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

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***Cover Page:**
Soldier beetle, Ichthyurus sp. (Cantharidae)
Place: Virajpet, Karnataka, India
Photo by Dr. M. A. Rashmi

Insect Environment

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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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Short popular insect notes, review essays, new records, profiles, tributes, and views are acceptable. There are no page charges; each article should preferably not exceed 500 words. Authors can refer to back volumes available on the website for writing style. Good photographs are encouraged. A special insect photo gallery "Insect Lens" is to encourage professional and amateur photographs of insects. These will be published in the quarterly *Insect Environment.* The blogs are for quick dissemination of insect "news". These will be uploaded within a month of submission and will be on the website. Blogs should be about a hundred words with one photograph, in simple English.

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Editorial

The highlight of this quarter was the AVIAN Trust Award Ceremony, co-hosted by the *Insect Environment* team and Shreenidhi Plant Health Clinic, and expertly managed by the team from Rashvee International Phytosanitary Research and Services, Bengaluru. Now in its fourth consecutive year, the AVIAN Trust honored achievers across six categories for their contributions to environmental stewardship, teaching, agriculture, and life sciences.

This issue's photo gallery vividly captures the spirit of the event, which was graced by distinguished chief guests, Dr. J. P. Singh, Plant Protection Adviser, Government of India, Dr. C. A. Viraktamath, Emeritus Professor, University of Agricultural Sciences, Bengaluru, Mr. H. Manjunath, Deputy Inspector General (DIG), CISF, KIA, Bengaluru.

A total of 43 awardees were recognized for their excellence and impact. They represented diverse regions of the country, including Chhattisgarh, Tamil Nadu, Gujarat, Andhra Pradesh, Telangana, Maharashtra, Punjab, Karnataka, and West Bengal. Their achievements and citations, as recorded by the eminent jury, are truly worth emulating, and randomly selected few have been featured in this issue.

We are proud to share that Rashvee International Phytosanitary Research and Services, a startup supported by *Insect Environment*, received two prestigious national honors:

- Best Women-Led Innovation by the Confederation of Indian Industry (CII)
- Appreciation Certificate by Federation of Indian Chambers of Commerce & Industry (FICCI) under the Best Biologicals category

These accolades are dedicated to our readers, farmer-consumers, and fresh agri-exporters our true pillars of progress.

Thanks to IQAir, Switzerland, we now monitor pollution levels through the Air Quality Index (AQI). Urban centers across Asia and India continue to face high AQI levels, commonly referred to as smog. Emerging research suggests that pollutants from exhaust, fumes, and smoke may impair insect olfaction, mating, and survival, potentially disrupting food webs. This ecological concern deserves deeper scientific attention.

This issue features a compelling agro-clinic article by Dr. T. Manjunath, a leading expert in biological control. One referee aptly noted: "A thought-provoking article that addresses a critical gap in modern agriculture and horticulture. The concept of independent plant health clinics and plant doctors is presented with clarity and vision, drawing a compelling analogy to medical and veterinary practice. The idea of multispecialty plant hospitals and consultants as 'family doctors for farmers' is innovative and timely."

Globally, our weekly blogs continue to receive appreciation for their topical relevance and alert-value. We are grateful to our network of stringers who enrich our platform with timely insect news, making *Insect Environment* the only dedicated timely insect news source with a vibrant in-house reading community of 'insecters'.

As we close this quarter, we extend heartfelt thanks to all our authors for their exciting contributions including those whose submissions we could not publish due to editorial constraints. We especially thank scientists from ICAR, Zoological Survey of India, several universities for their scholarly support as authors and behind -the scene- reviewers to Insect Environment. Your feedback keeps us evolving: The encouraging notes on our blogs and articles continue to inspire our team.

On behalf of our editorial team Dr. M. A. Rashmi, Dr. S. Deepak, Ms. Prathika, Ms. Salome, and our entire web and production crew I wish all our readers and contributors a joyful, successful, and inspiring 2026.

Abraham Verghese
Editor-In-Chief
Insect Environment

Focus article

DOI: 10.55278/MLIN9630

Independent Plant Health Clinics and Plant Doctors: Potential Entrepreneurial Opportunities for Agri-Horticultural Professionals

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Abstract

Modern agriculture and horticulture face increasing challenges from climate variability, resource depletion, emerging pests and diseases, and rapidly advancing technologies. These complexities demand precise, timely, and accessible expert guidance at the farm level. This creates a growing entrepreneurial opportunity for trained agricultural and horticultural professionals to establish independent plant health clinics and practice as plant doctors, analogous to medical, dental, and veterinary practitioners. This article examines the rising need for specialized advisory services, outlines the scope for private consultancy, identifies essential qualifications and competencies, and introduces the concept of multispecialty plant hospitals. Establishing an independent consultancy requires a shift in mindset and offers significant self-employment potential for scientists. It benefits farmers and contributes to sustainable plant protection and production. An agricultural or horticultural consultant functions much like a family doctor for farmers, providing proactive, tailored, and comprehensive guidance for crop management. Unlike human patients who visit doctors, plant patients are immobile, so plant doctors must visit the fields.

Keywords: Plant health clinics; plant doctors; independent consultancy; multispecialty plant hospitals; advisory services; sustainable agri-horticulture; entrepreneurship.

Introduction

Agriculture in the 21st century is shaped by rapid technological advances, resource depletion, climate variability, emerging pests and diseases, and other complex challenges. Farmers now require precise, timely, and easily accessible expert guidance. While public extension systems play a vital role, there is considerable scope for private practitioners to supplement those services and address the diversity and scale of problems faced by farmers (ICAR, 2020; World Bank, 2020). In this context, agricultural and horticultural graduates have promising entrepreneurial opportunities to establish independent plant health clinics and practice as plant doctors. If medical, dental, and veterinary professionals can successfully run private clinics, agri-horticultural graduates with recognised bachelor's, master's, or doctoral degrees can do the same. A change in mindset is essential. This article outlines the need for specialised advisory services, highlights expanding opportunities for private consultancy, identifies essential competencies, and introduces the concept of multispecialty plant health hospitals. Independent consultancy offers substantial self-employment potential and can contribute to sustainable plant protection and production. An agricultural or horticultural consultant functions much like a family doctor, providing proactive, tailored, and comprehensive guidance for crop management. Unlike human patients who visit clinics, plant patients are immobile, so plant doctors must visit the fields.

Need for Consultancies and the Role of Consultants

- **Need for consultancies:**

Farmers face a wide range of challenges, including:

- **Environmental issues:** pests, diseases, weeds; climate change and unpredictable weather; water scarcity; soil degradation.
- **Economic issues:** post-harvest losses; high input costs; price volatility; low income.
- **Social and technological challenges:** labour shortages; limited awareness and adoption of modern technologies.

These challenges demand timely, scientific, and practical advice. Agricultural and horticultural consultants work closely with farmers to address these needs.

- **Role of consultants – they are like family doctors:**

Agricultural or horticultural consultants function much like family doctors by providing continuous, personalised, and proactive care for the farm's long-term health and productivity.

- **Personalised care and farm history:** Consultants understand the farm's unique history, soil types, challenges, and the farmer's goals. This enables tailored, context-specific advice, much like a doctor relying on a patient's medical history.
- **Trusted, long-term relationship:** Continuous engagement builds trust, making the consultant a dependable adviser for any farm-related concern.
- **Connecting with specialists:** When issues require deeper expertise, consultants serve as referral points, linking farmers to a wider expert network.
- **Technological integration:** With precision farming, data analytics, and biotechnology advancing rapidly, consultants help farmers adopt and use new tools effectively.
- **Sustainability and environmental compliance:** With increasing emphasis on eco-friendly agriculture - biopesticides, biofertilizers, reduced chemical inputs, organic practices, and conservation of soil

and water - consultants provide essential guidance for implementing such practices.

