

## Distribution and conservation of Afrotropical *Graptomyza* Wiedemann, with a new species description (Diptera: Syrphidae: Volucellini)

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Taxonomic revisions can be put to good use in the analysis of conservation priorities and biodiversity studies. Analysis of distribution with regards to vegetation, precipitation and effective temperature followed by species richness and endemism in the Afrotropical members of *Graptomyza* Wiedemann, 1820, indicate that few areas are protected for this genus. Most species are forest inhabitants. Single genus analyses are of little value unless compared with other distributions, nevertheless Naudesnek Summit in the Eastern Cape (South Africa) is proposed as an important conservation area. A new species, *G. spinifera*, from Gabon is described, bringing the number of Afrotropical species of this genus to 17; the key of Whittington (1992) is updated. An updated catalogue of Afrotropical species is provided.

**Keywords:** Syrphidae; *Graptomyza*; conservation; distribution; endemism; species richness.

### Introduction

Taxonomy has an essential role to play in the determination of species distributions and the presence of vulnerable species. Taxonomists have at their disposal one of the greatest resources applicable to studies of biodiversity, viz. vast databanks of distributional data. Information regarding species richness, endemism and areas of potential vulnerability or importance can be drawn from such databases. With increasing awareness of changes in global biodiversity, it is more important than ever before, that taxonomists provide the information about species distributions that environmental planners and policy-makers require. Unless these data are forthcoming, species are likely to be overlooked, an unwanted situation when the maintenance of biodiversity requires the protection of as large a variety of species as possible, in the shortest time.

Conservation and biodiversity come to the fore in taxa which are well studied. This has induced a bias toward vertebrates (95% of which are named; Ponder, 1992) and certain plant groups. On the other hand, invertebrate taxa comprise the bulk of described life forms (Marshall, 1992; Ponder, 1992). When invertebrate taxa are examined frequently there are (i) inadequate data for reasonable proposals, (ii) too much, unanalysed material (and therefore an incomplete taxonomic knowledge), or (iii) too little

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interest, because the taxa have little public appeal. Undescribed species estimates for insects range between 9 and 79 million (Stork, 1988, 1993). Nevertheless the starting point for invertebrate conservation should be at least as complete a taxonomic knowledge as is possible, highlighting the importance of revisionary work. Numerous revisionary works are already available; most of these have never been examined from a conservation or biodiversity point of view. These revisions hold valuable information, as yet untapped, and are key papers for accurate data retrieval and identification of taxa comprising the bulk of biodiversity. It is surprising therefore that support for alpha taxonomy (especially for invertebrate studies) remains so low, given the impending loss of biodiversity, although the opinion that time is short and the undescribed taxa too numerous (Crowe, 1993) is well made. The argument that the unit of conservation analysis should be the site, area or region rather than the taxon (reported by Crowe, 1993) is illogical, since one cannot identify the most valuable site unless there is an *a priori* analysis of species richness (i.e. the taxon unit). Agreed, better management of all ecosystems (Vane-Wright, 1992) may be the best case possible for many invertebrate species, but resolution of the time versus too-many-undescribed-species dilemma, could be the analysis of those vast, as yet untouched resources in unanalysed revisionary works and museum collections.

Species richness provides a useful first approximation for the conservation of species (Williams, 1993; Williams and Humphries, 1993), although it has certain constraints if used as a measure of biodiversity (Williams, 1993). Complementarity and taxonomic difference (Vane-Wright, 1992; Williams and Humphries, 1993) which to some extent overcome these constraints, are not used in this study of *Graptomyza*, since the purpose is to highlight areas of conservation importance, rather than to specifically designate areas of conservation priority. Moreover, a systematic analysis is unavailable, since only the Afrotropical members of this small tropical Old World genus have been revised (Whittington, 1992). The genus is thus presently unsuited to a complementarity analysis. Conservation proposals have, nevertheless, been made; some of these are based on endemism.

Endemism is taken to be a measure of limited distribution range or rarity. It is not a measure of diversity (Williams and Humphries, 1993), but rather of limited range or even lack of diversity. As pointed out by Williams (1993), it provides a handle on species which need protection because of their scarcity. In some respects it may indicate a collecting bias, based on road networks and nature conservation areas for example, but in this study few of the proposed areas coincide with areas already under protection.

It is difficult to assess the conservation potential of a locality based solely on distributional data (some of which are from the first half of the century). It is also undesirable to make conservation proposals on the examination of a single small genus. Nevertheless localities of importance for the genus can be highlighted in the hope that when superimposed with similar surveys, the results will indicate to the authorities and planners, where the most desirable localities for conservation areas are and which nature reserves need continued support. What is so important about this single small genus, that it warrants special attention for conservation? The answer is "nothing special", I use it as an example of how revisionary taxonomy can play an important role in highlighting areas of conservation potential. It is an integral part of the World's biodiversity, and deserves conservation for its "intrinsic worth and warrants respect re-

ardless of its usefulness to humanity" (World Congress on National Parks and Protected Areas, 1992).

