possibility that his mother bred this plant using a Group 2 yellow as the pollen plant. If we used the pollen from a Group 2 yellow in place of 'Vico Yellow' and unpigmented seedlings emerge,

Photo : Shigetaka Sasaki

Toshio Koike's broad short leaved yellow *Clivia* No.1.

Photo : Shigetaka Sasaki

Toshio Koike's broad short leaved yellow *Clivia* No.2.

Photo : Shigetaka Sasaki

The ruler shows the dimensions of these leaves.

then we could say with certainty that the broad and short-leafed yellow variegate was a group 2 yellow.

When I previously visited Solomone's green house he explained to me that all of the yellows he has been producing initially came from a single yellow. He continued breeding from this yellow, selecting his best to produce his own yellow hybrid. If his first yellow was a Group 2 yellow, then the broad and short-leafed yellow that I saw at Solomone's would also have been Group 2 yellow.

Photo : Shigetaka Sasaki

Joe Solomone's broad short leaved yellow.

I have the following hypothesis about Koike's breeding of a broad and short-leafed yellow from crossing Daruma with Group 2 yellow. In the F_1 hybrid yellow that was bred from crossing Group 2 yellow, the gene that determines the yellow colour and the gene that contributes the broad leaf type are independent and exist on different positions on the chromosome. If the gene determining the flower colour in Group 2 yellows and the gene influencing the leaf character were located in the same position on the chromosome and linked together, in addition to the yellow flower of an F_2 hybrid that comes from crossing Daruma and Group 2 yellows, we could expect a narrow leaf that is also characteristic of Group 2 yellows.

The above is just an hypothesis but from Koike's breeding of a broad and short-leafed yellow we can say that using Group 2 yellow in the breeding is the most effective method at present.

Through his breeding with Group 2 yellows of such *Clivia* as the green flower 'Hirao', the peach interspecific hybrid, and broad and short-leafed forms, Koike has shown us the high potential of this type of yellow. The breeding results of both Nakamura and Koike in Japan are likely to become the basic reference for the future breeding of unique *Clivia* hybrids.

This article is based on the author's presentation at the Huntington Clivia Symposium in March 2005. **Eds.**

Photo : Yoshikazu Nakamura

A Nakamura variegated yellow.

Photo : Shigetaka Sasaki

A *Clivia gardenii* cross produced this lovely peach.

Fungal Pathogens Associated with Clivia

Wijnand Swart, South Africa

Background

The following objectives were identified in a research proposal submitted to the Clivia Society during 2004:

- A systematic survey of organic organisms occurring on *Clivia* spp.
- Screening of *Clivia* genotypes for disease resistance.
- Screening fungicides and biocontrol agents for controlling *Clivia* diseases.

This report is a reflection of the most significant results obtained following the diagnosis of diseased *Clivia* leaves received during the course of the past 14 months at the NCPP laboratory of the Centre for Plant Health Management, UFS in Bloemfontein.

Modus operandi

- Samples were mostly received by post and kept in a refrigerator at 5°C pending examination.
- Prior to being manipulated for diagnosis all samples were photographed with a digital camera.
- Samples were then examined under a light microscope for any signs of fungal structures which would point to the presence of a possible pathogen.
- Samples were subsequently surface disinfected with 95% alcohol and 3% NaOCl (Jik) in order to remove any epiphytic or saprophytic fungi and bacteria on the surface of the leaves. This is standard plant pathology practise and a prerequisite for the isolation of micro-organisms from plant tissue.
- Small sections of diseased tissue (*ca.* 10 mm^2) were removed from the disinfected leaves and placed on corn meal agar (CMA)(2% strength) plates (Fig. 1A) to allow for the growth of fungi from inside the tissue.
- The remaining portion of the symptomatic leaf was then incubated in a humidity chamber at 25°C to allow for the development of fungal structures that might not grow on agar.
- Fungal colonies that emerged from the tissue pieces were selected according to their potential for being pathogens and sub-cultured on CMA plates for the next phase of diagnosis (Fig. 1B)
- Fungal structures that developed from leaves incubated in the humidity chamber were examined under a light microscope at 200-400x magnification and cultured on agar plates where possible.

Photos: Courtesy Wijnand Swart

Fig. 1. Growth of fungi from pieces of Clivia tissue in corn meal agar viewed from above(A) and below(B), and growth of a single sub-cultured colony on agar seen from above(C).

- The final phase of diagnosis involved the inoculation of a healthy plant with the isolated putative pathogen. This is in accordance with Koch's Postulates (KP). Where fungi were saprophytes KP was not performed.
- Potted plants obtained specifically for this purpose were inoculated in the glasshouse.
- Assays of detached leaves were also performed in the lab.
- Plants were observed for the development of symptoms similar to the original symptoms from which the fungus was isolated.
- The final phase was re-isolating the original fungus from symptoms on the inoculated plants.
- Failing the development of symptoms no firm diagnosis can be made and the primary cause of the symptoms remains open to speculation.

