Volume 25 (1) March 2022

ISSN 0975-1963

Insect Environment

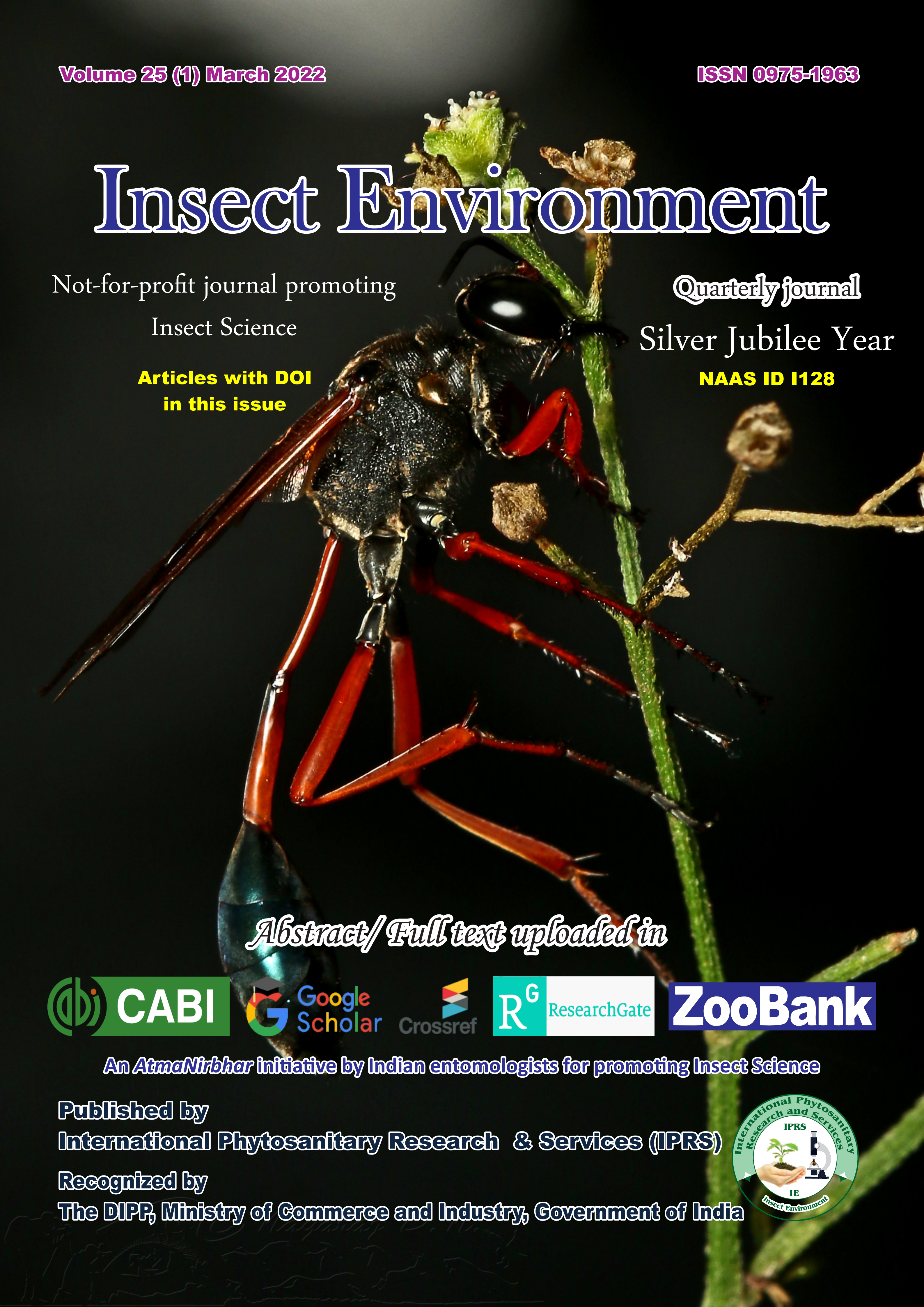
Not-for-profit journal promoting Insect Science

Quarterly journal

Silver Jubilee Year

Articles with DOI in this issue

NAAS ID I128



Abstract/ Full text uploaded in

CABI · Google Scholar · Crossref · ResearchGate · ZooBank

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

Editorial Board

***Cover Page: *Ammophila* sp (Sphecidae) identified by Dr. Arati Pannure, Assistant Professor, UAS, Bengaluru**

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 and technical research notes, extension notes for managing insect pests, 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

This journal is unique in that it encourages articles from students to amateurs to professionals! It is hosted in CABI and ZooBank, ensuring global coverage.

Editorial processing fee per article for each author (Note all authors have to pay): India: Students Rs. 200, Others Rs. 300, Overseas 10 USD for each author

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

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

Product announcement: Eco-friendly products for plant protection, eco-agri inputs, seeds and any product announcement of human interest is solicited in colour @ Rs. 3000/- per page.

Mail your papers/notes/queries related to Insect Environment to *einsectenvironment@gmail.com*

Contents

Volume 25 (1) March 2022

IE Blog Contents

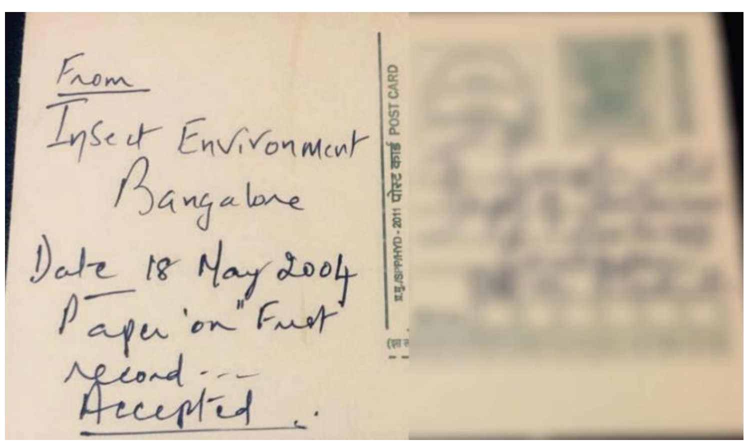
Sl. No.	Author/Authors	Date	Title of the blog
1	Salva Saidutty	09-01-2022	Herd of tree cattle on mango tree
2	Abraham Verghese	14-01-2022	Bitter gourd sweet to plant-loving ladybird beetle
3	Abraham Verghese	18-01-2022	Red Pierrot, *Talicada* sp.
4	Abraham Verghese	22-01-2022	Defying age: The long-living African soft tick
5	Deepak, S	23-01-2022	Tangy relish with medicinal value on your plate
6	Rashmi M.A	26-01-2022	Winged wonders as State symbols in India
7	Abraham Verghese	02-02-2022	Recent trends in IPM of tomato
8	M. Jayashankar	17-02-2022	A fly's Valentine "lift"
9.	Deepak, S	22-02-2022	Migration of Globe Skimmer
10	M. Jayashankar	25-02-2022	Why drag a bag, ye bagworms?
11	Abraham Verghese	05-03-2022	Xylocopa- the reason for my drumstick (Moringa)!
12	Abraham Verghese & Rashmi M.A	11-03-2022	Best pest management of mango fruit fly
13	Rashmi M.A	18-03-2022	Brilliant cabinet of trained fleas

Editorial

Post Card to Web-posts: Silver Jubilee Editorial of Insect Environment

It is with a deep sense of gratitude to God's Divine Providence and to the large entomological fraternity that I write this Editorial in the first issue of our Silver Jubilee year 2022, Volume 25 of Insect Environment (IE). As I look back, it has been a satisfying professional journey of 25 years involving networking of insect notes by the entomologists, to the entomologists, for the entomologists, and for entomology. The love for insects overrode every deterring concern, which often threatened to sink the journal into oblivion. But, this became a reality when my administrative responsibilities as Director, ICAR-National Bureau of Agricultural Insect Resources gave me little time to edit/proof-read and despatch hard copies. I decided to go online to save on money, obviating postal despatch, and expand our reach. Even then, many were stuck with our "affable" easily hand-holdable, Insect Environment, and soft copy concept (which was still not the in-thing in 2013s & 2014s) was less accepted. But nevertheless we had to go on an online platform.

During this phase, hard copy was still in vogue. But, Insect Environment transformed fully into soft online version and piggy backed on Current Biotica on www.currentbiotica.com which was online since 2010, and one of the journals conceptualized by me. Alas! Current Biotica lost steam and began to sink by 2018, and dragged Insect Environment with it!



We lost two years. It took some deep-diving salvaging to retrieve Insect Environment and now with its new website and avatar and young editorial team it again surfaced to light with full support from entomologists, insect-lovers, ICAR, Universities and disseminating engines like CABI (UK), Cross-reference, Research Gate, etc

The Genesis of Insect Environment

Like many biological natural history, entomology too had qualitative discourses, the best example being *Fauna of British India* series, and many others, mainly by British entomologists. Their observational notes, translated to important knowledge that whetted the insect story and syllabus for many entomological researches. From about the 1990's I found many papers missing the eye for details in insect study that prevailed in yester years. Journals were publishing planned cause & effect or confined behaviour studies with data accumulated and given a stamp of statistical approval. These, 'dried' the entomological stories! I felt many interesting facets of insect life, got lost or under-reported in such planned observations. Many journals followed strict regimentation of design, replication, punctuation, analysis, tests of significance and such systems. O my! What was lost was the free creativity and perhaps originality, of natural history.

When I conceived Insect Environment, I wanted (and still want) it to be a journal that would capture the in-betweens of research, the side-lights, the 'awe' factor in insects, the beauty of the form, colour and so many such, yet without comprising on the originality and truthfulness of science. There are many titbits, information of equally or more compelling value, lost in entomologists for want of a publication forum. It is here, Insect Environment filled the gap and bridged many researches. The sapota seed borer, *Trymalitis margaritas* was a pest first reported in Insect Environment. The fall armyworm on potato and banana was first reported by Insect Environment. *Thrips parvispinus* on chilli in south India was first reported by us. Many geographical and host records were documented in Insect Environment. In the last 24 years, more than 3000 articles have been given to the global entomological literature, here, thanks also to CABI (UK) for their unswerving support and valuing the importance of even 'small' information, which is indeed 'big' in many ways.

In the first 10 years or so when email was a luxury to many, Insect Environment used to send reminders, comments and acceptance on the humble post cards. I salute the Postal Department who unwittingly like the pollinating bees were networking for us, among entomologists. These post cards were hand written and I gratefully acknowledge the help of my students galore. For a rupee, we could reach out to four! I must acknowledge here the support given by Dr. A. K. Chakravarthy as the co-editor and Mr. S. Sridhar as the printer and publisher.

Insect Environment had and still has many uniqueness. As a policy we decided to encompass all insect lovers – amateurs, to students, to professionals. Honestly, we do not believe in any pretence to 'impact factor' 'quality', etc which often are regimental and serves career advancement scores (at a dollar price!) and supports corporate business journals. So, we in course of time had a repertoire of popular, semi-technical and even taxonomic contributions most of them from the Indian sub-continent. An entomologist at the

Royal Entomological Society once quipped in 2005, when I was in the RES library, then in the heart of London, that Insect Environment in one hour took us through the Oriental insect life! This is even true now, if one browse through our issues.

You will be amazed to see the range and mix of themes and diverse authors in this issue. We have an experienced Dr. Ramesh Arora bringing in management of insect pests in maize and sorghum on one hand and a high school student Ms. V. Varsha narrating how she took to watching insects as hobby. Diversity of butterflies in Gaya, Bihar; quarantine interception of a Histeridae, mango fruit borer of *Citripestis* on cashew; host plants of *Thysanophesia* in Himachal; first report of *Bagrada hilaris* on pearl millet in Gujarat; *Helopeltis* on mango and neem; new location report of a scarabaeid in Arunachal Pradesh, etc., all make interesting reading. Our hallmark is to encourage undergraduate students in taking to insect writing and when they see their nascent writing (which no so called journal of "repute" will accept) they will surely be on their way to becoming future entomologists. Many excellent entomologists shy away from writing, because of their secondary level in English. But for us they are important, and our high brand of editorial team, help them to make their papers publication worthy!

If you follow our 'received and accepted' period, it is perhaps the shortest. Even so called reputed journal, which run on fee and subscriptions with paid staff take more time! We believe every author is eager to see their paper in quotable focus, at the earliest. If a paper is acceptable our speed is the fastest! After all we are travelling on the digital highway.

IE recognized by Digital Object Identifier (DOI)

We are indeed moving with times. We are in a digital age and too familiar with digital tags which every country's citizens are marked with- be it passport, identification card, insurance, *aadhar* or whatever. With the surfeit of scientific literature, it only makes sense to digitally tag articles. I am glad to say from this issue onwards all our research notes will get internationally recognized DOI. We thank Cross-reference, the enabler. All our articles will now surface in Research Gate, Google Scholar and many trans-boundary abstracting agencies and I request all our authors to log into Research Gate-it is free. You or anybody to whom you send the DOI can access your paper and catch up with your publications in any part of the world.

I thank the entire team of advisors and editors for their devoted contributions. Our special thanks and congratulations to all the authors and photographers who are very much a part of our team.

Dr. Abraham Verghese,

Editor-in-Chief

Research articles

DOI: 10.55278/BPQO9562

First record of predation behaviour of *Perillus bioculatus* (Fabricius, 1775) (Pentatomidae: Asopinae) predating on *Aulacophora indica* (Gmelin, 1790) (Coleoptera: Chrysomelidae) a pest of bitter gourd in agro-ecosystem of Bihar, India

M. E. Hassan, Amartya Pal, P. C. Saha and Rahul Mondal
Zoological Survey of India, 'M' Block, New Alipore, Kolkata-700053, India.
Corresponding author: ehtashamulhassan@gmail.com

Abstract

Perillus bioculatus (Fabricius) (Pentatomidae: Asopinae) was reported for the first time as predator of adult and immature pumpkin beetle, *Aulacophora indica* (Gmelin, 1790) (Coleoptera: Chrysomelidae), feeding on bitter gourd. Detailed description of *P. bioculatus* is provided along with field data and photographs, showing predation behavior. Distribution of *P. bioculatus* has also been given in India and elsewhere.

Keywords: Hemiptera, Pentatomidae, *Perillus bioculatus*, bitter gourd, *Aulacophora indica*, biocontrol, Bihar.

Introduction

The members of the subfamily Asopinae, are commonly known as predatory stink bugs, characterized by a strong four segmented rostrum. First segment of rostrum is thickened which makes it easier to prey upon. This subfamily comprises nearly 303 species from 63 genera worldwide (Rider *et al.*, 2018) and nearly 30 species in 17 genera from India (Salini, 2019). Two spotted stink bug, *Perillus bioculatus* is a native of North America and spread from Mexico to Canada (Froeschner, 1988). However, it was reported that this species was recently reported from many European countries (Derjanschi and Elisoveţcaia, 2014 and Elisoveţcaia and Derjanschi, 2016). More or less at the same time, Prasad and Pal (2015) reported for the first time from North India (Meerut, Uttar Pradesh). Kaur (2020) reported *Perillus bioculatus* from Himachal Pradesh and Punjab and described morpho taxonomy and external genitalia. Both the nymph and adult of *P. bioculatus* are specialized predators of egg masses, larvae and adults of Colorado potato beetle, *Leptinotarsa decemlineata* (Say) in field populations, and effectively control the beetle in small scale release trials and in cage studies, both in different European countries and in the United States (Hough-Goldstein and McPherson, 1996). *Perillus bioculatus* has been introduced into various parts of Europe since 1966 *viz.* Belgium, Czechoslovakia, France, Germany, Hungary, Italy, Poland, Russia, Slovakia, Ukraine and former Yugoslavia and also in Asia to control the Colorado potato beetle, *L. decemlineata* with varying success (Briand, 1936; Lipa, 1976; Tamaki and Butt, 1978; Jermy, 1980; Gusev, 1991; DeClercq, 2000 and Rabitsch, 2008).

In the present studies, *P. bioculatus* was first time reported as a potential hemipteran predator in agro-ecosystem of Bihar on pumpkin beetle, *Aulacophora indica* (Gmelin, 1790) belonging to family Chrysomelidae under field condition on bitter gourd plant. Predation behaviors and additional diagnostic characteristics of *P. bioculatus* along with its distribution have been provided. Species of *Aulacophora* cause serious damage of cucurbits, including *Aulacophora indica* (Gmelin, 1790) which is pest on number of cucurbits, *viz.* watermelon, cucumber, giant pumpkin, bottle gourd, bitter gourd Etc.

Materials and Methods

During field survey, *Perillus bioculatus* (Fabricius) (both adult and immature forms) predating on adult and grub of pumpkin beetle, *Aulacophora indica* (Gmelin, 1790) belonging to family Chrysomelidae (Fig. 2a & 2b) were collected in the bitter gourd cultivation at Thakurbari Mard (N: 25.056244, E: 85.566066) and Gokhulpur (N: 25.327458, E: 85.409104) in Nalanda district of Bihar. Photographs of both predator (pentatomid bug) and pest (*A. indica*) were taken by using camera Nikon D7000 in field.

Specimens were collected carefully and killed by using killing jar having ethyl acetate. Collected specimens were set and pinned and identified. Additional diagnostic characters have been provided for *Perillus bioculatus*. Measurements of various body parts and images were taken with Leica M 205A. The specimens were deposited in the National Zoological Collection of Zoological Survey of India, Kolkata.

Results

The predatory pentatomid bug *Perillus bioculatus* has been reported for the first time from eastern part of India (Nalanda, Bihar) predating upon pumpkin beetle, *Aulacophora indica* (Chrysomelidae) a major pest of bitter gourd in Bihar. During the present studies, it has been observed that both adult and immature forms of *P. bioculatus* feeding on the grub and adult of *Aulacophora indica* (Fig. 2a, 2b), which is a serious pest of bitter gourd plant. *Perillus bioculatus*, was also found to be predating on the grubs of *Zygogramma bicolorata* Pallister (Coleoptera: Chrysomelidae) on *Parthenium* from Meerut (Uttar Pradesh), North India (Prasad and Pal, 2015) and larvae of poplar leaf beetle, *Chrysomela populi* L. (Coleoptera: Chrysomelidae), on poplar plant from Turkey's Anatolian side (Tarla and Tarla, 2018).

Perillus bioculatus (Fabricius, 1775) (Fig. a-h).

General body features: Macropterous form, body oblong, ovate, shiny, body length 10.51 mm. in male (Fig. 1e) and 10.91 mm. in female (Fig. 1a). Head, pronotum and scutellum coarsely and sparsely punctuate, while corium finely punctuate. *Perillus bioculatus* shows sexual dimorphism, as the colour of male (reddish brown with dark patterns on head, pronotum, scutellum and corium) is different from female (light dusky brown with dark patterns on head, pronotum, scutellum and corium).

Male

Dorsal Coloration:

Head is black and punctate; eyes are brownish; ocelli dark red; antennal segments are black; pronotum is bicolour with anterior reddish and posterior black portion; anterior half of pronotum is provided with two broad transverse black spots more or less triangular in shape. scutellum is reddish brown with a central Y-shaped black fascia, anterolateral margins of scutellum and clavus are black. Corium is black with outer margins reddish brown.

Ventral Coloration:

Head, rostrum, sternum and peritreme are black; abdomen is reddish in colour with broad black fascia with pilose (except 3^{rd} segment), 4^{th}, $5^{th}$and 6^{th}segments laterally. Legs are black, mid and hind tibia provided with light brown annulations in the middle, spiracles are black.

Structure:

Head: Head wider than long (Fig. 1g), coarsely and sparsely punctuate, apex rectilinear, lobes are of equal length. Head length: 1.120 mm, head width across eye: 2.230 mm, inter-ocular distance: 1.223 mm. Antennae five-segmented, A1: 0.227 mm<A3: 0.802<A2: 0.908 mm<A4: 1.207 mm< A5: 1.266 mm. Rostrum robust, four-segmented, reaching mesocoxae (Fig. 1h), R3: 0.394 mm<R4: 0.561 mm<R1: 0.932 mm< R2: 1.121 mm.

Thorax: Pronotum sub-triangular, wider than long, pronotal length 2.534 mm and width 5.823 mm, anterior pronotal angles obtusely rounded with a spine, posterior pronotal angels rounded (Fig. 1g); scutellum slightly longer than broad (length: 3.713 mm and width: 3.668 mm) (Fig. 1e), apex rounded; hemelytral membrane passing tip of abdomen (Fig. 1f); fore and mid tibia slightly shorter than femora.

Abdomen: Abdomen slightly longer than broad (length: 5.338 mm and width: 5.280 mm) (Fig. 1f).

Female:

Dorsal Coloration:

Head is brownish with a tinge of black and punctate; eyes brownish; ocelli dark red;

antennal segment I, II and basal part of III are light brown, while rest are black in colour; pronotum is bicolour with anterior light brown and posterior part dark brown; anterior part of pronotum is provided with two broad triangular shaped, transverse brownish black spots. Scutellum light brown with a central Y-shaped brownish-black fascia; anterolateral and basal margins of corium light brown (Fig. 1a).

Ventral Coloration:

Head is brown, prosternum is yellowish with an anterolateral black fascia, middle portion of mesosternum is black, metathoracic scent gland peritreme light brown with black spots; abdomen light brown in colour with broad black continuous fascia on III, IV, V and VI segments sub-laterally. Legs are dark brown, mid and hind tibia with light brown annulations in the middle, spiracles black (Fig. 1b).

Structure:

Head: Head wider than long (Fig. 1c), coarsely and sparsely punctuate, apex rectilinear, lobes are of equal length. Head length: 1.242 mm, head width across eye: 2.381 mm, inter-ocular distance: 1.210 mm. Antennae five-segmented, A1: 0.289 mm<A2: 0.991mm <A3: 1.037 mm<A5: 1.142 mm< A4: 1.256 mm. Rostrum robust, four-segmented, reaching mesocoxae (Fig. 1d), R3: 0.436 mm<R4: 0.6 mm<R1: 0.974 mm< R2: 1.134 mm.

Thorax: Pronotum sub-triangular, wider than long, pronotal length 3.111 mm and width 6.450 mm; anterior and posterior pronotal angles same as in case of male (Fig. 1c); scutellum slightly broader than long (length: 3.921 mm and width: 4.173 mm) (Fig. 1a), apex rounded; hemelytral membrane passing tip of abdomen (Fig. 1b).

Abdomen: Abdomen slightly longer than broad (length: 6.188 mm and width: 6.039 mm). Ventroanterior and ventroposterior margins of VII abdominal sternite is medially concave, look like an inverted broad U-shaped (Fig. 1b).

Material examined: 1 ♂, 1 ♀, Thakurbari Mard, Nalanda, Bihar, N: 25.056244, E: 85.566066, 25.viii.2021, coll. M.E. Hassan and party; 1 ♂, 1 nymph, Gokhulpur, Nalanda, Bihar, N: 25.327458, E: 85.409104 on 27.viii.2021, coll. M.E. Hassan and party.

Distribution: India (Bihar, Himachal Pradesh, Punjab, Uttar Pradesh), *Elsewhere*: Bulgaria, Canada, Czechoslovakia, France, Germany, Greece, Mexico, Republic of Moldova, Russia, Serbia, Turkey, USA, Yugoslavia.

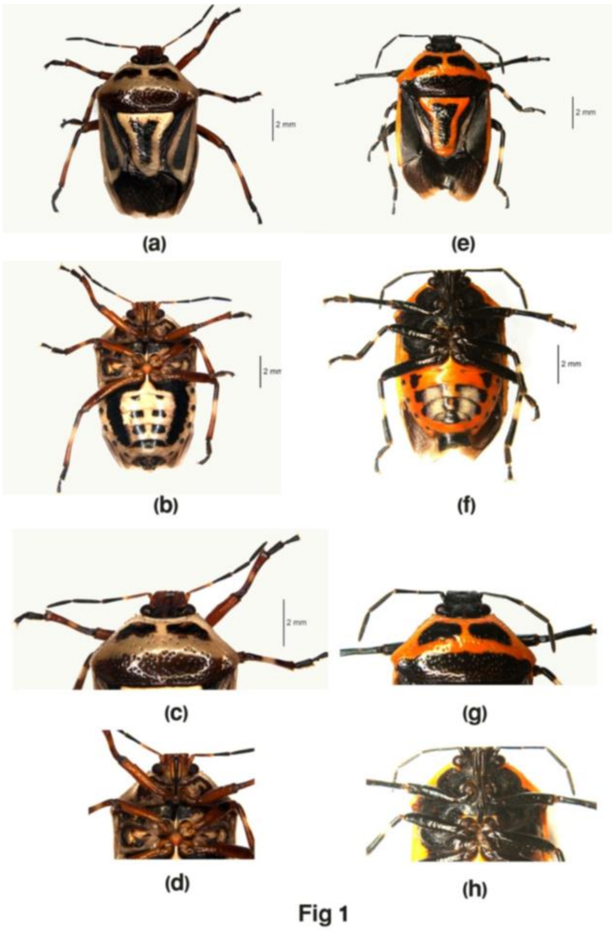
Discussion

Aulacophora indica (Coleoptera: Chrysomelidae) is one of the major pests of bitter gourd (*Momordica charantia*) of the family Cucurbitaceae, which is an important vegetable crop in India which have a unique bitter taste and medicinal value, as bitter gourd is considered a rich source of vitamins (88 mg / 100 g of vitamin C) and minerals. Bitter gourd has medicinal value and is used for curing diabetes, asthma, blood diseases and rheumatism. Drinking fresh bitter gourd juice is recommended by naturopaths and roots and stem of wild bitter gourd are used in many ayurvedic medicines.

Mature and immature stages of *Aulacophora indica* (Gmelin, 1790) cause serious damage of cucurbits including bitter gourd. It causes large holes in leaves and may cause partial or complete defoliation, sometimes they also damage flowers (Sahu and Samal, 2020). No information is available about the natural control of this beetle. Present studies are the first to report *P. bioculatus* as predator on mature and immature stages of *Aulacophora indica*, a potential bio-control agent under field condition on bitter gourd plant. Generally, immature *P. bioculatus* approaches pumpkin beetle, *Aulacophora indica* for predation and penetrate its rostrum (4th segment completely) in the lower abdomen (ventrally) of the mature beetle. In the IPM, of *A. indica*, addition of new dimension of *P. bioculatus* as predator will complement the pest management in bitter gourd ecosystem and other cucurbits. Among hemipteran predator, *Perillus bioculatus*, is an important natural biocontrol agent of the pumpkin beetle, *Aulacophora indica* under field condition on bitter gourd plant. Adults and nymphs of *Perillus bioculatus* were observed predating both mature beetle and immature stages (grubs). Further studies have to be conducted for the estimation of predation potential of *Perillus bioculatus* to the pumpkin beetle, *A. indica* both under laboratory and in natural condition so that *P. bioculatus* can be introduced in bitter gourd and other cucurbit ecosystems in India.

Acknowledgements

The authors are grateful to Dr. Dhriti Banerjee, Director, Zoological Survey of India for encouragements and laboratory facilities. We are greatly thankful to Dr. C. Raghunathan, Divisional-in-charge, Entomology Division, Zoological Survey of India for his valuable suggestions and support. Authors are thankful to staff members of Hemiptera Section and Library Section for their helpful co-operation in preparation of manuscript. We are also thankful to Dr. Devashu Gupta, Scientist-C & Officer-in-charge, Coleoptera Section, ZSI, Headquarters for the identification of beetle for the present study.



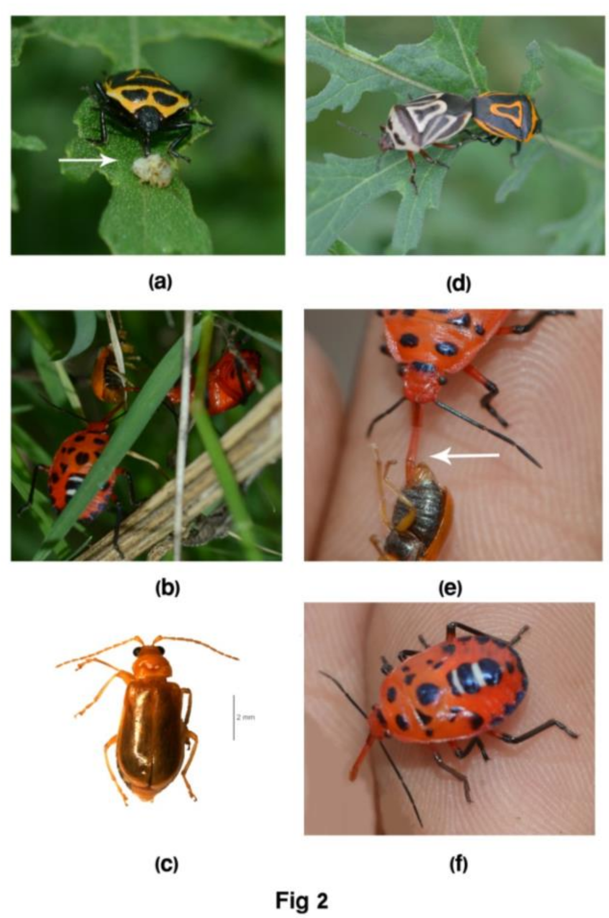


Fig. 1. ***Perillus bioculatus***. (female, a-d), **1a.** Dorsal view **1b.** Ventral view, **1c.** Head and pronotum (dorsal view), **1d.** head and thorax (ventral view), (male, e-h), **1e.** Dorsal view, **1f.** Ventral view, **1g.** Head and pronotum (dorsal view), **1h.** Head and thorax (ventral view).

Fig. 2a. *P. bioculatus* predating on the grub, **2b.** Immature forms of *P. bioculatus* predating on adult of *Aulacophora indica*, **2c.** Mature *Aulacophora indica* (dorsal view), **2d.** showing mating behaviour of *P. bioculatus* in the field, **2e.** Immature *P. bioculatus* penetrated its rostrum (4th segment completely) in the lower part of abdomen (ventrally) to the mature *A. indica*, **2f.** nymph of *P. bioculatus.*

References

Briand, L. J. 1936. Shipping of potato beetle parasites and predators to France with notes on the species involved. 66th Annual Report of the Entomological Society of Ontario (1935): 31-34.

De Clercq, P. 2000. Predaceous Stink bugs (Pentatomidae: Asopinae). In: Heteroptera of Economic Importance. Schaefer, C. and Panizzi, A. (Eds.): pp. 737-789 CRC Press, Boca Raton, FL.

Derjanschi, V. and Elisoveţcaia, D. 2014. Predatory Stink Bug *Perillus bioculatus* F. (Hemiptera, Pentatomidae) in the Republic of Moldova. *Oltenia. Studiişicomunicări (Studies and communications). Ştiinţelenaturii (Natural Sciences). Museum of Oltenia Craiova*, **32**: 67-70.

Elisoveţcaia, D. and Derjanschi, V. 2016. Hibernation of the predatory stink bug *Perillus bioculatus* F. (Hemıptera, Pentatomidae) under laboratory conditions. *Oltenia. Studii şi comunicări (Studies and communications). Ştiinţele naturii (Natural Sciences). Museum of Oltenia Craiova*, **30**(1): 104-107.

Froeschner, R. C. 1988. Family Pentatomidae Leach, 1815. In: Catalogue of the Heteroptera, or True Bugs, of Canada and the Continental United States. Henry, T.J. and Froeschner, R.C. (Eds.): pp. 544-597E.J. Brill, Leiden.

Gusev, G. V. 1991. *The entomophages of Colorado potato beetle*. Edit. "Agropromizdat". Moscow. 172.

Hough-Goldstein, J. and McPherson, D. 1996. Comparison of *Perillus bioculatus* and *Podisus maculiventris* (Hemiptera: Pentatomidae) as potential control agents of the Colorado potato beetle (Coleoptera: Chrysomelidae). *Journal of Economic Entomology*, **89**:1116-1123.

Jermy, T. 1980. The introduction of *Perillusbioculatus*into Europe to control the Colorado beetle, *Leptinotarsa decemlineata*. *Bulletin of the European Mediterranean Organization for Plant Protection*, **10**: 475-480.

Kaur, R. 2020. Morphotaxonomy and external genitalic attributes of a biological control agent: *Perillus bioculatus* (Fabricius) (Heteroptera: Pentatomidae: Asopinae) with new distributional records from India. *International Journal of Entomology Research*, **5** (5): 10-14.

Lipa, J. J., 1985. Progress in biological control of the Colorado beetle (*Leptinotarsa decemlineata*) in Eastern Europe. *EPPO Bulletin*, **15**: 207-211.

Prasad, C. S. and Pal, R. 2015. First record of two spotted stink bug, *Perillus bioculatus* (Fab.) from Meerut (U.P.) North India. *International Journal of Environmental & Agriculture Research (IJOEAR),* **1**: 9-11.

Rabitsch, W. 2008. Alien true bugs of Europe (Insecta: Hemiptera: Heteroptera). *Zootaxa*, **1827**: 1-44.

Rider, D. A., C. F.Schwertner. and J. Vilimova. 2018. Higher systematics of the Pentatomoidea. In: Invasive Stink Bugs and Related Species (Pentatomoidea) Biology, Higher Systematics, Semiochemistry and Management. McPherson, J. E. (Ed.): pp. 25-201 CRC Press, Tayler & Francis Group, Boca Raton, FL.

Sahu, B. K. and Samal, I. 2020. Pest complex of Cucurbits and their management: A review, *Journal Entomology & Zoology Studies,***8** (3): 89-96.

Salini, S. 2019. Pentatomidae (Hemiptera: Heteroptera: Pentatomoidea) of India. In: Indian Insects Diversity and Science. S. Ramani, Prashanth Mohanraj and H. M. Yeshwanth (Eds.): pp. 121-146 CRC Press, Tayler & Francis Group, Boca Raton, FL.

Tamaki, G. and Butt, B. A., 1978. Impact of the *Perillus bioculatus* on Colorado potato beetle and plant damage. *U.S. Depart. Agric. Tech. Bull*. 1581.

Tarla, S. and Tarla, G. 2018. Detection of *Perillus bioculatus* (F.) (Heteroptera: Pentatomidae) on a New Host in Anatolia. *International Journal of Agriculture Innovations and Research (IJAIR),* **7** (3): 317-319.

MS Received 18 December 2021
MS Accepted 23 February 2022

DOI: 10.55278/CBMZ7758

Interception of *Hololepta plana* (Sulzer) (Coleoptera, Histeridae) a rare beetle on poplar logs imported from Belgium

D. K. Nagaraju, N. Kasturi, Maharaj Singh, D. Iyyanar, Om Prakash Verma and Ravi Prakash

Directorate of Plant Protection, Quarantine and Storage, NH-IV, Faridabad 121 001, India

Corresponding author: dknagaraju@gmail.com

Populus nigra Linnaeus (Salicaceae) commonly called as poplar is a raw material of splints used in the match industry. Poplar in the form of logs is being imported into India from Belgium and Germany to meet the huge demand for splints of the match industries located in Tamil Nadu, India. The imported logs are inspected and if found with live infestation/infection are treated as per the provisions of Plant Quarantine (Regulation of Import into India) Order, 2003 before release. During our routine plant quarantine inspections at Plant Quarantine Station, Tuticorin (Tamil Nadu, India), adult beetles of *Hololepta plana* (Sulzer) (Coleoptera: Histeridae) were intercepted on multiple occasions. The beetles were always associated with phoretic mesostigmatic mites. The beetles were 8-9 mm long, blackish, shiny, dorsoventrally flat, with sickle-shaped mandibles and antenna and tarsi variably red.

The adult phoretic mites, *Lobogynioides andreinii* (Berlese, 1910) (Acari: Mesostigamta: Diplogyniidae) were found on adults of *H. plana* and larvae of *Cucujus* sp. (Coleoptera: Cucujidae) and *Pyrochora* sp. (Coleoptera: Pyrochroidae) under the bark of poplar. Adult mites exhibit kleptoparasitic behaviour consuming part of prey (Trach, 2013).

Between 2018-2020, a total of 500 consignments of poplar logs were imported from Belgium and 19 consignments were intercepted with *H. plana.* However, 40 consignments imported from Germany during the same period were found free of beetles (Table 1). *Hololepta plana* is reported for the first time on imported poplar logs from India and these were appropriately treated to prevent entry into the country.

Jan Bosselaers collected nine specimens of *H. plana* in Limburg, Belgium in 1984 and has reported it as a rare beetle. He has given distribution of the beetle within Belgium and reported it as occurring in Central Europe, Siberia and Transcaucasia, and not occurring in Germany.

The beetles were known to live under the bark of poplar trees along with other beetles namely *Agonum assimile* Paykull (Carabidae), *Thanasimus formicarius* L. (Cleridae), *Uleiota planata* (L.) and *Silvanus* *unidentatus* (F.) (Cucujidae), and the Spiders, *Araneus unbraticus* Clerck and *Marpissa muscosa* (Clerck) and fruiting bodies of the myxomycete *Perichaena corticalis* (Batsch) Rost.

Table 1: Details of imported consignments and interceptions of *H. plana*.

Country	Consignments imported (Number)	Quantity imported (MT)	Interception *H. plana* (Number of Consignments)
2018-19			
Belgium	260	61608	01
Germany	19	4178	00
2019-20			
Belgium	240	55711	18
Germany	21	4007	00

***Fig. 1: Hololepta plana* with phoretic mites**

He reported them as carnivores. *Hololepta plana* was also found on the bark of *Quercus* sp. (Oak), *Pinus sylvestris* L. (Scots pine), *P. tremula* and *P. alba* (Jan Bosselaers, 1984; Anon, 2020). Allen and Hance (2009) first reported these beetles in United Kingdom in 2009. The species is now widespread in most of Europe (Maxwell, 2018).

Hololepta plana, carnivores are rare beetles harmless for agriculture and forestry. However, the import of natural enemies is covered under ISPM 3 and attracts Pest Risk Analysis for import of such organisms. In the present case, the beetles were also associated with phoretic mesostigmatic mites, which exhibits kleptoparsasitic behaviour and cannot be ignored from an import risk analysis point of view. Therefore, the imported consignments were fumigated with Methyl Bromide @ 48 g/m^3 for 24 hours at NAP before the release of the consignments.

Acknowledgement

We thank the Plant Protection Advisor, Directorate of Plant Protection Quarantine and Storage, Faridabad, India for facility and encouragement.

References

Allen, A. J. and Hance, D. 2009. *Hololepta plana* (Sulzer, 1776) (Histeridae) in Norfolk-new to Britain. *The Coleopterist*, **18**: 153-154.

Anonymous. 2020. www.ukbeetles.co.uk.

