

Volume 29 (3) September 2026

ISSN 0975-1963

Insect Environment

Not-for-profit journal promoting
Insect Science

Quarterly Journal

Articles with DOI

NAAS Rating 3.53

Abstract/ Full text uploaded in



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

Published by

Abraham Verghese Insect And Nature Trust (AVIAN Trust), Bengaluru, India

Supported by

International Phytosanitary Research & Services (IPRS), Bengaluru

Shree Nidhi Agrochemicals, Vijayapura, Devanahalli

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***Cover Page: *Pyrops delessertii* (Guérin-
Ménéville, 1840)**, Place: Honnavar, Uttara
Kannada district, Karnataka, India

Photo by Dr. Abhishek Venkateshaiah.,
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Insect Environment

(Quarterly journal to popularize insect study and conservation) ISSN 0975-1963

NAAS Rating 3.53

The first issue of Insect Environment was published in 1996. The sole objective of 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.

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Editorial

Fruit Fly, FIFA, and Flood

There is a strange yet interesting quadrennial regularity between fruit flies, soccer and Commonwealth Games. They all meet internationally the same year, once every four years. In 2010, Spain won the FIFA Cup, and coincidentally, the International Conference of Economically Important Fruit Flies was also held in Spain.

I was invited to present a lead paper on IPM of fruit flies, which by then was a successfully concluded flagship programme of ICAR-IIHR. When my last "thank you" slide was displayed, there was a thunderous applause not because my talk was over but the slide said, "Congratulations Spain for Winning the World Soccer Cup!" The Spaniards (like cricket in India) go ga-ga over soccer, and after that I became a 'noted' participant among them. Language was indeed a barrier but not bonhomie! I stayed in the international students' hostel (low rate, but = 5 star). So, at breakfast it was plenty of greetings, '*hola*' (meaning hello) for that small congratulatory expression thanks to the talk on IPM of fruit fly in India. This year too, Spain is our Soccer Champ -IE congratulates them!

We had published a blog on the diminishing *Pantala flavescens* dragonfly. Our idea was to stir some urgency of our dragonfly conservation. Among the many professional entomologists who browsed through the blog, only a mere three gave a "thumbs up." Maybe it was not new news, or maybe conservation is a low priority. On the other hand, non-entomologists, amateur horticulturists and so on, showed and expressed concern, and even decided to keep watch over migrating dragonflies. One thing seemed to surface: insect conservation (except for butterflies, in a small way) is overall not a serious concern. This trend ought to change, and IE calls for higher involvement of naturalists, policy makers conservationists and of course entomologists!

IE's support team Rashvee International Phytosanitary Research and Service got their third patent (GoI). Thanks to Siddaganga Incubation Foundation (SIF), Siddaganga Institute of Technology and Department of Science and Technology (our supporters and funders) we could develop an herbal protectant fumigant that deters development of pulse beetles in stored pulses in retail and kitchen shelves.

As usual, every week we publish 'insect alerts' or small topical features, missed by major journals and reports. These have been especially useful to farmers and lay readers, that we have decided to widen its scope to encompass biodiversity, agriculture, farmers etc. Hence the new nomenclature: *Insects, Environment and Beyond*. But, the blog flavour would remain. We are glad to inform that more than 8000 readers browse through our 'blog' every week.

This issue of *Insect Environment* 29 (3) 2026 has a rich array of tremendously interesting insect write-ups that any entomologist will only be glad to read and share with fellow entomologists and students. Here are some of them: The article on pollination services in moringa demonstrates how beekeeping can simultaneously enhance crop productivity and support value-added honey production. Of particular contemporary significance is the contribution addressing climate-driven changes in pomegranate thrips fauna and the emergence of *Thrips parvispinus* as a serious pest threat, offering timely insights for researchers, extension personnel, and growers. Together with several first reports and new distributional records from across India, these articles exemplify the journal's commitment to documenting insect diversity while addressing practical challenges in agriculture and ecosystem management.

The Zoological Survey of India (ZSI) has been rendering exemplary service in the fields of faunal exploration, taxonomy, ecology, biosystematics, applied zoology, museum curation, and biodiversity documentation. We extend our heartfelt congratulations to Dr. Dhriti Banerjee, Director, ZSI, and the entire scientific fraternity of the organization for their dedicated efforts in advancing faunal research including Entomology.

We particularly acknowledge the outstanding contributions of ZSI entomologists, who have consistently supported *Insect Environment* by publishing high-quality articles and valuable natural history notes on insects belonging to diverse taxonomic groups. These contributions have enhanced the scientific reputation of the journal and have been widely appreciated by readers and researchers alike.

We are equally grateful for the encouragement and support received from leading institutions such as the Indian Council of Agricultural Research (ICAR), the Central Silk Board,

and numerous universities and research organizations in India and across the globe, whose contributions have played a significant role in the continued success of the journal.

Floods, glacial melts, higher thermal air etc., in Nepal, Europe, have all disturbed biodiversity and man. The Assam floods have rendered wild elephants, crocodiles, birds etc homeless while poor insects go missing, unrecorded! Can we entomologists do at least some documentations? Amidst these, IE marches on.

We congratulate all our authors for their vital contributions in this issue and in the past. Your contributions are carefully "webbed" in permanence for insect science and posterity. Demand for our hardcopy volumes are ever as high, and we strive to retrieve them and help authors and reprint requestors.

We are also pleased to inform you that the AVIAN Trust proposes to organize its Awards Ceremony in December 2026. As in previous years, the brochure containing detailed information will be circulated soon. We look forward to your enthusiastic participation and continued association.

The Editorial Team expresses their gratitude to all of you, our valuable readers.

Abraham Verghese
Editor-in-Chief

Research Articles

DOI: 10.55278/ZTPY1190

Hidden Diversity in an Urban Agroecosystem: A Faunal Inventory of Fruit Flies (Diptera: Tephritidae: Dacinae) from Attur Farm, Bengaluru, India

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Abstract

Dacini fruit flies are taxonomically diverse and include several species of horticultural and quarantine significance. To document their diversity in a peri-urban agricultural landscape, we compiled a voucher-based inventory of specimens collected from Attur Farm, northern Bengaluru, between 2012 and 2023 using parapheromone-baited traps, sweep-netting, manual collection, and rearing from infested plant material. Twenty-two species were recorded, comprising 11 *Bactrocera*, six *Zeugodacus* and five *Dacus*. The assemblage included major horticultural pests, members of morphologically challenging species complexes and less frequently recorded taxa. Reported lure and attractant responses included cue lure, methyl eugenol and zingerone. Host rearing and verified host records provided host-plant information for 11 species. Because sampling effort varied among years, collectors and collection methods, the records are interpreted as presence-based species richness rather than measures of relative abundance. This inventory establishes a taxonomic baseline for standardized Dacini surveillance in Bengaluru's peri-urban agricultural landscape.

Keywords: *Bactrocera*; *Dacus*; *Zeugodacus*; faunal inventory; peri-urban biodiversity

Introduction

Fruit flies (Diptera: Tephritidae) are a taxonomically diverse group that includes numerous species of horticultural and quarantine significance. Nearly 300 species have been documented from India, with tribe

Dacini forming a major component of the Indian fauna. Globally, the tribe Dacini comprises more than 900 described species and is particularly diverse in the Oriental and Australasian regions (Doorenweerd *et al.*, 2018; David *et al.*, 2025, Abhishek and David, 2026).

Indian Dacini are represented by the genera *Bactrocera* Macquart, *Dacus* Fabricius and *Zeugodacus* Hendel. Their taxonomy and distribution have been progressively clarified through catalogues, illustrated identification keys and recent revisions (Agarwal and Sueyoshi, 2005; David and Ramani, 2011, 2019; David et al., 2017, 2024; Abhishek et al., 2024a, b). Despite these advances, close external resemblance among members of several species complexes continues to complicate reliable identification, underscoring the importance of examined voucher specimens and current diagnostic literature.

Peri-urban farms have received limited attention in Indian fruit fly inventories, although they often contain cultivated crops, unmanaged vegetation and frequent movement of plant material. Dacini specimens collected from Attur Farm in northern Bengaluru were previously dispersed among survey collections and museum holdings. The present study consolidates these records to document the species richness, taxonomic composition, reported lure-response spectrum and host associations supported by rearing or verified source accounts.

Material and Methods

Study locality and source material

Attur Farm, Yelahanka, Bengaluru, Karnataka, India, was the focal locality. The approximate coordinates of the study site are

13°01'51.2"N, 77°34'59.8"E (Fig. 1). The inventory comprises specimens labelled Attur, Attur Farm or Attur Campus and collected between October 2012 and June 2023. Voucher material is deposited principally in the National Insect Museum (NIM), ICAR-National Bureau of Agricultural Insect Resources, Bengaluru, and includes recent field collections and earlier records examined during the doctoral study of Abhishek (2024).

Collection and identification

Specimens were collected using traps baited with methyl eugenol, cue lure or zingerone, supplemented by sweep-netting, manual collection and host rearing. Infested fruits, vegetables and flowers were collected and maintained in rearing cages; immature stages were reared to adult emergence to confirm species identity and host association. Representative field deployment of the traps is shown in Fig. 2. Adults obtained through field collection or rearing were euthanized with ethyl acetate, card-point-mounted or double-mounted, and labelled with locality, date, collector and, where available, host plant. Preparation procedures followed Abhishek (2024).

Species were identified using Drew and Raghu (2002), David and Ramani (2011), Drew and Romig (2013) and David and Ramani (2019). Recent Indian treatments were consulted to verify species placement and diagnostic limits (David *et al.*, 2017, 2024; Abhishek *et al.*, 2024a, b).

Data treatment

Diversity was summarized as documented species richness and taxonomic composition, with records consolidated by species. Table 1 presents selected Attur voucher material rather than an exhaustive specimen list. Host-plant information was compiled from rearing records generated during the broader study and from additional verified source accounts; these associations do not all originate from Attur Farm. Reported lure and attractant responses likewise do not necessarily indicate how each listed voucher was collected. Because sampling effort was not standardized among years, collectors or collection methods, abundance-based diversity indices and seasonal comparisons were not undertaken.

Results and Discussion

Species richness and composition

The inventory comprised 22 species in three genera (Table 1): *Bactrocera* 11 species (50.0%), *Zeugodacus* six (27.3%) and *Dacus* five (22.7%). Members of the *Bactrocera dorsalis* (Hendel), *B. nigrotibialis* White & Tsuruta and *Zeugodacus tau* (Walker) species complexes were represented, underscoring the need for voucher-based identification and current diagnostic literature (David and Ramani, 2019; David et al., 2017, 2024; Abhishek et al., 2024a, b). Representative live dacines photographed at the study site are shown in Fig. 3.

Lure-response spectrum and surveillance relevance

Cue lure had the broadest taxonomic coverage, with responses reported for 14 species when weak responses were included. Zingerone was reported for seven species and methyl eugenol for six; Latilure and clove oil were each associated with one species (literature). *Dacus persicus* (Hendel) lacked a known response to the standard lures considered here. The resulting spectrum indicates that a single-lure survey would underestimate the local fauna and supports the combined use of multiple attractants and direct collection methods.

Host-rearing and host associations

Host information was available for 11 species and included both rearing records from the broader study and additional verified source accounts. *Syzygium hemisphericum* served as a rearing host for *Bactrocera correcta*, *B. dorsalis*, *B. nigrofemoralis* and *B. syzygii*; other rearing hosts included *Psidium guajava* for *B. caryae*, *Solanum indicum* for *B. latifrons*, *Calotropis gigantea* for *Dacus persicus*, *Luffa acutangula* for *Zeugodacus cucurbitae* and *Lagenaria siceraria* for *Z. tau*. Additional verified host records included *Solanum nigrum* for *B. latifrons*, *Psidium guajava* and *Citrus reticulata* for *B. zonata*, tomato for *Z. cucurbitae* and flowers and fruits of *Cucurbita moschata* for *Z. diversus*. These associations provide biological context for the faunal inventory but should not be interpreted

as standardized measures of host use at Attur Farm (Abhishek, 2024).

Taxonomic significance and limitations

The inventory brings together widespread crop pests and comparatively infrequently documented dacines at a single urban-fringe agricultural site, giving it value for biodiversity documentation and plant-health surveillance. However, records were accumulated opportunistically across multiple years by different collectors using diverse sampling methods. They therefore provide a presence-based baseline rather than evidence of dominance, population density, seasonal peaks or temporal trends. Future surveys employing standardized sampling protocols, fixed trap densities and regular sampling intervals would enable robust quantitative comparisons of species diversity, abundance and seasonal dynamics.

Conclusion

Attur Farm harbors a voucher-confirmed assemblage of 22 Dacini species representing the genera *Bactrocera*, *Dacus* and *Zeugodacus*. The occurrence of economically important pests, morphologically challenging members of species complexes and less frequently documented taxa highlights the taxonomic and surveillance value of this peri-urban agricultural landscape. By integrating voucher records, multi-lure surveillance and host-rearing information, the inventory provides a reference baseline for future assessments of fruit fly diversity, distribution and host use in Bengaluru. The study also establishes a foundation for long-term monitoring and contributes baseline information for pest-risk assessment, biodiversity documentation and regional quarantine surveillance.

Table 1. Selected voucher material of Dacini recorded from Attur Farm, Bengaluru, with reported lure/attractant responses and host-plant information.

Sl. No.	Species	Selected Attur voucher material examined	Reported lure/attractant response and host-plant information
1	<i>Bactrocera affinis</i> (Hardy)	2♂♂, 29.vii.2013, K.J. David; 1♂, 26.x.2017, G. Prabhu	Lure/attractant: Methyl eugenol Host: No host record included in this compilation
2	<i>Bactrocera apiconigroscutella</i> Drew	1♂, 27.ix.2018, G. Prabhu	Lure/attractant: Cue lure Host: No host record included in this compilation
3	<i>Bactrocera caryeae</i> (Kapoor)	2♂♂, 18.viii.2016, G. Prabhu	Lure/attractant: Methyl eugenol Host: <i>Psidium guajava</i> (guava; Myrtaceae)
4	<i>Bactrocera correcta</i> (Bezzi)	20♂♂, 01.v.2023, V. Abhishek	Lure/attractant: Methyl eugenol Host: <i>Syzygium hemisphericum</i> (Wight) Alston (rose apple/Venjara; Myrtaceae)
5	<i>Bactrocera digressa</i> Radhakrishnan	2♂♂, 13.iv.2023, V. Abhishek	Lure/attractant: Cue lure; zingerone Host: No host record included in this compilation

Sl. No.	Species	Selected Attur voucher material examined	Reported lure/attractant response and host-plant information
6	<i>Bactrocera dorsalis</i> (Hendel)	13♂♂, 23♀♀, 20.ii.2023; 3♂♂, 20.ii.2023; 9♂♂, 13.iv.2023, V. Abhishek	Lure/attractant: Methyl eugenol; zingerone Host: <i>Mangifera indica</i> (mango; Anacardiaceae); <i>Psidium guajava</i> (guava; Myrtaceae); <i>Syzygium hemisphericum</i> (Wight) Alston (rose apple/Venjara; Myrtaceae)
7	<i>Bactrocera latifrons</i> (Hendel)	1♀, 02.ix.2013, K.J. David	Lure/attractant: Latilure Host: <i>Solanum indicum</i> L. (African eggplant/Brihati; Solanaceae); <i>Solanum nigrum</i> L. (black nightshade; Solanaceae)
8	<i>Bactrocera nigrofemorialis</i> White & Tsuruta	24♂♂, 21.iii.2023, V. Abhishek	Lure/attractant: Cue lure; zingerone Host: <i>Syzygium hemisphericum</i> (Wight) Alston (rose apple/Venjara; Myrtaceae)
9	<i>Bactrocera syzygii</i> White & Tsuruta	2♂♂, 23.ii.2023, V. Abhishek	Lure/attractant: Zingerone Host: <i>Syzygium hemisphericum</i> (Wight) Alston (rose apple/Venjara; Myrtaceae)
10	<i>Bactrocera vishnu</i> Drew & Hancock	1♂, 30.vi.2014, G. Prabhu	Lure/attractant: Cue lure Host: No host record included in this compilation
11	<i>Bactrocera zonata</i> (Saunders)	2♂♂, 10.iv.2023, V. Abhishek	Lure/attractant: Methyl eugenol Host: <i>Psidium guajava</i> L. (Myrtaceae) and <i>Citrus reticulata</i> Blanco (Rutaceae)
12	<i>Dacus crabroniformis</i> (Bezzi)	1♂, 07.xii.2014, G. Prabhu	Lure/attractant: Zingerone; weak cue lure response Host: No host record included in this compilation
13	<i>Dacus discophorus</i> (Hering)	1♂ each, 02.ix.2013, 16.ix.2013 and 16.vi.2014, K.J. David	Lure/attractant: Cue lure; clove oil; weak zingerone response Host: No host record included in this compilation
14	<i>Dacus persicus</i> (Hendel)	1♀, 19.vii.2014, A. Verghese	Lure/attractant: No standard lure known Host: <i>Calotropis gigantea</i> (L.) (crown flower/giant milkweed; Apocynaceae)
15	<i>Dacus ramanii</i> Drew & Hancock	8♂♂, 05.vi.2023, V. Abhishek	Lure/attractant: Cue lure; zingerone Host: No host record included in this compilation
16	<i>Dacus sphaeroidalis</i> (Bezzi)	1♂ each, 02.ix.2013, 16.ix.2013 and 16.vi.2014, K.J. David	Lure/attractant: Cue lure Host: No host record included in this compilation
17	<i>Zeugodacus cucurbitae</i> (Coquillett)	8♂♂, 13♀♀, 20.ii.2023, V. Abhishek	Lure/attractant: Cue lure Host: <i>Luffa acutangula</i> (L.) Roxb. (Chinese okra/ridge gourd; Cucurbitaceae); tomato (Solanaceae)
18	<i>Zeugodacus diversus</i> (Coquillett)	3♂♂, 01.v.2023, V. Abhishek	Lure/attractant: Cue lure; weak methyl eugenol response Host: <i>Cucurbita moschata</i> Duchesne ex Poir., flowers and fruits (pumpkin; Cucurbitaceae)

Sl. No.	Species	Selected Attur voucher material examined	Reported lure/attractant response and host-plant information
19	<i>Zeugodacus gavisus</i> (Munro)	2♂♂, 01.x.2012, K.J. David; 1♂ each, 30.iv.2014, 26.v.2014 and 30.vi.2014, G. Prabhu	Lure/attractant: Cue lure Host: No host record included in this compilation
20	<i>Zeugodacus tau</i> (Walker)	4♂♂, 13.iv.2023, V. Abhishek	Lure/attractant: Cue lure Host: <i>Lagenaria siceraria</i> (Molina) Standl. (calabash/bottle gourd; Cucurbitaceae)
21	<i>Zeugodacus trilineatus</i> (Hardy)	7♂♂, 20.ii.2023, V. Abhishek	Lure/attractant: Cue lure Host: No host record included in this compilation
22	<i>Zeugodacus zahadi</i> (Mahmood)	1♂, 09.vii.2013, K.J. David	Lure/attractant: Cue lure Host: No host record included in this compilation

Note: ♂ = male; ♀ = female. Host-plant information combines rearing records generated during the broader study with selected verified source accounts; these associations do not all originate from Attur Farm. “No host record included in this compilation” means that no host association was used for that species in the present inventory table and should not be interpreted as absence of host information from the wider literature. Reported lure and attractant responses likewise do not necessarily indicate the method by which each voucher specimen was collected.

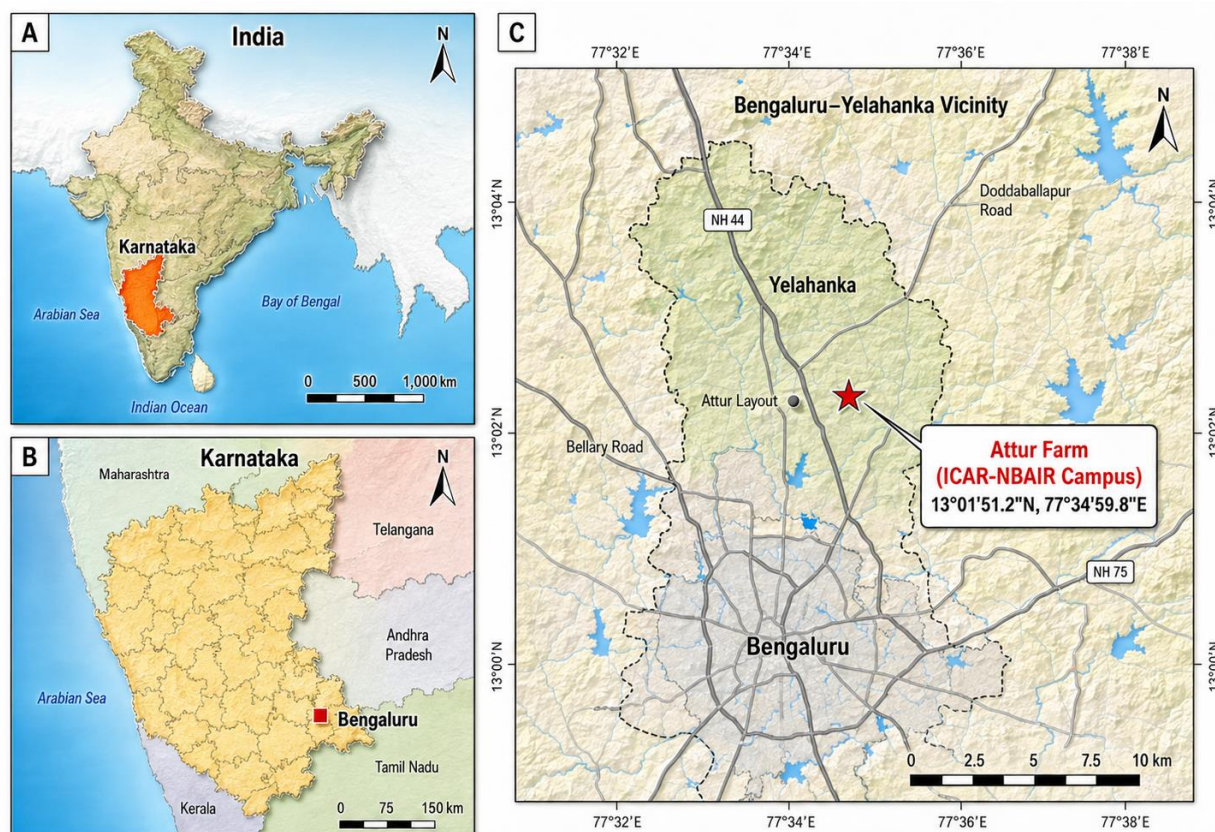


Figure 1. Location of Attur Farm (ICAR-NBAIR campus), Yelahanka, Bengaluru, Karnataka, India.

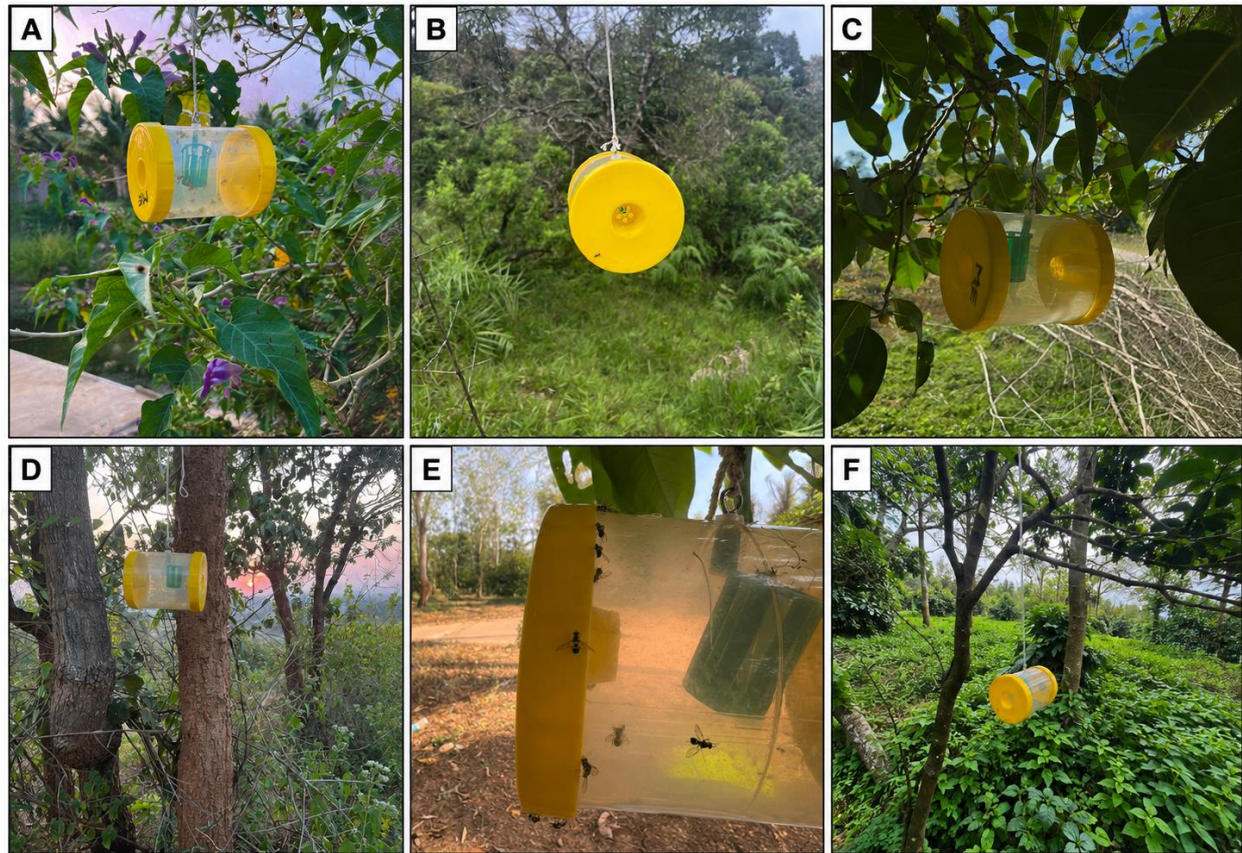


Figure 2. Parapheromone traps (A to F) used for male Dacini surveillance, including methyl eugenol, cue lure and zingerone attractants.