Consultants thus act as the primary point of contact, offering holistic and location-specific solutions. While government agencies provide broad support, many issues require expert, personalised attention (Boone & Pierre, 2019; Danielsen & Matsiko, 2016; Prasad & Madhavi, 2017). Independent plant doctors can fill these critical gaps and build long-term professional relationships with farmers.

Essential Qualifications and Professional Competencies

A recognised degree in agriculture, horticulture, or allied sciences forms the foundation for independent consultancy. Higher degrees (M.Sc., Ph.D.) strengthen diagnostic and analytical skills and enhance credibility. Key competencies include:

- Strong theoretical and practical understanding of crop sciences
- Accurate diagnosis of field problems
- Ability to communicate scientific concepts in simple terms
- Integrity, professionalism, and transparency
- Entrepreneurial skills
- Regular engagement with farmers and field realities

Exposure to diverse field situations enhances expertise. A reasonable fee structure and good rapport with farmers help build long-term relationships.

Scope for Multispecialty Plant Hospitals – A New Concept

Agri-horticultural problems are often multidimensional (CABI, 2020). Similar to multispecialty hospitals in human healthcare, there is an entrepreneurial opportunity to establish Multispecialty Plant Hospitals, where experts from entomology, pathology, soil science, agronomy, plant physiology, breeding, biotechnology, water management, agri-business, and other fields collaborate to provide comprehensive advisory services.

Advantages:

- ✓ Holistic diagnosis through interdisciplinary expertise
- ✓ Shared infrastructure: soil testing labs, molecular diagnostics, nutrient analysers, remote sensing tools
- ✓ Farm case histories: long-term soil health and crop performance records for precise advisories
- ✓ Tele-agriculture: remote diagnostics via digital platforms, sensors, and drones
- ✓ Sustainability focus: integrated, eco-friendly, climate-resilient, and resource-efficient strategies

These hospitals should remain farmer-friendly, modest, and affordable. The model can transform agricultural advisory services with collaboration, innovation, and scientific precision.

Farmers' Response to Consultancies: Personal Reflections

I was involved in establishing the Bio-Control Research Laboratories (BCRL) of Pest Control India Ltd., Bengaluru, in 1981. It was India's first commercial insectary dedicated to mass production and supply of biological control agents and pheromones for integrated pest management (IPM) (Manjunath, 1984). My experience with farmers during the 1980s provided valuable insights into their needs. Farmers readily purchased these products - even though new to them - indicating their openness to new technologies, a trend that continues today.

During that period (1980s & 1990s), I frequently travelled across several states and visited farms growing sugarcane, cotton, coconut, grapevine, guava, vegetables, and other crops to explain the use of biocontrol agents, pheromones, and IPM. Farmers were highly receptive. In our interactions, they also discussed issues related to diseases, soil fertility, irrigation, crop varieties, and post-harvest concerns. I addressed some myself and referred others to experts in universities or state departments. This clearly showed their need for scientific guidance.

Their trust grew, and many began visiting BCRL for the purchase of biocontrol agents and pheromones. They were excited to see these being mass-produced. Some brought plant and soil samples for advice. Over time, such visits increased significantly, and many began contacting by phone. These advisory services were provided free as goodwill. Thus, what began as product support gradually evolved - almost unconsciously - into an informal consultancy, effectively making BCRL a Plant Health Clinic. This reaffirmed that farmers value dependable, science-based services.

Even in the 1980s, I observed active consultancy networks in grape-growing regions of Andhra Pradesh, where consultants managed multiple farms, obtained expert inputs when required, and enjoyed both financial success and farmers' appreciation. I came in contact with them when they approached me for management of grapevine mealybugs. I am sure such consultancy is continuing even now.

I am aware that more recently, several reputed plant scientists - including Dr. G. S. Prakash, Dr. Vasanth Kumar Thimakapura, and Dr. Abraham Verghese - have taken up independent consultancy after official retirement. They enjoy impressive clientele and strong farmer trust. Many others are also engaged in such work.

These experiences highlight a key insight: India is ready for independent, professional Plant Health Clinics and Plant Doctors. What is needed now is to formalise, expand, and professionalise this ecosystem, creating meaningful opportunities for both experienced (including retired) and young professionals.

Huge Area and Diverse Crops – Golden Opportunities Await

India's gross cropped area was about 219 million hectares in 2021–22, encompassing diverse agricultural, horticultural, and other crops. This includes areas under multiple cropping within the same year. The following data illustrate the extent of acreage and diversity of crops grown in India (DA&FW, 2024):

- Agricultural (Food Grain) Area – 127.6 million ha:
  - ✓ Cereals: rice, wheat, maize, sorghum (jowar), bajra, ragi (finger millet)
  - ✓ Pulses: chickpea (gram), pigeon pea (tur/arhar), black gram (urad), green gram (moong), lentil (masoor)
  - ✓ Oilseeds: groundnut, soybean, rapeseed, mustard, sunflower, castor
- Horticultural Area – 28.0 million ha:
  - ✓ Vegetables: potato, onion, tomato, cauliflower, cabbage, okra
  - ✓ Fruits: mango, banana, citrus, guava, papaya
- Other crops:
  - ✓ Commercial crops: sugarcane, cotton, jute
  - ✓ Plantation crops: tea, coffee, rubber, coconut, arecanut
  - ✓ Spices: chilli, cumin, coriander, turmeric, ginger

About 55% of India's workforce is engaged in cultivation and related activities. This vast landscape clearly indicates the enormous demand and opportunity for thousands of consultants and plant health clinics across the country. This golden opportunity awaits Plant Doctors.

Conclusion

India is predominantly an agricultural country with a huge area of over 219 million hectares under cultivation, encompassing a wide variety of agricultural, horticultural, and other crops. About 55% of India's workforce is engaged in cultivation and related activities. These clearly reflect the enormous demand and opportunity for thousands of consultants and plant health clinics across the country.

Independent plant health clinics and plant doctors represent a significant yet under-utilised opportunity for agri-horticultural graduates. The model also enables retired scientists to continue contributing their expertise. As agriculture becomes increasingly knowledge-intensive, the need for expert advisory services is set to grow further (ICAR, 2020; MANAGE, 2019, 2022).

For committed professionals, independent consultancy offers a fulfilling career pathway and a meaningful opportunity to contribute to sustainable agriculture. The time is opportune for trained professionals to redefine agricultural advisory services in India.

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Research articles

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The Population Status and Female Genitalia of *Melanitis zitenius* (Herbst, 1796), (Lepidoptera: Nymphalidae: Satyrinae) in Arunachal Pradesh, India

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Abstract

The female genitalia of the rare butterfly *Melanitis zitenius* (Herbst, 1796) was examined for the first time from Namdapha National Park, Arunachal Pradesh, India. This study provides an updated morphological description of the species, with emphasis on diagnostic features distinguishing it from other congeners. Field surveys conducted between 2019 and 2022 confirmed the extreme rarity of *M. zitenius* in Arunachal Pradesh, with only a single specimen recorded. The findings contribute new taxonomic information and highlight the species' restricted occurrence, underscoring the need for continued monitoring of its population status in accordance with conservation priorities under the Wildlife (Protection) Act, 1972 (amended up to 2022).

Keywords: Lepidoptera, Nymphalidae, Satyrinae, Melanitis, Namdapha National Prak, India.

Introduction

The Eastern Himalayan region of India encompasses Arunachal Pradesh, a major biodiversity hotspot dominated by subtropical wet forests. It is the largest state in the north-eastern region, sharing borders with China, Tibet, Bhutan, and Myanmar, and lies between latitudes 26°28′–29°30′ N and longitudes 91°30′–97°30′ E. Forests cover nearly 82% of its 83,743 km² area, underscoring its ecological richness.

The butterfly subfamily Satyrinae includes moderately sized, dull brown or blackish species with short, broad wings marked by eye-like spots (ocelli). Many genera exhibit distinct seasonal forms: wet-season forms with fully developed ocelli, and dry-season forms with angular wings, cryptic patterns, and reduced ocelli. Genera such as *Mycalesis*, *Ypthima*, and *Melanitis* show conspicuous seasonal variation, making species-level identification difficult without examination of genitalia.

