Volume 24 (4) (December) 2021 ISSN 0975-1963

Insect Environment

Quarterly journal

IE is abstracted in CABI and ZooBank

CABI

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An *AtmaNirbhar* initiative by Indian entomologists for promoting Insect Science

Published by
International Phytosanitary Research & Services (IPRS)

Recognized by
The DIPP, Ministry of Commerce and Industry, Government of India

For Private Circulation only

Editorial Board

Cover Page: *Apis dorsata

Photo by: Dr. Nagaraj, D.N Senior Scientist

Bio Pest Management Pvt. Ltd. Kanakapura Road, Bangalore

Insect Environment

(Quarterly journal to popularize insect study and conservation)

ISSN 0975-1963

The first issue of the Insect Environment was published in 1996. The sole objective of the Insect Environment is to popularize insect study through popular, semi-technical research notes, photographs, short blogs and essays on all aspects of insects. The journal is published quarterly, in March, June, September, and December.

Insect Environment subscription is free; articles can be downloaded from the website **https://insectenvironment.com/** or anyone requesting by email to IE will receive a copy of the journal.

Author guidelines

Short popular insect notes, review essays, new records, profiles, tributes and views are acceptable. There are no page charges; each article should preferably not exceed 500 words. Authors can refer to back volumes available on the website for writing style. Good photographs are encouraged. A special insect photo gallery "Insect Lens" is to encourage professional and amateur photographs on insects.

The blogs are for quick dissemination of insect "news". These will be published within a week of submission. Blogs should be about hundred words with one photograph, in simple English

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Send to A/c No: 520101048085843; IFSC: UBIN0907979

Swift Code: UBININBBPEE, AD CODE: 02903GQ (for remittance from abroad)

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Editorial

In my last editorial I wrote that it was a 'floody' quarter. Well, this quarter, till early December, as I write this, it's been a 'soaky' quarter! The state I stay, Karnataka in South India received 250% more rains. Parts of absolute dry areas like Tumkur, Kolar, etc., were flooded, and sprigs of lush green sprung all over. I joked to friends that I am reminded of my home state Kerala which is always watery and green!

As I wrote in the last quarter, insects adapted to dry terrain, will certainly be affected by the excessive wetness. Any studies possible? I have been a slow believer of climate change, perhaps justifying it as a buzzword only to draw funds! Now I have changed my perception, with the raging tempest and sea billows rolling from Bay of Bengal to the Arabian Sea, battering the terra firma in between. Just imagine how many migratory and flying insects must have been caught in the gushing cross currents of swirling water and wind.

Insect environment is unique in that it captures many small links in research, and that makes a big difference! It's not interested in long drawn regimented papers for there are several entomological journals catering to such! Ours is the only insect journal disseminating with speed- information, news, photos etc! The blogs we published last quarter was @ one a week. Digital track being what it is, we are aiming even speedier visibility. This issue again is on time and will be uploaded by end December.

Natural history from Darwin to even early insect studies of 19th and 20th centuries are good reading of geographical fauna with biological qualitative details. These laid the foundation for all our biological studies including insect fauna. We still draw from their rich repertoire found in Fauna of British India series and many old books.

The inimitable *Journal of Bombay Natural History Society (JBNHS)* of which I am an avid reader, is a telling testimony of mesmerizing natural history science. Reading some of the articles therein, I always felt the authors enjoyed what they did and wrote! This is the essence we wish to enshrine through Insect Environment. Insect Environment serves such insect lovers, amateurs, photographers, and professionals who manifest a special passion for our six leggies!

I am sure you may have noticed that Insect Environment is evolving into an insect photo journal! Thanks to our professional photographer Drs. D.N. Nagaraj and Sevgam

Subramanian, and many digital nomads who come across strange insects on the trot, and capture them with smart phones. These are as clearer to the last setae, that we publishing such pictures help permanently document their efforts. A picture in addition is a record of an insect in a particular location/ habitat/ plant. Our readers will be happy to note that our Insect LENS, receives the first flip-through by thousands of students, lay amateurs and professionals too!

In this issue we have published photographs of Mr. A Raghuram, an electronic engineer, who has a passion for macro and micro photography of arthropods. He is the son of Dr. A Seetharam, a well-known millet specialist based out of University of Agricultural Sciences, Bengaluru. Dr. Sunil Jagannavar from Dharwar has also sent some excellent photographs. We also document some remarkable insects from Arunachal Pradesh by Dr. Temjenmongla. It is the studied endeavour of IE that this journal documents insect pictures for permanency and posterity.

We congratulate Dr. Debjani Dey, Head and Professor, Division of Entomology, ICAR-Indian Agricultural Research Institute, New Delhi for organizing the XIIIth Dr S. Pradhan Memorial Lecture rendered by Dr Zeyaur R. Khan, Principal Scientist and Programme Leader, International Centre of Insect Physiology and Ecology, (ICIPE)), Nairobi, Kenya & Adjunct Professor, Department of Entomology, College of Agriculture and Life Sciences, Ithaca, USA on " Exploiting Chemical Ecology and Plant Signalling for Developing Sustainable Crop Protection Strategies for Smallholder Farmers" -- A Lifetime Journey of an Indian Scientist from Lab to Land. His push pull approach in pest management arising from his own research was very convincing. This superb lecture is available on the YouTube (https://youtu.be/L5QwmVRp_Kc). Another report by Dr. K. Subaharan on taxonomy diversity *vis-a-vis* functional diversity in insects is equally fascinating.

Readers should note that in this issue we have an article by Ajil Benny, an undergraduate student from Kerala. IE is the only journal that encourages documentation at that level. We wish he becomes a great entomologist. After all "a fall of the sparrow" was the first step for the great ornithologist, the late Dr Salim Ali!

Where there is an insect blast, there should be IE. The outbreak of invasive thrips, *Thrips parvispinus* on chilli was as hot as the Guntur chilli of Andhra Pradesh in South India. We had blogged it too. But, this issue has a detailed note including managements by Dr. K. Sireesha, Dr. D. Anitha Kumari, and Dr. Nagaraju, D.K. and all their co-authors. We are the earliest of journals to blog and report on this and we are happy it has reached scientists and policy makers across India and abroad.

Dr. Hamadttu, A. F. El-Shafie and Dr. J. R. Faleiro have reported a rearing protocol

for the longhorn date palm borer, *Jebusaea hammerschmidtii*. This is a very useful study in the management of the beetle in the Gulf region.

We have several new records of interest. I would like to comment on the note by Dr. K. Vanitha on red ants devouring mosquitoes. Now these are interesting facets of insect natural history which many of us come across but only a few document! But these are important ecological bridges which add up to insect ecology. These are the sort of notes which only IE will publish, for anything small is Big for us!

Any entomologist being awarded or felicitated is a matter of joy for us at IE. We profile a few of them in this issue, Dr. John Peter, Dr. Chalapathi Rao, Dr. B.R Jayanti Mala and our editors Dr. Jayashankar and Dr. Rashmi, M. A.

We have now over 4000 subscribers all over the world and as IE is free forwards and downloads, it is being shared far beyond our enumeration. For us at IE "more the merrier"!

2022 is our Silver Jubilee Year. Looking back, we have lots to reminiscence. That's for the next issue! But meanwhile we are kicking off our celebration. First would be the Asia-Pacific Conference on Beekeeping for Sustainable Agriculture, Ecosystem Services and Rural Livelihoods (BEE 2022), partnering with V. Sivaram Research Foundation (VSRF). Secondly we will be nominating Young Insect Environmentalist and Insect Environment and Conversation Awards probably in May 2022. Read more on these in our website.

As we stand at the threshold of 2022, with potential of many "polyvariants" of COVID a possibility, we wish all our readers absolutely safety.

Make your own 'bubble' and stay healthy! A happy New Year.

Dr. Abraham Verghese

Editor-in-Chief

XIIIth Dr S. Pradhan Memorial Lecture

Report from ICAR-Indian Agricultural Research Institute, New Delhi, India

Dr S. Pradhan, a doyen among entomologists, during his 33 years of professional career made such an impact on entomological research and teaching that Entomology and Plant Protection Science came to the forefront of agricultural research in India. His success story would continue to encourage Plant Protection Scientists of the country for generations to come.

Dr Pradhan joined the Indian (then Imperial) Agricultural Research Institute in 1940 and became the first Professor of Entomology in 1958 when the Post-Graduate School was established at the Institute and became Head of the Division soon afterwards in 1962.

Dr Pradhan was the first to visualize the country's need for integrated pest management instead of the conventional method of chemical control alone, which though successful at the time had started showing adverse effects. He always emphasized on the fact that '*protection research was more needed than production research in the tropics'.* Therefore crop protection research should have its rightful place in the overall agricultural research efforts of the country. His forceful arguments for adopting Integrated Pest Management to fully realize the production potential of new high yielding strains of different crops, had their impact and the country adopted IPM as a national strategy, although after his demise.

To remember his contributions to Indian Entomology, a corpus fund was put in place with contributions from his family, individual entomologists, ex-students and his well-wishers and as part of the golden jubilee year of our country's independence, Division of Entomology started Dr S. Pradhan Memorial Lecture series. Till date 12 lectures have been delivered by eminent entomologists in this prestigious lecture series on various aspects of Entomology.

The XIIIth Dr S. Pradhan Memorial Lecture Organized by the Division of Entomology, ICAR- Indian Agricultural Research Institute was held on November 8, 2021 on Zoom platform. The lecture was delivered by Dr Zeyaur R. Khan, Principal Scientist and Programme Leader, International Centre of Insect Physiology and Ecology, (*ICIPE)*), Nairobi, Kenya & Adjunct Professor, Department of Entomology, College of Agriculture and Life Sciences, Ithaca, USA on " **Exploiting Chemical Ecology and Plant Signaling for Developing Sustainable Crop Protection Strategies for Smallholder**

Farmers" - *A Lifetime Journey of an Indian Scientist from Lab to Land***.**

Prof. Zeyaur Rahman Khan is one among the distinguished alumni of Indian Agricultural Research Institute, New Delhi, receiving both his M.Sc. (1977) and Ph.D. (1980) degrees from the institute. Soon after completing his Ph.D he taught for a brief period at Rajendra Agricultural University (1980–1983) in Bihar, India. Thereafter he worked in various capacities at the International Rice Research Institute (IRRI), Philippines (1983–1985; 1986–1991), University of Wisconsin, Madison (1985-1986), Kansas State University (1991–1993) before finally joining International Centre of Insect Physiology and Ecology, Nairobi, Kenya in 1993.

During his student days Dr Khan impressed by Dr. Pradhan's vision on India's need for integrated pest management instead of the conventional chemical control alone, went ahead and explored the many facets of insect-plant interactions for his Ph. D. Degree and continued to do so through his entire career.

After joining ICIPE in 1993, Dr Khan moved to its field station in rural Western Kenya, to lead ICIPE's flagship project 'Push-Pull' to control stem borers, fall armyworm and Striga weed, all of which are major constraints to maize production while protecting the environment and improving soil fertility. He has dedicated more than 30 years of his career for advancing the science and practice of entomology by studying and applying chemical ecology, insect behaviour, plant–plant, insect–plant and plant-soil interactions etc.

Dr Khan is internationally lauded for his development and Africa-wide dissemination of the innovative system of "push–pull farming," which simultaneously addresses issues of crop pests, soil improvement, food security, climate change and sustainability. His work in developing the push-pull technology is a wonderful example demonstrating that creativity and innovation in agricultural sciences can provide practical solutions for the real problems of poor smallholders by removing constraints of their farming and ultimately leading to better food security and sustainable livelihoods.

He was awarded the **Louis Malassis International Scientific Prize for Outstanding Career in Agriculture in 2015** for his exemplary and promising contribution in promoting innovation through research, development and capacity building in order to improve food and sustainability in agricultural systems as well as contributing towards addressing food security and poverty reduction. Among the many other recognitions received by Dr Khan noteworthy ones include : Honorary Fellow of the Royal Entomological Society,

London, Fellow of Entomological Society of America; Fellow of African Academy of Sciences; Council Member, International Congress of Entomology; and President of International branch of Entomological Society of America (2019). Dr Khan has authored more than 170 scientific papers, and 20 books and book chapters

Dr Khan spoke about the challenges he had faced and also ways and means devised to overcome them. The successful use of 'Push-Pull' to control stem borers, fall armyworm and Striga weed, all major constraints in maize production on one hand and while on the other hand protecting the environment and improving soil fertility in sub-Saharan Africa wherein most of the smallholder farmers are resource-constrained and unable to afford expensive chemicals for crop protection.

All his research efforts led to the development of novel strategies for integrated pest and weed management involving selection of appropriate plants which naturally emit signalling chemicals (semio-chemicals) and influence plant-plant and insect-plant interactions in other words development of a cropping strategy, known as 'push–pull' (www.push-pull.net), which exploits the phytochemicals released by the companion plants grown in between and around the main cereal crops.

Principles of the chemical ecology involving insect-plant and plant-plant interactions formed the basis of the push-pull technology could not only achieve intensification of crop and livestock production but also generate sustainable beneficial impact on food sufficiency/security, nutrition, farm income without any detrimental effect on soil health and environment. All of which supported resource poor households under their existing socio - economic and agro - ecological conditions.

Some of the benefits of Push-pull technology highlighted by Dr. Khan are:

- It does not depend on external inputs such as pesticides and mineral fertilizer, which is a boon, especially to small farmers.
- Is environmentally friendly, as fewer synthetic chemicals are put into the environment and agro-biodiversity is increased, which benefits ecosystem services
- In addition to raising cereal productivity, the technology restores soil system fertility through nitrogen fixation, better moisture retention, lower soil temperatures, decreased loss of topsoil, and more soil system capacity to sequester carbon.
- It results in positive environmental and soil health impacts: increased nitrogen and soil

organic matter reserves, less soil erosion, and improved soil microbial community composition with long-term application of the method.

- These changes make smallholder farming systems less dependent on external inputs.
- Each of the benefits accrued itself, and also when undertaken collectively reinforce one another, contributing to more sustainable soil system productivity.

The write up of the lecture can be accessed at https://www./iari.res.in/Entomology

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Taxonomic diversity vis-a-vis functional diversity in insects - Back to basics but looking forward

Webinar report from ICAR-National Bureau of Agricultural Insect Resources, Bengaluru, Karnataka, India

ICAR-NBAIR organized an online webinar as a part of Azadi Ka Amrit Mahotsav on 06 October 2021 at 15.30 hrs. One hundred participants from ICAR institutes, AICRP (BC), State Agricultural Universities and Zoological Survey of India attended the webinar. Dr. Kesavan Subaharan, Principal Scientist, ICAR–NBAIR welcomed the speaker and participants. Dr. M. Nagesh (Director Acting, ICAR-NBAIR) in his introductory remarks stressed the importance of taxonomic studies to address the problems posed by alien invasives entering India. The need to understand the functional diversity of insects for their effective utilization was highlighted in his remarks. This followed by a talk on 'Taxonomic diversity vis-a-vis functional diversity in insects - Back to basics but looking forward' by Dr. (Smt.) Dhriti Banerjee, Director, ZSI, Kolkata. Prior to her talk she lauded the efforts taken by ICAR-NBAIR in taking forward the studies on insect diversity that would benefit the country. She expressed that ICAR NBAIR and ZSI should work in tandem, and this would yield better results to serve the community. In her lecture she elaborated the research and activities carried out at ZSI and its regional centers across the country in survey, exploration, and monitoring of faunal diversity in various states, ecosystems and protected areas of India. The online database *viz.*, Species page of fauna of India, Geo-spatial database and ZSI type specimen repository were introduced to the participants. The role of ZSI in the preparation of red data book was discussed. In her talk, she briefed upon the research activities being taken up by their 'Centre on disease vectors' in the lines of faunal inventorization of mosquito vectors, advance real time surveillance system and utilization of essential oils in the management of vectors. The molecular tools used to decipher the gut microbiome in Thysanoptera using next generation sequencing carried out by ZSI was discussed. The problems associated with digitization of insect museum specimens and need to quantify the biodiversity of insects in agro-ecosystems was deliberated. The talk was followed by a discussion on key issues like the establishment of synergy between the ICAR NBAIR and ZSI to address the gaps in taxonomic studies. Dr. Abraham Verghese former Director, ICAR NBAIR mooted the idea of establishing a regional centre of ZSI in Karnataka. Among the other participants who participated in the discussion were Dr Chandish R. Ballal and Dr. N. Bakthavatsalam Former

Directors of ICAR–NBAIR and the researchers from other institutes. Dr. M. Nagesh in his concluding remarks agreed upon the need to have closer interaction between the researchers at ICAR NBAIR and ZSI to bring about a synergy in insect taxonomy related works. Dr. Sunil Joshi, HOD, GCC, ICAR NBAIR proposed vote of thanks. The program was organized and coordinated by Dr. Kesavan Subaharan, Dr. Amala Udayakumar and Dr. M. Pratheepa.

Dr. Kesavan Subaharan, Dr. Nagesh, M., Dr. Amala, U., & Dr. Pratheepa, M.
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Research articles

A simple laboratory rearing protocol for the longhorn date palm borer, *Jebusaea hammerschmidtii* (Reiche, 1878) (Coleoptera: Cerambycidae)

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Abstract

The date palm longhorn beetle, *Jebusaea hammerschmidtii* (Reiche)(Coleoptera: Cerambycidae) has emerged as a key pest of date palm, *Phoenix dactylifera* L. Little information is known on the biology of this beetle, due to its cryptic feeding behavior, relatively long period of larval stage, seasonality and short life of adults. We developed a simple laboratory rearing protocol, where the larvae were successfully reared to adult stage with 65% rearing efficiency. The details of the rearing protocol and measures to optimize it are discussed.