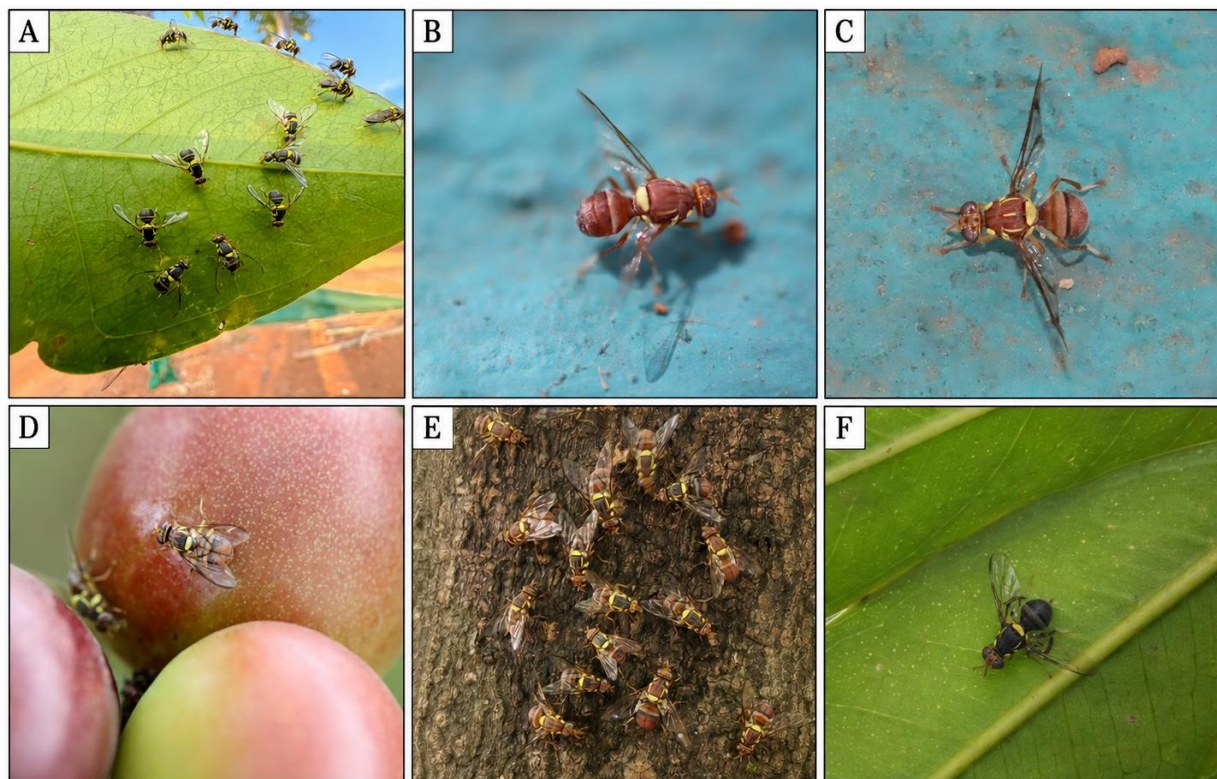


Figure 3. Representative Dacini fruit flies recorded from the study area. A. *Bactrocera (Bactrocera) syzygii* White and Tsuruta; B. *Bactrocera (Bactrocera) digressa* Radhakrishnan; C. *Zeugodacus (Zeugodacus) cucurbitae* (Coquillett); D. *Bactrocera (Bactrocera) dorsalis* (Hendel); E. *Bactrocera (Bactrocera) dorsalis* (Hendel); F. *Bactrocera (Bactrocera) nigrofemoralis* White and Tsuruta.

Acknowledgements

The authors thank the Director, ICAR-National Bureau of Agricultural Insect Resources, Bengaluru, for facilities and access to the National Insect Museum. We acknowledge Sachin, G. Prabhu, Maruthi and other collectors whose specimens contributed to the inventory.

Conflict of Interest

The authors declare that they have no conflict of interest.

References

- Abhishek, V. 2024. Taxonomic studies on species complexes of fruit flies of tribe Dacini (Diptera: Tephritidae: Dacinae) in India. Ph.D. thesis, Keladi Shivappa Nayaka University of Agricultural and Horticultural Sciences, Shivamogga, Karnataka, India.
- Abhishek, V. & David, K.J. 2026. A catalogue and updated checklist of Dacini fruit flies from India (Diptera: Tephritidae: Dacinae), with new host, lure and distribution records. *Zootaxa*, **5885**(1):

- 1–66.
<https://doi.org/10.11646/zootaxa.5885.1.1>
- Abhishek, V., David, K.J., Hancock, D.L., Pradeep, S., Kalleshwaraswamy, C.M., Sridhara, S. and Satish, K.M. 2024a. New Indian species of *Dacus* Fabricius (Diptera: Tephritidae: Dacinae: Dacini) similar to *Dacus crabroniformis* (Bezzi), endemic to the Western Ghats and Northeastern Himalayas. *Zootaxa*, **5446**(3): 366–382. <https://doi.org/10.11646/zootaxa.5446.3.3>
- Abhishek, V., David, K.J. and Pradeep, S. 2024b. Two new species and a new record of *Bactrocera* Macquart (Diptera: Tephritidae: Dacinae: Dacini) from India with an updated key to species of subgenus *Bactrocera*. *Zootaxa*, **5486**(2): 283–300. <https://doi.org/10.11646/zootaxa.5486.2.6>
- Agarwal, M.L. and Sueyoshi, M. 2005. Catalogue of Indian fruit flies (Diptera: Tephritidae). *Oriental Insects*, **39**: 371–433. <https://doi.org/10.1080/00305316.2005.10417450>
- David, K.J. and Ramani, S. 2011. An illustrated key to fruit flies (Diptera: Tephritidae) from Peninsular India and the Andaman and Nicobar Islands. *Zootaxa*, **3021**(1): 1–31. <https://doi.org/10.11646/zootaxa.3021.1.1>
- David, K.J., Hancock, D.L., Singh, S.K., Ramani, S., Behere, G.T. and Salini, S. 2017. New species, new records and updated subgeneric key of *Bactrocera* Macquart (Diptera: Tephritidae: Dacinae: Dacini) from India. *Zootaxa*, **4272**(3): 386–400. <https://doi.org/10.11646/zootaxa.4272.3.4>
- David, K.J. and Ramani, S. 2019. New species, redescrptions and phylogenetic revision of tribe Dacini (Diptera: Tephritidae: Dacinae) from India based on morphological characters. *Zootaxa*, **4551**(2): 101–146. <https://doi.org/10.11646/zootaxa.4551.2.1>
- David, K.J., Abhishek, V., Kennedy, N., Ajaykumara, K.M., Gracy, R.G. and Hissay, C.B. 2024. Four new species of *Zeugodacus* Hendel (Diptera, Tephritidae, Dacinae, Dacini) and new records of dacines from India. *ZooKeys*, **1188**: 1–26. <https://doi.org/10.3897/zookeys.1188.114031>
- David, K.J., Noor Mahammed, N.R., Abhishek, V., Salini, S., Verghese, A. and Rashmi, M.A. 2025. Fruit flies (Diptera: Tephritidae) in India. In: Omkar (Ed.), *Flies: Agricultural and Public-Health Perspectives*. CRC Press, Boca Raton, pp. 46–62. <https://doi.org/10.1201/9781003482581-5>
- Doorenweerd, C., Leblanc, L., Norrbom, A.L., San Jose, M. and Rubinoff, D. 2018. A global checklist of the 932 fruit fly species in the tribe Dacini (Diptera, Tephritidae). *ZooKeys*, **730**: 19–56. <https://doi.org/10.3897/zookeys.730.21786>

Drew, R.A.I. and Raghu, S. 2002. The fruit fly fauna (Diptera: Tephritidae: Dacinae) of the rainforest habitat of the Western Ghats, India. *Raffles Bulletin of Zoology*, **50**: 327–352.

Drew, R.A.I. and Romig, M.C. 2013. *Tropical Fruit Flies (Tephritidae: Dacinae) of South-East Asia: Indomalaya to North-West Australasia*. CAB International, Wallingford, 653 pp. <https://doi.org/10.1079/9781780640358.0000>

MS Received on 15th June, 2026

MS Accepted on 19th August, 2026

DOI 10.55278/GLII2516

Beekeeping-Mediated Yield Enhancement and Monofloral Honey Production in Moringa (*Moringa oleifera*) Orchards

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Abstract

The drumstick tree (*Moringa oleifera* Lam.) is a nutrient-rich, entomophilous tree crop whose flowers depend heavily on insect visitation for fruit set, yet its association with managed honey bees has received little documented attention. This study reports on-farm observations from a moringa-growing belt in Korkai Manaloor, Eral, Tuticorin (Tamil Nadu), where migratory colonies of *Apis cerana indica* were introduced into orchards at approximately 5% flowering. Bee-assisted pollination increased fruit set by up to 30-fold on tagged branches, alongside marked gains in fruit size and weight, with no significant increase in pest incidence. Floral biology observations showed that moringa flowers produce large quantities of pollen and nectar, attracting a diverse guild of Hymenoptera, Lepidoptera and Diptera, among which *A. cerana indica* and *A. dorsata* were the dominant foragers. Beyond its pollination benefits, the practice yielded a distinctive monofloral moringa honey (19% moisture, 82 g sugars and 304 kcal per 100 g) with reported nutritional and medicinal value. Economic analysis indicated that 30 hives per hectare could generate an additional income of about Rs. 3,24,000 per hectare per year from honey alone, over and above gains from enhanced fruit yield. These findings highlight beekeeping in moringa orchards as a low-input strategy for simultaneously improving pollination-dependent yield and diversifying farm income, with further potential through value addition, organic certification and export of moringa honey.

Key words: *Moringa oleifera*; *Apis cerana indica*; pollination; fruit set; monofloral honey; entomophily; farm income diversification

Introduction

The drumstick tree, *Moringa oleifera* Lam., the most widely cultivated species of the genus *Moringa*, is a small, graceful, deciduous

tree also known as the miracle tree, wonder tree, horseradish tree or ben-oil tree. A fast-growing, drought-tolerant, multipurpose tree of great medicinal and industrial importance, it is native to the foothills of the Himalayas in

India but is now grown across most tropical, subtropical and semi-arid regions of the world. It is widely cultivated for its tender fruits and leaves, which are used as vegetables and in traditional herbal medicine (Anwar *et al.*, 2007). Moringa is an exceptionally nutrient-dense superfood. Every 100 g of moringa fruit contains 9.4 g protein, 185 mg calcium, 337 mg potassium and 4 mg iron. The plant contains more than 92 nutrients, 46 types of antioxidants and 36 anti-inflammatory agents, besides vitamins A, B1, B2, B3, B6, B7, C, D, E and K (Anwar *et al.*, 2007). Gram for gram, it provides roughly seven times the vitamin C of oranges, four times the calcium and twice the protein of milk, four times the vitamin A of carrots, and three times the potassium of bananas, along with a high antioxidant content.



Fig. 1. Beehive colonies migrated into a moringa orchard at Korkai Manaloor, Eral, Tuticorin

India is the world's leading producer of moringa, with an annual production of 2.20–2.40 million tonnes of tender fruits from about 38,000 ha. Tamil Nadu is one of the largest moringa-growing states, producing 3.60 lakh tonnes annually from 7,343 ha. Among its

districts, Tuticorin leads in both area and production (1,646 ha), followed by Dindigul (1,440 ha), Theni (1,397 ha), Karur (810 ha) and Erode (633 ha).

The Moringa–Honey Bee Association

Until recently, little was known about the association between moringa and honey bees, although the plant's floral biology and dependence on bee visitation had been documented in earlier studies (Jyothi *et al.*, 1990; Krieg *et al.*, 2017). Mr. Jose of Kulathoor, Kerala, a progressive beekeeper trained under the All India Coordinated Research Project (AICRP) on Honey Bees and Pollinators (ICAR), Vellayani centre of Kerala Agricultural University, migrated his colonies to Korkai Manaloor, Eral, Tuticorin, for honey production.



Fig. 2. Bee colonies placed in rows within a moringa plantation, Tuticorin

Messrs. Murukesan, Thampiraj, Golden, Sundar Raj and Sunil were jointly cultivating moringa in this locality. The growers were initially reluctant to allow honey

bee colonies into their orchards, but were soon surprised by the resulting increase in fruit set and fruit weight following bee visitation. Encouraged by these results, more growers welcomed colonies into their gardens. Migration of Indian honey bee colonies (*Apis cerana indica*) into moringa plantations at

around 5 per cent flowering consistently resulted in improved fruit set, a pattern consistent with reports of managed *A. cerana indica* colonies improving fruit set and yield in moringa elsewhere in Tamil Nadu (Somiya *et al.*, 2023).



Fig. 3. Honey bee (Apis cerana indica) foraging on moringa flowers



Fig.4. Enhanced fruit set on moringa branches following bee-assisted pollination

Growers observed a marked increase in the size and weight of individual fruits. Under identical drip irrigation and fertigation regimes, a single branch that previously bore one fruit produced 30–35 fruits following bee visitation, with negligible pest incidence.

The plants are pruned once a year by growers, and flowering begins within the first six months after planting. Depending on the region, flowering occurs once a year in cooler areas, or twice, or even year-round, in areas with regular rainfall. The main flowering period extends from February to April, peaking in March. Flowers are borne on slender, hairy stalks in spreading or drooping clusters; they are fragrant and bisexual, with five unequal, thinly veined, yellowish-white petals, and develop into long, slender, triangular seed-pods (Jyothi *et al.*, 1990). Tender fruits are ready for harvest from June to October.

Pollen and Nectar



Fig. 5. Close-up of a moringa flower showing floral parts

The zygomorphic flowers are borne in axillary panicles up to 15 cm long (Jyothi *et al.*, 1990). Anthesis occurs in the morning (0600–1200 h), after which pollen dehiscence and nectar secretion follows (0700–1300 h). The stigma becomes receptive a day before the flower opens and remains receptive through the day of opening. Each flower is a rich source of nectar and pollen, producing an average of 23,525 pollen grains, or about 523 pollen grains per ovule, making the flowers highly attractive to honey bees and other pollinators.

The plant is entomophilous and strongly cross-pollinated owing to its heteromorphic floral biology, with bees as the dominant pollinators (Jyothi *et al.*, 1990; Krieg *et al.*, 2017). Successful pollination requires a large number of insect visits per flower. Recorded floral visitors include Hymenoptera (*Apis cerana indica*, *A. dorsata*, *A. florea*, *Xylocopa latipes*, *X. pubescens*, *Megachile* spp. and *Halictus* sp.), Lepidoptera (Papilionidae and Pieridae) and Diptera (syrphid and muscid flies) (Saravanan *et al.*, 2025). Among these, *A. cerana indica* and *A. dorsata* forage most heavily for pollen and nectar, with peak foraging activity generally recorded during the mid-morning hours (Narmadha *et al.*, 2021; Saravanan *et al.*, 2025, Verghese, 2022). Various dipteran flies, butterflies and parasitoids also visit the flowers for nectar, and hummingbirds have been observed as active pollinators as well.

Table 1: Insect Visitors of Moringa Bloom

Order	Family	Insect visitors
Hymenoptera	Apidae	<i>Apis cerana indica</i> , <i>Apis dorsata</i> , <i>Apis florea</i>
	Halictidae	<i>Nomia</i> sp.
	Apidae	<i>Xylocopa latipes</i> , <i>X. pubescens</i>
	Megachilidae	<i>Megachile bicolor</i> Fab., <i>Megachile lanata</i> Fab.
Lepidoptera	Nymphalidae (Danainae)	<i>Danaus plexippus</i> L.
	Lycaenidae	<i>Lampides boeticus</i>
	Pieridae	<i>Pieris brassicae</i>
Diptera	Syrphidae	<i>Eristalis</i> sp., <i>Syrphus</i> sp.
	Muscidae	<i>Musca domestica</i>



Fig. 6. Moringa orchard maintained with migratory bee colonies for pollination and honey production

Impact on Yield and Honey Production

To optimise moringa yield, 30 Indian bee colonies were placed at 50 m spacing per hectare, yielding about 3 kg of honey per hive per extraction. Over the full four-month nectar-flow period, honey was extracted six times, indicating a potential yield of 18 kg of honey per hive per flowering season. At an average market price of Rs. 600 per kg, this represents an additional income of about Rs. 10,800 per hive per year.



Fig. 7. Honeycomb frames from colonies maintained in moringa orchards

For 30 hives per hectare, this translates to a total additional income of roughly Rs. 3,24,000 per hectare from honey sales alone, a figure that would rise further with organic certification. The average productivity of tender fruits in Tamil Nadu is about 21 tonnes per hectare; growers in Korkai Manaloor, Eral, Tuticorin, report that

bee-assisted pollination can increase this yield by up to 30-fold under favourable conditions, a magnitude consistent with the significant yield gains from managed bee pollination documented in other moringa-growing tracts of Tamil Nadu (Somiya *et al.*, 2023).



Fig. 8. Bunches of tender moringa fruits harvested from a bee-pollinated orchard

Moringa Honey

Moringa honey is produced by honey bees from the nectar of moringa flowers. It is dark brown, with a rich, thick consistency, a fine flavour and a strong aroma. As a monofloral honey, it is reported to help retain calcium in the body and to protect against heart disease. Gaining recognition as a superfood, moringa honey is valued for its high nutritional content, antioxidants and anti-inflammatory properties, along with a range of other health benefits (Anwar *et al.*, 2007). Honey samples analysed from the plantation showed a moisture content of 19 per cent, placing the honey in a special quality grade.



Fig. 9. Bottled moringa honey harvested from orchard-based colonies

Table 2: Composition of moringa honey (per 100 g)

Constituent (per 100 g)	Value
Moisture	19%
Sugars	82 g
Energy	304 kcal
Sodium	4 mg
Potassium	52 mg
Dietary fibre	0.2 g

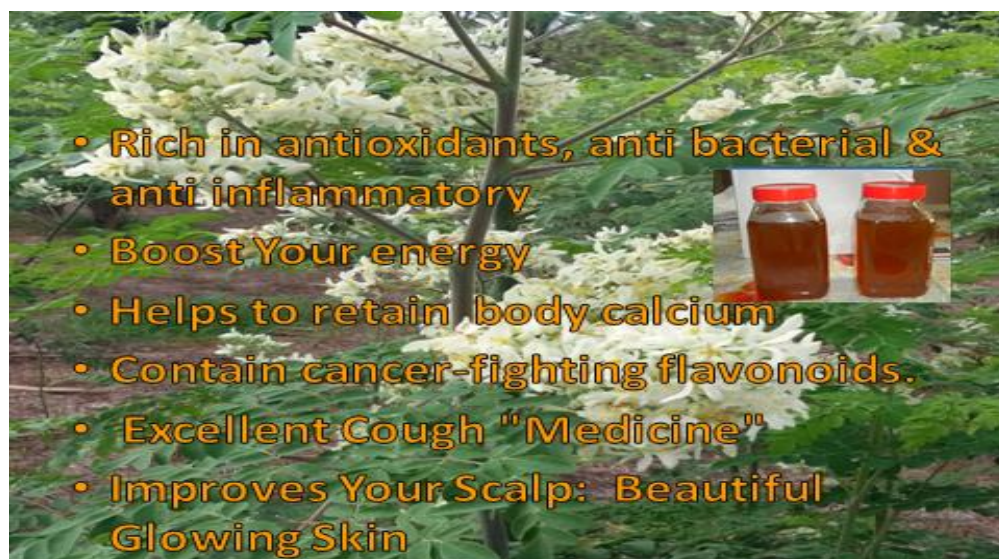
Medicinal Uses

According to the Ayurvedic system of medicine, moringa is used in the management of around 300 conditions (Anwar *et al.*, 2007). It is palatable and highly nutritious, and its honey is traditionally valued for supporting

digestion, liver and kidney function, and for helping to balance blood sugar and cholesterol levels. These traditional and reported pharmacological benefits are attributable to specific constituents present in moringa honey, summarised in Table 3.

Table 3. Medicinal constituents of moringa honey and their reported health benefits

Constituent / Property	Reported Health Benefit
Flavonoids and polyphenolic antioxidants	Neutralise free radicals; flavonoids are of interest in cancer-related research
Retained calcium	Supports bone mineral density; traditionally used to manage osteoporosis in women
Potassium	Eases arthritis and joint inflammation
Anti-inflammatory compounds	Help manage arthritis, rheumatism and general joint inflammation
Antibacterial compounds	Associated with reduced incidence of ulcers and gastrointestinal disorders
Natural sugars	Provide a readily available, sustained source of energy
Blood-glucose-regulating compounds	Help stabilise blood sugar levels; beneficial for diabetes management
Hepato-renal and digestive-supportive compounds	Support liver and kidney function and aid digestion
Cardio-protective compounds	Support cardiovascular health and help balance cholesterol levels

*Fig. 10. Health and nutritional attributes associated with moringa honey*

Conclusion

Migrating honey bee colonies into moringa orchards offers growers a sustainable and profitable additional income stream. Under the favourable weather conditions of Tuticorin, Tamil Nadu, with its prolonged summer months, bee-assisted pollination markedly increases the yield of vegetable moringa, in line with earlier reports of enhanced fruit set and yield following managed bee pollination in moringa (Jyothi *et al.*, 1990; Somiya *et al.*, 2023; Saravanan *et al.*, 2025).

Value addition of tender fruits, leaves and honey during the production season would

help ensure fair prices for growers. Given its culinary and medicinal value, moringa honey has considerable market potential as a specialty product, comparable to Manuka honey from New Zealand, which retails at around Rs. 9,000 per kg. Adoption of organic farming with organic certification would further support premium pricing for unifloral, natural moringa honey.

Establishing long-term cold storage facilities and developing export channels for moringa honey, fruits and leaves would help ensure better returns and profitability for moringa farmers.



Fig. 11. A thriving moringa orchard supported by managed honey bee pollination

References

- Anwar, F., Latif, S., Ashraf, M. and Gilani, A. H. (2007). *Moringa oleifera*: A food plant with multiple medicinal uses. *Phytotherapy Research*, **21**(1), 17–25. <https://doi.org/10.1002/ptr.2023>
- Jyothi, P. V., Atluri, J. B. and Subba Reddi, C. (1990). Pollination ecology of *Moringa oleifera* (Moringaceae). *Proceedings of the Indian Academy of Sciences (Plant Sciences)*, **100**(1), 33–42. <https://doi.org/10.1007/BF03053466>
- Krieg, J., Goetze, D., Porembski, S., Arnold, P., Linsenmair, K. and Stein, K. (2017). Floral and reproductive biology of *Moringa oleifera* (Moringaceae) in Burkina Faso, West Africa. *Acta Horticulturae*, **1158**, 63–70. <https://doi.org/10.17660/ActaHortic.2017.1158.8>
- Narmadha, K. M., Saravanan, P. A., Umamathy, G. and Velmurugan, M. (2021). Foraging activity of managed bee pollinator (*Apis cerana indica*) in bitter gourd cropping system in India. *Uludağ Bee Journal*, **21**(2), 216–226. <https://doi.org/10.31467/uluaricilik.1000935>
- Somiya, C., Srinivasan, M. R. and Saravanan, P. A. (2023). Influence of Indian honey bees and other pollinators on the yield improvement of moringa. *Madras Agricultural Journal*, **110**(4-6), 1–11.
- Saravanan, P. A., Ravichandran, V., Veeramani, P., Velmurugan, M., Jayakumar, J. and Alagar, M. (2025). Unveiling the secret pollinators: A deep dive into moringa's pollination ecology. *Plant Science Today*, **12**(1), 1–7. <https://doi.org/10.14719/pst.6655>
- Verghese, A. 2022, March 5. *Xylocopa: The reason for my drumstick (Moringa)!* Insect Environment. <https://insectenvironment.com/f/xylocopa--the-reason-for-my-drumstick-moringa>

MS Received on 12th June, 2026

MS Accepted on 17th August, 2026

DOI:10.55278/FKTE2433

Inventory of Orthoptera (Insecta) from Ranjit Sagar Conservation Reserve, Punjab, India

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Abstract

During recent surveys by the Zoological Survey of India from April 2021 to March 2024, along with data from previous surveys, a total of 37 species belonging to 28 genera and 5 families of Orthoptera were recorded from the Ranjit Sagar Conservation Reserve. Superfamily-wise analysis revealed that Acridoidea was the most species-rich group, comprising 28 species (76%), followed by Pyrgomorphoidea (4 species, 11%), Tetrigoidea (2 species, 5%), Grylloidea (2 species, 5%) and Tettigonioidea (1 species, 3%). Observations on relative abundance of Orthoptera diversity revealed that of these 37 species, 10 species (27%), were found to be common, 17 species (46%) uncommon and remaining 10 species (27%) less common. The present study shows that 73% of the Orthopteran species in the Ranjit Sagar Conservation Reserve are Uncommon or Less Common and were under anthropogenic pressure before the declaration of the Conservation Reserve in 2018.

Keywords: Orthoptera, Acrididae, Ranjit Sagar, Punjab, Shivalik

Introduction

The order Orthoptera includes a variety of katydids, crickets, and grasshoppers, all of which have distinct eating habits. Its individuals often have large prothorax and hind legs, somewhat thicker tegmina, and incomplete metamorphosis. With about 28284 species worldwide, the order Orthoptera is one of the largest insect orders (Cigliano *et al.*, 2018). Kirby (1914) made the most significant contribution to Indian Orthoptera in "Fauna of British India, including Ceylon and Burma,

Orthoptera (Acrididae)," which contained 329 species under 124 genera.

Indian Tetriginæ were researched by Hancock (1915) and Chopard (1969) in "The Fauna of India and surrounding countries, Orthoptera vol. 2 Grylloidea," which comprised 355 species. A checklist of Indian Orthoptera including 1033 species and subspecies from 400 genera was created by Shishodia *et al.* (2010).