Jan Bosselaers. 1984. *Hololepta plana* (Sulzer) in the north-east of Belgium (Coleptera, Hesteridae): 51-54

ISPM 3. 2005. Guidelines for the export, shipment, import and release of biological control agents and other beneficial organisms, Rome, IPPC, FAO. Pp. 16.

Maxwell V. L. Barclay. 2018. *Hololepta plana* (Sulzer) (Histeridae) from Margravine Cemetery, West London. *The Coleopterist*, **27(1)**: 27-28.

Trach, V. A. 2013. On the morphology, biology and distribution of *Lobogynioides andreinii* (Acari, Mesostigmata, Diplogyniidae), *Entomological Review*, **93**: 105-112.

MS Received 22 December 2021
MS Accepted 02 February 2022

DOI: 10.55278/QUDW1537

Species diversity of butterflies in Gaya district (Bihar), India

***Mohammad Danish Masroor*[1]*, Zakkia Masroor*[2]*, Abhishek Kumar (I.F.S.)* [3]**

[1]P. G. Department of Zoology, Magadh University, Bodhgaya, Narhat, Nawada, Bihar, 805122 India

[2]Dr. B. R. Ambedkar College of Education, Bodhgaya, Narhat, Nawada, Bihar, 805122, India

[3]Divisional Forest Officer, Gaya Forest Division, Shanti Bagh, Kareem Ganj, Gaya, 823001

Corresponding author: mohammaddanishmasroor@gmail.com

Abstract

Seventy-two species of butterflies belonging to five families were recorded for first time from Gaya district. Six sites were selected post pilot survey on the basis of both, nectar and larval host plant richness, diversity and anthropogenic pressure along with road connectivity. The maximum species diversity and richness was observed in winter season, while minimum in summer season. Plain tiger, Common jezebel, Common crow, Common castor, Tawny castor, Common emigrant, Peacock pansy, Grey pansy, Chocolate pansy, Common Pierrot, Lime blue, Great eggfly, Common grass yellow, Common sailor, Common evening brown and Small branded swift were dominant butterfly species in all selected sites while Common silverline, Indian sunbeam and Apefly were rare. Pollution due to dust, vehicular movements and activities like damaging nectar and larval host plant during breeding season, in and around habitats, due to lack of information seems to adversely effect the species diversity and population density in the region.

Key words: - Butterfly, Species diversity, Gaya, Bihar.

Introduction

Butterflies, the delicate and colorful creatures play an important role in ecosystem indication and as a food source for many species in food chain. The species diversity and butterflies association with flora reflects the persistence of population and ecological stability of the butterflies. They serve an important role as ecological indicator for habitat degradation and modification due to an intimate relation with their native habitat. In the developmental biology of butterflies including larval and adult stages, multi-dimensional factors like larval host plants, adult nectar plants, habitat and safety from the predators are ecologically different (Gilbert, 1984). Due to a complex relation with the environment and critical relation among required food plants, predators and parasitoids, butterflies explore multiple situations within their life cycle.. India is a country having a mega-diversity of insect fauna and representing 1504 species diversity of butterflies known till date (Kunte *et al*. 2012). While 285 species of butterflies are found in southern India and 64 species reported from Rajgir, Bihar. In the context of Magadh division no data is available till now. In recent years, use of pesticides, climate change and deforestation are causing habitat loss and decline in butterfly populations. According to a report compiled by Mongabay during 2001-2018, India lost 1, 625, 97 hectare of tree cover which is 19.1% of total tree covering area (Mongabay India, 2018/02). Food and Agriculture Organization also reported that about 35 percent of pollinators and about 17% of vertebrate are facing extinction globally (Mongabay India, 2022/12). Butterflies being highly sensitive in their nature require special ecological condition for reproduction and survival. The ecologically typical butterfly habitats include grasslands, plant canopies, semi-wild, forest and bank of rivers.

Gaya (in Bihar) is situated at 24˚47´ N latitude and 85˚98´E longitude and has a warm and temperate climate. It has an area of 308 Km² and population of 4.71 lakh. Mainly the vegetation consists of deciduous and thorny forests. The geographical land cover of Gaya is influenced by multiple hills and elevations like Brahmyoni hill, Katari hill, Ramsila hill, Pretsila hill and Murli hill. Along with the hills, Falgu River is also an historical as well as ecological factor which provides large area covered by grasslands at the edge of river providing a favorable habitat for the butterfly species diversity.

However, various reasons have altered the butterfly habitats like human intervention and deforestation. As a result of this alteration some species are on the verge of extinction and if a single species is extinct, it will push multiple related species also on the path of extinction. The need of butterfly conservation is therefore demand of the hour. For the conservation, the information and data regarding their species diversity, status and factors affecting their population and survival is preliminary requirement for forecasting the need of conservation for those species butterflies whose population are declining.

Material and Methods

Survey method

The species diversity of butterflies was surveyed by simple random method for a period of two-years from August 2019 to November 2021. The number of butterflies was counted arbitrarily in a range of 15 feet in the early morning to afternoon hours weekly. The path of observation was specific and fixed in time and movement patterns. The survey was conducted in good weather and extreme hot and rainy weather were not taken as a part of survey. To study species diversity of the butterflies in Gaya district the photographic identification method was used by the authors. The photographs were taken from their natural habitats with the help of Galaxy J7 Max Tab for identification. The photographs were taken in GPS enabled mode in their respective survey during consequent months.

Survey site

Random survey method was used to select important sites for observation and after those six different sites with the abundance of nectar and larval host plants along with anthropogenic pressure was selected for the further observation. These were (SITE 1) Magadh University campus, (SITE 2) JaiPrakash park Bodhgaya, (SITE 3) Katari Hill, (SITE 4) Brahamyoni Hill, (SITE 5) Pretshila Hill and (SITE 6) Ramshila Hill were selected as important sites for the study.

Site: - 1. Magadh University Campus & **Site: - 2.** Jai Prakash Park, Bodhgaya & **Site: - 4.** Brahamyoni Hill: - Selected due to abundance of nectar, larval host plant and less anthropogenic pressure.

Site: - 3. Katari Hill, **Site: - 5.** Pretshila Hill & **Site: - 6.** Ramshila Hill: - Selected due to a smaller number of nectar plants, larval host plants and high anthropogenic pressure like regular human conflict, dust laden plants.

Identification of species diversity

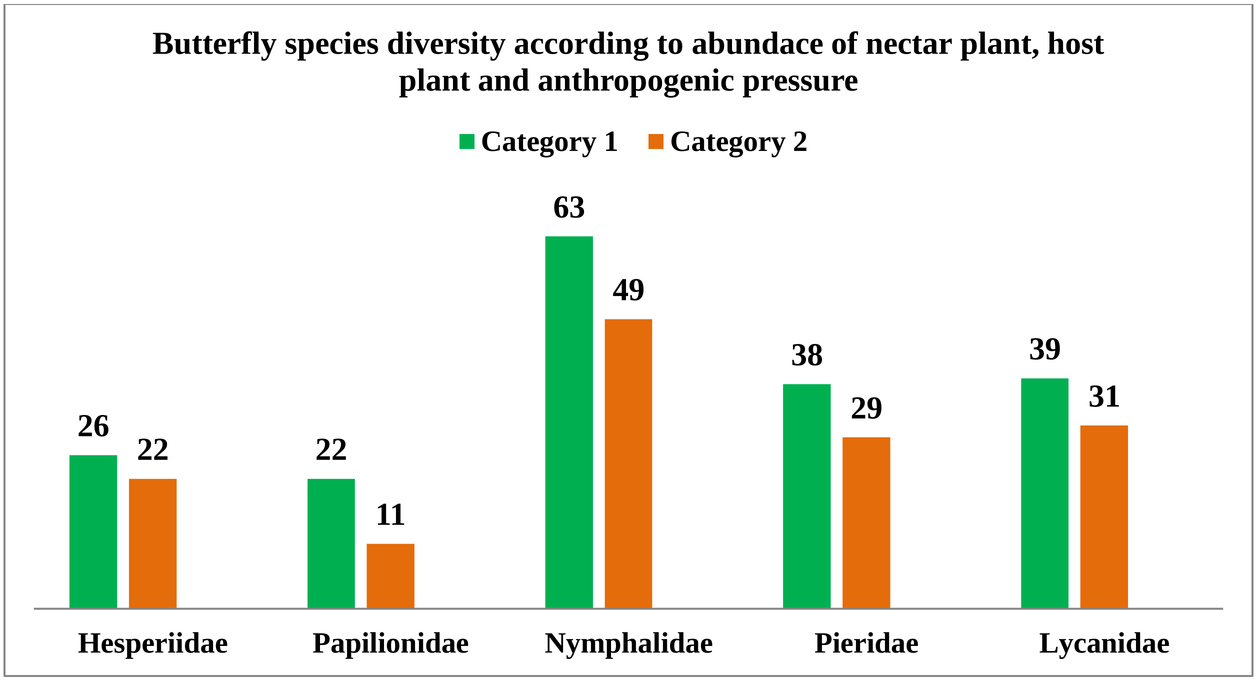
The color photographs were used for the identification procedure of butterflies. The coloration of body, wing patterns, wing design and other outer morphological features of identification were compared for identification of butterfly species with the help of relevant literatures i.e., Bingham, 1905 and 1917, Evans, 1932, Kehimkar, 2008, Gupta and Majumdar, 2012, Gajbe, 2016, Kumar, 2016, Sharma and Kumar 2017, Sondhi and Kunte, 2018, Ghatak and Roy, 2013 and Kumar and Sharma 2021.

Results and Discussion

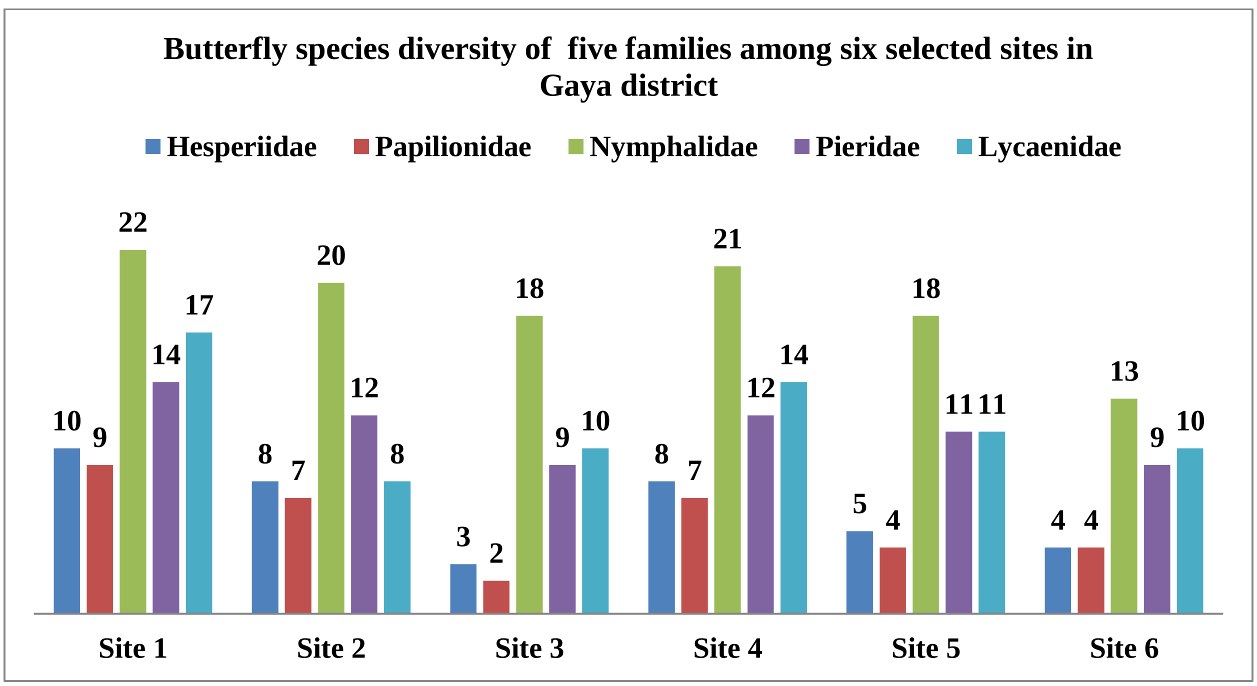
A total of seventy-two species including two sub-species of butterflies were reported during first time documentation of butterflies in Gaya district (Table 1). Twenty-two species belonging to Nymphalidae (30.5%), seventeen species of Lycaenidae (23.7%), fourteen species of Pieridae (19.4%), ten species of Hesperiidae (13.8%) and nine species of Papilionidae (12.6%) were observed (Histogram 1 & 2). Seventy-two species of butterflies were observed in site 1, fifty-five in site 2, forty-two in site 3, sixty-two in site 4, forty-nine in site 5 and forty in site 6. Nymphalidae family was observed in maximum number among all families. Maximum number of Blue tiger butterfly was observed in site 1 while maximum number of Common leopard butterfly was observed in site 4. In view of anthropogenic pressure Common castor and Plain tiger butterfly was observed in maximum numbers at the places under anthropogenic pressure. In the places where nectar and larval host plants were low in diversity, the butterfly diversity was low in comparison to where nectar and larval host plant was abundant and not in under anthropogenic pressure. The statistical analysis of correlation between category 1 (Abundance of nectar and larval host plant with less anthropogenic pressure) and category 2 (High anthropogenic pressure and smaller number of nectar and larval host plant) shows significant result at $p < 0.05$, while calculated mean of category 1 was 37.6 and of category 2 was 28.4, Pearson (r) was 0.979 and P-Value is 0.003642 which indicates strong positive correlation between both categories. The results are indicative that area with abundance of nectar plants and larval host plants under less anthropogenic pressure represents more species than the area having high anthropogenic pressure along with less nectar and host plants. Larvae or pupae not been observed on plants laden with dust particles near construction sites or continuous movement of vehicles act as anthropogenic pressures. A detailed study will be needed for exploring complete species biodiversity and population density at a micro habitat level and to understand the adaptation mechanism by butterflies under anthropogenic pressure in Gaya region.

Some unusual observations

Common emigrant and Common crow were observed preparing chrysalis on Milkweed plant. Hundreds of Common evening brown were found foraging during evening hours on rotten fruits of *Ficus* in J. P. Park.



Histogram 1. Number of butterfly species belonging to each family observed during study.



Histogram 2. Graph showing butterfly species diversity of five families in six selected sites of Gaya district.

Table 1. List of butterfly species observed around six selected sites in Gaya district during August 2021- October 2021

Sl. No.	Common name	Scientific name	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6
	Family: Hesperiidae							
1	Indian Palm Bob	*Saustus grenius* (Fabricius,1798)	*	*		*	*	
2	Small Branded Swift	*Pelopidas mathias* (Fabricius 1798)	*	*	*	*	*	*
3	Common Red Eye	*Matapa aria* (Moore, 1866)	*	*				
4	Paint Brush Swift	*Baoris farri* (Moore,1878)	*	*		*		
5	Grass Demon	*Udaspes folus* (Cramer,1775)	*	*		*		*
6	Contiguous Swift	*Polytremis lubricans* (Herrich-Schaffer, 1869)	*	*		*		
7	Rice Swift	*Barbo cinnara* (Wallace,1866)	*				*	*
8	Dark Palm Dart	*Telicota bambusae* (Moore,1878)	*	*	*	*	*	*
9	Asian Grizzled Skipper	*Spialia galba* (Fabricius, 1793)	*		*	*		
10	Common Palm Dart	*Telicota colon* (Fabricius, 1775)	*	*		*	*	
	Family: Papilionidae							
11	Common Mormon	*Papilio polytes* (Linnaeus, 1758)	*	*	*	*	*	*
12	Indian Common Mormon	*Papilio polytes romulus* Cramer, 1775	*	*		*	*	
13	Lime Butterfly	*Papilio demolus* (Linnaeus,1758)	*	*		*		*
14	Common Jay	*Graphium doson* (C. & R. Fedler, 1864)	*	*	*		*	
15	Tailed Jay	*Graphium agramemnon* (Linnaeus, 1758)	*	*		*		*
16	Common Rose	*Pachliopta aristolochiae* (Fabricius, 1775)	*			*		
17	Common Mime	*Papilio clytia* Linnaeus,1758	*			*	*	*
18	Blue Mormon	*Papilio polymnestor* (Cramer,1775)	*	*		*		
19	Crimson Rose	*Pachliopta hector* (Linnaeus, 1758)	*	*				
	Family: Nymphalidae							
20	Gray Pansy	*Junonia atlites* (Linnaeus,1763)	*	*	*	*	*	*
21	Peacock Pansy	*Junonia almana* (Linnaeus, 1758)	*	*	*	*	*	*
22	Chocolate Pansy	*Junonia iphita* (Cramer,1779)	*	*	*	*	*	*
23	Lemon Pansy	*Junonia lemonias* (Linnaeus,1758)	*	*	*	*	*	*
24	Yellow Pansy	*Junonia hierta (Fabricius, 1798)*	*	*			*	
25	Blue Pansy	*Junonia orithya* (Linnaeus,1758)	*	*	*	*	*	
26	Plain Tiger	*Danus chrysippus* (Linnaeus,1758)	*	*	*	*	*	*
27	Striped Tiger	*Danus genutia* (Cramer,1779)	*	*		*	*	
28	Blue Tiger	*Trimula limniace* (Cramer,1775)	*	*	*	*		*
29	Common Baron	*Euthalia aconthea* (Cramer, 1777)	*	*		*	*	
30	Common Leopard	*Phalanta phalanta* (Drury,1773)	*		*	*		
31	Common Crow	*Euuploea core* (Cramer, 1780)	*	*	*	*	*	*
32	Common Evening Brown	*Melantis leda* (Linnaeus, 1758)	*	*	*	*	*	*
33	Common Four-ring	*Ypthima huebneri* Kirby, 1871	*		*	*		

Sl. No.	Common name	Scientific name	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6
34	Common Bush Brown	*Mycalesis perseus* (Fabricius,1775)	*	*	*	*	*	
35	Commander	*Moduza procris* (Cramer,1777)	*	*		*	*	*
36	Great Eggfly	*Hypolimnas bolina* (Linnaeus,1758)	*	*	*	*	*	*
37	Danaid Eggfly	*Hypolimnas misippus* (Linnaeus, 1764)	*	*	*	*	*	*
38	Common Castor	*Ariadne merione* (Cramer, 1777)	*	*	*	*	*	*
39	Tawny Castor	*Acraea terpsicore* (Fabricius,1793)	*	*	*	*	*	*
40	Common Sailor	*Neptis hylas* (Linnaeus, 1758)	*	*	*	*	*	
41	Common Palmfly	*Elymnias hypermnestra* (Linnaeus, 1763)	*	*	*	*		
	Family: Pieridae							
42	Mottled Emigrant	*Catopsilia pyranthe* (Linnaeus,1758)	*	*	*	*	*	
43	Common Emigrant	*Catopsilia pomana* (Fabricius, 1775)	*	*	*	*	*	*
44	Oriental Mottled Emigrant	*Catopsilia pyranthe pyranthe*	*	*				
45	Yellow Orange Tip	*Ixias pyrene* Linnaeus, 1764	*	*	*	*		*
46	White Orange Tip	*Ixias Marianne* (Cramer,1779)	*			*	*	
47	Common Jezebel	*Delias eucharis* (Drury,1773)	*	*	*	*	*	*
48	Common Wanderer	*Pareronia hippia* (Cramer,1776)	*	*		*	*	
49	Common Grass Yellow	*Eurema hesabe* (Linnaeus,1758)	*	*	*	*	*	*
50	Spotless Grass Yellow	*Eurema laeta* (Boisduval,1836)	*	*	*	*	*	*
51	Lesser Gull	*Cepora nadia* (Lucas, 1852)	*					*
52	Common Gull	*Cepora nerissa* (Fabricius,1775)	*	*	*	*	*	
53	Indian Cabbage White	*Pieris canidia* (Sparrman, 1768)	*	*		*	*	*
54	Small Grass Yellow	*Eurema brigitta* (Stoll, [1780])	*	*	*	*	*	*
55	Psyche	*Leptosia nina* (Fabricius,1793)	*	*	*	*	*	*
	Family: Lycaenidae							
56	Common Pierrot	*Castalius rosimon* (Fabricius,1775)	*	*	*	*	*	*
57	Common Silverline	*Cigaritis vulcanus* (Fabricius,1775)	*				*	
58	Plains Cupid	*Chilades pandava* (Horsefield,1829)	*	*	*	*	*	*
59	Slate Flash	*Rapala manea* (Hewitson,1863)	*		*	*	*	
60	Dark Grass Blue	*Zizeeria karsamdara* (Moore,1865)	*	*	*	*	*	*
61	Lesser Grass Blue	*Zizina otis* (Fabricius,1787)	*	*	*	*	*	*
62	Rounded Pierrot	*Tarucus nara* (Kollar,1884)	*	*	*	*	*	*
63	Common Guava Blue	*Virachola isocrates* (Fabricius,1793)	*			*		
64	Lime Blue	*Chilades lajus* (Stoll, [1780])	*	*	*	*	*	*
65	Gram Blue	*Euchysops cnejus* (Fabricius,1798)	*	*	*	*	*	*
66	African Babul Blue	*Azanus jesous* (Guerin-Meneville,1849)	*			*		
67	Pea Blue	*Lampidus boeticus* (Linnaeus,1767)	*	*	*	*	*	*
68	Ape fly	*Spalgis epeus* (Westwood, 1851)	*					*
69	India Sunbeam	*Curetis thetis* (Drury, [1773])	*			*		*
70	Saronis Sunbeam	*Curetis saronis* Moore,1877	*		*			
71	Spotted Pierrot	*Taucus callinara* Butler,1886	*			*	*	
72	Margined Hedge Blue	*Celatoxia marginata* (de Niceville, [1884])	*			*		

References

Bingham, C. T.1905. Butterflies In The fauna of British India (Ceylon and Burma). Taylor and Franc. Red Lion Court, Fleet Street, London, EC-4. I.

Bingham, C. T.1917. Butterflies In The fauna of British India (Ceylon and Burma). Taylor and Francis, Red Lion Court, Fleet Street, London, EC-4. II.

Evans, W. H. 1932. The Identification of Indian Butterflies—2nd Edition. Bombay Natural History Society, Bombay, x+454pp+32pl.

Gajbe, P. U. 2016. Diversity of Butterflies in Karhandla Region of Umred -Karhandla Wildlife Sanctuary, Maharashtra, India. *Journal on New Biological Reports*, JNBR **5(1)**: 35-40(Online).

Gupta, I. J. and Majumdar, M. 2012. *Handbook on Diversity in some of the Indian Butterflies* (Insecta: Lepidoptera): 1-310. (Published by the Director, Zool. *Surv. India*, Kolkata).

Gilbert, L.E. 1984. The biology of butterfly communities, in *The Biology of Butterflies.* Eds. Vane-Wright, R.I. and Ackery, P. R. Symposium of the Royal Entomological Society of London, Academic Press.

Kumar, R. and G. Sharma. 2021. An updated checklist of butterflies of Rajgir Wildlife Sanctuary, Bihar. Bugs R All #195, In: *Zoo's Print*, **36(5)**: 15–22.

Kehimkar, I. (2008). The Book of Indian Butterflies. Bombay Natural History Society and Oxford University Press, Mumbai, 497 pp.

Kunte, K., S. Sondhi, B.M. Sangma, R. Lovalekar, K. Tokekar and G. Agavekar (2012). Butterflies of the Garo Hills of Meghalaya northeastern India: Their diversity and conservation. *Journal of the Threatened Taxa* **4(10)**: 2933–2992. https://doi. org/10.11609/JoTT.o2945.2933-92

https://india.mongabay.com/2020/12/as-butterfly-parks-come-up-for-awareness-butterflies-continue-to-lose-habitat-overall/

https://rainforests.mongabay.com/deforestation/archive/India.html

MS Received 19 December 2021
MS Accepted 22 January 2022

DOI: 10.55278/GLKS7562

Report of incidence of mango fruit borer, *Citripestis eutraphera* (Meyrick) (Lepidoptera: Pyralidae) as apple and nut borer in cashew, *Anacardium occidentale* L. (Anacardiaceae) in maidan parts of Karnataka, India

Kori Nagaraj[2], N. Aswathanarayana Reddy[1&2], Subramanyam, B[1] and Ramegowda G.K[3]
[1]AICRP on Cashew, HREC, Hogalagere -563 138, Kolar district, Karnataka, India
[2]Department of Entomology, College of Horticulture, Kolar - 563103, Karnataka, India
[3]Department of Entomology, College of Horticulture, Mysore - 571130, Karnataka, India
Corresponding author: nanreddy5002@gmail.com

Introduction

Cashew (*Anacardium occidentale* L), belongs to the family Anacardiaceae, which is widely grown for its highly nutritious and tasty kernels and is popularly known as "king of nuts" or "wonder nut". This crop is a native of Brazil, introduced to India by Portuguese travellers for the purpose of afforestation and soil conservation during 16th century. The area under cashew crop started increasing from the beginning of 21st century in non-traditional cashew growing regions in maidan partsof Karnataka (mainly districts og Kolar, Chicballapur, Bangalore Rural, Tumkur etc) of south India. However, the cashew pest scenario in non-traditional regions is also changing and becoming alarming. The successful cultivation of cashew is determined by number of biotic and abiotic factos. Among biotic factors, more than 190 species of insect and mite pests have been listed on cashew occurring in different cashew growing countries of the world (Sundararaju, 1984). Of which, tea mosquito bug (*Helopeltis antonii* Sign.) cashew stem and root borer (*Plocaederus ferrugineus* L.) are major insect pests (Anon., 2017).

Recently, the mango fruit borer, *Citripestis eutraphera* (Meyrick) which belongs to Family Pyralidae of Order Lepidoptera first described by Meyrick (1933) became a major pest on cashew as apple and nut borer. Geographically, it is distributed in countries like Java, Indonesia, India, Northern Territory in Australia and Bangladesh as a minor pest of mango (Soumya *et al*., 2016). However, in India, the *C. eutraphera* was first reported from Andaman and Nicobar Islands on local endemic mango species (*Mangifera andamanica* L.) belonging to family Anacardiaceae (Bhumannavar, 1991) indicating the geographical spread within the country. Later, this species became a major pest on cashew (*Anacardium occidentale*) from Andaman Islands (Jacob *et al.*, 2004). Soumya *et al*. (2016) reported that *Citripestis eutraphera* was fairly well established in Kolar, Bengaluru Rural and Hassan districts of Karnataka. They were found infesting lime-sized mango fruits up to pre-harvest, when serious fruit rotting on tree sets in. As advanced stage of infestation is rotten fruits which can be detected, it is unlikely that mature fruits brought from the Andamans must have inadvertently resulted in the introduction of the insect. It is then most probably be the early stages (lime-sized) used for pickles, which have been brought by tourists from the Andamans. Chances are that these mangoes with larvae may have got discarded as kitchen waste, a probable route of introduction. Another possibility is that *C. eutraphera* must have existed in the mainland and may have gone undetected by its sheer low numbers, and caught attention, when infestation became noticeable. This *C. eutraphera* recently invaded and spread in different states like Karnataka, Tamil Nadu, Kerala and Gujarat. Hiremath *et al*. (2017) reported that the *C. eutraphera* infests seedlings and grafts of cashew in Kerala and as apple and nut borer on cashew in maidan parts of Karnataka.

The moth lays eggs on tender vegetative shoots of cashew and after hatching the neonate larva initially bores into the terminal tender shoots, and seedlings/grafts in nursery. The larva damages vascular bundles inside the tender shoots by excessive tunneling, throwing frass material and their excreta from the bored holes. This affects uptake of water and nutrient to upper terminal canopy, resulting in yellowing, drying of leaves and wilting of terminal shoots. After apple and nut formation stage, larva bores an immature apple as well as nuts, and feeds on internal content of apple as well as on young developing kernels. The infested apple and nuts become partially unfilled and dries up before full development and maturity of nuts. Generally single caterpillar was seen feeding either in the apple or nut, but there are reports stating that up to five larvae can occur in cashew apples and three in developing nuts.

The extent of damage ranges from 10 to 16 percent on developing young cashew apples in maidan parts of Karnataka. The peak infestation of *C. eutraphera* as apple and nut borer of cashew was found during February to May, which coincides with apple and nut formation stage. These observations are in agreement with the findings of Kori Nagaraj *et al.* (2020), who reported that peak infestation of apple and nut borer, *C. eutraphera* was during peak summer months in Bangalore condition and also in maidan parts of Karnataka (Aswathanarayana Reddy *et al*., 2016). Similarly, Jayanthi *et al*. (2014) also reported on occurrence of fruit borer, *C. eutraphera* (Meyrick) from mainland causing extensive damage to fruits of mango (*Mangifera indica* L.) in Karnataka and Tamil Nadu. Therefore, timely plant protection operations are extremely important to minimize yield loss.

1a. Infestation at marble size

1b. Infestation of immature apple and nut

1c. Tunneling inside the apple

1d. Infestation of mature apple and nut

2a. Male

2b. Female

Plate 2. Adults of *Citripestis eutraphera*


Plate 3: Field damage of apple and nut borer, *Citripestis eutraphera* on immature apple and nuts

Acknowledgement: The authors are greatful to Dr. C. A. Viraktamath, Emeritus Professor of Entomology and Dr. H.M. Yeshwanth, Assistant Professor of Entomology, Insect Taxonomy Laboratory, Department of Entomology, UAS, GKVK, Bengaluru for insect identification and timely help.

References

Anonymous. 2017. Annual Report 2016-17. *All India Coordinated Research Project on Cashew*, ICAR- Directorate of Cashew Research, Puttur. p. 232.

Aswathanarayana Reddy, N., B. Subramanyam, Vasudeva, K. R. and Rajendra, B. N., 2016, Population dynamics and management of cashew apple and nut borer, *Thylecoptila panerosema* (Lepidoptera: Pyralidae) in maidan parts of Karnataka. In: *Procceedings of National Seminar on Strategies for Development of Cashew*, held on 19-20 February at Regional Fruit Research Station, Vengurle, Maharashtra. Pp 63.

Bhumannavar, B. S., 1991, Record of *Citripestis eutraphera* Meyrick (Pyralidae: Lepidoptera) on *Mangifera andamanica* in India. *J. Bombay Nat. Hist. Soc*, **88**(2): 299.

Hiremath, S. R., Kumara, S. A. and Prathapan, K. D., 2017, First report of the mango fruit borer, *Citripestis eutraphera* (Meyrick) (Lepidoptera: Pyralidae) as a seedling borer of cashew, *Anacardium occidentale* L. (Anacardiaceae). *Journal of Lepidopterists Society*, **71**(2):115–116.

Jacob, T. K., Veenakumari, K. and Bhumannavar, B. S., 2004, Insect pests of cashew in the Andaman Islands. *Cashew*, **18**(4): 25–28.

Jayanthi, P.D.K., Abraham Verghese, P.R. Shashank and Vivek Kemparaj, 2014, Spread of indigenous restricted fruit borer, *Citripestis eutraphera* (Meyrick) (Lepidoptera : Pyralidae) in mango: Time for domestic quarantine regulatory reforms. *Pest Management in Horticultural Ecosystems*, **20**(2): 227-230.

Kori Nagaraj, Ramegowda, G.K., Aswathanarayana Reddy, N., Narabenchi, G.B. and Vishuvardhana, 2020, Studies on apple and nut borer, *Citripestis eutraphera* Meyrick (Lepidoptera: Pyralidae) in cashew. In: Procceedings of "*XVII AZRA International Conference on Frontier Research in Applied Zoology and Insect Pest management Strategies: A way forward for Food and Nutritional Security"* from 12-14th, February, 2020 at UAS, Raichur, Karnataka, Pp 82-83.

Soumya, B. R., Abraham Verghese, P. D. Kamala Jayanthi and S. K. Jalali, 2016. Need to strengthen quarantine between Andaman and Nicobar Islands and mainland India. *Current Science*: **111** (11): 1753 - 1756.

Sundararaju, D. 1984. Studies on cashew pests and their natural enemies in Goa. *Journal of Plantation Crops,* **12**: 38-46.

MS Received 19 December 2021
MS Accepted 01 February, 2022

DOI: 10.55278/XNHV5266

Record of host plants of *Thysanoplusia orichalcea* Fab. in mid hills of Himachal Pradesh, India

Ritu Rani, K. S. Verma, R. S. Chandel and Himanshu Thakur*
Department of Entomology, CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur, Himachal Pradesh-176062, India
Corresponding author: himanshumaimor@gmail.com

Thysanoplusia orichalcea (Fabricius), commonly known as the slender burnished brass moth, cabbage semilooper or soybean looper belongs to family Noctuidae. The adult of this species is a stout moth with straw coloured forewings which are extensively covered with a metallic golden shimmering surface (Plate 2). The larvae are light green in colour with a thin white lateral line and two white lines on back, active and form loop in motion, swollen at posterior end and tapers anteriorly (Plate 2). The early instar larvae causes damage by feeding on chlorophyll of tender leaves resulting in transparent leaf spots, while later instars feed from margins and defoliate, leaving midribs in case of severe incidence. It is a polyphagous pest which has worldwide distribution. In India, it has been reported from a number of states such as Punjab, Haryana, Uttar Pradesh, Madhya Pradesh, Karnataka etc. besides Himachal Pradesh. The larvae of *T. orichalcea* feed on many host plants including vegetables, herbs, pulses, oilseeds, cereals, weeds and aromatic plants (Kravchenko *et al*., 2005; Kumar, 2007; Eddaya *et al*., 2010). Being polyphagous in nature, it is reported to feed on cabbage, cauliflower, carrot, celery, lettuce, pea, soybean, radish and other vegetables from seedling to harvesting stage and thereby causing significant damage to these crops (Batra, 1956; Sharma and Bhalla, 1964; Sagar and Ramji, 1991). It is also known as one of the key pest of kalazira, *Bunium persicum* in Kinnaur disrict of Himachal Pradesh (Bhardwaj and Panwar, 1990; Sharma, 1998). The large host range and nutritional divergence of a species is considered as an important factor for better survival during growth and development (Simpson *et al*., 2002; Despland and Simpson, 2005).

The present investigation was conducted to record the host plants of this polyphagous pest at mid hills of Himachal Pradesh. The investigation for the record of host plants was conducted at CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur (N 32º05'39.96"; E 76º32'46.86" Altitude 1222 mts. amsl), during 2019. In order to study the host plants of *T. orichalcea*, weekly surveys were made in different crops sown in fields at seed farm, vegetables farm, agronomy farm and entomology farm in CSKHPKV, Palampur. The observations were recorded on the larval population on different crops, and percent leaf infestation by the larvae were recorded simultaneously. For this purpose, we randomly counted damaged and healthy leaf. The percent mean leaf infestation was calculated based on ten observations.

Under field conditions, the pest was found active during March – November, 2019. During this period, the larvae of *T. orichalcea* were observed feeding on 16 different host plants including vegetables, legumes, herbs and weeds at Palampur belonging to 10 different families (Table 1; Plate 1). Among these host plants, the highest plant infestation (35.7%) was recorded on soybean (*Glycine max*) crop belonging to family Fabaceae followed by cabbage (*Brassica oleracea* var. *capitata*) (16.2%) and cauliflower (*B. oleracea* var. *botrytis*) (12.0%) from family Brassicaceae. The lowest infestation of *T. orichalcea* was recorded on spinach (*Spinacia oleracea*) crop (2.4%). Besides soybean, *T. orichalcea* larvae was recorded to feed on black gram **(***Vigna mungo*), and other vegetable crops such as potato (*Solanum tuberosum*) and tomato (*Solanum lycopersicum*). Among the herbal and spice plants, it was recorded on mint (*Mentha spicata*) and coriander (*Coriandrum sativum*). Weed plants are alternate and alternative hosts for many insects and diseases in agricultural ecosystem (Kumar *et al*., 2021). In the present investigation, white clover (*Trifolium repens*) was reported to support population buildup of *T. orichalcea.* The pest was also reported to infest red clover (*T. pretense*), pink morning glory (*Ipomea carnea*), Mexican fleabane (*Erigeron karvinskianus*), hairy beggar-ticks (*Bidens pilosa*), isabgol (*Plantago ovata*) and wandering jew (*Commelina benghalensis*) (Table 1; Plate 1).

The present study provides an insight about the host range as well as damaging potential of *T. orichalcea* in different crops grown in the region. The knowledge of host range of a pest is important for exploring the integrated pest management options against the pest species (Conlong and Rutherford, 2009; Smit *et al*., 2021). This information on host range of *T. orichalcea* can be used in IPM programs, where alternate and alternative weed hosts can be completely destroyed from the crop ecosystem to avoid the completion of life cycle of pest on these weed host in the absence of main crop. Crop rotation strategies can also be followed based on the host range of pest in order to avoid regular pest attack throughout the year in different seasons. The pest voltinism can be affected by this strategy thereby reducing economic damage due to *T. orichalcea* in different crops.