Introduction

The date palm longhorn beetle (LHB), *Jebusaea hammerschmidtii*is an extremely destructive pest of edible date palm *Phoenix dactylifera* L. (Aldryhim, 2008; Ali and Hama, 2016; El-Shafie and Mohammed, 2016). This insect has a high degree of specificity to the date palm (Blumberg, 2008). The life cycle of LHB takes almost a year and the larval stage, which is responsible for the damage may take about 11 months. There is only one generation per year (univoltine) and the adult beetles appear for a short period during May-June (El-Shafie, 2021).The larvae, which are the damaging stage, create feeding and hiding tunnels in the base of fronds and the trunk, and in severe infestation, they may reach the apical meristem causing eventual death of the palm (El-Shafie, 2021) (Figure 1).

Figure 1. Larval damage of *J. hammerschmidtii* on the apical meristem of date palm offshoot

The pest is capable of destroying the entire date palm plantation if infestation is not detected at an early stage and management measures are adopted. Until recently there was a few published information on this beetle. Dias *et al*., (2021) reported that the mitochondrial genome of *J. hammerschmidtii* includes 15619 bp and contains 13 protein coding, 22 transfer RNAs, and 2 ribosomal RNAs genes. The phylogenetic analysis placed the beetle within the subfamily Cerambycinae and the gene content and organization were identical to other Cerambycid beetles.

Many factors have contributed to the difficulty of studying the biology of the LHB, notably the seasonality of adults, the relatively long larval period, and the cryptic nature of larvae, which usually develop in galleries inside the date palm trunk (El-Shafie, 2015, 2021). Little information is available on the biological parameters of this species due to lack of rearing and handling protocols (Keena, 2017). For rearing *J. hammerschmidtii* under semi-field conditions, Al-Saadi (2017) used a feeding substrate consisted of pulverized tissue of date palm trunk and date syrup (Dips) with a ratio of 95: 5 moistened with distilled water. In an attempt to overcome the rearing difficulties of this pest, the present work has been carried out to develop a simple, affordable, and reliable protocol for rearing the longhorn beetle in the laboratory for availing enough test insects of high quality for the different experiments.

Materials and methods

Larvae of different ages and sizes were collected during October 2020 from the frond bases of highly infested date palms selected from the orchard of the Date Palm Research Center of Excellence, King Faisal University Al-Ahsa, Saudi Arabia (Latitude: 25.268528 °N, Longitude: 49.707218 °E). A chisel and forceps was used to retrieve and remove the larvae from their feeding galleries at the bases of old fronds (Figure 2). The larvae were then put in plastic boxes containing chewed palm tissues and frass collected from the feeding tunnels and were brought to the laboratory (Figure 2).

Figure 2 *J. hammerschmidtii* larvae at the feeding galleries (left), larvae collected in plastic box (right)

In the laboratory, the larvae were rinsed with distilled water to remove plant debris and chewed tissues of the infested palm that were adhered at their bodies and they were put on a tissue paper to dry before being transferred into cut fronds used as feeding substrate (Figure 3).

Figure 3. Collected larvae of *J. hammerschmidtii* after being washed with distilled water

Freshly cut bases of date palm frond (petioles) were used as substrate for rearing larvae. The frond bases were longitudinally cut into two equal parts using an electric saw and small groove was made in the inner side of one part to accommodate a developing larva. A larva was introduced into each cut frond base, and the two parts of the frond were fastened together and held in place using a metal wire (Figure 4). Larvae were reared individually to avoid cannibalism (Keena, 2017). The developing larvae inside the fronds were then putin a wire mesh cage in the laboratory. Old frond bases (desiccated tissues) were changed every month and larvae were carefully moved to fresh petioles (Figure 5).

Figure 4. Freshly cut date palm frond bases, each frond containing one larva of *J. hammerschmidtii*

Figure 5. Old date palm frond bases showing larval feeding frass, molt skins and pupal chambers of *J. hammerschmidtii*

Results and discussion

Through the above mentioned rearing protocol, *J. hammerschmidtii* larvae were successfully reared to the adult stage (Figure 6).

The rearing efficiency was above 65% indicating that some refinement of the method may be needed to increase this percentage. Under semi-field conditions, 85% efficiency of adult emergence was obtained (Al-Saeedi, 2019). The most important problems facing this

rearing protocol are the fungal and mite contamination and desiccation of the cut fronds. Cut bolts can be treated with ultraviolet light for 30 minutes to eliminate fungi and both ends of the date palm frond could be dipped in paraffin, if available, to retain moisture and prolong its duration as rearing substrate. (Keena, 2017).

Figure 6. An adult of *J. hammerschmidtii* emerged from larva fed upon a cut date palm frond base under laboratory conditions

Cerambycid beetle mate at night or late in the day (Linsely, 1959). Male competition for female is often violent, resulting in mutilation, thus, beetles must be mated in single pairs when reared under laboratory conditions. Normally, the eggs of *J. hammerschmidtii* are laid at the base of date palm fronds and in cracks along the trunk, while in captivity it oviposits at the bottom of the container (El-Shafie, 2015). In such a case, the eggs could be collected, transferred to a Petri dish lined with moistened filter and kept for hatching. The collected eggs can be surface sterilize with 70% alcohol, then thoroughly washed three times with distilled water. The newly hatched larvae can then be moved to a cut date palm frond to start the rearing process. As the larvae become pre-pupae, the body segments shorten, with a section near the head becomes translucent and just before pupation they become flaccid (Keena, 2017). These developmental stages are delicate and must be handled carefully. Thus, the movement and disturbance of pre-pupae and pupae should be kept to the minimum to avoid damaging them. Additionally, transferring of pupa will damage the pupal chamber in which it develops to the adult stage (Keena, 2006). Freshly emerged adults (teneral) require several days to sclerotize before emergence. Many adult cerambycids reproduce normally without feeding, while others require feeding for egg maturation and oviposition (Linsely, 1959). In this respect, Al-Saeedi (2019) reported no feeding activities of *J. hammerschmidtii* adults; however, more evidences are needed before declaring this beetle as non-feeder in the adult stage. Possible food sources for adult cerambycids include honeybee pollen, succulent twigs and leaves; 10% honey solution and 30% sucrose solution (Gardiner, 1970).

Conclusion

J. hammerschmidtii can be successfully reared, to adult stage, on cut date palm fronds under laboratory conditions. This rearing protocol can pave the way for understanding the biology and behavior of this serious date palm pest. More trials are needed to for optimizing the protocol and increasing the rearing efficiency.

Acknowledgements

We thank Mr. Ibrahim BouKhowa and Mr. Mohammed Hatab for assisting in the collection and rearing of larvae. The logistic support provided by the Date Palm Research Center of Excellence, King Faisal University is appreciated and sincerely acknowledged.

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MS Received 15 September 2021
MS Accepted 9 October 2021

Outbreak of invasive thrips species *Thrips parvispinus* in chilli growing areas of Andhra Pradesh

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Introduction

Chilli is being cultivated as an important commercial crop in Andhra Pradesh in an area of 1.8 lakh hectares with a production of 8.36 lakh tonnes (2020-21). The most important districts cultivating chilli are Guntur, Prakasam, Kurnool, Krishna, Ananthapur and East Godavari. Guntur occupies the first place and contributing major share in production and export of chilli from Andhra Pradesh. During 2021-22, 30% increase in the area of chilli cultivation is being observed in Guntur district due to various reasons like increased incidence of pink boll worm in cotton and increased demand for chilli in the market and being a commercial crop most of the farmers preferred to go for chilli cultivation in Andhra Pradesh, Telangana and Karnataka. Incidence of sucking pests and vector transmitted viral diseases are major threat to chilli cultivation. Though thrips (*Scirtothrips dorsalis*) is a regular pest occurring on chilli and observed throughout the crop growth period no flower thrips incidence was recorded in chilli until last year.

Chilli flower thrips were first noticed in Chilakaluripeta and Pratipadu mandals of Guntur district (16.09 N 80.16E & 16.16 N 80.22E) during January, 2021 and subsequently its spread was noticed in all chilli growing areas of Andhra Pradesh. The samples were collected by Dr. K. Sireesha, Senior Scientist (Entomology), Horticultural Research Station, Lam of Dr. YSR Horticultural University and submitted to NBAIR, Bangalore on 23.02.2021 and ZSI, Kolkata on 23.04.2021. Preliminary identification showed that it is complex of *Thrips florum*, *Thrips hawaiiensis*, *Thrips palmi* and *Frankliniella schulzei*. Later it was communicated that the sample also consisted of *Thrips parvispinus* and it was confirmed that the 90-95% of the thrips species occurring on chilli are *Thrips parvispinus*. This is the first record from India on the occurrence of this species in chilli ecosystem. This species is native to Asian tropics and has been reported from Indonesia, India, Thailand, Malaysia, Singapore, Taiwan, China, Philippines, Australia and the Solomon Islands (Mound and Collins, 2000). Though it was reported from India by Tyagi *et al*., 2015 and Rachana *et al*., 2018 on other crops it was not reported from chilli ecosystem anywhere in India. It was reported that it is most damaging to papaya in Hawaii and Indonesia, peppers and Solanaceous crops in Indonesia and ornamentals in Europe and Indonesia.

Sexual dimorphism

Male and female insects differ in size and colour. Females are 1 mm long with brown head and prothorax, yellowish brown meso and metathorax and black abdomen, forewings are dark, with light coloured base (Fig.1). Males are 0.6 mm long and evenly yellow (Fig.2). Larvae are bigger in size having different instars and uniform yellow in colour (Fig.3).

Other hosts

Vegetable crops like bitter gourd and beans are suspected to be the other host crops for this pest at this region.

Nature of Damage and Symptoms:

On Leaves

1. Deep punctures and scratches on under- side of the leaves due to sucking of sap. (Fig 4)
2. Due to scraping of chlorophyll on under side of the leaf and sucking of cell sap corresponding portion on upper side of the leaf looks yellowish. (Fig 5)
3. Under- side of the leaf turns reddish brown. (Fig 6)
4. Distorted leaf lamina with necrotic areas and yellow streaking was also observed. (Fig 7)
5. If the infestation is severe on newly emerging leaves, such leaves are dried/ blighted. (Fig 8)
6. Portions adjacent to veins are preferred.

On floral parts

1. Scraping on petals using mouth parts results in brownish streaks on petals. (Fig 9)
2. Thrips feeds on pollen which may affect pollination.
3. Drying and withering of flower. (Fig 10)
4. Fruit set gets affected.

Probable reasons for flower thrips outbreak in chilli

- *Thrips parvispinus* is already reported as invasive pest on other crops and it is polyphagous in nature.
- Exposure to heavy insecticides use in case of chilli resulted in resurgence of pest.

Present scenario in Andhra Pradesh

Chilli leaf curl incidence is also in increasing trend towards the flowering stage of crop growth coupled with the incidence of flower thrips and continuous rains during the crop growth period resulted in severe flower drop which created panic situation for the farmers. Similar situation was noticed in chilli growing areas of Telangana and Karnataka also.

Measures taken by the Dr.YSR Horticultural University:

Conducting surveys and creating awareness among the farmers on identification and integrated management of the flower thrips and mass campaigning along with the Department of Horticulture (Fig 11 and 12). Organized meeting with AP state senior

entomologists to tackle the problem in effective way.

Immediate recommendations to the farmers: (*adhoc*)

1. Application of recommended and balanced use of fertilizers. Recommended fertilizer dose is 120:24:48 NPK/acre.
2. Nitrogen and potash fertilizers need to be applied in five splits during crop growth.
   a) Organic fertilizers like FYM@10 tones/ acre,
   b) Neemcake @200kg/acre
   c) Vermicompost @2tonnes/acre
   d) *Azospirillum* and phosphate solubilizing bacteria each @2kg/acre, in order to maintain proper nutrition to the plants
3. Application of neem cake @ 200 kg /acre even on the standing crop keeping the biology of pest in view.
4. Recommending the installation of blue and yellow sticky traps @ 30 per acre on community basis to reduce the adult population and also for monitoring (Fig 13,14 & 15)
5. Application of azadirachtin 10,000ppm @1ml/L before flowering either as single application or in combination with recommended chemicals after thorough mixing in order manage the resistance development.
6. Rotation of recommended insecticides.
   a) Fipronil 80WG @ 40g/acre
   b) Fipronil 40% + imidacloprid 40% @ 40g/acre
   c) Cyantraniliprole 10% @ 240ml/acre
   d) Acetamiprid 20SP @ 40g/acre
   e) Spirotetramat 150 OD @ 160 ml/acre
7. Growing sunflower as trap crop.
8. Strict quarantine procedures need to be followed.
9. Avoid use of non-descriptive molecules on chilli

Fig. 1: Female *T. parvispinus*

Fig. 2: Male *T. parvispinus*

Fig. 3: Nymph

Fig. 4: Deep punctures on under surface of leaf

Fig. 5: Yellowing on upper surface of leaf

Fig. 6: Reddening of the leaf due to severe scraping

Fig. 7: Distorted leaf lamina

Fig. 8: Drying of new foliage

Fig. 9: Scrapping on petals

Fig. 10: Drying of affected flower

Fig. 11: Visit to farmer's field

Fig. 12: Creating awareness among the farmers

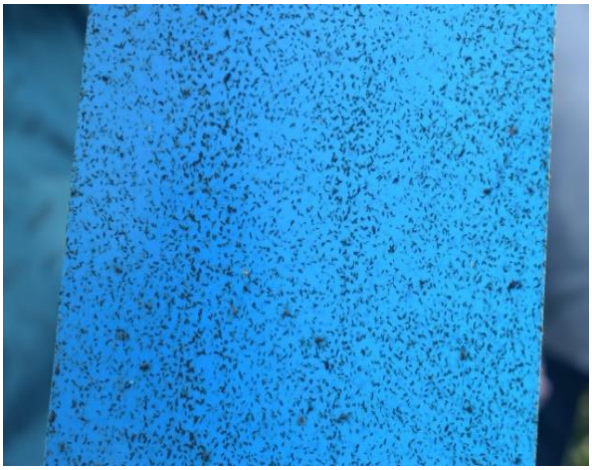

Fig. 13: Efficacy of blue sticky trap under open field

Fig. 14: Efficacy of yellow sticky trap under open field

Fig. 15: Installation of blue and yellow traps in field

Acknowledgements

Sincere thanks to Honorable Vice Chancellor Dr. T. Janaki Ram Dr.YSR Horticultural University and Director of Research Dr. R.V.S.K. Reddy, Dr.YSR Horticultural University, Venkataramanna Gudem for their encouragement. My sincere thanks to Rachana R. Remani, Scientist, ICAR-NBAIR, Bangalore for identification of the thrips species. I am very much thankful to the guidance of all senior entomologists of Andhra Pradesh for their guidance and support. I thank Dr. Cherukuri Srinivasa Rao, Dr.G.M.V Prasada Rao and Dr. Durga Prasad for sharing their views. Immensely thankful to the Retired professor and head of the department of entomology Dr. N. Venugopala Rao for guiding us in educating the farmers. I am also thankful to the Retired professor and head of the department of entomology Dr.T. Ramesh Babu for creating a platform for discussing this burning problem with all senior entomologists in AP.

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MS Received 27 September 2021
MS Accepted 15 October 2021

A new invasive chilli thrips (*Thrips parvispinus)* in Telangana State

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Chilli is the major spice crop grown in Warangal, Jayashankar Bhoopalpally, Mahabubabad, Khammam, Suryapet, Gadwal, Nagarkurnool, Mahabubnagar and Adilabad districts (18^0 N and 79 ^{0}E) of Telangana State. During *kharif,* 2020 chilli was grown in 1,17,765 acres and during *kharif* 2021 the area drastically increased to 3,58,557 acres. Usually chilli crop is attacked by Thrips, (*Scirtothrips dorsalis*) mites, pod borers,viruses etc. But, during November 2021, a new invasive thrips (*Thrips parvispinus)* was observed in all the chilli growing areas of Telangana State.

Survey

The scientists of Sri Konda Laxman Telangana State Horticultural University, Mulugu, Siddipet (dist), Telangana State conducted a survey during last the 3rd and 4th weeks of November on the new invasive thrips in the major chilli growing districts of Telangana State. The collected samples were sent to the ICAR-National Bureau of Agricultural Insect Resources (NBAIR), Bengaluru where the following species were identified.

S. No.	Places surveyed	Samples	Species Identified	Remarks
Sample-1	Villages: Chandrayapalle Mandal : Narsampet District : Warangal	Flower	*Thrips parvispinus* (Karny)	
			Thrips hawaiiensis (Morgan)	
Sample-2	Villages: Chandrayapalle Mandal : Narsampet District : Warangal	Flower	*Thrips parvispinus* (Karny)	
			Thrips hawaiiensis (Morgan)	
			Thrips florum Schumutz	
Sample-3	Villages: Chandrayapalle Mandal : Narsampet District : Warangal	Flower	*Thrips parvispinus* (Karny)	
		Leaves	*Thrips parvispinus* (Karny)	Mainly Larvae and Males
		Mixture	*Thrips parvispinus* (Karny)	
Sample-4	Village :Bodhigonda Mandal : Pedda Guduru District : Mahabubabad	Flower	*Thrips parvispinus* (Karny)	
		Leaves	*Thrips parvispinus* (Karny)	Leaf infestation was severe as compared to flower
		Mixture	*Thrips parvispinus* (Karny)	
Sample-5	Village :Kambalapalli Mandal : Mahabubabad District : Mahabubabad	Flower	*Thrips parvispinus* (Karny) *Thrips hawaiiensis* (Morgan)	95% was *T. parvispinus* a few females of *T. hawaiiensis* were there.
		Leaves	*Thrips parvispinus* (Karny)	Leaf infestation was not there, males dominated the population.
		Mixture	*Thrips parvispinus* (Karny)	
Sample-6	Village : Mudigonda Mandal : Mudigonda District : Khammam	Flower	*Thrips parvispinus* (Karny)	
		Leaves	*Thrips parvispinus* (Karny)	
		Mixture	*Thrips parvispinus* (Karny)	
Sample-7	Village : Dondapadu Mandal : Chintalapalem District : Suryapet	Flower	*Thrips parvispinus* (Karny)	
		Leaves	*Thrips parvispinus* (Karny)	
		Mixture	*Thrips parvispinus* (Karny) *Thrips florum* Schumutz	95% was *T. parvispinus* a few females of *T. florum* was also noticed.