Less research has been done on this group in the state of Punjab, where Ranjit

Sagar Conservation Reserve is located. Thakur *et al.* (2004) found 42 species of Orthoptera from Punjab's Ropar wetland. An account of 52 species of Orthoptera from Punjab was compiled by Chandra (2011). Another significant research on Punjab's Orthoptera has been done by Shishodia *et al.* (2006), Thakur & Thakur (2012), Kumar & Usmani (2012), Kumar *et al.* (2013), Usmani & Kumar (2013), and Shishodia *et al.* (2014). 54 species from 27 genera of Acrididae were identified in Punjab by Kumar & Usmani (2015). Six additional reports of short-horned grasshoppers from Punjab were recently reported by Sharma (2017). An account of 155 species/subspecies from 91 genera and 12 families of Orthoptera from Punjab was compiled by Sharma *et al.* (2019).

In the present document, Orthoptera of Ranjit Sagar Conservation Reserve, Punjab has been compiled resulting in the presence of 37 species/subspecies belonging to 28 genera under 5 families.

Material and Methods

Study area

This Conservation Reserve covers 4559.71 acres and is located in the District of Pathankot of the state Punjab. In accordance with section 36A of the Wildlife (Protection) Act, 1972, the area was designated as a Conservation Reserve by Notification No. 34/11/2017-Ft-5/1177745/1 dated 5.3.2018. It is a part of a hydroelectric plant on the Ravi

River built by the Punjab Irrigation Department. It is located on the border of Punjab and Jammu & Kashmir, two Indian states. With a 600-megawatt capacity, the project is Punjab's biggest hydroelectric dam. The region is extremely rich in biodiversity since the lake is located in the Shivalik mountain system, which forms the border between J&K, Punjab, and Himachal Pradesh. The region has a subtropical climate with monsoons, warm summers, and chilly winters.

The reserve area's original terrestrial vegetation was Northern Tropical Dry Deciduous. The primary tree species that make up the current stand are *Ficus religiosa* (Pipal), *Ficus bengalensis* (Bohar), *Eucalyptus globules* (Safeda), *Acacia nilotica* (Kikar), *Dalbergia sissoo* (Sheesham), *Albizia lebbbeck* (Siris), *Zizyphus sp.* (Ber), *Mangifera indica* (Mango), *Acacia catechu* (Khair), *Cedrela toona* (Toon), *Syzgium cumini* (Jamun), and *Salmalia malabarica* (Simbal). Trees in the upper canopy with dense shrub undergrowth, including: *Murraya koenigi* (Gamdhala), *Adhatocia vasica* (Basuti), *Dodonaea viscosa* (Vilayti Mehdi), *Zizyphus nummularia* (Mallah), *Capparis deciduas* (Hins), *Carissa spinarum* (Garna), and *Cassia tora* (Panwar). Weeds *i.e.*, Bhagiari Booti (*Lantana camara*), Congress grass (*Parthenium hysterophorus*) and Bhang (*Cannabis sativa*). Shrubs as Hins (*Capparis zeylanica*), Jahu (*Artemesia sp.*), Gruna (*Carissa spinarum*), Karir (*Capparis decidua*), Bhang (*Cannabis sativa*), Jindoo (*Xanthium strumarium*), Kahi (*Saccharum*

spontaneum), and Akk (*Ipomoea fistuloca*) make up the undergrowth.

Some endangered species, such as the Pangolin, Python, Leopard, and Indian Monitor Lizard, rely heavily on the catchment area surrounding the reservoir. Additionally, it serves as a significant breeding ground for a variety of animals, including jackals, hog deer, sambhar, and barking deer.

Methodology

Collections and observations were conducted in the Ranjit Sagar Conservation Reserve (N 32.2665666°; E 75.440931°; Elevation 390-777 m above sea level (asl) from April 2021 to March 2024. Grasshoppers were collected using a standard insect (butterfly) net and manual hand-picking methods. Voucher specimens were collected, preserved, and subsequently identified following standard taxonomic procedures. After identification, the specimens were deposited in the National Zoological Collections (NZC) at the Northern Regional Centre, Zoological Survey of India, Dehradun.

The identification of grasshoppers was carried out using the standard taxonomic keys and relevant literature cited above. The abundance status presented herein is based on an arbitrary frequency scale developed from the present observations and the number of encounters recorded for each species. Species were categorized as follows: Common (encountered 6-10 times), Less Common

(encountered 3-5 times), and Uncommon (encountered only once or twice).

Result and Discussion

A total of 37 species belonging to 28 genera and 5 families were found in Ranjit Sagar Conservation Reserve. Out of 37 species, 30 species were recorded during the recent surveys w.e.f. April, 2021 to March, 2024 under the mandate of Zoological Survey of India and the species which could not be collected are quoted from literature are marked with asterisk in the table. Superfamily wise analysis of the number of grasshopper species indicate that the Superfamily Acridoidea was with maximum number of species (28 species, 76%), followed by Pyrgomorphoidea (4 species, 11%), Tetrigoidea (2 species, 5%), Grylloidea (2 species, 5%) and Tettigonioidea (1 species, 3%). (Table I). Observations on relative abundance of Orthoptera diversity revealed that of these 37 species, 10 species (27%), were found to be common, 17 species (46%) uncommon and remaining 10 species (27%) less common. The present study shows that 73% of the Orthopteran species in the Ranjit Sagar Conservation Reserve are Uncommon or Less Common and were under anthropogenic pressure before the declaration of the Conservation Reserve in 2018.

The conservation reserve represents 24 % (37 species) of the total Orthopteran species *i.e.*, 155 species reported from the state Punjab (Sharma *et al.*, 2019). The Ranjit Sagar Conservation Reserve is situated in the North-

West part of the Punjab Shivaliks. 45 % Orthopteran species is represented from Conservation Reserve as compare to 77 species under 55 genera of Orthoptera from Punjab Shivaliks (Shishodia *et al.*, 2006). When we compare the Orthopteran diversity of Ranjit Sagar Conservation Reserve (also includes Ranjit Sagar Dam) with the Ropar Wetland of Punjab, the latter wetland is having more Orthoptera species i.e., 42 species

(Thakur *et al.*, 2004). The species, *Acrida gigantea* (Herbst), *Xenocatantops karnyi* (Kirby), *Eucoptacra praemorsa* (Stål, 1861), *Oxya japonica japonica* (Thunberg, 1815), *Chrotogonus (Chrotogonus) armatus* Steinmann, 1965, *Chrotogonus (Chrotogonus) brachypterus* Bolívar, 1902 are recorded from Ranjit Sagar Conservation Reserve are the new additions to the Punjab Shivaliks.

Table 1. Systematic list of Orthoptera (Insecta) in Ranjit Sagar Conservation Reserves (CR) of Punjab

S. No.	Name of the species	Status
	Superfamily Acridoidea Family Acrididae Subfamily Acridinae	
1	<i>Acrida exaltata</i> (Walker, 1859)	Less Common
2	<i>Acrida gigantea</i> (Herbst, 1786)	Uncommon
3	<i>Phlaeoba infumata</i> Brunner von Wattenwyl, 1893	Less Common
	Subfamily Catantopinae	
4	<i>Choroedocus illustris</i> (Walker, 1870)	Uncommon
5	<i>Pachyacris vinosa</i> (Walker, 1870)*	Uncommon
6	<i>Diabolocantantops innotabilis</i> (Walker, 1870)	Less Common
7	<i>Xenocatantops humilis</i> (Serville, 1838)	Less Common
8	<i>Xenocatantops karnyi</i> (Kirby, 1910)	Uncommon
	Subfamily Coptacrinae	
9	<i>Eucoptacra praemorsa</i> (Stål, 1861)	Uncommon
	Subfamily Cyrtacanthacridinae	
10	<i>Chondracris rosea</i> (De Geer, 1773)	Uncommon
	Subfamily Eyprepocnemidinae	
11	<i>Tylotropidius varicornis</i> (Walker, 1870)*	Uncommon
12	<i>Eyprepocnemis roseus</i> Uvarov, 1942	Less Common
	Subfamily Gomphocerinae	
13	<i>Gelastorhinus laticornis</i> (Serville, 1838)*	Uncommon
14	<i>Aulacobothrus luteipes luteipes</i> (Walker, 1871)	Uncommon
15	<i>Aulacobothrus sinensis</i> (Uvarov, 1925)*	Uncommon
	Subfamily Hemiacridinae	

S. No.	Name of the species	Status
16	<i>Hieroglyphus banian</i> (Fabricius, 1798)	Less Common
	Subfamily Oedipodinae	
17	<i>Chloebora grossa</i> Saussure, 1884*	Uncommon
18	<i>Aiolopus thalassinus tamulus</i> (Fabricius, 1798)	Common
19	<i>Gastrimargus africanus africanus</i> (Saussure, 1888)	Common
20	<i>Gastrimargus marmoratus</i> (Thunberg, 1815)	Uncommon
21	<i>Oedaleus abruptus</i> (Thunberg, 1815)	Common
22	<i>Ceracris nigricornis nigricornis</i> Walker, 1870	Less Common
23	<i>Trilophidia annulata</i> (Thunberg, 1815)	Common
	Subfamily Oxyinae	
24	<i>Oxya fuscovittata</i> (Marschall, 1836)	Common
25	<i>Oxya hyla</i> Serville, 1831	Common
26	<i>Oxya velox</i> (Fabricius, 1787)	Less Common
27	<i>Oxya japonica japonica</i> (Thunberg, 1815)	Uncommon
	Subfamily Spathosterninae	
28	<i>Spathosternum prasiniferum prasiniferum</i> (Walker, 1871)	Common
	Superfamily Pyrgomorphoidea Family Pyrgomorphidae Subfamily Pyrgomorphinae	
29	<i>Atractomorpha crenulata crenulata</i> (Fabricius, 1793)	Common
30	<i>Chrotogonus (Chrotogonus) armatus</i> Steinmann, 1965	Uncommon
31	<i>Chrotogonus (Chrotogonus) trachypterus trachypterus</i> (Blanchard, 1836)	Common
32	<i>Chrotogonus (Chrotogonus) brachypterus</i> Bolívar, 1902	Uncommon
	Superfamily Tetrigoidea Family Tetrigidae Subfamily Tetriginae	
33	<i>Ergatettix guentheri</i> Steinmann, 1970*	Uncommon
	Subfamily Scelimeninae	
34	<i>Thorodonta apiculata</i> Hancock*	Uncommon
	Superfamily Grylloidea Family Gryllidae Subfamily Gryllinae	
35	<i>Loxoblemmus taicoun</i> Saussure, 1877	Common
36	<i>Teleogryllus (Brachyteleogryllus) occipitalis occipitalis</i> (Serville, 1838)	Less Common
	Superfamily Tettigonioidea Family Tettigoniidae Subfamily Phaneropterinae	
37	<i>Ducetia japonica</i> (Thunberg, 1815)	Less Common

Acknowledgements

Authors are thankful to Director, Dr. Dhriti Banejee, Zoological Survey of India, Kolkata and Officer Incharge, Northern Regional Centre, Zoological Survey of India, Dehradun for all sorts of facilities in connection with surveys. Thanks, are also due to different survey parties for collecting the specimens.

References

- Chandra, K. 2011. Insect fauna of states and union territories in India. In, Arthropods and their Conservation in India (Insects and Spiders) (Eds. Uniyal, V. and Srivastava, A.). *ENVIS Bulletin*: **14(1)**: 189-218 (Published by Wildlife Institute of India, Dehradun).
- Chopard, L. 1969. *Orthoptera. Vol. 2. Grylloidea. The Fauna of India and the Adjacent Countries*. i-xviii, 1–421.
- Cigliano, M.M., Braun, H., Eades, D.C. and Otte, D. 2018. *Orthoptera Species File*. Version 5.0/5.0. [13.xii.2018]. <<http://Orthoptera.SpeciesFile.org>>.
- Hancock, J.L. 1915. V. Indian Tetriginæ (Acrydiinæ). *Records of the Indian Museum*, **11**:55–137.
- Kirby, W.F. 1914. *Fauna of British India, including Ceylon and Burma. Orthoptera (Acrididae)*. 276 pp.
- Kumar, H. and Usmani, M.K. 2012. A checklist of Acridoidea (Orthoptera) of Punjab, India. *Journal of Entomological Research*, **36 (2)**: 173–175.
- Kumar, H. and Usmani, M.K. 2015. Taxonomic studies on Acrididae (Orthoptera: Acridoidea) from Punjab (India). *International Journal of Fauna and Biological Studies*, **2(2)**: 38–58.
- Kumar, H., Usmani, M.K. and Akhtar, M.H. 2013. Effect of some ecological factors on the distribution and diversity of Pyrgomorphidae (Orthoptera: Pyrgomorphae) in Punjab of India. *Munis Entomology & Zoology*, **8(2)**: 646–653.
- Sharma, N. 2017. New records of Acridoidea (Insecta: Orthoptera) from Punjab, India. *Records of the Zoological Survey of India*, **117(1)**: 1–3.
- Sharma N., Kumar H., Gupta S. K. and Chandra K. 2019. Insecta: Orthoptera. *Fauna of Punjab, State Fauna Series*, **23**: 79-118. (Published by the Director, Zoological Survey of India, Kolkata).
- Shishodia, M.S, Chandra, K. and Gupta, S.K. 2010. An annotated checklist of Orthoptera (Insecta) from India. *Records of the Zoological Survey of India, Occasional Paper*, **314**: 1–366.
- Shishodia, M.S, Mehta, H.S. & Thakur, S.K. 2006. Order: Orthoptera: 486–501. In: Jerath, Neelima, Puja & Chadha Jatinder (Editors). 2006. *Biodiversity in the Shivalik Ecosystem of Punjab*,

- India. Punjab State Council for Science and Technology, Chandigarh.
- Shishodia, M.S., Thakur, S.K. and Saini, K. 2014. Orthoptera: Insecta of Chandigarh (UT) and surrounding areas. *Records of the Zoological Survey of India*, **114(3)**: 411–428.
- Thakur, S.K. and Thakur, M.S. 2012. Orthopteran crop-pest relationship in Roper wetland and its environ Punjab, India. *International Journal of Plant, Animal and Environmental Sciences*, **2(1)**: 52–54.
- Thakur, S.K., Shishodia, M.S., Mehta, H.S. and Mattu, V.K. 2004. Orthopteran Diversity of Ropar Wetland, India. *Zoos' Print Journal*, **19(11)**: 1697.
- Usmani, M.K. and Kumar, H. 2013. *Diversity, Distribution and Taxonomy of Pyrgomorphidae (Orthoptera: Pyrgomorphoidea) of Punjab (India)*. 299–315. In: Animal Diversity, Natural History and Conservation. Daya Publishing House, New Delhi.

MS Received on 10th June, 2026
MS Accepted on 14th August, 2026

DOI:10.55278/AZED9818

Diversity and Distribution of Twirler Moths (Lepidoptera: Gelechiidae) in Mandi District, Himachal Pradesh, India

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Abstract

Field surveys conducted across twenty localities in Mandi District, Himachal Pradesh, India, between 2022 and 2025 yielded twenty-five species of twirler moths (Lepidoptera: Gelechiidae) belonging to nine genera and three subfamilies *i.e.*, Anacampsinae, Dichomeridinae and Gelechiinae. Anacampsinae was the most species-rich subfamily (12 species; genera *Anarsia* and *Hypatima*), followed by Dichomeridinae (10 species; five genera, dominated by *Dichomeris*) and Gelechiinae (3 species). Three species *Anarsia renukaensis*, *A. tanyharensis*, and *A. valvata* are Himalayan endemics previously known only from limited Himachal Pradesh localities, each represented here by just two specimens, suggesting narrow distribution and habitat specialization. *Dichomeris rasilella* and *Helcystogramma hibisci* were the most widely distributed and abundant species across the region. Three economically important Gelechiinae species were also recorded *Pectinophora gossypiella* (pink bollworm, a major cotton pest), *Phthorimaea operculella* (potato tuber moth), and *Sitotroga cerealella* (a serious stored-grain pest) all classified as common in the present collections. This study substantially expands the known diversity and distribution of Gelechiidae in Himachal Pradesh and provides baseline data for future taxonomic, ecological, and conservation work on this poorly studied family.

Keywords: Diversity, distribution, Gelechiidae, Lepidoptera, Moths, Himachal Pradesh, India

Introduction

Moths, butterflies, and skippers collectively known as scaly-winged insects belong to the order Lepidoptera within the class Insecta. Lepidoptera is the third largest insect order, following Coleoptera (beetles) and Diptera (flies). Zhang (2013) estimated

that the order comprises approximately 158, 570 described species worldwide, of which about 138, 656 are moths and the remaining species are butterflies. More recently, Singh *et al.* (2024) reported that the order Lepidoptera consists of 166, 320 species belonging to 43 superfamilies, 143 families, and 317 subfamilies globally. Of these, only 13,124

species have so far been documented from India. The family Gelechiidae belongs to the superfamily Gelechioidea and comprises predominantly minute-sized moths. Globally, the family is represented by 5,371 described species, of which 351 species have been reported from India (Singh *et al.*, 2024). Adult Gelechiidae are generally small, with a wingspan ranging from approximately 5 to 20 mm, and are weak fliers, making their collection and identification particularly challenging. Owing to these constraints, this ecologically and economically important group has remained largely neglected by both applied and fundamental entomologists, including agricultural and forest entomologists, in India for many years.

To address this knowledge gap, field surveys were conducted during different seasons between 2022 and 2025 across various localities in Mandi District, Himachal Pradesh, to collect adult specimens and document the diversity and distribution of Gelechiid moths. In total, 20 localities across Mandi District, Himachal Pradesh, were surveyed during the study period. The details of localities visited are being mentioned in table-1.

Material and Methods

Adult gelechiid moths were collected during the night, corresponding to their nocturnal activity, using portable light traps. In addition, specimens were collected by suspending a 125-W mercury-vapour lamp in front of a white cloth screen or a whitewashed

wall to attract adult moths. The collected specimens were killed using either ethyl acetate or 1,1,2,2-tetrachloroethane and were subsequently pinned, stretched, and preserved following the standard procedures described by Lindquist (1956), Tagestad (1974), Zimmerman (1978), Mikkola (1986), and Landry and Landry (1994). For morphological examination, the wings and genitalia were prepared using standard techniques. Wing preparation and examination followed the method of Zimmerman (1978), whereas genitalia were dissected, cleaned, mounted, and examined according to the procedure described by Robinson (1976). Taxonomic descriptions were based on external morphological characters following Park (1995), wing venation terminology and interpretation followed Common (1970) and Zimmerman (1978), and genitalia terminology followed Klots (1970). High-resolution photographs of adult specimens were taken prior to dissection to document their external morphology and colour pattern. Photographs of dissected genitalia and other diagnostic structures were obtained using a stereoscopic microscope equipped with a digital imaging system. All examined specimens were assigned unique voucher numbers and deposited in the designated institutional collection for future reference.

Observations

The collected specimens were sorted, curated, and subjected to preliminary taxonomic segregation based on external morphological characters. Identification of the collected specimens was carried out using standard taxonomic keys and published literature. The principal references consulted included the works by Meyrick (1912–1916, 1916–1923, 1923–1930, 1930–1936), Fletcher (1921, 1929), Gaede (1937), Clarke (1955, 1965, 1969, 1969a), Roonwal *et al.* (1964), Nye and Fletcher (1991), Holloway *et al.* (1992), Robinson *et al.* (1994), Park and Hodges (1995), Hodges (1998), Pathania and Rose (2003, 2003a), Rose and Pathania (2003, 2003a, 2004), Nandhini *et al.* (2024), and Singh *et al.* (2024). Species were identified using standard morphological and genitalic characters and confirmed against authenticated reference material housed at the NPC, IARI, New Delhi; PAU Insect Museum, Ludhaina and Punjabi University, Patiala.

Order: Lepidoptera

Superfamily: Gelechioidea

Diagnosis: Vertex and frons covered with smooth scales; labial palpus three

segmented, upturned, third segment long, acute; forewing with veins R4+R5 stalked; hind tibia with dorsal surface furnished with long slender scales.

Family : Gelechiidae

Gelechiidae Stainton, 1854, *Insecta Br. Lepid. Tineina*, 10 (key) and 75 (spelled as Gelechidae).

Type-genus: *Gelechia* Hubner, (1825) 1816, *Verz. Bekannter Schmett.*, 415.

The family is characterized by the following diagnostic features: vertex and frons covered with smooth scales; antenna shorter than three-fourths the length of the forewing; labial palpus strongly upturned, with the second segment elongate and the third segment acute; hindwing with veins R1 and Sc united from base of wing or R1 running into Sc beyond base of wing, discocellular perpendicular to long axis of wing or directed at 45-degree angle toward base of wing from M2, termen excavated. The list of collected species is provided on table-2.

Table-1: Details of localities visited in Mandi district of Himachal Pradesh

Localities surveyed	Latitude	Longitude	Altitude (mASL)
Tanihar	31.67°	76. 87°	1120
Tihra	31.72°	76.95°	1100
Gadhidhar	31.75°	76.92°	1150
Sandhol	31.78°	76.84°	1090
Awahadevi	31.69°	76.86°	1400
Cholthara	31.74°	76.88°	1180
Sarkaghat	31.70°	76.73°	650
Joginder Nagar	31.99°	76.79°	1220
Dhrampur	31.93°	76.82°	1280
Gadhidhar	31.75°	76.92°	1150
Shatalai	31.80°	76.91°	1160
Kataula	31.80°	77.13°	1680
Parashar	31.75°	77.17°	2730
Salapar	31.54°	76.90°	780
Sundernagar	31.53°	76.91°	1174
Aut	31.85°	77.16°	1070
Pandoh	31.68°	77.05°	900
Nirchowk	31.53°	76.89°	760
Karsog	31.38°	77.20°	1404
Janjhal	31.56°	77.20°	2150

Table-2: List of collected/identified species

Based on the current classification of the family Gelechiidae, the 25 species can be arranged subfamily-wise as follows:

Sr. No.	Subfamily	Name of Species	Old distribution	Collected examples	Status
1.	Anacampsinae	<i>Anarsia didymopa</i> Meyrick	Pusa (Bengal), Dehradun (Uttarakhand), Patiala (Punjab)	05	NC
2.		<i>Anarsia ephippias</i> Meyrick	Pusa (Bengal)	08	C
3.		<i>Anarsia patulella</i> (Walker)	Dehradun (Uttarakhand)	05	NC
4.		<i>Anarsia reciproca</i> Meyrick	Madras, Coimbatore (Tamilnadu)	01	R
5.		<i>Anarsia renukaensis</i> Rose and Pathania	Renuka (Himachal Pradesh)	02	NC
6.		<i>Anarsia tanyharensis</i> Rose and Pathania	Tanyhar (Himachal Pradesh)	02	R
7.		<i>Anarsia tegumentus</i> Rose and Pathania	Dehradun (Uttarakhand)	05	NC
8.		<i>Anarsia triglypta</i> Meyrick	Pusa (Bihar), Mandi (Himachal Pradesh)	10	C
9.		<i>Anarsia valvata</i> Rose and Pathania	Solan, Mandi (Himachal Pradesh)	2	R
10.		<i>Hypatima spathota</i> (Meyrick)	Dehradun (Uttarakhand), Renuka (Himachal Pradesh)	03	NC
11.		<i>Hypatima tephroptila</i> (Meyrick)	Dehradun (Uttarakhand)	6	C
12.		<i>Hypatima vinculata</i> Pathania and Rose	Patiala (Punjab)	02	NC
13.	Dichomeridinae	<i>Brachmia engrapta</i> Meyrick	Lahore, (Punjab)	04	NC
14.		<i>Dichomeris acuminata</i> (Staudinger)	Solan (Himachal Pradesh), Dehradun (Uttarakhand)	05	NC
15.		<i>Dichomeris quercicola</i> Meyrick	Kangra (Himachal Pradesh)	03	NC
16.		<i>Dichomeris rasilella</i> (Herrich-Schäffer)	Solan, Renuka (Himachal Pradesh),	05	C
17.		<i>Dichomeris sicaellus</i> Pathania and Rose	Solan (Himachal Pradesh)	08	NC
18.		<i>Helcystogramma clarkei</i> Pathania and Rose	Patiala (Punjab), Dehradun (Uttarakhand)	06	NC
19.		<i>Helcystogramma hibisci</i> (Stainton)	Renuka, Solan (Himachal Pradesh), Dehradun (Uttarakhand), Patiala (Punjab)	08	C
20.		<i>Helcystogramma uedai</i> Rose and Pathania	Renuka, Mandi (Himachal Pradesh), Dehradun (Uttarakhand)	02	R
21.		<i>Stegasta comissata</i> Meyrick	Brazil, Obidos, Santarem, Parintins, Manaus, Patiala (Punjab), Dehradun (Uttarakhand), Jammu (Jammu & Kashmir)	05	NC
22.		<i>Stegasta omelkoi</i> Pathania and Rose	Solan, Dharampur, Renuka, Palampur (Himachal Pradesh)	05	N C
23.	Gelechiinae	<i>Pectinophora gossypiella</i> Saunders	Bathinda (Punjab)	06	C
24.		<i>Phthorimaea operculella</i> Zeller	Shimla, Solan (Himachal Pradesh)	06	C
25.		<i>Sitotroga cerealella</i> (Olivier)	Likiang (China), Ludhiana, Faridkot (Punjab)	10	C

C: Common, NC: Not common, R: rare

Discussion

The present investigation documents 25 species belonging to three subfamilies of Gelechiidae, namely Anacampsinae, Dichomeridinae, and Gelechiinae, collected from twenty different localities of Mandi district of Himachal Pradesh. The study considerably expands the understanding of the distribution and abundance of gelechiid moths in the region and provides valuable baseline information for future taxonomic, ecological, and conservation studies.

The Anacampsinae subfamily was the most species-rich, represented by 12 species distributed under the genera *Anarsia* and *Hypatima*. The species i.e., *Anarsia didymopa*, *A. patulella*, *A. tegumentus*, *Hypatima spathota*, and *H. vinculata*, were represented by moderate numbers of specimens and were categorized as not common. In contrast, *Anarsia ephippias*, *A. triglypta*, and *Hypatima tephroptila* were comparatively abundant and classified as common species. Three endemic Himalayan species, namely *Anarsia renukaensis*, *A. tanyharensis*, and *A. valvata*, described earlier from Himachal Pradesh, were represented by only two specimens each from Mandi district. Their restricted occurrence indicates a narrow geographical distribution and possible habitat specialization.