Table 1. Record of host plants of *T. orichalcea* at Palampur during 2019

Sr. No.	Common Name	Scientific name	Family	Plant infestation (%)
A	**Vegetables**			
1	Cabbage	*Brassica oleracea* var. *capitata* L.	Brassicaceae	16.2
2	Cauliflower	*Brassica oleracea* var. *botrytis* L.	Brassicaceae	12.0
3	Potato	*Solanum tuberosum* L.	Solanaceae	8.5
4	Tomato	*Solanum lycopersicum* L.	Solanaceae	6.0
5	Spinach	*Spinacia oleracea* L.	Amaranthaceae	2.4
B	**Herbs**			
6	Mint	*Mentha spicata* L.	Lamiaceae	7.8
7	Coriander	*Coriandrum sativum* L.	Apiaceae	7.4
C	**Legumes**			
8	Soybean	*Glycine max* (L.) Merr	Fabaceae	35.7
9	Mash	*Vigna radiata? (L.) Hepper*	Fabaceae	10.3
D	**Weeds**			
10	White clover	*Trifolium repens* L.	Fabaceae	11.0
11	Red clover	*Trifolium pratense* L.	Fabaceae	9.0
12	Pink morning glory	*Ipomea carnea* Jacq.	Convolvulaceae	4.7
13	Mexican fleabane	*Erigeron karvinskianus* DC.	Asteraceae	4.0
14	Hairy beggar-ticks	*Bidens pilosa* L.	Asteraceae	3.4
15	Isabgol	*Plantago ovata* Forssk.	Plantaginaceae	3.2
16	Wandering jew	*Commelina benghalensis* L.	Commelinaceae	2.6

	
Coriandrum sativum	***Vigna radiate***
	
Trifolium repens	***Erigeron karvinskianus***
	
Bidens pilosa	***Commelina benghalensis***

Glycine max

Fig. 1 *T. orichalcea* feeding on different host plants

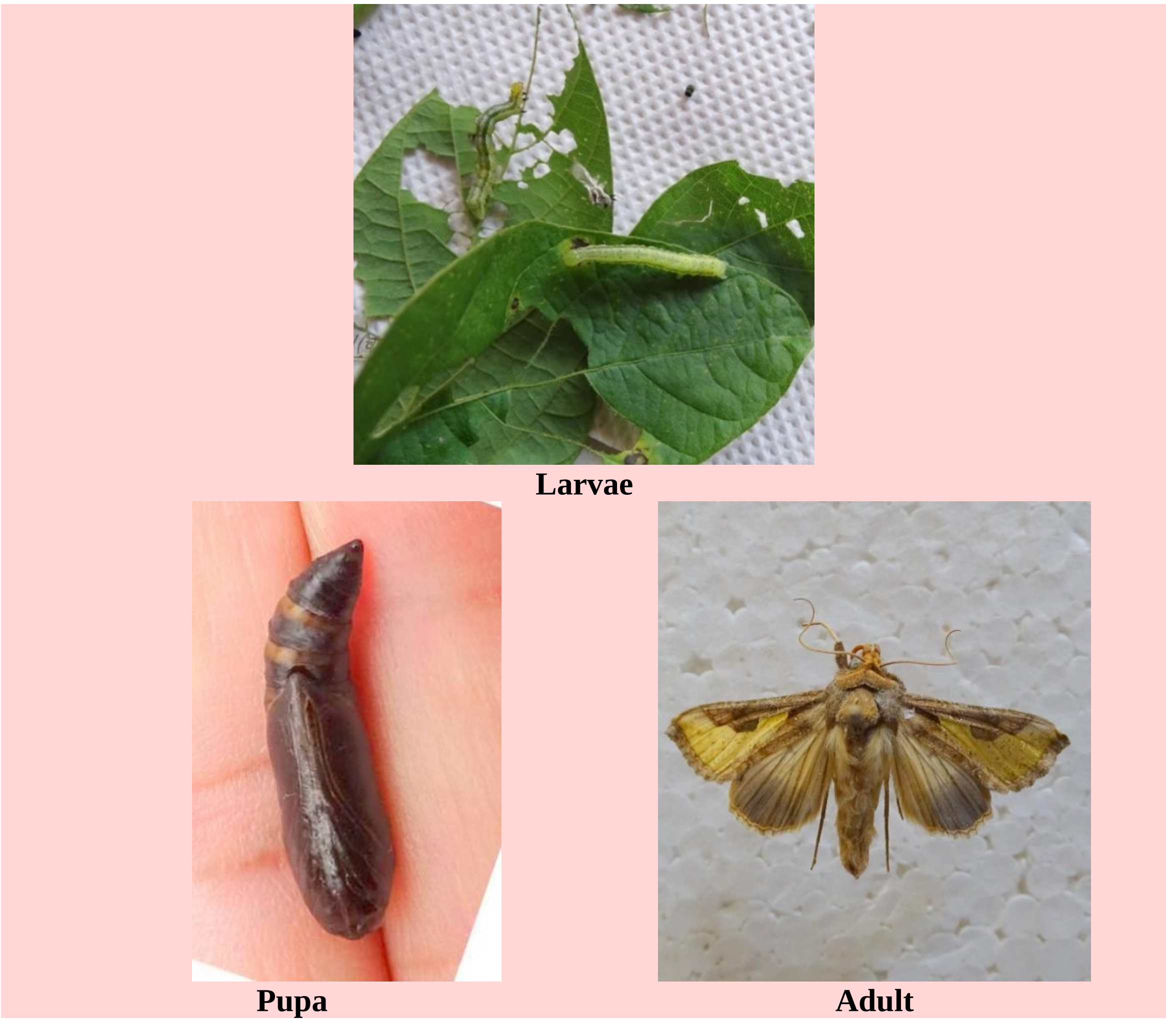


Fig. 2: Different stages in life cycle of *T. orichalcea*

References

Batra, H. N. 1956. Record of some insect pests of economic importance in Kullu Valley. *Bulletin of Plant Protection*, **8**(3-4): 18-23.

Bhardwaj, S. P. and Panwar, K. S. 1990. Outbreak of *Heliothis armigera* Hubner and *Plusia orichalcea* Fabr. on blackzira in the dry temperate region of' India. *Tropical Pest Management*, **36**(1): 73-74.

Conlong, D. E. and Rutherford, R. S. 2009. Conventional and new biological and habitat interventions for integrated pest management systems: review and case studies using *Eldana saccharina* Walker (Lepidoptera: Pyralidae). Innovation-Development Process (ed. by R. Peshin and A. K. Dhawan), pp. 241–261. Springer, Dordrecht, The Netherlands.

Despland, E. and Simpson, S. J. 2005. Food choices of solitarious and gregarious locusts reflect cryptic and aposematic antipredator strategies. *Animal Behaviour*, **69**(2): 471-479.

Eddaya, T., Boughdad, A., Zaid, A. and Amechrouq, A. 2010. Faune associee a lamenthe dans la region du Meknes (Maroc). In: Proceedings du Septieme Congres de l'association Marocaine de Protection des Plantes, Marocco, pp. 135–141.

Kravchenko, V. D., Fibiger, M., Ronkay, L., Orlova, O.B., Mooser, J., Muller, C. L. and Muller, G. C. 2005. The Plusiinae of Israel (Lepidoptera: Noctuidae). *SHILAP Revista de Lepidopterologia*, **33 (132)**: 449 – 459.

Kumar, N. G. 2007. Seasonal incidence, foliar damage and chemical control of *Thysanoplusia orichalcea* Fabr. (Lepidoptera: Noctuidae) – a pest of sunflower. *Journal of the Entomological Research Society*, **9(1)**: 39-40.

Kumar, S., Bhowmick, M. K. and Ray, P. 2021. Weeds as alternate and alternative hosts of crop pests. *Indian Journal of Weed Science*, **53(**1): 14-29.

Sagar, P and Ramji. 1991. A study on the host range of cabbage semilooper, *Thysanoplusia orichalcea* (Fab.) in Punjab. *Indian Perfumer*, **35**(1): 61-62.

Sharma, P. L. and Bhalla, O. P. 1964. A survey study of insect pests of economic importance in Himachal Pradesh. *Indian Journal of Entomology*, **26**(3): 3 18-33.

Sharma, S. D. 1998. Insect pests of kalazira in the hills of Himachal Pradesh. *Insect Environment*, **4**(2): 43.

Simpson, S. J., Raubenheimer, D., Behmer, S.T., Whitworth, A. and Wright, G.A. 2002. A comparison of nutritional regulation in solitarious and gregarious phase nymphs of the desert locust, *Schistocerca gregaria*. *Journal of Experimental Biology*, **205**: 121–129.

Smit, C., Marion, J., Desmond, E.C., Grant, H. and John, S.T. 2021. Host range determination in a novel outbreak pest of sugarcane, *Cacosceles newmannii* (Coleoptera: Cerambycidae, Prioninae), inferred from stable isotopes. *Agricultural and Forest Entomology*, **23**(3): 378-387.

MS Received 03 January 2022
MS Accepted 25 Feburary 2022

DOI: 10.55278/HXFL9012

Record of *Henosepilachna septima* Dieke on organic bitter gourd on terrace urban, Bengaluru, India

Abraham Verghese[1]* and Rashmi M. A[2]
*[1]Former Director ICAR-National Bureau of Agricultural Insect Resources and Former Head, ICAR-Indian Institute of Horticultural Research, Hesaraghatta, Bengaluru, Karnataka, India
[2] Regional Plant Quarantine Station, Directorate of Plant Protection, Quarantine & Storage Bengaluru, India
Corresponding author: abraham.avergis@gmail.com

Several forays to cucurbit fields in and around Bengaluru as part of fruit fly surveys in the last one decade, have never led to the sighting of the Epilachna beetle, *Henosepilachna septima* Dieke (Subfamily: Epilachninae, *Famil*y: Coccinellidae, Order: Coleoptera). Katakura *et al*., 2001 reported *H. septima* specialized to bitter-melon *(Momordica charantia*) and to "wild bitter cucumber" *M. subangulata*. There are also records of serious pest status in Pakistan on bitter gourd (Falak and Mian, 2013).

The cucurbit seeds sown are invariably treated with insecticides and from germination farmers resort to sprays, and *H. septima* being very vulnerable to any spray, seemed rare. But they have found a new haven in organic bitter gourds grown in urban homesteads and terraces, thanks to the demand for organic bitter gourd leaf juice, widely trumpeted as a health booster, especially for diabetics. Many urbanites therefore grow bitter gourds at homes in Bangalore (12.9716° N, 77.5946° E). In November 2021 we found potted bitter gourd leaves with extensive skeletonising in several terrace gardens in the city of Bangalore, India.

The beetle, both adults and grubs were found skeletonising the leaves and causing great debilitation to the gourds throughout the growth stages. The pest is normally active during warmer part of the cropping season and is recorded from end of January to beginning of April. The population was recorded to be at peak during the first to third week of March (Uikey *et al.,* 2016).

The total life cycle of the beetle varies from 22-26 days according to the temperature and relative humidity. Freshly laid eggs are cigar shaped and yellow in colour with circular depression like markings on their surface. The eggs are laid in clusters, usually on under surface of leaves (Fig.1). Incubation period varies from 4-6 days, and newly hatched grubs are yellow in colour and campodeiform in shape. Dorsal surface of body is clothed with long tri-forked processes arranged in longitudinal rows on thoracic and abdominal segments with 12-15 days larval period (Uikey *et al.*, 2016) (Fig.2). Pupa is anteriorly rounded and posteriorly tapered, shining yellow with brownish white markings on its dorsum (Fig.3) with 3-4 days pupal period. Adult beetles (Fig.4) are oval in shape with highly convex body, elytra dark brown each with 12 black spots. Beetle has a longevity of 16-25 days (Uikey *et al.*, 2016).

The population of *Epilachna* beetle was positively correlated with maximum temperature and wind direction and negatively correlated with minimum temperature, rainfall, relative humidity and wind speed (Mawtham *et al.*, 2020, Tushar *et al.* 2014). But its sighting in November does not agree with these findings. Perhaps in an urban scenario or with adaptation to cooler regimes, the beetle in this case was found in November, 2021.

We dare not recommend any sprays - even a safe neem- for neem bitters would add on to the bitter of the bitter gourd, and may distaste the leafy concoction which health fads drink. So, in infested terrace gardens we just picked each beetle and allowed them to fly off. The eggs and grubs were just brushed off with a Camlin paint brush.

Fig. 1. *Henosepilachna septima* egg mass

Fig. 2 *Henosepilachna septima* grubs

Fig. 3 *Henosepilachna septima* pupae

Fig. 4 *Henosepilachna septima* adult

Fig. ***5 Henosepilachna septima*** **damage symptoms (PC: Abraham Verghese)**

Acknowledgement: We thank Dr. J. Poorani (ICAR-NRC Banana, Trichi) for the photographs and identification.

References

Katakura, S., Nakano, S. Kahana, I., Abbas and K. Nakamura, 2001. *Epilachnine* ladybird Beetles (Coleoptera, Coccinellidae) of Sumatra and Java, *Tropics*, **10 (3):** 325-352.

Falak Naz. and Mian Inayatullah, 2013, *Henosepilachna septima* Dieke (Coccinellidae; Coleoptera); A New Record for Pakistan along with Notes on its Taxonomy, Host Plants and Distribution, *Sarhad J. Agric.* **29(2)**: 235-238.

Uikey. B. L., Bhupendrakumar, T. M. Ghule, S. Jha and R. K. Kekti, 2016. Incidence pattern and biology of Epilachna beetle, *Henosepilachna septima* Dieke on Bottle Gourd in Gangetic new alluvial zone of West Bengal, *Journal of Insect Science*, **29(1):** 63-66.

Mawtham., C. Gailce Leo Justin., S. Sheeba Joyce Roseleen. and M. Chandrasekaran, 2020. Correlation of Weather Factors on the Incidence of *Epilachna* Beetle *Henosepilachna septima* Dieke and its Natural Enemy, *Int. J. Curr. Microbiol. App. Sci*., **9(6):** 2637-2642.

Tushar M. Ghule, Bhajan Lal Uikey, Pranab Barma. and S. Jha 2014. Incidence studies on some important insect pests of cucumber (*Cucumis sativus* L.) *The Ecoscan*, **8 (1&2):** 177-180.

MS Received 30 December 2021
MS Accepted 20 Janavary2022

DOI: 10.55278/AWDS1247

Dissipation patterns of insecticides in okra (*Abelmoschus esculentus*)

Deepak. S[1*] and Shashi Bhushan V[2]
[1*]Directorate of Plant Protection Quarantine & Storage, Faridabad, India
[2]Former Professor, Department of Entomology, Agriculture of College, Hyderabad, India
[*]Corresponding author: deepaksihimoge@gmail.com

Abstract

A field experiment was conducted at Students' Farm, College of Agriculture, Hyderabad to evaluate the efficacy of six different insecticides *viz.,* bifenthrin 10 EC at 80 g a.i/ha, fipronil 5 SC at 500 g a.i/ha, flubendiamide 480 SC at 60 g a.i/ha, quinalphos 25 EC at 350 g a.i/ha, profenofos 50 EC at 400 g a.i/ha and beta-cyfluthrin 25 SC at 18.75 g a.i/ha against insect pests of okra. Among them, Profenophos, Beta-cyfluthrin and Flubendiamide were found effective against leafhopper, whitefly and shoot and fruit borer, respectively. Hence, dissipation studies of Profenophos, Beta-cyfluthrin and Flubendiamide were carried out at Laboratory of AINP on Pesticide Residues, Hyderabad by collecting okra fruits at 0, 1, 3, 5, 7, 10 and 15 days. The initial deposits of flubendiamide, prophenophos and beta-cyfluthin were recorded to be 1.49, 1.52 and 0.11 mg kg^{-1}, respectively and dissipated to below detectable level (BDL) on the 5^{th}, and 10^{th} day, respectively. The half-life worked out for flubendiamide, profenofos and beta-cyfluthrin were 1.83, 2.16 and 1.13 days with waiting periods for a safe harvest of the okra fruits were 4.19, 5.10 and 2.62 days, respectively.

Introduction

There are more than 1000 pesticides used around the world to ensure food is not damaged or destroyed by pests. Each pesticide has different properties and toxicological effects.As pesticides are intrinsically toxic and deliberately spread in the environment, the production, distribution and use of pesticides require strict regulation and control.

World Health Organization has two important objectives in respect of pesticides. The first one is to ban pesticides that are most toxic to humans and remain for the longest time in the environment. And second is to protect public health by setting maximum limits for pesticide residues in food and water.

The acceptable daily intakes used by governments and international risk managers, such as the Codex Alimentarius Commission to establish Maximum Residue Limits (MRLs) for pesticides in food. Codex standards are the reference for the international food trade, so that consumers everywhere can be confident that the food they buy meets the agreed standards for safety and quality, no matter where it is produced. Currently, there are Codex standards for more than 100 different pesticides (WHO, 2022). In this background, this experiment was conducted to determine the persistence pattern of a few commonly used and new insecticide molecules in okra (*Abelmoschus esculentus).*

Materials and Method

An experiment was conducted at Students' Farm of Agriculture College, Hyderabad, India, to evaluate the efficacy of six different insecticides *viz.,* bifenthrin 10 EC at 80 g a.i/ha, fipronil 5 SC at 500 g a.i/ha, flubendiamide 480 SC at 60 g a.i/ha, quinalphos 25 EC at 350 g a.i/ha, Profenophos50 EC at 400 g a.i/ha and beta-cyfluthrin 25 SC at 18.75 g a.i/ha against on insect pests of okra.

Among them, Profenophos at 400 g a.i/ha, Beta-cyfluthrin at 18.75 g a.i/ha and Flubendiamide at 60 g a. i/ha was found effective against leafhopper (*Amrasca biguttula*), whitefly (*Bemisia tabaci*) and shoot and fruit borer (*Earias vittella*) respectively.

Further, dissipation studies of Profenophos, Beta-cyfluthrin and Flubendiamide was carried out at the Laboratory of All India Network Project on Pesticide Residues, Hyderabad. Fruits samples size of 250g was collected from the insecticide-treated plots in polythene bags at an interval of 0, 1, 3, 5, 7, 10 and 15 days after the last spray and brought to the laboratory for residue analysis.

Analysis of Residues

Preparation of standard stock solution

From the technical grade of insecticide, one ppm standard solution was prepared by diluting with n-hexane for profenophos and with acetonitrile for flubendiamide and beta-cyfluthrin and used for carrying out recovery and comparative studies of pesticide residues in the fruit samples collected at different intervals.

Extraction and clean up

Prophenophos: A representative sample (okra fruits) of 25 g was homogenized with 50 ml acetonitrile and was filtered. Then the filtrate was evaporated to near dryness using a vacuum rotary evaporator and the contents were re-dissolved in 25 ml of hexane. Then recovered filtrate was partitioned after adding 100 ml of acetonitrile and 125 ml of 5 percent sodium chloride solution. The extract was cleaned up with florosil column eluting with dichloromethane. The elute was concentrated again and dissolved in n-hexane and later subjected to alumina column clean up. The final elution was done with hexane: acetone (9:1) and evaporated to dryness and analyzed on GC. Residues were estimated by comparing the peak area of the standard with that of the peak in the sample under identical conditions.

Flubendiamide**:** A representative sample (okra fruits) of weight 25 g was extracted with 50 ml acetonitrile containing 0.01per cent hydrochloric acid twice by using a mechanical shaker for 30 minutes. The extraction mixture was filtered and evaporated to near dryness using a vacuum rotary evaporator and the contents were re-dissolved in 20 ml of acetonitrile.

A glass column was packed with 5 g of alumina using hexane as a solvent and drained the excess of solvent. The sample was transferred into the column and eluted with 50 ml of 10:1 hexane: ethyl acetate solvent mixture.

Discarded the first 10 ml fraction and collected the elute over anhydrous sodium sulphate, the process was repeated thrice. Approximately 150 ml of elute was collected. The elute was completely dried or drained and evaporated to near dryness. The residues were recovered in a 5ml volume of acetonitrile for HPLC analysis. Residues were estimated by comparison of peak area of the standards with that of the unknown or spiked samples run under identical conditions.

Beta-cyfluthrin: A representative fruit sample of 25 g was homogenized with 50 ml acetone: hexane (1:9) and was filtered. The filtrate was partitioned after adding saturated Nacl and Dichloromethane. The extract was cleaned up with florosil column eluting with hexane. The elute evaporated to dryness for Gas Chromatography analysis. Residues were estimated by comparing the peak area of the standard with that of the peak in the sample under identical conditions.

Fortification and Recovery Studies

Before sample analysis, recovery tests were conducted. For the recovery test, 25 g of okra fruit samples were collected from control plots and fortified at two levels separately i.e. 0.01 ppm and 0.10 ppm for profenofos, flubendiamide and beta-cyfluthrin from the standards prepared. The contents were mixed thoroughly and the samples were extracted and cleaned up as per the procedure described above. All the recovery samples were replicated thrice.

The mean percent recovery of Profenophos in the okra fruit sample was 88 and 87, flubendiamide was 87 and 88 and beta-cyfluthrin was 86 and 88, respectively at 0.01 ppm and at 0.10 ppm level of fortification for each insecticide.

Estimation

The residues of profenofos and beta-cyfluthrin were estimated using Gas Chromatograph - Electron Capture Detector (GC-ECD). Similarly, residues of flubendiamide were estimated using High-Performance Liquid Chromatography (HPLC). Residues were estimated by comparing the peak area of the standard with that of the peak in the sample under identical conditions.

Interpretation of Data

Residues (mg/kg)

The formula used to arrive at the residues is as follows.

$$\frac{\text{Area of sample}}{\text{Area of standard}} \times \frac{\mu\text{l of sample injected}}{\mu\text{g of standard injected}} \times \frac{\text{Final volume}}{\text{Weight of the Sampling}} \times \frac{100}{\text{Per cent mean recovery}}$$

Dissipation (%)

$$\text{Per cent dissipation} = \frac{\text{Initial deposit} - \text{Residues at given time}}{\text{Initial deposit}} \times 100$$

Prediction of approximate time required to dissipate the residue below the tolerance limit

The period to be allowed to expect the residues to reach below the tolerance limit after treatment for safe use of the treated material was calculated by using the formula (Gunther and Blinn, 1955).

$$Y = a + bX$$

Where,

Y = Log of tolerance limit

a = Log of initial deposit

b = Slope of the regression line

Waiting Period: the minimum number of days to lapse before the insecticide reaches the tolerance limit. The waiting periods were calculated by the following formula.

$$T_{tol} = \frac{[a - \text{Log tol}]}{B}$$

Where,

T_{tol} = Minimum time (in days) required for the pesticide residue to reach below the tolerance limit.

a = Apparent initial deposits obtained in the regression equation

tol = Tolerance limit of the insecticide

b = Slope of the regression line

Calculation of Half-life Values (RL_{50}): time in days required to reduce the pesticide residues to half of its initial deposits.

$$RL_{50} \text{ (or) } t_{1/2} = \text{Log } 2 / K_1 = 0.301/K_1$$

K_1 = Slope of regression line (Hoskins, 1961)

Results and Discussion:

Flubendiamide

The initial deposit and subsequent residues of flubendiamide in okra fruit sample was 1.49 mg/kg at 0 days, which gradually dissipated to 0.84, 0.47, 0.10 and 0.01 mg/kg at 1, 3, 5 and 7 days, respectively. The residues fell below maximum residue limit (MRL) of 0.2 mg kg^{-1} in 4days after the treatment. The half-life (RL_{50}) of flubendiamide was worked to be 1.83 days.

The results are in agreement with the findings of Sahoo *et al.* (2009) who evaluated that the average initial deposits of flubendiamide on chilli to be 1.06 and 2.00 mg/kg, respectively, following two applications of flubendiamide 480 SC at 60 and 120 g a.i/ha at 10 days interval. Residues of flubendiamide dissipated below detectable level of 0.01 mg/kg in 7 and 10 days at single and double dosages, respectively (Table 1).

Prophenophos

Initial deposits of Profenophos in okra fruit sample was 1.52 mg/kg at 0 days and further degraded to 1.14, 0.75, 0.62 and 0.09 mg/kg after 1, 3, 5 and 7 days, respectively. The results showed that the residues of Profenophos reached below tolerance limit of 0.5 mg/kg in seven days while corresponding half-life was worked out to be 2.16 days.

The results are in agreement with the findings of Sahoo *et al.* (2004) who reported an initial deposit of 1.37 mg/kg following application of Profenophos at 500 g a.i/ha on tomato. These levels were reduced to below detectable level (BDL) after 15 days of application.

Beta-cyfluthrin

The initial deposit of beta-cyfluthrin (18.75 g a.i. ha^{-1}) in okra was 0.11 mg/kg and at one day after treatment itself around 45.04 per cent dissipation was recorded. Further very rapid dissipation was evident by third day was noticed and initial deposit dissipated to 80.95 per cent by third day. The residues at the end of first and third day were 0.06 and 0.02 mg/kg respectively. The residues of beta-cyfluthrin dissipated to below tolerance limit of 0.02 mg/kg in three days.

The results are in conformity with those of Singh and Singh (2007) who studied the dissipation of beta-cyfluthrin on chickpea following foliar applications at 12.5 and 25 g a.i/ha, recording initial deposit of beta-cyfluthrin 0.109 and 0.135 mg/kg in green pods which dissipated to 88.1-92.6% with half-life of 3.34 and 4.01 day, respectively.

The variation in the rate of dissipation in vegetables may be due to changes in the crop matrix. In addition, the dissipation of pesticide residues in/on crops depends on climatic conditions, type of application, plant species, dosage, interval between application and time of harvest.

Summary

Insecticides *viz.*, flubendiamide (60 g a.i/ha), Profenophos (400 g a.i/ha) and beta-cyfluthrin (18.75 g a.i/ha) sprayed on okra were dissipated more than 90 per cent of its original concentration after seventh day of spray and are safe for harvesting and consumption after that.

Table 1. Dissipation of Flubendiamide, Profenophos andBeta-cyfluthrinin okra

Day	Residues / Deposits (mg/kg)			Dissipation (in percentage)		
	Flubendiamide	Profenophos	Beta-cyfluthrin	Flubendiamide	Profenophos	Beta-cyfluthrin
0	1.49	1.52	0.11	0	0	0
1	0.84	1.14	0.06	43.30	24.92	45.40
3	0.47	0.75	0.02	68.08	50.44	80.95
5	0.10	0.62	BDL	93.14	58.96	100
7	0.01	0.09	BDL	98.88	93.88	-
10	BDL	BDL	BDL	100	100	-

Fig. 1 Sample Collection

Fig. 2 Extraction

a. Extraction (Filteration) **b. Extraction (Separation)**

Fig. 3 Steps in estimation of insecticide residue

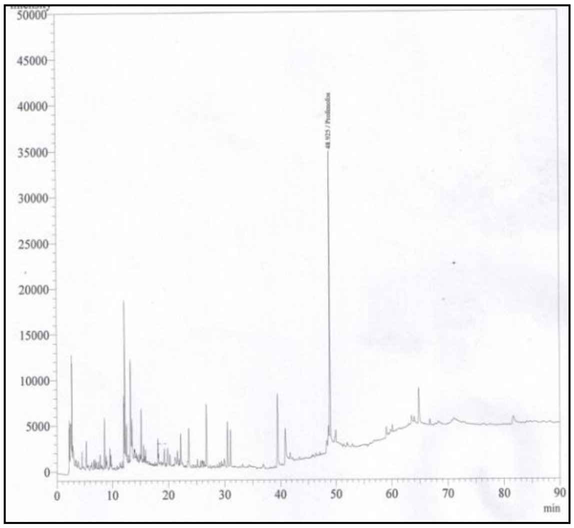


Fig. 4 Chromatograms of Prophenophos (400 g a.i/ha) Profenophos (7 DAS)

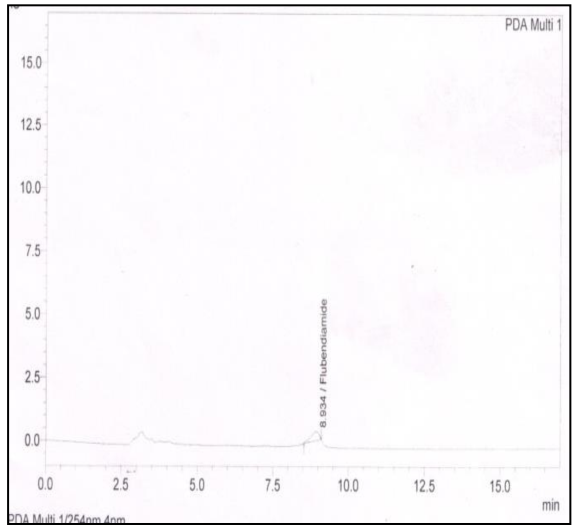


Fig. 5 Chromatograms of Flubendiamide (60 g a.i/ha) Flubendiamide (7 DAS)

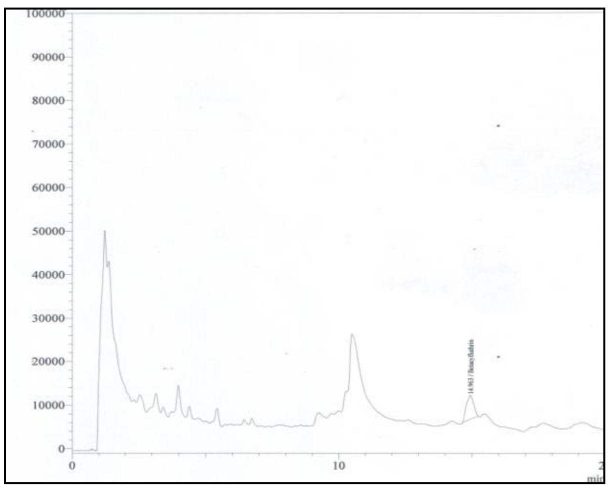


Fig. 6. Chromatograms of Beta-Cyfluthrin (18.75 g a.i/ha) Beta-cyfluthrin (3DAS)

References

Gunther, F. A and Blinn R. C. Analysis of Insecticides and Acaricides, Interscience Publishers, New York, 1955, 696.

Hoskins, W. M. 1961. Mathematical treatments of loss of pesticide residues. *Plant Protection Bulletin.* FAO.9: 163-168.

Sahoo, S. K., Kapoor, S. K and Singh, B. 2004. Estimation of flubendiamide residues of profenofos in/on tomato (*Lycopersicumesculentum* Mill.). *Bulletin of Environmental Contamination and Toxicology*.**72**: 970-974.

Sahoo, S. K., Sharma, R. K., Battu, R. S and Balwinder Singh. 2009. Dissipation kinetics of flubendiamide on chilli and soil. *Bulletin of Environmental Contamination and Toxicology*. **83** (3): 384-387.

Singh, N. K and Singh, S. P. 2007. Dissipation of beta-cyfluthrin residues on chickpea. *Pesticide Research Journal*. **19** (1): 104-105.

World Health Organization (WHO) 2022 Pesticide residues in food, https://www.who.int/news-room/fact-sheets/detail/pesticide-residues-in-food.

MS Received 05 January 2022
MS Accepted 07 February 2022

DOI: 10.55278/FUYS5625

First report of painted bug, *Bagrada hilaris* on pearl millet in Anand, Gujarat, India

Kahkashan Wali[1], C. B. Varma[2], D.B Sisodiya[1]
[1]Department of Agri. Entomology, BACA, AAU, Anand, Gujarat, 388110, India
[2]Department of Agri. Entomology, COA, AAU, Vaso, Gujarat, 388110, India
Corresponding author: chiragvarma@aau.in, kahkashan.wali123@gmail.com

Pearl millet (*Pennisetum glaucum* L.) also known as bulrush, cattail, candle or spiked millet is an annual grass of the family Poaceace, widely grown in Africa and India as a grain and forage crop. A study was conducted to identify the pests infesting pearl millet crop at Entomology farm, Department of Entomology, B. A. College of Agriculture, Anand, (22.57 ^{0}N, 72.93 ^{0}E) Gujarat, India during summer of 2021. During the field visit, a hemipteran bug was observed on pearl millet. After collection, killing and pinning, photos were taken. The bagrada bug identified was painted bug, *Bagrada hilaris,* a true bug in the order Hemiptera, and more specifically is a stink bug in the family Pentatomidae. It was first reported in the United States on June, 2008 in Los Angeles, California (Reed *et al.*, 2013).

The study conducted on pearl millet revealed the serious infestation of *Bagrada hilaris* from vegetative to reproductive stage of the crop. Different life stages were observed including eggs, five nymphal instars, adults as well as the mating pairs on different parts of the plant *viz.*, leaves, stems, ligules and ear heads.

Both adult and nymphal stages feed on the host plant. Adult females feed longer and cause greater damage than males do. Feeding damage by bagrada bug on leaves is characterised by star shaped chlorotic lesions that may become necrotic. It also damages stem and developing ear heads resulting in reduced yield. This investigation concluded that bagrada bug was first time observed on pearl millet in Anand, Gujarat, India in an aggregate form on pearl millet crop and adversely affected the plant growth, yield and market value.

We are thankful to Dr. Hemant Ghate, Indian taxonomist, Department of Zoology, Pune, India for identifying the painted bug, *Bagrada hilaris*.



Fig. 1. Eggs laid on leaves in groups; Fig. 2. Third instar nymph of painted bug; Fig. 3. Adult of painted bug

Fig. 4. (A) Infestation appeared on leaves as star shaped lesions (B) mating adults on ear head of bajra appeared (C) eggs, nymphal instars and mating adults observed on ear head

References:

Reed, D. A., Palumbo, J. C., Perring, T. M., and May, C. 2013. *Bagrada hilaris* (Hemiptera: Pentatomidae), An Invasive Stink Bug Attacking Cole Crops in the Southwestern United States, *Journal of Integrated Pest Management*. **4 (3)**: pp. 1-7.

MS Received 02 January 2022
MS Accepted 18 February 2022

DOI: 10.55278/KIFT1486

Unusual outbreak of tea mosquito bug, *Helopeltis antonii* Signoret (Hemiptera: Miridae) on mango and neem in Mysuru, India

Ramegowda, G. K. [1]****, Venkatesha, S. C.*** [1]***, Nagana Goud, M.*** [2] ***and Gubbaiah*** [3]

[1]College of Horticulture, Yalachahalli Horticulture Farm, Yelawala, Mysuru-571130, Karnataka, India

[2]Eco Agripreneurs Pvt. Ltd., 173/01, NR Road, Davanagere-577001, Karnataka, India

[3]Sampurna Group of Institutions, Belekere, Mudugere Gate, Channapattana Tq., Ramanagara Dist.- 562160, Karnataka, India

Corresponding author: gkramegowda@yahoo.co.in

Abstract: Unusual necrotic lesions on new leaves and blighted appearance in new mango shoots were observed at College of Horticulture, Mysuru and Sampurna Group of Institutions, Agriculture College campus, Belekere, Channapattana (both in Karnataka, India) during November 2021. Careful field and laboratory observations revealed that the new shoot damage is due to *Helopeltis antonii* Signoret. Field observations at College of Horticulture, Mysuru revealed similar damage to new shoots of neem, guava, pomegranate, jamun, custard apple, Hanuman phal and drumstick in decreasing order. Several blighted shoots in neem trees planted on ring road median from Hinakal to Bogadi around Mysuru city during October 2021 to January 2022 ranged between 0.0 to 100 percent.

Keywords: *Helopeltis antonii,* mango, neem.

Introduction

Tea mosquito bugs, *Helopeltis* spp. (Hemiptera: Miridae) are making frequent news in peninsular India on pomegranate (Kamala Jayanthi *et al*., 2016), cotton (Dharajothi *et al*., 2018), drumstick (Jayanthi Mala *et al*., 2020) and neem {Dr. Shanakara Murthy M. (Personal Communication) (UAS, Raichur)}, besides its continued damage/threat on guava, cashew, cocoa and tea (Saroj *et al*., 2016; Thube *et al*., 2020). Host range expansion and change in pest intensity are documented here.

Material and Methods

Routine insect pest survey during 2nd week of November 2021 in orchards with three to 50-year old mango and cashew trees at College of Horticulture (CoH), Yalachahalli Horticulture Farm, Yelawala, Mysuru (Karnataka, south India) revealed blighted leaves in mango (Figure a). Careful and detailed observations confirmed the presence of necrotic lesions followed by blighted leaves only on trees with a new flush. Whereas the trees with matured leaves were completely free from infestation. A week later, similar observations (Figure b) were also observed at Sampurna Group of Institutions, Agriculture College campus at Belekere, Channapattana (Karantaka). Critical observations during the cool hours of the day revealed the presence of tea mosquito bugs in the 12 years old mango plantation.

Efforts were made to assess the extent of damage in mango with eight more hosts at plants at Yalachahalli (12° 22' 40" N; 76° 31' 33" E; 758 m MSL). In mango and cashew, ten random new flush shoots from ten randomly selected infested trees were observed and on other hosts 100 random new flush shoot counts per host were observed for damage with slight modifications to methodologies prescribed and used in cashew (Mahapatro, 2008; Ambika *et al*., 1979).

Another set of observations was made in neem trees from October 2021 to January 2022 in over 350 neem trees planted at 20 feet apart on ring road median from Hinakal (12° 20' 20" N; 76° 36' 28" E; 779 m MSL) to Bogadi (12° 18' 30" N; 76° 36' 12" E; 755 m MSL), Mysuru on blighted new shoots.

Results and Discussion

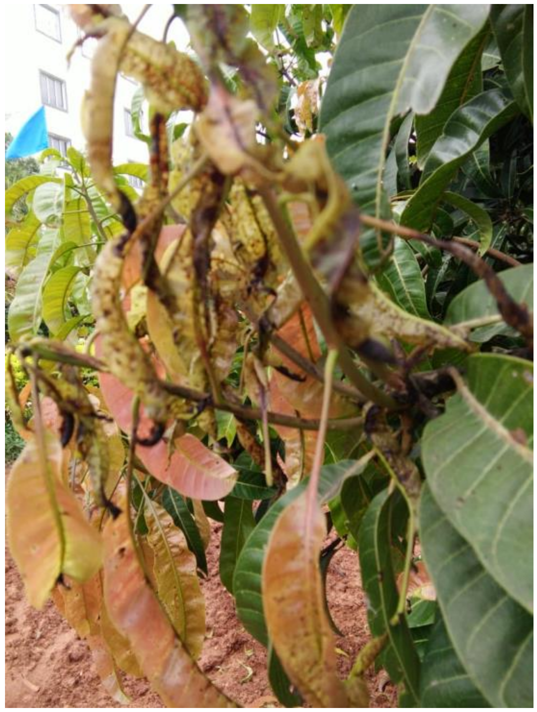
The extent of blighted leaves (Figure a) were almost cent percent on new flush; besides 15 percent twig blight (Figure c) in case of mango at Yalachahalli farm. Observations for the presence of twig blight on cashew revealed it was scanty and negligible (3%) for want of new flush compared to 18 percent inflorescence blight (only with ≅10% trees). Other host plants of tea mosquito bug, revealed negligible to considerable damage to new flush or shoot buds in guava (16%); pomegranate (9%); jamun (8%); custard apple (8%); Hanuman Phal (8%) and drumstick (1%). The twig blight in neem was 17 percent on trees (>10 feet tall) compared to nil in seedlings from fallen seeds scattered here and there on the campus.

Adult bugs captured using a sweep net was introduced into an insect cage (18 cm^3) having tender mango shoots with their cut ends wrapped with wet cotton. Observations revealed the same symptoms as in the field on mango trees. The adult specimens were examined carefully and confirmed as *Helopeltis antonii* Signoret (Hemiptera: Miridae) using established keys (Srikumar *et al*., 2015; Stonedahl, 1991).

It is a well known fact that the tea mosquito bug is polyphagous and the extent of damage on mango foliage is unusual. It may be due to lack of tender shoots and inflorescence on its primary hosts *viz*., cashew and guava. Observations clearly established that the damage was almost cent percent on new flush and negligible damage on other hosts as observed and presented above. Incidentally by the end of November and early December 2021 observations at many pomegranate and drumstick farms in Vijayanagara, Davanagere and Chitradurga districts revealed extensive damage by tea mosquito bug. Drumstick plots in Hagaribommanahalli taluk of Vijayanagara district (Karnataka, India) had damage to the tune of 80 percent leading to heavy loss of plants (Figure d).