Varietal Susceptibility

The farmers of Telangana state cultivate wide range of cultivars *i.e.,* local land races, varieties and high yielding hybrids. The local land race (Warangal Chapata) belongs to paprika which is growing in pockets of Warangal, Mulugu, Bhoopalapally and Khammam districts. Warangal chapata variety has big size flowers and bold pods with negligible pungency. The varieties developed by hybridization and selection (open pollinated) are also cultivated which are having thin and long pods. Under the category of F1 hybrids (Single cross hybrids) developed through hybridization, both the Tejaswini Segment (Thin pods with high pungency and small flower size) and Byadagi segments *i.e.,* paprika (Bold pods with negligible pungency) are cultivated. During the survey we observed that Warangal Chapata is more susceptible than Tejaswini segment and Byadagi segment. Of all the three varieties, Warangal Chapata flowers and fruits were severely affected as the flowers are big in size and fruits are succulent. It was observed that, varieties with big flower size had severe infestation compared to smaller flowers.

Nature of damage

Females of *Thrips parvispinus* were observed mostly on petals and below the stamens near the ovary. Whereas, males were congregating underside of leaves in large numbers and sucking the sap from the leaves as well as pods. Females are black in colour and bigger in size than the males. Males are in yellow colour and smaller than females. *Scritothrips dorsalis* causes damage by sucking sap on the leaves and upward leaf curl is observed. In case of *T. parvispinus,* they suck the sap from flowers, leaves and fruits. The infested flowers wither and there is no fruit set. Thrips suck sap from the lower surface and leaf is deformed. The fruits attain abnormal shape. If unchecked, it may lead to serious loss to chilli farmers.

Life cycle of *Thrips parvispinus*

Thrips parvispinus belongs to order Thysanoptera, sub-order: Terabratia and family Thripidae. It is observed that, these thrips are damaging flowers, leaves and fruits of chilli crop. Thrips lay eggs on the lower side of the leaves. From the eggs, larvae emerge. They pupate in soil or dried leaves and from the pupa, adults emerge. Adults lay around 20-30 eggs (Hutasoit *et al.,* 2017). It was observed that none of the samples sent for identification were having *Scirtothrips dorsalis* which was the major thrips species observed in chilli till last year. Further, research has to be conducted for ecology, life cycle and management of new thrips species. Research has to be done on whether any species replacement is observed in future studies.

The following management practices were effective to some extent:

1. Installation of sticky traps (Blue & Yellow) @ 50/ acre.
2. Application of neem oil (10000 ppm) @ 3ml/lit or Azadirachtin @ 3ml/l
3. Spraying of Fipronil 80% WG @0.2 g/lit or Cyantraniliprole @ 1.25 ml/lit or Acetamaprid @ 0.2 g /lit or Spinosad @ 0.3 ml/lit water as sequential sprays at weekly interval.

Acknowledgements: We express our sincere gratitude to Dr. Rachana, Scientist, (Germplasm collection and characterization) ICAR-NBAIR, Bengaluru for identification of thrips species. Further we also extend our thankfulness to Dr. M. Raj Kumar, Director of Research and Dr. A. Kiran Kumar, Director of Extension, SKLTSHU, Mulugu, Telangana State for constant support.

<table>
<tr><td>  </td><td>  </td></tr>
<tr><td>Thrips parvispinous on chilli flower</td><td>T. parvispinous damage on chilli plant</td></tr>
<tr><td>  </td><td>  </td></tr>
<tr><td>Damage on leaves</td><td>Damage on fruits</td></tr>
<tr><td colspan="2">  </td></tr>
<tr><td colspan="2">Adults of Thrips parvispinous</td></tr>
</table>

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MS Received 10 November2021
MS Accepted 25 November 2021

Occurrence of *Thrips parvispinus* (Karny) (Thripidae: Thysanoptera) in major chilli (*Capsicum annum)* growing areas of Karnataka

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Thrips parvispinus (Karny) (Thripidae: Thysanoptera) is a polyphagous pest on many fruits, vegetables and flower crops. This species is native to the tropics of Asia and has been reported from Indonesia, India, Thailand, Malaysia, Singapore, Taiwan, China, Philippines, Australia, the Solomon Islands, Greece, France, Spain, The Netherlands, Tanzania, Mauritius, Reunion and Hawaii (Mound and Collins 2000; Mound *et al.* 2016). Mound and Collins (2000) reported its occurrence in India. Subsequently Tyagi *et al.* (2015) reported it on papaya (*Carica papaya*) and Rachana *et al.* (2018) on *Dahlia rosea* Cav.

T. parvispinus is polyphagous and is reported to feed on papaya, peppers, potatoes, eggplants, beans, shallots and strawberries. The damage is inflicted by direct feeding of larvae and adults on leaves and growing buds. In papaya, *Cladosporium* a saprophytic fungus is known to cause a secondary infection on tissue damaged by the thrips (Lim, 1989). Ornamentals such as dahlia, chrysanthemum, gardenia, dipladenia, Anthurium, hoya and Ficus are affected in green houses.

Female and male thrips of *T. parvispinus* differ in size and color. Females are nearly one mm long, with brown head and prothorax, yellowish brown meso- and metathorax and black abdomen; forewings are dark, with light colored base . The third antennal segment and the base of the fourth and fifth segments are light colored (either yellow or white). Males are 0.6 mm long and evenly yellow (Hutasoit et al. 2017).

Eggs are inserted into leaves and incubation period lasts for four to five days. Larvae feed on leaves and flowers. Larvae go through two molts in four to five days, mature and pupate. The two pupal stages last for two to three days. The life cycle is completed in 13–14 days. Reproduction is sexual and on average females lay 15 eggs. Mated females live for nine days. Adult males live for six days on chilli under controlled conditions in greenhouses (Hutasoit et al. 2017).

The species has been reported as pest on chilli flowers in Guntur District of Andhra Pradesh during 2020-21 (Verghese, 2021). With

an objective to know its occurrence and severity in Karnataka, intensive surveys were undertaken in major chilli growing areas of Karnataka such as Chitradurga, Bellary and Raichur districts during November and December 2021. The current status, distribution, hosts plants, possible management strategies and impact of such upsurges on the export are discussed in this paper.

Material and methods

During the survey, flowers and terminal shoots of chilli pepper and sweet pepper were individually plucked and collected in 10% ethyl alcohol in plastic vials (3 cm diameter and 8 cm length). A minimum of 20 terminal shoots and flowers were sampled from each field. The vials were coded using location and the crop. Similarly, crop species such as maize Zea mays subsp. mays, okra *Abelmoschus esculentus*, green gram, *Vigna radiata*, red gram, *Cajanus cajan* , cotton, *Gossypium*, field bean, *Vicia faba*, tomato, *Solanum lycopersicum*, marigold *Tagetes*, gingelly, *Sesamum indicum*, sorghum, *Sorghum bicolor*, bitter gourd, *Momordica charantia*, etc. observed in and around chilli fields were also surveyed, and shoots and flowers were collected in 10% ethyl alcohol. Tree species of neem, *Azadirachta indica* and pongamia, *Millettia pinnata* and weed species of parthenium, *Amranthus* sp., *Axonopus* sp., *Ageratum* sp. *Alternanthera* sp. *Thunbergia* sp. etc found in and around chilli crops were also surveyed. Wherever necessary flowers and shoots were beaten on light coloured trays to find the thrips incidence. Information on the variety, cropping pattern, pest scenario crop management practices followed during the cropping season were gathered from farmers, officers of State Horticulture Department, seed industry personnel available there during the survey.

The plant materials sampled were shifted to the laboratory at the Regional Central Integrated Pest Management Centre (RCIPMC), Bangalore for further observations. Plastic funnels (8 cm diameter) were placed in a conical flask (100 ml) and a layer of blotting paper was placed in the funnels. The contents of individual plastic vials were poured on to the blotting paper to facilitate to strain of alcohol into the conical flask. The material retained on the tissue paper was carefully observed under stereo binocular microscope.

The terminal shoots were counted for the number of open, unopen and flowers buds. Observations on the number of females, males, nymphs of *T. parvispinus* and other species of thrips, and other insects were recorded. Characters given by Rachana *et al.* (2018) were used to identify males and females of *T. parvispinus.*

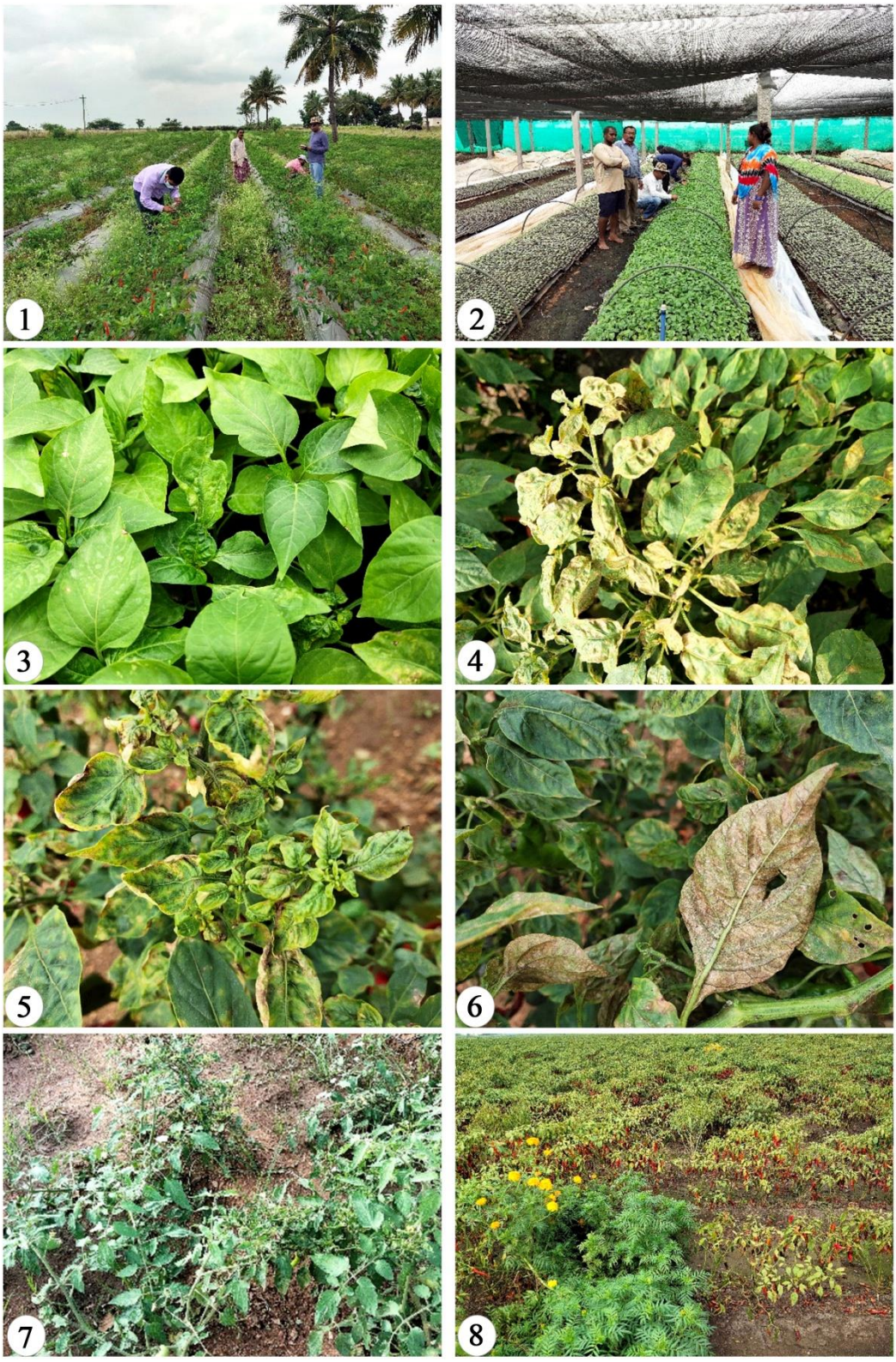

Figure 1 Chilli field, 2. Nursery, 3. Infested plants in nursery, 4, 5, 6. Infested chilli plants, 7 & 8. Bronzing of leaves.

Results

Thrips parvispinus infestation on chilli was observed in almost all chilli growing districts surveyed. Chilli crops were found infested with a mean of 7.98 ♀ and 0.84 ♂ thrips/flower in Bellary, 7.41 ♀ and 0.38 ♂/flower in Chitradurga, 6.3 ♀ and 1.8 ♂/flower in Gadag, 2.00 ♀ and 0.28 ♂/flower in Koppal and 4.4 ♀ and 0.5 ♂/flower in Raichur.

Bell pepper cultivated in an open field was observed infested with a mean of 4.1 ♀ and 0.85 ♂ thrips/flower in Raichur district. It was observed that, both tender shoots and flowers of chilli and bell pepper were infested. However, number of thrips were more in flowers compared to tender shoots in all the locations surveyed. Number of females to male ratio on tender shoots was approximately 4:1, respectively. It is interesting to note that *T. parvispinus* infestation on foliage of crops other than chilli and bell pepper was negligible. The correlation between number of open leaves and females was negatively correlated (r = -0.210135961, *p*=0.2).

Though more number of thrips was found on flowers, evident thrips damage was not found on fruits both in chilli and bell pepper. However, flowers exhibited symptoms of discoloration and tender leaves showed upward curling. Whereas, ventral sides of older leaves exhibited browning/bronzing and were brittle due to extensive feeding by thrips.

In addition, flowers of pigeon pea flowers (2.94 ♀ and 0.50 ♂/flower), green gram (1.11 ♀ and 0.50 ♂/flower), gingelly (1.80 ♀ and 0.20 ♂/flower), bhendi, field bean and maize grown as border crops were associated with *T. parvispinus.* Tomato flowers (0.68 ♀ and 0.16 ♂/flower) grown as mixed and that of marigold (32.00 ♀ and 2 ♂/flower) grown as trap crops were observed to have *T. parvispinus* infestation. Flowers of sorghum, maize, cotton and bitter gourd plants found in and around chilli crops were also found with thrips. Among different flowers, cotton (34 – 36.50 ♀ and 2 – 7 ♂/flower) recorded highest number of thrips followed by bitter gourd (15.50 ♀ and 1 ♂/flower). Nymphs and other species put together were also more on cotton (7 – 28/flower) and bitter gourd (6.5/flower). The infested flowers showed brownish specks and discolouration.

Flowers of weeds species namely Parthenium, *Amaranthus* sp., *Axonopus* sp., *Ageratum* sp. *Alternanthera* sp. *Thunbergia* sp. found in chilli fields and foliage of neem and pongamia bordering chilli fields were also found infested with thrips.