The genus *Melanitis Fabricius*, commonly called "Evening Browns," comprises crepuscular, leaf-mimicking butterflies. Globally, eleven species are recognized, of which *M. leda*, *M. phedima*, and

M. zitenius occur in India (Lepidoptera, 2025; Funet website). During the present study, the external female genitalia of the rare *M. zitenius* from Namdapha National Park, Arunachal Pradesh, was examined for the first time.

These butterflies typically conceal themselves among leaf litter, bushes, or tree roots during the day. Weak fliers, they seldom leave forest interiors, and when disturbed are flushed from hiding. Their closed wings, angled to one side, provide effective camouflage against dry leaves.

Material and Methods

Study Area

Namdapha National Park and Tiger Reserve is located in the Changlang district of Arunachal Pradesh, near the international border with Myanmar (27°23′30″–27°39′40″ N; 96°15′2″–96°58′33″ E; 200–4571 m asl). Covering 1,985 km², it comprises a 177 km² buffer zone and a 1,808 km² core area. Established as a wildlife sanctuary in 1972, it was upgraded to a national park and tiger reserve in 1983 under Project Tiger. The name "Namdapha" derives from the Singpho words *nam* (water) and *dapha* (origin).

The park's diverse habitats support exceptional biodiversity. According to De & Maheswaran (2019), Namdapha harbors 597 invertebrate species (including insects, mollusks, arachnids, and ticks) and 507 vertebrate species (mammals, birds, amphibians, reptiles, and fishes). Remarkably, all four big cats *Panthera tigris*, *P. pardus*, *P. uncia*, and *Neofelis nebulosa* occur here, along with several smaller felids. The park also sustains rich primate diversity, including *Macaca assamensis*, *M. leonina*, *M. arctoides*, and *Hoolock hoolock*.

Methodology

In the forenoon of March 4, 2022, the author conducted a survey of the forest area of Haldibari, Namdapha National Park, Arunachal Pradesh, in accordance with the directives of the Zoological Survey of India. From the scrubby habitat, the author collected one female specimen of *Melanitis zitenius* (Herbst). Butterfly net was used to collect the specimen, and the thorax was gently pressed to kill the specimen. The adult specimens were stored in an insect folder with the following information: date, locality name, latitude, longitude, and altitude. After that, the specimen was stretched, relaxed, and pinned in the Entomology laboratory Zoological Survey of India's Dehradun. It was then allowed to dry for two or three days in the drying chamber. A digital camera (Nikon DX-80 model) was used to take dorsal and ventral images of the adult. The identification of the species was confirmed from Evans (1932), Wynter-Blyth (1957), and D'Abrera (1985).

MATERIAL: Arunachal Pradesh, district Changlang, Namdapha National Park, Haldibari, 27.524° N, 96.397° E, 4.iii.2022, 1 ♀, Narender Sharma.

SYSTEMATIC POSITION

Class Insecta Linnaeus, 1758

Order Lepidoptera Linnaeus, 1758

Family Nymphalidae Rafinesque, 1815

Subfamily Satyrinae Boisduval, 1833

***Melanitis zitenius* (Herbst, 1796)**

Papilio zitenius Herbst, 1796; in Jablonsky, *Naturs. Schmett*. 8: 5.

Description (**Fig. 1 & 2**): Dry-season form: Forewing with costal margin more rounded, outer margin more falcate at vein M_2, then inwardly curved, subapical orange patch more prominent, subapical white and black spots prominent, underside ground colour variable i.e., fulvous, ferruginous, pale, very minute white subapical dots, one black spot near the middlie of discal cell, post-discal black band not reaching tornus; hindwing outer margin produced outwardly from vein M_3 to vein 1A+2A, minute white dots present in Cula and Cu1b, underside with post-discal dark band continued to forewing underside, black spot in the middle of the discal cell, underside with curved, post-discal series of six white dots, submarginal dark area.

Female genitalia (Fig. 3): Corpus bursae membranous, more or less oval in shape; signa elongated, paired, each with scobinate patches; corpus bursae opens into ductus bursae, the latter longer, membranous, tubular, 1/3rd broader posteriorly, opens into ostium bursae; genital plate more or less globular with two lateral thin processes, one on each side; ostium bursae present in the genital plate; apophysis anterioris missing, apophysis posterioris moderately longer, pointed, membranous, papilla analis normal, pilose.

Results & Discussion

Intensive surveys were undertaken in Arunachal Pradesh between April 2019 and March 2022 under the mandate of the Zoological Survey of India. During this period, only a single female specimen of the dry-season form of *Melanitis zitenius* (Herbst) was collected from Haldibari, Namdapha National Park. This species is considered very rare in Arunachal Pradesh as well as in India, as confirmed by recent surveys. Rose & Sharma (1998), while working under two ICAR projects (1991–1994; 1995–1998), surveyed several localities in north-western India but did not record the species. Similarly, despite extensive surveys in north-western India since 2004, the author also failed to encounter this butterfly in any locality.

Figure 1. *Melanitis zitenius* (Herbst), Dorsal Side

Figure 2. *Melanitis zitenius* (Herbst), Ventral Side

Globally, *M. zitenius* is represented by thirteen subspecies: *M. z. andamanica* Evans (Andaman Islands), *M. z. gokala* Moore (Maharashtra to Kerala), *M. z. kalinga* Moore (Andhra Pradesh, Chhattisgarh), *M. z. zitenius* (Herbst) (Himachal Pradesh to north-east India), *M. z. ambasara* Moore (Java), *M. z. gnophodes* Butler (Java, Bali, Lombok), *M. z. xantophthalmus* Staudinger (Sumba), *M. z. auletes* Fruhstorfer (southern Burma, Peninsular Malaya, Thailand–Indochina, southern Yunnan), *M. z. sumatranus* Fruhstorfer (Sumatra), *M. z. rufinus* Fruhstorfer (Borneo), *M. z. niasicus* Fruhstorfer (Nias), *M. z. zenon* Fruhstorfer (Sumbawa), and *M. z. hainanensis* Gu (Hainan). Of these, four subspecies occur in India (*M. z. andamanica*, *M. z. gokala*, *M. z. kalinga*, and *M. z. zitenius*) (Varshney & Smetacek, 2015). Based on zoogeographical distribution, Arunachal Pradesh is represented by *M. z. zitenius* (Herbst).

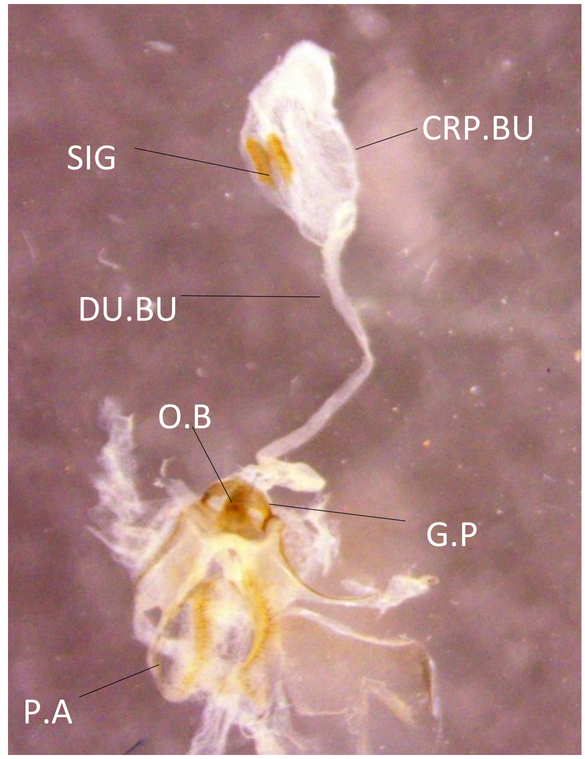

Figure 3. Female genitalia of *Melanitis zitenius* (Herbst)

Abbreviations used in photos are: CRP. BU: Corpus bursae; DU. BU: Ductus bursae; G.P: Genital plate; O.B: Ostium bursae; P.A: Papilla analis; SIG: Signum

Within India, three species of *Melanitis* are known: *M. leda* (Stoll), *M. phedima* (Stoll), and *M. zitenius* (Herbst). Rose & Sharma (1998) studied the female genitalia of *M. leda* and *M. phedima*. Comparative examination shows that in *M. zitenius*, the signa are longer and narrower, the lateral thin processes of the genital plate are more elongated, and the apophysis posterioris is moderately longer than in the other two species.