Observations on neem trees on ring road median from Hinakal to Bogadi, Mysuru ranged from nil blighted new shoots in 13 trees to all blighted new shoots in 38 trees during mid November 2021. The twig blight went on intensifying since mid-December 2021 leading to drying and defoliation (Figure e). It is too early to state the fate of 49 trees that have been completely defoliated by mid-January 2022. Similar was the damage to almost all the neem trees on the ring road median in other stretches around Mysuru. Heavy infestation or damage in these neem trees on road median may be due to lack of other hosts nearby (urbanisation) or may be because of pollution (dust and smoke) that might have favoured the pest build-up needs to be ascertained. It is also important to ascertain the tea mosquito bug species(s) causing the twig blight on these neem trees and any plant pathogen association (primary/secondary), if any.

The unusual outbreak of tea mosquito bug in Karnataka during last quarter of 2021 may be due to congenial micro and macro climate during entire monsoon in southern Karnataka besides the synchrony of new flush with tea mosquito bug's incidence. Availability of diverse host plants and young shoots and blossoms, absence of targeted management measures (except guava and pomegranate) that too during monsoon period might have favoured this unusual outbreak. The concern being if the new flush and blossoms are affected, the productivity and quality of the produce will be affected. Thus, there is an urgent need to monitor the pest with crop phenology and weather besides evolving stage-specific crop management tools in a sustainable way without affecting the environment.



Blighted mango leaves due to tea mosquito bug

Fig a. CoH, Yalachahalli Horticulture Farm, Yelawala, Mysuru

Figure b. SGI (Agriculture) campus, Belekere, Channapattana

Fig c. Mango twig blight caused by tea mosquito bug

Fig d. Tea mosquito bug damage intensity on drumstic Vijayanagara dt.

Fig e. Tea bug damage intensity in neem trees on ring road median at Bogadi, Mysuru

References

Ambika, B., Abraham, E. E. and Vidyadharan, K. K. 1979. Relative susceptibility of cashew types to infestation by *Helopeltis antonii* Sign. (Hemiptera: Miridae). In: *Proceedings of PLACROSYM II.* C. S. Venkata Ram and B. Chandra Mouli (Eds.): pp. 513-516, Indian Society for Plantation Crops, CPCRI. Kasargod, Kerala.

Dharajothi, B., Prakash, A. H, Venkatesan, R. and Gnana Prasuna, J. 2018. Tea Mosquito Bug Helopeltis theivora Waterhouse (Hemiptera: Miridae): A New Pest on Cotton. *Cotton Research Journal*, **9** (1 & 2): 61-63.

Jayanthi Mala, B. R., Kamala Jayanthi, P. D., Nagaraja, T. and Bhat, P. S. 2020. Monitoring tea mosquito bug, *Helopeltis antonii* Signoret (Hemiptera: Miridae) using sticky traps in drumstick, *Moringa oleifera* Lam. *Pest Management in Horticultural Ecosystem*, **26** (2): 279-281.

Kamala Jayanthi, P. D., Nagaraja, T., Raghava, T. and Vivek, K. 2016. Pomegranate, a newly documented host plant of tea mosquito bug, *Helopeltis antonii* Signoret. *Pest Management in Horticultural Ecosystems*, **22** (1): 88-90.

Mahapatro, G. K. 2008. A refined damage rate scoring method for tea mosquito bus infestation in cashew. *Indian Journal of Entomology*,**70** (3): 273-277.

Saroj, P. L., Bhat, P. S. and Srikumar, K. K. 2016. Tea mosquito bug (*Helopeltis* spp.) – A devastating pest of cashew plantations in India: A review. *Indian Journal of Agricultural Sciences*, **86** (2): 151–62

Srikumar, K. K., Bhat, P. S., Raviprasad, T. N., Vanitha, K., Krishna Kumar, N. K., Rebijith, K. B. and Asokan, R. 2015. Distribution of Major Sucking Pest, *Helopeltis* spp. (Hemiptera: Miridae) of Cashew in India. *Proceedings of the Zoological Society*, **68** (1): 30-35.

Stonedahl, G. M. 1991. The Oriental species of *Helopeltis* (Heteroptera: Miridae): A Review of Economic Literature and Guide to Identification. *Bulletin of Entomological Research*, **81**: 465-490.

Thube, S. H., Mahapatro, G. K., Mohan, C., Pandian, R. T. P., Apshara, E. and Jose, C. T. 2020. Biology, feeding and oviposition preference of *Helopeltis theivora*, with notes on the differential distribution of species of the tea mosquito bug species complex across elevations. *Animal Biology*, **70** (1): 67-79.

MS Received 18 December 2021
MS Accepted 23 January 2022

DOI: 10.55278/KMKV4181

Report of heavy infestation of the thrips, *Thrips parvispinus* on coriander in Bangalore, India

Abraham Verghese [1*], Rashmi. M. A[2] and Deepak. S[3]
[1*]Former Director ICAR-National Bureau of Agricultural Insect Resources Bangalore,560024 and Former Head, ICAR-Indian Institute of Horticultural Research, Hesaraghatta, Bangalore,560089, India
[2]Regional Plant Quarantine Station, Bangalore,560024, India
[3]Directorate of Plant Protection Quarantine & Storage, Faridabad, India
Corresponding author: abraham.avergis@gmail.com

Thrips parvispinus (Karny) (Thripidae: Thysanoptera), an invasive thrips has been recorded on papaya in Hawaii, *Gardenia* sp. in Greece and in vegetable crops like capsicum, green beans, potato, and brinjal from other countries (Murai *et al.,* 2009). Recently, it was reported serious on chillies in South India (Verghese, 2021; Nagaraju *et al*, 2021; Nagaraju, 2021; Rashmi, 2021; Sireesha *et al*, 2021; Kumari, 2021). In January, 2022, heavy infestation of *T. parvispinus* was seen on two-week old to a month old, herbal coriander grown in pots (Fig.1). The dorsal side of the leaf had white specks, while the thrips were on the underside (Fig.2). The infested herbs were pulled out and destroyed, to prevent spread of the thrips. As coriander is a popular herb in terrace gardens, it is advocated to be vigilant and uproot and destroy early infestations to prevent spread. No other recommendations are advocated.

Fig. 1. Damage of *T. parvispinus* on coriander

Fig. 2. *T. parvispinus* on coriander

References

Kumari. A, D., Bhasker. K and V. Suresh. 2021. A new invasive chilli thrips (*Thrips parvispinus*) in Telangana State, *Insect Environment*, **24 (4)**: 520 – 522.

Sireesha, K., Prasanna, B. V. L., Vijaya Lakshmi, T. and Reddy, R. V. S. K. 2021. Outbreak of invasive thrips species *Thrips parvispinus* in chilli growing areas of Andhra Pradesh. *Insect Environment*, **24 (4)**: 514 – 519.

Murai, T., Watanabe, H., Toriumi, W., Adati, T. and Okajima, S. 2009. Damage to vegetable crops by *Thrips parvispinus* Karny (Thysanoptera: Thripidae) and preliminary studies on biology and control. *Journal of Insect Science*, **10:** 166.

Nagaraju, D. K., Vivek Uppar., Ranjith, M., Sriharsha., Ramesh, G., Om Prakash Verma., and Ravi Prakash. 2021. Occurrence of *Thrips parvispinus* (Karny) (Thripidae: Thysanoptera) in major chilli (*Capsicum annum*) growing areas of Karnataka, *Insect Environment*, **24 (4)**: 523-532.

Nagaraju, D. K., 2021 Co-occurrence of thrips and anthracnose: In major chilli growing areas, *Insect Environment Blog* dated 21st December 2021

Rashmi, 2021 Chilli thrips spreading in South India (Karnataka), *Insect Environment Blog* dated 09th December 2021.

Verghese, 2021, High thrips infestation in South India, *Insect Environment Blog* dated 22nd November 2021.

MS Received 01 February 2022
MS Accepted 28 February 2022

DOI: 10.55278/BALR6861

Screening of cashew varieties to identify tolerant or resistance types against apple and nut borer, *Citripestis eutraphera* (Meyrick) (Lepidoptera: Pyralidae) in maidan parts of Karnataka, India

N. Aswathanarayana Reddy[1,2*], Subramanyam B[1], Rajendra, B.N[1] and Ramachandra, R. K[1]
[1]All India Coordinated Research Project on Cashew, HREC, Hogalagere- 563 138, Karnataka, India
[2]Department of Entomology, College of Horticulture, Kolar- 563103, Karnataka, India
Corresponding author: nanreddy5002@gmail.com

Cashew (*Anacardium occidentale* L), belongs to the family Anacardiaceae, is widely grown for its highly nutritious and tasty kernels. Cashew is infested by more than 190 species of insects and mite pests in different cashew growing countries of the world (Sunderaraju, 1984). Of which, tea mosquito bug (*Helopeltis antonii* Sign.) and cashew stem and root borer (*Plocaederus ferrugineus* L.) are being major insect pests in cashew growing regions of India as well as in Karnataka (Anon., 2017). Nowadays, the mango fruit borer, *Citripestis eutraphera* (Meyrick) became a major pest on cashew apples and nuts causing up to 12 percent loss in Karnataka (Aswathanarayana Reddy, 2016) and from Andaman Islands (Bhumannavar, 1991; Jacob *et al.,* 2004). Therefore, for the management of *C. eutraphera*, growers solely depend on application of toxic chemicals. In view of this, the present work was carried to identify any tolerant or resistant cashew varieties for effective management of this pest.

Field experiment was carried out under ICAR – All India Coordinated Research Project on Cashew operating at Horticulture Research and Extension Centre (HREC), Hogalagere (13°20'3" N Latitude and 78°17'34" E Longitude; elevation of 836 m above mean sea level), Kolar district, which falls in the Eastern dry zone (Zone-5) of Karnataka. Fifty-two released cashew varieties of ten years old planted at a spacing of 8m x 8m in different multi-location trial (MLT-II, III & V) blocks were screened from 2014 to 2021 for incidence of *C. eutraphera*. From each variety, two plants were selected randomly and labelled for recording observations. Totally 104 plants from 52 varieties/germplasm were selected for recording observations. The data on number of healthy and damaged cashew apple and nuts by *C. eutraphera* were counted and recorded in one square meter area at bottom, middle and upper canopy of each plant in all the four directions, and finally mean infestation / damage was worked out (Anon., 2017). Results indicated that none of the released cashew varieties screened showed either tolerance /resistance to attack of *C. eutraphera*, indicating no varietal preference for infestation. The extent of damage/infestation ranged from 10 to 17 percent on developing young cashew apples. The peak infestation of *C. eutraphera* as apple and nut borer of cashew was found during February to May, which coincides with apple and nut formation stage of the crop. These results are in agreement with the findings of Kori Nagaraj *et al.* (2020), who reported peak infestation of *C. eutraphera* on cashew during peak summer months in Bangalore condition, and as apple and nut borer on cashew during March - May months in maidan parts of Karnataka (Aswathanarayana Reddy, 2016). Hiremath *et al.* (2017) reported that the *C. eutraphera* infests seedlings and grafts of cashew in Kerala. Similarly, Jayanthi *et al*. (2014) also reported the occurrence of fruit borer, *C. eutraphera* from mainland causing extensive damage to immature fruits of mango (*Mangifera indica* L.) in Karnataka and Tamil Nadu. Soumya *et al*. (2016) reported that *C.eutraphera* was fairly well established in Kolar, Bengaluru Rural and Hassan districts of Karnataka. They were found infesting lime-sized mango fruits up to pre-harvest, when serious fruit rotting on tree sets in. Bana *et al*. (2018) observed incidence of an indigenous restricted fruit borer, *C. eutraphera* on mango in south Gujarat causing 5-45% damage / infestation. The correlation between *C. eutraphera* population and weather parameters revealed that sunshine hours influence its incidence in a positive manner (r= 0.673) whereas, rainfall showed a negative effect. The weather factors were observed to explain the variation in infestation to an extent of 48% and this forewarning model might provide decision support for its IPM.

Acknowledgement: The authors are indebted to ICAR - Directorate of Cashew Research, Puttur, Karnataka for financial assistance to carry out this research work and also to Dr. C. A. Viraktamath, Emeritus Professor of Entomology and Dr. H.M. Yeshwanth, Assistant Professor of Entomology, Insect Taxonomy Laboratory, Department of Entomology, UAS, GKVK, Bengaluru for insect identification.

References

Anonymous, 2017, Annual Report - 2016-17, All India Coordinated Research Project on Cashew, ICAR - Directorate of Cashew Research, Puttur Pp 232.

Aswathanarayana Reddy, N., B. Subramanyam, Vasudeva, K. R. and Rajendra, B. N., 2016, Population dynamics and management of cashew apple and nut borer, *Thylecoptila panerosema* (Lepidoptera: Pyralidae) in maidan parts of Karnataka. In: *Proceedings of National Seminar on Strategies for Development of Cashew*, held on 19-20 February at Regional Fruit Research Station, Vengurle, Maharashtra. Pp 63.

Bana, J. K., Hemant Sharma and D. K. Sharma, 2018, Mango fruit borer, *Citripestis eutraphera* (Meyrick) in south Gujarat:

need for domestic quarantine. *Indian Journal of Entomology*, **80**(3): 654-657.

Bhumannavar, B. S., 1991, Record of *Citripestis eutraphera* Meyrick (Lepidoptera: Pyralidae) on *Mangifera andamanica* in India. *J. Bombay Nat. Hist. Soc*., **88** (2): 299.

Hiremath, S. R., Kumara, S. A. and Prathapan, K. D., 2017, First report of the mango fruit borer, *Citripestis eutraphera* Meyrick (Lepidoptera: Pyralidae) as a seedling borer of cashew, *Anacardium occidentale* L. (Anacardiaceae). *J. Lepid. Soc*., **71**(2): 115-116.

Jacob, T. K., Veenakumari, K. and Bhumannavar, B. S., 2004, Insect pests of cashew in the Andaman Islands. *Cashew*, **18** (4): 25–28.

Jayanthi, P.D.K., Abraham Verghese, P.R. Shashank and Vivek Kemparaj, 2014, Spread of indigenous restricted fruit borer, *Citripestis eutraphera* (Meyrick) (Lepidoptera: Pyralidae) in mango: Time for domestic quarantine regulatory reforms. *Pest Management in Horticultural Ecosystems*, **20** (2): 227-230.

Kori Nagaraj, Ramegowda, G.K., Aswathanarayana Reddy, N., Narabenchi, G.B. and Vishuvardhana, 2020, Studies on apple and nut borer, *Citripestis eutraphera* Meyrick (Lepidoptera: Pyralidae) in cashew. In: *Proceedings of "XVII AZRA International Conference on Frontier Research in Applied Zoology and Insect Pest management Strategies: A way forward for Food and Nutritional Security"* from 12-14th, February, 2020 at UAS, Raichur, Karnataka, Pp 82-83.

Soumya, B. R., Abraham Verghese, P. D. Kamala Jayanthi and S. K. Jalali, 2016, Need to strengthen quarantine between Andaman and Nicobar Islands and mainland India. *Current Science*, **111** (11): 1753 - 1756.

Sundararaju, D., 1984, Studies on cashew pests and their natural enemies in Goa. *J. Plant. Crops*, **12**: 38-46.

MS Received 01February 2022
MS Accepted 05 March 2022

Announcement

Organic pest management strategies for successful silkworm rearing

Sericulture is practiced mainly in Karnataka, Tamil Nadu, Andhra Pradesh, West Bengal, Jammu & Kashmir and parts of the northeastern states of India, with Karnataka contributing to a massive share of 40% of the silk produced today in the country.

The cultivation of mulberry plays a significant role in determining the cost of cocoons and silk. It is estimated that 60-70% of production cost goes to mulberry cultivation— a chief food for *Bombyx mori*. One hectare of fertile land can produce about 15-40 tones of mulberry leaves over 12 months. Hence, the farmers' endeavour has always been to increase the yield of mulberry leaves in order to minimise the overall cost of production.

Of the several pests that infest the mulberry crop, two species, *Tetranychus sp* and *Polyphagotarsonemus latus* are present throughout the year. A small white mark appears on the tender leaves of the mulberry when these insects are overgrown. The mulberry leaves decolour from green to brown, and broad markings appear. Such infested leaves become unsuitable for silkworm feeding.

The silkworm *Bombyx mori* is highly susceptible to insecticides, and the application of insecticides is not advisable because the silkworms can be harmed by chemicals on the leaves, either through consumption of contaminated leaves or through other contacts with the insecticides. Hence, mulberry plantations intended for silkworms should be free of pesticides. It has been reported that production can be reduced by more than 30 per cent annually due to insecticide poisoning.

Our field experience in controlling the mite with our eco-friendly product

The purpose of this study was to design a strategy to control mite infestation in mulberry plantation using our organic product (CODED SAMPLE FOR TRIAL) APEDA Input certified. The experimentation demonstrated that farmers who applied the product were satisfied with the product's performance. Acceptance level grew with wide popularity among the farming community. The product was sprayed at 3ml per litre and was able to control more than 90% of the pest population with two applications and a longevity of more than 25 days. Moreover, the crop showed a positive physiological difference in terms of increased leaf lamina, increased stem girth and leaf thickness which contributed to increased yield. Besides, the product proved to be safe for silkworms since the product had no chemical residues that could potentially pose a risk to the growth and multiplication of silkworms.

Conclusively, the knowledge on product safety will help us assist more farmer groups to initiate preventive and curative management measures. The additional inbound feature of the product that promotes increased growth and yield of mulberry besides controlling the pest warrants wider acceptability to protect and safeguard the sericulture industry.

DOI: 10.55278/MFPN8273

Diversity of insect pollinators in Mount Carmel College campus, Bengaluru

Geeta Mohan[1] and Ruchita Naidu.D[2]
[1]Department of Zoology, Mount Carmel College, Autonomous, 58, Palace road, Bengaluru – 560052, India
[2]Department of Zoology, Christ University, Hosur road, Bengaluru – 560029, India
Corresponding author: naiduruchita2000@gmail.com

Abstract

An insect pollinator diversity study was conducted on the campus of Mount Carmel College, Bengaluru, south India. There was a total of 27 species recorded with the Subclass Endopterygota dominating with 25 species and Subclass Paraneoptera consisting of only two species. Order Hymenoptera was found to be the most abundant and Order Lepidoptera being the second most abundant. Among the Families, Apidae was the most abundant and Vespidae, Nymphalidae and Pieridae being the second most abundant followed by Formicidae and Papilionidae.

Keywords: Insects, pollinators, diversity, Bengaluru

Introduction

Insects belong to the Phylum Arthropoda contributing to over 30 million species worldwide. They make up to almost more than half of the rest of the organisms existing (Prabakaran *et al* 2014). Flowering plants have found to have mutualistic and antagonistic interactions with pollinating insects. They contribute to reproduction in floral plants by helping with cross pollination and enabling fruit set (Palatty Allesh Sinu and Shivanna, 2016). In return insects get rewards in the form of nectar and pollen to feed their larval young ones. The objective of this study was to analyze the richness of insect pollinator species on the campus of Mount Carmel College, Autonomous. The campus is located at a latitude of 12.9892 and a longitude of 77.5862 which is 3000 feet above sea level. It is spread over an area of 9.25 acres which has a Botanical garden and also small garden areas which includes trees, shrubs and a wide range of potted floral plants in and around campus which attract a large number of insect pollinators. In this study it was found that the campus has a very rich insect fauna belonging to Subclass Endopterygota which act as pollinators.

Materials and methods

The survey was conducted over a period of 8 months spanning from July 2019 to

March 2020. The photographs of the insects were taken from various sites of the campus. The areas surveyed on campus include the garden patch in front and within the LSCB block, the patch of floral plants opposite the GJB block and also the Bougainvillea bush floral patch near the administrative block. The garden patch in front of the chapel was found to be the most species abundant area on campus. The survey was conducted in day light as pollinators are most active at that time. It was carried out thrice a week between 9am to 3pm. The camera of the Phone Samsung SM-J500F with a resolution of 2322*4128 was used to document the insects. The butterfly species documented were identified using the field guide 'Bengaluru Butterflies' by O.K. Remadevi *et al*, 2018.

Fig 1. An aerial view of the campus

Results

The data that was analyzed suggested that Mount Carmel College campus has a very rich insect fauna diversity. The numbers indicated that there were a total of 27 species of insect pollinators in and around the campus. Subclass Endopterygota was dominating with a total of 25 species alone out of 27 rounding off to 92.5% of participation. Whereas subclass Paraneoptera was the second most dominant with only 2 species and 7.4% of participation. Among the 5 Orders, Hymenoptera consisted of 12 species (44.4%), Lepidoptera with 10 species (37%), Hemiptera and Diptera with 2 species each (7.4%) and Coleoptera with only 1 species (3.7%). There were a total of 15 Families documented out of which Apidae dominated with 4 species (14.8%), Vespidae, Nymphalidae and Pieridae being the second most dominant consisted of 3 species each (11.1%) followed by Formicidae and Papilionidae having 2 species each (7.4%).The rest of the families consisted of 1 species each (3.7%).

Table 1. Checklist of species.

Sl	Subclass	Order	Family	Scientific Name	Common Name
1	Endopterygota	Diptera	Muscidae	*Musca domestica*	House Fly
2	Endopterygota	Hymenoptera	Formicidae	*Myrmicaria brunnea*	Ants
3	Endopterygota	Lepidoptera	Nymphalidae	*Ariadne merione*	Dakhan Common Castor
4	Endopterygota	Diptera	Dolichopodidae	*Condylostylus*	Long Legged Flies
5	Paraneoptera	Hemiptera	Rhopalidae	*Boisea trivittata*	Boxelder Bug
6	Endopterygota	Hymenoptera	Vespidae	*Vespa crabro*	European Hornet
7	Paraneoptera	Hemiptera	Pentatomidae	*Halyomorpha halys*	Marmorated Stink Bug
8	Endopterygota	Lepidoptera	Papilionidae	*Graphium Agamemnon*	Tailed Jay
9	Endoperygota	Hymenoptera	Apidae	*Xylocopa violacea*	Carpenter Bee
10	Endopterygota	Coleoptera	Coccinellidae	*Menochilus sexmaculatus*	Lady Bugs
11	Endopterygota	Hymenoptera	Formicidae	*Camponotus floridanus*	Florida Carpenter Ant
12	Endopterygota	Lepidoptera	Pieridae	*Catopsilia pyranthe*	Oriental Mottled Emigrant (Male)
13	Endopertygota	Lepidoptera	Nymphalidae	*Hypolimnas bolina*	Oriental Great Eggfly (Male)
14	Endopterygota	Hymenoptera	Vespidae	*Vespa affinis*	Lesser Banded Hornet
15	Endopterygota	Lepidoptera	Papilionidae	*Papilio polytes*	Common Mormon
16	Endopterygota	Hymenoptera	Apidae	*Apis florea*	Dwarf Honey Bee
17	Endopterygota	Lepidoptera	Nymphalidae	*Elymnias caudate*	Tailed Palmfly
18	Endopterygota	Lepidoptera	Hesperiidae	*Baoris farri*	Complete Paint Brush Swift
19	Endopterygota	Hymenoptera	Vespidae	*Polistes versicolor*	Common Paper Wasp
20	Endopterygota	Lepidopetera	Pieridae	*Catopsilia pomona*	Common Emigrant (Female)
21	Endopterygota	Lepidoptera	Pieridae	*Catopsilia pomona*	Common Emigrant
22	Endopterygota	Lepidoptera	Hesperiidae	*Pelopidas mathias*	Small Branded Swift
23	Endopterygota	Hymenoptera	Halictidae	*Lipotriches*	Sweat Bees
24	Endopterygota	Hymenoptera	Apidae	*Amegilla cingulate*	Blue Banded Bees
25	Endopterygota	Hymenoptera	Colletidae	*Hylaeus*	Yellow Faced Bees
26	Endopterygota	Hymenoptera	Apidae	*Meliponini*	Stingless Bees
27	Endopterygota	Hymenoptera	Ichneumonidae	*Rhyssa persuasoria*	Sabre Wasp

Table 2. Species distribution with respect to the orders

Sl. No.	Order	Number of species	% of fauna
1	Hymenoptera	12	44.4%
2	Lepidoptera	10	37%
3	Diptera	2	7.4%
4	Hemiptera	2	7.4%
5	Coleoptera	1	3.7%

Table 3. Species distribution with respect to the families

Sl No.	Family	Number of species	% of fauna
1	Apidae	4	14.8%
2	Vespidae	3	11.1%
3	Nymphalidae	3	11.1%
4	Pieridae	3	11.1%
5	Formicidae	2	7.4%
6	Papilionidae	2	7.4%
7	Hesperiidae	2	7.4%
8	Muscidae	1	3.7%
9	Dolichopodidae	1	3.7%
10	Rhopalidae	1	3.7%
11	Pentatomidae	1	3.7%
12	Coccinellidae	1	3.7%
13	Halictidae	1	3.7%
14	Collectidae	1	3.7%
15	Ichneumonidae	1	3.7%

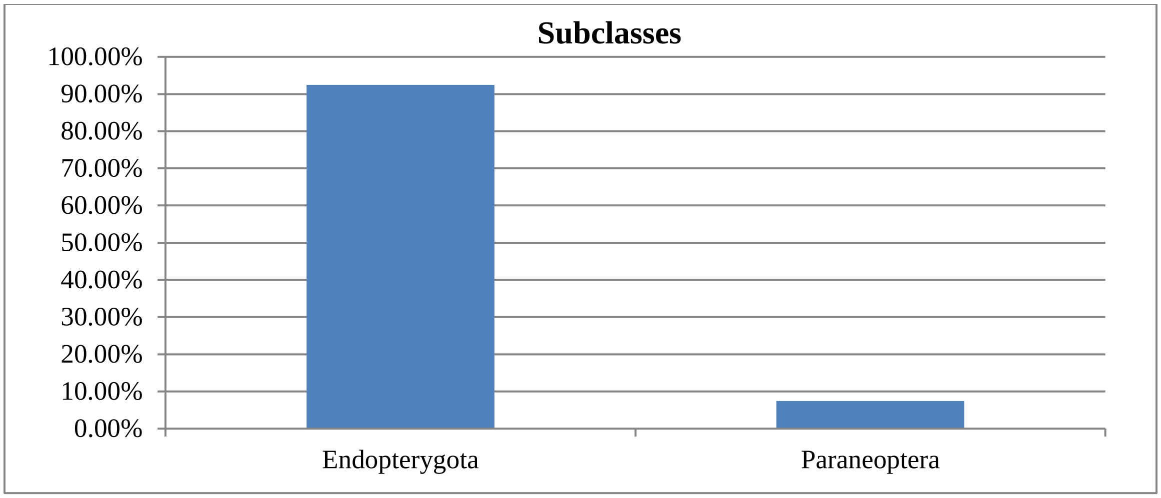


Fig 2. Graphical representation of Subclass comparison

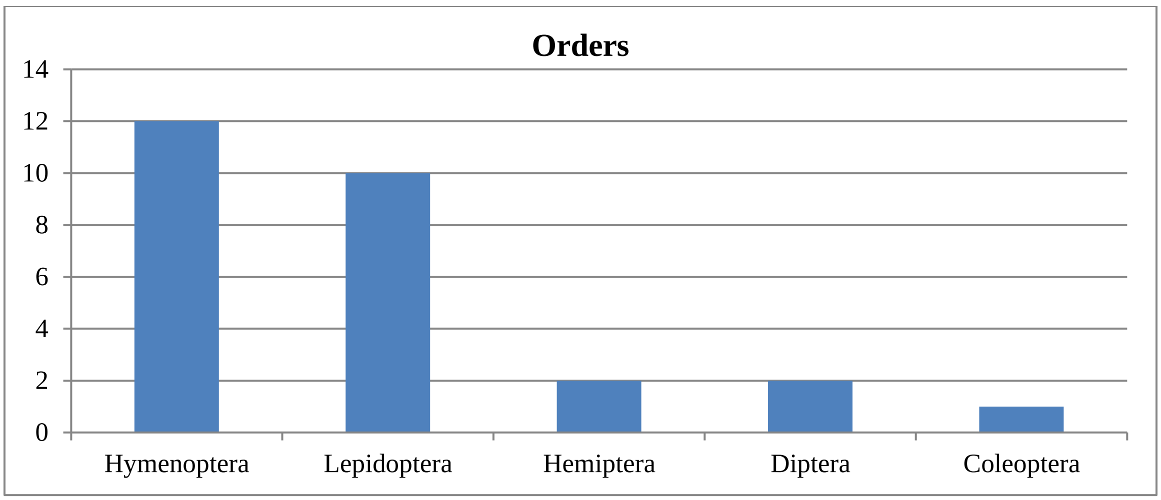


Fig 3. Graphical representation of Order comparison

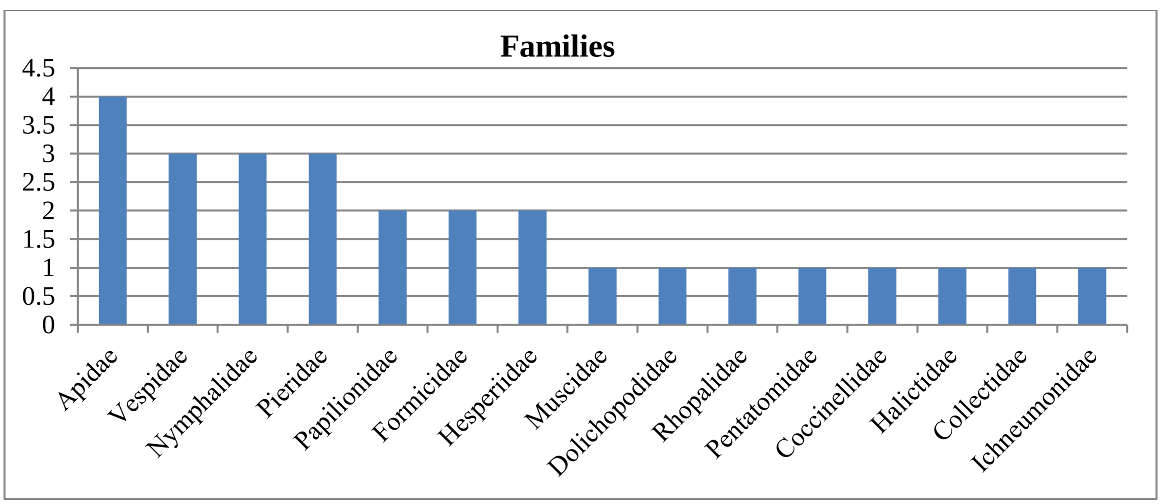
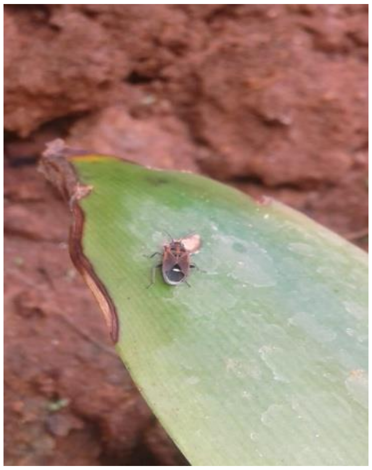
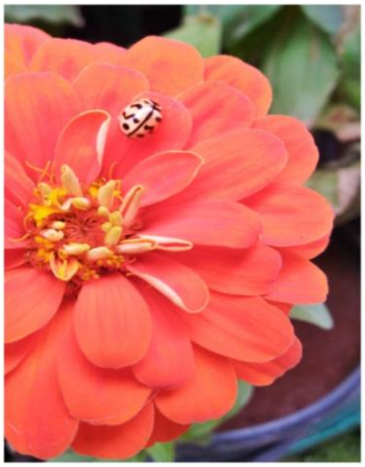
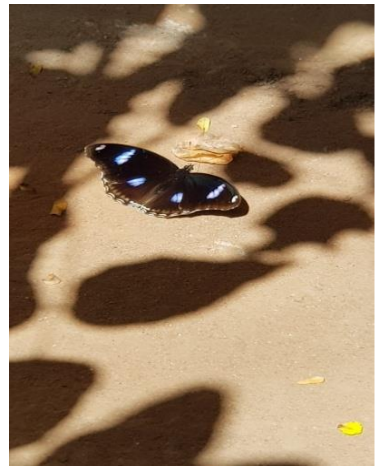
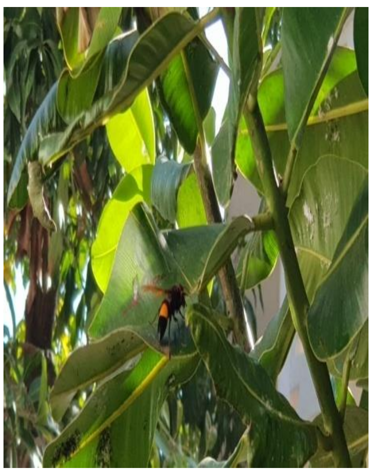
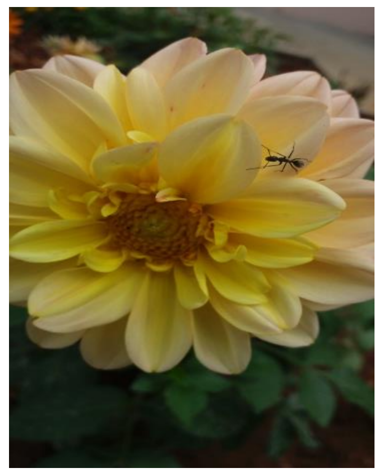
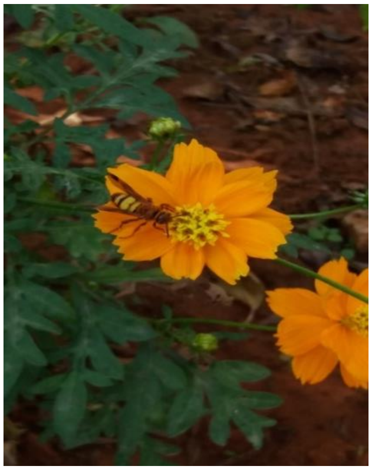


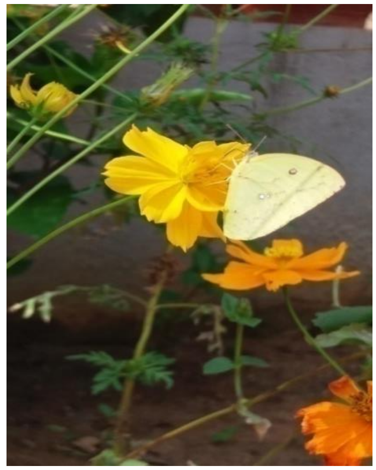
Fig 4. Graphical representation of Family comparison

Table 4. Pictures of species

 House fly	 Ants	 Dakhan common castor
 Long legged fly	 Boxelder bug	 European hornet
 Marmorated stink bug	 Tailed jay	 Carpenter bee

 Ladybird beetle	 Oriental mottled emigrant (male)	 Oriental great eggfly (male)
 Banded hornet	 Common mormon	 Carpenter ant
 Dwarf honey bee	 Tailed palmfly	 Complete paint brush swift


Common paper wasp


Common emigrant (female)


Common emigrant


Small branded swift


Sweat bees


Blue banded bee


Yellow faced bee


Stingless bee


Sabre wasp

Discussion

Insect pollinators are considered to be a very important group of organisms in the environment. They promote the process of pollination in floral plants to increase fruit set. There are many plants which cannot take up cross pollination due to various environmental conditions. Insect pollinators help these plants to cross breed.The population of insect pollinators largely depend upon climatic variation and temperature. It is seen that they are most active during the hottest period of the day and less active when the temperatures are low. Though artificial pollination is possible nowadays and science has progressed to such an extent that we can breed plants by scientific methods but we still need to make changes in our environment to protect the pollinators.

Urbanization and increase in human activities which has led to pollution and aforestation have caused a decline in many species. We can promote increased urban garden space at schools, colleges and office premises to attract these pollinators. Pollinators may approach only specific plant species, so depending on the type of pollinators you want your garden to be approched you can decide the types of floral plants you would want to have in your garden. This can be a small contribution to the environment.(O.K Remadevi *et al*, 2018). Plant and animal interaction studies have to be included in the academic syllabuses of college students to increase awareness among students and young researchers to take up such small studies and projects to conserve nature.

Conclusions

This study provided knowledge about the diversity of insect pollinators on the college campus. There were a total of 27 species documented and more number of species may be added to it in the future studies. Thus this study makes the campus eligible for diversity studies and projects. There was a domination by Subclass Endopterygota in this study and further studies can be performed in order to make comparative analysis. Urban gardens space should be increased to protect and conserve these species which are important pollinators. Urban gardens serve to be an important food source for various pollinators. It is becoming difficult for pollinators to survive as floral plants and fields are being replaced by areas with single type of crops for agricultural purposes. By the development of urban gardens in our cities the pollinators will ensure they fly from one garden to the other by collecting maximum amount of nector for food.. Each one of us can contribute to these urban gardens by having a hedge, a bed of floral plants or even a window box with few flowers to attract these nector-lovers at our offices and apartment complexes. Depending on our preference and the season we would want to have a garden, we can decide the type of plants that would be most compatable and ensure that these species do not go extinct as we really need them for natural cross pollination (Nicholas Tew *et al*, 2022).

Acknowledgements

The authors are thankful to Dr. Abraham Verghese for identifying some of the insect pollinator species and for the support provided. We are also thankful to Ms.Noorunnisa.G, Ms.Diana Jose and the Applied Entomology team for contributing pictures of insect species clicked by them on campus.

References

Prabakaran S., Chezian Y., Evangelin G. and John William S. 2014. Diversity of butterflies (Lepidoptera:Rhophalocera) in Tiruvallur district, Tamil Nadu, India. *Editor Biolife Journal*, **2(3):**769-778.

O. K. Remadevi., Sooraj S., Chaturved Shet R., K. H Vinaya Kumar and Ritu Kakkar. 2018. 'Bengaluru Butterflies: A field guide' . Centre for climate change, Environmental Management and Policy Research Institute, Bengaluru.

Pallatty Allesh Sinu and K. R Shivanna. 2016. 'Mutualistic Interactions between Flowering Plants and Animals'. Manipal University Press.

Nicholas Tew., Jane Memmott and Katherine Baldock. 2022. 'Urban gardens are crutial food sources for pollinators – here's what to plant for every season'. The Conversation, 2022

MS Received 01 January 2022
MS Accepted 10 February, 2022

DOI: 10.55278/NBXM2601

Evaluation of botanical extracts and essential oils against lesser wax moth, *Achroia grisella* F. (Lepidoptera: Pyralidae) under stored condition

P. Sabatina, G. Umapathy, P.A. Saravanan
Department of Agricultural Entomology, Tamil Nadu Agricultural University, Coimbatore
Corresponding author*: *sabitinajustin@gmail.com

Abstract

Honey bees are resourceful insects offering honey, wax, resin, royal jelly, etc. Wax moths are posing serious threat to beekeeping as their intrusion and invasion decimate entire colony under both field and storage conditions. Considering the environmental safety, sensitive nature of the hive environment and cost effectiveness, the role of non chemical management practices has got enormous scope in the pest management system against the foes of bees. The laboratory bio-assay of selected plant extracts (at 5% dose) on the lesser wax moth larvae exhibited the effectiveness of *Ocimum basilicum* affording 89.05 % larval mortality. Among the essential oils (at 5% dose), *Mentha piperita* treatment performed well against wax moth, with 79.04% overall kill of larvae.