Results

Twenty seven samples of diseased *Clivia* tissue parts displaying various symptoms were received from *Clivia* growers throughout South Africa. Twenty four of these samples were of diseased leaves while two were of diseased roots and one of a diseased stem. A database of photographic images of symptoms and their putative/confirmed biotic or abiotic causes was compiled from this information.

Sample type 1

Each representative "sample type" is be depicted and discussed below.

- Lesions on leaf characterized by small black fruiting bodies containing spores and indicative of primary or secondary fungal colonization.
- Incubation of leaves and inspection of fruiting bodies revealed a *Phoma* sp. Isolation from tissue also yielded a *Phoma* sp.
- Koch's postulates were performed but no symptoms developed.
- Based on these results we can tentatively conclude that a *Phoma* sp. was associated with the symptoms but in a secondary capacity.
- The fungus isolated from the lesions is therefore:Probably a saprophyte and not associated with the onset of disease, or
- A very weak opportunistic pathogen not able to cause disease on a healthy undamaged leaf.
- No fruiting bodies were visible thus only tissue isolation was conducted.
- Isolation revealed only *Alternaria tenuissima*, a known leaf pathogen of plant hosts but also a facultative saprophyte.

Sample type 2

- Koch's postulates did not confirm the primary role of *A. tenuissima* as a pathogen.
- The conclusion is therefore that the primary cause was abiotic and either physiological (e.g. too many salts in soil or water) or possibly physical such as sun scald.
- Physiologically induced damage is either due to a mineral deficiency or toxicity and can lead to the plant becoming weakened with the result that opportunistic pathogens are able to colonize it.

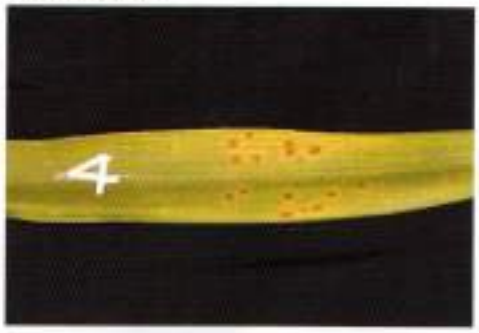
Sample type 3

- No fruiting bodies visible.
- The leaf damage was physical indicating the possibility that insects were the primary cause.
- Isolations revealed only the presence of saprophytes.

Sample type 4

- Leaf rot
- Only saprophytic fungi and bacteria isolated.
- Primary cause difficult to determine but could be mechanical with secondary bacterial infection.
- Samples that are in this condition are usually very difficult if not impossible to diagnose.

Sample type 5



- Symptoms described as leaf spots characterized by chlorosis surrounding the necrotic area.
- No fruiting bodies observed and none developed following incubation in a humidity chamber.
- These symptoms are more indicative of pathogen activity than the previous three types.
- They are not typical of a nutrient deficiency or toxicity.

- Isolation revealed *Colletotrichum* sp. but KP was negative.
- Possible cause in light of negative KP is very difficult to speculate on but it is also probably an insect with sucking/piercing mouthparts.
- Too localized to be a virus.

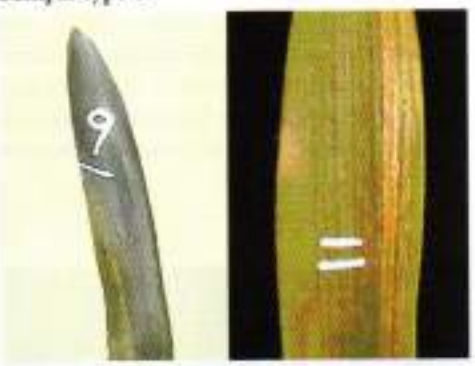
Sample type 6

- Very obviously insect damage with biting/chewing mouthparts.
- Small black spots are also insect damage but similar to sample type #4 although lacking chlorosis around penetration sites.
- Isolation from tissue revealed no fungi.

Sample type 7

- Leaf necrosis
- Isolation from the lesions revealed no fungal pathogens only saprophytes.
- KP not conducted.
- Atypical of nutrient deficiency or toxicity.
- Possible cause is insect damage.

Sample type 8



- No fungal pathogens isolated from tissue displaying the above general symptoms.
- Not typical of nutrient deficiency or toxicity.
- Cause is presumably physiological but could be a virus as well.