Table 1. Incidence of *Thrips parvispinus* on flowers (mean/flower)

District	Crop	# Females	# Males	# Nymphs & other species
Bellary	Chilli	7.98	0.84	1.64
	Gingelly	1.80	0.20	0.00
	Sorghum	0.90	0.00	0.40
	Bitter gourd	15.50	1.00	6.50
	Cotton	34.00	7.00	28.00
Chitradurga	Chrysanthemum	0.80	0.50	0.00
	Chilli	7.41	0.38	0.37
	Cotton	36.50	1.50	7.00
	Pigeon pea	2.94	0.50	0.13
	Green gram	1.00	0.50	0.50
	Marigold	32.00	2.00	2.00
	Tomato	0.68	0.16	0.21
Gadag	Chilli	6.3	1.8	2.00
Koppal	Chilli	1.04 – 2.00	0.28	0.60 – 0.96
Raichur	Chilli	4.4	0.5	1.5
	Capsicum	4.1	0.85	0.85

Table 2. Incidence of *Thrips parvispinus* on shoots of different crops (mean range/shoot)

District	Crop	# Females	# Males	# Nymphs & Other species
Bellary	Chilli	5.40 - 7.80	1.20 - 1.80	3.40 - 4.60
Chitradurga	Chilli	0.00 – 6.10	0.00 - 080	0.00 - 0.40
	Tomato	0.00	0.00	0.00
Gadag	Chilli	6.3	1.8	2.00
Koppal	Chilli			
Raichur	Capsicum	1.50	0.00	0.25
	Chilli	1.67	0.00	1.00

Table 3. Relationship between chilli shoot parameters and thrips infestation

Parameters	Correlation Co-efficients (r)				
	# open leaves	*# unopened leaves*	*# flower buds*	*# females*	*# males*
# females	-0.210135961*	0.055108	-0.12982		
# males	-0.201149591	0.003209	-0.24706*	0.294397*	
# nymphs	0.069494993	0.149958	-0.1537	0.158282	0.376961*

N = 36, * Significance at $p = 0.2$

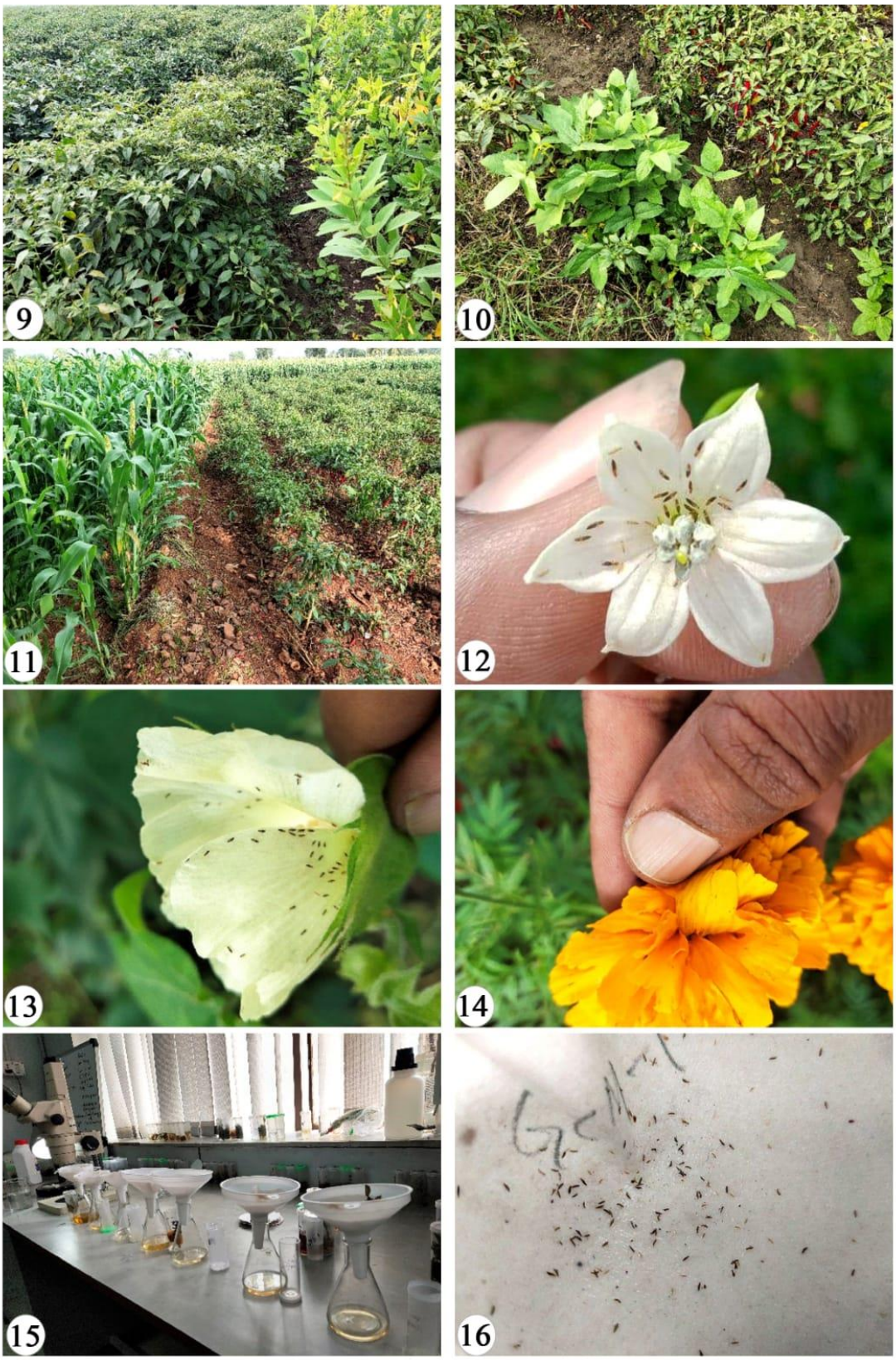

Figure 9. Pigeon pea as border crop, 10. Green gram as border crop, 11. Sorghum as border crop, 12. Thrips on chilli flowers, 13. Thrips on cotton flowers, 14. Thrips on marigold flower, 15 & 16. Extraction of thrips in laboratory.

Discussion

Chilli is being extensively grown in Bellary, Chitradurga, Gadag, Koppal and Raichur districts (Fig 17). BHH 5531, BHH 2043, 355-Kalsa, Indo 5, Commercial dubbi, Commercial Kaddi, Byadagi dabbi, Byadagi Kaddi, etc are the some of the major hybrids/varieties found in the field during the survey. Chilli crop in all the districts surveyed were heavily infected by Anthracnose and Powdery Mildew due to unseasonal rains received during the fruiting stage of the crop. *T. parvispinus* commonly called as tobacco thrips has further aggravated the farmers' woes during the current season. None of the farmers had noticed tobacco Thrips infestation during the previous year. The infestation noticed during November 2021 in Bellary has spread to all the areas. Farmers are of the opinion that, the thrips have been introduced along with planting materials from neighbouring Andhra Pradesh, Telangana where thrips infestation was noticed in Vijayawada, Nellore and Guntur during January 2020 itself. Farmers have procured seedling of a variety called Vajra (5531) from the seedling nurseries from neighbouring districts of Andhra Pradesh, which is believed to be carrier of thrips to chilli growing regions of Bellary. Thrips infestation was noticed even in nurseries during the present survey corroborate the fact that nurseries could aid breeding and spread of pests to new locations.

The infestation was more on flowers compared to tender shoots. It is interesting to note the thrips presence in almost all flowers found in and around the chilli crops. In cotton, marigold and okra, thrips were found in groups at the base of the stamen and moved upwards upon disturbance. Their presence could be detected only by careful observation or by beating on a white surface. Whereas, thrips were easily detectable in open flowers like chilli and capsicum.

Cotton and bitter gourd harboured more number of thrips in flowers. It will be interesting to study the effect of flower size, colour of petals, arrangement of petals, quantity and quality of the pollen, and quantity and quality of nectar on population dynamics of thrips. Though more thrips were found in flowers, foliage of all crop plants and weeds except chilli and bell pepper were completely devoid of thrips as well as damage symptoms.

Farmers have sprayed number of pesticides in cocktails to contain thrips and anthracnose in chilli in the current season. Insecticides such as Fipronil 5% SC, Acetamiprid 10% SC, Spinetoram 11.7% SC, Spinosad 45% SC, Imidacloprid 40% WG and many of them in combination are being sprayed by farmers regularly. Use of these insecticides could have limited otherwise regular sucking pests of chilli such as *Scirtothrips dorsalis* Hood, *Bemicia tabaci* Genn., *Aphis gossypii* Glover, *Polyphagotarsonemus latus* Banks, etc. and eliminated all natural enemies of sucking pests in general and thrips in particular. In present survey, none of the predators could be observed on tender shoots and flowers. This could be the possible reason for upsurge of *T. parvinpinus* in chilli and all major chilli growing areas. Use of bio-pesticides, pheromone traps, sticky traps, botanicals was almost nil in all the areas surveyed.

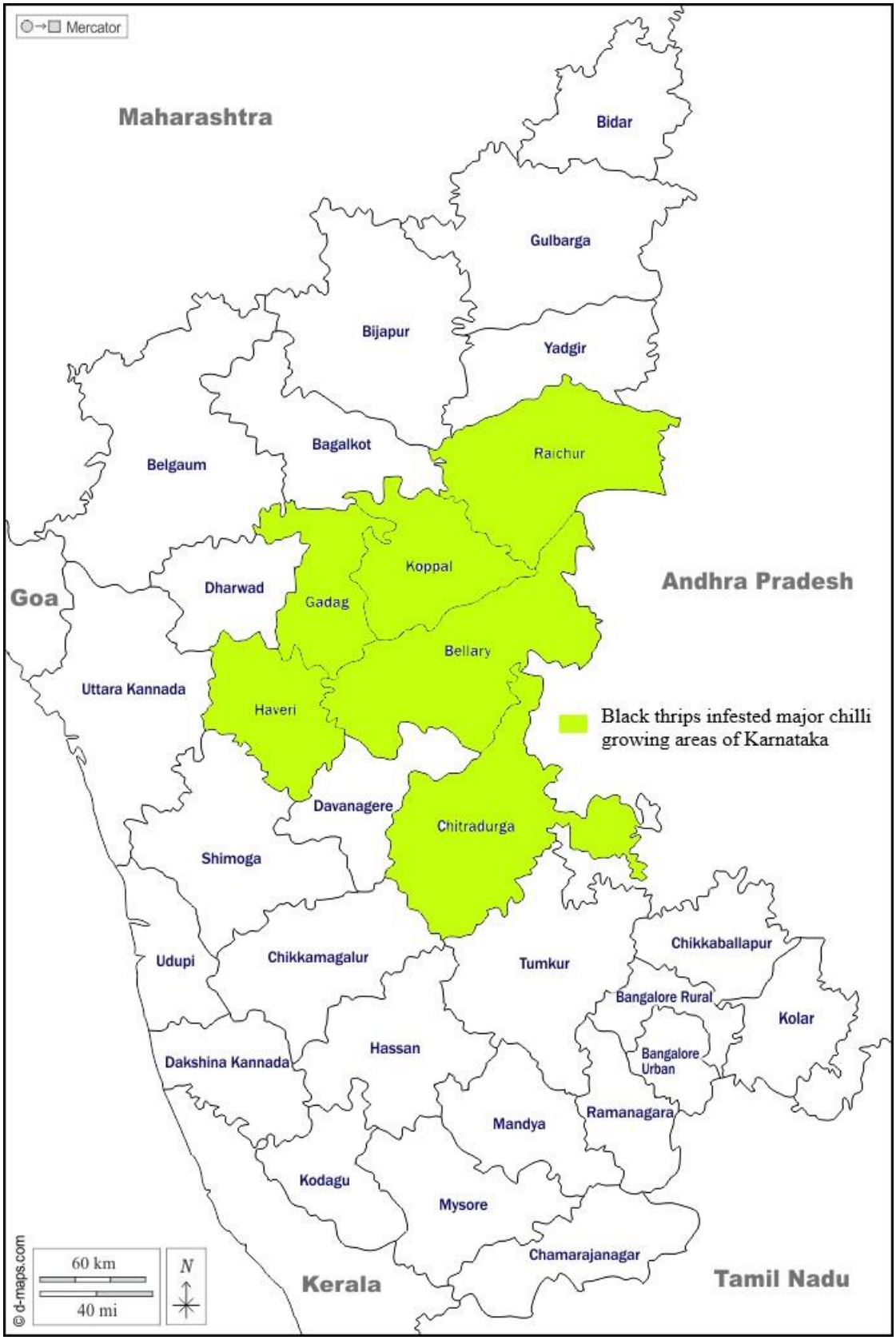

Figure 17. Districts affected by *T. parvispinus.*

Thrips parvispinus is major pest of chilli in Indonesia and Tyagi *et al.* (2015) opined that Indonesia could be the probable source of Invasion. Plants and planting materials if imported from Indonesia could have been the source of this exotic thrips. However, India has a very strong interdisciplinary Plant Quarantine setup to prevent entry and establishment of such quarantine pests. Plant Quarantine (Regulation of Import into India) Order 2003 issued under the aegis of Destructive Insect Pest Act (DIPA) 1914, empowers the plant quarantine authorities to inspect and detect the exotic pests on arrival at least at two stages. Plants for planting/ propagation are allowed to import only through Regional Plant Quarantine Stations (RPQS) located at New Delhi, Mumbai, Chennai, Amritsar, Kolkatta and Bangalore, who carry out the first inspection on arrival at point of entry and issues provisional Import Release Order (IRO), if found free of Quarantine Pests. Subsequently, the planting materials are shifted to approved Post Entry Quarantine Facilities (PEQ) of the Authorized Importers where, they are kept under the supervision of Designated Inspection Authorities (DIA) for a specified period of time. State Agricultural Universities (SAUs), ICAR institutes, etc are performing the duties and responsibilities of a DIA. The final release will be given by the DIA, if satisfied on the freedom from exotic pests. In spite of all these regulatory measures, it is surprising that India is witnessing frequent pest incursions of known invasive pests on major crops of India, which needs immediate scientific scrutiny.

Now, the pest has been introduced into India and is threatening cultivation of Chilli in major chilli production areas. Immediate steps needs to be taken on containing the pest from further spread to other areas using effective monitoring and IPM techniques. Use of insecticide alone is a futile exercise and farmers also have realized the same. Instead, the pesticides have eliminated all major natural enemies supposed to be there in chilli ecosystem. It is pertinent to mention here that, Fall Army Worm (FAW) an introduced invasive was pest introduced into India in the year 2018. FAW which was expected to be a threat for Maize production has been kept under control by the action of parasitoids, predators and entomopathogenic fungi. Use of fewer pesticides and microclimate with high RH due to good rain in maize ecosystem has made this possible. There is a need to explore the effective natural enemies of *T. parvispinus* in the native range and if necessary, Classical Biological Control needs to be employed immediately.

India is a leading exporter of cut flowers to many countries. Therefore, it is necessary that the movement of pests to rose and Gerbera cultivating polyhouses should be monitored and immediate steps to be taken to contain the pest. Otherwise it is of great concern to India in export of cut flowers, green leafy vegetables, fresh fruits and vegetables. The relation between upsurge of *T. parvispinus* and diseases such as Anthracnose and Powdery Mildew together needs to be studied, as thrips are known to predispose the fruits for secondary infection.

Acknowledgments

The authors are grateful to Dr. N. K. Krishna Kumar, former DDG (Horticulture), ICAR, New Delhi for the scientific advise throughout the study and for critically reviewing the manuscript. Thanks to Dr. R. R. Rachana, Scientist, NBAIR, Bangalore for confirming the identity of *T. parvispinus* and for providing *habitus* photographs. Thanks to R. Honnamma Rani for reviewing initial draft of this paper.

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MS Received 20 November2021
MS Accepted 11 December 2021

Incidence of leafhopper, *Amrasca splendens* (Ghauri) in mango

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Leafhoppers are serious pests of mango at flowering and fruiting stages resulting in yield loss up to 100 per cent (Verghese, 2000). The hopper activity coincides with the maximum emergence of inflorescence and new shoots. Both nymphs and adults suck sap from tender leaves, buds, flowers, flower stalk and fruits. Severely infested leaves become curled, and inflorescence gets dried which cause non-setting of flowers and dropping of immature fruits, thereby reducing the yield (Srinivasa *et al*., 2017). Species of leafhoppers infesting mango are *Idioscopus nitidulus, Idioscopus nagpurensis, Amrasca splendens*, *Amritodus atkinsoni* and *Idioscopus clypealis* (Virakthmath, 1989; Girish *et al.,* 2019). During our field visits, we found severe incidence of mango leaf infesting hoppers and hence sampling was done to assess the level of population.

A sampling was done at University of Agricultural and Horticultural Sciences, Shivamogga, College of Agriculture campus, Navile, Shivamogga, Karnataka (13° 58′N ; 75° 35′ E, 588 msl). Five trees of mango of same age (20 years old) were randomly selected in the orchard. Leafhoppers was sampled in the mango orchard at 10:00 AM by using insect sweep net (Figure 1) during the month of April 2021.

Sampling was done by sweeping the insect net five times in each direction of the tree (East, West, North and South). After sweeping, the leafhoppers were collected by inserting head (collector) into the net (Figure 2) and sucked into aspirator (Figure 3). Then the leafhoppers were killed by transferring to the poison bottle. Finally, the leafhopper collected were transferred to 5 ml plastic vials containing 70 per cent ethyl alcohol, labeled and counted. The specimens were sent to Dr. C. A. Virakthmath, Emeritus Professor, Department of Entomology, UAS, GKVK, Bengaluru for species identification. The leafhopper specimens were confirmed as *Amrasca splendens* (Figure 7).

The population of *Amrasca splendens* ranged from 15.75 to 72.0 hoppers per five sweeps (Table 1). Due to severe population and feeding by leafhoppers, tip burning was noticed (Figure 4) which is a typical *Amrasca* damage with leaves dried (Figure 5). All the infested trees were devoid of fruit bearing leading to complete loss (Figure 6). There was no fruit set in more than 20 trees in the orchard out of 35 trees of different varieties due to its feeding damage. Literatures from previous studies indicated *Amritodus atkinsoni*, *Idioscopus nagpurensis* and *Idioscopus nitidulus* were major leafhopper species infesting mango but *Amrasca splendens* was

considered minor. But in this report, *Amrasca splendens* was observed to be serious one. The study may help to standardize the sampling technique for leafhoppers in mango and also to analyze the severity of its incidence.