Keywords: Lesser wax moth, *Achroia grisella*, botanical extracts, essential oils, .

Introduction

Honey bees (*Apis* spp.) are the proven pollinators, responsible for pollination of about 70% of major crops grown across the globe **(**Steffan-Dewenter *et al*., 2006). Among several biotic factors challenging bee keeping are two species of wax moths *viz.*, greater wax moth, *Galleria mellonella* L. and lesser wax moth, *Achroia grisella* F. These are considered to be serious under field and storage conditions. Use of chemical pesticides in a bee hive is impracticable due to the high sensitiveness of bees besides toxicity hazards (Pinto *et al*., 2010). The botanicals are one of the perfect options over chemical pesticides due to their less toxicity to non-target organisms and the capacity to degrade quickly (Isman, 2006). Several plant extracts and essential oils derived from neem, eucalyptus, tobacco *etc*., have proven effective against wax moths (Taillebois *et al*., 2018).

Materials and Methods

The bio-efficacy experiments involving steam distillates and solvent extracts were carried out at the apiary, TNAU during April 2021. As the role of botanicals and their products has ample scope in the management of wax moths in a beehive (Farghaly *et al*., 2017), four plant extracts (*Acorus calamus*, *Curcuma longa*, *Coleus forskohlii* and *Ocimum basilicum*) and three essential oils (derived from *Mentha piperita*, *Eucalyptus globulus* and *Cymbopogan citratus*) were evaluated against wax moths under storage conditions (Table 1). The plant extracts were obtained by using microwave assisted extraction unit and essential oils were extracted by steam distillation unit.

Test insects (Fig. 1) were mass reared in netted insect rearing cages (55 x 45 x 50cm size) wherein the wax moth eggs were released onto honey-harvested, aged combs for faster multiplication of target pests. About one year old, relatively darker, honey-harvested combs with uniform size and weight (10g) were placed inside the insect cages and lesser wax moth larvae at 20 numbers per comb were released. The botanical extracts and essential oils at 5% dose were sprayed by an atomiser and observations on the larval mortality at 48 hours after spraying was recorded. The potency of selected treatments in terms of damage to combs was assessed by calculating the difference between the initial and final weight honey comb (10 g) which was allowed for feeding by different instars of wax moth larvae.

Table 1. List of medicinal and aromatic plants used against wax moths

SI. No.	Common name	Botanical name	Family	Plant parts used
1.	Sweet flag	*Acorus calamus* L.	Acoraceae	Rhizome
2.	Turmeric	*Curcuma longa* L.	Zingiberaceae	Rhizome
3.	Sweet basil	*Ocimum basilicum* L.	Lamiaceae	Leaves
4.	Medicinal coleus	*Coleus forskohlii* B.	Lamiaceae	Leaves and tubers
5.	Eucalyptus	*Eucalyptus globulus* L.	Myrtaceae	Leaves
6.	Peppermint	*Mentha piperita* L.	Lamiaceae	Leaves
7.	Lemongrass	*Cymbopogan citratus* S.	Poaceae	Whole plant

Results and discussion

Evaluation of botanical extracts against the larvae of lesser wax moth, *A. grisella*

The efficacy of selected plant extracts against *A. grisella* showed the effectiveness of *O. basilicum* with 84.05% larval mortality (82.56 % reduction over control) followed by, *A. calamus* with 74.99% kill, *C. forskohlii* (73.56%) and *C. longa* (66.66%). Among the essential oils tested (steam distillates @ 5%), *M. piperita* was found to be highly effective against lesser wax moth larvae, affording 79.04% kill of larvae (77.08% reduction over control), followed by *E. globulus* and *C. citratus* with 74.99% and 70.71% larval mortality respectively. The botanicals applied as solvent extracts (*O. basilicum*) and steam distillates (essential oil of *M. piperita)* were found promising against both wax moths which were in accordance with the findings of Beyene and Woldatsadik (2019) who concluded that the leaf extracts of *Azadirachta indica* and *O. basilicum* were proved to be more effective against wax moths within 48 hours and this might be attributed to their insecticidal, growth regulatory and anti-feedant properties **(Table 2)**.

In the present study, an attempt was made to record the actual influence of different botanical treatments against the loss inflicted by instar-wise larvae of lesser wax moths. The overall mean comb weight reduction (Fig. 2) due to all botanical treatments in general, recorded less damage than the combs left uncared (control). Contamination and persistence could be the possible foremost challenges while using chemicals. Hence, botanicals could be the best option over chemical pesticides.

1a. Egg mass (Magnified)	1b. Larva (Magnified)	1c. Pupa inside cocoon	1d. Adult moth

Fig 1. Life stages of lesser wax moth, *A. grisella*

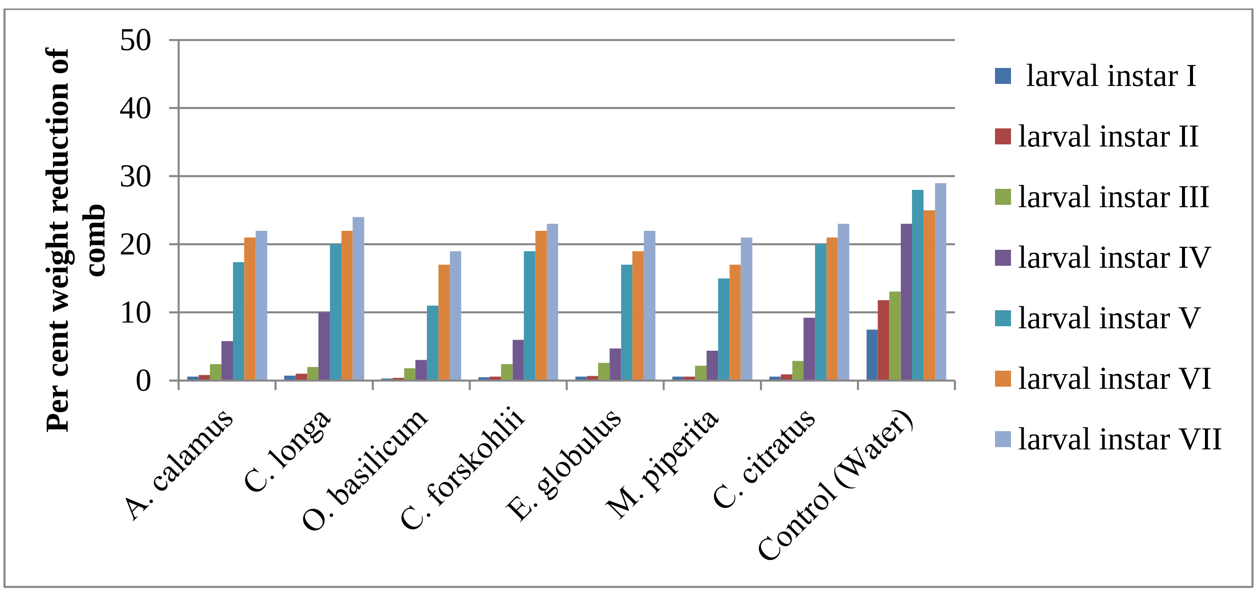


Fig. 2. Weight reduction of comb (%) by lesser wax moth, *A. grisella*

Table 2. Efficacy of botanical extracts and essential oils against different larval instars of lesser wax moth, *A. grisella* under stored conditions.

Treatment	% mortality of larval instars (I to VII) of *A. grisella* *± S.D							Overall Mean	Reduction over control (%)
	I	II	III	IV	V	VI	VII		
Solvent extract at 5%									
1. *Acorus calamus*	100.0±0.00 (89.71)[a]	93.30±5.77 (77.62)[ab]	85.00±5.00 (67.40)[b]	78.33±2.89 (62.29)[bc]	70.00±5.00 (56.84)[bc]	53.33±5.77 (46.92)[bc]	45.00±5.00 (42.12)[cd]	74.99	72.65
2. *Curcuma longa*	91.66±2.87 (73.40)[c]	88.33±2.89 (70.12)[b]	75.00±5.00 (60.08)[c]	65.00±5.00 (53.76)[d]	65.00±5.00 (53.76)[c]	43.33±2.89 (41.16)[c]	38.33±2.89 (38.25)[d]	66.66	63.54
3. *Ocimum basilicum*	100.00±0.00 (89.71) [a]	98.33±2.89 (85.50) [a]	91.66±2.89 (73.40) [a]	88.33±2.89 (70.12) [a]	80.00±5.00 63.55) [a]	70.00±5.00 (56.84) [a]	60.00±5.00 (50.79)[a]	84.05	82.56
4. *Coleus forskohlii*	100.0±0.00 (89.71)[a]	91.66±2.89 (73.40)[b]	81.66±2.89 (64.69)[bc]	80.00±5.00 (63.55)[bc]	68.33±2.89 (55.77)[bc]	50.00±5.77 (46.95)[bc]	43.33±2.89 (41.16)[cd]	73.56	71.09
Steam distillate at 5%									
5. *Eucalyptus globulus*	96.66±2.89 (81.29)[b]	93.30±2.89 (75.24)[ab]	83.33±5.77 (66.15)[b]	80.00±5.77 (63.93)[abc]	68.33±2.89 (55.77)[bc]	55.00±5.00 (47.88)[b]	48.33±2.89 (44.04)[bc]	74.99	72.65
6. *Mentha piperita*	100.0±0.00 (89.71)[a]	95.00±5.77 (79.45)[ab]	86.66±2.89 (68.66)[ab]	81.66±2.89 (64.70)[ab]	71.66±2.89 (58.93)[b]	65.00±7.64 (55.85)[a]	53.33±2.89 (46.91)[ab]	79.04	77.08
7. *Cymbopogan citratus*	93.33±2.89 (75.24)[c]	91.66±2.89 (73.40)[b]	80.00±5.00 (63.55)[bc]	71.66±2.89 (57.86)[cd]	66.66±2.89 (54.75)[bc]	51.66±7.64 (45.97)[bc]	40.00±5.00 (39.21)[d]	70.71	67.97
8. Control (Water)	11.66±2.89 (19.88)[d]	8.30±2.89 (16.56)[c]	8.33±2.89 (16.60)[d]	8.33±2.89 (16.60)[e]	8.33±2.89 (16.60)[d]	8.33±2.89 (16.60)[d]	6.60±2.89 (14.76)[e]	8.55	-
SEm±	9.97	9.05	11.75	13.18	6.86	14.99	5.85	-	-
C.D (p= 0.05)	5.47	4.56	5.93	6.28	4.53	6.70	4.19	-	-

Note: * Mean of three replications for each instar. Figures in parentheses are arc sine transformed values; S.D: Standard Deviation; SEm: Standard Error of mean; C.D: Critical Difference. Figures are not having the same alphabetical letters in a same column differ significantly at $p < 0.05$.

Acknowledgement

I express my sincere gratitude to, Dr. G. Umapathy, Entomologist (CPPS, TNAU) and my research guide Dr. P.A. Saravanan, Entomologist (TCRS, TNAU) and Dr. D. Uma, Professor and Head (Dept. of Biochemistry, TNAU) for their immense guidance and valuable support throughout my research.

References

Beyene, T. and Woldatsadik, M. 2019. Laboratory evaluation of the effectiveness of some botanical extracts against the larvae of greater wax moth, *Galleria mellonella* (L.). *Journal of Entomology and Zoology Studies*, **7 (6)**: 842-846

Farghaly, D., Sharkawy, A., Rizk S. and Badr, N. 2017. Physiological studies on the effect of gamma radiation and some plant oils on greater wax moth, *Galleria mellonella* (Linnaeus) (Lepidoptera: Pyralidae). *Journal of Nuclear Technology in Applied Science*, **5**:143-152.

Isman, M.B. 2006. Botanical insecticides, deterrents, and repellents in modern agriculture and an increasingly regulated world. *Annual Review of Entomology*, **51**:45-66.

Pinto, D.M., Blande, J.D., Souza, S.R., Nerg, A.M. and Holopainen, J.K. 2010. Plant volatile organic compounds (VOCs) in ozone (O_3) polluted atmospheres: the ecological effects. *Journal of Chemical Ecology*, **36** (1):22-34.

Steffan-Dewenter, I., Klein, A.M., Gaebele, V., Alfert, T., and Tscharntke, T. 2006. Bee diversity and plant-pollinator interactions in fragmented landscapes. *Specialization and generalization in plant-pollinator interactions*, pp. 387-410.

Taillebois, E., Cartereau, A., Jones, A.K., and Thany, S.H. 2018. Neonicotinoid insecticides mode of action on insect nicotinic acetylcholine receptors using binding studies. *Pesticide biochemistry and physiology*, **151**:59-66.

MS Received 01 January 2022
MS Accepted 31 January, 2022

DOI: 10.55278/SEWP1607

First report of false chinch bug, *Nysius inconspicuus* on pearl millet in Gujarat, India

Swati Gamit[1*], C. B. Varma[2], D. B Sisodiya[1]
[1]Department of Agri. Entomology, BACA, AAU, Anand, Gujarat, 388110
[2]Department of Agri. Entomology, COA, AAU, Vaso, Gujarat, 388110
Corresponding author: swati.gamit2611@gmail.com

Pearl millet [*Pennisetum glaucum* (L.)] is popularly known as "Bajra" and belongs to the family of Poaceae. *Bajra* is a coarse grain crop and considered to be the poor man's staple nourishment.

A study was conducted to identify the new occasional pests infesting pearl millet in Gujarat, India. During the field visit in May 2020, pearl millet crop in experimental plots of entomology farm, B. A. College of Agriculture, Anand Agricultural University, Anand, was found infested with new occasional pests (Fig. 2). Adults were collected and brought to the laboratory of Entomology for identification and further study. In India, Distant (1903) described false chinch bug (FCB), *Nysius inconspicuus* (Hemiptera: Lygaeidae) from Bor Ghat and later reported the same from Mysore. A severe infestation of sesame by *N. inconspicuus* Distant was reported from Tindivanam in the Indian State of Tamil Nadu (Thangavelu *et al*., 1989). In Gujarat, *Nysius ericae* (Schilling) (Lygaeidae), a hemipteran pest was found feeding on muskmelon for the first time (Zala *et al*., 2013).

The findings of morphological studies and by dissection endorse the species as *Nysius inconspicuus* (Hemiptera: Lygaeidae) and this is the first confirmed report of occasional pest in pearl millet fields of Gujarat State, India. It is a highly polyphagous and occasional pest. It has smaller size, greyish brown coloration and transparent wings (Fig. 1a, b). The species of the genus *Nysius* are uni- or bivoltine, but some have been found to complete three generations in a year. Although, the pest is recorded on pearl millet crop, it may feed on other crops *viz.*, sorghum, wheat, cotton, vegetables etc. so it may be an emerging threat to other agricultural crops also.

Ackowledgement: We are thankful to Dr. Yeshwanth, Indian taxonomist, Department of Agricultural Entomology, University of Agricultural Science, GKVK, Bangalore – 560 065, India for identifying the false chinch bug (*Nysius inconspicuus*).

Fig. 1. (A, B) Adult of *Nysius inconspicuus*

Fig. 2: (A) *Nysius inconspicuous* Distant (Lygaeidae) infesting pearl millet ear head (B) Mating adults on ear head of pearl millet appeared

References:

Distant, 1904. *Nysius inconspicuous. Fauna British India, Rhynchota,* **2:** 18-19.

Thangavelu, S., Kandasamy G., Sivanadam M. and Baskaran R.K.M. 1989. Problems and progress of sesame production in India. In: *Oil Crops: Sesame and Sunflower subnetwork, Proceed. of the Joint Second Workshop,* A. Omran, Ed., IDRC, Cairo, Egypt, Sep. 1989, IDRC-MR271e: pp. 27-30.

Zala, M. B., Patel, H. C., Bharpoda, T. M., and Borad, P. K. 2013. First report of *Nysius ericae* (Schilling) on Muskmelon, *Cucumis melo* L. in Gujarat. *Insect Environment,* **19 (1):** 26.

MS Received 30 December 2021
MS Accepted 19 January, 2022

DOI: 10.55278/MVFB1677

New location reports of *Anomala dimidiata ssp. dimidiata* (Hope, 1831) (Coleoptera: Scarabaeidae) in Arunachal Pradesh, India

Mahendra Devanda[1], Shreyas Mandyam[2] and M.Jayashankar[2]
[1,3]Arunachal Pradesh Regional Centre, ZSI, Senki Valley, Itanagar, Arunachal Pradesh, India
[2]St. Joseph's College (Autonomous), Bengaluru-560 027, India
Corresponding author:jay81zoology@gmail.com

The Pleurostict beetle *Anomala dimidiata ssp. dimidiata* (Hope 1831) (Coleoptera: Scarabaeidae) has a geographical distribution from Arunachal Pradesh (Itanagar), Assam, Haryana, Madhya Pradesh, Sikkim, Uttar Pradesh, Uttarakhand and West Bengal in India (Chandra and Gupta, 2012). Pinned specimens of *Anomala dimidiata* (Hope, 1831) preserved in APRC ZSI from Arunachal Pradesh, Itanagar, ZSI Campus were examined by Chandra and Gupta (2012). Sonowal *et al*., (2021) reported *Anomala* spp as pest of pulses in Namsai District, Arunachal Pradesh. The present observations are the species feeding on Taro from Yazali (27.405373, 93.740616) (Fig.1) and Litchi (27.374576, 93.873774) (Lower Subansiri District) and Kimin (27.328324, 93.981201) (Papumpare district) during local surveys undertaken during May-November 2017. The genus *Colocasia* Schott, (Araceae: Colocasieae) includes about 20 species mainly confined to tropical and subtropical Asia, India is home to multiple wild species of *Colocasia* (Li and Boyce, 2010). Different pest insects have been reported damaging the plant (DPPQ&S, 2022). The present observation on multiple occasions is a new location reports from the aforesaid three locations in two different districts of Arunachal Pradesh.

Fig. 1. *Anomala demidata* on Colocasia (11.6.2017 at Yazali, Lower Subansiri district)

References

Bora, M. S., M. Kanwat., H. Kalita., D. Sasmal., A. Rahman. and B. Ngangom. 2021. Diversity of Insects in Pulses at Arunachal Pradesh. *Indian Journal of Entomology* Online published Ref. No. e20327 DoI.: 10.5958/0974-8172.2021.00149.8

Chandra. K. and Gupta D. 2012. Pleurostict scarabs (Coleoptera: Scarabaeidae): New distributional records in Arunachal Pradesh, north-east India. *Check List*. **8**(5): 889–893

DPPQ&S, 2022. http://ppqs.gov.in/PDF/PQ%20leaflets/Taro%20IPM%20for%20export.pdf

Gogoi. R and S. Borah. 2013. Two new species and a new record for *Colocasia* (Araceae: Colocasieae) from Arunachal Pradesh, Northeast India. Gardens' Bulletin Singapore **65**(1): 27–37.

Li, H. and Boyce, P.C. 2010. *Colocasia*. In: Flora of China 23. Pp. 73-75. Beijing: Science Press; St. Louis: Missouri Botanical Garden Press.

MS Received 02 January 2022
MS Accepted 29 January, 2022

DOI: 10.55278/UWFK9862

Liquid pongamia soap unsettles *Tetranychus* sp. on Moringa

Abraham Verghese [1*], Rashmi. M. A[2] and Deepak. S[3]

[*1]Former Director ICAR-National Bureau of Agricultural Insect Resources and Former Head, ICAR-Indian Institute of Horticultural Research, Hesaraghatta, Bangalore,560089, India

[2]Regional Plant Quarantine Station, Bengaluru, 560024 India

[3] Directorate of Plant Protection Quarantine & Storage, Faridabad, India 121001

Corresponding author: abraham.avergis@gmail.com

In January, 2022, a heavy infestation of the red spider mite, *Tetranychus* sp. was found on the organic drumsticks (*Moringa oleifera*) maintained in pots on a terrace garden in Bangalore (12.9716° N, 77.5946° E), India. The dorsal surface of the leaves showed white specks (Fig.1, 2) while the ventral surface had mites. A pre-count showed 28-34 mites/leaflet on 20 random leaflets. Two treatments as given in Table 1 was administered using a 2-litre pneumatic hand sprayer. As the plants were about three feet in height, in pots, spraying under the leaves was very easy. After 24 hours, water spray dislodged about 40 % of the mites (14-21 mites/leaflet) while, a spray of liquid pongamia soap (10%) blend @ 3ml /litre showed only 2-6 mites/leaflet. Further, these too disappeared in 72 hrs, in the soap spray, as probably the host was rendered unpalatable to the mites.

In South Africa, Moringa seedlings were attacked in greenhouses by *Tetranychus* sp. resulting in the withering of species (Dube *et al.,* 2015; Olson, 2014). Globally there are more than 1200 spider mite species in the Tetranychidae family (Prostigmata: Acari) that infests different crops. Feeding activity of the vegetable mite, *Tetranychus neocaledonicus* (Andre) on *M. oleifera* led to the formation of conspicuous white spots, manifested through chlorosis of the leaves. Affected leaves exhibited chlorophyll loss and subsequent drying up and shedding (Kotikal and Math, 2016). Studies of Kaimal *et al.* (2017) revealed that lower surface of the leaves of *M. oleifera* had heavy infestations of *Tetranychus neocaledonicus* (Andre) compared to the upper surface. Dense populations of these mite with all life stages were seen under silken webs. As Moringa is grown in terrace for the leaves, as a medicinal herb, spraying organic friendly liquid pongamia soap is a safe option.

Fig. 1. Dorsal surface of the leaves showing white specks

Fig. 2 Mites on the ventral surface of leaves

Table 1. Efficacy of Liquid Pongamia Soap* on the mite *Tetranychus* on Moringa in a terrace Garden in Bangalore, India

Treatments		Number of mites / Leaflets (n=20) (Range)
Prior to treatment		28-34
After Treatment (24 hr)		
1.	Water Spray	14-21
2.	Liquid PongamiaSoap Spray	2-6

*Rashvee Liquid Pongamia (10%) soap blend @ 3ml/litre

References

Kaimal Sangeetha G., and N. Ramani. 2007. Biological studies of *Tetranychus neocaledonicus* (Andre) (Acari: Tetranychidae) infesting Moringa oleifera Lam. *Bulletin of Pure & Applied Sciences-Zoology*, **vol. 26 (**2): p. 51. Gale Academic.

Kotikal Y. K, Math M. (2016) Insect and Non-Insect Pests Associated with Drumstick, *Moringa oleifera* (Lamk.). *Entomol Ornithol Herpetol* 5: 1000180.

DOI:10.4172/2161-0983.1000180.

Olson, M. E. 2013. Spider mites love Moringas. *The International Moringa Germplasm Collection*. https://moringaceae.org/imgc-moringa-blog/spider-mites-love-moringas

Dube, Z. P., Mashela, P.W. and Abdelgadir, A.H. 2015. Identification of spider mites from *Moringa oleifera* using molecular techniques, *Acta Agriculturae Scandinavica*, Section B - Soil & Plant Science, 65:5, 479-482,

MS Received 01 February 2022
MS Accepted 20 February 2022

DOI: 10.55278/GXYW2405

Observations on stingless bees in St. Joseph's College (Autonomous), Bengaluru

Renu Murthy and M. Jayashankar*
St. Joseph's College (Autonomous), Bengaluru-560 027, India
Corresponding author: jay81zoology@gmail.com*

Tetragonula iridipennis (Stingless Bees) also called as Dammar bees (Hymenoptera: Apidae) are usually found in small groups in the crevices of stone or rock buildings, hollow tree trunks etc. These spatial generalists build their nest around human dwelling spaces by using human constructed materials for nesting (Karthick *et al*., 2018). They are reported as pollinators in different crop ecosystems in and around Bengaluru region on sunflower (Kumar *et al.,* 2020); *Cocos nucifera, Areca catechu, Eucalyptus sp., Helianthus annus, Peltophorum ferrugineum, Pongamia pinnata* (Shwetha, 2012). They are usually tropical bees and are found in the Indo-Malay region, Sri Lanka and Islands of Indonesia. Eight species of stingless bees are known from the Indian subcontinent: *Lepidotrigona arcifera* (Cockerell), *Lisotrigona cacciae* (Nurse), *Lisotrigona mohandasi* Jobiraj & Narendran, *Tetragonula* aff. *laeviceps* (Smith), *Tetragonula bengalensis* (Cameron), *Tetragonula gressitti* (Sakagami), *Tetragonula iridipennis* (Smith), *Tetragonula praeterita* (Walker), and *Tetragonula ruficornis* (Smith) (Rasmussen, 2013). Stingless bees are said to have honey with medicinal properties and meliponiculture is practiced in different parts of India. These bees cannot defend themselves by stinging but by biting.

Nesting preferences of the stingless bees was reported by Pavithra *et al*. (2013) in Jnana Bharathi Campus of the Bangalore University. This communication is based on observations on stingless bees in St. Joseph's College (Autonomous), Bengaluru during 2019-2020. The Ccllege located in the heart of the city of Bengaluru, India has 8.44 acres including the hostel block. The hostel block built in 1948 is a remarkable architecture with a semi-circular-crescent-shaped stone building. The numbers of bee colonies present in various areas around the college, the flowers these bees pollinate were noted. The nests were found to be from 1-4 feet above the ground level in the crevices of the stone wall. The average size dimension of the nest entrances was about 3-5 mm in length and about 2-3 mm in width. Some nests were constructed around wood pieces used for lighting purposes during celebrations and festivities. The surface of the nest was rough and irregular (Figs. 1 and 2).

Fig. 1. An active colony

Fig. 2. A abandoned nest

The stingless bees were found pollinating *Passiflora incarnata, Wedelia lobata, Vinca rosea, Passiflora coccinea, Pseuderanthemum reticulatum, Spathiphyllum.*

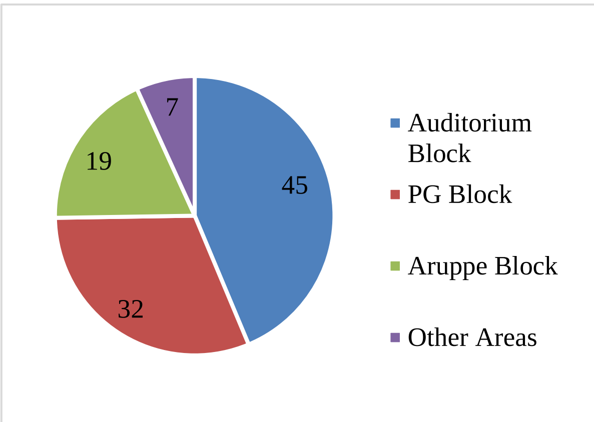


Fig. 3. Stingless bee colonies in SJC

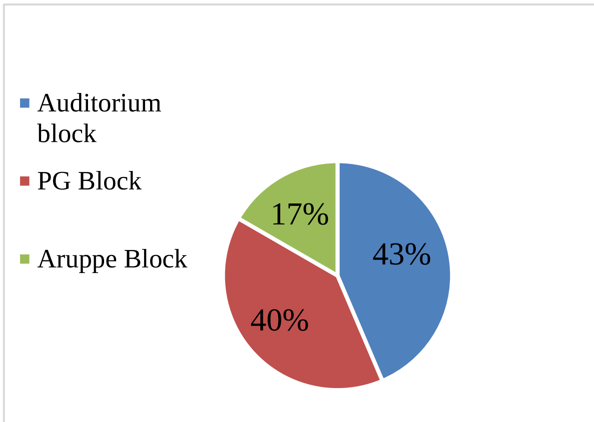


Fig. 4. No. of stingless bees in different sites in the campus

Figures 3 and 4 show the number of stingless bee colonies and their occurrence in the college campus. Most of the colonies are in the Hostel stone building (45) and the PG block (32). The stone building provides nesting spots with cervices between the stones. The antique building is secluded with less movement of individuals, availability of flowering plants. During the observational period, it was noticed that many of the nests were empty and very few number of stingless bees present which is a matter of concern. This could perhaps be due to the construction happening in and around the college. Stingless bees are very sensitive about their habitat and prefer a quiet and undisturbed area. The observations were that these bees are found near pollinating plants at various time intervals of the day. The legs of the stingless bees were observed and they were found to be of different colors indicating the presence of pollens and that they are aiding in pollination**.** Measures including the planting of flowering plants and ensuring minimal movement will be undertaken.

References

Karthick K. S., C. Chinniah, P. Parthiban. and A. Ravikumar. 2018. Prospects and challenges in Meliponiculture in India. *International Journal of Research Studies in Zoology*. **4** (1):29-38

Kumar H. R., Srinivasa Reddy KM., Shishira D. and Eshwarappa G. 2020. Stingless bees in sunflower pollination. *Journal of Entomology and Zoology Studies*. **8**(1): 299-302

Pavithra N. P., Reddy Shankar, M. and Jayaprakash. 2013. Nesting Pattern Preferences of Stingless Bee, *Trigona Iridipennis* Smith (Hymenoptera: Apidae) in Jnanabharathi Campus, Karnataka, India. *ISCA Journal of Biological Sciences*, **2** (2).: 44-50

Rasmussen, S. 2013. Stingless bees (Hymenoptera: Apidae: Meliponini) of the Indian subcontinent: Diversity, taxonomy and current status of knowledge. Zootaxa, **3647** (3): 401–428

Shwetha, B V. 2012. Studies on the floral diversity of stingless bees in Peninsular India. http://hdl.handle.net/10603/71464. 142 pp.

MS Received 06 February 2022
MS Accepted 27 February 2022

DOI:10.55278/DIEB9067

The fluffy white waxy herbivore giant red–eye *Gangara thyrsis* (Fabricius) in an urban garden

Rufina Sujatha K.G.
Department of Zoology
Mount Carmel College Autonomous,
Bengaluru 560052 India
Corresponding author: rufina_martin@yahoo.com

In my previous article I wrote about a hungry nocturnal herbivore, the caterpillar of the palmfly- *Elymnias hypermnestra* that was feeding on the fronds of my ornamental palm. I was constantly on the lookout for the adult butterflies which appeared now and then and I would carefully search the underside of the leaves while watering to check for any larval forms. I don't know how I missed this new pest. The pots were kept out for some sunlight and brought into the living room, early one morning I noticed some leaves missing and was upset and looked for the caterpillar of the palmfly, but to my surprise I spotted two huge caterpillars. The caterpillars were white and fluffy with numerous thread like projections (Fig. 1) and I could not make out its real structure. I moved the caterpillar a bit to the side and to my surprise the fluffy white thread like projections began to fall off and the caterpillar's true form was clear (Fig. 2). The caterpillar is the larval form of the common giant red-eye butterfly *Gangara thyrsis*, belonging to the family Hesperiidae. It breeds on a number of palm species including my indoor ornamental palm. The butterflies of the family- Hesperiidae are commonly called 'skippers'. Due to their rapid bounding flight. There are 3,500 species of skippers in the world and 321 species are found in India. They can be easily mistaken for moths. The skippers have a stout body, angular wings, and at the club end of the antennae is a extension or hook called apiculus.

The adult red-eye butterflies are distributed in South of India, West Bengal, Sikkim to Northeast, Andamans, Nepal, Bangaladesh, Myanmar and Sri Lanka. The adults are dark chocolate brown in colour. They have large wine red eyes. The wing expanse is about 75-83mm. On the fore wings, there are bright yellow semi-transparent quadrate spots and three smaller apical spots. Under the hind wings there are grey scales forming indistinct bands.

Sexes are similar in appearance, but males have pale yellow hairs on Vein1 on the under the fore wing. The female lays her eggs on the leaves of palms. The eggs are large and hatch into white caterpillars that feed on the palm leaves and stay unnoticed under the leaf. The caterpillar is greyish white in colour and have dark yellowish brown (ochre) spots on its dorsal side. The body has several uneven thread like covering reportedly made of wax. When the larvae are disturbed the filaments fall off. The last instar larva turns into a pupa and it settles in a tunnel like 'home' formed by weaving or joining the leaves. Though my leaves were damaged, and the pests were removed, the giant red-eye butterflies play an important role as pollinators and their presence is important in a garden.

Fig. 1 Fluffy white waxy predator

Fig. 2 The "nude" caterpillar

References

The book of Indian butterflies by Issac Kehimkar, Bombay Natural History society, Oxford University Press. Bombay, 1994

https://www.ifoundbutterflies.org

Butterflies of India - *Gangara thyrsis* - learnaboutbutterflies.com https://www.learnaboutbutterflies.com › India – Gangar

https://en.wikipedia.org/wiki/Gangara_thyrsi

MS Received 23 January 2022
MS Accepted 28 February 2022

DOI: 10.55278/HASQ6148

Evaluation of field efficacy of some selected acaricides against *Tetranychus urticae* Koch on okra

Biswajit Patra
Regional Research Station (Hill Zone), Uttar Banga Krishi Viswavidyalaya, Kalimpong, West Bengal 734301, India.
Corresponding author: biswa.kris@gmail.com

Abstract

An experiment was conducted to evaluate the field efficacy of some selected acaricides against two spotted spider mites, *Tetranychus urticae* Koch at Regional Research Station (Hill Zone), Uttar Banga Krishi Viswavidyalaya, Kalimpong, West Bengal, India during 2020 and 2021. Among the various acaricidal treatments, spiromesifen 22.9 SC@120 g a.i/ha was found to be the best treatment in terms of mean per cent reduction of mite population as well as providing the highest yield during both the years of study. This treatment was followed by hexythiazox 5.45EC @25 g a.i./ha and fenazaquin 10 EC @ 125 g a.i./ha. Propagite 57 EC @ 850 g a.i./ha was found to be the least effective treatment although it was significantly superior to the control.

Key words: Red spider mite, *Tetranychus urticae,* spiromesifen, hexythiazox, bio-efficacy, okra.

Introduction:

India is the second largest producer of vegetables in the world (Anonymous, 2018). In India, the contribution of vegetables remains the highest (59 – 61%) in horticulture crop productions over the last five years (Anonymous, 2018).This may be due to significant progress in area expansion and production of vegetables. The production of vegetables was 101.2 Million Tonnes during 2004-05 whereas during 2017-18 it has increased to 184.40 Million Tonnes (Anonymous, 2018). Among various vegetables, the area as well as production of okra has increased significantly in last few years in India due to its unique taste, flavour and nutritional values as human food. As per the second advance estimate during 2019-20, okra was grown in 519000 ha area producing about 6371000 MT (Anonymous, 2019). In spite of these increase in area and production, the productivity of this crop is also very low in some states of India. Apart from several reasons, incidence of insect and acarine pest is one of the key factors for low productivity. Okra crop is infested by numerous insect and mite pests (Kumar, 2004). Among various pests infesting okra, *Tetranychus urticae* is an important and major biological constraint in okra production (Sarkar *et al*, 1996). It is a highly polyphagous acarine pest with a global distribution. It has also wide host range (more than 900 host plants) and it has been described as a serious pest of at least 150 economically important agricultural and ornamental plants (Kavitha *et al*, 2007). They usually colonize in the lower surface of leaves and both the nymph and adult suck the sap resulting yellowing and speckling of leaves, webbing, premature leaf fall, stunting of growth, reduction in photosynthetic activity and ultimately death of the whole plant in case of severe infestation (Varadaraju, 2010). To manage this acarine pest, farmers routinely spray various acaricides. In spite of routine acaricide spray, sometimes this pest becomes difficult to control. A major problem in the management of *T. urticae* is their ability to develop acaricide resistance rapidly because of their polyphagous in nature, high reproductive potential and short life cycle. Apart from these, frequent use of acaricides has aggravated the situation. Control failure of this pest has been reported from various countries including India due to development of resistance against acaricides. Continuous use of an ineffective chemical will ultimately increase the resistance, increase the cost of production, increase the residue problem and will lead to environmental pollution. Therefore, considering problems of management of this acarine pest, the present experiments were conducted to evaluate the field level efficacy of some selected acaricides for effective management.

Materials and methods:

The present experiment was conducted during 2020 and 2021 at Regional Research Station (Hill Zone), Uttar Banga Krishi Viswavidalaya, Kalimpong, West Bengal, India. The experiment was laid out in Randomized Block Design with seven treatments including control and each treatment was replicated thrice. The insecticides/acaricides evaluated were fenazaquin 10 EC @125 g a.i./ha, fenpyroximate 5 SC @30 g a.i/ha, hexythiazox 5.45%EC@25 g a.i/ha, spiromesifen 22.9 SC@120 g a.i./ha, diafenthiuron 50WP@300 g a.i/ha and propargite 57 EC@850 g a.i/ha. Okra seeds (Mahyco 10) were dibbled at 60×45 cm spacing between rows and plants respectively. All standard agronomic practices were followed along with proper disease control measures. Two rounds of sprayings of treatments were done using high volume knapsack sprayer fitted with hollow cone nozzle and using 500 litre of spray fluid per hectare. The spraying was done when the pest population reached at Economic Threshold Level (2 mites/leaf). Control plots were sprayed with equal volume of water. The number of mites was counted from 3 leaves per plant (top, middle and bottom) from five randomly selected and tagged plats per plot. The observations were recorded a day before spray as well as 3,7,10 and 14 days after each spray. The reduction or increase (+) of population was expressed in per cent. Yield of okra fruits was recorded at each picking and total yield per plot was calculated and converted to yield (quintal) per hectare. The data of per cent population reduction or increase (+) and yield increase (+) or decrease were subjected to analysis of variance after making necessary transformation (angular transformation) except in case of yield.

Results and discussion:

The pre-treatment count of red spider mite before first spray during 2020 ranged from 14.48 to 15.85 mites/leaf. The mite population started to decline from the pre-spray count in different insecticidal treatment but the per cent reduction varied from treatment to treatment. The results obtained after first spray and second spray during the first season (2020) are presented in Table-1. It was observed that all the insecticide treated plots gave significant mean per cent reduction of the mite population over control. But the best results was obtained from the plots treated with spiromesifen 22.9SC @ 120 g a.i./ha as it recorded the highest mean per cent reduction (91.20%) after 1st spray during 2020. The efficacy of this treatment was followed by the efficacy of hexythiazox 5.45 EC @ 25 g a.i./ha and fenazaquin 10EC @125 g a.i./ha. The result of the fenpyroximate 5SC and diafenthiuron 50WP was statistically at par. Propargite 57EC was found to be the least effective treatments showing about 81.19 mean per cent reduction of mite population. In untreated control plots, the mite population increased up to 112.47% (14 days after spray). The results of the second spray also showed the similar trend of efficacy. Spiromesifen 22.9 SC was found to be the best effective treatment resulting about 94.49 mean per cent reduction of mite population and propargite 57 EC was found to be the least effective treatment although it brought about 87.01% reduction of the mite population. The population in the untreated control plot increased up to 154.12 %.