Previous reports of *M. zitenius* from Arunachal Pradesh are scarce. Mazumder et al.

(2019) documented a single specimen from Namdapha National Park, while Sharma & Goswami (2021) recorded one specimen from Ganga Lake, Itanagar Wildlife Sanctuary. Other surveys (Borang *et al.*, 2008; Gogoi, 2012; Sondhi & Kunte, 2014, 2016; Singh, 2017) did not record the species from the state. The present study, which yielded only one female specimen, reinforces the rarity of *M. zitenius* in Arunachal Pradesh.

Importantly, this species is listed under the Wildlife (Protection) Act, 1972 (as amended up to 2022), and the present findings are consistent with conservation priorities outlined in the Act.

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First Record of Coffee Locust, *Aularches miliaris miliaris* (Linnaeus 1758) (Orthoptera: Pyrgomorphidae) from Bihar

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Abstract

The Coffee Locust, *Aularches miliaris miliaris* (Linnaeus, 1758), is reported for the first time from Bihar, extending its known distribution to the eastern part of India. One specimen was collected from Valmiki Tiger Reserve, West Champaran (Harnatad Forest Range), and another from the Sabalpur area of Gautam Buddha Wildlife Sanctuary, Gaya District. Diagnostic characteristics, morphometric measurements of key body parts, and notes on its distribution within India are provided to support identification and documentation of this new regional record.

Introduction

Caelifera, commonly known as short-horned grasshoppers, include grasshoppers and locusts. Globally, the order Orthoptera is represented by 30,539 species in 5.408 genera across 85 families (Cigilano *et al.,* 2025). In India, approximately 1,295 species under 459 genera belonging to 24 families have been recorded, including 52 species from the family Pyrgomorphidae (Chand *et al.*, 2025).

The genus *Aularches* belongs to Pyrgomorphidae and is monotypic, containing only one species with two subspecies: *Aularches miliaris pseudopunctatus* Kevan, 1974 and *Aularches miliaris miliaris* (Linnaeus, 1758) (Cigliano *et al.,* 2025). *Aularches miliaris*, commonly known as the Coffee Locust or Spotted Grasshopper, is native to South and Southeast Asia. Adults produce a distinctive squeaking sound, often associated with mating behavior (Vander Laan, 1981) and can discharge up to a teaspoon of slimy, bitter-tasting white froth from thoracic openings (Hingston, 1927; Carpenter, 1938; McCann, 1953; Whitman, 1990). This defensive secretion deters most vertebrate predators (Katiyar, 1955; Roffey, 1979; Whitman, 1990).

In India, *A. miliaris miliaris* has been widely reported from several states including Andhra Pradesh, Himachal Pradesh, Jammu & Kashmir, Jharkhand, Manipur, Maharashtra, Meghalaya, Odisha, Sikkim, Tamil Nadu, Uttarakhand, Uttar Pradesh, and West Bengal (Gaikwad *et al.,* 2018). The species is easily recognized by its bright aposematic coloration: a black head and pronotum with two prominent humps, a tuberculate metazona with uneven surface, and yellow lateral margins on the head and pronotum. The tegmina are brownish or greenish with conspicuous yellow spots, while the abdomen is vividly striped with alternating red and black bands.

The present study is based on specimens collected from the Harnatad Forest Range, Valmiki Tiger Reserve, and the Sabalpur area of Gautam Buddha Wildlife Sanctuary, Gaya District, Bihar.

Materials and Methods

During faunistic surveys conducted in the Valmiki Tiger Reserve (West Champaran District) and the Gautam Buddha Wildlife Sanctuary (Gaya District), Bihar, specimens were collected using an entomological net from shrubs and bushes. The collected specimens were euthanized with ethyl acetate and subsequently preserved in 70% ethanol.

Detailed examination was carried out under a stereo zoom microscope (Leica EZ4 E). Identification was performed using standard taxonomic literature, including Kirby (1914) and State Fauna Series 3: Fauna of West Bengal (Prabakar *et al*., 2005).

The specimens were registered and deposited in the National Zoological Collection, Gangetic Plains Regional Centre, Zoological Survey of India, Patna, ensuring proper documentation and long-term preservation.

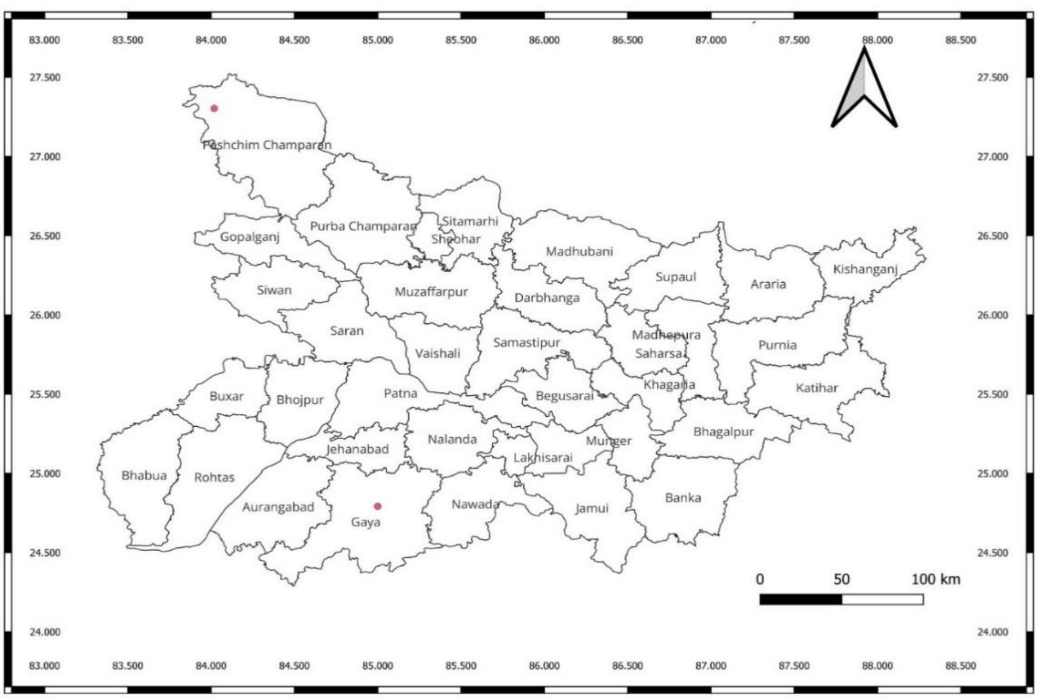

Fig. 1: A map of Bihar showing the collection site (in red dot) of *Aularches miliaris miliaris* (Linnaeus 1758).

Result:

Material examined: 1 ♀., Barba Kalan, Harnatad, West Champaran, Bihar, (Lat. 27.3030° N, Long. 84.0181° E), 06.xi.2023, Coll. M. E. Hassan & Party. 1 ♀., Sabalpur, Gautam Buddha Wildlife Sanctuary Gayaji, Bihar (Lat. 24.7914° N, Long. 85.0002° E), 25.viii.2017, Coll. N. Singh & Party.