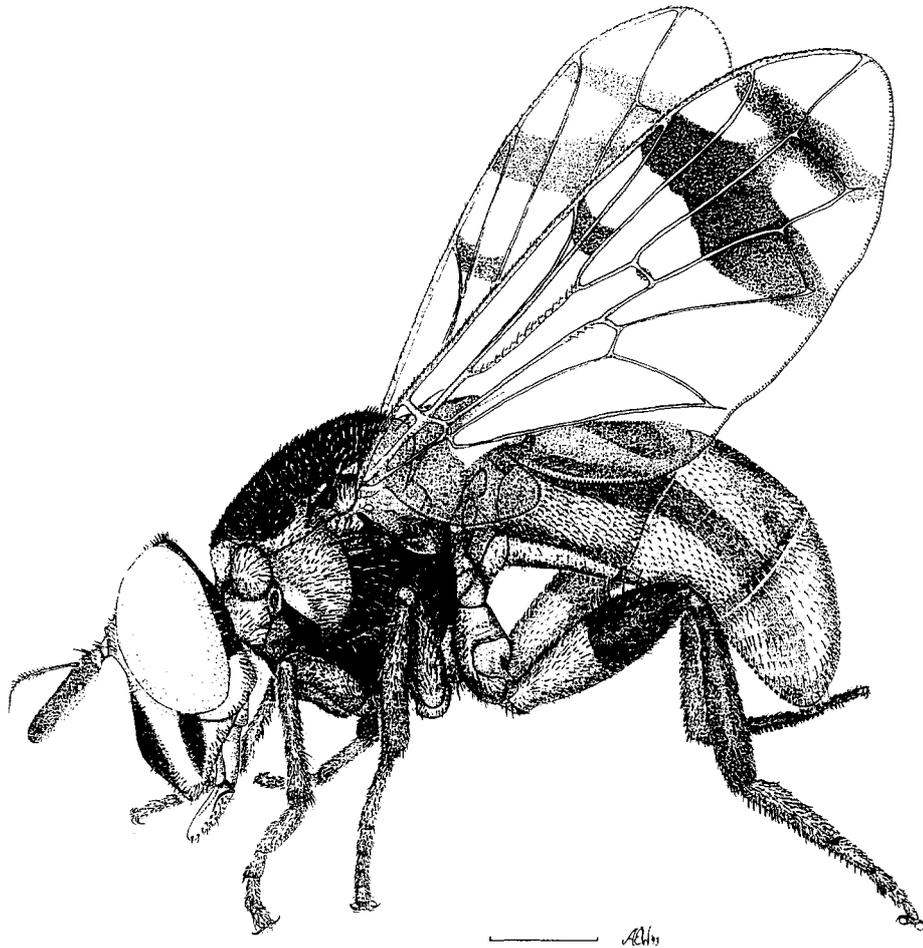
### Materials and methods

The description of the new species is based on the holotype. Variable character states are detailed (in parentheses) within the description. Bilaterally symmetrical features are described in the singular. Body length was measured from the apex of the profrons, to the apex of the abdomen. Wing length was measured from the base of the costa to the wing tip. The frons width is measured relative to head width (FH ratio) in the dorsal aspect. Label data of the primary type only is quoted verbatim with forward slashes between lines and semicolons between labels (with latitude and longitude in square brackets where not provided on the data label). Institutional codens follow Arnett *et al.* (1986). Reference to illustrations in Whittington (1992) are distinguished from Figure numbers of this paper by use of a lower case 'f'. For clarity the microtrichia on the wing membrane have been excluded from Fig. 1.

Distribution data plotted in the maps includes data additional to my 1992 data (Whittington, 1992). Species group distributions are discussed with reference to the vegetation zones of Unesco *et al.* (1981), to annual rainfall (Ade Ajayi and Crowder, 1985; MacKinnon and MacKinnon, 1986) and in southern Africa to effective temperature (Stuckenberg, 1969), although caution must be exercised when analysing apparent correlations between maps of distribution and environmental factors (Stuckenberg, 1969). It must be realised that vegetation maps are average conditions of a mosaic of vegetation over the landscape. In many cases, ecological data are included on labels with the specimens examined; the value of accuracy and completeness on specimen labels cannot be over-emphasized. Additional data regarding the locality and seasonality are included in the Tables. Species richness values were derived from the number of species collected at any one locality and represent overlap in species distributions. The distribution of *Graptomyza* in Africa was plotted and the richness (in single unit increments above 1) was superimposed, such that contours link areas of equal richness and surround areas of greater richness. Localities of possible conservation importance were highlighted based on highest species richness and rarity.

A catalogue of names is included. The last such list (Smith and Vockeroth, 1980) needs considerable revision, as 6 new names and numerous locality data have been added (Whittington, 1992). Furthermore, new records of *Graptomyza* include four African countries not previously listed. The catalogue lists all known Afrotropical species (synonyms indented), author-date, page number of the beginning of the description, coden for the depository of the primary type, country of type origin and, after the semicolon, other countries within the known distribution. For further discussion regarding species group position of *incertae sedis* refer to Whittington (1992); these names are included in the catalogue as *nomina dubia*.

Biological data have been gathered from specimens seen for the taxonomic revision of the genus (Whittington, 1992), the paper on puparia and larval biology (Whittington, 1994) and from additional specimens seen on recent visits to the Natural History Museum, London, the Museum National d'Histoire Naturelle, Paris and the Naturhistorisches Museum, Basel.



**Figure 1.** *Graptomyza spinifera* sp. nov. lateral view. Scale bar = 1 mm.

### **Taxonomy**

*Graptomyza spinifera* sp.nov. (Fig. 1).

Undescribed sp. 2 Whittington, 1992: 260 (figs 86, 93, 100, 107, 114, 120 and 125.)

*Body length* 6.92 (7.37) mm; *wing length*: 6.08 (6.13) mm.

*Head* Pale yellow with brown markings. Setae golden-yellow, brown at base of antennae and tip of epistome. Facial concavity poorly developed. Facial tubercle gibbose with a single elongate bump. Epistome projecting no further than middle of A.s.3. Eye dark red-brown. FH ratio 0.30:1. Antenna grey, ochre basoventrally. Arista ochre, darkening to black apically, dorsal vestiture longer than width of arista at base, slightly shorter ventrally. A.s.3 with silver pruinosity; 4.18 times longer than wide. Outer

sacculus ochre, oval  $0.04 \times 0.02$  (0.05) mm, situated one-third the length of A.s.3 from base. Setae: absent between antennae and facial tubercle.

*Thorax* Black; ochre on postpronotal lobe (humeral calli), on lateral edges of scutum, on propleuron, postero-dorsal part of anepisternum (mesopleuron), margins of scutellum and dorsal half of subscutellum. Scutellar depression dark brown, large  $0.34 \times 0.48$  ( $0.38 \times 0.50$  mm), shallow, with silver, recumbent hairs. Macrosetae: 2 npl, 3 spal, 3 pal, 1 ipal, 2 anepst and 2 scut. Subscutellum with silver pruinosity.

*Legs* Ochre, medio-distal two fifths of hind femur and entire hind tibia dark brown. Setae pale, brown on dark markings, with an anterodorsal row of prominent setae on dark part of hind femur and stout ventral spines medially to distally on hind tibia.