During the second year of study (2021) the pretreatment count of the mite population ranged from 17.89 to 18.85 mite/leaf. After first spray, the population started to decline in insecticide treated plots although the per cent reduction varied in different treatments. Spiromesifen 22.9SC was again found to be the best treatment resulting 92.25 mean per cent reduction of the population followed by hexythiaxox 5.45 EC which showed 87.92 mean per cent reduction of the mite population. Propargite 57EC was found to be least effective treatment showing 82.21 mean per cent reduction of mite population (Table-2). Similar trends of result were found after second spray.

All the insecticides treated plots showed significantly higher yield as compared to the untreated control. During the first year of study, the highest yield was obtained from the spiromesifen 22.9 SC treated plots (77.85 q/ha) followed by hexythaizox 5.45EC treated plots (75.34 q/ha). Propargite 57 EC was found to be the least effective insecticides treatment providing 71.66 q/ha of yield. The similar trend of result was observed during the second year of study (2021). Spiromesifen 22.9 SC again was found to be the best effective treatment (78.35 q/ha) followed by hexythiazox 5.45 EC (76.43 q/ha). Propargite 57EC was found to be the least effective treatments in terms of yield (72.76 q/ha). The lowest yield was observed from the control plots during both the years of study (2020 and 2021).The descending chronological order of effectiveness of treatments based on yield and per cent reduction of mite population was spiromesifen 22.9 SC > hexythiazox 5.45 EC > fenazaquin 10 EC> diafenthiuron 50 WP> fenpyroximate 5 SC> propargite 57 EC.

The present study revealed that spiromesifen 22.9 SC @120 g a.i/ha was found to be the best treatment. Almost similar findings were reported by Baloch *et al*., 2016 who revealed that oberon (Bayer) resulted in the overall average efficacy of 96.27 percent reduction. Elbert *et al*. (2005) also reported that Oberon (spiromesifen) showed excellent activity against spider mites in vegetables and field crops in USA. The excellent efficacy of spiromesifen may be due to the unique mode of action of the chemical. It acts on lipid synthesis by inhibiting acetyl CoA carboxylase (Singh *et al.*, 2016**)** and causes a significant decrease in total lipids (Ghanim and Ishaaya, 2011; Bensafi-Gheraibia *et al*., 2013). Hexythiazox 5.45 EC was found to be the second best treatment in the present experiment. The effectiveness of hexythiazox was also revealed by Shulka, (2018). The study also revealed the better performance of fenpyroximate 5 EC @ 25g a.i./ha for management of red spider mite. The present study indicated that fenazaquin also provided excellent control of the mite population. The good efficacy of fenazaquin 10 EC (150g a.i./ha) was also reported by Wale *et al*. (2010) on okra. Sangeetha and Ramaraju (2013) reported that fenazaquin 10 EC at 125 and 150 g a.i./ha caused the highest reduction in numbers of mites in pot culture and field experiments. Bhaskaran *et al* (2007) reported that diafenthiuron 50 WP at 450 g a.i./ha recorded the highest mean reduction of mite population after first and second round of spraying. Thus, the present findings are more or less similar with the findings of the past workers. The dissimilarity within results may be due to the variation in environmental factors or dose of the treatments or may be due to the lower susceptibility to the chemical.

It can be concluded from the results of the present experiment that the tested chemicals are effective for management of the red spider mite. The use of spiromesifen 22.9SC, hexythiazox 5.45EC and fenazaquin 10EC may be continued for management red spider mite on okra. Care should be taken to use the chemicals in rotation based on mode of action. The Pre-harvest interval period of the chemicals should also be considered before use of these chemicals. The susceptibility level of the chemicals should be evaluated periodically for effective management of the pest. Otherwise, frequent use of the chemicals having same mode of action may lead to development of resistance within a short span of time.

Acknowledgement: Authors are thankful to In-Charge, Regional Research Station (Hill Zone), Uttar Banga Krishi Viswavidyalaya, Kalimpong for providing necessary facilities for the research work.

Table-1: Effect of 1st and 2nd spray of different treatments on incidence of red spider mite of okra during 2020 (Mean of three replications).

Treatments	Dose (ga.i./ha)	PTC	% reduction after 1st spray				Mean	PTC	% reduction after 2nd spray				Mean	Yield (q/ha)
			3DAS	7DAS	10DAS	14DAS			3DAS	7DAS	10DAS	14DAS		
Fenazaquin 10 EC	125	15.23	80.36 (63.70)	84.21 (66.59)	87.82 (69.58)	86.83 (68.72)	84.81 (67.06)	5.66	89.45 (71.06)	90.25 (71.81)	91.36 (72.91)	89.21 (70.83)	90.07 (71.63)	73.28
Hexythiazox 5.45 EC	25	14.87	82.37 (65.18)	85.61 (67.71)	90.38 (71.93)	89.13 (70.75)	86.87 (68.76)	5.87	90.10 (71.66)	91.32 (72.88)	92.84 (74.48)	91.85 (73.42)	91.53 (73.08)	75.34
Spiromesifen 22.9 SC	120	15.28	89.28 (70.93)	90.40 (71.96)	92.75 (74.39)	92.35 (73.97)	91.20 (72.74)	4.85	93.75 (75.52)	94.13 (75.98)	95.30 (77.48)	94.78 (76.80)	94.49 (76.42)	77.85
Fenpyroximate 5 SC	30	14.48	77.36 (61.59)	82.54 (65.31)	87.16 (69.00)	86.14 (68.14)	83.30 (65.88)	6.56	88.12 (69.84)	90.12 (71.68)	90.98 (72.53)	88.25 (69.96)	89.37 (70.97)	72.84
Propargite 57 EC	300	14.89	76.37 (60.92)	79.71 (63.23)	84.74 (67.00)	83.95 (66.38)	81.19 (64.30)	6.33	85.37 (67.51)	87.28 (69.11)	87.93 (69.67)	87.45 (69.25)	87.01 (68.87)	71.66
Diafenthiuron 50WP	850	15.85	79.39 (63.00)	82.74 (65.45)	85.48 (67.61)	85.87 (67.93)	83.37 (65.93)	5.47	86.24 (68.23)	89.25 (70.87)	90.54 (72.09)	89.24 (70.86)	88.82 (70.46)	73.15
Untreated control (Water spray)	-	15.23	+35.26 (0.00)	+65.35 (0.00)	+95.63 (0.00)	+112.47 (0.00)	+82.18 (0.00)	5.87	+120.24 (0.00)	+135.89 (0.00)	+167.52 (0.00)	+192.83 (0.00)	+154.12 (0.00)	63.54
S.Em(±)		-	0.47	0.30	0.23	0.27	0.10	-	0.25	0.29	0.51	0.32	0.11	1.42
CD at 5%		NS	1.46	0.93	0.71	0.81	0.32	NS	0.76	0.90	1.55	0.99	0.35	4.26

N.B.:- **PTC**-Pre-treatment count (No. of motile stage/leaf); **DAS**-Days after spraying. Figures in parentheses are angular transformed values.

Table-2: Effect of 1st and 2nd spray of different treatments on incidence of red spider mite of okra during 2021 (Mean of three replications).

Treatments	Dose (ga.i./ha)	PTC	% reduction after 1st spray				Mean	PTC	% reduction after 2nd spray				Mean	Yield (q/ha)
			3DAS	7DAS	10DAS	14DAS			3DAS	7DAS	10DAS	14DAS		
Fenazaquin 10 EC	125	18.25	81.37 (64.44)	85.27 (67.44)	88.84 (70.49)	87.84 (69.59)	85.83 (67.89)	5.42	88.65 (70.32)	91.46 (73.01)	92.22 (73.82)	90.15 (71.71)	90.62 (72.17)	74.82
Hexythiazox 5.45 EC	25	17.89	83.37 (65.94)	86.70 (68.61)	91.49 (73.05)	90.13 (71.69)	87.92 (69.66)	5.28	89.29 (70.90)	92.38 (73.99)	93.97 (75.79)	92.78 (74.42)	92.11 (73.68)	76.43
Spiromesifen 22.9 SC	120	18.54	90.38 (71.99)	91.46 (73.02)	93.80 (75.59)	93.36 (75.09)	92.25 (73.84)	5.54	92.97 (74.63)	95.14 (77.27)	96.17 (78.73)	95.68 (78.00)	94.99 (77.07)	78.35
Fenpyroximate 5 SC	30	18.63	78.55 (62.41)	83.59 (66.11)	87.99 (69.72)	87.18 (69.02)	84.33 (66.68)	5.21	87.37 (69.19)	91.13 (72.68)	90.68 (72.22)	89.28 (70.90)	89.62 (71.20)	73.48
Propargite 57 EC	300	17.97	77.41 (61.63)	80.72 (63.96)	85.71 (67.79)	85.01 (67.22)	82.21 (65.05)	6.24	84.56 (66.86)	88.28 (69.98)	89.11 (70.74)	88.41 (70.10)	87.59 (69.37)	72.76
Diafenthiuron 50WP	850	18.52	80.56 (63.84)	83.75 (66.23)	86.59 (68.52)	86.88 (68.77)	84.45 (66.77)	5.38	85.54 (67.65)	90.42 (71.99)	91.13 (72.68)	90.17 (71.74)	89.32 (70.92)	74.51
Untreated control (Water spray)	-	18.85	+42.58 (0.00)	+63.52 (0.00)	92.38 (0.00)	+124.65 (0.00)	+80.78 (0.00)	5.98	+134.53 (0.00)	+148.58 (0.00)	+178.59 (0.00)	+190.27 (0.00)	+162.99 (0.00)	64.45
S.Em(±)		-	0.48	0.31	0.26	0.28	0.13	-	0.25	0.34	0.32	0.31	0.14	1.49
CD at 5%		NS	1.49	0.97	0.78	0.84	0.39	NS	0.78	1.05	0.99	0.95	0.43	4.47

N.B.:- **PTC**-Pre-treatment count (No. of motile stage/leaf); **DAS**-Days after spraying. Figures in parentheses are angular transformed values.

References:

Baloch, A. Q., Solangi, B. K., Khan, N.,Yaqoub, M., Ali, A., Khtran, S.,Pasand, S., Zehri, S., Ahmed, R., Anwar, S., Ali, N. and Zafar, S. 2016. Bio Efficacy of Different Acaricide Spray Schedules Against the Mite Population in Okra. *Developing Country Studies*, **6**(10):72-81.

Anonymous, 2018. Horticultural Statistics at a Glance 2018. Horticulture Statistics Division, Department of Agriculture, Cooperation & Farmers' Welfare, Ministry of Agriculture & Farmers' Welfare Government of India, pp2-3. (Accessed from - http://nhb.gov.in/statistics/Publication/Horticulture%20Statistics%20at%20a%20Glance-2018.pdf).

Anonymous, 2019. Area and Production of Horticulture Crops : All India. Accessed from http://nhb.gov.in/StatisticsViewer.aspx?enc=MWoUJibk35dW2g36TUJWAoZqESmAYFi7h2irlsmjlINTcFl1rG/kLbq8ZQbWUvuM

Bhaskaran, E. V., Ramaraju, K. and Gunasekaran, K. 2007. Evaluation of new acaricides against two spotted spider mite, *Tetranychus urticae* Koch on bhendi. *Pestology.*, **31**(12), 31-34.

Elbert, B. A., Melgarejo, E., Schnorbach, J.H. and Sone, S . 2005. Field development of Oberon Reg. for whitefly and mite control in vegetables, cotton, corn, strawberries, ornamentals and tea. *Pflanzenschutz. Nachrichten*. Bayer., **58** (3): 441-468.

Bensafi-Gheraibia, H., Menail, A.H. and Soltani, N. 2013. Activity of a lipid synthesis inhibitor (spiromesifen) in *Drosophila melanogaster*: lipid levels and peroxydation and effects in offspring *Bull Soc Zool Fr*, 138 (1–4):189-199.

Kavitha, J., Bhaskaran, E. V., Gunasekaran, K. and Ramaraju, K. 2007. Evaluation of new acaricides against two spotted spider mite, *Tetranychus urticae* Koch on bhendi. *J. Acarol.* **17**,-: 77-78.

Kumar, A. 2004. Effect of neem based pesticides on germination of okra, *Abelmoschus esculantus* Maech. seed. *Shashpa*,11.,(1) : 83-85.

Ghanim, M. and Ishaaya, I. 2011. Insecticides with novel modes of action mechanism and resistance management in tolerance to environmental contaminants. C. Amiard-Triquet, P.S. Rainbow, M. Romeo (Eds.), Insecticides with novel modes of action: mechanism and application, pp. 385-407

Sangeetha, S. and Ramaraju, K. 2013. Relative toxicity of fenazaquin against two spotted spider mite on okra. *Int. J. Vegetable Sci.* 19:, - 282-293.

Sarkar, P. K., Mukherjee, A. B. and Ghosh, J. 1996. Assessment of loss of bhendi against red spider mite. *Environ. Ecol.* **14**:, - 480-481.

Shukla, A. 2018. Evaluation of hexythiazox 5.45 EC against red spider mites (Tetranychus urticae) on okra. *Journal of Entomology and Zoology Studies.*, **6**(2): 43-46.

Singh, V., Sharma, N. and Sharma S.K. 2016. A review on effects of new chemistry insecticides on natural enemies of crop pests. *Int J Sci Environ Technol.*, **5** (6):4339-4361.

Varadaraju, M. V. 2010. Seasonal incidence and management of okra mites, *Tetranychus* spp. *M. Sc. (Agri.) Thesis*, University of Agricultural Sciences, Dharwad, Karnataka.

Wale, S. D., Kadu, R. V., Landge, S. A. and Handele, A. G. 2010. Evaluation of magister (fenazaquin 10 EC) against mites on okra. *Bioinfolet* 7:,- 230-234.

MS Received 06 February 2022
MS Accepted 27 February 2022

Extension notes

DOI: 10.55278/GWLX6225

Management of insect pests in maize and sorghum

Ramesh Arora
Faculty of Agriculture, Shri Guru Granth Sahib World University, Fatehgarh Sahib-140407, India
Corresponding author: arorarame@gmail.com

Maize stem borer, *Chilo partellus* is the most important pest of maize during the Kharif season. The damage is caused by creamy pink to yellowish-brown coloured caterpillars which have four rows of dotted stripes and a reddish-brown head along their backs. Initially, the newly hatched larvae crawl inside the leaf whorls and scrape the leaves. When the rolled leaves unfurl, a series of pinholes and papery windows are visible. After about a week, the larvae moves out of the whorl and bores upwards in the developing stalk resulting in a 'dead heart'. The main shoot usually dies, and the plant often gives rise to tillers.

The following measures are suggested for its management.

Trap cropping: Planting of paired border rows of Napier-bajra (pearl millet) all around the maize or sorghum field is recommended. Most of the stem borer females lay eggs on these border rows. The larvae hatching from these eggs feed on the Napier-bajra leaves and die in 2-5 days. The Napier-bajra thus acts as a dead-end trap crop for the stem borer. The maize and sorghum crops are thus saved from the attack of stem borer. An additional advantage is that the Napier-bajra plants may be harvested about 50 days after planting to serve as green fodder for the animals.

Mechanical control: At the time of hoeing, the plants attacked by the stem borer may be uprooted and destroyed.

Biological control: Two releases of *Trichogramma chilonis* (as Tricho cards)- 60,000 parasitized host eggs/acre at 7 and 15-days after germination of the crop serve to control the early attack of the pest is highly recommended. The parasitized host eggs are pasted on the Tricho cards with glue. These cards should be cut into small pieces each with about 1000 eggs each. These tricho-card pieces are stapled on the lower side of leaves of the central whorl of uniformly spread maize plants in the evening. The parasitoids emerging from these cards search and parasitize the eggs of maize borer. The release of tricho-cards should be avoided on rainy days as the emerging parasites are quite delicate.

Chemical control: In case of a serious attack, spray the crop with 30 ml of chlorantraniliprole

18.5 SL in 60 liters of water with the help of a manually operated Knapsack sprayer. In fodder crops of maize and sorghum, a waiting period of 15 days must be observed after spray for harvesting fodder from the sprayed field.

Fall armyworm (FAW), *Spodoptera frugiperda*: This pest has recently invaded India and is causing serious damage to maize crop in various parts of the country. The female moths lay eggs in masses of 50-150 eggs covered with tan-coloured scales. FAW attacks all stages of the maize crop from seedling emergence to ear development. The young larvae feed in and around the whorl leaves by scraping and skeletonizing the upper epidermis leaving a silvery transparent membrane resulting in papery spots. The larvae are distinguished by a reddish-brown head with a prominent white, inverted Y-shaped suture between the eyes. The older larvae feed inside the whorls. The damage by late instars results in extensive defoliation and the presence of large amounts of faecal pellets in the whorls. Following measures may be undertaken for its management.

Pre-planting practices:

Deep plough the fields to expose the pupae to sunlight and predatory birds.

Add neem cake @ 200kg/acre to the fields.

Maintain field bunds clean and plant flowering plants such as marigold, sesame, niger, sunflower, coriander, fennel, etc. to attract natural enemies.

Seed treatment with cyantraniliprole 19.8% and Thiamethoxam 19.8 FS @ 6ml/kg seed.

Early-crop stage:

Plant 2-3 rows of Napier-bajra as trap crop around maize fields.

Erect bird perches @ 10/acre to encourage natural predation by birds.

Install pheromone traps @ 4/acre after sowing and monitor moth catches regularly.

Adopt clean cultivation to eliminate possible alternate hosts of FAW.

The first spray should be with 5% neem seed kernel extract (NSKE) or azadirachtin 1500ppm @ 5ml/litre when trap catch of 1 moth/trap/day or 5% infestation of the pest is recorded on the main or trap crop.

At 5-10% infestation, whorl application of *B. thuringiensis* var. *kurstaki* @ 400gm/acre should be done.

If infestation exceeds 10%, whorl application of any one of these insecticides should be done: chlorantraniliprole 18.5 SL@ 80ml/acre or Spinetoram 11.7 SC @ 100ml/acre or emamectin benzoate 5 SG @ 80g/acre.

Fig. 1. Damage by the maize borer a. A leaf showing scrapping by the neonates and young larvae b. Entry holes of maize borer larvae. The larvae enter inside the whorl making holes.

Fig. 2. When the rolled leaves unfurl, they show small holes in rows. c. A dead heart formed by feeding of the larva inside the central whorl (pictures courtesy: Dr Surinder K Sandhu)

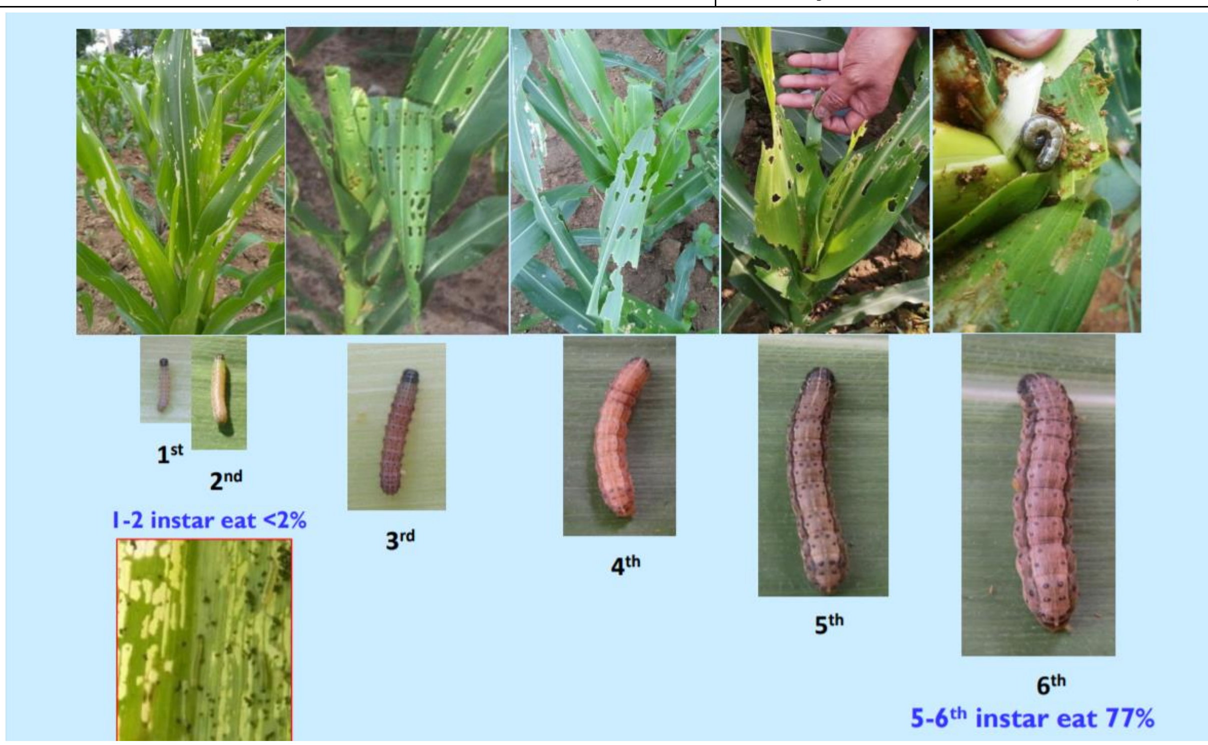


Fig. 3. Damage by the fall armyworm caterpillars. The young instars scrap and skeletonize the leaves, while the grown-up caterpillars devour much of the foliage and feed inside the whorl (Pictures courtesy: Dr Surinder K Sandhu)

MS Received 29 December 2021

MS Accepted 28 January 2022

Short reviews

DOI: 10.55278/LPLZ3657

Necrophoresis: The funeral ways of social insects

Ashish V. V and Haseena Bhaskar
AINP on Agricultural Acarology, Department of Agricultural Entomology,
College of Agriculture, Vellanikkara, Kerala Agricultural University,
Thrissur- 680656, India
Corresponding author: ashishvv98@gmail.com

Social insects are the only animals, apart from humans, that have sophisticated behavioural strategies for the final disposal of dead conspecifics, known since ancient times. Nestmates that die inside the nests represent a high epidemiological risk for insect societies because of the opportunistic microbial proliferation they may cause, especially when they die due to some infectious agent (Cremer *et al*., 2007). The four major behavioural strategies known in social insects towards dead conspecifics include necrophoresis, intraspecific necrophagy, burial and necrophobia. Among these, necrophoresis, the distant removal of corpses is the main strategy employed largely by social Hymenoptera and scarcely by termites (Lopez-Riquelme and Fanjul-Moles, 2013).

The extreme division of labour in social insects has produced individuals who engage in the specialized task of 'undertaking', which involves disposal of dead nestmates or those mortally sick due to infections. The individuals engaged in undertaking are known as 'undertakers'. *Apis mellifera* which exhibits temporal polyethism has dedicated undertakers. In the common red ant, *Myrmica rubra* (*Fig. 1*), undertakers are short term specialists that split their time between disposing of the dead and foraging (Diez *et al.*, 2013). Specialized undertakers have several neurobiological adaptations for efficient processing of death stimuli such as specializations in antenna and brain, as well as additional neural pathways and neurotransmitters.

***Fig. 1. Myrmica rubra* involved in necrophoresis**

(Source: https://antpestcontrol.com/dead-ants-why-do-live-ants-carry-their-dead-away/)

Necrophoresis proceeds through three stages *viz.,* corpse recognition, processing of death-related stimuli and the final transport of the corpse. Presence of necromones, as well as absence of certain 'lifeness signals' in corpse, aid in death recognition. In *A. mellifera,* a blend of oleic acid and β-ocimene is more consistent in triggering necrophoric behaviour than either of the fatty acids alone (McAfee *et al.,* 2018).

On detection of the corpse, the undertakers analyse information from the corpse by peripheral and central nervous mechanisms. Information extracted by sensory organs on antennae are processed and coded, first in the antennal lobes and then in higher brain centres, mainly the mushroom bodies. Necrophoresis terminates with abandoning the corpses out of the hive as seen in bees or dumping them in refuse dumps called 'cemeteries' or 'middens' as in the Indian black ant, *Camponotus compressus* (Banik *et al*., 2010) or using them as a 'corpse boundary' against competing species, as in *Formica cinerea* (Fig. 2) and *F. rufa*. (Czechowski, 2009).

***Fig. 2. Formica cinerea* involved in necrophoresis**

(Source: https://www.bwars.com/ant/formicidae/formicinae/formica-rufa)

Necrophoresis confers social insects with social immunity and survival advantage which very much contribute to the success of social life. In *M. rubra,* significance of necrophoresis in colony survival is evident from the increased survival rate of nestmates recorded in free removal colonies than in limited removal colonies (Diez *et al*., 2014).

Through necrophoric behaviour, insect societies prevent the proliferation of pathogens and the risk of infection among the members of the society, mainly the queen and the brood, on whom the fitness of the society depends. Necrophoresis, despite its complexity and sophistication, represents an altruistic behaviour in social insects for the survival and success of the colony.

References

Banik, S., Biswas, S., Karmakar, R., and Brahmachary, R. 2010. Necrophoresis in two Indian ant species, *Camponotus compressus* (Fabricius) and *Diacamma vagans* (Smith) (Insecta: Hymenoptera: Formicidae). *Proc. Zool. Soc.* **63** (2): 87–91.

Cremer, S., Armitage, S. A. O., and Schmid-Hempel, P. 2007. Social immunity. *Curr. Biol.* **17:** 693 -702.

Czechowski, W., Marko, B., and Godzinska, E. J. 2009. Corpse carrying in ants (Hymenoptera: Formicidae): Behavioural side effect of aggressive arousal or competitive signalling?. *Polish J. Ecol.* **57**(2): 341-352.

Diez, L., Lejeune, P., and Detrain, C. 2014. Keep the nest clean: Survival advantages of corpse removal in ants. *Biol. Lett.*, **10(**7): 306.

Diez, L., Le Borgne, H., Lejeune, P., and Detrain, C. 2013. Who brings out the dead? Necrophoresis in the red ant, *Myrmica rubra*. *Anim. Behav*. **86**(6): 1259-1264.

Lopez-Riquelme, G. O. and Fanjul-Moles, M. L. 2013. The funeral ways of social insects: Social strategies for corpse disposal. *Trends Entomol.* **9**: 71-129.

McAfee, A., Chapman, A., Iovinella, I., Gallagher-Kurtzke, Y., Collins, T. F., Higo, H., Madilao, L.L., Pelosi, P., and Foster, L.J. 2018. A death pheromone, oleic acid, triggers hygienic behavior in honey bees (*Apis mellifera* L.). *Sci. Rep*. **8**(1): 1-13.

MS Received 11 January 2022
MS Accepted 07 February 2022

DOI: 10.55278/QLWQ9332

A multidimensional view of weaver ant, *Oecophylla smaragdina*

Deepak. S[1]*, Rashmi M. A[2] and Abraham Verghese[3]

[1]Directorate of Plant Protection, Quarantine & Storage Faridabad, India 121001

[2] Regional Plant Quarantine Station, Bengaluru 560024, India

[3]International Phytosanitary Research and Services, Former Director ICAR-National Bureau of Agricultural Insect Resources and Former Head, ICAR-Indian Institute of Horticultural Research, Hesaraghatta, Bangalore, 560089, Karnataka, India

Corresponding author: deepaksihimoge@gmail.com

The red ant, *Oecophylla smaragdina* Fab. (Hymenoptera: Formicidae) is also known as the weaver ant, green ant, Kerengga red ant, emerald leaf dweller, Indian tree ant or orange gaster. These ants are distributed in the tropical Old World from India to Taiwan and across Southeast Asia to Australia (Wetterer, 2017). Ants are arboreal and build leafy nests in trees like mango, jamun and jackfruit. The workers construct the nest by glueing the edges of adjacent leaves using the sticky silk secreted by the larvae. (Verghese *et al.*, 2013). Weaver ants are highly territorial and workers aggressively defend their territories against intruders. Weaver ants vary in color from reddish to yellowish-brown depending on the species. Colonies are founded by one or more mated females (Queens) (Peng *et al*., 1998). Colonies can be extremely large consisting of more than a hundred nests spanning numerous trees and containing more than half a million workers (Wiki, 2022).

Tangy relish of weaver ant

Weaver ants are one of the most valued types of insects eaten by humans. Weaver ants can be utilized directly as a protein and a food source since the ants (especially the ant larvae) are edible for humans and high in protein and fatty acids.

The hilly region of Malnad (western and eastern slopes of the Western Ghats of Karnataka) is known for the unique *chigli chutney* (delicacy) made of the weaver ant, *Oecophylla smaragdina*. It is a unique recipe of food prepared in various parts of the country (Karnataka, West Bengal, Jharkhand, Bihar, Chhattisgarh, Andhra Pradesh, Assam, Himachal Pradesh, Manipur, Nagaland, Tripura and Meghalaya) also. The leafy nests are harvested before sunrise and the ants are roasted along with salt, grounded with garlic, bird-eye chili, onion, coconut and spices. This spicy and tangy relish is a winter delicacy that contains formic acid, protein, calcium, vitamin B_{12}, zinc and iron that boost the immune system (Deepak, 2022). Chutney is also relished by Gond tribals of Bastar (Chattisgarh) and sold in the local market of Jagadalpur with name '*Chopada*' (Pers. Comm: Dr. Jayalakshmi). In Thailand, queen and eggs of the ant are sold as canned products through ecommerce platform.

As medicine

The Indian healers in Chhattisgarh prepare oils in which they dip the collected ants. After 40 days, oils are used externally to cure rheumatism, gout, ringworm or other skin diseases, and also as an aphrodisiac (Oudhia, 2002).

As pedator

Records show that in China, *Oecophylla* nests were introduced in citrus orchards to control the pests of citrus since AD 300, and from then on are being utilized for biological control in fruit plantations in Australia and Asia. Further, it was also observed that, introducing *Oecophylla* ants in cashew reduces the menace of the tea mosquito bug, *Helopeltis antonii* (Hemiptera: Miridae). Keeping this in view, methods of boosting *Oecophylla* nests in orchard plantations is gaining momentum in crops like cashew, mango, citrus, coffee, cocoa and coconut (Verghese *et al.*, 2013).

As pest

Studies indicate that the presence of *Oecophylla* colonies has negative effects on the performance of host plants by reducing fruit consumption by mammals and birds and thereby reducing seed dispersal and also lowering the flower-visiting rate of pollinators. Weaver ants protect sap-feeding insects from which they collect honeydew. Further, by protecting these insect pests from predators they increase their population and increase the infestation of tree/host (Donald, 1988 and Kazuki *et al*., 2004)

Fig. 1 Nest of *Oecophylla smaragdina*
PC: Basile Morin (Wikipedia)

Fig. 2 Ant *chutney*
PC: Mangalore today (weaver ants)

Fig. 3 Canned weaver ant eggs
PC: Thailand unique

Fig. 4 Canned queen weaver ants
PC: Thailand unique

References:

Deepak. S, 2022. Tangy relish with medicinal value on your plate, *Insect Environment Blog*. https://insectenvironment.com/f/tangy-relish-with-medicinal-value-on-your-plate?blogcategory=Deepak%2C+S

Oudhia, P. 2002. Traditional medicinal knowledge about red ant *Oecophylla smaragdina* (Fab.) [Hymenoptera; Formicidae] in Chhattisgarh, India. *Insect Environment*, **8(3):** 114–115.

Peng, R. K., Christian, K and Gibb, K. 1998. "How many queens are there in mature colonies of the green ant, *Oecophylla smaragdina* (Fabricius)?". *Australian Journal of Entomology*. **37 (3)**: 249–253.

Thomas Donald W. 1988. The influence of aggressive ants on fruit removal in the tropical tree, *Ficus capensis* (Moraceae). *Biotropica*. **20(1):** 4953.

Tsuji Kazuki., Ahsol Hasyim., Harlion and Koji Nakamura. 2004. "Asian weaver ants, *Oecophylla smaragdina*, and their repelling of pollinators". *Ecological Research.* **19(6):**669–673.

Verghese Abraham., P. D Kamala Jayanthi K., Sreedevi K., Sudha Devi., Viyolla Pinto. 2013. A quick and non-destructive population estimate for the weaver ant *Oecophylla smaragdina* Fab. (Hymenoptera: Formicidae). *Current Science*. **104(5):** 641-646.

Wikipedia, 2022, https://en.wikipedia.org/wiki/Weaver_ant#cite_note-:0-3

James K Wetterer, 2017. Geographic distribution of the weaver ant *Oecophylla smaragdina*, *Asian Myrmecology* **Vol. 9**, e009004, DOI: 10.20362/am.009004

MS Received 31 January 2022
MS Accepted 28 February 2022

DOI: 10.55278/MUOM5799

The drivers of insect decline

Sharanabasappa M. Ganganalli and Haseena Bhaskar*
*AINP on Agricultural Acarology, Department of Agricultural Entomology,
College of Agriculture, Vellanikkara, Kerala Agricultural University,
Thrissur- 680656, India
Corresponding author: mgsharanabasappa@gmail.com

Biologists and ecologists have been concerned about the worldwide reduction in biodiversity of many terrestrial and aquatic vertebrates. However, recently scientists have voiced similar concerns about invertebrate taxa, mainly insects. The rapid rate of insect decline may lead to the extinction of 40 per cent of the world's insect species over the next few decades (Sánchez-Bayoa and Wyckhuysb, 2019). Indian entomologists too agree that the country is witnessing a slump in insect numbers (Iyer, 2019).

The major factors responsible for the decline in insect fauna include habitat change, pollution, invasive species and climate change (Ceballos *et al*., 2017). Habitat change is an immediate consequence of urbanisation, industrialisation, intensive farming and deforestation. The tremendous human population growth and urban development in the city of Liberia, Costa Rica ($9^0$47’34”N, $83^0$51’29”W) caused a decline in the diversity and abundance of bees on the flowering tree, *Andira inermis* (W. Wright) (Frankie *et al*., 2009). Due to industrialisation, the diversity of insect fauna reduced in Midnapur ($22^0$24’49”N, $87^0$20’51”E) district of West Bengal by 23.33 per cent (Jana *et al*., 2006).

Intensive farming practices, monocultures, recurrent use of synthetic fertilisers, herbicides and pesticides are the major drivers of insect declines in both terrestrial and aquatic ecosystems. Neonicotinoid insecticides, the most widely used molecules for agricultural pest management have crucial negative side effects, especially on pollinators and other beneficial insects feeding on floral nectar and pollen (Calvo-Agudo *et al*., 2019).

Water pollution reduces the quality of freshwater habitat, leading to a decline in aquatic insects. Light pollution interferes with insects that use natural light from the moon or stars as orientation cues for navigation (moths) and with communication of insects that use bioluminescent signals (fireflies). Noise pollution interferes with acoustic communication in insects like grasshoppers and cicadas. Electromagnetic radiation of mobile telecommunication antennas have a detrimental effect on the abundance and composition of pollinators like wild bees, hover flies, bee flies, beetles and wasps (Lazaro *et al*., 2016).

Introduction of invasive species may lead to local loss of native insects, particularly those exhibiting narrow geographic distributions. A long-term field study to assess the composition of ladybird beetles in the orchards of East Anglia, England revealed a decline in the native ladybird beetles caused by the invasive harlequin ladybird, *Harmonia axyridis* (Brown and Roy, 2017). Climate change causes threats to insects and the ecosystems they depend on. Climate warming in central Spain resulted in a decline in species richness of butterflies in 90 per cent of the region, due to the shift in the geographical range of many species from plains to higher elevations (Wilson *et al*., 2007).

The decline of insects is a serious threat that the society must urgently address. Conservation strategies to counter the insect decline include reducing greenhouse gas emissions, replacing intensive agriculture with agro-ecological methods, curbing local light and noise pollution and protecting and creating microhabitat features for insects (Harvey *et al*., 2020). If we do not stop the decline of our insects, there will be profound consequences on humans and all life on earth.

Reference:

Brown P. M. J. and Roy, H. E. 2017. Native ladybird decline caused by the invasive harlequin ladybird *Harmonia axyridis*: evidence from a long-term field study. *Insect Conserv. Diversity*, **11**(3): 230-239.

Calvo-Agudoa, M., Gonzalez-Cabrerac, J., Yolanda, P., Calatayud-Vernichd, P., Alberto, U., Marcel, D., and Alejandro, T. 2019. Neonicotinoids in excretion product of phloem- feeding insects kill beneficial insects. *PNAS* **116**(34): 16819.

Ceballos, G., Ehrlich, P. R., and Dirzo, R. 2017. Biological annihilation via the ongoing sixth mass extinction signaled by vertebrate population losses and declines. *Proc. Natl. Acad. Sci*. **114**: E6089-E6096.

Frankie, G. W., Rizzardi, M. S., Bradleigh, V., and Griswold, T. L. 2009. Decline in bee diversity and abundance from 1972-2004 on a flowering leguminous tree, *Andira inermis* in Costa Rica at the interface of disturbed dry forest and the urban environment. *Journal of the Kansas Entomological Society*. **82**(1): 1-20.

Harvey, J. A., Robin, H., Inge, A., Yves, B., James, H. G., and Bezemer, T. M. 2020. International scientists formulate a roadmap for insect conservation and recovery. *Nature Ecology and Evolution*. **4**(2): 174-176.

Iyer, G. 2019. Why India's insects are disappearing. *The wire* [on-line]. Available: https://thewire.in/environment/why-indias-insects-are-disappearing. [20 Aug. 2020].