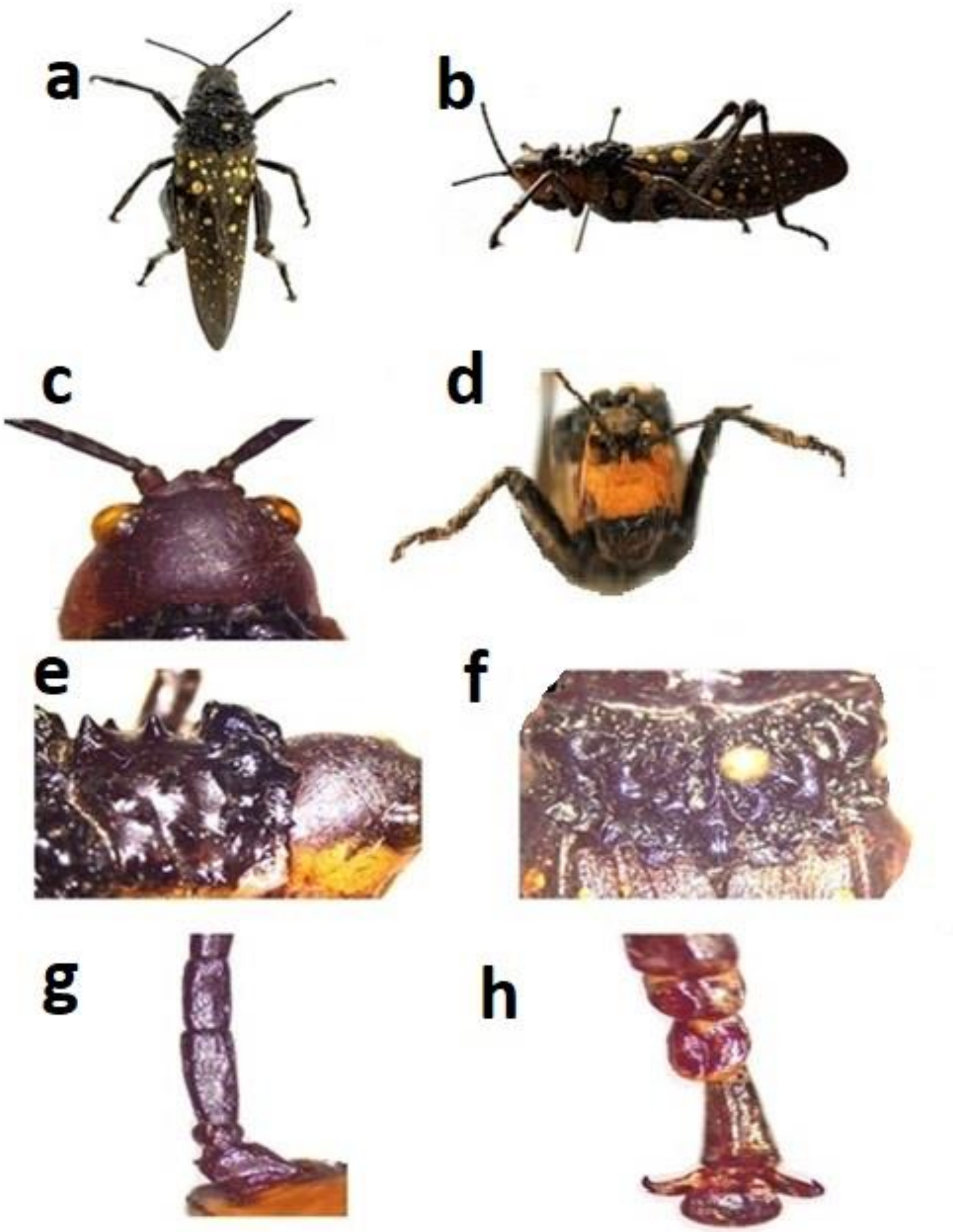

Fig.2 (a-f). *Aularches miliaris miliaris*, a. Dorsal view, b. Lateral view, c. Dorsal view of head, d. Frons view, e. Prothorax and Mesothorax region showing humps and spines, f. Metathorax region showing rugose area, g. Antenna (1-3 segments), h. Hindi tarsus showing claws and arolium.

Diagnosis

Body dark brown (except lateral side of head and pronotum) to black, tegmina fully developed with numerous round and oval yellow spots (relatively larger at base and smaller apically). Antennae filiform, 1st segment longest, about two times as long as wide. Eyes oval, slightly longer than wide. Pronotum with two large humps towards the anterior margin, about 10 conical tubercles in the middle of the pronotum and the posterior part very rugosely and coarsely punctate. Abdomen black with reddish intersegmental membrane.

Measurements

Body elongated, about 4x to the body width (body length 54.20 mm, body width 13.40 mm), head wider than long (length 5.42 mm, head width 6.10 mm), pronotum length 15.64 mm, hind femur slightly longer than tibia (femur length 23.41 mm and hind tibia length 21.67 mm).

Discussion

Aularches miliaris is recognized as a major economic pest of coffee, hence commonly referred to as the "Coffee Locust", due to its destructive impact on coffee plantations. Green (1906) and Hutson (1926) reported that the nymphs are highly polyphagous, feeding on a wide range of wild and cultivated plants. In addition to coffee, *A. miliaris* has been documented as a minor pest of several crops including banana, arecanut, coconut, teak, mango, cardamom, cassava, castor, durian, guava, maize, mulberry, oil palm, rice, sugarcane, chili, cocoa, cotton, custard apple, jute, pigeon pea, rubber, sesame, sorghum, and pine, occasionally causing significant economic damage (Jones, 1940; Roffey, 1979; Nair, 1990; Josephrajkumar, 2007).

Orthopteran diversity in Bihar has been studied by several workers. Bhowmick (1992) reported 62 species, while Usmani and Nayeem (2012) documented 37 species representing 29 genera. More recently, Tabrez and Nayeem (2024) recorded 14 species from Patna District, and Saurav and Singh (2017) reported 8 species from western Patna. Raj et al. (2025) documented 11 species from Bhimbandh Wildlife Sanctuary, Munger.

Aularches miliaris is a widely distributed species under the family Pyrgomorphidae in India, occurring across diverse habitats except in arid regions. The present study constitutes the first record of *A. miliaris miliaris* from Bihar, thereby extending its known distribution to the eastern part of India.

Further investigations are warranted to assess the pest status of this species in northern and northeastern India, particularly in relation to its potential impact on economically important crops.

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First Documentation of *Sycanus collaris* Predation on the Tea Twig Caterpillar (*Ectropis bhurmitra*) in India

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Assassin bugs (Hemiptera: Heteroptera: Reduviidae) are venomous predatory insects, the majority of which prey on invertebrates. It is a large and diverse group of insects comprising approximately 6,800 species in 25 subfamilies, distributed across all continents except Antarctica (Hwang & Weirauch, 2012). Their predatory success is largely attributed to a highly specialised venom delivery system associated with piercing–sucking mouthparts modified into a proboscis (Walker *et al*., 2017). Unlike phytophagous hemipterans, reduviids use this proboscis to inject venom into prey, resulting in rapid paralysis, tissue liquefaction and death (Walker *et al*., 2017). Assassin bug venom exhibits paralytic and lethal effects on invertebrates and possesses strong cytolytic and proteolytic properties. This liquefying action is regarded as a form of extra-oral digestion, facilitating ingestion of prey tissues through the narrow food canal of the proboscis (Walker *et al*., 2017). Once the internal tissues are liquefied, the predator feeds by sucking the fluid contents of the prey.