Figure 1. Sweep net sampling for mango leafhoppers

Figure 2. Collection of leafhoppers by inserting head with aspirator in mouth

Table 1. Incidence leafhoppers in mango by using sweep net method of sampling

	Number of leafhoppers per five sweeps				
	East	**West**	**North**	**South**	**Average number of leafhoppers per five sweeps**
Tree-1	57	28	62	71	54.5
Tree-2	15	14	21	13	15.75
Tree-3	64	72	58	62	64.0
Tree-4	43	51	38	58	47.5
Tree-5	82	78	62	66	72.0

Figure 3. Aspirator used for collection

Figure 4. Apical tip burning of leaves

Figure 5. Typical Amrasca damage

Figure 6. Mango tree with *Amrasca spendens* damage deviod of fruit bearing

Figure 7. *Amrasca splendens* (Ghauri)

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MS Received 27 September 2021
MS Accepted 01 November 2021

Colour polymorphism in *Acrida exaltata* and *Acrida gigantea* in par with seasonal changes in the habitat background

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Introduction

Generally, grass hoppers are either green or brown with the exception of a few being brightly coloured found to live either on grass or on bald land patches. Some species live on short plants too and a few grasshoppers are capable of change body colour resembling their back ground. One of the basic features of insects is the body colour specific to species with a definite pattern of pigment distribution but this definitive colour pattern of insects is also variable due to influence of several factors (Gilbert and Epel, 2009). Adaptation to a kind of habitat by camouflage is a common strategy through change in body colour in insects. Though the body colour pigmentations are determined by the genetic composition (Tool and Aquadro, 2007) and its regulation (Gompel *et al.*, 2009) often it is modified by environment. Grass hoppers exhibit colour polymorphism with a degree of intra specific variability is recorded by several workers (Hochkirch *et al*., 2008; Dieker *et al*., 2018; Edelaar *et al.,* 2008; Imene *et al*., 2019; Uvarov,1939; Fisher,1939). The body colour variation is brought about by both biotic and abiotic factors. The biotic factors that instigate colour variation include predation and crypsis (Olendorf *et al*., 2006), selection, survival and evolution (Andre´s *et al.,* 2002; Gray and McKinnon, 2002). Abiotic factors responsible to bring variations in morphological colour include temperature, humidity and food resource, due to these pigments responsible for thermoregulation (Forsman, 1997) and microhabitat utilization (Ahnesjo and Forsman, 2005) are developed. Changes in the morphological colour variations in grasshopper *Acrida exaltata* and *Acrida gigantean*, with the change of season in this part of the country has not been explored. These two species of grasshoppers live on short grass patches as sympatric species. In this study we have observed and recorded the occurrence of exclusively green coloured morphs during rainy season when the grass is lush green and light yellowish brown coloured, dark brown pigmented grasshopper morphs of these two species during winter when the grass was either totally dry with straw colour or partly dry with grey colour with dark patches on the withering grass blades.it has also been recorded, that the different body colour morphs of these two species of hoppers with seasonal changes in the environment in their natural habitat. The study was carried out at different locations, and has been analysed w.r.t the changes in habitat at

each site. *Acrida exaltata* and *Acrida gigantea* are greenish in colour predominantly inhabit short green grass. Both species are bivoltine, first generation appears during rainy season and the second generation appear during winter season. The two species have narrow range taxonomical and morphological variation, distinguished by presence of white line on the sides of thoracic region in *A. exaltata* and presence of a red line on the sides of thorax in *A. gigentea*. Both the species have a narrow molecular variation, compared to other congeneric grass hoppers (Jayashree and Channaveerappa, 2016).

Material and methods

Observation of the phenotypic variations in two species of grass hoppers were recorded between the months June and September and last week of November to end of March comprising rainy season and winter respectively (Table 1 and Figure 1). Two species of congeneric grasshoppers *A. exaltata* and *A. gigantia* were collected from the natural habitats of three geographical regions namely, Mysuru 12.295^0N and 75.6304^0E, University of Agriculture sciences campus, Dharwad 15.4589^0N and 75.0078^0 E and from Kushalnagar 12.4602^0N and 76.6394^0 E in Kodagu region.

Dharwad and Kushalnagar are located at about distance 450 km and 100 km from city of Mysuru. In Mysuru, two areas with different characteristic features were selected for observation of phenotypes of both the species of grass hoppers. One, the Manasagangotri campus that had fast drying grass with no water body in the vicinity, the other Karanji lake area that had slow drying green grass patches mixed with dry grey grass because of occasional watering and a lake located nearby at about fifty meters of observation site but due to severity of the cold temperature there was drying of grass. The nature of other three sites were entirely different. The grass patches were completely dry and grey in the months of mid-November to April of coming year by this time reproductive season of the winter population ends. Regular rainy season starts mid-June in these localities and induces the appearance of green grass. The change nymphs of these two species emerge those are exclusively green and develop in to green varieties of grass hoppers. Edit sentence- too long and not clear. In contrast to this, only light brown nymphs appeared during winter at three localities other than Karanji lake where green nymphs emerged during winter turned in to green grass hoppers with white or brown patches. Each morphological type of grasshoppers marked in to type for green polymorphs, and brown morphs having different range of pigment patterns. The on field distance covered during observation/collection of these insects, to record the density of distribution in both the seasons, measured using the step tracker app on android phone and the counted numbers are shown in a graphic representation.

Observations

These two species of grass hoppers appear as green morphs during rainy season and no alternate phenotype has been recorded (Fig.1a-b), the generation of these two species appearing in winter have different coloration on

the body and marking on fore wing and thorax. In this season these grasshopper were found to appear in five distinct morphological forms, ranging from light colour mixed white line along the fore wing with brownish grey body colour (Fig.2b-f), brownish grey body colour without any marking (Fig. 2b), brownish grey body colour with dark brown patches (Fig.2c), brownish grey body colour with dark or brown granular structure on the wings (Fig.2d-f), these morphological variations appeared in a characteristic background colour. We have encountered such phenotypes in the same species of insects collected from Coorg and Dharwad regions also with the similar features of their natural habitat where the insect found. In Karanji lake where green nymphs emerged during winter turned in to green grass hoppers with white patches and without melanin pigments on the thoracic region as in other two regions studied (Fig.1d).

The climate conditions during winter were cold, dry, and less humid and there were no rains. A continued dry phase turned grass blades, in to grey, greyish brown, leading to formation of black or brown spots on the dried grass blades, hence green grass was completely absent. The temperature at night (average 18-19 °C) was lower than the average day temperature (average 22-24 °C). The number of grasshoppers of both the species were found to be more in rainy season and scanty during winter/dry season (Fig.3).

All the morphological types resembled the back ground colours of grass of that season. The changes in the body colour may help the insect to escape from the view of the predators like lizards and birds etc.

Discussion

Adaptations to habitat through camouflage for protection are a common strategy in nature. Camouflage prevents the organism from getting detected by the predator. Such camouflages have been reported in other grasshoppers too. Further, positioning behaviour in a novel habitat by individual color variation of (Villalba Baños *et al*., 2017) *S. azurescen*, with respect to climatic change in aridzone grasshoppers. Phenotypic plasticity in two ground grasshoppers (Hochkirch *et al*., 2008) *Tetrix ceperoi*and *Tetrix Subulata*, two colour polymorphism in an alpine grasshopper with seasonal changes (Dieker *et al*., 2018). Colour polymorphism with genetic basis appears too frequent by recurrent mutations (Fisher,1930; Huxley,1955). Not all cases of phenotypes need to be genetically controlled while some may due to phenotypic plasticity (Eberhard, 2003). In some of the orthopterans, the green-brown polymorphs have been found to be under the control of environment with a specific background and moisture, playing a key role during nymphal development (Dearn,1990; Rowell,1971). The green colour of grasshoppers is formed by tetrapyrales produced during regular nymphal moulting (Shamim,2014). Due to less moisture, dry conditions prevailed in the months of December and January. Presence of dry brownish background might have influenced regular sequence of pigments formation in developing nymphs, to molt into yellowish brown morphs of these two species of

grasshoppers, to hide their existence. Such colour morphs of fore wings are recorded in the butterfly *Araschnia levana* in the spring and summer generation due to influence of changed conditions on developing pupal stages (Baudach *et al*., 2018). The phenotypes thus generated in adult *A. exaltata* and *A. gigantea* may be supportive to suit the dry grass background and protecting from the predation. In these two species of grasshoppers colour change is a slow process starting from nymph to adult stage. In the wild populations analysed, all the individuals exhibited a typical match between the grasshoppers and dry grass or green grass back grounds. These insects always preferred to live with the background supporting their hide. Such matching habitat choices in other grasshoppers has been interpreted in relation to directed gene flow and increased colour matching due to increased risk of predation has been explained by the studies on grasshopper species *S. azurescens* (Edelaar *et al*., 2008, 2017).

Environment influenced colour polymorphism is a more common phenomenon among insect (West and Hazel, 1979). Darker colour of the body in insects is due to melanin pigment manifests more in colder climates in majority of insects to absorb solar energy to maintain optimal body temperature (Wilson, 2001) and get protection from the pathogens (Watt, 1968) contrastingly in warmer conditions will have lighter body coloration (Gilbert *et al.*,1998) to avoid the risk of overheating. The phenotype of an insect can also be influenced by environmental cues prevailed during nymphal stages of ontogeny such as colour of the substrate as examined in ground hoppers *Tetrix subulata* and *T. ceparoi* (Hochkirch *et al*., 2008) and confirmed basic colour and colour pattern are influenced by back ground. The Karanji lake population manifested a green phenotype with white patches has to be assumed was an indicative that dark brown pigment synthesis blocked as it contrast the green background of slow drying grass and brown could be a mismatch. Among insects it is well known that the dark pigment on the wing and thorax is due to melanin pigment (Shamim, 2014) and in a few insects such as butterflies the neuro endocrine interaction during embryonic development induce more melanin pigment synthesis (Gilbert and Epel,2009) Therefore, in Karanji lake population the white patches on the thoracic region of green phenomorphs may be due to non-production of dark brown pigment. Thus interaction of developing nymphs with the slow drying green grass back ground might have developed a phenotype to match the back ground.

Colour polymorphism in winter population of the two grasshoppers with dark pigments combined with light or brown colour may help in increasing their camouflage in the preferred habitat, also the melanin pigment help in absorption of solar energy to perform physical actions like jumping. Melanin pigments predominantly found on thoracic region and melanin granules are spread on femur of hind legs where the energy generator gadget of grasshoppers are located where as in rainy season the grass is more green the body colour too appeared green in these two species of grasshoppers.

Roonwal (1977) and Uvrov (1966) have discussed the significance of body colour changes in grasshoppers giving presumed causal agents and evolutionary trends for these changes in morphology though these authors have recorded two phenotypes in the genera Acrida, the detailed analysis gives to the natural background and seasonal changes are not given. This colour matching with the back ground may help in survival and perpetuation of these species if it so stand as good example of survival strategy, yielding more relevance to this study.

Acknowledgements

We are thankful to the Chairman, Department of Studies in Zoology, University of Mysore for providing facility, UGC SAP CAS PHASE 1 grant, UOM and Prof. H.A. Ranganath for the critical comments on the manuscript.

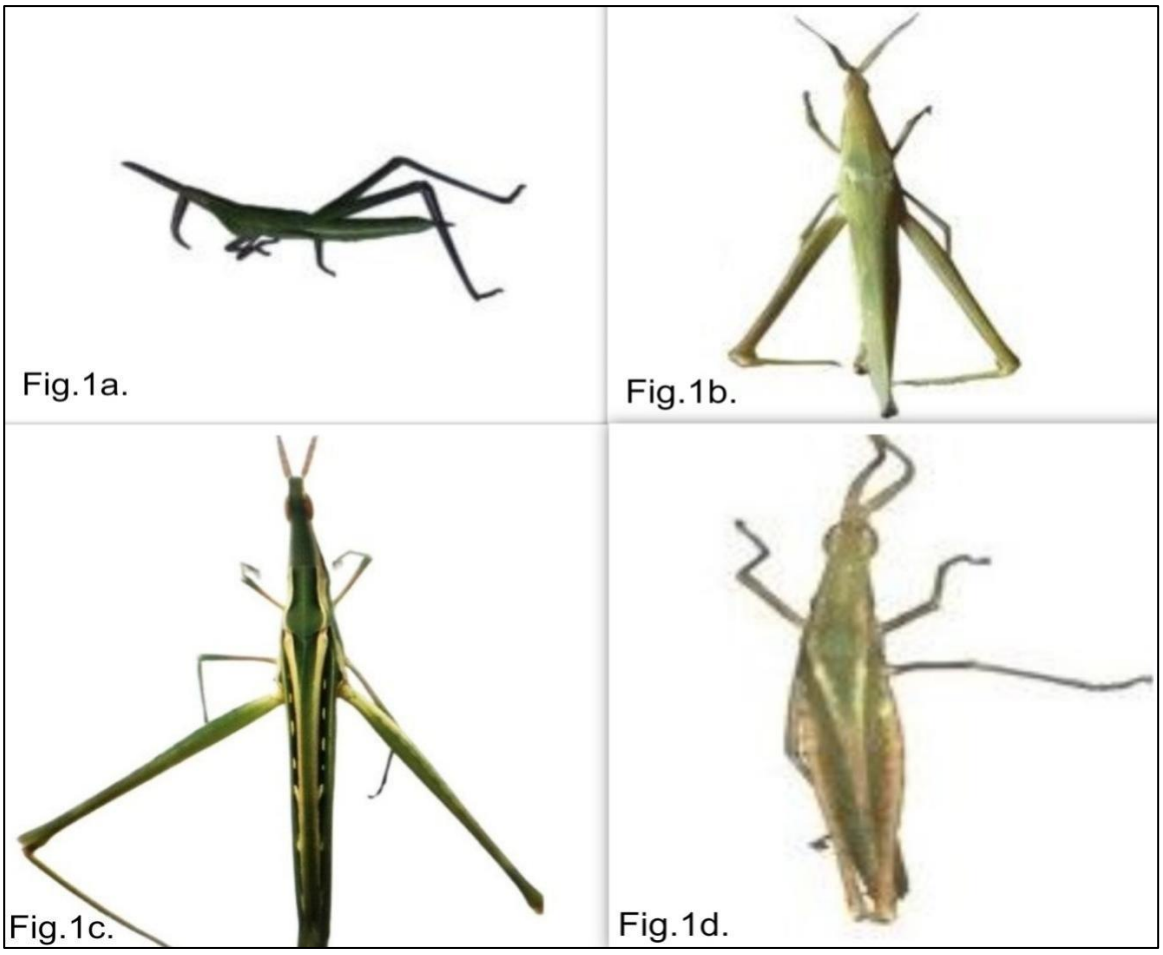

Fig. 1a. Green Nymph (common in rainy season/rare in winter. Appears both the species *A. exaltata, A. gigantean*, **Fig.1b.** Green morph - *A.exaltata*, **Fig.1c.** Green morph polymorphism in white band and discontinuous white pigment on sides, **Fig.1d.**Green morph *A. gigantean* - white bands but broken white line missing

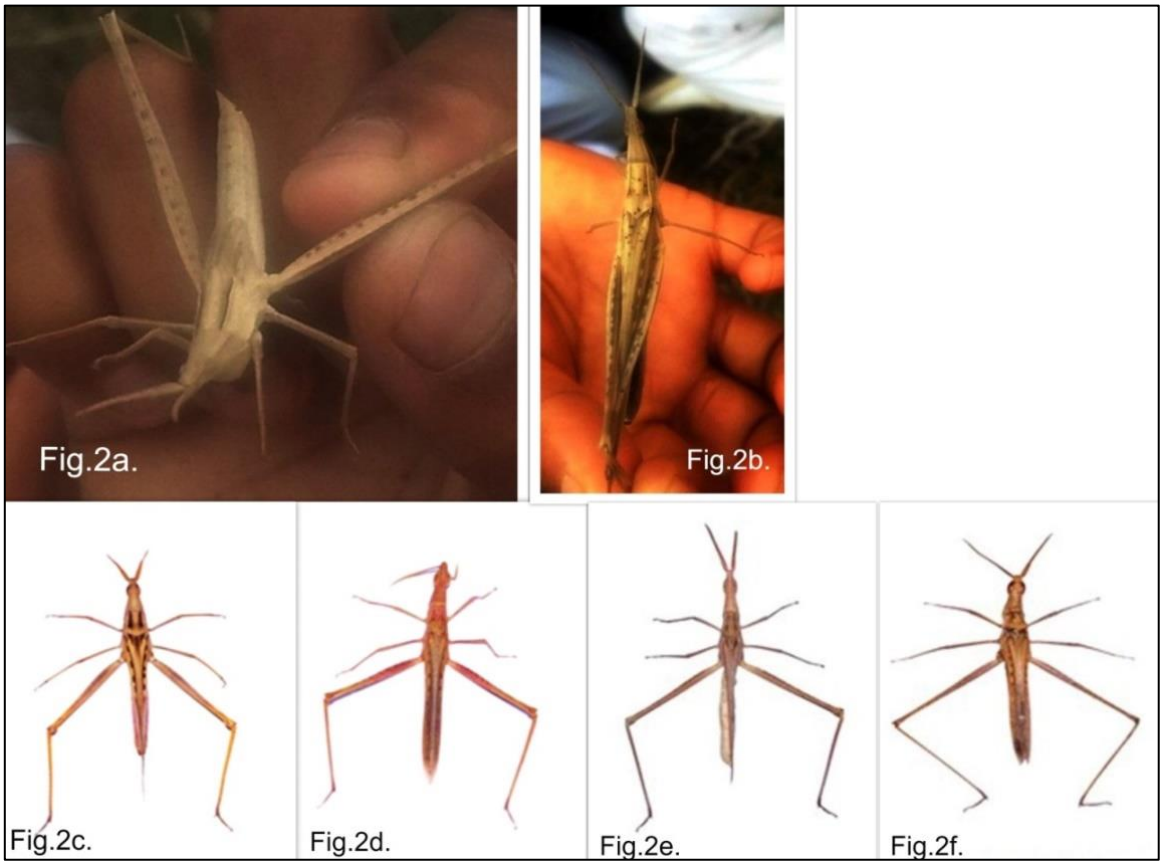

Fig. 2a. Brown nymph: appears in winter season seen in both the species, **Fig. 2b.** Brown morph : *A. exaltata* with least expression of black bands on thorax and sides of wings., **Fig. 2c.** Brown morph: *Aexaltata* deep dark bands on prothorax, inverted triangle black band and broken dark lines on sides, **Fig. 2d.** *A. gigantea* dark band of small size on thoracic regions and sides of wings, **Fig. 2e. and 2f.** *A. gigantea*- With two small thoracic bands the inverted black band missing but has small side bands.