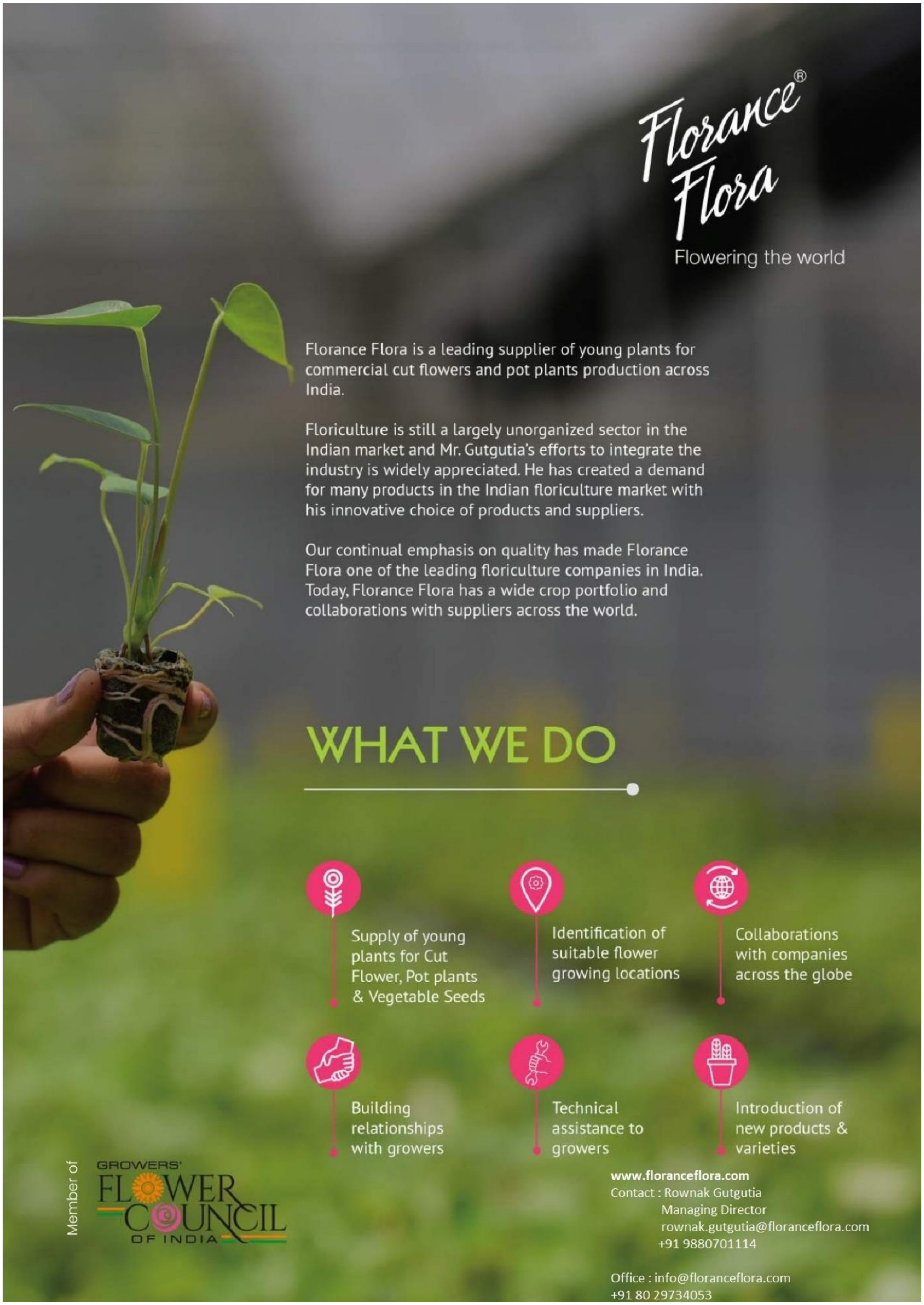
Jana, G., Misra, K. K., and Bhattacharya, T. 2006. Diversity of some insect fauna in industrial and non-industrial areas of West Bengal, India. *Journal of Insect Conservation*. **10**: 249- 260.

Lazaro, A., Chroni, A., Tscheulin, T., Devalez, J., Matsoukas, C., and Petanidou, T. 2016. Electromagnetic radiation of mobile telecommunication antennas affects the abundance and composition of wild pollinators. *Journal of Insect Conservation*. **20:** 315-324.

Sánchez-Bayoa, F. and Wyckhuysb, K. A. G. 2019. Worldwide decline of the entomofauna: a review of its drivers. *Biological Conservation.* 232: 8-27.

Wilson, R. J., David, G., Javier, G., and Victor, M. J. 2007. An elevational shift in butterfly species richness and composition accompanying recent climate change. *Global Change Biolology*. **13**(9): 1873-1887.

MS Received 20 January 2022
MS Accepted 26 February 2022


Florance Flora®
Flowering the world
Florance Flora is a leading supplier of young plants for commercial cut flowers and pot plants production across India.
Floriculture is still a largely unorganized sector in the Indian market and Mr. Gutgutia's efforts to integrate the industry is widely appreciated. He has created a demand for many products in the Indian floriculture market with his innovative choice of products and suppliers.
Our continual emphasis on quality has made Florance Flora one of the leading floriculture companies in India. Today, Florance Flora has a wide crop portfolio and collaborations with suppliers across the world.
WHAT WE DO
Supply of young plants for Cut Flower, Pot plants & Vegetable Seeds
Identification of suitable flower growing locations
Collaborations with companies across the globe
Building relationships with growers
Technical assistance to growers
Introduction of new products & varieties
Member of
GROWERS' FLOWER COUNCIL OF INDIA
www.floranceflora.com
Contact : Rownak Gutgutia
Managing Director
rownak.gutgutia@floranceflora.com
+91 9880701114
Office : info@floranceflora.com
+91 80 29734053

DOI: 10.55278/ZGXF9057

Global crop pollinators-not just bees!

Sharanabasappa M. Ganganalli and Haseena Bhaskar*
*AINP on Agricultural Acarology, Department of Agricultural Entomology,
College of Agriculture, Vellanikkara, Kerala Agricultural University,
Thrissur- 680656, India
Corresponding author: mgsharanabasappa@gmail.com

Pollen transfer in plants is accomplished by various abiotic and biotic agents. Abiotic agents of pollination are inanimate physical forces like wind, water and gravity, and thus pollination is at random. Biotic pollination carried out by animals, termed as zoophily on the other hand, is accurate. Animal pollinators are engaged in a remarkable mutually beneficial interaction with the plants. By recent estimates, nearly 90 percent of the described angiosperm species are pollinated by animals (Ollerton *et al.*, 2011). Globally, animal pollinated crops have been estimated to constitute 1/3rd of the human diet (Klein *et al*., 2007).

The biotic pollination naturally falls into several distinct classes: pollination by insects (entomophily), pollination by invertebrates such as snails and slugs (malacophily) and pollination by vertebrates, such as birds (ornithophily), bats (chiropterophily) and nonflying mammals (Simpson, 2010). Insect pollination or entomophily is the most common type and has played a major role in the evolution of angiosperms. Bee pollination (melittophily) of crops is well documented and bees are often assumed to be the most important pollinators.

Wild pollinators other than honey bees recently have been recognized for their role in increasing and stabilizing crop-pollination services. Non bee insect pollinators include beetles (cantharophily), flies (myophily), butterflies (psychophily), moths (phalaenophily) and ants (myrmecophily). Midges in the family Ceratopogonidae (Diptera) are the most important pollinators of cacao globally (Adjaloo and Oduro, 2013). The African weevil, *Elaedobius kamerunicus* was introduced into Malaysia in 1980 to increase pollination of oil palm, and within a few years, the weevil established in oil palm plantations nationwide. Following the introduction, the fruit set improved and yield increased by 20 percent in Peninsular Malaysia (Ponnamma, 1999). Ant pollination is a rare mutualistic association and often occurs with flowers that are low growing and inconspicuous. *Conospermum undulatum* (Proteaceae), a threatened plant species, endemic to Australia has evolved pollen with resistance to the negative effect of ant secretions on pollen grains, with ants providing effective pollination services (Delnevo *et al*., 2020).

Pollination by snails and slugs is considered as a rare and infrequent phenomenon. The graceful awl snail, *Lamellaxis gracile* plays a significant role in the pollination of morning glory, *Volvulopsis nummularium* (Convolvulaceae), especially on rainy days when the activity of bees is completely lacking (Sharma *et al*., 2007). The nectar-feeding glossophagine bats searching for flowers are guided by their echolocation system as well as olfactory cues in detecting and recognizing nectar sources. (Helversen *et al.,* 2002).

Bird pollination is as important as insect pollination in the tropics and in Southern temperate zones. Balasubrmanian (2012) reported that 292 forest birds are involved in pollination and seed dispersal in south India. Out of them, birds belonging to family Nectariniidae, Sturnidae and Zosteropidae represented by sunbirds, mynas and starlings form the major avian pollinators in Indian forests.

Pollination appears to be increasingly endangered by human activities in many ecosystems worldwide. The need for conservation of pollinators must be fully recognized by biologists, ecologists and agriculturists for maintaining biodiversity and sustainable crop production. Conservation efforts for pollinators should focus on regulation of pesticides, integrated pest management and conservation or restoration of natural/semi-natural habitat.

Reference:

Adjaloo, M. K. and Oduro, W. 2013. Structure and Stability of Cocoa Flowers and Their Response to Pollination. http://dx.doi.org/ 10.1155/2014/513623

Balasubramanian, P. 2012. Pollination and seed dispersal services by Indian forest birds. In: Ecosystem services: do we need birds? Proceedings of Annual Conference- 2012, British Ornithologist's Union. 3-5 April 2012.

Delnevo, N., Etten, E. J., Clemente, N., Fogu, L., Pavarani, E., Byrne, M. and Stock, W. D. 2020. Pollen adaptation to ant pollination: a case study from the Proteaceae. *Annals of Botany* **126**: 377-386.

Helversen, D. V., Holderied, M. W., and Helversen, O. V. 2002. Echoes of bat-pollinated bell-shaped flowers: conspicuous for nectar-feeding bats. *J. Exp. Biol.* 206: 1025- 1034.

Klein, A. M., Vaissiere, B., Cane, J. H., Steffan-Dewenter, I., Cunningham, S. A., and Kremen, C. 2007. *Importance of crop pollinators in changing landscapes for world crops.* *Proc. Royal Soc. B: Biol. Sci.* **274**: 303-313.

Ollerton, J., Winfree, R. and Tarrant, S. 2011. How many flowering plants are pollinated by animals? *Nordic Society Oikos* **120**: 321-326.

Ponnamma, K. 1999. Diurnal variation in the population of *Elaeidobius kamerunicus* on the anthesising male inflorescences of oil palm. *The Planter* **(881)**: 405-410.

Sarma, K., Tandon, R., Shivanna, K. R. and Ram, H. Y. M. 2007. Snail-pollination in *Volvulopsis nummularium*. *Curr. Sci*, **93**: 6.

Simpson, M. G. 2010. Plant Reproductive Biology. *Plant Systematics* (2nd edition), 573-584. doi:10.1016/b978-0-12-374380-0.50013-0.

MS Received 01 February 2022
MS Accepted 28 February 2022

Student notes/Essays/Poems

Fall armyworm: A destructive pest of maize

N. Mohamed Saheel
Agricultual College & Research Institute, Kudumiyanmalai
Pudukottai, Tamil Nadu, 622104, India
Corresponding author: saheelsaheel1513@gmail.com

Introduction

Spodoptera frugiperda (Smith), fall armyworm is a lepidopteran belonging to Noctuidae family. The fall armyworm is native to the tropical regions of the western hemisphere from the United States to Argentina. In 2016 it was reported for the first time in West and Central Africa, but now it threatens Africa and Europe. The term armyworm can refer to several species often describing the large-scale invasive behavior of the species. Larval stage '*frugiperda'* Latin for lost fruit, named because of the species ability to destroy crops.

Life cycle of fall armyworm:

It includes egg, 6 growth stages of caterpillar, pupa and moth.

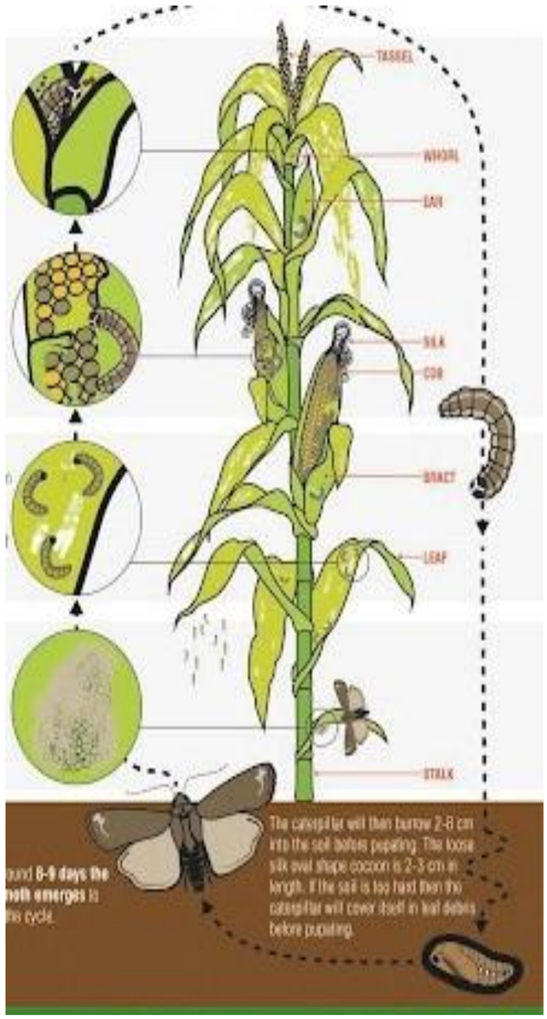
Day 1-3: The cycle begins when 100 to 200 eggs are laid on the underside of the leaves, typically near the base of the plant, close to junction of the leaf and stem.

Day 3-6: After hatching the young one feed on leaves leaving semi transparent patches called windows. In young plants, the caterpillars prefer to eat the leaf whorl, but in older prefer leaves around the cob silks.

Day 6-14: Caterpillars will also eat their way through the protective leaf bracts into the side of the cob where they feed on developing kernals. By the time the caterpillars reach the top of the plant. They will be bigger and do the most damage, leaving ragged holes in the leaves. On young plants, this can kill the growing point, stopping new leaves or cobs from developing.

Day 14 -23: After approximately 14 days, fully grown caterpillars will drop to the ground and pupate. Before pupating the caterpillars burrow 2-8 cm into the soil. Around 8th day adult moth will emerge from the ground and the cycle will start all over again.

The life cycle is completed in about 30 days during the summer, but 60 days in the spring and autumn, and 80 to 90 days during the winter.



A picture from FAO (2018), IPM of fall armyworm

On Maize ;A guide for farmer field schools in Africa.

Early stages of development of Fall armyworm

Source; *Photograph by James Castner, University of Florida..*

Identification

The egg is dome shaped; the base is flattened and the egg curves upward to a broadly rounded point at the apex

Larvae: There usually are six instars in fall armyworm. However, this larva does not feel rough to the touch, as does corn earworm, *Helicoverpa zea* because it lacks the microspines found on the similar-appearing corn earworm. Fall armyworm resembles both armyworm and corn earworm

The pupa is reddish brown in color

Adult: In the male moth, the forewing generally is shaded gray and brown, with triangular white spots at the tip and near the center of the wing. The forewings of females are less distinctly marked, ranging from a uniform grayish brown to a fine mottling of gray and brown. Adults are nocturnal. Duration of adult life is estimated to average about 10 days

Male

Female

(Photo by J.E. Smith)

Two distinct features identify fall armyworms. The head has light markings that form an upside down “Y” while the opposite end has four black dots that form a square.

This species seemingly displays a very wide host range. The most frequently consumed plants are field corn and sweet corn, sorghum, Bermuda grass, and grass weeds such as crabgrass, *Digitaria* spp. The UN FAO estimates that *S. frugiperda* will reduce corn yield by 17.7 million metric tons if not successfully controlled. They show cannibalistic behaviour.

Damage and Symptoms: Larvae cause damage by consuming foliage. Young larvae initially consume leaf tissue from one side, leaving the opposite epidermal layer intact. By the second or third instar, larvae begin to make holes in leaves, and eat from the edge of the leaves inward. Feeding in the whorl of corn often produces a characteristic row of perforations in the leaves while ear feeding results in both quality and yield reduction.

Scraping of leaf, extensive foliage damage, whorl damage with excreta, tassel damage, ear damage.

Management

- ➢ Deep plough fields to expose pupae to sunlight and predators.
- ➢ Add neem cake @ 200kg/acre
- ➢ Follow ridge and furrow planting method
- ➢ Seed treatment Cyantraniliprole 19.8% + Thiamethoxam 19.8% FS @ 6 ml/kg of seed offers protection for 15-20 days of crop growth.
- ➢ Intercrop with legumes in 2:1 ratio
- ➢ Install pheromone traps @ 4/acre
- ➢ Natural enemies:
  - Egg parasitoid: *Trichogramma pretiosum*,
  - Egg-larval parasitoid: *Coccygidium sp*
  - Wasp parasitoids: *Cotesia marginiventris* and *Chelonus texanus*.
  - Fly parasitoids: *Archytas marmoratus*
  - Predators: Striped earwig, Spined soldier bug and insidious flower bug.
  - Entomopathogen : *Nomuraea rileyi*
- ➢ Early harvest allows many corn ears to escape the higher armyworm densities that develop later in the season

[Ref: FAO (2018), Integrated management of Fall armyworm on Maize: A guide for farmer field schools in Africa.]

Pest status in Bangladesh:

Fall armyworm is a serious pest causing significant economic damage to to several crops if it is not controlled in its earlier stages.

References:

Ashley T. R., Wiseman B. R., Davis F. M, Andrews K, L. 1989. The fall armyworm: a bibliography. *Florida Entomologist* 72: 152-202.

Goergen G., Kumar PL., Sankung S. B., Togola A., Tamo M. 2016. First report of outbreaks of the fall armyworm *Spodoptera frugiperda* (JE Smith) (Lepidoptera, Noctuidae), a new alien invasive pest in west and central Africa. *PLoS ONE*, DOI: 10.137/journal.pone.0165632

B. M. Prasanna, Joseph E Huesing., Regina Eddy, 2018. Fall armyworm in Africa; A guide for Integrated Pest Management, First Edition. Mexico. CDMX: CIMMYT.

FAO (2018), Integrated management of Fall armyworm on Maize: A guide for farmer field schools in Africa.

MS Received 25 December 2021
MS Accepted 18 January 2022

Pollination biology of pomegranate (*Punica granatum* L.) with special reference to entomophily

Suresh R. Jambagi[1]* and Nandini H K[2]
[1]Department of Agricultural Entomology, University of Agricultural Sciences, GKVK Bengaluru, Karnataka, India-560065
[2]Agricultural Research Station, Hoogeri, Bidar, Karnataka, India-585401
Corresponding author: jambagisuru@gmail.com

Abstract

The pomegranate (*Punica granatum* L.) of Punicaceae family is the earliest and most significant outgrowth crop of arid and semi-arid environments all over the world. Pollination is the one phenomenon, which influences fruit set in many horticulture crops. From the several studies, pomegranate is found to have all three types of pollination modes (Self, cross and often-cross pollination). Fruit production for agricultural yield necessitates the synchronisation of several critical reproductive processes. Understanding the juvenile period, flowering behaviour, duration and flowering seasons in different parts of the country is most crucial in modern crop improvement programmes. So, in depth knowledge of floral biology is an inevitable pre-requisite for development of new cultivars. With this perspective, it is necessary to review the current state of knowledge on floral biology of pomegranate.

Key words: Entomophily, Floral biology, Fruit set, Pollination, Pomegranate

Introduction

The pomegranate (*Punica granatum* L.), which belongs to the Punicaceae family, is an old and important tropical and subtropical fruit. It is thought to have originated in the regions of Iran and northern India (Soriano *et al.*, 2011). Many countries have recorded wild pomegranate bushes being planted in gardens for their fruits or even for their aesthetic appeal (Xhuveli, 2012). Pomegranates is reportedly grown all over the world between the latitudes of 41° N and 42° S. It is grown on around 1.20 lakh ha in India, with a yearly yield of 28.45 lakh tonnes and a productivity of about 6.60 tonnes per ha (Kumar *et al.*, 2020). Maharashtra is the largest producer of this fruit crop in India. For the past decade, it has become an important export crop in India (Chandra and Jadhav, 2008).

Flowering period

In north India, there are two flowering seasons, but Nalawadi *et al*. (1973) recorded three blooming seasons in western India. There are three different blossoming seasons in subtropical central and western India *viz*., ambe bahar (January-February), mrig bahar (June-July), and hasth bahar (September-

October). Growers choose ambe bahar because of its great yield due to profuse blossoming when compared to other flowering seasons (Prasannakumar, 1998). Flowering was recorded in Karnataka for 80-87 days between June and August (Nalawadi *et al*., 1973). Only one flowering season was seen in Punjab, from April to June (Josan *et al*., 1979a).

Pollination

Pollination is a regular phenomenon in flowering plants, particularly horticulture crops, and it influences fruit set intensity and yield. Through varietal compatibility, synchronised blooming and ideal environmental conditions, it entails effective pollinator and pollinizer integration. A pollinator is a biotic agent that delivers pollen from the anther to the stigma of a flower, causing fruits or seeds to develop through fertilisation. Bees, flies, bats, moths and birds are examples of such pollinators. A pollinizer, on the other hand, is a plant that serves as a pollen source for related plants in order for effective pollination to occur. Many horticultural crops are self-sterile and require cross pollination in order to develop seeds and fruit (Free, 1993).

Both self and cross pollination noticed in pomegranate, however cross pollination is favoured for increased fruit yield. Hand pollination yielded a higher proportion of fruit set than pollination under natural circumstances (Josan *et al*., 1979a, Bavale, 1978).

Role of insects in pomegranate pollination

A greater number of insects, including black ants, honey bees, beetles and lemon butterflies visit the pomegranate blooms. Meanwhile, all flower visitors may necessarily not pollinators. They may visit flowers by mistake, landing on flower/ substrata for taking rest after long flight or there may be possibility of accidently, they caught on particular plant in surveyor eyes while looking for the pollinators. Even though, they are aiding in pollination service, there efficiency is not quantifiable or infrequent.

In comparison with self-pollination, bee pollination might greatly enhance the fruit set and weight of pomegranate fruit (Tao *et al*., 2010). Fruit set is boosted by 68 percent with cross pollination and fruit quality (number of seeds per fruit, fruit size) is also improved (Anonymous, 2006). Three insects *viz*., *Camponotus* spp., *Apis* spp., and *Papilio demoleus* were responsible for increased yield (67.9 % fruit set) in pomegranate as compared with induced self-pollination by emasculation (46 %) as reported by Nath and Randhawa (1959a). According to research Western Australia's Department of Agriculture and Food (DAF, 2005), stated that honey bees are responsible for 10 per cent increase in pomegranate pollination. One of the projects initiated by crop life India Pvt. Ltd in Maharashtra that aims in creating awareness about the importance of honey bees in crop yield enhanced the pomegranate yield by 35 percent and provided 42 percent additional income, not only due to increase in yield, but also by improved fruit quality (Anonymous, 2018). With the elaborative work on cross pollination, still there is a scarcity of quantitative data on the role and pollination efficacy of honey bees in pomegranate pollination. In the earlier study, Knuth (1908) enumerated that the beetles of the genus *Trichodes* and *Cetonia* can influence both self and cross-pollination while they devouring the flowers of pomegranate tree.

While some research studies suggests that insect pollinators such as honey bees are beneficial in enhancing fruit set and quality of pomegranate yields, many scientific reports have shown that significant yields can still be obtained from self-pollination. In this perspective, less research has been conducted on pomegranate cross pollination and role of pollinating agents like insects (Entomophily). Meanwhile, there is a huge scope with respect to evaluation and quantification of role of insect fauna in cross pollination of pomegranate in future.

Conclusion

Pomegranate sex appearance varies depending on blooming season and timing. Studies aimed at determining when male and bisexual flowers are required would give insight on what ecological and physiological variables may play a role in pomegranate sex determination. Still there is need to explore more information regarding extent of cross pollination involving biotic and abiotic agents, meanwhile fruit set due to crossing of pollen from male, intermediate and bisexual flowers.

Acknowledgments

Author wish to thank Dr. V. V. Belavadi, Emeritus Scientist, University of Agricultural Sciences, GKVK Bangalore for his untiring guidance, constant support and much needed suggestions to improve the quality of this manuscript.

References

Anonymous, 2006. Grower and beekeeper guide: Avocado pollination-best practice guidelines. Avocado Industry Council Ltd., Tauranga, New Zealand.

Anonymous, 2018. The Importance of Insect Pollinators for Agriculture. *BEEINFOrmed*. https://www.cropscience.bayer.com/sites/cropscience/files/inlinefiles/BEEINFOrmed_7_The-Importance-of-Insect-Pollinatorsjlouz8q1.pdf

Bavale, S.V., 1978. Floral biology of different cultivars of pomegranate *(Punica granatum L.)*. Doctoral dissertation, Mahatma Phule Krishi Vidyapeeth, Rahuri.

Chandra, R. and Jadhav, V.T., 2008. Pomegranate (*Punica granatum* L.) biodiversity and conservation. In: proceedings of International

Biodiversity Day, Uttar Pradesh State Biodiversity Board, Uttar Pradesh, India, pp 63-69.

DAF, 2005. 'Honey bee pollination benefits for crops and orchards in Western Australia'. [Online]. Department of Agriculture and Food in Western Australia.

Free, J.B., 1993. Insect pollination of crops 2nd ed. Academic Press, London, U. K. 684.

Josan, J.S., Jawanda, J.S. and Uppal, D.K., 1979a. Studies on the floral biology of pomegranate. II. Anthesis, dehiscence, pollen studies and receptivity of stigma. *Punjab horticultural journal*. **19**(1): 66-70.

Knuth, P., 1908. Handbook of flower pollination. 2, Translated by J. R, A. Davis.

Kumar, V.N., Godara, A. and Mirza, A., 2020. Characteristics of Flowering and Fruiting Description of Pomegranate (*Punica granatum* L.). *Int. J. Curr. Microbiol. App. Sci*. **9**(11): 401-412. doi: https://doi.org/10.20546/ijcmas.2020.911.049

Nalawadi, V.G., Farooqui, A.A., Dasgupta, N., Reddy. M.A., Gubbaiah, S.G.S. and Nalini, A.S., 1973. Studies on the floral biology of pomegranate (*Punica granatum* L.). *Mysore J. Agric. Sci.* **7**:213-225.

Nath, N. and Randhawa, G. S., 1959a. Studies on floral biology of pomegranate. II. Anthesis, dehiscence, pollen studies and receptivity of stigma. *Indian J. Hortic.* **16**: 121-135.

Prasannakumar, B., 1998. Pomegranate. In: Chattopadhyay TK (Ed) A Textbook on Pomology (Vol 3), Kalyani Publishers, Ludhiana, pp. 232.

Soriano, J.M., Zuriaga, E., Rubio, P., Lla´cer, G., Infante, R. and Badenes, M.L., 2011. Development and characterization of microsatellite markers in pomegranate (*Punica granatum* L.). *Mol. Breeding.* **27**: 119–128.

Tao De-shuang, Dong Xia, Dong Kun, Zhang Xue-wen and Yu Yu-sheng, 2010. Study on the effects of pollination by honey-bees on pomegranate (*Punica granatum* L.). *J. Bee* **3**: 10-11.

Xhuveli, L., 2012. Albania, the domestication country for pomegranate (*Punica granatum* L.). *Genet. Resour. Crop Evol*. **59**: 1605-1610.

MS Received 31 January 2022
MS Accepted 26 February 2022

Bee a non-vegetarian

Challla Nalini [1], Mahesh Balaso Gaikwad [2]
[1] Teaching Associate, College of Horticulture, Anantharajupeta, Kadapa, Andhra Pradesh, India 516105
[2] Project Associate, CSIR-Central Institute of Medicinal and Aromatic Plants, Lucknow, Uttar Pradesh, India 226015
Corresponding author: nalinichalla18@gmail.com

"Busy as a bee" is a real saying. A bee is the epitome of multitasking. If I ask you to imagine a bee, what is the first thing that comes to your mind? Contemplating, with an exception of a few, the majority of people reading this article are either interested in entomology or have already mastered the subject. I hope the answer to my above question is not just HONEY. To an extent, we are all aware of what a multi performer a bee is. Here is a quick snippet of skills majority of the bees have.

A janitor: The very first job a bee gets to do is to clean the hive, removing the dead bees out of the colony and maintaining hygiene (1-2 days-Worker)

A nurse: Feeds and cares for the young ones, drones and ueen bee (3-10 days -worker)

A trainee: They train themselves by taking orientation flights prior to their first foraging flights (11-12 days- worker)

A carpenter: They build honeycomb, packs pollen and seals honey in the cells (12-18 days)

A water carrier: They carry water to the foraging bees and put it back on their abdomen to reduce the heat that is produced.

A security guard: They guard the entrance of the hive (20-21 days)

A forager: Field collection of honey and pollen (21st day onwards)

An absent father: Drones or male bees will vie for the honour of insemination, mate with the queen, and die a victorious death.

A royal queen/mother: For a bee to become Queen, it must be fed a unique diet called royal jelly, which is secreted from special glands in young worker bees and is extremely nutrient-dense. She's more like the matriarchal hive's 'mother.' (After all, she did give birth to every single bee in the hive.)

A dancer: Honeybees communicate a variety of information, ranging from the need to swarm to the direction and distance to a food source through dance.

A singer: Buzzing isn't just for show; vibrations of their wings and bodies cause pollen to be transferred from one bloom to another, resulting in "pollination." Bees also buzz to defend themselves or their hives and an “altruist” in a whole.

So now let me put another question are bee’s vegetarian or non-vegetarian?? Well, that’s not quite a tricky question! Majority of your answer would be VEGETARIAN since they obtain nectar from the plants which obvious is a vegetarian source. Bee species can be classified as vegetarian wasps since they evolved from a carnivorous group of wasps known as the spheciform complex. Bees were prompted to use a new energy source not previously utilised by other insects as their feeding patterns changed from carnivorous to floral-based. The proliferation of bee species paralleled the evolution of flowering plants as time passed and evolution selected in favour of these relationships, providing a wonderful example of co-evolutionary connection. This split between wasps and bees occurred between 140 million and 110 million years ago, the mid-Cretaceous period.

Although we can speculate on how the gut microbiome of bees altered when they evolved into vegetarian wasps, we do not know how such drastic transformation took place. What if some extant bee species went back to consuming meat as a nutrition source after becoming vegetarians? Exploring this question, research published in November 2021 in “Microbial Ecology” garnered a lot of attention late last year 2021 (Figueroa *et al*. 2021). Where they studied stomach microbiota of a group of bees in the American tropics. These bees are possibly the most surprising living example of how dietary changes affect the gut microbiome in animals, as bizarre as that may sound. These bees take meat from carcasses instead of pollen from blossoms in deep tropical jungles from Costa Rica to Brazil. Given their partial or complete reversion to a carnivorous diet making themselves Vulturous bees.

These stingless bees, are members of the Meliponini tribe, these bees are eusocial in habit. In 1982, David Roubik, Ph.D., an entomologist at the Smithsonian Tropical Research Institute, was the first to record a bee species called *Trigona hypogea* that was discovered in the tropical rainforest of Panama and practised obligate necrophagy (eating only on dead animals). *Trigona hypogea*, *Trigona necrophaga*, and *Trigona crassipes* are the world's only three carrion-feeding bee species (Camargo *et al*., 1991). Other stingless bee species can gain nutrients by eating both pollen and carrion, making them omnivores. However, how do vulture bees only eat carrion? Vulture bees deliver carrion to their nests after slicing flesh from deceased creatures like lizards, snakes, birds, and even fish. However it is unknown how they store it. Two conflicting scenarios have been offered by experts: Vulture bees deposit and mix carrion directly in wax pots in the initial stage. The mixture grows into a nutritious paste that the colony members are fed after 14 days. Young vulture bee workers devour the carrion to create a secretion with a specific gland, according to the second idea. Workers then store the secretion in wax pots to create the nutritious paste. Whatever technique vulture bees employ to consume the meat they collect, one thing is certain: they regained the taste for rotting flesh that vegetarian bees had lost!

What about the microbiota of vulture bees? The bacterial groups that live in their stomach could have been affected by such a drastic alteration in their nutritional habit. All stingless bees, including vulture bees, are members of the corbiculate bee family, which also includes bumble bees, honey bees, and orchid bees. Corbiculate bees' gut microbiota is made up of five primary bacterial groups that are common and conserved throughout most corbiculate bee species. The vulture bee gut microbiota's reaction to the drastic change in feeding regimen, on the other hand, remained a mystery to bee experts.

"Vulture bees lost some ancestral core bacteria, kept others, and formed new relationships with acidophilic microorganisms," according to the study's findings. What makes acidophilic bacteria so special? You would be more exposed to germs if you ate decaying meat, raising your chances of getting a serious infection. Acidophilic bacteria would be your best friends in such a situation. Carnobacterium and Apilactobacillus, for example, may increase the acidity of your gut, preventing pathogens from making you sick when you chew decaying meat bits. The vulture bee microbiome, unlike the microbiome of pollen-eating bees, contains lactic acid bacteria and acetic acid bacteria to feed on carrion.

So, next time when someone asks you to imagine a bee or you spot a bee visiting flowers, take into account its vulture species and their carnivorous nature to meet the protein requirement.

References:

Figueroa LL, Maccaro JJ, Krichilsky E, Yanega D, and McFrederick QS. 2021. Why Did the Bee Eat the Chicken? Symbiont Gain, Loss, and Retention in the Vulture Bee Microbiome. *Microbial Ecology*, 12: e02317-21.

Camargo J, and Roubik DW. 1991. Systematics and bionomics of the apoid obligate necrophages - the Trigona-hypogea group (Hymenoptera, Apidae, Meliponinae). *The Biological Journal of the Linnean Society* ,44:13-39.

MS Received 02 January 2022
MS Accepted 12 February 2022

(Photo by Quinn McFrederick, Ph.D., Figueroa *et al*. 2021)

S. Bradleigh Vinson: Life and Contributions

Rajesh V
Division of Entomology, ICAR-Indian Agricultural Research Institute, New Delhi-110012 India
Corresponding author**: **rajeshrv8919@gmail.com

Dr. S. Bradleigh Vinson, professor at Texas A & M University, College Station, TX, retired on January 31, 2016, after 47 years of employment. He is internationally recognized for research in the physiology and behaviour of parasitic Hymenoptera, imported fire ants (IFAs), and solitary bees of the genus *Centris*. Vinson was born in Mansfield, Ohio on April 1938, he is known throughout the world for his work on the physiological ecology of parasitic wasps, including polydnaviruses, which are viruses that are injected along with venom and an egg into a host caterpillar. These viruses prevent the caterpillar's immune system from attacking the wasp's egg when the host is stung.

Other projects of Vinson includes work on chemical communication between hosts and their natural enemies in the form of pheromones, various aspects of reproductive biology, tritrophic interactions between parasitoids, their host insects, and host plants the pest species feed upon.

In addition, he has conducted largely independent research programs on the ecology and biology of red imported fire ants and the field ecology of solitary bees inhabiting the forests of Costa Rica. His latest projects include writing a book about the use of *Trichogramma* wasps, tiny stingless wasps that parasitize other insects' eggs, and collaborating with colleagues in the College of Engineering on a research project involving cockroaches serving as drones.

Inspiration for writing contributions of S. Bradleigh Vinson:

Mutualism between eukaryotes and viruses is not often reported and one of those kinds is Polydnaviruses, first discovered by Bradleigh Vinson accidentally. This caught my interest and inspired me to know about him.

Polydnaviruses that live in association with parasitoid wasps are the best-known example of insect-vector symbionts.

MS Received 30 January 2022
MS Accepted 27 February 2022

Watching insects: my enjoyable hobby

Varsha. V
ELGI Nagar, Coimbature, Tamil Nadu 641016, India
Corresponding author: varsha.vjr@gmail.com

Hello!! My name is Varsha V. I'm 15 years old studying in class X, I live in a city called Coimbatore (South India) and I'm an insect watcher. I've been watching insects for the past couple of months and this has become my new hobby. It all started with the book- "Watching Insects by Dr. Abraham Verghese" gifted to me by my friend.

That book sat on my shelf for 2 years because I didn't think that insects could be interesting. I usually found them boring and annoying, especially the house flies and the mosquitoes.

But one day, we were cutting down creepers from my balcony and I saw a couple of big red ants scurrying about on my gate. I'd never really given much thought to ants before, probably because I get bitten a lot, but that day I was fascinated watching them move in line, the same day they were cleaning our garden and I watched a lot of ants coming out from a damp wood piece. Its abdomen was nearly transparent; I think they are red carpenter ants. After watching those ants and a few other bugs and insects for the next consecutive days, I became so fascinated that I started reading the book.

The book helped me understand insects on a more scientific level as I learned about their body parts, their scientific names etc. I slowly started observing the diversity of the insects and how beautiful they could be. I loved watching spiders too, even though they are not insects.

I collected a spider egg sac from my curtains. I took them because they were going to be killed when the curtains were washed. So I then hung them on a lid of a box and closed it shut. The spiderlings hatched and seven of them had come out while the others were still in the sac. I also noticed a spider web outside my house hosting about 50-60 tiny spiderlings or, probably more than that.

I usually go out to look for dead insects so that I could start an insect collection. I now have a tiny collection of insects mostly made up of small moths. I love watching moths when they sit on my glass window at night, they are attracted to the light from the bulb. Seeing my interest in insects my mother called out to me one afternoon to show me a butterfly. It was hovering over my mother's precious curry leaf plant and after a couple of minutes, it flew away. I was naturally curious and checked out the plant. It had a yellow egg under the leaf and after research, I found out that it was the common Mormon butterfly's egg. Right now my plant hosts two tiny caterpillars and an egg. Honestly, this hobby isn't as tough or boring as it seems. On the other hand it's extremely easy and very fascinating. I made a terrarium for hosting insects temporarily so that I can watch and observe them. You can easily make an insectarium, just find a box (a glass box would be better for easy observation), put mud and rocks at the bottom. Add in some twigs or a branch and keep some plants. I mostly prefer snake plants as they can survive even in harsh climates and they don't need a lot of water and maintenance. Currently, it's hosting a brown grasshopper whom I named Mr.Hoppey. He is my temporary pet. And I may release him back to my garden soon.

Watching insects ultimately brings you closer to nature and is definitely an enjoyable hobby.

With my insectarium

(Congratulations Varsha- keep going; may insects charm you all your life -Editors)

Obituary

Professor E. O. Wilson, nicknamed 'Darwin's Natural Heir' is no more

"He was a true visionary with a unique ability to inspire and galvanize. He articulated, perhaps better than anyone, what it means to be human".

- David J Prent,
Chairman of the Board, EO Wilson Biodiversity Foundation

Professor Edward Osborne Wilson, who passed away recently (Dec 26, 2021) was a path-breaking American entomologist (myrmecologist to be precise). He consistently extended the scope of his theories to cover all organisms including humans. His research has extended deep into other realms of science, sometimes with provocative results. His life and work are an inspiration for all biologists and naturalists, and especially so for entomologists. A summary of his early life and his outstanding contributions are briefly mentioned in this obituary.