During a field survey conducted in 2023, a light trap was installed near the Eco-tourism Cottages at Bondla, North Goa, Goa to document nocturnal insect fauna. At around midnight, an adult assassin bug, identified as *Sycanus collaris* (Fabricius, 1781) (Hemiptera: Reduviidae), was observed approaching a geometrid moth attracted to the illuminated sheet (Fig. 1A). The predator exhibited characteristic reduviid stalking behaviour, moving slowly and pausing intermittently before making a swift attack. Upon contact, the bug inserted its rostrum into the thoracic region of the moth, injecting salivary secretions that rapidly immobilised the prey (Fig. 1B-E & F). The assassin bug remained attached and fed on the liquefied body contents of the moth for several hours (Fig. 2). The prey exhibited a markedly shrunken abdomen following fluid extraction (Fig. 1G & Fig. 2). The prey specimen was subsequently examined and identified morphologically in the field as *Ectropis* cf. *bhurmitra* (Walker, 1860).

Based on a review of the available literature, predation by *S. collaris* on the tea twig caterpillar has not been previously recorded. Hence, the present observation constitutes the first field record of *S. collaris* preying on *E. bhurmitra*. The observed behaviour provides direct evidence of predator–prey interaction under natural conditions.

S. collaris is a well-known predatory assassin bug widely distributed across Asia and parts of Africa. It is a voracious and polyphagous predator within Reduviidae (Padamshali *et al*., 2019), and its potential as a biological control agent has been noted owing to its ability to subdue a wide range of agricultural and forest pests. The geometrid moth *E. bhurmitra* is a widespread pest in the Asia–Pacific region, responsible for significant defoliation in tea (*Camellia sinensis*) and teak (*Tectona grandis*) plantations. Heavy infestations may lead to complete foliage loss, retarded growth, and, in severe cases, plant mortality (Prasad & Mukhopadhyay, 2013).

Previous studies have reported *S. collaris* feeding on several economically important pests, including *Corcyra cephalonica*, *Spodoptera litura* (Rajan *et al*., 2017), and *Hyposidra talaca*, a major pest of tea (Sarkar *et al*., 2019). The species is also known to prey upon *Helopeltis theivora*, *Clostera* spp., *Eutectona machaeralis*, *Helopeltis antonii*, *H. bradyi*, *H. cinchonae*, *Hyblaea puera*, *Pyrausta machaeralis*, *Riptortus clavatus*, *Antheraea mylitta*, and *Sinohala helleri* (George *et al*., 1998; Venkatesan *et al*., 1999; Bhat *et al*., 2013; Srikumar *et al*., 2017; Kammatterikunnu & Thattanteparambil, 2025).

Padamshali *et al*. (2019) reported that the feeding efficiency of *S. collaris* varies depending on prey type and nutritional quality. Studies on other reduviids, such as *Sycanus indagator*, have demonstrated prey preferences, with a tendency to select nutritionally favourable hosts when given a choice (Bass & Shepard, 1974). Feeding behaviour in *Sycanus* species has also been reported to be sporadic rather than continuous (Bass & Shepard, 1974; Ahmad & Kamarudin, 2016). Understanding prey preference and feeding ecology is therefore essential for evaluating the effectiveness of *S. collaris* as a biological control agent against *E.* cf. *bhurmitra*.

The present record highlights the ecological role of assassin bugs in regulating populations of economically important lepidopteran pests. Although based on a single observation, this first field report contributes valuable information to the natural history of *S. collaris* and supports its potential relevance in integrated pest management programmes. Further studies on prey preference, feeding efficiency, and field-level impact are necessary to assess its effectiveness as a biological control agent in tea and forest ecosystems.

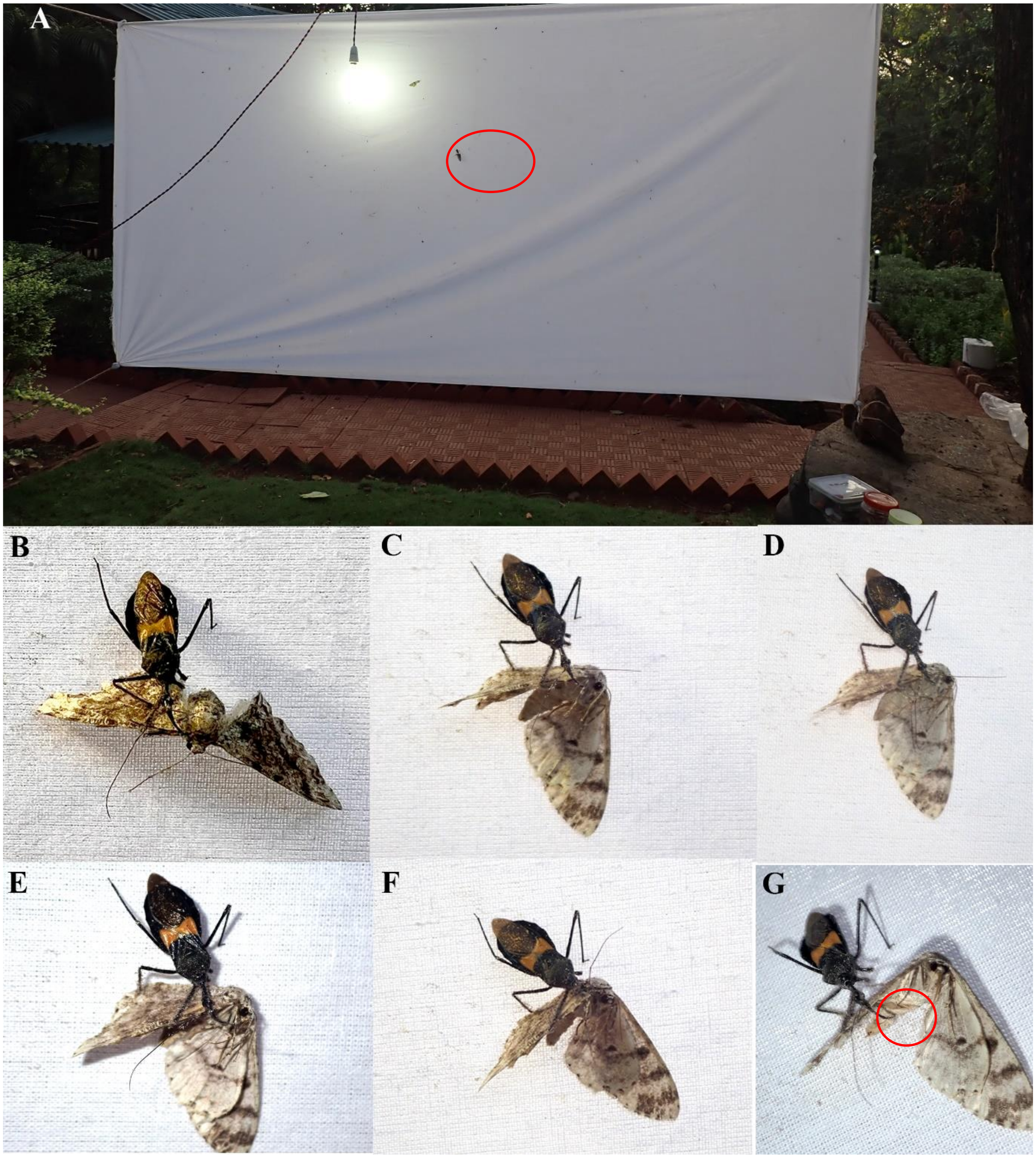

Fig. 1. A. Assassin bug with the prey on light trap, B-E. rostrum in the thorax of the prey image taken in different angles, F. changes in rostrum position, G. shrunken abdomen following fluid extraction.

Fig. 2. The prey exhibited a markedly shrunken abdomen following fluid extraction.

Conclusion

The present observation provides the **first field record of** *Sycanus collaris* **preying on the tea twig caterpillar** *Ectropis cf. bhurmitra* under natural conditions. This predator–prey interaction highlights the ecological importance of assassin bugs in suppressing populations of economically significant lepidopteran pests. Although based on a single documented event, the finding adds valuable information to the natural history of *S. collaris* and supports its potential role in integrated pest management strategies for tea and forest ecosystems. Future studies focusing on prey preference, feeding efficiency, and population-level impacts will be essential to evaluate its effectiveness as a biological control agent.