The subfamily Dichomeridinae comprised ten species belonging to five genera. Members of *Dichomeris* constituted the largest proportion within this subfamily.

Dichomeris rasilella and *Helcystogramma hibisci* were categorized as common species and occurred across several localities of Himachal Pradesh, Punjab, and Uttarakhand. Their broad distribution suggests ecological adaptability and efficient utilization of diverse host plants. Conversely, *Dichomeris acuminata*, *D. quercicola*, *D. sicaellus*, *Helcystogramma clarkei*, *H. uedai*, *Stegasta comissata*, and *S. omelkoi* were less frequently encountered and therefore categorized as not common or rare.

The occurrence of *Stegasta comissata* deserves particular attention because the species was originally described from the Neotropical region and has subsequently been reported from scattered localities in India.

The subfamily Gelechiinae was represented by only three economically important species, namely *Pectinophora gossypiella*, *Phthorimaea operculella*, and *Sitotroga cerealella*. Although species diversity within this subfamily was comparatively low, all three species were common in the present collections. *Pectinophora gossypiella* is a serious pest of cotton, *Phthorimaea operculella* damages potato crops both in the field and during storage, whereas *Sitotroga cerealella* is one of the most destructive pests of stored cereals worldwide.

Overall, the present study significantly contributes to the knowledge of the taxonomy, diversity, abundance, and geographical

distribution of Gelechiidae from Mandi district. The findings emphasize the importance of continued faunal surveys in the region, where many species remain poorly documented and additional undescribed taxa are likely to occur. Future investigations integrating morphological taxonomy with DNA barcoding, host plant associations, ecological observations, and long-term monitoring will further improve our understanding of species diversity, evolutionary relationships, and conservation requirements within this ecologically and economically important family.

Acknowledgements

The authors are grateful to the Director, Zoological Survey of India (ZSI), Kolkata, for providing the necessary laboratory facilities. The authors express their heartfelt gratitude to Kyu-Tek Park (Republic of Korea) for generously providing valuable literature and reference materials, which greatly facilitated the taxonomic identification and completion of this work.

References

- Clarke, J.F.G. (1955). *Catalogue of the type specimens of microlepidoptera in the British Mus. (Natural History) described by Edward Meyrick*, Trustees of the British Museum (Natural History), London, Vol. I: 332 pp.
- Clarke, J.F.G. (1965). *Catalogue of the type specimens of microlepidoptera in the British Mus. (Natural History) described by Edward Meyrick*, Trustees of the British Museum (Natural History), London, Vol. V: 581pp.
- Clarke, J.F.G. (1969). *Catalogue of the type specimens of microlepidoptera in the British Mus. (Natural History) described by Edward Meyrick*, Trustees of the British Museum (Natural History), London, Vol. VI: 537pp.
- Clarke, J.F.G. (1969a). *Catalogue of the type specimens of microlepidoptera in the British Mus. (Natural History) described by Edward Meyrick*, Trustees of the British Museum (Natural History), London, Vol. VII: 531pp.
- Common, I.F.B. (1970). *Lepidoptera*, In Mackerras, I. M. (ed.). *The Insects of Australia. A Textbook for Students and Research Workers*. 1st edition. Melbourne University Press, Carlton, Australia. xiii + 1029, 765-866 pp.
- Fletcher, T.B. (1921). Life history of Indian Insects, Microlepidoptera. *Memoirs of Department of Agriculture., India* 6: 1-217.
- Fletcher, T.B. (1929). A list of the generic names used for Microlepidoptera. *Memoirs of Department of Agriculture., India* 11: ix + 246 pp.

- Gaede, M. (1937). Catalogue of Gelechiidae. *Lepidopterorum catalogus*, 79: 1-630.
- Hodges, R.W. (1998). *The Gelechioidea*. In: Kristensen, N.P. (Ed.), *Lepidoptera, Moths and Butterflies 1*. Handbuch der Zoologie / Handbook of Zoology IV/35. Walter de Gruyter, Berlin & New York, 131–158.
- Holloway, J.D., Bradely, J.D. & Carter, D.J. (1992). *The Guide to Insects of Importance to Man* (Lepidoptera) : 1-21.
- Klots, A.B. (1970). Taxonomists Glossary of Genitalia in Insects. *Munksgaard, Copenhagen Lepidoptera*. pp. 115-139 in Tuxen.
- Landry, J.F. & B. Landry (1994). A technique for setting and mounting microlepidoptera. *Journal of Lepidopterists Society*, **48** (3): 205-227.
- Lindquist, O.H. (1956). A technique for pinning and spreading small microlepidoptera. *Canadian Entomologist*, **138** (1) :24-25.
- Meyrick, E. (1912-1916). *Exotic Microlepidoptera*, E. W. Classey, Hampton, Middlesex, 1:1-640.
- Meyrick, E. (1916-1923). *Exotic Microlepidoptera*. E. W. Classey, Hampton, Middlesex, **2**: 1-640.
- Meyrick, E. (1923-1930). *Exotic Microlepidoptera*. E. W. Classey, Hampton, Middlesex, **3**: 1-640.
- Meyrick, E. (1930-1936). *Exotic Microlepidoptera*. E. W. Classey, Hampton, Middlesex, **4**: 1-642.
- Mikkola, K. (1986). Tower spreading, a handy method for provisional field preparation for microlepidoptera. *Nota entomológica*, **66**: 101-102.
- Nandhini, D., Shashank, P.R., Joshi, R. & Reddy, K.M. (2024). A catalogue of Indian Gelechiidae Stainton, 1854 (Lepidoptera: Gelechioidea) *Zootaxa* **5420**(1):1–121. DOI:10.11646/zootaxa.5420.1.1
- Nye, I.W.B. & Fletcher, D.S. (1991). The generic names of Moths of the world. *Natural History Museum Publications*, **6**: 1-368.
- Park, K.T. (1995). Gelechiidae of Taiwan 1. Review of *Anarsia*, with descriptions of four new species (Lepidoptera: Gelechioidea). *Tropical Lepidoptera*, **6** (1): 55-66.
- Park, K.T. & Hodges, R.W. (1995). Gelechiidae (Lepidoptera) of Taiwan III. Systematic Revision of the genus *Dichomeris* in Taiwan and Japan. *Ins. Koreana*, **12** : 1-101.
- Pathania, P.C. & Rose, H.S. (2003). Taxonomic notes on the genus *Hypatima* Hubner (Lepidoptera: Gelechiidae) alongwith a new species

- from India. *Journal Pest management & Economic Zoology*, **11** (2): 163-171.
- Pathania, P.C. & Rose, H.S. (2003a). Two new records and one new species of genus *Dichomeris* Hübner (Lepidoptera: Gelechiidae) from India. *Him. J. Env. Zool.*, **17** (1): 9-16.
- Robinson, G.S. (1976). The preparation of slides of Lepidoptera genitalia with special reference to microlepidoptera. *Entomologists Gazette*, **27** (2): 127-132.
- Robinson, G.S., K.R. Tuck & Shaffer, M. (1994). *A field guide to the smaller moths of South-East Asia*. Malaysian Nature Society, Malasia 308 pp., pls. 1-32.
- Roonwal, M.L., Mathur, R.N., Bhasin, G.D., Chatterjee, P.N., Sen-Sharma, P.K., Singh, B., Chandra, A., Thapa, R.S. & Krishna, K. 1964. A systematic catalogue of the main identified entomological collection at the Forest Research Institute, Dehradun, Parts 22-38, 197-537.
- Rose, H. S. & Pathania, P.C. (2003). Taxonomic studies on the genus *Anarsia* Zeller (Lepidoptera: Gelechiidae) from Siwaliks in India. *Entomon*, **28**(4): 329-354.
- Rose, H. S. & Pathania, P.C. (2003a). Two new species along with first record of the genus *Helcystogramma* Zeller (Lepidoptera: Gelechiidae) from India. *Pb. Univ. Res. J (Sci.)*, **53**: 81-90.
- Rose, H. S. & Pathania, P.C. (2004). A new species and A new record of the genus *Stegasta* Meyrick (Lepidoptera: Gelechiidae) from India., *Journal of Environmental Science.*, **8** (2): 152-156.
- Singh, N., Joshi, R, Kendrick, R.C, Pathania, P.C. & Banerjee, D. (2024). An illustrated guide to the Lepidoptera of India. Taxonomic procedures, family characters, diversity and distribution. 308pp. (Published by Director, Zoological Survey of India, Kolkata).
- Tagestad, A.D. (1974). A technique for mounting microlepidoptera. *Journal of the Kansas Entomological Society*, **47**: 26-30.
- Zhang, Z. Q. (Ed.). (2013). Animal biodiversity: An outline of higher-level classification and survey of taxonomic richness (Addenda 2013). *Zootaxa*, **3703**(1), 1–82.
- Zimmerman, E.C. (1978). Microlepidoptera. *Ins. Hawaii*, Vol. 9. University Press of Hawaii, Honolulu. xviii+1903 pp.

MS Received on 18th June, 2026

MS Accepted on 22nd August, 2026

DOI:10.55278/PVMY8539

First Report of *Myrmicaria brunnea* Saunders (Insecta: Hymenoptera: Formicidae) from Rajasthan, India

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Abstract

The ant genus *Myrmicaria* Saunders, 1842 (Hymenoptera: Formicidae: Myrmicinae) is widely distributed across the Afrotropical, Oriental and Indo-Australian zoogeographical regions. In India, the genus is represented by four species, viz., *Myrmicaria brunnea* Saunders, 1842, *M. brunnea subcarinata* (Smith, 1857), *M. carinata* (Smith, 1857) and *M. fodica* (Jerdon, 1851). During recent faunistic surveys conducted in Mount Abu Wildlife Sanctuary and Todgarh Raoli Wildlife Sanctuary, Rajasthan, India, specimens of *Myrmicaria brunnea* Saunders were collected and identified. This represents the first confirmed record of the genus *Myrmicaria* and *M. brunnea* from the state of Rajasthan, extending the known distribution of the species into the north-western semi-arid region of India. Diagnostic characters, habitat information and distributional remarks are provided. The present record contributes to a better understanding of the ant fauna of arid and semi-arid regions of India and emphasizes the need for further systematic surveys.

Key words: Formicidae, *Myrmicaria*, Myrmicinae, new record, ant diversity, arid zone, Rajasthan

Introduction

Ants (Hymenoptera: Formicidae) are ecologically dominant insects in most terrestrial ecosystems, where they play vital roles in soil modification, nutrient cycling, predation, scavenging, and seed dispersal. Through their nesting and foraging activities, ants influence soil aeration, organic matter decomposition, and the regulation of arthropod populations, thereby contributing significantly to the stability and functioning of ecosystems (Hölldobler & Wilson, 1990; Folgarait, 1998). Owing to their high abundance, wide

distribution, and sensitivity to environmental changes, ants are widely recognized as effective bioindicators of habitat quality and ecological disturbance (Andersen, 1997; Underwood & Fisher, 2006).

The ant genus *Myrmicaria* Saunders, 1842 was erected based on the type species *Myrmicaria brunnea* Saunders, 1842 and belongs to the subfamily Myrmicinae. The genus is widely distributed throughout the Old-World tropics, including South Asia, Southeast Asia, and tropical Africa (Bolton, 2003; Yahya et al., 2009), with the highest species richness

recorded in the Afrotropical and Oriental zoogeographical regions. Species of *Myrmicaria* are particularly characteristic elements of tropical ant faunas and are frequently encountered in both forested and semi-open habitats.

Members of *Myrmicaria* are medium- to large-sized ants and are predominantly ground-dwelling in habit. They commonly inhabit forest floors, open woodlands, scrublands, grasslands, and occasionally human-modified environments such as agricultural fields, plantations, and roadside vegetation (Hölldobler & Wilson, 1990). Morphologically, species of this genus are readily distinguished from other myrmicine ants by their strongly sculptured head and mesosoma, a long pedunculate petiole and postpetiole, and an elongate gaster bearing a well-developed functional sting (Bolton, 2003). The presence of prominent propodeal spines and robust body sculpture further contributes to the distinct appearance of the genus.

Ecologically, *Myrmicaria* species are epigaeic foragers that exhibit generalized omnivorous feeding behaviour. Their diet includes small arthropods, insect remains, plant-derived materials, and honeydew obtained through trophobiotic associations with hemipterans (Hölldobler & Wilson, 1990). Nests are typically constructed in soil, beneath stones, within leaf litter, or at the base of herbaceous plants and shrubs, sometimes

forming low, inconspicuous soil mounds. When disturbed, workers often display a characteristic defensive posture by raising and flexing the gaster forward, reflecting their reliance on a functional sting.

In the Indian subcontinent, *Myrmicaria brunnea* Saunders, 1842 is the most widespread and commonly recorded species of the genus (Bingham, 1903; Bharti et al., 2016). It has been reported from a wide range of habitats across several Indian states, indicating considerable ecological adaptability. However, despite its extensive distribution across India, there has been no published record of this species from the states of Rajasthan. The present study documents the first confirmed occurrence of *M. brunnea* from these states, thereby extending its known distribution into the north-western semi-arid region of the Indian subcontinent and contributing new insights into the ant fauna of arid and semi-arid landscapes of India.

Material and Methods

Specimens were collected during faunistic surveys carried out between July 2024 and December 2025 from Mount Abu Wildlife Sanctuary (Rajasthan) and Todgarh Raoli Wildlife Sanctuary (Rajasthan). The region is characterized by a semi-arid to arid climate, sparse vegetation, sandy to loamy soil, and extreme seasonal temperature variation. Ants were hand-collected with the aid of fine forceps from the ground, beneath stones, and along soil mounds, and occasionally by using

a soft brush. Specimens were preserved in 70% ethanol and later mounted for detailed examination.

Identification was carried out using standard taxonomic keys and original descriptions, particularly those of Saunders (1842), Bingham (1903), and subsequent revisions (Bharti et al., (2016). Morphological terminology follows Bolton (1994). Voucher specimens are deposited in the National Zoological Collections, Desert Regional Centre, Zoological Survey of India, Jodhpur, Rajasthan.

Results:

Systematic Account

Order: Hymenoptera Linnaeus, 1758

Family: Formicidae Latreille, 1809

Subfamily: Myrmicinae Lepeletier, 1835

Genus: *Myrmicaria* Saunders, 1842

Myrmicaria Saunders, 1842: 57 [as subgenus of *Myrmica*].

Type-species: *Myrmicaria brunnea* Saunders, 1842: 57, by monotypy.

Myrmicaria brunnea Saunders, 1842

Myrmicaria brunnea Saunders, 1842: 57, INDIA.

Type locality: Northern India (Saunders, 1842)

Material examined: 6 workers, Rajasthan, Mount Abu Wildlife Sanctuary, Sirohi, Near

GadaWayra (Lat. 24°34'03.89"N; Long. 72°45'20.06"E), 19.vii.2024; 6 workers, Rajasthan, Mount Abu Wildlife Sanctuary, Sirohi, Abu Range, Aarna Village, Eco-Tourism Site (Lat. 24°33'58.06"N; Long. 72°45'21.86"E), 26.ix.2024; 6 workers, Rajasthan, Todgarh Raoli Wildlife Sanctuary, Rajsamand, Raoli Range, Dudhaleshwar (Lat. 26°30'49.20"N; Long. 73°01'81.38"E), 3.xii.2025.

Diagnostic Characters Worker: Total length 5.8-6.9 mm; body shining, chestnut-brown with lighter appendages. Head sub-rectangular, longer than broad, posterior margin weakly concave with longitudinal striations, eyes prominent. Mandibles triangular with distinct teeth, finely and longitudinally striated. Antennae 7-segmented without a distinct club. Mesosoma elongated; pronotum and mesonotum weakly convex in profile. Propodeum armed with a pair of short but distinct spines directed posterodorsally. Petiole long, pedunculate, with a distinct node; postpetiole broader than petiole. Gaster oval and smooth, legs long. Body surface finely punctate with sparse, erect setae.

Distribution India: Arunachal Pradesh, Assam, Bihar, Goa, Himachal Pradesh, Jammu & Kashmir, Jharkhand, Karnataka, Kerala, Maharashtra, Manipur, Meghalaya, Punjab, Sikkim, Tamil Nadu, Uttarakhand, West Bengal (Bharti et al., 2016), Puducherry (Gowri & Sankaraiyah, 2024), Rajasthan (new record); Elsewhere: Bangladesh, China,

Indonesia, Malaysia, Myanmar, Pakistan, Philippines, Singapore, Sri Lanka, Thailand, Vietnam (www.antweb.org, Janicki et al.

2016, Guénard et al. 2017), Nepal (Subedi et al., 2022).



Fig 1. *Myrmecaria brunnea* worker profile



Fig 2. *M. brunnea* worker, head, frontal view

Discussion

The present record represents a significant westward extension of the known distribution range of *Myrmecaria brunnea* Saunders, 1842 into the state of Rajasthan, a region characterized predominantly by arid and semi-arid climatic conditions. Previous records of this species are largely concentrated in mesic and semi-mesic habitats across eastern, central, and southern India (Bingham, 1903; Bharti et al., 2016), where it is commonly associated with forested landscapes. Its occurrence in Rajasthan, particularly within semi-arid habitats, indicates that *M. brunnea* possesses a broader ecological tolerance than previously recognized, enabling it to persist under conditions of high temperature, low moisture availability, and sparse vegetation.

The presence of *M. brunnea* in such environments suggests a degree of behavioral

and physiological adaptability, potentially including flexible nesting strategies, generalized foraging behavior, and tolerance to seasonal climatic extremes. Similar ecological plasticity has been reported for other widely distributed ant species inhabiting both forested and open habitats, underscoring the capacity of some myrmecine ants to exploit diverse ecological niches. The ability of *M. brunnea* to occupy semi-arid landscapes may also reflect the availability of suitable microhabitats, such as shaded soil patches, leaf litter accumulations, or anthropogenically modified areas that provide refuge from extreme environmental conditions.

Biogeographically, the present record fills an important distributional gap between previously known populations from northern and central India and those reported from western and peninsular regions. This finding highlights the underexplored nature of ant diversity in Rajasthan, where faunistic surveys

have historically been limited in comparison to more humid parts of the country. The apparent absence of earlier records from Rajasthan is therefore likely attributable to insufficient sampling rather than true absence of the species.

Further intensive and systematic surveys employing standardized sampling techniques across different habitat types and seasons in Rajasthan, and adjacent arid regions are likely to yield additional records of *M. brunnea* and other ant taxa. Such studies will not only refine the known distribution patterns of ant species but also contribute to a better understanding of ant community structure, ecological adaptations, and biogeographical affinities in arid and semi-arid ecosystems of India. Continued documentation of ant diversity from these regions is essential for developing a comprehensive baseline for future ecological monitoring and conservation planning.

Acknowledgements

The author expresses sincere gratitude to Dr. Dhriti Banerjee, Director, Zoological Survey of India, Kolkata, for her valuable guidance and for providing the necessary facilities to carry out the present study. The author is also thankful to the Officer-in-Charge, Desert Regional Centre, Zoological Survey of India, Jodhpur, for support and encouragement.

References

- AntWeb. Version 8.114. California Academy of Science, Accessed 24.05.26. <https://www.antweb.org/>
- Andersen, A.N. 1997. Using ants as bioindicators: Multiscale issues in ant community ecology. *Conservation Ecology*, **1(1)**: 8. <https://ecologyandsociety.org/vol1/iss1/art8/>
- Bharti, H., Guénard, B., Bharti, M. & Economo, E.P. 2016. An updated checklist of the ants of India with their specific distributions in Indian states (Hymenoptera: Formicidae). *ZooKeys*, **551**: 1–83. <https://doi.org/10.3897/zookeys.551.6767>
- Bingham, C.T. 1903. *The Fauna of British India, including Ceylon and Burma. Hymenoptera, Vol. II. Ants and Cuckoo-wasps*. Taylor and Francis, London, 506 pp. <https://zsi.gov.in/PDFVolumes/fbi/045/index.pdf>
- Bolton, B. 1994. Identification Guide to the Ant Genera of the World. *Harvard University Press, Cambridge, Massachusetts*, 222 pp. <https://archive.org/details/identificationgu0000bolt>
- Bolton, B. 2003. Synopsis and Classification of Formicidae. *Memoirs of the American Entomological Institute*, **71**: 1–370.
- Folgarait, P.J. 1998. Ant biodiversity and its relationship to ecosystem functioning:

- a review. *Biodiversity and Conservation*, **7**: 1221–1244. https://home.cyf-kr.edu.pl/~uxlaskow/ET_S800/Materialy/Ants_Folgarait_1998.pdf
- Gowri, K. & Sankaraiyah, K. 2024. First distributional record of ant species (Hymenoptera: Formicidae) from Botanical Garden, Puducherry, India. *Journal of Applied Entomologist*, **4(1)**: 19–23. <https://www.dzarc.com/entomology/article/view/437>
- Guénard, B., Weiser, M., Gomez, K., Narula, N. & Economo, E. 2017. The Global Ant Biodiversity Informatics (GABI) database: synthesizing data on the geographic distribution of ant species (Hymenoptera: Formicidae). *Myrmecological News*, **24**: 83–89.
- Janicki, J., Narula, N., Ziegler, M., Guénard, B. & Economo, E.P. 2016. Visualizing and interacting with large-volume biodiversity data using client–server web-mapping applications: The design and implementation of ant maps. *Ecological Informatics*, **32**: 185–193. <https://doi.org/10.1016/j.ecoinf.2016.02.006>
- Hölldobler, B. & E.O. Wilson. 1990. *The Ants*. Harvard University Press, Cambridge, Massachusetts, 732 pp.
- Saunders, W.W. 1842. Descriptions of two hymenopterous insects from northern India. *Transactions of the Entomological Society of London*, **3**: 57–58. <https://www.biodiversitylibrary.org/item/48701#page/79/mode/1up>
- Subedi, I.P., Budha, P.B., Yusupov, Z.M. & Bharti, H. 2022. Myrmicine ants of Nepal with six new records and updated species list (Hymenoptera: Formicidae: Myrmicinae). *Nepalese Journal of Zoology*, **6(1)**: 10–19. <https://doi.org/10.3126/njz.v6i1.46749>
- Underwood, E.C. & Fisher, B.L. 2006. The role of ants in conservation monitoring: If, when, and how. *Biological Conservation*, **132(2)**: 166–182. <https://doi.org/10.1016/j.biocon.2006.03.022>
- Yahya, B.E., Yamane, S. & Mohamed, M. 2009. Morphological and Behavioral Characters of the Two Species Groups of the Ant Genus *Myrmecaria* (Insecta: Hymenoptera: Formicidae: Myrmicinae) from Southeast Asia. *Species Diversity*, **14(4)**: 249–265. <https://doi.org/10.12782/specdiv.14.249>

MS Received on 01st July, 2026

MS Accepted on 06th September, 2026

DOI: 10.55278/MBGJ8145

Ground Beetles (Coleoptera: Carabidae) of Corbett Tiger Reserve, Uttarakhand, India: A study based on Museum Collections

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The Corbett Tiger Reserve (CTR) is situated in the Shivalik foothills of the Himalayas within the Bhabar–Terai landscape of Uttarakhand, India, encompassing parts of Pauri Garhwal, Nainital and Almora districts. Corbett National Park, established in 1936, is India's first national park and was among the nine tiger reserves established under Project Tiger in 1973. In 1991, an additional 797.72 km² was incorporated into the reserve as a buffer area, including Sonanadi Wildlife Sanctuary and parts of the Kalagarh and Ramnagar Forest Divisions. Subsequently, the Government of Uttarakhand formally notified Corbett Tiger Reserve under Section 38V (1) of the Wild Life (Protection) Act, 1972, on 26 February 2010, with a total notified area of 1,288.31 km² (Government of Uttarakhand, 2010).

The reserve comprises hills, valleys, riverine habitats, grasslands and plateaus, with *Shorea robusta* (Sal) as a dominant tree species. It experiences a predominantly subtropical climate with distinct summer, monsoon and winter seasons. Annual rainfall ranges from approximately 1,400 to 2,800 mm, with most precipitation occurring during the

southwest monsoon from June to September (Bargali & Ahmed, 2018; Nautiyal, 2023).

Several studies have contributed to documenting the faunal diversity of Corbett Tiger Reserve, including investigations of various insect groups such as butterflies, dragonflies and damselflies, as well as other insect taxa (Arya et al., 2020; Arya et al., 2024; Dayakrishna & Arya, 2015; Singh & Prasad, 1977; Verma, 1979). Despite these efforts, information on the beetle fauna of the reserve remains comparatively limited. The Fauna of Corbett Tiger Reserve, published by the Zoological Survey of India, reported only 10 species of beetles from the reserve (Bhargava, 1979; Khanna, 2008), while records of ground beetles (Coleoptera: Carabidae) remain particularly scanty. In this context, the present study examined and identified previously unstudied beetle specimens from the National Zoological Collections housed at the Northern Regional Centre, Zoological Survey of India, Dehradun.

The available specimens included both pinned material and specimens preserved in 70% ethanol. The ethanol-preserved specimens were subsequently processed,

pinned and identified using relevant taxonomic literature (Akhil *et al.*, 2019; Chanu & Swaminathan, 2017; Hegde & Manthen, 2017; Shiju *et al.*, 2012; Venugopal & Thomas, 2019).

The present study documented 18 species (Table 1; Figure 1&2) of ground beetles belonging to 10 genera and seven subfamilies, adding to the existing knowledge of the beetle fauna of Corbett Tiger Reserve through the examination of previously unstudied museum collections. However, all specimens examined were collected prior to the designation of the respective areas as a

Tiger Reserve; hence, the present records primarily represent the historical ground beetle fauna and do not reflect its current diversity. The earlier *Fauna of Corbett Tiger Reserve* reported only 10 species of beetles from the reserve (Khanna *et al.*, 2008), indicating that historical museum collections can provide valuable supplementary records. Comprehensive field-based inventories across the different zones, ranges and habitats of the reserve are therefore required to document the contemporary ground beetle fauna and establish its present-day distribution and diversity.