*Wing* Base of costa with 2 black macrosetae. Dorsal surface of Rs proximal to R<sub>1</sub> branch with 16 long setae on each wing; dorsal surface of M just proximal to branch bm-cu with 4 long setae on each wing. Pterostigma tinged yellow-brown with proximal and distal third brown, continuous with infuscation. Wing tinged pale brown, infuscation smoky. Haltere pale ochre brown.

*Abdomen* Dark ochre with brown lateral markings, starting on posterior margin of T1, a forward pointing v-shape medially on T2, and markings on T3 and T4 indistinct (incomplete, forward pointing v-shape on T3 and 2 parallel stripes on T4). Setae dark over brown markings, golden-yellow on ochre ground colour. Genital shield developed, spineless.

*Holotype* 1♀ "IPASSA PISTE PANTHÈRE [00°30'N:12°48'E] / (MALAISE) 11-16-V-1974"; "Museum Paris / GABON / Mission M. DONSKOFF et J. LE BRETON" [black framed label]; "HOLOTYPE ♀ / *Graptomyza spinifera* / sp.nov. / Det. A.E. Whittington" [red framed label with HOLOTYPE in red print]. MNHN. Condition good; right mid leg and hind tarsomeres (except basitarsomere) missing.

Additional material examined: CAMEROUN: 1 ♀, Fulasi [02°58'N:11°57'E], xii.1913, collector unknown (CNCI).

*Discussion* *Graptomyza spinifera* is a member of the *varia* species group, previously recorded as Undescribed species 2 in Whittington (1992). The *varia* species group is characterized by the following diagnostic characters: stout spines on hind tibiae and chevron markings on abdomen. In addition the following characters are shared by all members of this species group, although these may also be present in other species groups: brown bands on facial tubercle from antennal base to margin of epistome, across gena from eye margin to tip of epistome and on frons and vertex. Occiput dark brown to black. Eyes brown to red brown with moderate pile of pale golden setae. Antennal tubercle margined with brown. Pit of outer sacculus organ positioned between one quarter and one third the length and midway on width of A.s.3. Facial setae black on antennal tubercle, A.s.1 and 2 and on facial tubercle. Arista dorsally and ventrally plumose. Thorax pale yellow on *prepm*, *pprn lb* and posterior half of *anepst*. Macrosetae: 2 *anepst*, 2 *sctl*; numerous black setae between *sctl* macrosetae. Leg setation

conspicuously longer on posterior margins. Distal half of hind basitarsus and remaining tarsomeres with ventral combs of setae. Abdominal setae pale golden. Genital shield without spines.

The name *G. spinifera* was inadvertently published as a *nomen nudum* (Whittington, 1991) for the Fulasi specimen, which, because of its poor condition, is not considered here as part of the type series. The description given now clarifies the placement of this species and the specimen from Ipassa (in better condition) is designated as holotype.

The arrangement of hind tibial spines of this species closely resembles those of *G. triangulifera*. The following differences distinguish the new species: Face in profile slightly more gibbose and narrower in dorsal view (figures 83 and 90 compared to figures 86 and 93 (Whittington, 1992)). Propleuron and scutellum completely ochre coloured, scutellar depression moderate (0.38 × 0.50 mm). Wing infuscation similar, but sub-apical bar more extensive, partly linked to the apical bar. Abdominal markings open chevrons rather than closed triangles.

The key in Whittington (1992) needs little adjustment to incorporate this new species. The final couplet, previously referring to Undescribed species 2, should now read:

18 Medial dark marking on T2 forming a closed triangle (fig. 118); propleuron dark brown; scutellum margins bicoloured (fig. 110) .....

**triangulifera** (Bigot)

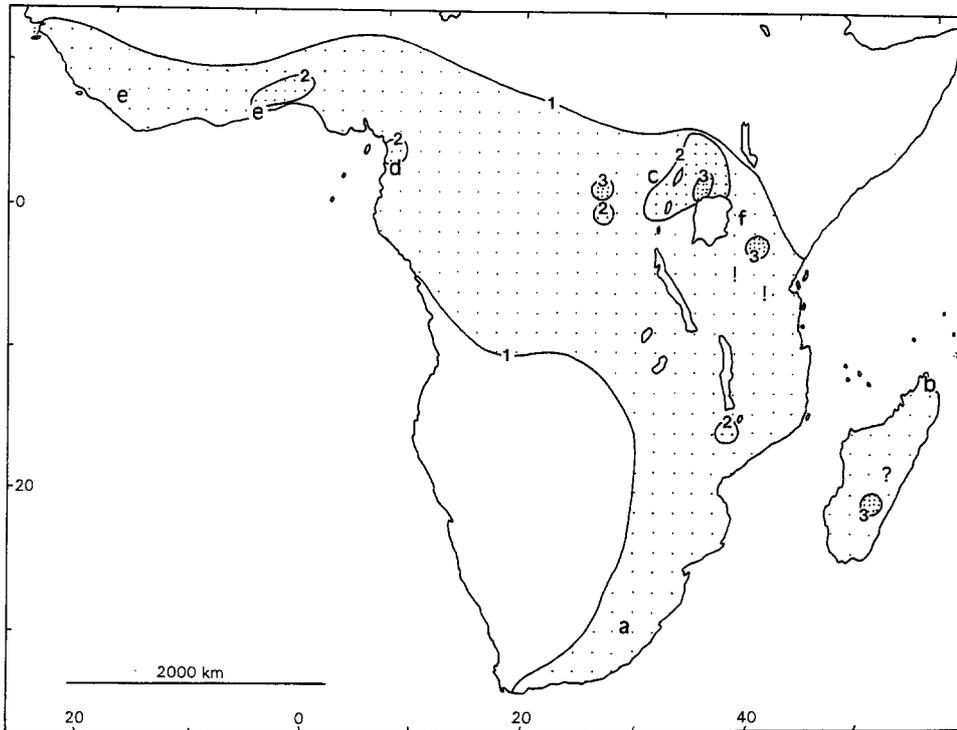
– Medial dark marking on T2 forming an inverted 'V' (fig. 120); propleuron ochre; scutellar margins ochre coloured only (fig. 114).