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Occurrence of Diapriidae (Hymenoptera) in Leaf Galls of Sea Urchin: A First Report

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Abstract

Sea urchin leaf galls on *Senegalia caesia* (L.) Maslin, Seigler & Ebinger are distinctive echinate structures induced by a cecidomyiid fly in the Southern Western Ghats. Galls collected from Janakikkad, Kerala, were reared to identify the gall inducer and to document associated parasitic hymenopterans. The gall inducer was identified as a cecidomyiid fly belonging to the tribe Lasiopterini. Parasitoids emerging from the galls represented seven hymenopteran families. Notably, this study provides the first global record of the family Diapriidae emerging from a plant gall, represented by *Basalys nilgiriensis* (Sharma). These findings underscore the need for further research on the biology of this diapriid species and its ecological role within gall-associated insect communities.

Keywords: Leaf gall, *Basalys nilgiriensis*, Cecidomyiidae, parasitic Hymenoptera

Introduction

Plant galls represent unique microhabitats formed through complex interactions between host plants and gall-inducing organisms (Raman, 2007). Among these, the sea urchin gall is particularly notable for its hypophyllous, globose structure densely covered with bristle-like projections, imparting a characteristic echinate appearance (Krishnan *et al*., 2011). Gall-inducing insects typically exhibit strong host specificity (Raman, 2007).

From the Southern Western Ghats, India, four echinate galls have been documented to date on the following host plants: *Aporosa cardiosperma* (Gaertn.) Merr. (Phyllanthaceae), *Senegalia caesia* (L.) Maslin, Seigler & Ebinger (Fabaceae), *Hopea ponga* (Dennst.) Mabb. (Dipterocarpaceae), and *Ficus benghalensis* L. (Moraceae). Among these, galls on both *A. cardiosperma* and *S. caesia* are induced by Cecidomyiidae (Diptera) (Saleem and Nasser, 2015). Notably, only the leaf galls on *S. caesia*—commonly known as soap bark—exhibit the distinctive hairy, echinate morphology (Krishnan *et al*., 2011).

Distinguishing gall inducers from inquilines and parasitoids is often challenging, requiring verification of the nutritional mode of gall inhabitants (Narendran *et al*., 2007). Parasitoid associations with sea urchin galls remain poorly documented, and to date, no parasitoids have been recorded from the hairy leaf sea urchin gall on *S. caesia*. Typically, hymenopteran parasitoid families such as Eulophidae, Eurytomidae, Pteromalidae, Tanaostigmatidae, Torymidae, Ormyridae, Aphelinidae, Encyrtidae, Eupelmidae, Trichogrammatidae, Mymaridae, Chalcididae, Platygastridae, Braconidae, and Ichneumonidae are associated with plant galls (Narendran et al., 2007; Saleem and Nasser, 2015).

The present study investigates the taxonomic identity of a diapriid species (Hymenoptera: Diapriidae) associated with sea urchin leaf galls on *S. caesia*, representing the first such record globally

Material and Methods

Galls induced by a cecidomyiid fly (Diptera: Cecidomyiidae) on Senegalia caesia at different developmental stages were collected from Janakikkad (11.64° N, 75.78° E), Calicut, Kerala, during the post-monsoon seasons between 2020 and 2024. The galls were maintained in 1000 ml glass jars, covered with muslin cloth, and properly labelled.

Daily inspections were carried out to monitor the emergence of gall-inducing insects and associated arthropods. Emerged insects were aspirated and preserved in 70% ethanol, and the numbers of gall inducers and parasitoids were recorded. Galls were dissected to check for remnants of inhabitants (e.g., exuviae).

Photographs of intact galls were taken using a Canon EOS 6D Mark II DSLR camera (Canon Inc., Ota, Japan), while insect images and internal gall structures were captured with a Zeiss Stereo Discovery V20 microscope (Oberkochen, Germany).

The host plant was identified and confirmed by Dr. K. Pradeep, Department of Botany, University of Calicut, following the taxonomic treatment of Wu and Raven (2010).

Result and Discussion

Sea urchin leaf galls on *S. caesia* were observed on the abaxial surface (Fig. 1a), yellowish-green during early development and gradually darkening to brown at maturity. The galls were spherical and characterized by a dense covering of bristle-like hairs, forming a characteristic hairy echinate structure. They occurred either solitarily or in clusters and were unilocular, each containing a single yellowish-orange larva of the gall midge within a round gall cavity. The galls measured 3.5–10.0 mm in diameter, with a larval chamber diameter of 1.0–2.0 mm and gall wall thickness ranging from 1.0–2.8 mm. During maturation, the galls detached from the leaf surface and fell to the ground. Typically, one or more galls were observed per leaflet, mostly during the post-monsoon period. The gall inducer was identified as a cecidomyiid dipteran fly belonging to the tribe Lasiopterini (Cecidomyiidae: Diptera) (Fig. 1b, c). A total of seven families of gall-associated parasitoids emerged, including parasitoids like *Basalys nilgiriensis* (Sharma, 1979) (Diapriidae), *Aprostocetus* sp. and *Neotrichoporoides* sp. (Eulophidae), *Synopeas* sp. and *Platygaster* sp. (Platygastridae), *Bracon* sp. (Braconidae), *Merismus* sp. (Pteromalidae), *Polynema* sp. (Mymaridae), and *Eupelmus* sp. (Eupelmidae). A total of 30 galls were collected during November 2021, and the details of parasitoid emergence are given in Table 1.

This study has several peculiarities: it represents the first record of parasitic Hymenoptera from the cecidomyiid-induced hairy sea urchin gall on *S. caesia*, also documents the family Diapriidae for the first time from a plant gall, constituting the first global record of any diapriid wasp associated with a plant gall. Although a few *Trichopria* Ashmead and *Stylaclista* Dodd (Hymenoptera: Diapriidae) have been reported as parasitoids of cecidomyiids, their emergence in association with leaf galls is rather new (Yoder, 2009). The family Diapriidae is a diverse group of pupal or larval-pupal endoparasitoids, mainly of dipteran families such as Tabanidae, Stratiomyidae, Syrphidae, Muscidae, Anthomyiidae, Tachinidae, Calliphoridae, Sarcophagidae, Chloropidae, and Tephritidae. Diapriids are small, smooth-bodied wasps, typically black, characterized by reduced wing venation and antennae set above the clypeus on a raised ledge with upward-facing sockets. The genus *Basalys* Westwood is one of the highly diverse genera within the family Diapriidae, and is known to parasitize a wide range of insects, specifically flies (Chloropidae, Phoridae, Psilidae, Anthomyiidae), beetles (Curculionidae), and ants (Formicidae) (Yoder, 2009; Loiácono *et al*., 2013). The genus *Basalys* presently comprises 154 species worldwide (Hou & Xu, 2016), including 10 species recorded from India (Rameshkumar et al., 2025, in press). Key diagnostic features of *Basalys* include forewing with basal vein, a submarginal vein remote from the foremargin of the wing and a 12-segmented female antenna with an abrupt clava. The species identified as *Basalys nilgiriensis* (Fig. 2d, e) is of particular significance because its host range remains almost entirely unknown. The species *B. nilgiriensis* recognized based on distinct morphological features such as vertex with a prominent median spine, scutellum trapezoid with a shallow groove in front, which correspond well with the original description provided by Sharma (1979). Additional studies are warranted to investigate its biological roles and interactions within the gall ecosystem.