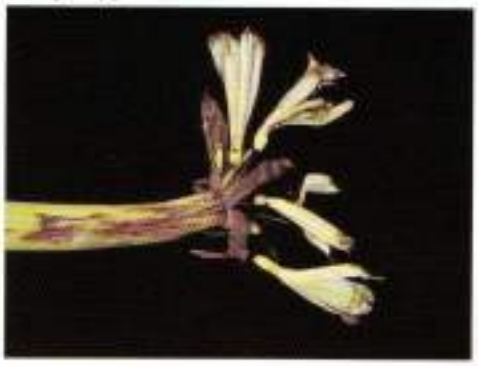
Sample type 9

- Basal stem rot : *Fusarium oxysporum* was isolated from tissue adjacent to the rotting tissue.
- KP negative.
- Cause therefore unknown although bacteria cannot be excluded despite the fact that we did not isolate bacteria on the specific medium we used in this instance.

Sample type 10

- Basal stem rot
- Isolation revealed saprophytic fungi and bacteria only that are both secondary.
- Primary cause is there probably mechanical damage during handling or transplanting.

Sample type 11



- Stem damage
- Physical damage caused by insects or other mechanical means.

Discussion

- The symptoms depicted above are in most cases indicative of physical tissue damage (i.e. insect damage, sun scald, etc.) or physiological problems associated with nutrient deficiencies.
- The fact that no fungi isolated from symptomatic tissue could induce the same, or any, symptoms substantiates this statement. The fungi that were isolated from certain samples, *Fusarium oxysporum*, *Alternaria tenuissima*, *Colletotrichum* sp., and *Phoma* sp. are known facultative parasites - meaning they are primarily saprophytes - living as epiphytes on leaves or in the soil - but able, under conditions of stress in the host plant (physiological, wounding, etc.) to induce disease.
- These specific species of fungi may also have an endophytic phase in their hosts meaning they exist in intercellular spaces where they feed on sugars that occur there naturally. Only when the host is exposed to stress (such as nutrient deficiencies) or ageing and the metabolism of the host is no longer able to suppress pathogenicity, do they express themselves by causing symptoms. This avenue of research is currently being pursued by a Master's student working under supervision of myself and Prof. Johan Spies of the UFS. **It is possibly the most important investigation on *Clivia* diseases at present and crucial to understanding the dynamics of disease in this particular plant. Funding for this project is therefore of crucial importance to the successful diagnosis of *Clivia* diseases.**
- In one instance only (sample type 8) were symptoms possibly due to a virus. This could not be confirmed however since the techniques to identify a plant virus are expensive and not possible within the confines of the present budget.
- Although bacteria were isolated from rotting tissue they are probably of a secondary nature (i.e. saprophytes) due to the advanced decomposed state of the tissue concerned.
- Due to the fact that pathogenicity could not be confirmed with any of the organisms isolated, the second and third objectives of

the present project could not be conducted as these require a confirmed pathogen for the experimental phase of the research.

Recommendations

In view of the fact that no specific pathogens were identified in the present study it is not possible to make specific recommendations. However, there are many ways by which healthy plants can be maintained. These will be discussed briefly below:

- Sanitation is probably the cheapest and safest method of controlling the spread of disease in a population of plants. Physically removing the bulk of symptomatic plant parts and destroying them or removing them entirely from the area.
- Spray regularly with an appropriate systemic (e.g. benomyl) or general fungicide (e.g. Dithane) to prevent opportunistic pathogens from causing infection to weakened/stressed plants.
- Keep a sharp eye out for insects that feed on plants - by night or day. Treat with a suitable insecticide.
- Be careful not to water too much or too little as this is an important cause of stress in plants.
- Do not expose plants to too much or too little sunlight.
- Resort to regular tests of the nutrient status and pH of soil/potting mixtures as well as the electrical conductivity (EC) of irrigation water. This is an extremely valuable indicator of which salts are present and their concentration, which if too high is the cause of toxicity problems that present themselves as symptomatic leaves.
- It is also a good idea to adapt the fertilizing of plants to the nutrient status of leaves. This, together with soil and water analyses is an excellent way in which to maintain the general health of plants.
- Good hygiene is also important. Wash hands before handling healthy plants after you have worked with sick plants. Sterilize garden tools after using them around diseased plants. Plant viruses can reach a *Clivia* plant through an insect or from the hands or unsterile tools of a gardener.

Photo Tony Barnes

Wouldn't we all like to make a meal of this delectable fruit salad dish!
The different colours of these fruits only hint at what the result of sowing this seed might be in four years time.

The Clivia Society

www.cliviasociety.org

The Clivia Society caters for *Clivia* enthusiasts throughout the World. It is the umbrella body for a number of constituent Clivia Clubs and Interest Groups which meet regularly in a number of South African cities and towns. In addition, the Society has individual members in many countries, some of which also have their own Clivia Clubs. An annual Yearbook and regular Newsletters are published by the Society. For information on becoming a member and / or for details for the following Clivia Clubs and Interest Groups contact the Clivia Society secretary or where appropriate, the International Contacts, at the addresses listed below.

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