**spinifera** sp.n.

## Discussion

Various larval feeding media were reported in a paper on larval biology and puparia morphology (Whittington, 1994). Foods included tomatoes and unspecified rotting fruit for *G. signata* (Walker, 1860), unspecified pods for *G. triangulifera* (Bigot, 1883) and fallen fruit of *Castanospermum australe* A. Cunningham for a species near *G. flavicollis* (Ferguson, 1926). New label data indicate that a specimen of *G. triangulifera* was collected at Lugala (Uganda, 00°13'N; 33°55'E) at or on the large seed pod of *Kigelia africana* (Lam.) Benth. Another from Mpagha (Uganda, possibly: 00°32'N; 30°40'E) was collected at tree sap. Neither of these records indicates that oviposition was evident and therefore no link can be made regarding larval food resources. The data does, nevertheless, extend knowledge concerning the biology of the genus and may aid further collecting. A question remaining about the diet concerns the larval food source of grassland species (eg. *G. summa*), since the small bushes in grasslands are unlikely to supply fruits of sufficient size for the development of larvae. It may well be that these grassland species retreat to wooded riverine vegetation for oviposition.

New locality data, especially from central Africa and central West Africa (i.e. Cameroun and Gabon), confirm former distributional concepts (Whittington, 1992) with no species occurring in arid parts of Africa and a mainly tropical distribution (Fig. 2; Table 1). The northward boundary of distribution coincides broadly with the boundary of tropical savanna woodland (see Ade Ajayi and Crowder, 1985) or the undifferentiated woodland of Unesco *et al.* (1981). At the southern limits of the distribu-



**Figure 2.** Afrotropical *Graptomyza* species richness and endemism. Species richness contours indicate richness of 1, 2 and 3 species at any one locality. Letters and symbols indicate regions of endemic species or those of special interest respectively: a. *G. summa*, Lesotho and South Drakensberg. b. *G. pallidnotata*, Ambilobe, Madagascar. c. *G. lutea*, Epulu, Zaïre. d. *G. spinifera*, Fulasi, Cameroun and Ipassé, Gabon. e. *G. xanthopoda*, Obuasi, Ghana and Kpaine, Liberia. f. *G. nigricavum* nr. Nakuru, Kenya. ? *G. hova, incertae sedis*, Central Plateau, Madagascar. ! *G. quadrifaria, incertae sedis*, Mujenyi and Kimamba, Tanzania.

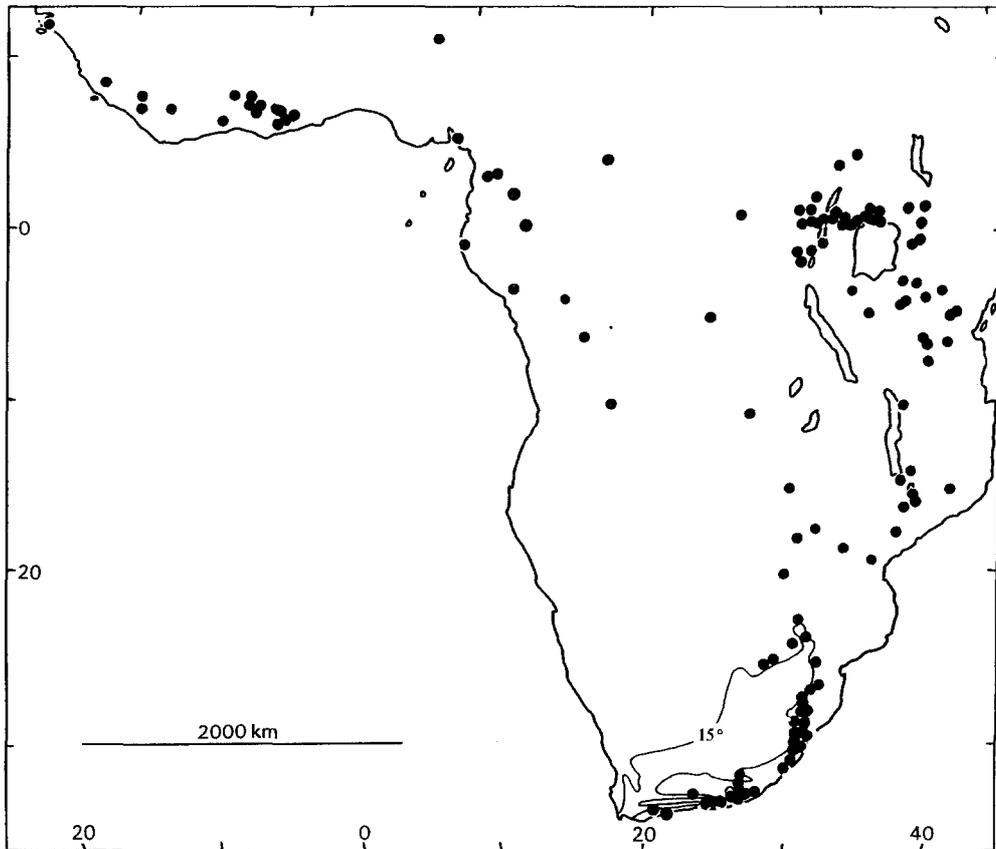
tion, a boundary is formed by the tropical wooded steppe of southern Angola and Zambia (i.e. the Zambezian transition zone of Unesco *et al.*, 1981) and semi desert steppe of the Kalahari. While tropical dry savanna appears to form a vegetative barrier at the northern limits, *G. signata* is distributed across this vegetation type in the middle of its range, suggesting that the northern zone of dry savanna acts as a buffer to the drier steppe (i.e. Sahel wooded grassland, Unesco *et al.*, 1981) to the north or that another environmental factor, such as moisture, plays a dominant role in the distribution of this genus.