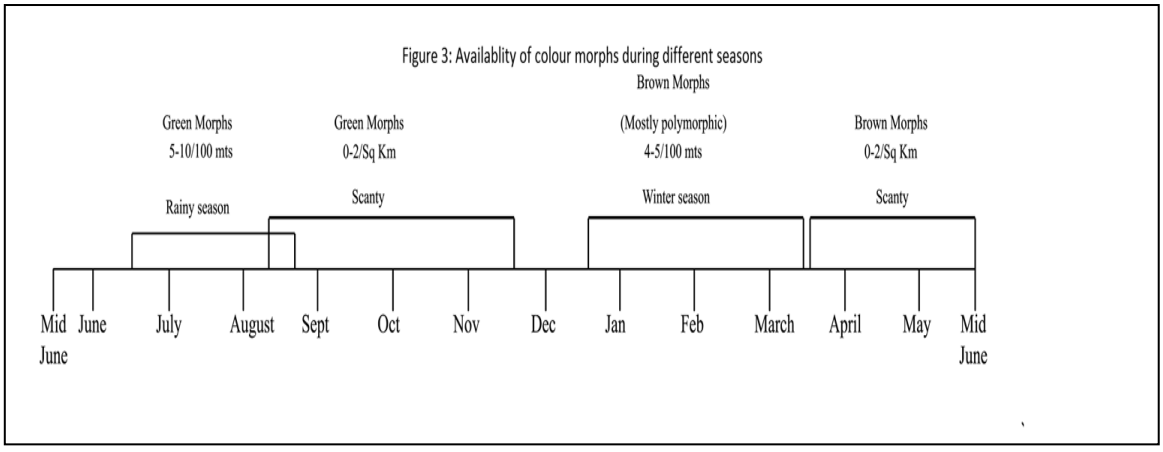

Fig. 3. Availability of colour morphs during different seasons

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MS Received 30 September2021
MS Accepted 26 November 2021

A report on the incidence of planthopper, *Diostrombus carnosa* (Westwood) (Hemiptera: Derbidae) from *kharif* Rice

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Rice (*Oryza sativa* L.) is one of the major staple food crops for more than half of the global population. It is cultivated in almost all the tropical, subtropical and temperate countries of the world. Rice is the dominant cereal crop in India and its production is estimated at 102.36 MT in the *Kharif* season of 2020-21 as against 101.98 MT in 2019-20 (Reddy *et al*., 2020). The insect species complex in rice varies in terms of abundance and distribution from region to region.

In West Bengal, rice is grown under diversified situations across the six agro-climatic zones. The crop is being attacked by more than 100 species of insects and a few of them *viz*. stem borer (*Scirpophaga incertulas Walker),* leaf folder **(***Cnaphalocrocis medinalis Guenee),* plant hoppers (*Nilaparvata lugens Stal and Sogatella furcifera Horvath), leaf hoppers (Nephotettix virescens Distant and N. nigropictus Stal),* earhead bug (*Leptocorisa oratoria Fabricius),* etc. are a matter of serious concern because they can inflict economic crop damage. We encountered the incidence of derbid plant hopper, *Diostrombus carnosa* (Westwood) (Hemiptera: Derbidae) (Fig.1) from the experimental plots of the C-Block Farm of Bidhan Chandra Krishi Viswavidylaya, Kalyani, West Bengal ($22^0$59'16" N Latitude and $88^0$27'19" E Longitude) during *Kharif* 2021. The activity of this pest was noticed during the August and September months and was found harboring on the rice tillers (Fig.2). This is the first record of its kind from West Bengal as well as from the eastern part of India.

Derbidae is the third largest family of Fulgoroidea which includes nearly 1600 described species and most species are associated with monocots (Yap and Bourgoin, 2016). The head of the adult hopper is usually small and greatly compressed. They bear paired lateral ocelli which are usually conspicuous and situated on the lateral area of the head in front of the compound eyes. The legs are slender, quite elongate and the second segment of the hind tarsi is large, with a row of spines at the apex. The members of this group have highly modified piercing and sucking mouthparts and some of them are vectors of plant diseases like *D. mkurangai*, the vector of coconut lethal yellowing disease (Bila *et al*., 2017).

Rice crop is known to suffer losses of up to 200 MT globally owing to various factors (Singh and Tiwari, 2020). One of the major biotic constraints of the low productivity of rice in India is the occurrence of insect pests at different phenophases of the crop. Different species of hoppers are recorded from rice, which are involved in the transmission of viral diseases

such as rice yellow and grassy stunt viral diseases. *D. carnosa* is a small and active hopper, having an orange coloured body with macropterous wing and diurnal flight activity. There is little known information about the pest status and it was previously reported as the pest of rice (Dorji, 2016) from Bhutan; maize in northeastern states of India (Kuotsu and Lalrinfeli, 2019). Their incidence was also reported in vegetable crops *viz*. chilli (Sankarganesh, 2017) and okra (Kumar and Omkar, 2018). However, unlike other species, the occurrence of *D. carnosa* is unusual and not reported to cause any economic damage in the crops including rice. There is a need to work out the pest-risk analysis as well as a comprehensive investigation on the nature of crop damage inflicted by them. As per the existing scientific literature, this is the first report of *D. carnosa* from the rice crop in this region.

Fig. 1: Adult derbid, *D. carnosa*

Fig. 2: *D. carnosa* incidence in rice field

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MS Received 23 September 2021
MS Accepted 26 October 2021

Incidence of *Spodoptera litura* (Fab.) (Noctuidae: Lepidoptera) in tobacco nursery

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Tobacco (*Nicotiana tabacum*) is a leading commercial crop valued for its leaf containing nicotine and plays an important role in the socio-economic well-being of the people in India. Several biotic and abiotic factors contribute to low quality tobacco production, of which insect pests are the major component. *Spodoptera litura* (F.) commonly known as the tobacco caterpillar is a generalist herbivore infesting more than 290 species of plants belonging to 80 to 99 families (Wu *et al*., 2004). It causes significant damage to different types of tobacco both in nursery and in field conditions. Damage due to *S. litura* in tobacco nurseries varied from 80 to 100 per cent (Chari *et al*., 1986) and 10-25 per cent in the main crop, the leaf yield reduced up to 23 to 50 per cent (Patel *et al.*, 1971).

In the nursery, the young larvae of *S. litura* feed gregariously on leaves in the early stages. The first and second instar larvae (Fig. 1) scrape the epidermal layer causing papery leaves whereas, third and fourth instar larvae (Fig. 2) are particularly voracious feeders causing defoliation of leaves. They migrate to other seedlings as they grow in size and become solitary. In case of serious infestation, larvae destroy the seedlings necessitating resowing of the nursery. Hence, continuous monitoring and management is essential in the nursery ecosystem of tobacco. Severe defoliation was observed in experimental plots of tobacco nursery (Fig. 3) of All India Network Project on Tobacco (AINPT), Zonal Agricultural and Horticultural Research Station, University of Agricultural and Horticultural Sciences, Navile, Shivamogga, Hence its incidence and damage were recorded.

We encountered the incidence of tobacco caterpillar, *S. litura* (Lepidoptera: Noctuidae) in tobacco nursery during *Kharif* 2021. The plot is located at All India Network Project on Tobacco, Zonal Agricultural and Horticultural Research Station, University of Agricultural and Horticultural Sciences, Navile, Shivamogga, Karnataka, which is located at 588 meters above mean sea level at 13° 58′ North latitude and 75° 35′ East longitude in the Southern Transition zone (Zone-7) of Karnataka. The seedlings were raised by following package of practices of UAHS, Shivamogga in raised beds of (1m X 2m). The maximum activity of *S. litura* larvae was noticed during the second fortnight of June with a maximum of 10.6 larvae per bed with an average seedlings foliage damage of 56.76 per cent (Table 1). Per cent foliage damage was calculated by counting the number of plants damaged by *S. litura* over total number of plants in each bed.

Favourable environmental conditions such as cloudy weather with continuous drizzling of rainfall during the month of June 2021 may be the reason for population increase. For effective management of *S. litura* in

tobacco, future planning of integrated pest management components is essential instead of only depending on chemical insecticides.

Table 1: Incidence of *Spodoptera litura* and its foliage damage in tobacco nursery

	Number of larvae per bed (1m X 2m)	Per cent seedlings (foliage) damage
Bed-1	9	39.26
Bed-2	13	71.42
Bed-3	8	37.30
Bed-4	11	66.41
Bed-5	12	69.41
Average	**10.6**	**56.76**

Fig. I. Early instar larvae of *Spodoptera litura* in tobacco in tobacco nursery

Fig. II. Later instar larvae of *Spodoptera litura* larvae in tobacco

Fig. III. Defoliation of Spodoptera litura in Tobacco nursery

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MS Received 23 October 2021
MS Accepted 29 November 2021

Effect of vermiwash on growth of entomopathogenic fungi *Lecanicillium lecanii*

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An entomopathogenic fungi *Lecanicillium lecanii* is found effective against various sucking insect pest like thrips, whiteflies, mealybugs etc. on various crops. In mango it is reported pathogenic to mango hopper by Kumar *et al.,* 1983, Srivastava and Tandon, 1985; *Valvi et al.,* 2018 and Raghunandan *et al*., 2020. In organic farming, mango farmers spray vermiwash to boost up the plant growth as it contains Nitrogen, Phosphorus, Potassium and Calcium (Gorakh Nath *et al.,* 2009) and *L. lecanii* for the management of sucking pest. Therefore, to reduce the time and application cost, compatibility of *L. lecanii* with vermiwash is always questioned by the farmers. As no information on compatibility of *L. lecanii* with vermiwash is available, the present experiment was carried out as preliminary study in the laboratory to understand the effect of vermiwash on the growth of *L. lecanii.*

The present investigation was carried out at the Bio-control Laboratory, Regional Fruit Research Station, Vengurle (15.8514° N, 73.6389° E) during 2016-17 in Completely Randomised Design with seven treatments and three replications. Vermiwash was obtained from local commercial vermicompost unit. Vermiwash and distilled water were autoclaved at 121.9 ^{0}C temperature for 15 minutes. Different concentration of vermiwash *viz.,* 5%, 10 %, 20%, 40%, 80%, and 100% were prepared with autoclaved distilled water. A little inoculum of entomopathogenic fungi *L. lecanii* was taken from the mother culture and was inoculated on Potato Dextrose Agar (PDA) plate for seven days. After seven days a circular disc of *L. lecanii* culture (0.5 cm diameter) grown on PDA plate was bored out with the help of cork borer and placed in the middle of each PDA plate in aseptic condition. One ml of each concentration of vermiwash was transferred with a micropipette and released in each PDA plates whereas in control one ml distilled water was added. The plates were incubated for 5 days at room temperature. Radial growth of centrally placed *V. lecanii* disc were measured with measuring scale at 3, 4 and 5 days after inoculation (DAI) and average growth in three replications is presented in table 1.

Data presented in the table clearly shows that radial growth of *L. lecanii* disc on a PDA plate in each vermiwash concentration and at each time interval is significantly more than the control. It also reveals that as the concentration of vermiwash increases, the radial growth of *L. lecanii* disc also increases. Thus the result of preliminary study indicates that, there is some growth promoting factors in the vermiwash which promotes the growth of

entomopathogenic fungi *L. lecanii*. The literature on compatibility of vermiwash and entomopathogenic fungi is not available. However, many scientists like Samadhiya *et al.*, 2013; Subha Mary Varghese and Lakshmi Prabha, 2014 and Kaur *et al.*, 2015 proved the efficacy of vermiwash on the vegetative growth of different plant species.

Table 1: Effect of different concentrations of vermiwash on the radial growth of *Verticillium lecanii*

Sr. No.	Treatment	Radial growth of *L. lecanii* at (cm)		
		3 DAI	4 DAI	5 DAI
T1	Vermiwash 5%	2.77	5.33	7.30
T2	Vermiwash 10%	4.00	5.57	7.47
T3	Vermiwash20%	4.40	5.37	7.47
T4	Vermiwash 40%	4.90	5.67	7.63
T5	Vermiwash 80%	5.33	6.03	8.43
T6	Vermiwash 100%	5.60	6.40	8.63
T7	Control (Distilled water)	2.73	5.27	7.33
	S.Em.	0.25	0.22	0.09
	CD	0.77	0.68	0.28

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MS Received 15 October 2021
MS Accepted 2 December 2021

A new record on the infestation of a millipede in agricultural crops of Kerala

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Millipedes are known to be detritivorous organisms, feeding on decaying organic matter. These are considered as farmers' friends as they are involved in litter decomposition aiding in nutrient cycling and soil formation (Culliney, 2013). Even some of the millipede species such as *Arthrosphaera magna* are employed for compost preparation from plantation residues in Karnataka (Ashwini and Sridhar, 2006) and *Xenobolus carnifex* for composting the commonly available organic waste such as leaf litter, sugarcane trash, rice husk and saw dust in Tamil Nadu, India (Karthigeyan and Alagesan, 2011).Though their occurrence in agricultural fields and humid forest lands are common, they are not reported as serious pests in agricultural crops of Kerala.

In October 2021, the bitter gourd and cucumber crops cultivated in Vazhikkadavu, Panchayath (Latitude 11.377413^{o}, longitude 76.352802^{o}, elevation 158.41±8 m) Malappuram district, Kerala, had a heavy infestation of millipedes. The tender leaves of the crops were severely defoliated by feeding the leaf lamina, leaving only the veins. The millipedes were found resting beneath the weeds during day time, and they were actively feeding in large swarms on the crops during night. This pest defoliated seventy per cent of the plants, and they climbed to 75-90 cm height to feed on the tender leaves. Around 5-7 millipedes were infesting each vine. The field sanitation was poor as the farmer could not perform timely weeding operations due to the continuous rains. The specimens of millipedes were collected from the infested field and were taxonomically identified as *Carlogonus gayathri* Sankaran and Sebastian, 2020.

The species was originally described by Pradeep M. Sankaran and Pothalil A. Sebastian in 2020, which was collected from Thrippalur, Palakkad district, Kerala (Sankaran and Sebastian, 2020). The specific epithet refers to the Gayathripuzha River, a tributary of Bharatapuzha River flowing through the Palakkad district. They reported that the species are seen during the onset of rains and inhabit the open ground system covered with dried leaves and debris. They described that the species is in brown and yellow mixed colour with a round shape, and it has 65 circles and 239 legs on its body which grows up to 133 mm and 55 to 59 small eyes on both sides of its body.

Detailed investigation on its potential to cause economic damage to the crops and their management is needed. The investigation on whether climate change causes a shift in the feeding behaviour of millipedes is also necessary.

Fig. 1: Millipede, *Carlogonus gayathri* Sankaran and Sebastian, 2020

Fig. 2 Millipedes infesting bitter gourd

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Acknowledgement

The authors are highly grateful to Dr. Sudhikumar A. V., Head of the department, Department of Zoology and Ms. Aswathy M.D., Ph. D. Research Scholar, Centre for Animal Taxonomy and Ecology (CATE), Department of Zoology, Christ College, Irinjalakuda, Kerala, for the taxonomic identification of millipede specimens.

MS Received 18 September 2021
MS Accepted 6 Novemeber2021

New report of Neotropical invasive Bondar's nesting whitefly, *Paraleyrodes bondari* Peracchi (Hemiptera: Aleyrodidae) from West Bengal, India

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Globalization has enhanced international agricultural trade. The movement of goods and planting materials across the countries risks the introduction of invasive pests. Despite strict quarantine measures, various insect pests have hitherto entered. The invasion causes significant losses to biodiversity and a greater impact on agriculture crop production and the economy of the country. India has witnessed the incursion of different species of exotic whiteflies (Selvaraj *et al*., 2020) and raised biosecurity concerns.

Recently, the occurrence of invasive Bondar's Nesting Whitefly (BNW), *Paraleyrodes bondari* Peracchi (Hemiptera: Aleyrodidae) has been documented in West Bengal ($22^0$59'31"N Latitude and $88^0$26'54"E Longitude). *Paraleyrodes bondari* was first described on Citrus species from Brazil in 1971 (Peracchi, 1971) and later in 2011, it was detected in Florida USA (Stocks, 2012) where it is considered an emerging pest. Previously, nesting whiteflies, *P. bondari* and *P. minei* were confined and restricted only in the Southern parts of India which were first reported on coconut palms in Kerala (Josephrajkumar *et al*., 2019). *Paraleyrodes minei* closely resembles *P. bondari*, but lacks distinct markings on wings and constructs loose wax nests (Iaccarino *et al.*, 2011).

Although BNW made its first entry in continental India during 2019, its occurrence has not yet been reported from Eastern parts of India. Soon after understanding its invasion, a roving survey was undertaken to explore their incidence pattern. During our survey, *P. bondari* was found to be colonizing on different host species *viz.*, coconut, arecanut, banana, guava and jack fruit (Table. 1) at Nadia districts of West Bengal during late October 2021. The specimens were collected from the infested plants and the identity of the pest species was confirmed through morphological characteristics (Martin, 2004; Josephrajkumar *et al*., 2020).