Table 1. Ground beetle species recorded from the present study

Subfamily	Genus	Species	Specimen details (No. of specimens; Locality; Date; Collector; Registration number)
Brachininae Bonelli, 1810	<i>Brachinus</i> Weber, 1801	<i>Brachinus pictus</i> (Hope, 1833)	2 exs, Boxar, 26.01.1971, Coll. J C Tripathy & Party, Reg. No. A-20223
Broschinae Hope, 1838	<i>Broscodes</i> Bolivar y Pieltain, 1914	<i>Broscodes championi</i> (Andrewes, 1923)	6 exs, Malani, 01.03.1970, Coll. A. Singh & Party, Reg. No. A-19536
Licininae Bonelli, 1810	<i>Chlaenius</i> Bonelli, 1810	<i>Chlaenius chlorodius</i> Dejean, 1826	2 exs, Bijrani, 09.03.1970, Coll. A. Singh & Party, Reg. No. A-20116
Licininae Bonelli, 1810	<i>Chlaenius</i> Bonelli, 1810	<i>Chlaenius laevioplaga</i> Chaudoir, 1876	11 exs, Kalagarh, 28.08.1964, Coll. T. D. Soota & Party, Reg. No. A-19624
Licininae Bonelli, 1810	<i>Chlaenius</i> Bonelli, 1810	<i>Chlaenius nitidicollis</i> Dejean, 1826	6 exs, Khinanauli, 29.01.1971, Coll. JC Tripathi & Party, Reg. No. A-20020
Licininae Bonelli, 1810	<i>Chlaenius</i> Bonelli, 1810	<i>Chlaenius pretiosus</i> Chaudoir, 1856	2 exs, Khanda, 08.07. 1969, Coll. JC Tripathi & Party, Reg. No. A-20021

Subfamily	Genus	Species	Specimen details (No. of specimens; Locality; Date; Collector; Registration number)
Licininae Bonelli, 1810	<i>Chlaenius</i> Bonelli, 1810	<i>Chlaenius quadricolor</i> (Olivier, 1790)	4 exs, Bijrani, 09.03.1970, Coll. A. Singh & Party, Reg. No. A- 20117
Licininae Bonelli, 1810	<i>Chlaenius</i> Bonelli, 1810	<i>Chlaenius flavipes</i> Ménétries, 1832	24 exs, Bijrani, 09.03.1970, Coll. A. Singh & Party, Reg. No. A- 20024
Harpalinae Bonelli, 1810	<i>Chydaeus</i> Chaudoir, 1854	<i>Chydaeus bedeli</i> (Tschitscherine, 1897)	8 exs, Malani, 01.03.1970, Coll. A. Singh & Party, Reg. No. A- 20024
Anthiinae Bonelli, 1813	<i>Macrocheilus</i> Hope, 1838	<i>Macrocheilus bensoni</i> Hope, 1838	4 exs, Sarapduli, 22.01.1971, Coll. JC Tripathi & Party, Reg. No. A-20222
Anthiinae Bonelli, 1813	<i>Macrocheilus</i> Hope, 1838	<i>Macrocheilus</i> <i>chaudoiri</i> Andrewes, 1919	7 exs, Sarapduli, 22.01.1971, Coll. JC Tripathi & Party, Reg. No. A-20221
Lebiinae Bonelli, 1810	<i>Masoreus</i> Dejean, 1821	<i>Masoreus orientalis</i> Dejean, 1828	2 exs, Khanda, 08.07.1969, Coll. JC Tripathi & Party, Reg. No. A- 20022
Brachininae Bonelli, 1810	<i>Pheropsophus</i> Solier, 1833	<i>Pheropsophus</i> <i>bimaculatus</i> (Linnaeus, 1771)	1 ex, Near Nakatal, 03.03.1970, Coll. A. Singh & Party, Reg. No. A-19230
Brachininae Bonelli, 1810	<i>Pheropsophus</i> Solier, 1833	<i>Pheropsophus catoirei</i> (Dejean, 1825)	12 exs, Near Nakatal, 03.03.1970, Coll. A. Singh & Party, Reg. No. A-19230
Brachininae Bonelli, 1810	<i>Pheropsophus</i> Solier, 1833	<i>Pheropsophus</i> <i>sobrinus</i> (Dejean, 1826)	18 exs, Bijrani, 09.03.1970, Coll. A. Singh & Party, Reg. No. A- 20118
Harpalinae Bonelli, 1810	<i>Progonochaetus</i> G.Müller, 1938	<i>Progonochaetus</i> <i>indicus</i> Kataev, 2002	7 exs, Bijrani, 09.03.1970, Coll. A. Singh & Party, Reg. No. A- 20019
Harpalinae Bonelli, 1810	<i>Pseudognathaphanus</i> Schauberger, 1932	<i>Pseudognathaphanus</i> <i>rusticus</i> (Andrewes, 1920)	2 exs, Bijrani, 09.03.1970, Coll. A. Singh & Party, Reg. No. A- 20115
Scaritinae Bonelli, 1810	<i>Scarites</i> Fabricius, 1775	<i>Scarites indus</i> Olivier, 1795	2 exs, Sultan, 21.01.1971, Coll. JC Tripathi & Party, Reg. No. A- 20223



Figure 1. Ground beetles (Coleoptera: Carabidae) recorded from Corbett Tiger Reserve A-

I. (A) *B. pictus* (Hope, 1833); (B) *B. championi* (Andrewes, 1923); (C) *C. chlorodius* Dejean, 1826; (D) *C. laeviplaga* Chaudoir, 1876; (E) *C. nitidicollis* Dejean, 1826; (F) *C. pretiosus* Chaudoir, 1856; (G) *C. quadricolor* (Olivier, 1790); (H) *C. flavipes* Ménétries, 1832; (I) *C. bedeli* (Tschitscherine, 1897);

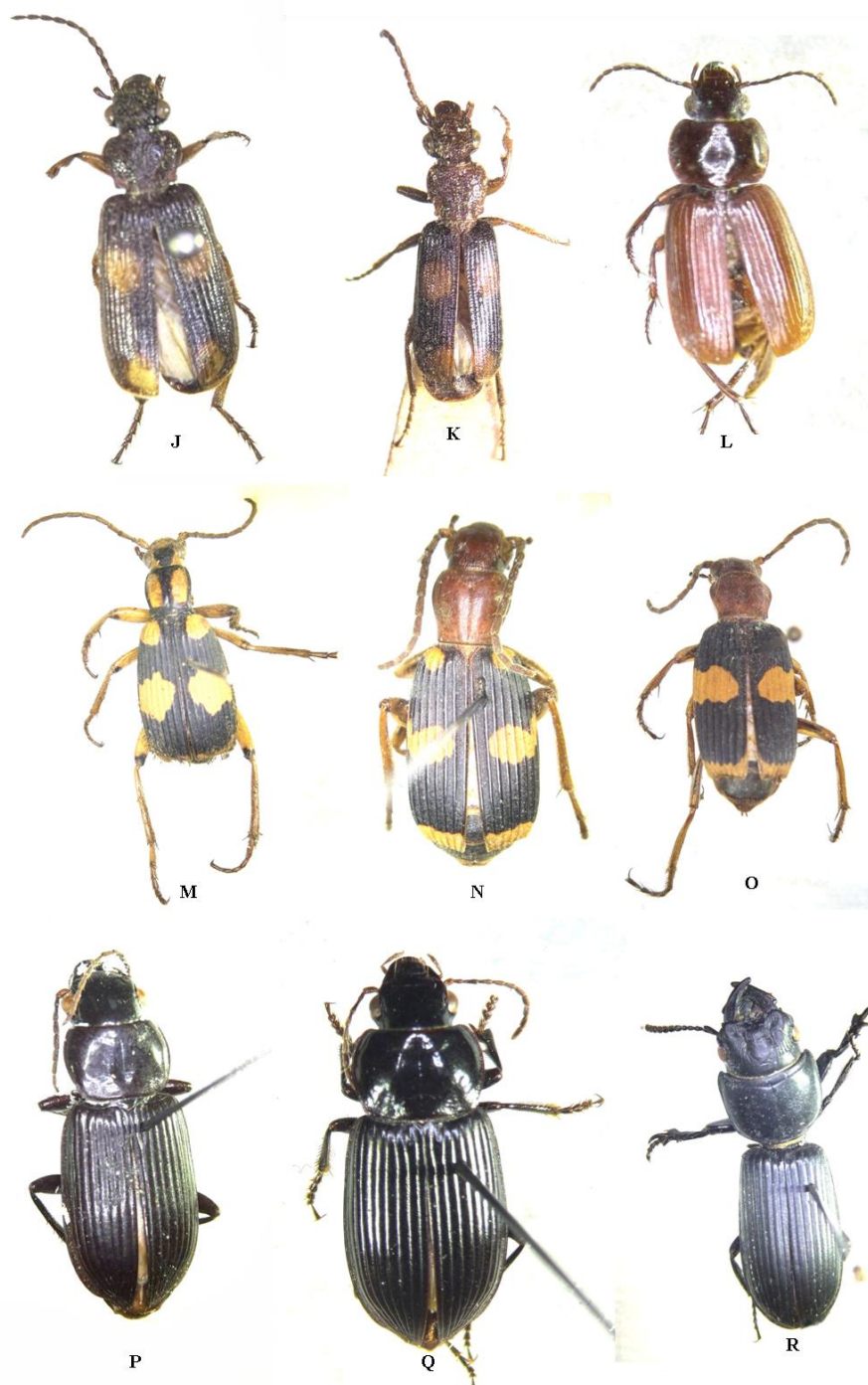


Figure 2. Ground beetles (Coleoptera: Carabidae) recorded from Corbett Tiger Reserve J-

R. (J) *M. bensoni* Hope, 1838; (K) *M. chaudierei* Andrewes, 1919; (L) *M. orientalis* Dejean, 1828; (M) *P. bimaculatus* (Linnaeus, 1771); (N) *P. catoirei* (Dejean, 1825); (O) *P. sobrinus* (Dejean, 1826); (P) *P. indicus* Kataev, 2002; (Q) *P. rusticus* (Andrewes, 1920); (R) *S. indus* Olivier, 1795.

Acknowledgements

We are grateful to the Director, Zoological Survey of India (ZSI), Kolkata for providing the necessary facilities and support.

References

- Akhil, S.V., Sabu, T.K. & Divya, M. (2019). Two new species of *Macrocheilus* Hope (Carabidae: Anthiinae: Heliunini) from the south Western Ghats of India. *Journal of Insect Biodiversity*, **9**(1): 28–33. <https://doi.org/10.12976/jib/2019.09.1.3>
- Arya, M.K., Dayakrishna & Verma, A. (2020). Patterns in distribution of butterfly assemblages at different habitats of Corbett Tiger Reserve, Northern India. *Tropical Ecology*, **61**: 180–186.
- Arya, M., Bisht, S., & Tiruwa, A (2024). Ecological insights into insect diversity in protected area networks of Kumaun Region, Western Himalaya. *Entomologia Hellenica*, **33**: 34–69.
- Bhargava, R.N. (1979). Coleoptera (Beetles). In: Lamba, B.S. & Bhatnagar, R.K. (Eds.), *Fauna of Corbett National Park. Cheetal*, **21**(1): 47.
- Chanu, N.Y. & Swaminathan, R. (2017). Notes on species of the genus *Chlaenius* Bonelli, 1810 (Coleoptera: Carabidae, Chlaeniini) from four agro-climatic zones of Rajasthan, with description of two new species. *Zootaxa*, **4237**(3): 545–566.
- <https://doi.org/10.11646/zootaxa.4237.3.5>
- Dayakrishna & Arya, M.K. (2015). Study on the abundance and diversity of dragonflies and damselflies (Insecta: Odonata) of Corbett Tiger Reserve, Uttarakhand, India. *Journal of Entomology and Zoology Studies*, **3**(4): 467–472.
- Government of Uttarakhand. (2010). *Notification No. IX-2-2010-19(34)/2006, dated 26 February 2010: Declaration of Corbett Tiger Reserve*. Government of Uttarakhand.
- Hegde, V.D. & Manthen, S. (2017). To the knowledge of the genus *Chlaenius* Bonelli, 1810 (Coleoptera: Carabidae: Chlaeniini) from Maharashtra state (India). *Zoology and Ecology*, **27**(3–4): 257–260. <https://doi.org/10.1080/21658005.2017.1383037>
- Khanna, V. (2008). Insecta (Various orders). In: Editor-Director (Ed.), *Fauna of Corbett Tiger Reserve, Uttarakhand*. Conservation Area Series, **35**, pp. 195–203. Zoological Survey of India, Kolkata.
- Bargali H.S. & Ahmed, T. (2018). Patterns of livestock depredation by tiger (*Panthera tigris*) and leopard (*Panthera pardus*) in and around Corbett Tiger Reserve, Uttarakhand, India. *PLOS ONE*, **13**(5): e0195612.
- Nautiyal, J. P., Lone, A. M., Ghosh, T., Mallick, A., Yadav, S.P., Ramesh, C., &

- Ramesh, K. (2023). An Illustrative Profile of Tiger Reserves of India. EIACP Programme Centre, (MoEFCC), Wildlife Institute of India, Chandrabani, Dehradun-248001, Uttarakhand, India. pp – 314.
- Shiju, R.T., Madani, J.I. & Sabu, T.K. (2012). A new carabid species of the genus *Macrocheilus* (Coleoptera) from India. *Oriental Insects*, **46**(2): 97–106. <https://doi.org/10.1080/00305316.2012.689485>
- Singh, A. & Prasad, M. (1977). Odonata (Insecta) of Corbett National Park (Uttar Pradesh, India). *Journal of the Bombay Natural History Society*, **73**: 419–421.
- Verma, S.C. (1979). Termite (Insecta: Isoptera). In: Lamba, B.S. & Bhatnagar, R.K. (Eds.), *Fauna of Corbett National Park*. *Cheetal*, **21**(2–3): 45–46.
- Venugopal, A.S. & Thomas, S.K. (2019). Bombardier beetles of the genus *Pheropsophus* Solier, 1833 (Carabidae: Brachininae: Brachinini) from Indian subcontinent. *Zootaxa*, **4608**(1): 65–89. <https://doi.org/10.11646/zootaxa.4608.1>

MS Received on 28th June, 2026

MS Accepted on 02nd September, 2026

DOI: 10.55278/XIVN2684

First Report of *Phaenacantha* (*Phaenacantha*) *bicolor* (Hemiptera: Lygaeoidea: Colobathristidae) from India

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Abstract

Phaenacantha (*Phaenacantha*) *bicolor* (Distant, 1901) (Hemiptera: Lygaeoidea: Colobathristidae) is reported for the first time from India, based on material collected from Nagi Dam Bird Sanctuary, Jamui District, Bihar, in February 2025. Prior to this study, only one species of this genus *P. (P.) sedula* Horváth was known from India. The species is redescribed with detailed diagnostic characters of the head, thorax, and abdomen, along with full morphometric data and segment-wise ratios of the antennae and rostrum, which are proposed as additional diagnostic tools for separating closely allied congeners. Colour plates illustrating the habitus (dorsal, ventral, and lateral views) and key structures (head, thorax, abdominal tip) are provided. The specimen is deposited in the National Zoological Collection, Gangetic Plains Regional Centre, Zoological Survey of India, Patna. This record extends the known distribution of the genus *Phaenacantha* in India and adds a second species to the Indian fauna of the family Colobathristidae.

Keywords: Colobathristidae, Colobathristinae, *Phaenacantha* (*Phaenacantha*) *bicolor*, new record.

Introduction

The genus *Phaenacantha* belongs to the subfamily Colobathristinae of the family Colobathristidae, was erected by Horvath (1904) for the species *Phaenacantha biroi* Horvath from New Guinea, has published a monograph of Colobathristinae with detailed descriptions of each species. It is the largest genus of Colobathristidae, having 34 species distributed mainly in the Oriental region and New Guinea, while four species occur in

Queensland, Fiji Island, Palaearctic China and Guatemala respectively, has published a synopsis of the genus *Phaenacantha* Horvath (Subgenus *Anorygma* Horv.) including eight known species with detailed keys, their status, diagnostic characters and illustrations (Stys, 1974). Prior to this study, only one species under this genus was known from India Mukherjee et al. (2018). Distant (1910) recorded *Phaenacantha* (*Phaenacantha*) *sedula* Horváth from Myanmar, Malaysia

(Penang), Singapore, Philippines (Cape Engano), and Indonesia (Mentawai Island).

During the present study, based on the two specimens collected from Nagi Bird Sanctuary the species *Phaenacantha bicolor* of the family Colobathristidae was recorded for the first time from Nagi Dam Bird Sanctuary, Bihar.

Material and Methods

This study is based on the sample collected in field survey from Nagi Bird Sanctuary, Jamui district of Bihar (India). Specimens collected were preserved in 70% ethanol, set and pinned. Morphological studies and images of the species were taken with a Leica (M 205A) stereo microscope using the software (Leica application suite, V3.8). All measurements are in millimeters. Specimens were identified with the help of available literature Mukherjee et al. (2018), Distant (1910). The specimen is deposited in the National Zoological Collection, Gangetic Plains Regional Centre, Zoological Survey of India, Patna.

Results and Discussion

Genus *Phaenacantha* Horvath, 1904

1904. *Phaenacantha* Horváth, *Ann. Mus. Hung.*, 2: 120.

Type species: *Phaenacantha biroi* Horvath, from New Guinea.

Diagnosis: Head vertical and slightly broader than the pronotum with two anteriorly diverging fuscous bands present, not carinate on lateral side, gula horizontal; ocelli remote from the eyes; antennae longer than body; 3rd joint longest, about 2.38x, followed by 4th joints about 2.01x to the 1st joint, 2nd segment slightly shorter than 4th segment (A2/A4: 0.95); rostrum reaching nearly intermediate coxae and slightly passing the middle of mesosternum with darkened apex, fourth segment shorter than third; pronotum slightly narrow at anterior region, anterior lobe moderately convex; posterior lobe punctate and twice longer than anterior lobe; scutellum with a long erect spine; hemelytra not or slightly passing apex of abdomen; corium without an ante-apical areola; abdomen incrassated apically or behind middle for male and narrowed near apex for female; anterior femora marked with ante-apical spine, anterior tibiae unarmed.

Phaenacantha bicolor (Distant, 1901)

1901. *Curupira bicolor* Distant, *Ann. Mag. nat. Hist.*, 7 (7): 426.

2001. *Phaenacantha bicolor* Kerzhner, *The Netherland Entomological Society.*, 4 : 243.

Description:

Colour: General colour reddish-brown to dark brown; gula, anterior lobe of pronotum, scutellum and sternum, dark brown (Fig.1); head above marked with two anteriorly diverging dark brown bands; eyes reddish-

brown; apex of third antennal segment and fourth segment, dark brown (Fig.5); apex of rostrum, black (Fig.4); scutellum brown black, with apex reddish brown (Fig.6); veins of hemelytra, brownish yellow (Fig.1); posterior lobe of prosternum and the acetabula reddish-brown to brownish-yellow; orifices, posterior angle of the metasternum, connexivum and lateral margins of abdomen beneath whitish-yellow, first and base of last abdominal segment, black; apices and bases of tibia, dark brown; apex of tarsi, black (Fig. 2).

Structure: Head: Head short, vertical, pilose, not carinate on lateral area, wider than pronotum, width of head about 1.25x to the maximum width of pronotum, pairs of ocelli lies in the middle of compound eyes, close to each other; eyes as long as wide, more or less spherical (Fig.3); first segment of antennae slightly shorter than second, (Fig.6); rostrum long, almost reaching the intermediate coxae and slightly passing middle of mesonotum, 1st and 2nd segment subequal in length, 3rd segment longest, relative length of rostral segments: I/I : II/I : III/I : IV/I :: 0.10 : 0.93 : 0.70 : 0.80 (Fig.4).

Thorax: Pronotum longer than wide (1.00 : 0.83), anteriorly narrowed and gradually widen posteriorly, anterior lobe moderately convex, pilose, dark brown or black in colour, centrally impressed, shorter than posterior lobe, distinctly punctate (Fig.3); scutellum longer than broad and with scattered punctures, armed with a long, vertical or subvertical (80°), erect

apical spine, about 1/10th of body length (Fig.6); hemelytra complete, longer than broad, slightly passing the apex of abdomen (Fig.1); sternum punctuate (Fig.6); legs long, pilose, fore tibia unarmed, tibia cylindrical and longer than femora (Fig.6).

Abdomen: Abdomen smooth, pilose, longer than broad (1.00: 0.22) (Fig.2), apically distinctly incrassated in males or slightly ampliate behind middle, narrowed at apex, third segment on ventral region more than twice as long as 2nd, 3rd and 4th segments in female, the third segment slightly longer than the last three segments; female genital segments as in, hemelytra not passing the abdominal apex, lateral margins of abdomen light brown followed by black narrow strip to abdomen laterally. (Fig.2).

Measurements: [in mm, ♀ (n=1)]. Body length 7.6; head length 0.5, width between eyes 0.64; length of eye 0.63, width of eye 0.52; length of antennae 7.77, lengths of antennal segments I: 1.3, II: 2.5, III: 3.1, and IV: 2.62, rostral length 5.6, length of rostral segments I: 1.3, II: 1.4, III: 1.3 and IV: 1.6, relative length of rostral segments: I: II: III= 1.3 : 1.4 : 1.3: 1.6; length of pronotum 1.94, length of anterior pronotal lobe 0.6, posterior pronotal lobe 1.32, width of anterior pronotal lobe 1.47, posterior pronotal lobe 1.5; length of scutellum 1.3, width of scutellum 0.9n ; length of abdomen 5.47, width of abdomen 1.72; length of forecoxa: 1.65, trochanter: 2.32, femur: 3.29, tibia: 2.99, tarsus: 1.10, claws:

0.5; midcoxa: 1.65, trochanter: 2.52, femur: 2.86, tibia: 3.02, tarsus: 1.17, claw: 0.48;

hindcoxa: 2.0, trochanter: 2.1, femur: 4.21, tibia: 5.15, tarsus: 1.73, claw: 0.38.

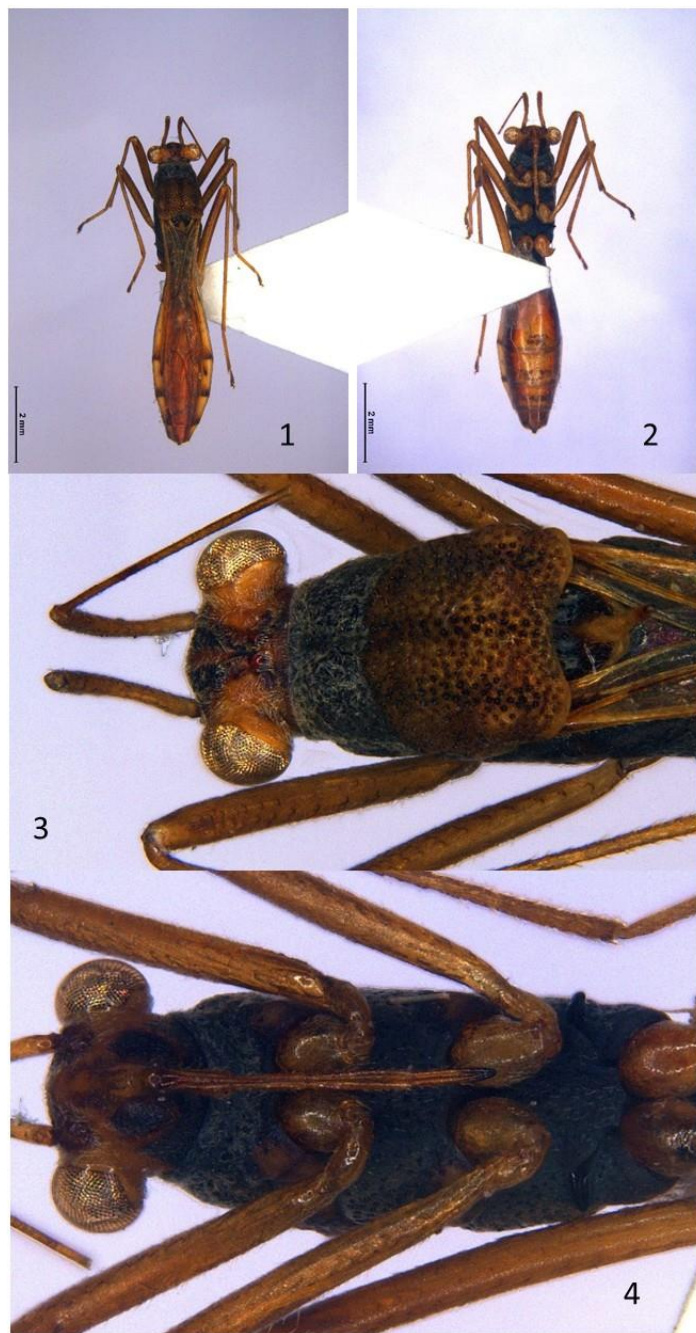


Fig. 1-4: *Phaenacantha bicolor*, 1. Dorsal view (female), 2. Ventral view female, 3. Dorsal view head and thorax, 4. Ventral view head and thorax



Fig. 5-7: *Phaenacantha bicolor*, 5. Lateral view (female), 6. Lateral view head and thorax, 7. Ventral abdominal tip (female)

Material examined: 2 exs., Nagi Dam Bird Sanctuary, Dist., Jamui, 24.824.569N, 86.461507E, 25.ii.2025, M. E. Hassan and party.

Distribution: India: Bihar (Nagi Dam Bird Sanctuary, Jamui).

Elsewhere: China, Myanmar, Malaysia (<https://lygaeoidea.speciesfile.org/otus/923613/overview>); Singapore (<https://www.catalogueoflife.org/data/taxon/VF3FN>)

Summary

Colobathristid bug, *Phaenacantha bicolor* (Distant, 1901), belonging to the subfamily Colobathristinae of the family Colobathristidae, which is reported for the first time from the Jamui District of Bihar. Distant (1910) [3] recorded *Phaenacantha (Phaenacantha) sedula* Horváth from Myanmar, Malaysia (Penang), Singapore, Philippines (Cape Engano), Indonesia (Mentawai Island). Measurements of different body parts were taken and ratios between stable body parts were calculated, which can be utilised as an additional diagnostic character to separate allied species and may serve as tool for the revisionary work.