Although isohyets for the whole of Africa are coarse (eg. MacKinnon and MacKinnon, 1986), the above distribution patterns fit broadly to an annual rainfall requirement of at least 400 mm. The absence of species in arid regions indicates the important role of rainfall in the distribution of *Graptomyza*. It is not clear which part of the life cycle this relationship with moisture affects, but it is possible that the larval stage is more adversely affected by aridity than is the adult. The saprophagous larvae appear to

**Table 1.** Distribution of *Graptomyza* in the Afrotropical Region

Species	West			Country Central						East						South									
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Z
<i>amplicavum</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
<i>aurea</i>	-	-	-	-	■	■	■	■	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5
<i>breviscutum</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	■	-	-	-	-	-	-	-	-	3
<i>clariata</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
<i>lutea</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
<i>nigra</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	■	-	-	-	-	-	-	-	-	2
<i>nigrivavum</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	■	-	-	-	-	-	-	-	1
<i>pallidantotata</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
<i>perforata</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	■	-	-	-	-	-	-	1
<i>robusticornis</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
<i>signata</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
<i>spinifera</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9
<i>suavissima</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
<i>summa</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6
<i>triangulifera</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
<i>varia</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	20
<i>xanthopoda</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Undescribed sp 1.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
Undescribed sp 3.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
<i>incertae sedis</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
<i>hova</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
<i>quadrifaria</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
No. species (Total 21)	1	2	2	1	3	3	4	2	1	2	1	6	1	2	6	4	2	4	2	4	2	3	2	1	1

A = Guinea Bissau, B = Sierra Leone, C = Liberia, D = Ivory Coast, E = Ghana, F = Nigeria, G = Cameroun, H = Central Africa Rep., I = Equatorial Guinea, J = Gabon, K = Congo, L = Zaïre, M = Angola, N = Sudan, O = Uganda, P = Kenya, Q = Rwanda, R = Tanzania, S = Malawi, T = Madagascar, U = Zimbabwe, V = Moçambique, W = South Africa, X = Lesotho  
Z = No. countries (Total 24).



**Figure 3.** Afrotropical distribution of the *Graptomyza varia* species group. The 15° effective temperature (ET) isoline is indicated for southern Africa.

require moist fruits for their development; through the effect of rainfall on the vegetation, these fruits are seldom distributed in arid areas. This is nevertheless unlikely to be the sole reason for the distribution pattern.

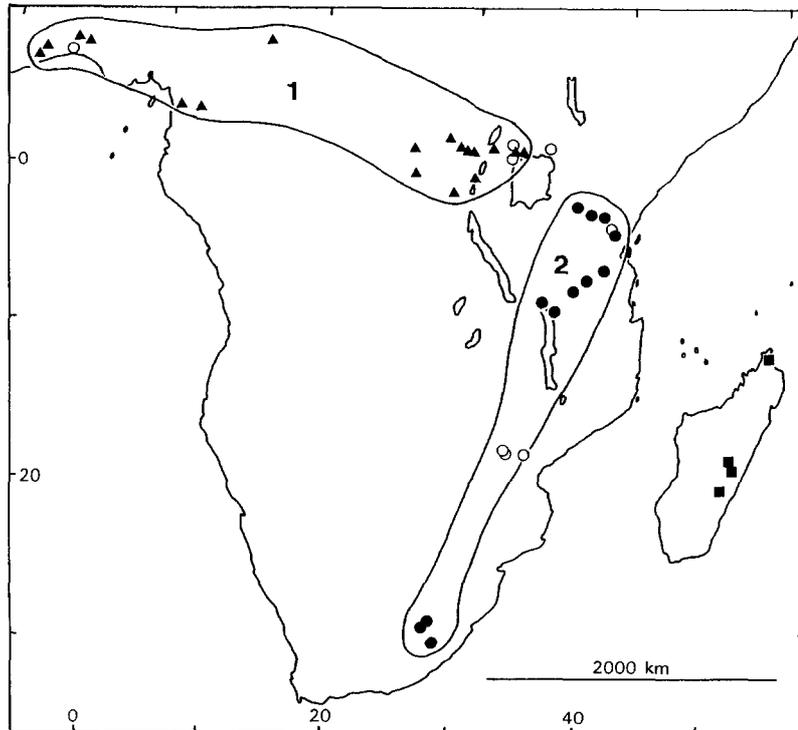
As noted by Stuckenberg (1969), temperature is likely to be of secondary importance. This is evident in the southern part of the distribution of the *varia* species group (Fig. 3). The predominant species distributed south of the Zambezi River is *G. signata*, which is restricted to and above the 15° effective temperature (ET) isoline (in Fig. 3, taken from Stuckenberg, 1969; fig. 5). This species is clearly restricted by the isoline south of the Limpopo River and east of the Drakensberg mountains, but its westward range in the Transvaal (and north thereof) is not so limited. In this part of the distribution rainfall evidently becomes more limiting than ET. There are only sufficient data to discuss seasonality in two species. Table 2 indicates that there is little seasonality in the more tropically distributed *G. triangulifera*, as expected. A distinct decline in numbers during the cooler months (June to September) is evident, however, for the less tropical *G. signata*. This decline coincides with the dry season, as well as with the effect of the 15° effective temperature isoline.

**Table 2.** Seasonal occurrence of *Graptomyza* species in the Afrotropical Region

Species	Month of the year												♂	♀
	J	F	M	A	M	J	J	A	S	O	N	D		
<i>amplicavum</i>	–	2	1	–	–	–	–	–	–	–	–	–	0	3
<i>aurea</i>	–	1	2	–	–	–	3	2	–	1	4	1	3	9
<i>breviscutum</i>	1	–	–	–	–	–	1	2	–	–	–	4	2	5
<i>clarala</i>	–	2	–	–	–	–	–	–	–	–	–	–	0	2
<i>lutea</i>	–	–	–	–	–	–	–	–	–	1	–	–	1	0
<i>nigra</i>	1	–	–	–	–	–	5	–	1	1	–	1	5	4
<i>nigricavum</i>	–	–	–	–	–	–	–	–	–	–	–	1	1	0
<i>pallidinotata</i>	–	–	–	–	–	–	–	–	3	–	–	–	1	2
<i>perforata</i>	–	–	1	–	–	2	1	2	–	1	2	–	2	9
<i>robusticornis</i>	2	–	1	–	–	–	–	–	–	1	–	2	0	5
<i>signata</i>	39	31	56	28	17	4	7	3	9	23	21	28	90	192
<i>spinifera</i>	–	–	–	–	1	–	–	–	–	–	–	1	0	2
<i>suavissima</i>	2	3	1	1	–	6	–	1	–	2	–	–	8	10
<i>summa</i>	3	–	–	–	–	–	–	–	–	–	–	–	1	2
<i>triangulifera</i>	21	5	1	5	26	13	12	13	20	15	17	18	73	99
<i>varia</i>	–	–	–	–	–	–	–	–	–	–	1	–	1	0
<i>xanthopoda</i>	–	–	–	–	–	1	–	–	–	1	–	–	0	2
Undescribed sp 1	–	–	–	–	–	–	–	–	–	1	–	–	1	0
Undescribed sp 3	–	–	–	–	–	–	–	–	1	–	–	–	0	1
<i>incertae sedis</i>														
<i>hova</i>	–	–	–	1	–	–	–	–	–	–	–	–	0	1
<i>quadrifaria</i>	–	–	–	–	1	–	–	–	1	–	–	–	?	?
No. species (Total = 19)	7	6	7	4	4	5	6	6	6	10	5	8	189	348