Table 1. Host plants of *P. bondari* recorded in West Bengal

Host Species	Family	Economic Importance
Coconut, *Cocos nucifera* L.	Arecaceae	Plantation crop
Arecanut, *Areca catechu* L.	Arecaceae	Plantation crop
Banana, *Musa* sp.	Musaceae	Fruit crop
Guava, *Psidium guajava* L.	Myrtaceae	Fruit crop
Jack, *Artocarpus heterophyllus* Lam	Moraceae	Fruit crop

The intensity and severity of this pest were found to be more on coconut palms (> 30 adults/leaflet), moderate in arecanut (11-20 adults/leaflet) and low in other recorded hosts (<10 adults/leaf). The infestations produce circular white nests that create a dot pattern (Fig.1). In coconut palms, the co-occurrence of previously reported rugose spiralling whitefly (RSW), *Aleurodicus rugioperculatus* Martin with *P. bondari* was observed (Fig. 2). A similar observation on the concomitant occurrence of RSW and nesting whiteflies was reported by previous researchers on coconut from Southern parts of India (Chandrika *et al*., 2019; Vidya *et al.*, 2019). The feeding damage of BNW has lesser than RSW with minimum honeydew and sooty mold deposits. During the field investigation, we could not observe any parasitized nymph or puparium. Nevertheless, natural enemies like chrysopid and spider activity were noticed in the infested leaflets.

Fig. 1. Symptoms of damage on coconut palm

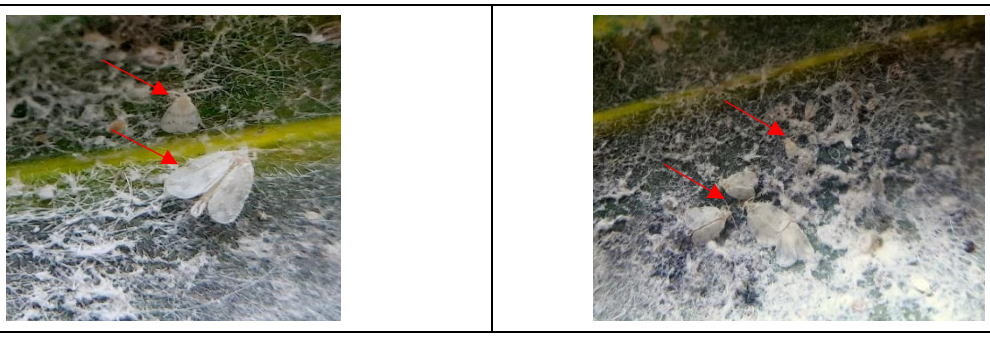

Fig. 2. Co-existence of RSW, *A. rugioperculatus* with BNW, *P. bondari* and heavily infested coconut palm

P. bondari constructs unique woolly wax nests on the abaxial surface of leaves. It lays stalked (Fig.3), clustered eggs (Fig.4) and hatches into first instar crawler (Fig.5), which find a feeding site and settle. The nymphs (Fig.6) are creamy yellow and transparent with the presence of marginal hairs, the pupa is flat (Fig. 7) with a characteristic pattern of wax around. The adult is a small fly measuring about 1.0 mm with a dull yellow body and possesses 'X'-shaped oblique grayish markings on forewings (Fig. 8).

Fig. 3 Stalked egg of BNW, *P. bondari*

Fig. 4 Egg clusters of BNW, *P. bondari* in woolly wax nest

Fig. 5 Mobile crawler of BNW, *P. bondari*

Fig. 6 Nymphal stages of BNW, *P. bondari*

Fig.7 Pupa of BNW, *P. bondari*

Fig. 8 Adult BNW, *P. bondari* inside the waxy nest

The aedeagus of *P. bondari* is unique and easily distinguished from other *Paraleyrodes* species (Fig. 9) and male genitalia resembles rod-like with anterior and posterior horns (Martin, 2004; Vidya *et al.*, 2019). Apart from trade and transport, a drastic shift in weather patterns may influence the invasion and upsurge of this pest in newer areas. The polyphagous feeding nature and absence of specific natural enemies of this exotic BNW may pose a great concern to the horticulture sector if left unchecked. There is an urgent need to formulate suitable management strategies by exploring potential natural enemies to tackle this invasive pest and warrants stringent quarantine protocols to prevent its further spread to newer areas.

Fig. 9 Abdominal terminalia of BNW, *P. bondari*

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MS Received 22 October 2021
MS Accepted 11 November 2021

Review articles & Short notes

Mustard oil bomb' in herbivory defense mechanism- A review

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Introduction

Mustard (*Brassica nigra* L.; Family: Brassicaceae) and rapeseed (*Sinapis spp*. L.; Family: Brassicaceae) plants are annual shrubs, grown in *rabi* season, belongs to order Cruciferae. Plants possess a wide range of morphological barriers (Trdan *et al*., 2009) and toxic biochemical substances (secondary metabolites) to protect themselves against harmful insect pests (Lucas-Barbosa *et al*., 2011). Secondary metabolites are inherited due to the evolutionary advantages they impart to the plant for defense from abiotic and biotic stress (Dong and Kahmann, 2009). The *Brassica* plants contain many phytochemicals that have medicinal value. The main phyto-chemicals present in *Brassica* species include polyphenols, phenolic acids, flavonoid, carotenoids (zeaxanthin, lutein, β carotene), tannins, alkaloids, saponins, anthocyanins, phytosterols, chlorophyll, glucosinolates, phytosteroids, terpenoids, glycosides, vitamin C, vitamin E and aliphatic and aromatic amines. Edible parts of Brassica plants show biological activities against different diseases and very effective in treating various diseases in humans like anti-microbial, anti-bacterial, anti-diabetic, anti-malarial, ant-aging, anti-ulcer, anti-hyperglycemic, anti-hyperlipidemic, anti-proliferative, neuro-protective, anti-genotoxin and anti-oxidant activities (Nawaz *et al*., 2018).

Glucosinolate is plant organic compound abundantly found in all Brassicaceae crops (Thinh-Nguyen *et al*., 2020). Glucosinolate derived from amino acids, which are glucosylated specialized metabolites (Blazevic *et al*., 2020) constituted of a β-thioglucose moiety, a sulfonated oxime moiety, and a structurally diverse side chain are categorized into aliphatic, indolic and benzenic glucosinolates (Agerbirk and Olsen, 2012). Glucosinolates have sulfur rich S-cells (Koroleva and Cramer, 2011), whereas the activating enzymes, myrosinases are present in protein enriched idioblasts called myrosin cells (Rask *et al*., 2000). Glucosinolates are present in plants in non-toxic and non-volatile form and are also known as 'mustard oil bomb' (Kissen *et al.*, 2009) in the event of herbivory by insects they are broken down by hydrolytic myrosinase to isothiocyanate or thiocynate or nitrite. About 130 glucosinolate structures have been discovered, sinigrin the most abundant aliphatic glucosinolates in Brassicaceae, directly controls

soil borne plant pests (Borek *et al*., 1994), indolic glucosinolate are involved in insect-deterring functions (Bednarek *et al*., 2009). Glucosinolate are important defense compounds in Brassicaceae against herbivores and pathogens. Glucosinolates contents and compositions vary depending on the *Brassica* species and insect damage (Tripathi and Mishra, 2007). It acts as an herbivory defense system deterrent herbivores and aiding parasitoids and predators (Hopkins *et al*., 2009).

Effect of glucosinolate on monophagous and polyphagous insect pests

Monophagous are those insects which feed on only a single species of plant or limited host range that is also known as specialist insect. Also define polyphagous and generalist. These specialists consume plants containing toxic compounds to detoxify or neutralize glucosinolate compound by enzymatic decomposition, excretion and sequestration, thereby converting into less toxic or non-toxic compounds (Poelman *et al*., 2008). Some specialists continuously feed the secondary metabolites, and develop a tolerance by depositing in their tissue to utilize for their defence (Fahey *et al*., 2001). Glucosinolate serve as attractant or stimulate (feeding and oviposition) for specialist insects (Wittstock *et al*., 2003). Some examples of specialists insects *Plutella xylostella*, has a sulfatase in its gut which cleaves the sulfate residue from the glucosinolate core structure and thus prevents its hydrolysis by myrosinase. The aphid *Brevicoryne brassicae* has been reported to possess its own myrosinase which produces isothiocyanates from sequestered glucosinolates when the aphid is damaged or killed. Interestingly, these isothiocyanates even serve as alarm signal to other members of the colony. Larvae of the *Pieris rapae* (cabbage white butterfly) form nitrite specific protein (NSP) in its gut to escape hydrolysis reaction by myrosinase. In brassicaceous plants, secondary chemicals, glucosinolates and their breakdown products effectively decrease performance of generalist herbivores (Agrawal and Kurashige, 2003). Glucosinolate products serve as defence compounds against generalist herbivores (ex. *Mamestra brassicae, Spodoptera eridania*) and it acts as biopesticides. Generalist herbivores are usually more sensitive to high levels of specific allelochemicals compared to specialists (Giamoustaris and Mithen 1995).

Conclusion

Many studies have been conducted worldwide regarding the study of glucosinolate as an active plant ingredient that regulates the population of monophagous and polyphagous pest. Myrosinase-glucosinolate system is present in plants of the Brassicaceae family. The enzyme myrosinase degrades glucosinolates into toxic products. This system is activated upon attack and is one of the defence barriers towards insect pests and pathogens. Sinigrin is the major glucosinolate present in *B. juncea* and gluconapin is the major glucosinolate in *B. napus* and the chemical defence mechanism (especially glucosinolates) is predominant in Brassicaceae (Bjorkman *et al*., 2011). According to Hopkins *et al*., (2009) high concentration of glucosinolates has an antibiotic

effect on both generalist and specialist pests. Schoonhoven *et al*., (2005) reported that some specialist herbivores even accumulate intact glucosinolates and use them for their own defence.

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MS Received 26 September 2021
MS Accepted 28 November 2021

Red ants devour mosquitoes too

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Mosquitoes pose great threat to human life, by serving as vectors of many life-threatening diseases like malaria, dengue, yellow fever, filariasis, chikungunya and recently zika. Mosquitoes have a number of natural enemies that collectively influence their populations. Biological mosquito control techniques include direct introduction of parasites, pathogens and predators to target mosquitoes (Eldridge, 2008). Many predators including fish, birds, dragon flies, spiders and other organisms play a part in mosquito control by targeting different life cycle stages (Ndava et al., 2018). During an observation in a household site at Puttur, Karnataka, it was noticed that lot of red ants (*Oecophylla smaragdina* F.) were found to move inside the drain holes of septic tank which were also the breeding sites of mosquitoes. The mosquitoes found in the site belong to the genus, *Armigeres* (Culicidae: Diptera) (Figure 1a and b), which are considered as medically important mosquito species. Movement of red ants carrying these mosquitoes was noticed continuously for a period of 6-8 days. Red ants are commonly present in the study site, where jack trees and mango trees are seen in backyard gardens.There are reports that red ants can control over 50 species of pests on many tropical tree crops and forest trees (Sarwar, 2015; Waage and Greathead, 1988).This interesting observation gives an indication that red ants can also serve as a predator of adult mosquitoes in its breeding sites and further study may aid in devising suitable biocontrol method of mosquitoes.

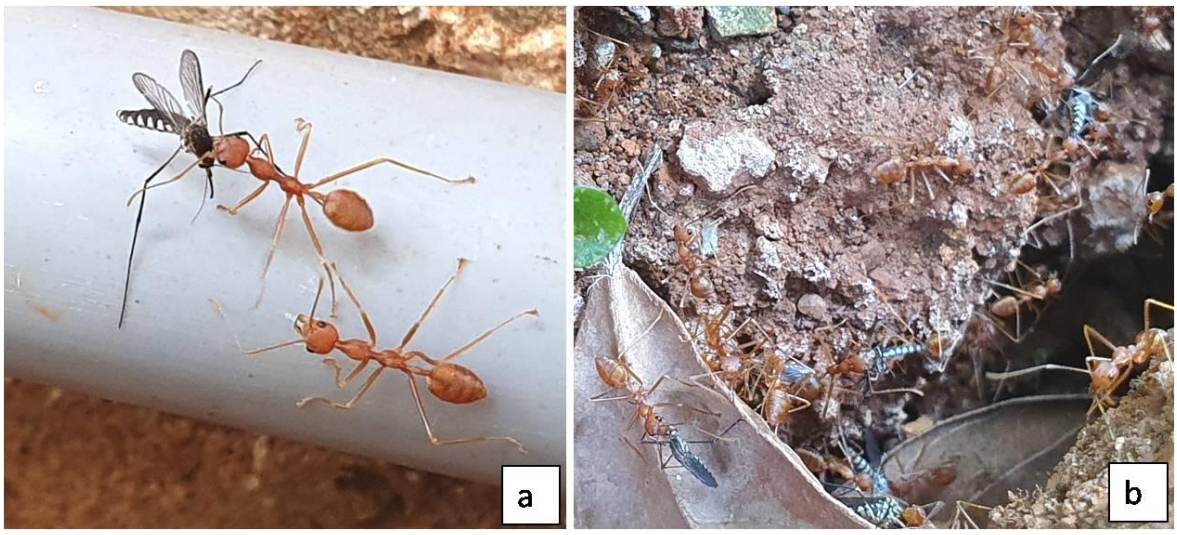

Fig. 1. Predation, a. Red ants carrying mosquito b. Red ants moving in and out of the opening at sewage site.

Acknowledgement

Author thankfully acknowledges the help of Dr. T. Seenivasagan, Scientist of Entomology, Defence Research & Development Establishment, DRDO, India for identifying the mosquito species.

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MS Received 5 October 2021
MS Accepted 19 November 2021

Bat avoidance behaviour in insects

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Some insects have evolved audition and evasive behaviors in response to selective pressure from bats, and other insects were pre-adapted to detecting ultrasonic signals. Some bats have evolved in turn, improving the range or resolution of sonar signals and serendipitously making them less detectable by insects. In other words, there is a kind of evolutionary escalation going on between bats and insects (Miller and Surlykke, 2001).

Moths, as do crickets and most insects that display bat avoidance behaviors, have tympanic organs that display phonotactic and directional hearing; they fly away from the source of the sound and will only have the diving behavior considered above when the sound is too loud or when, in a natural setting, the bat would be presumably too close to simply fly away. It was found that the moths' responses vary according to ultrasound intensity, diving towards the ground if the pulse was of high amplitude, or flying directly away from the sound source if the sound amplitude was low.

Crickets are preyed on by bats during the night while they fly from one place to another. The cricket will steer itself away from the source of the sound within a very short time frame (40–80 ms). The response is evoked by brief ultrasonic pulses in the 20 to 100 kHz range, pulses within the range of bat ultrasonic echolocating calls (Fullard *et al*., 2005).

In praying mantids, ultrasound avoidance behaviors are non-directional turns or power dives that are very effective in preventing capture by bats. The mantis ear, located in the midline between the meta-thoracic (third) legs, comprises two tympana within an auditory chamber that enhances sensitivity (Yager *et al*., 1990). A bilaterally symmetrical pair of auditory interneurons, accurately track the ultrasonic calls during the early stages of a bat attack.

Arctiid moths use a very different, but highly effective defense against bats. They produce loud ultrasonic clicks in response to ultrasound (Surlykke and Filskov, 1997). Depending on the species of moth and its ecology, the clicks may work by startling the bat, by jamming its echolocation system, or by warning of distastefulness (aposematism).

Green lacewings (Chrysopidae) have sensitive ears on their wings. Ultrasound causes flying lacewings to fold their wings and drop, an effective maneuver for evading capture by bats. Some tettigoniids use a similar strategy, although other species respond much like crickets.

The evolutionary arms race continues between bats and their insect prey, and undiscovered strategies await to be revealed. An individual bat can modify at least some of its strategies through learning, whereas insect counterstrategies appear through the slower process of natural selection. Does this mean insect strategies lag behind those of their predators? Perhaps not. The variability of an individual insect's anti-bat behaviors might be a response to the predator's ability to learn. Perhaps the "evitability" of the prey's behavior makes learning by the predator less effective.

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MS Received 18 November 2021
MS Accepted 3 December 2021

Helopeltis theivora finds a new host, *Anthurium* sp. - an observation

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Helopeltis theivora Waterhouse is commonly known as tea mosquito bug, belonging to Miridae family of Hemiptera. It is a serious pest in tea plantations. It is highly polyphagous in nature and its host range is very vast. Several annual and perennial crops of different families are infested by this notorious pest, among economic plants include tea, cashew, acacia, cocoa, camphor, pepper etc to which it causes considerable damage and yield loss. The nymphs and adults of this pest suck cell sap from tender stems, young leaves, buds, flowers and flower buds, fruits which results in the formation of brown or black lesions resulting in necrosis and drying of infested plant parts. When the major hosts are scarce, this pest also feeds on several non-crop hosts especially weed species. Thus, it breeds throughout the year and survives in adverse seasons until the major host is available (Mukhopadhyay and Roy, 2009). Reports on its increasing host range are added often (Vanitha *et al*., 2014, Roy *et al*., 2015, Srikumar *et al.*, 2016, Sivakumar and Yeswanth, 2019).

During October 2021, in Puttur region of Karnataka, infestation of *H. theivora* was noted for the first time on *Anthurim* sp, (Family: Araceae) an ornamental plant which is one of the important economic flowers of export potential. It is to note that these potted anthurium plants had proximity to the cashew plantations. Brownish necrotic spots were seen on its leaves as well as spadix. Eggs, nymphs and adults of *H. theivora* were found in the infested plants. In the study region besides cashew, *Chromolaena odorat*a, a common weed is also found abundant including few other hosts of *H. theivora*. Our literature survey shows that this is the new report of *H. theivora* on *Anthurium* sp. The study emphasizes on regular monitoring of *H. theivora* incidence on the non-crop plants especially during non-cropping season to understand its host range and possibility of further spread to crop plants.