Acknowledgement

Authors express their sincere gratitude to the Director, Zoological Survey of India for providing all sorts of necessary facilities and to

Dr. Anil Kumar, Scientist- E and Officer-in-charge, Gangetic Plains Regional Centre for his encouragements and guidance. Authors are also grateful to the staff members of Gangetic Plains Regional Centre, Zoological Survey of India, Patna for their helpful co-operation, without which it would have been difficult to collate the work.

References

- Horváth G. Monographia Colobathristinarum. *Annales Musei Nationalis Hungarici*. 1904; **2**:117-172.
- Stys, P. P. A Synopsis of the Genus *Phaenacantha* Horv., I. Subgenus *Anorygma* Horv. (= *Tagalisca* Horv.) (Heteroptera, Colobathristidae). *Annales Historico-Naturales Musei Nationalis Hungarici*. 1974; **66**:225-234.
- Distant, W. L. The Fauna of British India including Ceylon and Burma, Rhynchota. 1910; **5**:30-32.
- Mukherjee, P., Chandra, K. and Hassan, M. E. First report of *Phaenacantha (Phaenacantha) sedula* (Hemiptera: Lygaeoidea: Colobathristidae) from India, *International Journal of Fauna and Biological Studies*, 2018, **5** (4): 80-82.

MS Received on 24th June, 2026

MS Accepted on 29th August, 2026

DOI: 10.55278/OHSF5087

New Distributional Records of Vespid Wasps (Hymenoptera: Vespoidea: Vespidae) from Gujarat, India

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Abstract

New geographic distribution records of some vespid wasps from Gujarat State, India, are documented in the present study. A total of eight species belonging to seven genera and three subfamilies were recorded from different ecosystems of the state. These findings contribute to the existing knowledge of the distribution and diversity of Vespidae in Gujarat.

Key words: Gujarat, Hymenoptera, distribution records, species diversity, Vespidae.

Introduction

Family Vespidae of the superfamily Vespoidea is a widely distributed family of Hymenoptera, comprising about 3,794 described species under 205 genera worldwide (Girish Kumar & Sureshan, 2025). The family consists of six subfamilies: Euparagiinae, Eumeninae (potter wasps), Masarinae (pollen wasps), Polistinae (paper wasps), Stenogastrinae (hover wasps), and Vespinae (yellow jackets and hornets), of which Euparagiinae has not been reported from India. Their body size ranges from 6 to 28 mm (Girish Kumar et al., 2019). They exhibit complex behaviours, ranging from solitary to eusocial lifestyles. Solitary wasps make their own mud or clay nests or inhabit pre-existing cavities already constructed by other

hymenopterans and beetles, whereas social wasps live in colonies in which each colony consists of queen (fertile female), drones (males) and workers (sterile females). The subfamilies Eumeninae and Masarinae are considered solitary wasps while Stenogastrinae, Polistinae, and Vespinae are eusocial. Vespids are predominantly predatory and mainly prey upon the larvae of other insects and spiders. Therefore, they potentially play an important role in agriculture by naturally regulating the populations of insect pests and also serve in pollination (Girish Kumar, 2020).

Gujarat, the westernmost state of India, supports a wide range of ecosystems, including desert, semi-arid landscapes, wetlands, mangroves, coral reef-rich coastal areas, and

forests comprising dry deciduous, moist deciduous, and evergreen vegetations (Pilo *et al.* 1996). Even though it is diverse, the studies on the insect fauna from the state is limited. Only 385 species of Hymenoptera have been recorded from Gujarat to date. Among these, 34 species belonging to 17 genera are vespids. The present study documents some of the Vespidae fauna from different geographical areas of Gujarat, as additional distributional records.

Material and methods

Specimens were collected from different ecosystems of Gujarat State using standard collection methods. The major collection methods included sweep nets, light traps, and yellow pan traps. The collected specimens were subsequently curated,

examined, and photographed using a Leica Si9 microscope.

The taxonomic identification of the specimens up to species/subspecies level followed Das & Gupta (1989) and Girish Kumar & Sureshan, (2025). Geographical coordinates were recorded for the collection localities wherever possible. All the studied specimens were deposited in the National Zoological Collections of the Zoological Survey of India, Desert Regional Centre, Jodhpur, Rajasthan, India (ZSIDRC).

Results

The present study documented a total of eight species under seven genera and three subfamilies from Gujarat (Fig. 1). The details of the species are furnished in the Table 1.

Table 1. List of species/subspecies documented in the present study from Gujarat (Ref. Girish Kumar & Sureshan, 2025)

Sl. No.	Species	Subfamily
1	<i>Anterhynchium abdominale abdominale</i> (Illiger, 1802)	Eumeninae
2	<i>Delta companiforme</i> (Fabricius, 1775)	Eumeninae
3	<i>Eumenes macrops</i> de Saussure, 1852	Eumeninae
4	<i>Oreumenoides edwardsii</i> (de Saussure, 1852)	Eumeninae
5	<i>Rhynchium oculatum leviscutis</i> (Cameron, 1908)	Eumeninae
6	<i>Polistes stigma tamulus</i> (Fabricius, 1798)	Polistinae
7	<i>Vespa orientalis</i> Linnaeus, 1771	Vespinae
8	<i>Vespa tropica haematodes</i> Bequaert, 1936	Vespinae

Taxonomy**Family Vespidae Latreille, 1802****Subfamily Eumeninae Leach, 1815****Genus *Anterhynchium* de Saussure, 1863****1. *Anterhynchium abdominale abdominale* (Illiger, 1802)**

Material examined: India: Gujarat, Gir National Park & Wildlife Sanctuary, Amreli, Paniya Forest Range, Bherala gate, 12.ix.2025, 21.186900°N, 70.888652°E, Coll. I. Sharma & Party, ZSIDRC Regd. No. ZSI/DRC/16533/A; India: Gujarat, Godhra, Dohad road, 1 female, 20.viii.1989, Coll. R. Sewak & Party, ZSIDRC Regd. No. ZSI/DRC/17052/A; India: Gujarat, Mehsana, Vizapur, 1 female, 8.ix.1992, Coll. R. Sewak & Party, ZSIDRC Regd. No. ZSI/DRC/17055/A; India: Gujarat, Mehsana, Amaliyasan village, 1 female, 9.x.1992, Coll. R. Sewak & Party, ZSIDRC Regd. No. ZSI/DRC/17198/A.

Distribution: India: Chhattisgarh, Delhi, Goa, Gujarat (**new record**), Jharkhand, Karnataka, Keralam, Odisha, Madhya Pradesh, Rajasthan, Sikkim, Tamil Nadu, Telangana, Tripura, Uttar Pradesh, West Bengal. Elsewhere: China; Myanmar; Pakistan; Sri Lanka; Vietnam (Girish Kumar & Sureshan, 2025).

Genus *Delta* de Saussure, 1855**2. *Delta companiforme* (Fabricius, 1775)**

Material examined: India: Gujarat: Mehsana, Dharoi dam, 1 male, 14.ix.1992, Coll. R.

Sewak & Party, ZSIDRC Regd. No. ZSI/DRC/17045/A.

Distribution: India: Andamans, Arunachal Pradesh, Assam, Gujarat (**new record**), Meghalaya, Sikkim, Uttarakhand, West Bengal. Elsewhere: Australia; China; Cambodia; Indonesia; Laos; Malaysia; Myanmar; Nepal; Pakistan; Papua New Guinea; Philippines; Singapore; Thailand; U.S.A. (adventive); Vietnam (Girish Kumar & Sureshan, 2025).

Genus *Eumenes* Latreille, 1802**3. *Eumenes macrops* de Saussure, 1852**

Material examined: India: Gujarat, Aravali Mountain ranges, Ambaji Wildlife Sanctuary, Banaskantha, Divdi, Dauts West, 2 female, 19.xi.2025, Coll. R.H. Raina & Party, ZSIDRC Regd. No. ZSI/DRC/16532/A.

Distribution: India: Arunachal Pradesh, Assam, Gujarat (**new record**), Karnataka, Keralam, Maharashtra, Nagaland, Pondicherry, Rajasthan, Sikkim, Tamil Nadu, Telangana, Uttar Pradesh, West Bengal. Elsewhere: Indonesia; Malaysia (Girish Kumar & Sureshan, 2025).

Genus *Oreumenoides* Giordani Soika, 1961**4. *Oreumenoides edwardsii* (de Saussure, 1852)**

Material examined: India: Gujarat, Aravali Mountain ranges, Ambaji Wildlife Sanctuary, Banaskantha, Bedapani talab, 1 female,

16.xi.2025, Coll. R.H. Raina & Party, ZSIDRC Regd. No. ZSI/DRC/16525/A; India: Gujarat, Aravali Mountain ranges, Ambaji Wildlife Sanctuary, Banaskantha, Divdi, dauta west, 1 female, 19.xi.2025, R.H. Raina & Party, ZSIDRC Regd. No. ZSI/DRC/16526/A; India: Gujarat, Aravali Mountain ranges, Ambaji Wildlife Sanctuary, Banaskantha, Umianadi, Dabh chatra, 1 female, 15.xi.2025, Coll. R.H. Raina & Party, ZSIDRC Regd. No. ZSI/DRC/16527/A.

Distribution: India: Bihar, Chhattisgarh, Delhi, Goa, Gujarat (**new record**), Jharkhand, Karnataka, Keralam, Madhya Pradesh, Maharashtra, Meghalaya, Pondicherry, Rajasthan, Sikkim, Tamil Nadu, Telangana, Uttarakhand, Uttar Pradesh, West Bengal. Elsewhere: Myanmar; Pakistan; Sri Lanka; Thailand (Girish Kumar & Sureshan, 2025).

Genus *Rhynchium* Spinola, 1806

5. *Rhynchium oculatum leviscutis* (Cameron, 1908)

Material examined: India: Gujarat: Gir National Park & Wildlife Sanctuary, Junagadh, Sasan, 1 female, 21.175950°N, 70.617777°E, 15.x.2025, Coll. I. Sharma & Party, ZSIDRC Regd. No. ZSI/DRC/17420/A.

Distribution: India: Delhi, Gujarat (**new record**), Karnataka, Madhya Pradesh, Maharashtra, Rajasthan. Elsewhere: Afghanistan (Girish Kumar & Sureshan, 2025).

Subfamily Polistinae Lepeletier, 1836

Genus *Polistes* Latreille, 1802

6. *Polistes stigma tamulus* (Fabricius, 1798)

Material examined: India: Junagadh, Gir National Park & Wildlife Sanctuary, Devaliya Forest Range: Kathada Ness Vistar area, 1 female, 9.ix.2025, Coll. I. Sharma & Party, ZSIDRC Regd. No. ZSI/DRC/16473/A; India: Junagadh, Gir National Park & Wildlife Sanctuary: Junagadh, Dedakadi Forest Range: Dhadhiya Ness, 1 female, 9.ix.2025, Coll. I. Sharma & Party, ZSIDRC Regd. No. ZSI/DRC/16508/A; India: Junagadh, Gir National Park & Wildlife Sanctuary: Junagadh, Sasan forest range: Bheradiya, 1 female, 9.ix.2025, Coll. I. Sharma & Party, ZSIDRC Regd. No. ZSI/DRC/16509/A; India: Aravali Mountain ranges, Ambaji Wildlife Sanctuary, Banaskantha, Sembal pani, parewalpani, 1 female, 15.xi.2025, Coll. R.H. Raina & Party, ZSIDRC Regd. No. ZSI/DRC/16510/A; India: Aravali Mountain ranges, Ambaji Wildlife Sanctuary, Banaskantha, Umianadi, Dabh chatra, 1 female, 15.xi.2025, Coll. R.H. Raina & Party, ZSIDRC Regd. No. ZSI/DRC/16511/A; India: Gujarat, Dangs, Pipri and its vicinity, 1 female, 16.i.1989, Coll. R.K. Singh, ZSIDRC Regd. No. ZSI/DRC/17210/A; India: Gujarat, Gir National Park & Wildlife Sanctuary, Junagadh, Dalkhania Forest Range, Dubakiya Vistar, 1 female, 21.205897°N, 70.920447°E, 12.ix.2025, Coll. I. Sharma & Party, ZSIDRC Regd. No. ZSI/DRC/17410/A; India: Gujarat, Gir National Park & Wildlife Sanctuary,

Junagadh, Dalkhania Forest Range, Near Windmill Sarasiya forest Rest House, 1 female, 21.199567°N, 71.028065°E, 13.ix.2025, Coll. I. Sharma & Party, ZSIDRC Regd No. ZSI/DRC/17412/A; India: Gujarat, Gir National Park & Wildlife Sanctuary, Junagadh, Hadala Forest Range, Jinjivaniya water point, 1 female, 21.079419°N, 71.044012°E, 15.ix.2025, Coll. I. Sharma & Party, ZSIDRC Regd. No. ZSI/DRC/17418/A; India: Gujarat, Gir National Park & Wildlife Sanctuary, Junagadh, Sasan, 2 female, 21.175950°N, 70.617777°E, 15.ix.2025, Coll. I. Sharma & Party, ZSIDRC Regd. No. ZSI/DRC/17421/A; India: Gujarat, Gir National Park & Wildlife Sanctuary, Junagadh, Sasan, Bheradiya, 1 female, 21.159899°N, 70.601216°E, 07.ix.2025, Coll. I. Sharma & Party, ZSIDRC Regd. No. ZSI/DRC/17423/A.

Distribution: India: Bihar, Chhattisgarh, Delhi, Goa, Gujarat (**new record**), Himachal Pradesh, Jharkhand, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Meghalaya, Odisha, Puducherry, Rajasthan, Sikkim, Tamil Nadu, Telangana, Uttarakhand, Uttar Pradesh, West Bengal. Elsewhere: Pakistan; Sri Lanka; Vietnam (Girish Kumar & Sureshan, 2025).

Subfamily Vespinae Latreille, 1802

Genus *Vespa* Linnaeus, 1758

7. *Vespa orientalis* Linnaeus, 1771

Material examined: India: Gujarat, Gir National Park & Wildlife Sanctuary, Junagadh, Hadala Forest Range, Jinjivaniya water point,

2 female, 21.079419°N, 71.044012°E, 15.ix.2025, Coll. I. Sharma & Party, ZSIDRC Regd. No. ZSI/DRC/17427/A.

Distribution: India: Andhra Pradesh, Bihar, Delhi, Gujarat (**new record**), Haryana, Jammu & Kashmir, Jharkhand, Madhya Pradesh, Maharashtra, Odisha, Punjab, Rajasthan, Uttarakhand, Uttar Pradesh, West Bengal. Elsewhere: Afghanistan; Albania; Algeria; Bahrain; Bosnia & Herzegovina; Bulgaria; China; Croatia; Cyprus; Egypt; Ethiopia; Georgia; Greece; Iran; Iraq; Israel; Italy; Jordan; Kazakhstan; Kyrgyzstan; Lebanon; Libya; Macedonia; Malta; Montenegro; Nepal; Oman; Pakistan; Romania; Russia; Saudi Arabia; Somalia; Syria; Tajikistan; Turkey; Turkmenistan; U.A.E.; Uzbekistan; Yemen (Girish Kumar & Sureshan, 2025).

8. *Vespa tropica haematodes* Bequaert, 1936

Material examined: India: Gujarat: Gir National Park & Wildlife Sanctuary, Junagadh, Sasan Forest Range, Neary Sinh Sadan, Sasan-Gir, 1 female, 21.171438°N, 70.601158°E, 05.ix.2025, Coll. I. Sharma & Party, ZSIDRC Regd. No. ZSI/DRC/16469/A.

Distribution: India: Bihar, Chhattisgarh, Gujarat (**new record**), Haryana, Himachal Pradesh, Karnataka, Kerala, Odisha, Puducherry, Sikkim, Tamil Nadu, Tripura, Uttarakhand, West Bengal. Elsewhere: Bhutan; China; Myanmar; Nepal; Pakistan; Sri Lanka; Vietnam (Girish Kumar *et al.*, 2026).

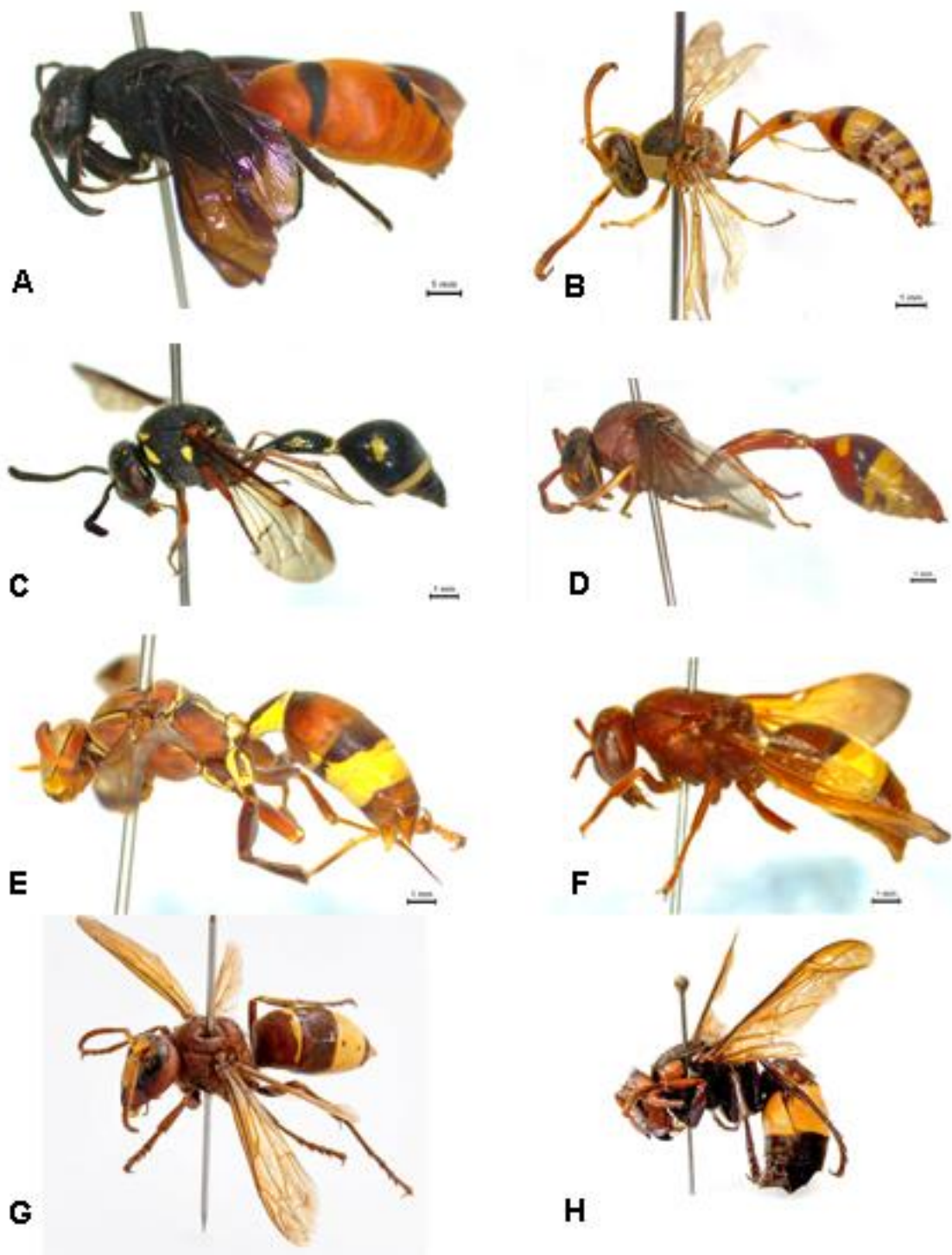


Figure 1. **A.** *Anterhynchium abdominale abdominale* (Illiger, 1802), **B.** *Delta companiforme* (Fabricius, 1775), **C.** *Eumenes macrops* de Saussure, 1852, **D.** *Oreumenoides edwardsii* (de Saussure, 1852), **E.** *Rhynchium oculatum leviscutis* (Cameron, 1908), **F.** *Polistes stigma tamulus* (Fabricius, 1798), **G.** *Vespa orientalis* Linnaeus, 1771, **H.** *Vespa tropica haematodes* Bequaert, 1936.

Discussion

The present study provides a preliminary documentation of the family Vespidae from different biogeographic zones of Gujarat. To date, only 34 species belonging to 17 genera and three subfamilies have been reported from the state. With the addition of the new distributional records documented herein, the known vespid fauna of Gujarat has increased to 42 species representing 21 genera and four subfamilies. Further comprehensive surveys and detailed taxonomic studies are required to better understand and document the diversity and distribution of Vespidae in the state.

Acknowledgements

The authors are grateful to the Director, Zoological Survey of India, Kolkata, and the Officer-in-Charge, Zoological Survey of India, Western Ghat Regional Centre, Kozhikode for providing facilities and encouragement.

References

- Bequaert, J.C. 1936. The common Oriental hornets, *Vespa tropica* and *Vespa affinis* and their color forms. *Treubia*, **15**: 329–351.
- Cameron, P. 1908. A contribution to the Aculeate Hymenoptera of the Bombay Presidency. *Journal of the Bombay Natural History Society*, **18**: 300–311.
- Das, B.P. and Gupta, V.K. 1989. The Social Wasps of India and adjacent countries (Hymenoptera: Vespidae). *Oriental Insects Monograph*, **11**: 1–292.
- de Saussure, H. 1852. Études sur la famille des Vespides 1: Monographie des Guêpes solitaires ou de la tribu des Eumeniens. Masson, V., Paris & Kessmann, J., Genève, 1–128 pp.
- de Saussure, H. 1854–1856. Études sur la famille des Vespides 3. La Monographie des Masariens et un supplement a la Monographie des Euménien. Masson, V., Paris & Kessmann, J., Genève, 1–352 pp.
- de Saussure, H. 1863. Melanges Hymenopterologiques II. Memoires de la Societe de Physique d'Histoire Naturelle de Geneve, **17**(1): 171–244.
- Fabricius, J.C. 1775. Systema Entomologiae, sistens insectorum classes, ordines, genera, species, adiectis synonymis, locis, descriptionibus, observationibus. Officina Libraria Kortii, Flensburgi et Lipsiae [Flensburg and Leipzig, Germany], xxxii + 832 pp.
- Fabricius, J.C. 1798. Supplementum entomologiae systematicae. Hafniae, [2] + 572 pp.
- Giordani Soika, A. 1961. Les lignées philetiques des Eumenes s.l. du globe (Hym. Vesp.). Verhandlungen XI Internationalen Kongresses für Entomologie Wien, **1**: 240–245.
- Girish, Kumar, P. 2020. Insecta: Hymenoptera: Vespoidea: Vespidae.

- In. faunal diversity of biogeographic zones of India: Western Ghats: 457-460.
- Girish Kumar, P. and Sureshan, P.M. 2025. Fauna of India and the adjacent countries- Hymenoptera: Vespidae-Solitary Wasps: 1-587
- Girish Kumar, P., Amal, S., Hanima Raveendran, K.P. and Terine, J.B. 2026. Insecta: Hymenoptera (Ampulicidae, Crabronidae, Sphecidae, Tiphidae, Scolidae, Vespidae & Mutillidae). In: Fauna of Megamalai Wildlife Sanctuary, Theni district, Tamil Nadu, Pp: 129-140. Eds: Subramanian, K.A., Rajappa Babu and Dhriti Banerjee. Published by the Director, Zoological Survey of India, Kolkata.
- Girish Kumar, P., Sureshan, P. M. and Nikhil, K. 2019. New distributional records of Vespidae (Hymenoptera: Vespoidea) for Telangana, India. *Records of the Zoological Survey of India*, 444-450.
- Illiger, K. 1802. Neue Insekten. Magazin fur Insektenkunde, 1(1-2): 163-20.
- Latreille, P.A. 1802. Histoire Naturelle, Générale et Particulière des Crustacés et des Insectes. Tome 3. Familles naturelles des genres. Paris: F. Dufart, xii + 467 pp.
- Leach, W. E. 1815. Entomology. In: Brewster, D. (ed.), *The Edinburgh Encyclopaedia*. Vol. 9, Part 1. Blackwood, Edinburgh, pp. 57-172.
- Lepeletier, A.L.M. 1836. *Histoire Naturelle des Insectes—Hyménoptères*. Vol. 1. Roret, Paris, 1, 547 pp.
- Linnaeus, C. 1758. *Systema naturae per regna tria naturae: secundum classes, ordines, genera, species, cum characteribus, differentiis, synonymis, locis*, Ed. 10. Lipsiae, impensis. Beer, G.E., 823 pp.
- Linnaeus, C. 1771. *Mantissa Plantarum. Laurentii Salvii. Holmiae* [Stockholm, Sweden], pp. 43-588.
- Pilo, B., Pathak, B.J., Kumar, B.A., Murukesan, V.K., Vinod, K.R. & Kumari, S. (1996). *Biological Diversity of Gujarat—Current Knowledge*. Gujarat Ecological Commission, Vadodara, Gujarat, India, 288 pp.
- Spinola, M. 1806. *Insectorum Liguria. Species novae austrariorum* 2. Genua (Y. Gravier), 1-262.

MS Received on 08th July, 2026

MS Accepted on 15th September, 2026

DOI: 10.55278/DHKU2710

Climate-Driven Shifts in the Thrips Complex of Pomegranate and the Emerging Threat of *Thrips parvispinus* (Karny, 1922)

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Abstract

Thrips constitute an increasingly unpredictable pest complex on pomegranate (*Punica granatum* L.), responding to temperature, rainfall and relative humidity in divergent rather than uniform directions. Three-season field monitoring (2024–2026) across Bengaluru Rural, Chikkaballapur and Kolar districts of Karnataka, south India showed that high temperature (31–40°C) and high cumulative rainfall (>1000 mm) suppressed populations, whereas moderate temperature (<30°C) combined with high humidity favoured build-up. This pattern coincided with an unprecedented April–June 2025–2026 outbreak of the invasive *Thrips parvispinus*, previously unrecorded as a pest of pomegranate, alongside the resident *Scirtothrips dorsalis*, *Rhipiphorothrips cruentatus* and *Anaphothrips oligochaetus*. A diagnostic, threshold-based management strategy combining canopy pruning, biorational and entomopathogenic interventions, and a five-spray resistance-rotation schedule alternating herbal, systemic and biological products achieved 92–96% reduction over untreated checks. Continuous three-parameter climate monitoring, rather than calendar-based spraying, is recommended for sustainable thrips management amid climate variability and expanding invasive-species risk. The recommendations are residue free and a feedback assessment from farmers showed high acceptance.