*Graptomyza summa* on the other hand has a narrow highland distribution, restricted in terms of ET below the 14° isoline. Much as there is a reasonable correlation between ET and species distribution in southern Africa, this trend does not continue north-westwards. By comparing Bailey's (1960) world map for ET with the range of *Graptomyza*, there is a broad correlation northwards along the eastern half of Africa from the Tropic of Capricorn and along the edge of the Sahara, but not westwards in the southern arid regions of Angola and Namibia; the categories used by Bailey (1960) are, however, broad and therefore the correlation is limited.

It is thus evident that the restrictions on distribution represent a complex of factors, eg. rainfall, ET, vegetation and other environmental factors (such as topography). Many of these factors are positively correlated (eg. ET and topography (Stuckenberg, 1969)), while others show a broad similarity (eg. rainfall and vegetation (Ade Ajayi and Crowder, 1985; MacKinnon and MacKinnon, 1986), vegetation and soils (van Wyk, 1972; Ade Ajayi and Crowder, 1985)). MacKinnon and MacKinnon (1986) point out that extremes of climate and duration of critical conditions are likely to be greater determinants of vegetation patterns than are individual correlations. Combinations of several climatic factors provide better correlations, but long term cycles and oscillations may be far more important (particularly regarding rainfall, Tyson, 1978), especially in the highly sensitive marginal zones between vegetation types.



**Figure 4.** Afrotropical distribution of ▲ *Graptomyza aurea* species group, ● *Graptomyza perforata* species group, ■ *Graptomyza robusticornis* species group and ○ *Graptomyza suavissima*. Areas 1 and 2 represent the proposed ranges of distribution for the *aurea* and *perforata* species groups respectively.

The *varia* species group coincides with the generic distribution in Africa (excluding Madagascar (Fig. 3)). It can be considered a generalist group existing in the full range of vegetation types: from West African mangrove and lowland rain forest to East African deciduous bushland and from Central African undifferentiated woodland to East African Coastal mosaic and Cape Fynbos. The *suavissima* group (Fig. 4) consists of one species widely distributed, but restricted in habitat to Guineo-Congolian dry rain forest, G-C rain forest grassland mosaic and Afromontane forest.

The other species groups are more restricted in their distributions. The *robusticornis* group is found only in Madagascar (Fig. 4) and is restricted to seasonally dry deciduous and montane rain forest habitats. The *perforata* species group predominates above 1500m (although a single specimen of *G. perforata* is known from 1000m). *G. perforata* is almost entirely an Afromontane forest species. *G. summa* is known only from the transition vegetation from Afromontane scrub forest to Highveld grassland of the Lesotho highlands and Eastern Cape Drakensberg between 2150 and 2680m. The *aurea* species group is West and Central African, being restricted to forest habitats of the following categories: Guineo-Congolian wet and dry rain forest, G-C rain forest grassland mosaic and Afromontane forest, Sudanian woodland and swamp forest.

Forest, especially rain forest, forms the major component of habitat type of

**Table 3.** Localities with maximum recorded species richness for Afrotropical *Graptomyza*

Species richness	Locality	Latitude and longitude	Vegetation type (categories) from Unesco, 1981)	Species
3	Kisangani, Zaïre	00°30'N:25°12'E	swamp forest (8)	<i>aurea nigra</i> and <i>triangulifera</i>
	Kampala, Uganda	00°19'N:32°35'E	Guineo-Congolian lowland rain forest and secondary grassland mosaic (11a)	<i>nigra</i> , <i>triangulifera</i> , undescribed sp. 3.
	Entebbe, Uganda	00°04'N:32°27'E	Guineo-Congolian lowland rain forest and secondary grassland mosaic (11a)	<i>signata</i> , <i>suavissima</i> , <i>triangulifera</i>
	Mt. Meru, Tanzania, 1500 – 1800 m	03°14'S:36°45'E	Afromontane (19a)	<i>perforata</i> , <i>signata</i> , <i>triangulifera</i>
	7 km W Ranomafana, Fianarantsoa Prov., Madagascar	21°15'S:47°25'E	Madagascar moist montane forest (5)	<i>amplicavum</i> , <i>clarala</i> , <i>robusticornis</i>
2	Oshogbo, Nigeria	07°46'N:04°34'E	Guineo-Congolian dry rain forest (2)	<i>aurea</i> and <i>triangulifera</i>
	Obuasi, Ghana	06°55'N:01°41'E	Guineo-Congolian dry rain forest (2)	<i>aurea</i> and <i>triangulifera</i>
	Imatong, Lomariti, Sudan	03°53'N:32°43'E	Afromontane (19a)	<i>signata</i> and <i>triangulifera</i>
	Lolodorf, Cameroun	03°17'N:10°50'E	Guineo-Congolian wet lowland rain forest (1a)	<i>aurea</i> and <i>triangulifera</i>
	Jinja, Uganda	00°27'N:33°14'E	Guineo-Congolian lowland rain forest and secondary grassland mosaic (11a)	<i>signata</i> and <i>triangulifera</i>
	Kawanda, Uganda	00°26'N:32°32'E	Guineo-Congolian lowland rain forest and secondary grassland mosaic (11a)	<i>suavissima</i> and <i>triangulifera</i>
	Lesse, Zaïre	00°20'N:29°40'E	East African evergreen bushland and secondary <i>Acacia</i> wooded grassland mosaic (45)	<i>breviscutum</i> and <i>triangulifera</i>
	Kakamega Forest, Yala River, Kenya	00°16'N:34°53'E	Guineo-Congolian dry rain forest (2)	<i>suavissima</i> and <i>triangulifera</i>
	Mlanje, Malawi	15°57'S:35°36'E	Afromontane (19a)	<i>signata</i> and <i>triangulifera</i>

Afrotropical *Graptomyza*. Although studies of single genera are of limited value compared to multi-generic biodiversity studies, this distribution suggests a high priority for the conservation of forest in Africa to secure the preservation of this genus. This concurs with the notion that the centre of arthropod diversity is tropical rain forest (Stork, 1988). Distribution in grassland appears to be a secondary extension of the habitat of certain species eg. *G. triangulifera*, *signata* and *summa*.