Edward Wilson was born on June 10, 1929, in Birmingham, Alabama and grew up in various towns of the Southern United States. His parents divorced when he was just seven and in the same year Wilson blinded himself in one eye in a fishing accident. He did not seek medical treatment and the lens of his right eye had to be removed after a few months due to development of cataract. From childhood, Wilson was deeply interested in the natural world. But damage to his depth perception because of the eye injury, and the onset of partial deafness during his adolescence limited his ability for observing birds. Nevertheless, he could easily notice small insects in fine detail with his 20/10 vision in the left eye. His natural explorations then drew him to the fascinating world of ants (Ruse, 2021).

Wilson obtained his early training in biology at the University of Alabama (BS 1949, MS 1950). After receiving a doctorate in biology (Taxonomy of ant genus *Lasius*) at Harvard University in 1955, he worked for nearly his entire professional life at the same university. Prof. Wilson was a member of the biology faculty (1956-76), Frank B. Baird Professor of Science (1976-94), Mellon Professor of Sciences (1990-93), Pellegrino University Professor (1994-97) and University Research Professor Emeritus (1997-2021) at Harvard. In addition, he served as curator in entomology at the Harvard Museum of Comparative Zoology (1973-97).

Prof. Wilson described 40 new species of ants and made important discoveries in pheromonal communication in ants. Wilson was a prolific and brilliant writer who wrote more than 30 books. Among his early works was the book, *The Theory of Island Biogeography* (1967), written with Robert H

MacArthur, in which they examined how species rise and fall to attain species equilibrium in isolated islands. *The Insect Societies* (1971) provided a comprehensive picture of the ecology, population dynamics and social behaviour of ants and other social insects.

He extended his theories of insect behavior to cover all organisms in his controversial book *Sociobiology: The New Synthesis* (1975), a systematic study of the biological basis of social behavior in animals including humans. He proposed that such behavior is conditioned by the genes, environment and past experiences. With this seminal work, he founded the new discipline of sociobiology and came to be known as the '**Father of Sociobiology'**. The ideas on humans were further explored in his later books- *On Human Nature* (1978) and *Genes, Mind and Culture: The Coevolutionary Process* (1981). The former won him his first Pulitzer Prize for General Non-fiction in 1979.

In 1990, he along with Bert Holldobler produced a comprehensive treatise on the systematics, biology, and behavior of ants entitled *The Ants*, which won him another Pulitzer Prize (in 1991) along with Holldobler and also earned him the nickname of '**Ant Man**'. This was followed by another monumental work, *The Diversity of Life* (1992), wherein he sought to explain how the world's living species became diverse and examined the massive species extinctions caused by anthropogenic activities. His autobiography, *The Naturalist* (1994) traced the trajectory of his life- from a childhood spent in exploring the Gulf Coast of Alabama and Florida to life as a tenured professor at Harvard.

In his later career, Wilson increasingly turned to religious and philosophical matters. In *Consilience: The Unity of Knowledge* (1998), he strove to demonstrate the interrelatedness of sciences and humanities and ultimately the origins of all human thought. In *Creation: An Appeal to Save Life on Earth* (2006), he developed further the evolutionarily informed humanism he had explored earlier in *On Human Nature* (Famous Scientists, 2021).

Wilson received more than 150 prestigious awards and medals around the world and was an honorary member/ fellow of more than 30 world renowned and prestigious organizations, academies and institutions. Two of his books – *The Insect Societies* and *Sociobiology: The New Synthesis* were honoured with the Science Citation Classic award by the Institute for Scientific Information. The Royal Swedish Academy which awards the Nobel Prize, awarded Prof.Wilson the Crafoord Prize (1990), an award designed to cover areas not covered by the Nobel Prizes. The Council of Scientific Society Presidents conferred Dr Wilson with the Carl Sagan Award (1994) for Public Understanding of Science. Wilson was recognized as one of the Time Magazine's Most Influential People in America (1995). He was declared as the Humanist of the Year by the American Humanist Association (1999).

The EO Wilson Biodiversity Foundation (eowilsonfoundation.org) was established in 2005 to honour Dr EO Wilson, one of the most distinguished and recognized American scientists in modern history for his lifetime of pioneering scientific work in biology.

Wilson won the TED prize in 2007 for fulfilling a wish to positively impact life on this planet. Dr Wilson said, "I wish that we will work together to help create the key tool that we need to inspire preservation of Earth's biodiversity the Encyclopedia of Life". The Encyclopedia of Life (eol.org) was launched in February 2008 with 30,000 entries with an aim to create a web page for every living organism on the planet. It now has trait data for more than 1.999 million species and higher taxa.

Professor Wilson proposed the most ambitious biodiversity conservation project called the Half-Earth Project to be implemented by the EO Wilson Biodiversity Foundation. The book, *Half Earth: Our Planet's Fight for Life* (2016) proposes an achievable plan to serve our imperiled biosphere. It calls for devoting half the surface of the Earth to nature to stave off the mass extinction of species including our own.

The Biodiversity Foundation brought together a team consisting of educators, writers, media artists, 3D animators and textbook professionals led by naturalist Edward O. Wilson to create a cultural landmark- a portal that introduces students to the grandest story there is, the story of life on earth. The iBook *E. O. Wilson's Life on Earth* (2014) is authored by Wilson with Morgan Ryan and Gael McGill and is available for free download from the iBook Store (Apple) (E. O. Wilson Biodiversity Foundation, 2021).

On the demise of Prof.Wilson, Paula Ehrlich, President of EO Wilson Biodiversity Foundation and Co-founder of Half-Earth Project described him as "a relentless synthesizer of ideas, his courageous scientific focus and poetic voice transformed our way of understanding and our planet". Several generations of students, researchers and professors have felt inspired by the writings, research and lectures of Prof.Wilson. He always encouraged his students and young researchers to spend time in nature to find researchable problems, which would fascinate them. The best tribute to him would be to work for the fulfillment of his ideas on biodiversity conservation and human advancement.

References

E. O. Wilson Biodiversity Foundation (2021) E.O. Wilson, Darwin's natural heir has passed away. Available at: https://www.eowilsonfoundation.org/e-o-wilson-darwins-natural-heir-has-passed-away-at-92. Accessed 31 Dec 2021.

Famous Scientists (2021) E. O. Wilson. Available At: https://www.famousscientists.org/e-o-wilson. Accessed 29 Dec 2021.

Ruse M. (2021) E. O. Wilson. Encyclopedia Britannica. Available at: https://www.britannica.com/biography/edward-o-wilson. Accessed 29 Dec 2021.

Dr Ramesh Arora
Shri Guru Granth Sahib World University
Fatehgarh Sahib-140407 India

Obituary

Dr. Kartar Singh Brar **(06.04.1947 to 27.01.2022)**

Dr. Kartar Singh Brar, Professor of Entomology (Retd.) Punjab Agricultural University, Ludhiana (Punjab) was born on April 6, 1947 at Village Jalal (District Bathinda) in Punjab. He completed school education from his home town. He persued B.Sc. (Agriculture), M.Sc. (Entomology) and Ph.D (Entomology) from PAU Ludhiana. He joined PAU as a Research Assistant in 1971 and thereafter worked in the University as Assistant Entomologist, Entomologist, Senior Insect Ecologist and Professor of Entomology. He attained superannuation on April 30, 2007. He was an excellent researcher, teacher and an extension worker by profession and a definitely a great human being. During his service tenure, he was actively involved in the development of effective and sound strategies for the management of major insect pests of cotton, rice, sugarcane, oilseed and vegetables. His contributions especially in the development of biocontrol based pest management programmes are indeed significant. Being Principal Investigator in ICAR-AICRP on Biological Control of Crop Pests and Weeds, he gave significant recommendations on the biocontrol of lepidopteran pests in sugarcane, rice and maize using *Trichogramma* bioagents, which is still being followed by the farmers of Punjab on large scale and has been adopted by the sugar mills of the state. His other notable contributions are the development of IPM modules for mustard aphid, white grub of groundnut, foliage feeders of sunflower, sucking pests and bollworm complex of cotton, tomato fruit borer etc. He handled two research projects as PI, three as Co-PI and eight as a collaborator. He published his research work in the field of biological control, crop entomology (vegetables, oilseeds, cotton) as major author and has co-authored in more than 132 research papers in reputed journals. He also has 15 full papers as proceedings and 2 book chapters. His research contribution has been presented in more than 41 conferences at the National and International level. As an extension worker, he had outstanding contributions in the demonstration and transfer of BIPM technology to the farmers of Punjab state. He has to his credit more than 75 extension articles published in vernacular language. He taught 9 UG courses and 3 PG courses and guided 4 M. Sc. and one Ph.D. students.

His immense and significant contributions in the field of entomology, especially biocontrol will be remembered forever. He left for heavenly abode on 27th January, 2022. Dr Kartar Singh Brar was a dedicated scientist and his sad demise is an irreparable loss not only to his family and relatives, but also to scientific community. We pray to God to grant peace to his departed soul and provide strength to the bereaved family to bear the irreparable loss.

Dr P.S. Shera, Ph.D.
Senior Entomologist
Department of Entomology
Punjab Agricultural University
Ludhiana-141004
Punjab (India)

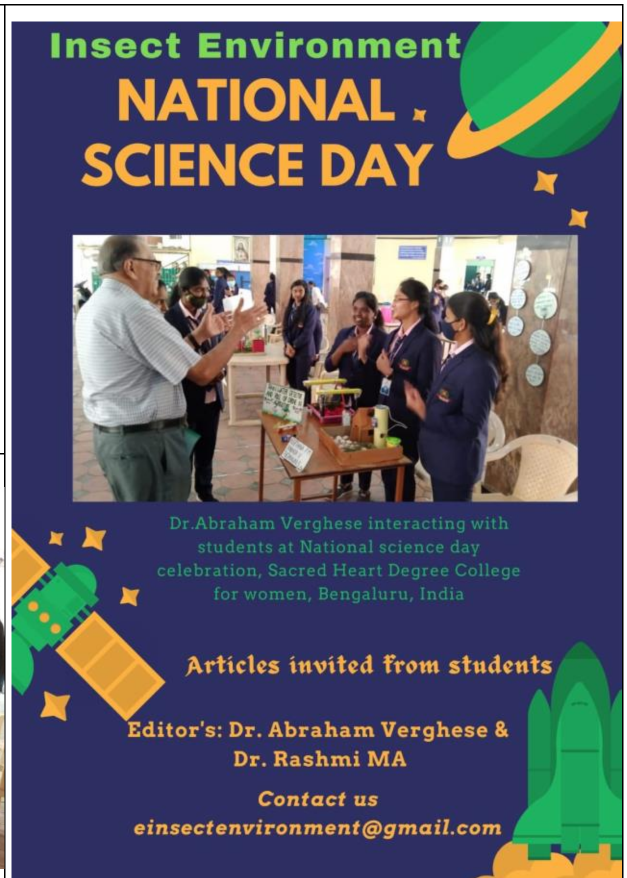
Extension activities of Insect Environment

Dr. Abraham Verghese, Editor-in-Chief, Insect Environment, Former Director ICAR-NBAIR Bengaluru was the chief guest at Josephites Forum for Birders (JFB) Natural Science Association, School of Life Sciences, Department of Zoology, St. Joseph's College (Autonomous) held on 19th February 2022.

From left **Dr. M. Jayashankar**, Editor IE, Assistant Professor, Department of Zoology, School of Life Sciences, St. Joseph's College (Autonomous), Bengaluru, **Dr. Rashmi, M.A**, Co-Editor-in-Chief IE, Senior Technical Officer (Entomology), Regional Plant Quarantine Station, Bengaluru. **Dr. Abraham Verghese**, Editor-in-Chief, Insect Environment, **Dr. Viyolla Pavana Mendonce,** Editor IE, Assistant Professor Zoology, School of Life Sciences, St. Joseph's College (Autonomous), Bengaluru, were present at Josephites Forum for Birders (JFB) Natural Science Association, School of Life Sciences Department of Zoology, St. Joseph's College.

National Science day

Dr. Abraham Verghese, Editor-in-Chief, Insect Environment, was the chief guest at National Science day celebration, Scared Heart Degree College for women, Bengaluru, India held on 28th February 2022.



Extension activities of Insect Environment

Sl. No.	Title	YouTube link for the videos
1	Management of fruit flies with rashvee fruit fly traps by Dr. Abraham Verghese & Dr. Rashmi, M.A	*https://youtu.be/K5u-bvdEWDw*
2	Salim Ali's reply sparked off first enumeration of birds in Bengaluru by Dr. Abraham Verghese	*https://youtu.be/PewV_x65K3Q*
3	Predators, Parasites & Pollinators for better crop production- Macrobials and Pollinators lecture by Dr. Abraham Verghese at BioAgri 2021 organised by Bioagri Input Producers Association (BIPA)	*https://youtu.be/hiDhQAmk1cc*
4	Management of mango tree borers using THAVEE tree gel by Dr. Abraham Verghese & Dr. Rakshitha Mouly	*https://youtu.be/_TE3T8JcAmg*
5	Raising residue-free potato with eco-friendly integrated pest management techniques	*https://youtu.be/-l6qDDaneaM*
6	Blue sticky *Tuta* pheromone traps to attract *Tuta*, thrips, whiteflies in tomato by Dr. Abraham Verghese & Dr, Rashmi, M.A	*https://youtu.be/YR96eo58RaI*
7	Pest Management in Tomato by Dr. Abraham Verghese & Dr, Rashmi, M.A	*https://youtu.be/ERKIvLAL1ec*
8	Pest Management in Mango (Flowering to Harvest) by Dr. Abraham Verghese& Dr, Rashmi, M.A	*https://youtu.be/W9QW8X0NZYM*
9	Integrated control of thrips complex in Chilli by Dr. Abraham Verghese & Dr, Rashmi, M.A	*https://youtu.be/Dvdu2WnktVE*
10	टमाटर में कीट प्रबंधन by Dr. Abraham Verghese	*https://youtu.be/x6Atfb8wqRI*
11	आम में कीट प्रबंधन (फूलों से कटाई तक) by Dr. Abraham Verghese	*https://youtu.be/64fwrm5a_do*

INSECT LENS

The banana skipper, Erionota thrax (Hesperiidae: Lepidoptera)

Banana Skipper is a serious defoliator of banana plantations throughout the South-East Asia and Papua New Guinea. The occurrence of this pest was reported from Madurai, Theni, Coimbatore and Erode districts of Tamil Nadu and Chamarajanagar district of Karnataka, India in 2013.

Author: *Suresh R. Jambagi, Ph.D. Scholar, UAS, GKVK Bangalore, Karnataka, India.*

Location: *Main Agricultural Research Station, UAS Dharwad, Karnataka, India*

Email: *jambagisuru@gmail.com*

Leaf-rolling cricket, Hyalogryllacris* sp. *(Gryllacrididae: Orthoptera)

These are non-jumping, wingless insects occurring worldwide, commonly known as raspy crickets. They weave or roll the leaves with the help of silk produced from mouthparts. These are very rare to spot.

Author: *Suresh R. Jambagi, Ph.D Scholar, UAS, GKVK Bangalore*

Location: *UAS, GKVK Bangalore, Karnataka, India*

Email: *jambagisuru@gmail.com*

Tachinid fly, Prosena siberite (Tachinidae: Diptera)

Adults are harmless nectar feeders on flowers of various plants viz., Clematis gouriana, Gnaphalium sp., Tecoma castanifolia, Seseli libanotis, Patrinia scabiosifolia, etc. Larva parasitizes the larva of various scarab beetles viz., Popillia japonica, Adoretus, Anomala, Leucopholis species. These tachinid flies are univoltine species.

Author: *Suresh R. Jambagi, Ph.D. Scholar, UAS, GKVK Bangalore, India*

Location: *Hirepadasalagi, Bagalkot, Karnataka, India*

Email: *jambagisuru@gmail.com*

Root/white grubs, Holotrichia* sp. *(Scarabaeidae: Coleoptera)

Holotrichia sp. is an important pest in groundnut. Adults become active with the arrival of the monsoon showers. If the monsoon is late, the beetle's emergence is similarly delayed. After emergance the beetles congregate on neem (Azadirachta indica), Butea monosperma and babul trees (Acacia arabica).

Author: *Suresh R. Jambagi, Ph.D. Scholar, UAS, GKVK Bengaluru, Karnataka, India*

Location: *Hirepadasalagi, Bagalkot, Karnataka, India*

Email: *jambagisuru@gmail.com*

Alate green peach aphid, Myzus persicae (Aphididae: Hemiptera)

Green peach aphids have a black head and thorax and a yellow-green abdomen. Whenever, food quality declines, winged females are developed and they leave in search of new host. In autumn, both male and female winged aphids develop and return to woody plants to mate and lay eggs.

Author: *Manjunath Badiger, M. Sc (Agril. Entomology) UAS, Dharwad Karnataka, India.*

Location: *Kempwad, Belagavi, Karnataka, India.*

Email: *mrbadiger1995@gmail.com*

Paper Wasp, Ropalidia marginata (Vespidae: Hymenoptera)

Ropalidia marginata scrape cellulose fibers from plants and masticate them into paper pulp to build open nests (gymnodomous). It has an indeterminate (several colony cycles repeating in the same nest), perennial (active throughout the year) and aseasonal (nests can be initiated and abandoned any time of the year) nesting cycle.

Author: *Manjunath Badiger, M. Sc (Agril. Entomology), UAS, Dharwad, Karnataka, India..*

Location: *UAS, Dharwad, Karnataka, India.*

Email: *mrbadiger1995@gmail.com*

Zygogramma bicolorata (Chrysomelidae: Coleoptera)

In India, the biocontrol program of parthenium was initiated in 1984 at Bangalore by the introduction of Zygogramma bicolorata from Mexico. After a successful introduction, Zygogramma bicolorata became colonized within 3 years and caused considerable damage to the parthenium plants and lowering its density in the released areas.

Author: *Manjunath Badiger, M. Sc (Agril. Entomology), UAS, Dharwad, Karnataka, India.*
Location: *Chinchali, Belagavi, Karnataka, India.*
Email: *mrbadiger1995@gmail.com*

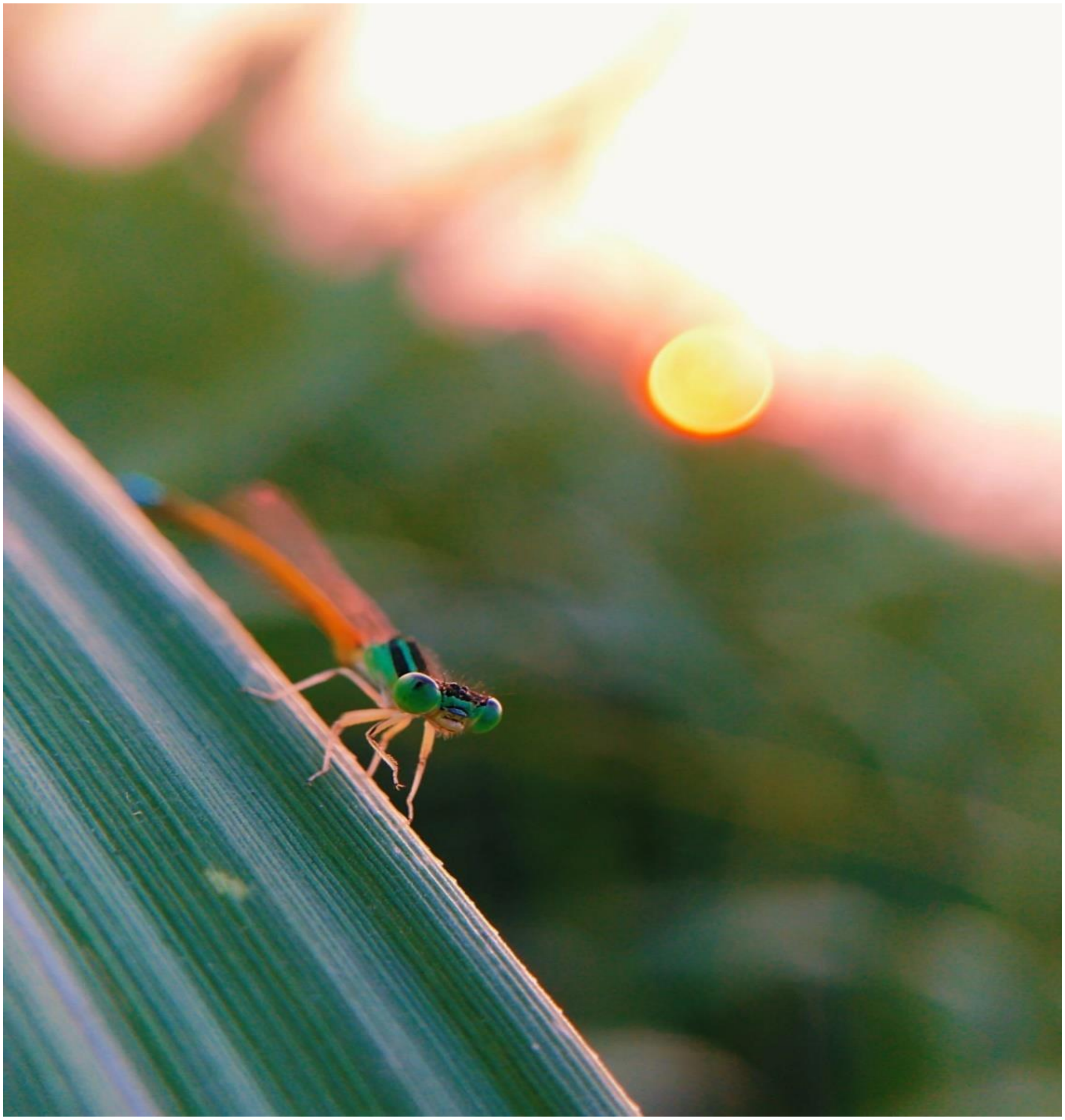
Derbid Planthopper, Proutista moesta (Derbidae: Hemiptera)

Proutista moesta is an economically important sap-sucking insect of palms and is implicated as a common vector of root wilt disease of coconut, yellow leaf disease of areca nut and spear rot disease of oil palm in India. Nymphs develop saprophytically by feeding on substrates undergoing fungal decomposition.

Author: *Manjunath Badiger, M. Sc (Agril. Entomology,) UAS, Dharwad, Karnataka, India.*

Location: *UAS, Dharwad, Karnataka, India.*

Email: *mrbadiger1995@gmail.com*



Western Golden Dartlet, Ischnura rubilio (Coenagrionidae*: *Odonata)

Western Golden Dartlet is a small apple green damselfly with black thoracic stripes, black-capped olive-green eyes and blue tipped yellow tail. These are found in Indian subcontinent and Iran. These breeds in weedy ponds, lakes and marshes.

Author: *Manjunath Badiger, M. Sc (Agril. Entomology), UAS, Dharwad, Karnataka, India.*

Location: *Kempwad, Belagavi, Karnataka, India.*

Email: *mrbadiger1995@gmail.com*

Sugarcane leafhopper, Pyrilla perpusilla (Lophopidae: Hemiptera)

Pyrilla perpusilla is a threat to Indian sugar industry and causing 31.6% reduction in cane yield and 2-3% reduction in sugar recovery if not properly managed. Gregarious pest found under the surface of the leaves. They suck sap and cause yellowing and eventually drying of leaves.

Author: *Manjunath Badiger, M. Sc (Agril. Entomology), UAS, Dharwad, Karnataka, India.*

Location: *Kempwad, Belagavi , Karnataka, India.*

Email: *mrbadiger1995@gmail.com*

Spot eyed hover fly, Eristalinus megacephalus (Syrphidae: Diptera)

Hoverflies are known to provide ecosystem services such as pollination by adults and immatures as predator. Eristalinus megacephalus is a good pollinator and exhibit 'Batesian mimicry' to look like hymenopteran bees and scare away predators. Its flight period is from May to October and June to July.

Author: *Manjunath Badiger, M. Sc (Agril. Entomology), UAS, Dharwad, Karnataka, India.*

Location: *Sankonatti, Belagavi, Karnataka, India.*

Email: *mrbadiger1995@gmail.com*

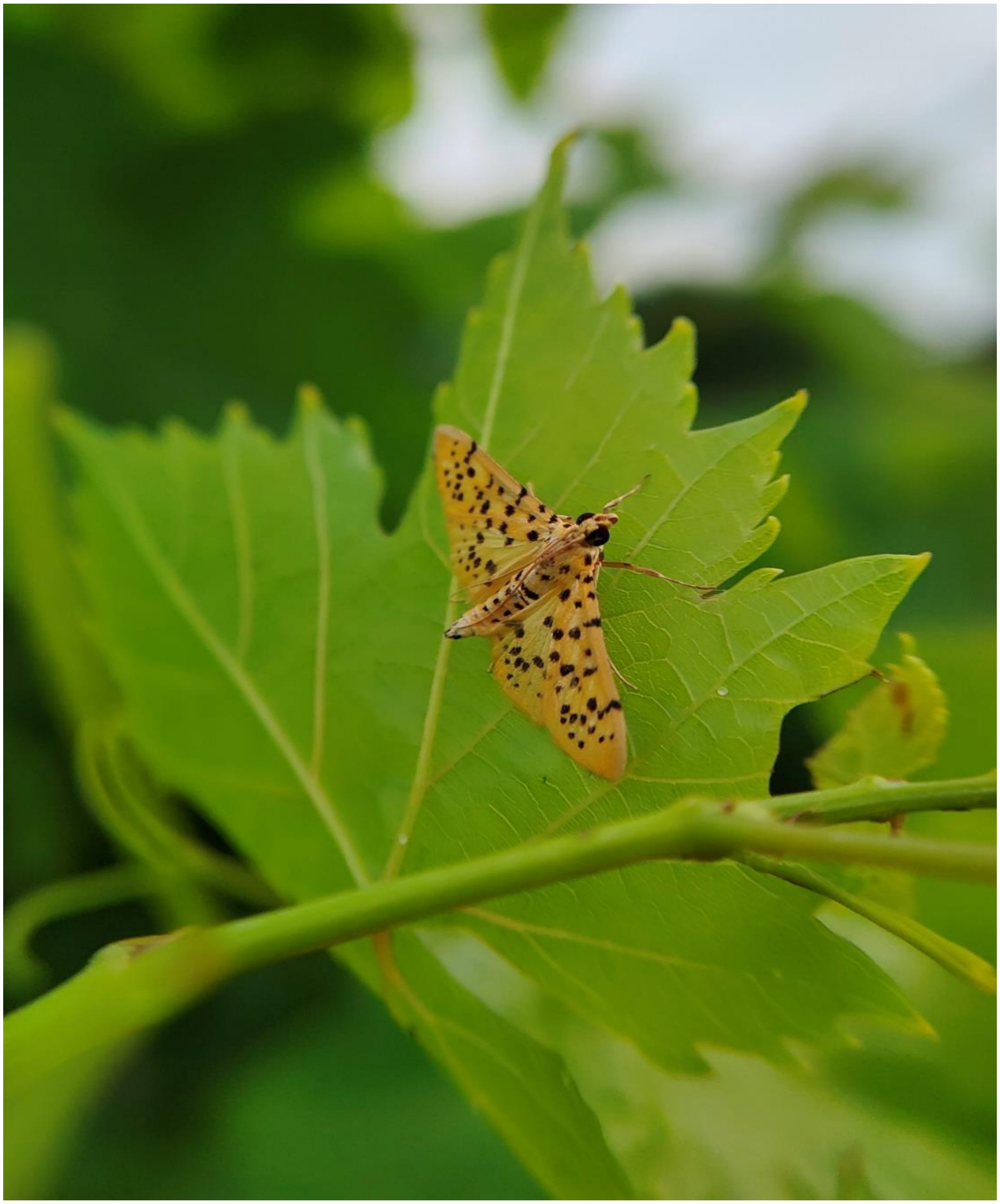
Meadow Froghopper, Philaenus spumarius (Aphrophoridae: Hemiptera)

Froghoppers are known for their 'Cuckoo Spit', the foamy mass found on plants/grasses. These masses are nest for their developing nymphs providing protection and moisture during this stage of development, which can last for up to fifty days.

Author: *Manjunath Badiger, M. Sc (Agril. Entomology), UAS, Dharwad, Karnataka, India.*

Location: *UAS, Dharwad, Karnataka, India.*

Email: *mrbadiger1995@gmail.com*



Fruit & Shoot borer, Conogethes punctiferalis (Crambidae: Lepidoptera)

Conogethes punctiferalis is a polyphagous serious pest of castor, guava, pomegranate, pear, turmeric, ginger, mango. The adult males emit powerful ultrasonic sounds (around 82KHz) in the courtship process to induce female to adopt the mating posture.

Author: *Manjunath Badiger, M. Sc (Agril. Entomology), UAS, Dharwad, Karnataka, India.*

Location: *Sankonatti, Belagavi, Karnataka, India.*

Email: *mrbadiger1995@gmail.com*

Citrus butterfly larvae, Papilio demoleus (Papilionidae: Lepidoptera)

A young larva disguises itself as a bird-dropping on a lime leaf. The larva later becomes green blending itself with the surrounding green curry leaves. When disturbed, the larva extrude a red forked process 'osmeterium' to deter predators.

Author: *Dileep Kumar N. T, Ph. D scholar, Dept of Entomology UAS, Dharwad, Karnataka, India.*

Location: *College of Agriculture, Vijayapura, Karnataka, India..*

Email: *dileepyadhu1996@gmail.com*

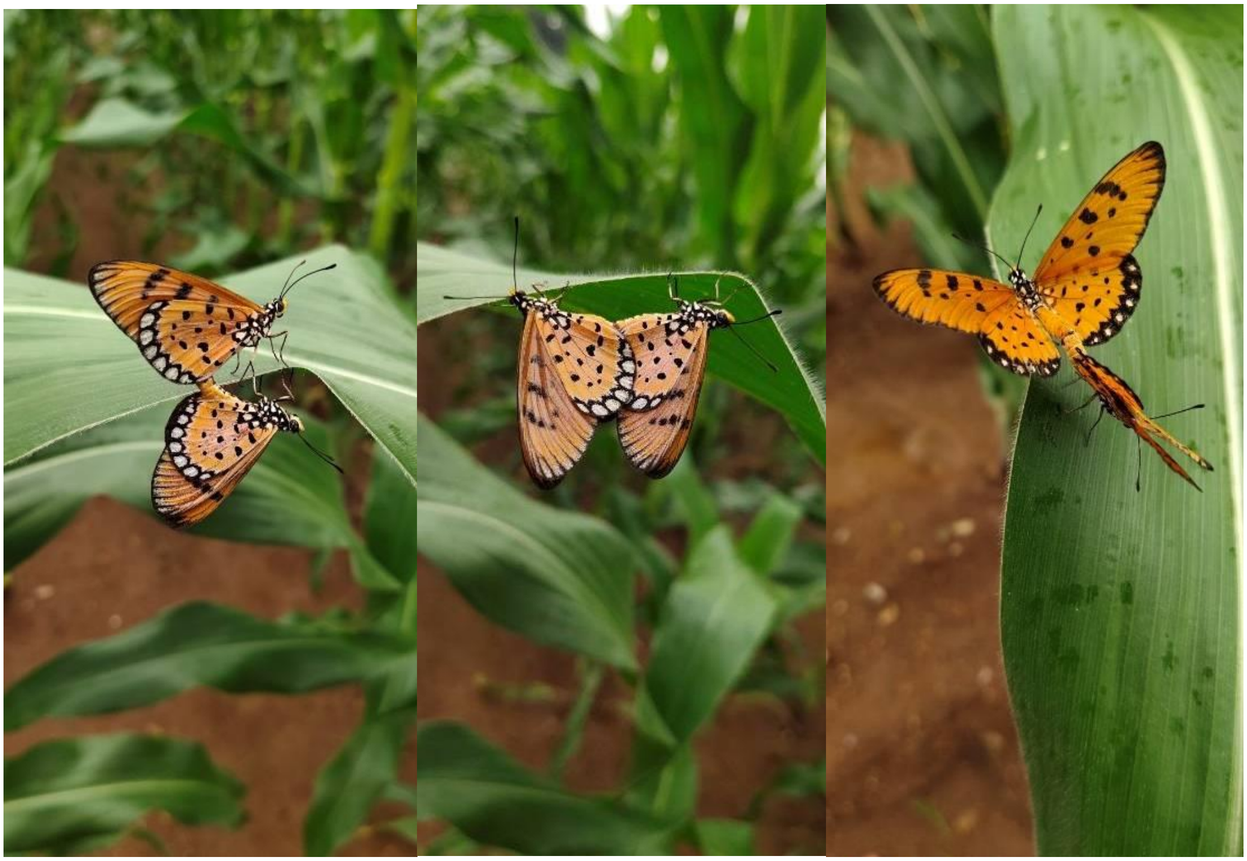
Pupa of Pod fly, Melanagromyza obtuse (Agromyzidae: Diptera)

Pod fly is also called as 'silent pod killer.' Because adult inserts eggs in immature pods and the infested pods do not show external evidence of damage until the fully-grown larvae chew exit holes in the pod walls at the time of maturity. Also, the adult is very minute and complicated to monitor in the field.

Location: *Insect Biodiversity Park, College of Agriculture, Vijayapura, Karnataka, India.*

Author: *Dileep Kumar N. T, Ph. D scholar Dept of Entomology UAS, Dharwad, Karnataka, India.*

Email: *dileepyadhu1996@gmail.com*



Tawny Coster, Acraea terpsicore (Nymphalidae: Lepidoptera)

Acraea terpsicore can be seen in abundance wherever its larval food plant (Passiflora species) is found. It is one of the boldest butterflies, protected as it is from predators by a nauseous chemical. When attacked it plays dead and exudes a noxious yellowish fluid from glands in the joints of the legs.

Location: *Agricultural College and Research Institute, Killikulam, Tutikorin,Tamil Nadu, India.*

Author: *Beulah Bhakiya Sherlin R, Department of Entomology, Agricultural College and Research Institute, Killikulam, Tuticorin, Tamil Nadu, India*

Email: *beulahwhite@gmail.com*

Stingless bee, Trigona* sp. *(Apidae: Hymenoptera) on okra

Stingless bees are small and highly social insects. They are closely related to common honeybees, carpenter bees, orchid bees and bumblebees. Naturally they nest in hollow trunks, tree branches, and rock crevices, if available, they'll go for man -made cavities. Like honeybees, even they produce honey and have stings, but they are too small and weak to penetrate human skin.

Author: *S. Devanesan***,** *Thiruvananthapuram, 695018, Kerala*

Location: *Trivandrum, Kerala, India*

Email: *devanesanstephen@gmail.com*

Eurybrachys tomentosa (Eurybrachidae: Hemiptera)

Eurybrachys tomentosa occurs in parts of Asia, Australia and Africa. They are remarkable for the sophistication of their automimicry. A common plant hopper attacks on Sandal and Calotropis gigantea in South India. This species is also responsible fro stag-headedness prevalent in sandal forests. They are remarkable for the sophistication of their automimicry.

Author: *D. N. Nagaraj*

Location: *Bengaluru, Karnataka, India*

Email: *nasoteya@yahoo.co.in*

Japanese Uzi Fly, Crossocosmia sericariae (Tachinidae: Diptera)

Tachinid flies are effective parasitoids of caterpillars. They are protelean parasitoids. Larvae are endoparasitoids while, adults are free-living on nectar.

Author: *D. N. Nagaraj*

Location: *Bengaluru, Karnataka, India*

Email: *nasoteya@yahoo.co.in*

Blackjack fruit fly, Dioxyna sororcula (Tephritidae: Diptera)

The smallest fruit flies of around 2.5 mm in length attacks a wide range of composite plants including weeds.

Author: *S. Subramanian*

Location**:** ICIPE - International Centre of Insect Physiology and Ecology**,** Kasarani, Nairobi, Kenya.

Email: *ssubramania@icipe.org*

Tiny eggs of Zigzag ladybird beetle, Cheilomenes sexmaculata (Coccinellidae: Coleoptera)

The eggs of C. sexmaculata were bright yellowish, cigar shaped with smooth chorion. Egg mass looks similar to banana bunch under microscope.

Author: *Mangali Ashwini, Ph.D (Agril. Entomology), Department of Entomology, Navsari Agricultural University, Navsari, Gujarat, India.*

Location: *Navsari Agricultural University, Navsari, Gujarat, India.*

Email: *m.ashwini2511@gmail.com*

Female wasp with ovipositor

Author : *Rana Nargees Sheikh, Student, Francis Xavier girls high school Pulikeshinagar, Bengaluru, Karnatak, India*

Location: *Pulikeshinagar, Bengaluru, Karnatak, India.*

Short-horned grasshopper, (Acrididae: Orthoptera)

They are typically ground dwelling insects with powerful hind legs which allow them to escape from threats by leaping vigorously. They are herbivorous and include some of the most destructive agricultural pests known. The plague, or migratory, species are called locusts.

Author: *Hemavathi K J, 3rd BSc student, Maharani's Science Ccollege for Women Bengaluru, Karnataka, India*

Location: *Bengaluru, Karnataka, India*

Email: *hemabiddu143@gmail.com*

Ladybird beetle, Illeis cincta (Coccinellidae:Coleoptera) eating its exuviae in Cotton

Author: *Kaneria Prashant B. Ph. D scholar & Senior Research Fellow, Junagadh Agricultural University, Gujarath, India*

Location: *Cotton Research Station, Junagadh Agricultural University, Gujarath, India*

Email: *prashantkaneriya959@gmail.com*

A Flesh Fly (Diptera: Sarcophagidae)

Species of medical importance in many parts of the world. It is a myiasis-producing agent as well as forensics as it is known to colonize decomposing human remains.

Author: *Rushikesh Rajendra Sankpal, Department of Environmental Sciences, Savitribai Phule Pune University, Pune*

Location: *Warananagar, Kolhapur, Maharashtra, India*

Email: *prof.sankpal@gmail.com*

Maize Fall armyworm Spodoptera frugiperda (Noctuidae: Lepidoptera)

Is a serious pest of maize that has invaded and subsequently spread through Sub-Saharan Africa since 2016 causing enormous crop losses.

Author: *Chaudhary Lalabhai S. M.Sc (Agri.) Dept of Entomology*

Location: *Navsari Agricultural University Campus, Navsari (Gujarat)*

Email: *lalabhai261999@gmail.com*

Brown planthopper (BPH), Nilaparvata lugens (Hemiptera: Delphacidae)

Macropterous gravid female inserts its ovipositor into the leaf sheath to lay eggs

Author: *Kondala Rao Yelisetti, (Retired Chief Technical Officer, Indian Institute of Rice Research, Rajendranagar, Hyderabad, India*

Location: *Rajendranagar, Hyderabad -500030, India*

Email: *ykondalarao@gmail.com*