Key words: Climate change; Integrated Pest Management; Invasive species; Pomegranate; Residue free; *Thrips parvispinus*; Thrips complex

Introduction

Pomegranate (*Punica granatum* L.) cultivation across the semi-arid tropics is one of the more climate-exposed fruit enterprises, with erratic rainfall, prolonged dry spells and shifting temperature regimes acting

simultaneously on host physiology and on the biology of its insect pests. Among these pests, thrips occupy an unusual position. Unlike root grub, whose adult emergence tracks rainfall onset in a fairly linear way, or the pomegranate aphid, which builds up more or less in step with rising temperature, thrips respond to

temperature, rainfall and relative humidity in different, and at times opposing, directions. This makes the group one of the harder pests to forecast, and one where sustained field monitoring is now beginning to yield genuinely actionable trends.

The present study was undertaken to investigate the impact of climatic variables on the population dynamics of the thrips complex in pomegranate and to formulate a suitable Integrated Pest Management (IPM) strategy for effective and sustainable pest control.

Material and Methods

Field surveys were carried out over three consecutive cropping seasons (2024–2026) in the major pomegranate-growing tracts of south-eastern Karnataka, spanning Bengaluru Rural, Chikkaballapur and Kolar districts. The detailed monitoring and the spray-rotation trials reported here (Table 1) were conducted at the Rashvee research farm, Yellodu village, Gudibande taluk, Chikkaballapur district, Karnataka (13.73914° N, 77.68647° E), under the joint aegis of Rashvee International Phytosanitary Research and Services Pvt. Ltd., Bengaluru, and Shreenidhi Plant Health Clinic, Devanahalli. The orchard comprised tissue-culture-raised pomegranate cv. Bhagwa, 3.5 years old at the time of the trial, planted at 13 ft (row-to-row) × 9 ft (plant-to-plant) spacing (approximately 380 plants/acre) over a total area of 11 acres, giving approximately 4,180 plants in all. The entire orchard, except for ten trees reserved as

an untreated check under a shade net, was maintained as a single whole-orchard treatment block. A large-scale, unreplicated field demonstration with high sampling intensity (which is a legitimate and common way to report large grower-scale trials).

Within the treated block, ten trees were selected by the diagonal (zig-zag) method the standard approach for sampling large, uniform orchard blocks avoiding border rows, and permanently tagged for repeated weekly observation across all three seasons; an equivalent set of ten untreated trees partitioned with shade net to avoid spray drifts served as the check, so that treated and check counts were always drawn from the same number of observation trees. 20 Sticky traps were hung at canopy height per acre for monitoring and surveillance. Hundred leaves, twigs, flowers or fruits tapped per sampling date were drawn proportionately from these ten tagged trees rather than at random across the block, so that the same trees and therefore the same microhabitat were tracked throughout the study. A pre-treatment (background) count was recorded one week before the first spray on both the tagged and check trees, to give a baseline against which post-spray reductions in Table 1 are expressed. The five-spray, insecticide resistance-rotation schedule (Table 1) was evaluated as a whole-orchard treatment: the entire orchard was sprayed at 7–10-day intervals following the schedule in Table 1. Daily maximum and minimum temperature, rainfall and relative humidity were recorded

from on-farm automatic weather station and compared with the data from IMD station.



Fig. 1 Thrips on different stages of frutis and flowers

Data was compiled and analysed using Microsoft Excel, computing weekly means for the thrips complex against temperature, rainfall and relative humidity, and per cent reduction over the untreated check for each spray in Table 1. We also selected 80 farmers and randomly took feedback on this spray schedule in 2026 on a score of 0-5.

Results and discussion

Pomegranate orchards in the region are attacked by a complex of thrips species rather than a single dominant one. Four species recur regularly in field counts: the chilli/yellow thrips *Scirtothrips dorsalis*, the rose/pomegranate thrips *Rhipiphorothrips cruentatus* Hood, (Balikai et al. 2011)

Scirtothrips dorsals Hood, *Anaphothrips oligochaetus* Karny, (Balikai et al. 2011) and, of growing concern, *Thrips parvispinus*.

All are minute, highly mobile Thysanoptera under 2 mm in length occurring on leaves, flowers and fruits (Fig. 1) (Palmer *et al.* 1989; Mound and Marullo 1996). Both nymphs and adults rasp the epidermis of young leaves, flower buds and the developing fruit rind, feeding on the sap that oozes from the wounds. On foliage this produces silvery, streaking and curling of tender leaves; on flowers it causes bud drop and poor fruit set; and on fruit it produces the corky, russeted rind-scarring that growers know well, which downgrades fruit for the fresh market even when the internal arils are edible. As thrips depend on tender growth flushes and floral tissues, damage peaks during vegetative flushing and flowering, both of which are themselves weather-cued phenological events, which is one reason thrips infestation is closely related to climate.

Field count and trap data for the thrips complex, analysed against local weather records (Gopinath et al. 2020), did not show a response to any single climatic factors. Instead, three variables acted more or less independently of one another (Fig. 2):

- High temperature (31 °C to 40 °C) was associated with a decline in thrips populations.

- High cumulative rainfall (>1000mm) was likewise associated with declining populations, most probably through the physical dislodgement of nymphs and adults from tender tissue during heavy showers, together with reduced feeding activity in wet conditions.
- Moderate temperature (<30 °C) combined with high relative humidity, favoured population build-up.

The practical consequence is that neither temperature nor rainfall alone can serve as a forecasting model for pomegranate thrips. A workable forecast model has to track temperature, rainfall and relative humidity together, because two of the three factors can move in directions that partly affect on the population.

This three-way pattern as shown in Fig. 2 was particularly visible during an unusual build-up of *T. parvispinus* recorded between April and June 2025, 2026, when a period of moderate temperature and high relative humidity, following a comparatively dry preceding season, appears to have created a favourable population window on pomegranate. To our knowledge, this is among the first substantial field records of *T. parvispinus* reaching pest status on this crop, and its response to the same three climatic cues will need confirmation over further seasons before it can be built into a routine forecast.

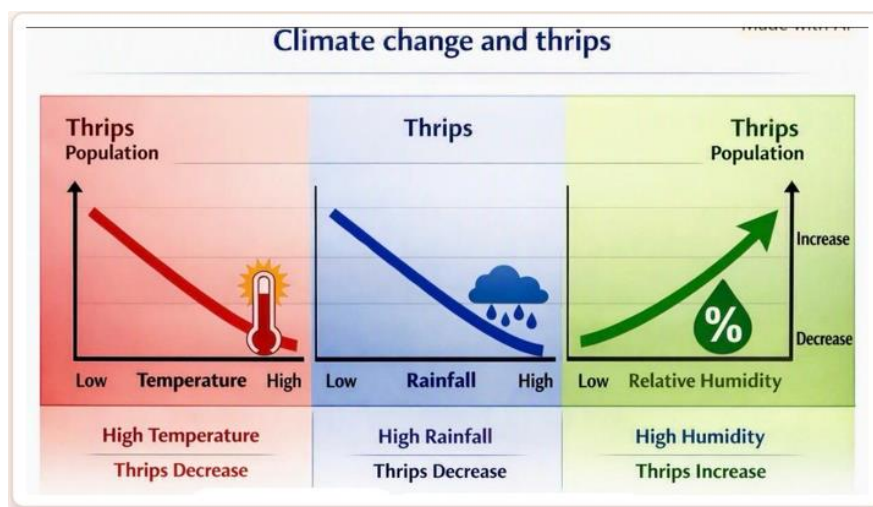


Fig. 2. Field response of the pomegranate thrips complex to temperature, rainfall and relative humidity, based on 2024–2026 orchard monitoring.

***Thrips parvispinus*: An Invasive Species Widening Its Host Range**

Thrips parvispinus (Karny) was first confirmed in India on the basis of morphological and DNA-barcoding evidence from chilli and other hosts (Tyagi et al. 2015), and has since caused repeated outbreaks in the chilli-growing tracts of Andhra Pradesh (Sireesha et al. 2021), prompting subsequent reviews of the species as an emerging pest of Indian growers (Yadav et al. 2023). It is now recognised internationally as an invasive, highly polyphagous thrips with a rapidly expanding host range, host-associated genetic diversification, and ready adaptation to tropical poly-crop systems (Palanisamy et al. 2023; CABI 2023), including a first report from cowpea in Chhattisgarh that itself represents a new host and locality record (Nagdev et al. 2022). Climate-suitability modelling has already flagged an expanding

invasion risk for *T. parvispinus* under current and projected climate-change scenarios (Hulagappa et al. 2022), a projection that sits uncomfortably well alongside its unexpected build-up on pomegranate reported here. On pomegranate, the species has so far shown a somewhat more aggressive damage pattern than the resident *Scirtothrips/Rhipiphorothrips* complex, with heavier scarring on young flushes and a tendency to concentrate on growing points and flower buds during its April–June 2026 build-up, though this observation will need to be confirmed with dedicated species-wise damage assessments rather than pooled thrips counts. Field evaluations elsewhere confirm that, once established, *T. parvispinus* is not straightforward to control, with markedly differential efficacy across conventional and biorational insecticides even under containment conditions (Ataide et al. 2024) a reminder that early detection, rather than

reactive spraying after populations have already peaked, is the more defensible strategy.

Management of thrips complex under a Variable Climate

As no single climatic cue reliably predicts thrips build-up on pomegranate, a diagnostic intervention approach works better than a fixed spray calendar.

Monitoring and forecasting with blue, white and yellow sticky traps, supplemented by leaf- and flower-tap counts, should be read alongside simple on-farm records of temperature, rainfall and relative humidity, since the three-way response above means that any single weather parameter will under- or over-predict risk if used on its own. Further symptom diagnostics like silver streaks leaf curl corkey stem and fruit rind tissues should also be taken into account while advocating management. Such as given below.

1. Cultural and canopy management. Pruning that opens up the canopy reduces the still, humid micro-climate that favours build-up at moderate temperatures, while avoiding moisture stress prevents this pest from multiplying.
2. Biological and biorational options. The Shreenidhi Plant Health Clinic programme has relied on entomopathogens together with the herbal biorational formulation Rashvee

Veraxaa™ combined with neem (azadirachtin, 10,000 ppm) for thrips suppression a residue-free option, compatible with natural-enemy conservation and consistent with the fruit-fly IPM package already running on the same orchards (ref). In a companion field trial against the same species on bitter gourd, combining *Beauveria bassiana*, *Metarhizium anisopliae* and *Verticillium lecanii* with the Rashvee Veraxaa™ herbal soap brought counts down from roughly 97 to about 5 thrips per 10 flowers within a week across two fields, whereas any single entomopathogen, the Veraxaa™ soap alone, or the insecticides tested fell well short of this level of control (Rashmi et al. 2025).

In addition to thrips management, Rashvee Veraxaa™ with other biologicals has consistently shown good field efficacy against major sucking pests of pomegranate, including aphids, mealybugs and mites, thereby offering a comprehensive biorational solution for sucking-pest management under residue-free production systems.

3. Judicious chemical use. Where populations cross threshold despite the above, need-based application of insecticides where experimented through rotation to avoid insecticide resistance in thrips populations (Reitz et al. 2011). Neonicotinoid-based products in

particular warrant caution and should not be relied on repeatedly, given their documented environmental risks to pollinators and natural enemies (Hladik et al. 2018) risks that would also undermine the biological-control component of the programme.

Field trials (Table 1) at our Rashvee research farm have converged on a seven-spray, resistance-rotation schedule for the thrips complex and *T. parvispinus* on

pomegranate, applied at crop-stage-linked intervals of roughly 7–10 days so that no single mode of action is used in successive rounds. The schedule opens at the vegetative-flushing stage with an herbal-chemical combination Rashvee Veraxaa™ (herbal liquid soap) at 1.5 ml/l with neem (azadirachtin 10,000 ppm) at 1 ml/l, paired with the systemic neonicotinoid thiamethoxam 25% WG at 1 g/l and continues into the pre-budding stage with Veraxaa™ combined with spinetoram 11.7% SC as a second, chemically distinct partner.

Table 1. Five-spray rotation schedule for thrips complex on pomegranate (7–10 day intervals).

Spray No.	Crop stage	Product(s) and dose	Category	Diagnostic trigger	% reduction over check *
1	Vegetative flushing	Rashvee Veraxaa™ (herbal liquid soap) 1.5 ml/l + neem (azadirachtin 10,000 ppm) 1 ml/l + thiamethoxam 25% WG 1 g/l	Herbal + chemical (systemic)	Silver streaks and leaf curl on new flush	95
2	Advanced vegetative growth, pre-budding	Rashvee Veraxaa™ 1.5 ml/l + spinetoram 11.7% SC 1 ml/l	Herbal + chemical	High trap catches on sticky traps	94
3	Pre-Flowering / blooming	<i>Beauveria bassiana</i> 5 ml/l + <i>Verticillium lecanii</i> 5 ml/l + <i>Metarhizium anisopliae</i> 5 ml/l (tank-mixed)	Biological	Visual count of thrips on flowers	93
4	Full Bloom	No spray	No Spray	<i>Pollinators active</i>	-
5	Bud and early fruit development	Rashvee Veraxaa™ 1.5 ml/l + neem (10,000 ppm) 1 ml/l + 1.2ml/ l Isocycloseram 9.2% w/w + 10% w/v DC (Simodis)	Herbal + chemical	Visual count of thrips on buds/developing fruit	96
6	Fruiting	<i>Beauveria bassiana</i> 5 ml/l + <i>Verticillium lecanii</i> 5 ml/l + <i>Metarhizium anisopliae</i> 5 ml/l (tank-mixed)	Biological	Tap-count on fruit	92
7	Pre-harvest	Rashvee Veraxaa™ (herbal liquid soap) 1.5 ml/l + neem (azadirachtin 10,000 ppm) 1 ml/l	Herbal	Prophylactic spray	93
Check	All stages	Water (untreated, shade-net partition)	Untreated control (n = 10 trees)	—	

Note 1: No insecticides should be sprayed during pollination; Rashvee Veraxaa™ was found to be safe for use at this stage.

Note 2: Treatments giving <80% efficacy in preliminary screening were excluded from the schedule (n = 100 sampling units per treatment).

Note 3: Average score: 4.9 (n=80 farmers)

A full biological round of *Beauveria bassiana*, *Verticillium lecanii*, and *Metarhizium anisopliae* (each at 5 ml/l, tank-mixed) is applied at pre-flowering to rebuild entomopathogen and natural-enemy pressure in the canopy ahead of bloom. No spray is applied during full bloom, in order to protect active pollinators. Once bud and early fruit development resume, the herbal base is paired with isocycloseram a newer diamide-class molecule ensuring the two chemical partners used across the schedule belong to different classes rather than repeating one another. A second biological round follows at fruiting to further slow resistance build-up, and the schedule closes with a prophylactic herbal-only spray (Veraxaa™ with neem) at pre-harvest, avoiding any chemical residue close to harvest (Reitz et al. 2011; Hladik et al. 2018)

This particular three-fungus combination has itself been validated against *T. parvispinus* in a controlled field trial on bitter melon, where it suppressed populations far more effectively than any single agent (Rashmi et al. 2025). This alternation of biorational, systemic-chemical and biological rounds keep at least two of the five sprays residue-free and natural-enemy-safe.

Conclusion

Thrips on pomegranate present a genuinely climate-complex pest problem: two of the three weather drivers that matter high temperature and high rainfall suppress the pest, while a specific moderate-temperature,

high-humidity combination favours it, and the recent appearance of *T. parvispinus* as a previously unrecorded pressure on this crop adds an invasive-species dimension to an already tangled picture. Effective management is likely to depend less on calendar-based spraying and more on continuous, three-parameter climate monitoring paired with biological and biorational suppression, backed by careful, resistance-aware use of chemical options once thresholds are crossed.

For growers and extension workers, the operational message is straightforward even where the underlying biology is not: a single hot, dry spell is not a reason to relax thrips vigilance if it is followed by a stretch of moderate temperature and high humidity, and *T. parvispinus* should now be watched for on pomegranate specifically during such windows rather than assumed to remain confined to chilli and vegetable hosts. Continued season-on-season monitoring at Shreenidhi Plant Health Clinic will indicate whether the April–June 2026 build-up was an isolated weather-driven event or the start of a recurring seasonal pattern.

Acknowledgments

The authors express their sincere gratitude to the Biotechnology Industry Research Assistance Council (BIRAC), Department of Biotechnology (DBT), Government of India, for providing the financial support that was instrumental in the development of this product. Special

appreciation is extended to ICAR–National Bureau of Agricultural Insect Resources (ICAR-NBAIR) for their valuable assistance in evaluating the efficacy of the product against sucking insect pests. The authors are deeply thankful to the farmers who provided valuable feedback during the field evaluations, and to the Shreenidhi and Rashvee field staff for their dedicated efforts in collecting and recording observations. Part of this research was presented at the International Conference on Pomegranate-2026, "Climate Resilient Pomegranate Ecosystem for Amritkaal: Fostering Sustainability, Innovation and Global Health." The authors sincerely thank the organizers, National Research Centre on Pomegranate (NRCP), Solapur, and the Society for Advancement of Research on Pomegranate (SARP), Solapur, for providing the opportunity to present their work at this prestigious event.

References

- Ataide LM, Vargas G, Velazquez-Hernandez Y, Reyes-Arauz I, Villamarin P, Canon MA, Revynthi AM (2024) Efficacy of conventional and biorational insecticides against the invasive pest *Thrips parvispinus* (Thysanoptera: Thripidae) under containment conditions. *Insects* **15**: 48.
- Balikai RA, Kotikal YK, Prasanna PM (2011) Status of pomegranate pests and their management strategies in India. *Acta Horticulturae* **890**: 569-583.
- CABI (2023) *Thrips parvispinus*. Invasive Species Compendium. CAB International. Accessed 25 Aug 2025.
- Hladik ML, Main AR, Goulson D (2018) Environmental risks and challenges associated with neonicotinoid insecticides. *Environmental Science & Technology* **52**: 3329-3335.
- Hulagappa T, Baradevanal G, Surpur S, Raghavendra D, Doddachowdappa S, Shashank PR, Kereyagalhalli MK, Bedar J (2022) Diagnosis and potential invasion risk of *Thrips parvispinus* under current and future climate change scenarios. *PeerJ* **10**: e13868.
- Mound LA, Marullo R (1996) *The Thrips of Central and South America: An Introduction. Memoirs on Entomology International* **6**: 1-488. Associated Publishers, Gainesville, Florida, USA.
- Nagdev P, Beerendra, Ganguli J, Ganguli RN (2022) First report of a new invasive thrips, *Thrips parvispinus* (Karny) (Thysanoptera: Thripidae), in cowpea (*Vigna unguiculata*) at Raipur, Chhattisgarh. *The Pharma Innovation Journal* **11**: 4557-4562.
- Palanisamy A, Marimuthu M, Narayanasamy C, Venkatasamy B, Gandhi K, Lakshmanan P (2023) Invasive flower thrips, *Thrips parvispinus* (Karny) occurrence, host expansion and genetic diversification in a tropical poly-crop ecosystem. *Molecular Biology Reports* **50**: 9909-9923.

- Palmer JM, Mound LA, du Heaume GJ (1989) *Thysanoptera (Thrips)*. Handbooks for the Identification of British Insects, Vol. 1, Part 11. Royal Entomological Society, London, United Kingdom.
- Rashmi M.A, Anitha A.A, Deepak, S, Ruchitha ND, Salome RJ, Raghavendra VG, Verghese A (2025) Integrated biocontrol of *Thrips parvispinus* Karny in bitter gourd: Synergistic effect of a liquid soap made of herbal essential oils. *Journal of Biological Control* **39**(2): 254-259. DOI: 10.18311/jbc/2025/50351.
- Rashmi MA, Verghese A, Raghavendra VG (2026) An integrated, climate-resilient approach for management of fruit flies *Bactrocera* spp. in fruit crops (mango, pomegranate, guava, dragon fruit and sapota). *Insect Environment* **29**(2): 262-264. DOI: 10.55278/BUHC1833.
- Reitz SR, Gao Y, Lei Z (2011) Insecticide resistance in thrips: Challenges and potential solutions. *Pest Management Science* **67**: 1001-1010.
- Riley DG, Joseph SV, Srinivasan R, Diffie S (2011) Thrips vectors of tospoviruses. *Journal of Integrated Pest Management* **2**: I1-I10.
- Sireesha K, Prasanna BVL, Vijaya Lakshmi T, Reddy RVSK (2021) Outbreak of invasive thrips species *Thrips parvispinus* in chilli growing areas of Andhra Pradesh. *Insect Environment* **24**: 514-519.
- Tyagi K, Kumar V, Singha D, Chakraborty R (2015) Morphological and DNA barcoding evidence for invasive pest thrips, *Thrips parvispinus* (Thripidae: Thysanoptera), newly recorded from India. *Journal of Insect Science* **15**: 1-4.
- Yadav M, Kumar S, Singh R (2023) *Thrips parvispinus* (Karny): Pest of concern to Indian farmers in chilli, a review. *Journal of Entomological Research* **47**: 345-354.

MS Received on 24th June, 2026

MS Accepted on 15th September, 2026

Short Notes

DOI: 10.55278/RUBQ3066

PVC-Based Stands: A Sustainable, Hygienic, and Cost-Effective Innovation in Silkworm Seed Production

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Grainages, the specialized units responsible for silkworm seed production, depend heavily on well-designed infrastructure to support cocoon handling, moth pairing, egg sheet mounting, and drying operations. The choice of stand material directly influences hygiene standards, operational efficiency, and long-term maintenance costs making it a small but consequential decision in the broader goal of quality seed production.

Quality silkworm seed production is vital for successful sericulture, where efficiency, hygiene, and durable infrastructure are essential. Traditionally, wooden and subsequently metal stands have been used in grainages for cocoon handling, moth pairing, egg sheet mounting, and drying. However, frequent disinfection with chlorine-based chemicals such as sodium hypochlorite and chlorine dioxide causes rapid corrosion of metal structures, leading to pitting, discoloration, and high maintenance costs. (Patra, et al. (2025) & Nikolova, T. (2019).

Wooden stands, though corrosion-free, absorb moisture, attract termites, and require regular upkeep. These limitations, combined with the need for lightweight and hygienic equipment, have driven the adoption of Polyvinyl Chloride (PVC) stands in silkworm seed production centres.

PVC offers several advantages over conventional wooden and metal stands, including excellent resistance to moisture, insects, and corrosion, along with a smooth, non-porous surface that is easy to clean and disinfect. It is lightweight, cost-effective, readily available, and requires minimal maintenance. The modular design enables easy dismantling, transportation, and reassembly, making PVC stands particularly suitable for dynamic grainage operations. Previous studies have reported that PVC structures outperform wooden and metal alternatives in terms of hygiene, durability, and operational efficiency, with an expected service life of 7–10 years under normal conditions (Edo *et al.*, 2026). For

optimum structural stability, 2-inch diameter PVC pipes (6 kg grade) were used for the vertical support legs, while $\frac{3}{4}$ -inch diameter PVC pipes (10 kg grade) were used for the horizontal rails. The structure was assembled using PVC T-connectors and elbow joints without solvent welding, allowing easy disassembly and reuse (Table 1). The design was developed and customized in collaboration with progressive farmer Mr. Shivkumar, ASR, SSPC Vijayapura, to meet the practical requirements of grainage operations.

Beyond operational benefits, PVC supports environmental sustainability by reducing timber use and eliminating the impacts of metal mining. Its recyclability, long service life, and reduced replacement needs lower waste generation, aligning with green sericulture goals. By minimizing corrosion-related downtime, lowering infrastructure costs, and improving ergonomics, PVC stands enhance productivity and hygiene. In a sector with tight margins and strict disease prevention needs, PVC-based solutions represent a simple yet impactful innovation offering durability, efficiency, and sustainability for the future of silkworm seed production.

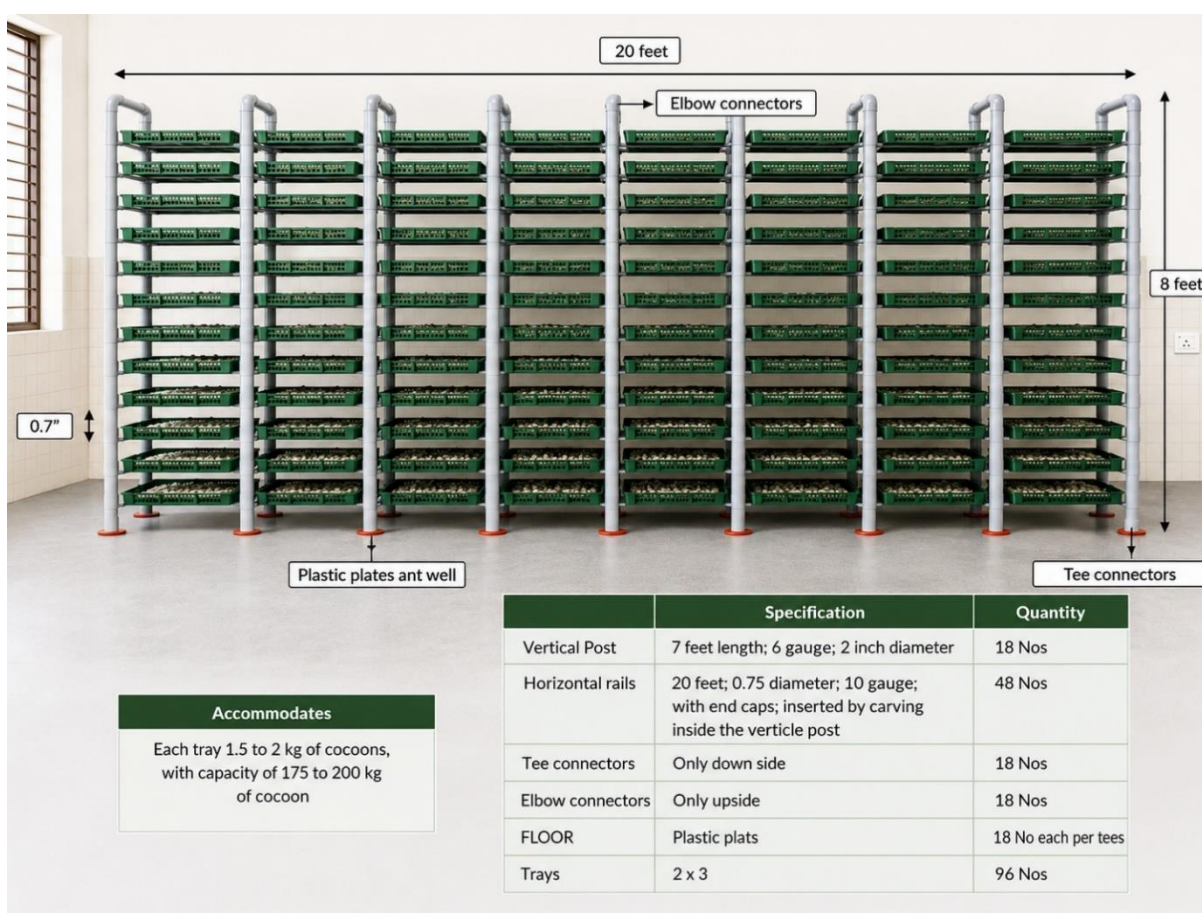


Figure 1. Schematic Design and Specifications of the PVC Tray Rack for Cocoon Storage (96-Tray Capacity)

Table 1. Technical Specifications of the PVC stand of 96 trays

Component	Specification	Quantity
Vertical Posts	7 ft length; 2-inch diameter; 6-gauge pipe	18 Nos.
Horizontal Rails	20 ft length; 0.75-inch diameter; 10-gauge pipe with end caps; rails inserted into machined openings in the vertical posts	48 Nos.
Tee Connectors	Installed at the bottom of the vertical posts	18 Nos.
Elbow Connectors	Installed at the top of the vertical posts	18 Nos.
Base Support	Plastic base plates	18 Nos.
Trays	2 ft × 3 ft perforated plastic trays	96 Nos.