**Table 4.** Localities of endemism and particular interest for Afrotropical *Graptomyza*

Locality	Latitude and longitude	Vegetation type (categories from Unesco, 1981)	Species	Comment
Sierra Leone	ca. 09°00'N:13°00'W	Guineo-Congolian lowland rain forest and secondary grassland mosaic (11a)	<i>varia</i>	only locality known
Kpaine, Liberia	07°10'N:09°07'W	Guineo-Congolian wet lowland rain forest (1a) and dry rain forest (2) mosaic (3)	<i>xanthopoda</i>	only localities known
Obuasi, Ghana	06°12'N:01°40'E	Guineo-Congolian dry rain forest (2)	<i>xanthopoda</i>	
Fulasi, Cameroun	02°58'N:11°57'E	Guineo-Congolian wet lowland rain forest (1a) and dry rain forest (2) mosaic (3)	<i>spinifera</i>	only localities known
Ipassse Piste Panthère, Gabon	00°30'N:12°48'E	? Guineo-Congolian wet lowland rain forest (1a)	<i>spinifera</i>	
Epulu, Zaïre	01°15'N:28°21'E	Guineo-Congolian lowland rain forest and secondary grassland mosaic (11a)	<i>lutea</i>	only locality known
14 miles NE Nakuru, Kenya	00°05'S:36°04'E	East African evergreen bushland and secondary <i>Acacia</i> wooded grassland mosaic (45)	<i>nigricavum</i>	only locality known
Mujenyi, Tanzania	05°06'S:34°48'E	Dry Zambian miombo woodland (26)	<i>quadrifaria</i>	<i>incertae sedis</i> , only localities known

Kimimba, Tanzania	06°47'S:37°08'E	Zanzibar-Inhambane coastal mosaic (16a)	<i>quadrifaria</i>	
Ambilobe, Ankarana, Madagascar	13°10'S:49°03'E	Madagascar dry deciduous forest and secondary grassland mosaic (22b)	<i>pallidinotata</i>	only locality known
Central plateau, Tananarive [Prov.], Madagascar	ca. 18°55'S:47°31'E	Madagascar cultivated and secondary grassland replacing upland and montane forest (18)	<i>hova</i>	<i>incertae sedis</i> , only locality known
Ranomafana National Park, Fianarantsoa Prov., Madagascar	21°15'S:47°25'E	Madagascar moist montane forest (5)	<i>amplivavum</i> and <i>clarata</i>	only locality known for each species and area of high species richness
Little Bokong River Lesotho	29°25'S:28°08'E	Transition Afromontane scrub forest to Highveld grassland (20)	<i>summa</i>	only localities known
Blue Mountain Pass Makhaleng Valley, Lesotho	29°44'S:27°43'E	Transition Afromontane scrub forest to Highveld grassland (20)	<i>summa</i>	
Summit Naudesnek, South Africa	30°44'S:28°08'E	Transition Afromontane scrub forest to Highveld grassland (20)	<i>summa</i>	

The measure of species richness produced only five localities with 3 species and nine localities with 2 species (Fig. 2; Table 3). An important feature is the regular occurrence of *G. triangulifera* with other species. This may reflect the general requirements of the species, but nevertheless it means that the species requires conservation status over a wider range of habitats than do the more endemic species. All localities with species richness greater than one are in forest: swamp forest, various forms of rain forest or Afromontane forest (Table 3), with particular emphasis on the Guineo-Congolian rain forest forms. Eight of the fourteen localities are urban areas, with many specimens collected in the first half of the century. Whether suitable habitats still remain at these localities is debatable.

Fourteen localities represent highly localized species (endemics) and species of particular interest (Fig. 2; Table 4). *G. varia*, *lutea*, *nigricavum*, *amplicavum*, *clarala* and *pallidinotata* are known from a single locality only and this is of course also the type locality. While scarcity may be a measure of the amount of collecting effort, the fact remains that these localities represent places of endemism. Consequently, with ever decreasing amounts of natural vegetation these localities need protection. The species listed in Table 4 (excepting the two *incertae sedis*) can be considered vulnerable in terms of the IUCN categorization (IUCN, 1988). Ranomafana National Park (not listed in MacKinnon and MacKinnon, 1986, but recognised as a conservation area (Steiner, *in litt.*) 7km West of Ranomafana (21°15'S: 47°25'E) is of particular interest, since, not only is it the only known locality for *amplicavum* and *clarala* (Table 4), it is also an area of high species richness (including *robusticornis*; Table 3). This is an excellent example of good conservation, in which both endemism and species richness are conserved. Known localities for the two *incertae sedis* species have been included in Table 4, since these localities represent the only link to the species names and their possible future identification.

It is important to note that few localities listed in Tables 3 and 4 lie inside the boundaries of nature reserves. This may herald a precarious existence for the nine unprotected species, especially since most are in forest areas, susceptible to developmental pressures and modification by an expanding human population. The following places, with high species richness and endemism, fall within the boundaries of conserved areas: Entebbe (Sanctuary), Mt Meru, Ranomafana National Park, Imatong, Jinja, Kakemega, Mlanje (Table 3 and 4), resulting in at least partial protection of nine (out of 19) species.