	
Infested spadix with *H. theivora* nymph	Infested Anthurium leaf

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MS Received 13November 2021
MS Accepted 3 December 2021

A study on life cycle of *Cheilomenes sexmaculata*

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Six spotted zig zag lady bird is a type of ladybird belonging to genus *Cheilomenes.* Even though the beetle is known to everyone their life cycle is not commonly known to us. The aim of this research project was to identify the different life stages of the six spotted zig zag beetle. Six spotted zig zag ladybirds (*Cheilomenes sexmaculata*) is a species of ladybird. It was described by Johan Christian Faricius in 1781 It is well known as a predator of aphids and other small insects. There are several types of this species. The species has a wide distribution range within Asia and subtropical zones from India to Japan and parts of Australia. Even though the ladybird beetles are commonly known their life cycle is not commonly known in detail. So I am publishing about my findings based on the life cycle of six spotted zig zag ladybird beetle.

About the study

This study was done at Sasthamangalam (8.5130° N, 76.9715° E), Thiruvanathapuram, Kerala, India on April 2020. Sasthamangalam is a place situated in the Thiruvanathapuram city, which is rich in biodiversity due to the presence of greenery and the killi river.

According to my observations there are seasons in which this six spotted zig zag ladybird beetle can be seen, basically during summer season many can be found. So I had opted to observe the six spotted zig zag ladybird in April. For my observations I had found a gooseberry tree in which there were may six spotted zig - zag ladybirds were found. There were habitated in branches. I realised that an ecosystem had been formed there.

As I was continuing the observation I had spotted a different shape insect among them. There were similarity between this and six spoted zig zag ladybird. While I was observing further, I had confirmed that this was the larva of the six spotted zig zag ladybird. I had also found the pupa stage of the six spotted zig zag ladybirds. But I was unable to spot eggs

Larval stage

It will just look like a caterpillar. The body can be divisible into head thorax and abdomen region. The head region was yellow in color. The legs will be present on the abdomen region and the thoracic region will be long which will appear like a tail. Both the thoracic and abdomen region are fused together both the region will be grey in color and will be have black and white spine like structure that spine like structure is known as tergal plates. The thoracic region is divisible into three region as pronotum, mesonotum and metanotum

At the initial stage the larva will be in black color. As it get older the tail region will become grey color with white spots will appear on it. The abdomen is mainly divided into segment.

They will have 6 legs (3 on each side) and is present on thoracic region

Fig. 1 The larva will feed on the aphids so it also help to control the aphids on the plants

Pupal stage

Pupa can be seen attached to the leaf. At the initial stage the pupa will be the same color as that of larva. Later the pupa will get a cream color with spiny like projections and will become black.

Both the ends of the pupa will be attached to the leaf and the mid region will be slightly bend. It will take 1-2 weeks for the adult six spotted zig zag ladybird beetle to come out.

Adult stage

Basically 2 varieties of six spotted zig zag ladybird was been observed. The six spotted zig zag lady bird beetle with yellowish orange colour were common among them. The other type was having a reddish orange shade.

Fig 2. Pupal stage

Fig 3. Reddish orange variety

Fig 4. Yellowish orange variety

There will be 2 zig zag line on the either side of it. The head region will be in a cream color. There will be two spots in the back side of it. These were the observation made during this research.

Acknowledgement

I am thankful to my uncle Jee Francis (Archeological Researcher) my teacher Dr K.G Manju (Assistan Proffesor, Zoology department, Mar Ivanios College and my friend Nayansubhramanyam for giving me all the support and inspiration to do this research and to publish the work successfully.

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MS Received 25 October 2021
MS Accepted 2 December 2021

Awards

The Honble Vice-President of India, M. Venkaiah Naidu conferred Rytunestam award under Scientists category for contribution in the field of coconut insect pest management with biological control, establishment of biocontrol labs in the state of Andhra Pradesh and popularizing and promoting the bio control based management to Dr. N.B.V Chalapathi Rao, Principal Scientist (Entomology) DRYSR Horticultural University, Horticultural Research Station, Ambajipeta, Andhra Pradesh, S India

Dr. B. Vasantharaj David foundation awards at Third National Conference on "Recent Advances in Crop Protection including IPM and Environmental Sciences from GLP Perspective" & Excellence Awards – 2021 Ceremony

Young Agricultural Scientist Award -2021 Dr. B.R. Jayanthi Mala Scientist ICAR-IIHR for her Contribution in Agricultural Entomology with focus on Pests of Horticultural Crops and Wax Degrading formulation

Dr. B. Vasantharaj David Foundation
76/2A Sree Ramulu street, Madanandapuram
Chennai 600 125, Mobile 98401 64099
Email davidfoundation2019@gmail.com
Trust Regn. No. 137/2019; www.bvdfoundation.com

is pleased to confer

Biodiversity Conservation Award – 2021

upon

Dr. M. JAYASHANKAR

Assistant Professor
Department of Zoology
St.Joseph's College (Autonomous),
Bengaluru-560027
Karnataka

for his

Contribution to Biodiversity Studies

Citation

Undertaken first distribution survey on the giant African snail one of the 100 worst global invasive species for doctoral studies, published papers on its distribution and management aspects in Bengaluru region and Kolar District. First reports on bipalid flatworms (Bengaluru) with Prof. Kawakatasu, the global authority on flatworm taxonomy, *Plesiophrictus* sp. (Araneae: Theraphosidae), gut associated nemathelminth in the giant African snail, malacofaunal pest complex (Bangalore region), drosophilids, avian and reptilian fauna (ecotone adjoining Bannerghatta National Park), Nectar probing in *Eythrina subumbrans* (hassk.) Merrby Drongos (Kodagu district).Part of the team that developed simulated prediction models for distribution of *Bactrocera dorsalis*, *B. papayae*, *Achatina fulica*, *Spodoptera litura* using bioclimatic modelling software 'CLIMEX' for the first time in India under the National Initiative on Climate Resilient Agriculture (NICRA) project, GOI. Undertaken surveys on cultural ecology of indigenous communities in B. R. Hills, Bandipur and Rajiv Gandhi National parks. Resource person for 'Green Skill Development' initiative of the MoEF& CC, GOI at Arunachal Pradesh Regional Centre, Zoological Survey of India. As part of Science communication initiative delivered 22 invited talks in different Institutions (including Indian Science Congress), published 33 popular articles in Arunachal Observer and Deccan Herald. As faculty coordinator for the Natural Science Association and the United Conservation Movement Association of the College involved in communicating ideas of conservation and sustainability among students, initiated the 'Josephite forum for birdwatchers' and "Natura Zoologia'newsletter.

The award is presented in the 3rd National Conference on "Recent Advances in Crop Protection including IPM and Environmental Sciences from GLP Perspective" held on Sunday, October 17, 2021 in Chennai 600116, Tamil Nadu.

Dr. B. Vasantharaj David
Trustee and Secretary *cum* Treasurer
Chennai 17.10.2021

Biodiversity Conservation Award-2021 Dr. M. Jayashankar Assistant Professor St. Joseph's College Bengaluru for his Contribution to Biodiversity Studies

Environmental Scientist Award – 2021 Dr. Rashmi, M. A Senior Technical Officer (Entomology), Regional Plant Quarantine Station, Bengaluru for her Contribution to Agricultural Entomology and Plant Quarantine with focus on Fruit fly


Organized by :
V. Sivaram Research Foundation (VSRF)
Asia-Pacific Conference on
Beekeeping for Sustainable Agriculture, Ecosystem Services and Rural Livelihoods
(BEE 2022)
March 9-10, 2022
Capitol Hotel, Raj Bhavan Road, Bangalore – 560001
In collaboration with Asian Apicultural Association (AAA) & ICPPR Canada
Knowledge Partners:
ASIAN APICULTURAL ASSOCIATION
AAA
ICPPR International Commission for Plant-Pollinator Relationships

Technical Sessions:

1. Bee Biology, Bee Genetics and Breeding
2. Asian Bees and Beekeeping
3. Plant – Pollinator Relationships
4. Beekeeping Technology and Bee Management
5. Beekeeping for Rural Development
6. Ecosystem services and Environment Sustainability
7. Bee Pest and Diseases
8. Bee- flora and crop Pollination
9. Bee Products and Apitherapy
10. Honey quality, Trade issues and challenges
11. Management of Non-apis species Pesticides and honeybees

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Dr Jian- Dong An (China)
Dr Mohana Rao (India)
Dr Chuleui Jung (South Korea)
Dr A Arunachalam (India)
Dr V K Mattu (India)
Dr Chinh Phung (Vietnam)






INSECT LENS

Spanish fly, Lytta vesicatoria belong to blister beetle family, Meloidae

They are also called as Cantharides as they produce a terpenoid cantharidin which is toxic blistering agent. Cantharidin is used medically as a topical skin irritant to remove warts.

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Hieroglyphus banian,* (*Orthoptera: Acrididae) The female lays eggs in pods each containing 30-40 eggs in the 5-8 cm deep in soil. They are phytophagous, both adults and nymphs of *Hieroglyphus banian feed on paddy and other crops, causing defoliation.

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***Cow bug/ Tree hopper, Oxyrachis tarandus* (Homoptera: Membracidae) It is commonly known as cow bug due to the 2 horn-liked structures on its head region. Cow bug has a mutualistic relationship with the weaver ant (Oecophylla smaragdina). Adults and nymphs excrete honey dew that attracts the ants and in return, the ants provide protection to the treehoppers against its predators.**

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Sorghum shoot bug, Peregrinus maidis (Hemiptera: Delphacidae), is a plant hopper a dreadful pest that attacks sorghum in India and many other countries all over the world. It transmits Maize stripe virus and Maize mosaic virus in sorghum and maize.

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Spiny Orb-Weaver, Gasteracantha cancriformis. This specimen here is a female spiny orb-weaver corresponding to its brightly coloured body and six prominent spines on its broad hardened abdomen. They are one of the most beneficial spiders since they prey upon small pests present in suburban areas. This species is most diverse in tropical Asia from India to Indonesia.

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Pink bollworm, Pectinophora gossypiella (Saunders) (Lepidoptera: Gelechiidae)

The pink bollworm is the most destructive pest of cotton. Though probably native to India, it is now distributed worldwide. It bores into cotton bolls, devouring blossoms and seeds.

Author: *Shefali D. Chaudhari, Senior Research Fellow and Anjali J. Patel, Young professional*
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A stingless bee, Tetragonula sp. caught by a crab spider, Thomisus sp. They are also called crab spiders due to their crab-like appearance and sideways motion. Crab spiders ambush pollinating insects on flowers and occupy sites where a high foraging success can be expected.

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Flower Chafer (Chiloloba acuta) Scarabaeidae: Cetoniinae. ***Chiloloba acuta is the sole member of its genus, widely distributed in the Indian subcontinent. The immature feed on decaying matter and adults occasionally on cultivated cereal and millet such as sorghum and maize, damaging flowers and grain.***

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Green Eyed Horse Fly (Tabanus nigrovittatus) (Diptera: Tabanidae). Females of Tabanus nigrovittatus are pests of humans and animals, they seek a source of blood protein to produce additional eggs. Females live for three to four weeks and may lay about 100 to 200 eggs per blood meal.

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Coin Spider (Herennia multipuncta). Herennia multipuncta also known as ornamental tree trunk spider belongs to family Nephilidae and native to Asia. It weaves a small web on the trunk of a tree or the wall of a building and is well camouflaged by its dappled colouration.

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Snout Moth (Endotricha sp.)(Lepidoptera: Pyralidae). It belongs to the tribe Endotrichini of the subfamily Pyralinae Adult moths Endotricha is characterized by the forewing usually having a dark-colored ground colouration

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Crane Fly (Limoiinae sp.) (Diptera: Tipulidae). Crane flies are sometimes known as "mosquito hawks" or "daddy longlegs". These flies resemble giant mosquitos are found in damp places throughout the world and many species form dense swarms in suitable habitats. They feed on different food sources, some are phytophagous, saprophagous, mycetophagous and predatory.

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Machaerota sp. (Machaerotidae: Hemiptera). ***Machaerota, a type of treehopper, are called tube-forming spittle-bugs as the nymphs form a calcareous tube within which they live. They have*** a ***long, free and spine-like process originating at the scutellum. These treehoppers are xylem-sap feeders.***

Author*: Ajil Benny, Student, BSc Zoolog, Department of Zoology, Mar Ivanios College, Nalanchira, Thiruvananthapuram,*
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Common Lime Butterfly (Papilio demoleus)(Lepidoptera: Papilionidae). Lime Butterfly gets its common name from its host plants, Citrus species, widespread from South Asia to Australia. They are described as the most destructive pests in citrus nurseries. Early stages, the caterpillar is light brown with white markings, closely resembling a bird's droppings as camouflage.

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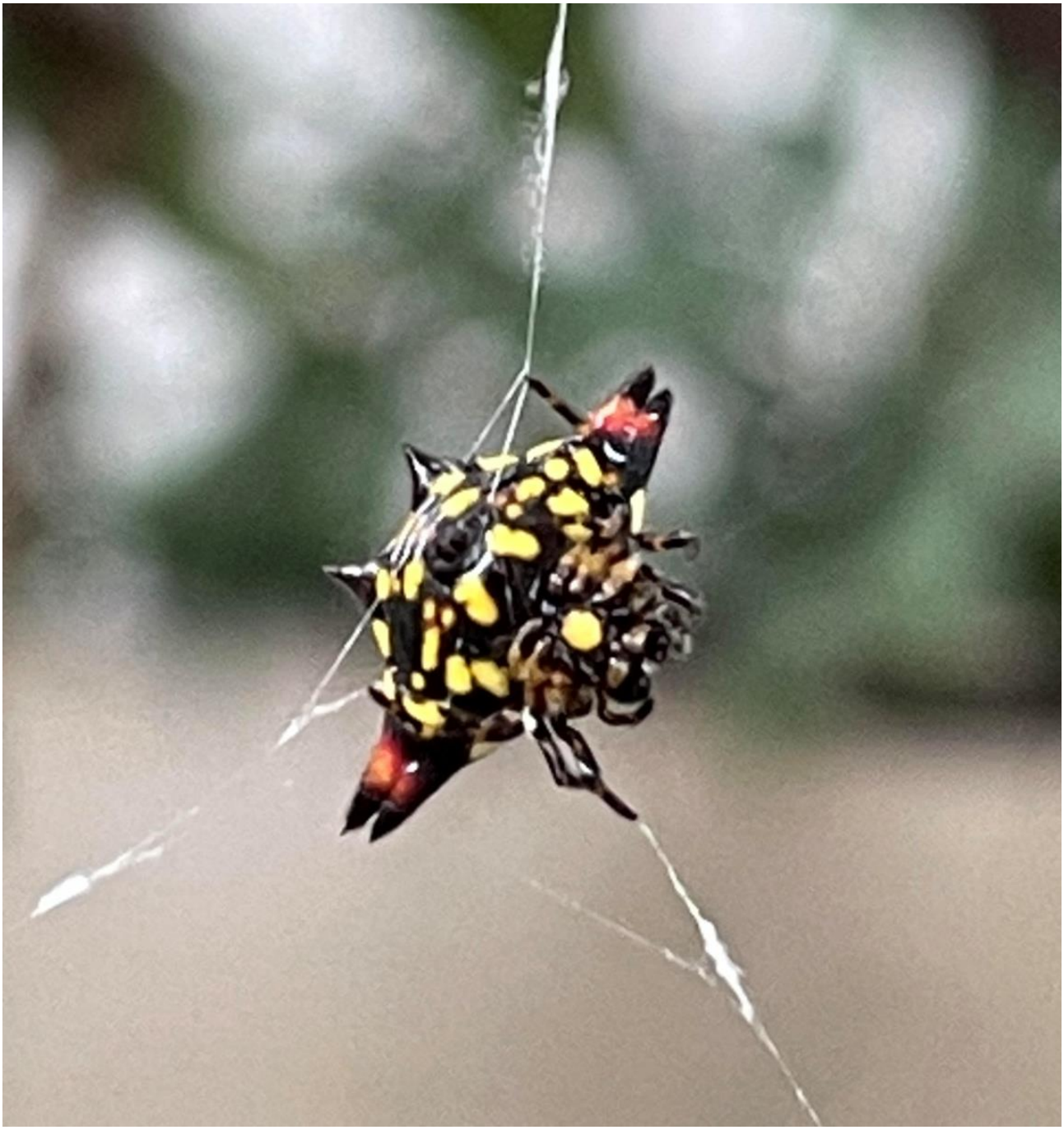

Jewel Spider, Austracantha minax commonly known as the jewel spider or the Christmas spider. They are relatively small spiders, reaching a maximum total body length of 12 mm for females, and 5 mm for males. They feed on small flying insects that get entangled in their webs.

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Bamboo Longhorn Beetle, Abryna regispetri (Coleoptera: Cerambycidae). An interesting cerambycid, first reported in May, 2011 in India from Tripura. It is also present in Laos, Burma (now Myanmar) and Malaysia.

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Prosopocoilus astacoides Poultoni (Boileau, 1911) (Coleoptera: Lucanidae)

Adult beetles live 8-10 months and their size is around 50-70mm. They have sharp mandibles used for fighting.

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Whip scorpions, Thelyphonus sepiaris (Butler, 1873) (Uropygi: Thelyphonidae)

"Whipscorpions" are moderately sized, tough and striking predators. They possess anal glands used to spray a chemical to dissuade their predators.

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Siamese Rhinoceros Beetle, Xylotrupes socrates (Schauffus, 1864) (Coleoptera: Scarabaeidae) Siamese rhinoceros beetle is a brilliant species of large scarab beetle belonging to the subfamily Dynastinae. These beetles are used for staging beetle fights, a traditional entertainment popular in the northern region of Thailand.

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Brachythemis contaminata (Odonata:Libellulidae) resting on bloom of a aquatic plant. It is a dragonfly with brown-capped yellowish-green eyes It breeds in weedy ponds, lakes, and slowly moving streams, especially in sluggish waters. It is very common along sewage canals, tanks, ponds and ditches

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