**Figure 2. Comparative Design of PVC, Wooden, and Steel Rack Systems with Plastic Trays**

Conclusion

In conclusion, the shift from conventional wooden and metal stands to PVC-based alternatives marks a practical step forward for grainage management. Given their proven durability, ease of maintenance, and alignment with sustainable practices, PVC

stands merit wider adoption across silkworm seed production units. Continued field-level validation and standardization of design specifications will further strengthen their role as a cost-effective, hygienic, and eco-friendly infrastructure solution for the sericulture sector.

References

- Edo, G. I., *et al.* (2026). Polyvinyl chloride (PVC): Modification, properties, industrial and diverse applications. *Journal of Materials Science: Materials in Engineering*, **21**, 90. <https://doi.org/10.1186/s40712-026-00468-z>
- Nikolova, T. (2019). Influence of heavy metals on cocoon *Bombyx mori* L. Scientific Papers. Series D. Animal Science, **62**(2).
- Patra, B., *et al.* (2025). Heavy metals and sericulture: Implications for industry sustainability. *International Journal of Ecology and Environmental Sciences*. <https://doi.org/10.55863/ijees.2025.0641>
- Krishnaswami, S. (1978). *New technology of silkworm rearing* (Bulletin No. 2). Central Sericultural Research and Training Institute, Central Silk Board, Mysore, India.

MS Received on 24th June, 2026
MS Accepted on 29th August, 2026

DOI:10.55278/CEZZ8726

First Molecular Evidence of *Tetragonula shubhami* (Hymenoptera: Apidae: Meliponini) from Gujarat, India

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Stingless bees (Meliponini) are important non-*Apis* pollinators that contribute significantly to the pollination of agricultural and natural ecosystems in tropical and subtropical regions and the most diverse group of corbiculate bees, comprising about 605 described species worldwide (Engel *et al.*, 2023). In India, several *Tetragonula* species have been reported, including recently described *Tetragonula shubhami* from Chhattisgarh (Viraktamath and Roy, 2022). For Accurate identification of cryptic species, molecular approaches along with morphometry provide an effective means. Despite the widespread occurrence of stingless bees in Gujarat, molecular information on their species diversity remains limited (Patel and Pastagia, 2016). Therefore, the present study aimed to develop DNA barcodes and assess their molecular diversity using mitochondrial *COI* and *COII* gene markers (Hebert *et al.*, 2003). Worker bees were collected from seven agro-climatic regions of Gujarat, namely Navsari, Anand, Junagadh, Dantiwada, Tapi, Valsad and Narmada, during 2025-2026. Genomic DNA was extracted, followed by PCR amplification, Sanger sequencing and

sequence analyses, including BLAST, nucleotide estimation, SNP, phylogenetic analysis and genetic distance. The validated sequences were submitted to the NCBI GenBank and BOLD databases. The study provides the first molecular evidence of *T. shubhami* from Gujarat based on *COI* DNA barcoding, extending its known distribution in India and enriching the molecular database of Indian stingless bees.

Morphometric analysis showed only minor variation among stingless bee populations from different regions of Gujarat, with all measurements falling within the reported range for *Tetragonula* spp. Genomic DNA of high quality (A_{260}/A_{280} : 1.78-1.92) was successfully extracted and mitochondrial *COI* (~700 bp) and *COII* (~750 bp) genes were amplified and sequenced. BLASTn analysis identified most populations as *Tetragonula iridipennis* (99-100% similarity), while the Anand *COI* sequence showed 99.41% similarity with *T. shubhami*. Nucleotide composition showed an AT-rich mitochondrial genome (*COI*: 66.06-69.47%; *COII*: 65.00-65.45%), Anand *COI* sequence exhibited

highest AT content (69.47%). SNP, Phylogenetic analysis and pairwise genetic distances revealed low genetic divergence among most Gujarat populations, which clustered with *T. iridipennis* reference sequences. In contrast, the Anand population formed a distinct *COI* clade with *T. shubhami* which exhibited distinct nucleotide substitutions and exhibited comparatively higher genetic divergence (0.21) calculated using the Kimura 2-parameter (K2P) model, indicating possible cryptic diversity. Fourteen mitochondrial sequences (7 *COI* and 7 *COII*) were deposited in GenBank and BOLD. This study provides the first molecular evidence of *T. shubhami* in Gujarat and also first DNA barcode records of *Tetragonula* spp. from Gujarat.

Morphometric analysis revealed low phenotypic variation among *Tetragonula* spp. populations from Gujarat. Mitochondrial *COI* and *COII* gene analyses confirmed most populations as *T. iridipennis*, while the Anand population was identified as *T. shubhami* based on *COI* DNA barcoding. Phylogenetic analysis, genetic distance and SNP analysis supported the distinct placement of the Anand

population suggesting the possible first molecular record of *T. shubhami* from Gujarat, subject to confirmation through male morphometry and genitalia analysis. Prior to this study, only three stingless bee species, viz., *T. iridipennis*, *T. laeviceps* and *T. pagdeni*, had been recorded from Gujarat. The present findings expand the known stingless bee diversity of the state. Fourteen DNA barcode sequences (seven *COI* and seven *COII*) were generated and deposited in the NCBI GenBank and BOLD databases. As of 17 June 2026, BOLD database contained a total of 50 barcode records for *T. iridipennis*, including twelve sequences generated in the present study. In contrast, only a single barcode record for *T. shubhami* was available in the database and the present study contributed two additional barcode sequences. These represent the first DNA barcode records of *Tetragonula* spp. from Gujarat, providing valuable baseline information for future taxonomic, phylogeographic, breeding and conservation studies supporting the sustainable utilization of stingless bees as effective pollinators in agricultural ecosystems.



**Photo 1: A) Natural nesting site of *Tetragonula* spp. on a tree trunk at Anand location
B) Microscopic view of an adult *Tetragonula* spp. worker bee**

Table 1: GenBank accession numbers and BOLD Process IDs of mitochondrial *COI* and *COII* sequences of *Tetragonula* spp. collected from different locations of Gujarat with their GPS coordinates

Sr. No.	Location	Latitude & Longitude	<i>COI</i> Accession no.	<i>COII</i> Accession no.	<i>COI</i> Process ID	<i>COII</i> Process ID
1	Navsari	20.923951°N 72.907643°E	PZ464381.1	PZ464569.1	SDP1222023-26	SDP1222024-26
2	Anand	22.536547°N 72.980402°E	PZ464709.1	PZ465277.1	SDP1222037-26	SDP1222038-26
3	Junagadh	21.522222°N 70.457986°E	PZ473159.1	PZ465729.1	SDP1222027-26	SDP1222028-26
4	Dantiwada	24.476863°N 72.291094°E	PZ467601.1	PZ465871.1	SDP1222029-26	SDP1222030-26
5	Tapi	21.096632°N 73.392396°E	PZ467638.1	PZ465958.1	SDP1222031-26	SDP1222034-26
6	Valsad	20.540102°N 73.179263°E	PZ467921.1	PZ467700.1	SDP1222032-26	SDP1222033-26
7	Narmada	21.629644°N 73.582877°E	PZ468132.1	PZ468110.1	SDP1222035-26	SDP1222036-26

Acknowledgement

We sincerely acknowledge, Dr. R. K. Kalaria (Department of Plant Biotechnology, ASPEE Shakilam Biotechnology Institute, Surat) and Dr. J. J. Pastagia (Professor and Head, Department of Entomology, N. M. College of Agriculture, NAU, Navsari) for their guidance, constructive suggestions and unwavering support throughout this research.

References

- Engel, M. S.; Rasmussen, C.; Ayala, R. and de Oliveira, F. F. (2023). Stingless bee classification and biology (Hymenoptera, Apidae): a review, with an updated key to genera and subgenera. *ZooKeys*, **1172**: 239.
- Hebert, P.; Ratnasingham, S. and de Waard, J. R. (2003). Barcoding animal life: Cytochrome c oxidase subunit 1 divergences among closely related species. *Proceedings of the Royal Society of London B*, **270**: 96-99.
- Patel, H. K. and Pastagia, J. J. (2016). Morphometric variation in workers of stingless bees *Tetragonula laeviceps* Smith in South Gujarat. *International Journal of Plant Protection*, **9**: 445-449.
- Viraktamath, S. and Roy, J. (2022). Description of five new species of *Tetragonula* (Hymenoptera: Apidae: Meliponini) from India. *Biologia*, **77**(7): 1769-1793.

MS Received on 4th July, 2026

MS Accepted on 15th September, 2026

INSECT LENS



Large aggregation of hairy moth caterpillars (Eupterotidae: Lepidoptera)

Author: Dr. Abhishek V., Senior Research Fellow, ICAR-NIVEDI

Location: Madikeri, Karnataka, India

Email: abhiento97@gmail.com



Tea Looper, Biston suppressaria (Geometridae: Lepidoptera)

Author: Dr. Nagaraj, D.N., Project Head (Entomologist) Ento. Proteins Pvt. Ltd.

Location: Bengaluru, Karnataka, India

Email: nasoteya@yahoo.co.in



Fiery emperor, Anax immaculifrons (Aeshnidae: Odonata)

Author: Dr. Nagaraj, D.N., Project Head (Entomologist) Ento. Proteins Pvt. Ltd.

Location: Bengaluru, Karnataka, India

Email: nasoteya@yahoo.co.in



Plant Hoppers, Eurybrachus sp. (Eurybrachidae: Hemiptera)

Author: Dr. Nagaraj, D.N., Project Head (Entomologist) Ento. Proteins Pvt. Ltd.

Location: Bengaluru, Karnataka, India

Email: nasoteya@yahoo.co.in



Treehopper (Membracidae: Hemiptera)

Author: Dr. Nagaraj, D.N., Project Head (Entomologist) Ento. Proteins Pvt. Ltd.

Location: Bengaluru, Karnataka, India

Email: nasoteya@yahoo.co.in



Oriental fruit fly, Bactrocera dorsalis (Tephritidae: Diptera) ovipositing on Nendran banana

Author: Dr. S. Devanesan

Location: Trivandrum, Keralam, India

Email: devanesanstephen@gmail.com



Tiger beetle, Cicindella sp. (Cicindelidae: Coleoptera)

Author: Dr. Nagaraj, D.N., Project Head (Entomologist) Ento. Proteins Pvt. Ltd.

Location: Bengaluru, Karnataka, India

Email: nasoteya@yahoo.co.in



Planthopper nymph., Salurnis marginella (Flatidae: Hemiptera)

Author: Dr. Nagaraj, D.N., Project Head (Entomologist) Ento. Proteins Pvt. Ltd.

Location: Bengaluru, Karnataka, India

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IE SELECTED BLOGS

Insect Environment Blog

Fruit Mealybugs: An Emerging Threat to Banana Production and Quality *Protecting Banana Bunches Through Sustainable Integrated Management*

22 July 2026

A. Mohanasundaram, N. Baskar and R. Thanigairaj

ICAR-National Research Centre for Banana, Tiruchirappalli, Tamil Nadu – 620 102, India

India is the world's largest producer of bananas, cultivating over 490,000 hectares. However, productivity and export potential are increasingly threatened by pests and diseases, particularly Fusarium wilt, weevil borers, and fruit mealybugs. Among these, fruit mealybugs have emerged as a serious concern because they reduce fruit quality and pose quarantine risks for international trade. Several mealybug species infest banana fruits in India, including *Maconellicoccus hirsutus*, *Rastrococcus iceryoides*, *Ferrisia virgata*, *Dysmicoccus neobrevipes*, and *Pseudococcus jackbeardsleyi*. Recently, *Dysmicoccus neobrevipes*, commonly known as the grey pineapple mealybug, has emerged as the most damaging species in southern India.



Dysmicoccus neobrevipes

This highly polyphagous pest attacks a wide range of host plants and has become a major problem in popular banana cultivars such as Karpooravalli, Poovan, Ney Poovan, Grand Nain, Ash Monthan, Kaveri Kalki, and Kaveri Saba. Unlike other mealybugs,



D. neobrevipes affected banana bunch

infestation by *D. neobrevipes* causes distinctive black spots on fruits that gradually enlarge into dark patches, leading to partial or complete black discoloration. These



Mealybug colonies on banana

blemishes often remain visible even after the insects are washed off, resulting in severe loss of market value.

During 2023-2026, severe outbreaks were reported in the canal-irrigated banana belt of the Cauvery River basin, particularly in Tiruchirappalli and Karur districts of Tamil Nadu. Recognizing the importance of rapid detection, ICAR-National Research Centre for Banana (NRCB) developed a simple and rapid RPA-based diagnostic assay for accurate identification of *D. neobrevipes*, supporting quarantine surveillance and timely intervention.



Banana bunch discolored by *D. neobrevipes*

Integrated Management of Fruit Mealybugs

Sustainable management should focus on eco-friendly approaches that conserve natural enemies while maintaining fruit quality.

- Grow intercrops such as pulses and coriander to enhance biodiversity and encourage beneficial predators and parasitoids.
- Use forceful water sprays to dislodge mealybug colonies from infested bunches.
- Apply Kaveri Fish Oil Soap or Kaveri Punga Neem Soap at 10 g/L of water to suppress mealybug populations.

- Spray *Beauveria bassiana* (NRCB isolate EPF-22) at 10 ml/L of water for effective control within 2-3 days.

Avoid indiscriminate use of chemical insecticides on banana bunches, as they can harm beneficial insects and leave undesirable residues on fruits.

An integrated, bio-intensive management approach is essential for sustainable banana production, improved fruit quality, and enhanced export competitiveness.

To cite this blog, (2026, July 22nd) A. Mohanasundaram, N. Baskar and R. Thanigairaj Fruit Mealybugs: An Emerging Threat to Banana Production and Export Quality (IE Blog No. 317). *Insect Environment*. <https://insectenvironment.com>

IE Blog No. 317

All IE blogs are available on website <https://insectenvironment.com>

Insect Environment Blog

Dr. Salim Ali: The Birdman of India

Dr. Salim Ali's book on Birds of India gives extensive notes on food of birds which contained sizable insect diet of birds

(Originally published in the Deccan Herald, June 27, 1987, and reproduced here as part of India's natural history heritage)

19 July 2026

Abraham Verghese

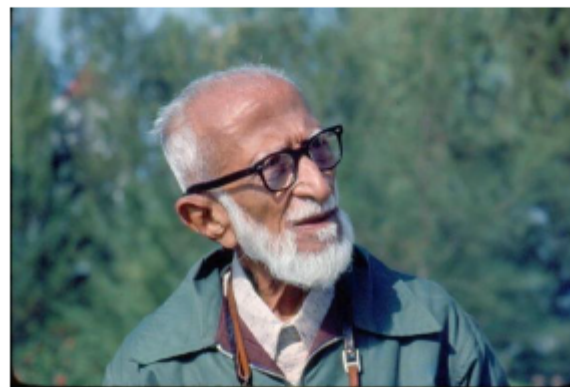
I LAST wrote to Dr. Salim Ali at the end of March. By then he had taken ill. But I received a reply, written on his behalf by Mr. J.C. Daniel, Curator of the Bombay Natural History Society.

Well, that's the person Salim Ali was; he promptly replied to all letters and even when sick, he saw to it that a query was answered.

I first wrote to him in 1972, when this bug called birdwatching had infected me. On hearing of his being awarded a gold medal, I shot off a congratulatory note. Prompt came the reply: "Thanks, but which gold medal?" The medal in question was the Sunderlal Hora Gold Medal, but Salim Ali by then had received several.

As a scientist one should chart one's own course, without idolising any great figure, though his worthy traits may be emulated. Though fully aware of this philosophy, when it came to Salim Ali, I partially succumbed. For he had the right blend of all that goes to make a true scientist: a definite goal, identifying fully with one's field of interest, honesty, academic abilities, and above all humility. He was accessible to all bird-lovers, amateurs and professionals, and never made distinctions of caste or creed. His tribe is indeed rare.

If ornithology had a Nobel Prize, Salim Ali would have surely bagged it. Not surprising then that he got the almost equivalent Paul Getty Conservation Award. The Indian Government honoured him with the Padma Shri, the Padma Vibhushan, and also nominated him to the Rajya Sabha. But all these honours and several degrees never went to his head, as is reflected on his simple letterhead which just says in small print: Salim Ali, 46 Pali Hill, Bombay. No decoration or position is mentioned.



PC: <https://www.deccanherald.com/>

Salim Ali was among the few who could read nature with deep insight and matching foresight. In 1978-79, one of the worst droughts affected the famous Bharatpur bird sanctuary in Rajasthan. When I visited the

place, it wore a deserted look, a clear contrast to the lively colourful, winged paradise I had seen in earlier years. The prophets of doom painted a gloomy picture, and dismal reports on the sanctuary poured in. But Salim Ali remained cool. He later wrote in the *Newsletter for Birdwatchers* that the drought would give the sanctuary an ecological rest, and all would be soon well. I likened this to a preschool stomach wash before term began. And Bharatpur sanctuary seemed purged: for in my next visit in 1981, Bharatpur was its usual — a teeming world of herons, egrets, waders and ducks, in the air, on water, and among the weeds.

Talking of cricket, what an innings he played, out in the field with his feathered bipeds. He winged his way into the avian world, at the age of eleven, and remained buoyant there for eight decades. Salim Ali has become the synonym of Indian birds and will remain so, though he has flown beyond to eternity.

Salim Ali's main contribution to Indian ornithology was the solid foundation he laid for future study in India. He opened all the doors of ornithological research to his students. But deep within, he probably lamented that there was none to match his pace or devotion, to build on from where he left. Sure enough, Indian ornithology will miss him for a long, long time.

But he has left behind him a rich heritage of books, literature and specimens for anyone to dabble and delve into the depths of the Indian bird world. In fact, because of these, birdwatching has come to stay as a hobby in India. Salim Ali would have loved to see a birdwatcher in every educated Indian; but, cricket and films hold greater sway.

To cite this blog, Verghese (2026, July 19th) Dr. Salim Ali: The Birdman of India (IE Blog No. 316). *Insect Environment*. <https://insectenvironment.com>

IE Blog No. 316

All IE blogs are available on website
<https://insectenvironment.com>

IE EXTENSION



Rashvee Team Participating in the 5th V.G. Prasad Memorial Lecture 2026, Organized by the Association for Advancement of Pest Management in Horticultural Ecosystems (AAPMHE), Bengaluru, at the Division of Crop Protection, ICAR–Indian Institute of Horticultural Research (ICAR-IIHR), Hesaraghatta Lake Post, Bengaluru.



Shreenidhi Plant Health Clinic and Rashvee Team Distributing Agricultural Blowers to Farmers in Collaboration with Sahayadri Agri Machinery Pvt. Ltd., IPRS Authorized Dealer of Sahyadri Agricultural Equipment, as Part of Farm Mechanization and Crop Protection Initiatives.



Rashvee Team with Mr. Gaurish Akki of Gaurish Akki Studio, Bengaluru, and Mrs. Prema Govindaraju, Horticulturist, Escorts Pvt. Ltd.



Dr. Abraham Verghese Presenting Rashvee's Cucurbit Fruit Fly Management Technologies at the International Workshop on "Area-Wide Management of Melon Fly: From Research to Field Application"



Rashvee team at International Workshop on "Area-Wide Management of Melon Fly: From Research to Field Application" organized by ICAR-National Bureau of Agricultural Insect Resources (ICAR-NBAIR), Bengaluru, India, in collaboration with the Center for International Research, Education and Development (CIRED), Virginia Tech, USA, held on 15 July 2026 to promote global research partnerships and sustainable field-based management of melon fly pests.



Rashvee Team with Officer In charge, Regional Plant Quarantine Station, Bengaluru and Scientists of ICAR-National Bureau of Agricultural Insect Resources (ICAR-NBAIR), Bengaluru, India during International Workshop on “Area-Wide Management of Melon Fly: From Research to Field Application



Rashvee Team with Director and Scientists of ICAR-National Bureau of Agricultural Insect Resources (ICAR-NBAIR), Bengaluru, India during International Workshop on “Area-Wide Management of Melon Fly: From Research to Field Application



Interaction of the Rashvee Team with Progressive Farmers at Shreenidhi Plant Health Clinic, Vijayapura, Devanahalli, promoting sustainable agriculture and improved plant health practices.



Shreenidhi Team interacting with Progressive Farmer Mr. Manjunath during a field visit to his Chrysanthemum net house.



Diagnosis and Identification of Pest and Disease Problems in Crop Samples Submitted by Farmers at Shreenidhi Plant Health Clinic, prior to recommendation.



Promoting Eco-Friendly Crop Production with Bioagents: Progressive farmers buying biological products



At Shreenidhi Plant Health Clinic, we promote the use of beneficial biological agents to improve soil health, plant health, and sustainable crop production. The biological products recommended include *Pseudomonas fluorescens*, *Metarhizium anisopliae*, *Verticillium lecanii*, *Paecilomyces lilacinum*, *Beauveria bassiana*, Phosphate Solubilizing Bacteria (PSB), and Potassium Solubilizing Bacteria (KSB), Entomopathogenic Nematodes (EPNs).

Glimpses of the International Conference on Pomegranate 2026
“Climate-Resilient Pomegranate Ecosystem for Amrit Kaal: Fostering Sustainability, Innovation and Global Health”
6-7 September 2026 | Pune, India



Rashvee Team with Dr. Bhagirath Choudhary, Director, South Asia Biotechnology Centre (SABC), Jodhpur, Rajasthan; Dr. Surinder Kumar Tikoo, agricultural scientist, renowned vegetable breeder, Dr. B. N. S. Murthy, Former Horticulture Commissioner, Government of India; Dr. N. K. Krishna Kumar, Former Deputy Director General (Horticulture), ICAR, New Delhi; and Dr. Jyotsana Sharma, Former Acting Director, ICAR-National Research Centre on Pomegranate (ICAR-NRCP), Solapur.



Rashvee Team with eminent scientists, horticultural experts, exporters, and progressive farmers at the International Conference on Pomegranate 2026.



Rashvee Team with Dr. Basana Gowda G, Senior Scientist, ICAR-National Research Centre on Pomegranate (NRCP), Solapur, and Scientists from ICAR Krishi Vigyan Kendra (KVK), Hirehalli, and ATARI during the International Conference



Rashvee Team with Dr. Manjunath N, Senior Scientist, ICAR-National Research Centre on Pomegranate (NRCP), Solapur



Rashvee Team networking with progressive farmers, Dr. Yogeshwara H. R., Chairman, SRPG FPO, Karnataka and Dr. Rajeshwari, University of Horticultural Sciences (UHS), Bagalkot.



Fruitful interaction between the Rashvee Team and Dr. Jyotsana Sharma, ICAR-NRCP, Solapur, discussing integrated blight management approaches and disease surveillance.



Dr Abraham Verghese, Chairman, Rashvee IPRS with Dr T K Behera, Director, ICAR-IIHR, Bengaluru and Dr. K. V. Prasad, Director, Directorate of Floricultural Research (ICAR-DFR), Pune



Dr. M A Rashmi, Presenting a paper at Farmer-Researcher-Entrepreneur Interface session



Best Oral Presentation Award Presented to Dr. M. A. Rashmi for the presentation of the research paper entitled "Cost-effective Whole-Orchard Netting for Fruit Piercing Moth Management in Pomegranate: A Farmer-adopted Innovation in Sustainable Horticulture" during the Farmer–Researcher–Entrepreneur Interface Session



Insightful invited lecture by Dr. Abraham Verghese, Former Director, ICAR-NBAIR, Bengaluru, on “Climate Change Impacts on Major Insect Pests of Pomegranate and Smart Surveillance Models,” highlighting emerging pest challenges and innovative monitoring strategies for climate-resilient pomegranate production.



Rashvee Team with Dr. Vishnuvardhan, Hon'ble Vice-Chancellor, UHS Bagalkot, scientists of ICAR-NRCP, and professors of UHS Bagalkot at the International Conference on Pomegranate 2026



Rashvee Team interacting with Dr. T. Sakthivel, Principal Scientist, Division of Fruit Crops, ICAR-Indian Institute of Horticultural Research (ICAR-IIHR), Bengaluru, on improved cultivation practices in custard apple cultivation, orchard management, productivity enhancement, and market opportunities for growers.