The case for conservation of *Naudesnek* (South Africa) is strong. The Lesotho localities at which *G. summa* were collected are unlikely to become nature reserves, due to the method of land tenure, although McVean (1977) recommended the Makhaleng Valley as a reserve area. Population pressure is high in Lesotho, with large amounts of habitat modification, and only 0.2% of the landmass is set aside for conservation i.e. Sehlabathebe National Park (MacKinnon and MacKinnon, 1986). This leaves *Naudesnek* in the eastern Cape highlands (30°44'S:28°08'E; the type locality for *G. summa*) as the only remaining location for protection of the species, although this region is privately owned farmland. The species was last collected from Lesotho in 1963 (B. and P. Stuckenberg, personal communication), and at *Naudesnek* in 1979 (J. Londt and B. Stuckenberg, personal communication). A recent Natal Museum collecting expedition to *Naudesnek* (1992) failed to locate *G. summa*, thus its status is uncertain, but most probably vulnerable.

Provision of protective legislation for Naudesnek is supported by the distribution of other fly species. For example *Pelloloma nigrifacies* Vockeroth, 1973 (Syrphidae; the only member of this genus) is known only from this locality between 2350 and 2525m. *Dasophrys montanus* Londt, 1981 and *Goneccalypsis montanus* Londt, 1982 (Asilidae) both occur at Naudesnek. For the former species it is the type locality and is known from one other nearby locality (Rhodes) and for the latter it is one of the localities listed from similar high altitude localities (including those mentioned in Lesotho for *G. summa*).

Furthermore, at least 12 highly restricted montane Empididae occur in habitats including the Blue Mountain Pass, Bushman's Pass (also in the Maloti Mountains of Lesotho), Naudesnek and Lundeans Nek (both in the Barkley East district, within 35km of each other) (Smith, 1969). Those species restricted to Naudesnek (and in some instances other localities in Lesotho) are: *Afrodromia reductus* Smith, 1969, *A. maculifemur* Smith, 1969, *A. flavifemur* Smith, 1969, *A. semperviva* Smith, 1969, *Drymodromia simplex* Smith, 1969, *Hilarempis julianus* Smith, 1967, *Platypalpus impololoi* Smith, 1969. Other endemic montane empidids not known specifically from Naudesnek, but known from Lundeans Nek and Lesotho highlands, include: *Drymodromia pseudofemorata* Smith, 1969, *Hilarempis breviseta* Smith 1967, *Platypalpus malotiensis* Smith, 1969, *P. vicina* Smith, 1969 and *P. fratercula* Smith, 1969. Both *Drymodromia* Becker, 1914 and *Afrodromia* Smith, 1969 are Subsaharan endemics, with the latter known only from South Africa. *Hilarempis Bezzi*, 1905 is an austral element, well represented in southern Africa (Smith, 1969), while *Platypalpus* Macquart, 1827 is more widespread. The highly localized species mentioned above and the restricted generic distributions of *Drymodromia* and *Afrodromia*, support the concept of a highland reserve, for which Naudesnek summit is proposed.

#### Catalogue of Afrotropical species

- amplicavum* Whittington, 1992: 225. Madagascar (USNM).  
*aurea* Bezzi, 1915: 59. Nigeria (BMNH); Ghana, Cameroun, Central African Rep., Zaïre.  
*breviscutum* Curran, 1929: 7. Zaïre (AMNH); Uganda, Rwanda.  
*clarala* Whittington, 1992: 228. Madagascar (USNM).  
*lutea* Whittington, 1992: 242. Zaïre (CASC – Type 16818).  
*nigra* Bezzi, 1915: 60. Uganda (BMNH); Zaïre.  
*nigricavum* Whittington, 1992: 247. Kenya (CASC – Type 16819).  
*pallidinotata* Whittington, 1992: 229. Madagascar (NMWC).  
*perforata* van Doesburg, 1960: 435. Tanzania (MRAC).  
*robusticornis* van Doesburg, 1957: 107. Madagascar (MNHN).  
*signata* (Walker, 1860): 288 (*Paragus*). South Africa (BMNH); Zaïre, Sudan, Uganda, Kenya, Tanzania, Zambia, Malaïwi, Zimbabwe, Moçambique.  
*vittigera* Bigot, 1884: 321.  
*spinifera* sp.n. Gabon (MNHN); Cameroun.  
*suavissima* Karsch, 1888: 382. Tanzania (ZMHB); Nigeria, Uganda, Kenya, Zimbabwe, Moçambique.  
*summa* Whittington, 1992: 234. Lesotho (NMSA – Type 510); South Africa.  
*triangulifera* (Bigot, 1883): cxiv (*Ptilostylomyia*). Sierra Leone (BMNH): widespread

Afrotropical mainland (not recorded from Madagascar, Zimbabwe, South Africa and Lesotho).

*liberiae* Greene, 1949: 78.

*melanura* Bezzi, 1908: 381.

*pentaspila* Bezzi, 1908: 381.

*varia* (Walker, 1849): 540 (*Microdon*). Sierra Leone (BMNH).

*xanthopoda* Bezzi, 1915: 57. Ghana (BMNH); Liberia.

Undescribed sp 1 Whittington 1992: 245. Cameroun.

Undescribed sp 3 Whittington 1992: 260. Uganda.

#### *nomina dubia*

*hova* Keiser, 1971: 260. Madagascar.

*quadrifaria* Szilády, 1942: 96. Tanzania.

#### *Species groups*

*aurea* group: *G. aurea* Bezzi, 1915, *G. breviscutum* Curran, 1929, *G. lutea* Whittington, 1992, *G. nigra* Bezzi, 1915, undescribed species 1.

*perforata* group: *G. perforata* van Doesburg, 1960 and *G. summa* Whittington, 1992.

*robusticornis* group: *G. amplicavum* Whittington, 1992, *G. clarala* Whittington, 1992, *G. pallidinotata* Whittington, 1992 and *G. robusticornis* van Doesburg, 1957.

*varia* group: *G. nigricavum* Whittington, 1992, *G. signata* (Walker, 1860), *G. spinifera* sp.n., *G. triangulifera* (Bigot, 1883), *G. varia* (Walker, 1849), *G. xanthopoda* Bezzi, 1915, undescribed species 3.

*incertae sedis*: *hova* Keiser, 1971, *quadrifaria* Szilády, 1942.

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