Table 1: Emergence data from *S. caesia* leaf gall

SI No	Date of emergence	Family	No. of individuals
1	16.xi.2021	Braconidae	1
2	17.xi.2021	Eulophidae	1
3	19.xi.2021	Platygastridae	1
4	19.xi.2021	*Cecidomyiidae	5
5	20.xi.2021	*Cecidomyiidae	2
6	21.xi.2021	Diapriidae	1
7	21.xi.2021	Eupelmidae	1
8	22.xi.2021	Mymaridae	1
9	23.xi.2021	Pteromalidae	2
10	24.xi.2021	*Cecidomyiidae	4
11	26.xi.2021	Eulophidae	1
12	27.xi.2021	*Cecidomyiidae	1
13	28.xi.2021	Eupelmidae	1
14	30.xi.2021	Platygastridae	1
15	01.xii.2021	*Cecidomyiidae	1
16	03.xii.2021	Platygastridae	1
17	04.xii.2021	Eulophidae	1

* indicates gall inducer, cecidomyiid dipteran fly belonging to tribe Lasiopterini, and the rest are parasitic hymenopterans

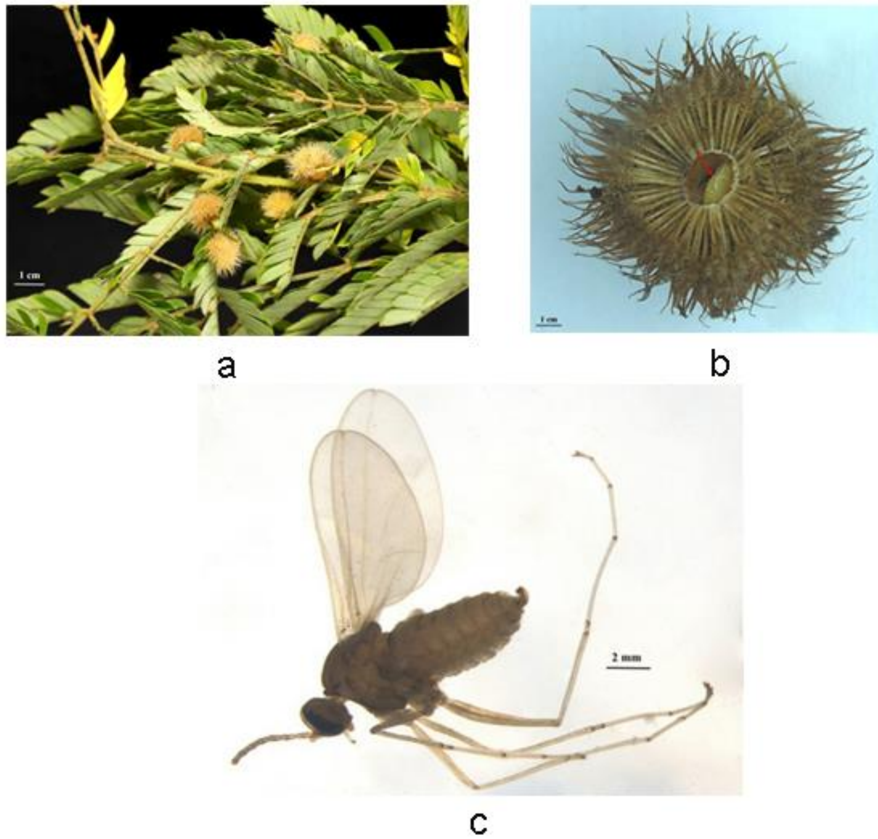

Fig. 1: a) Mature *Senegalia caesia* sea urchin gall b) LS of mature *S. caesia* sea urchin gall with inducer pupa c. adult cecidomyiid fly

Fig. 2: *Basalys nilgiriensis* (Sharma, 1979) d) dorsal view of e) lateral view

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Influence of Climatic Factors on the Population Dynamics of Red Pumpkin Beetle (*Aulacophora foveicollis*) in Bottle Gourd

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Abstract

An experiment was conducted during 2022 and 2023 at Changuria village, Gram Panchayat Mallickpur, District Birbhum, West Bengal, India, to study the population dynamics of the red pumpkin beetle (*Aulacophora foveicollis* Lucas) on bottle gourd (Lagenaria siceraria). The red pumpkin beetle was identified as a serious pest of bottle gourd cultivation in the study area, remaining active throughout the crop growing season. Meteorological parameters such as temperature (°C), relative humidity (%), and weekly total rainfall (mm) significantly influenced the population build-up of the pest. The incidence of red pumpkin beetle increased with rising temperature, while higher relative humidity and greater weekly rainfall were associated with reduced beetle populations. These findings highlight the strong influence of climatic factors on pest incidence and provide valuable insights for developing integrated pest management strategies for bottle gourd cultivation under changing agro-climatic conditions.

Keywords: Seasonal occurrence, red pumpkin beetle, abiotic factors, correlation co-efficient

Introduction

Bottle gourd (*Lagenaria siceraria*) is an important cucurbitaceous vegetable cultivated in Changuria village, Gram Panchayat Mallickpur, District Birbhum, West Bengal, India. It is valued as a rich source of carbohydrates, proteins, fats, vitamins, and essential minerals such as potassium, magnesium, and zinc, along with high energy and moisture content (Milind and Satvir, 2011). Despite its nutritional and economic importance, commercial bottle gourd cultivation faces several constraints, including insect pest damage, adverse climatic conditions, and disease incidence (Umar *et al*., 2013).

Among the insect pests, the red pumpkin beetle (*Aulacophora foveicollis* Lucas) is recognized as one of the most destructive, alongside pumpkin caterpillar (*Diaphania indica* Saunders), aphids (*Aphis gossypii* Glover), fruit fly (*Bactrocera cucurbitae* Coquillet), hadda beetle (*Epilachna vigintioctopunctata* Fabricius), serpentine leaf miner (*Liriomyza trifolii* Burgess), and whitefly (*Bemisia tabaci* Gennadius) (Haldhar et al., 2014). The red pumpkin beetle is a serious polyphagous pest of cucurbitaceous vegetables (Butani and Jotwani, 1984). Adult beetles feed voraciously on leaves, flower buds, and flowers, causing severe damage. Yield losses at the seedling stage have been reported to range between 35–75%, and in some cases, infestations can result in 30–100% crop loss (Rashid *et al*., 2014).

Understanding the population dynamics of the red pumpkin beetle in local agro-ecological conditions is essential for devising effective management strategies. With this objective, a study was undertaken at Changuria village to investigate the seasonal incidence and population dynamics of *Aulacophora foveicollis* on bottle gourd (*Lagenaria siceraria*).

Materials and Methods

The experiment was conducted during 2022 and 2023 at Changuria village, Gram Panchayat Mallickpur, District Birbhum, West Bengal, India. Bottle gourd (*Lagenaria siceraria*) was cultivated as a rabi season crop for two consecutive years. The experimental site lies in the red lateritic zone, with sandy to sandy loam soil (pH 6.8). The climate of the region is characterized by cool, dry winters and hot, humid summers.

To study the population dynamics of the red pumpkin beetle (*Aulacophora foveicollis* Lucas) in relation to weather parameters, bottle gourd was grown under recommended agronomic practices without any plant protection measures. Land preparation was carried out with the application of recommended manures and fertilizers. Local seeds of bottle gourd were procured from Suri market, soaked overnight, and sown the following morning by dibbling 3–4 seeds per hill. Sowing was completed in the second week of January in both years.

Each experimental plot measured 15 m × 4 m and contained ten plants, with a spacing of 1.5 m × 2 m. The experiment was laid out in a randomized block design (RBD) with three replications.

The population of red pumpkin beetle was recorded in the morning hours on randomly selected plants. Counts of beetles per plant were taken from ten randomly selected plants at seven-day intervals (standard meteorological weeks) throughout the crop-growing period, beginning from the initiation of infestation.

Meteorological parameters (temperature, relative humidity, and rainfall) were collected daily from the official website of the Indian Meteorological Department, and weekly averages were calculated. The correlation coefficient (r) was computed to determine the relationship between beetle population dynamics and weather parameters.

Results and Discussion

In the first year (2022), red pumpkin beetle infestation was initiated at a density of 2.3 beetles/plant during the 7th Standard Meteorological Week (SMW), corresponding to the second week of February. The population increased rapidly thereafter, with higher infestation levels recorded between the 9th and 15th SMW (fourth week of February to second week of April). During this period, the temperature ranged from 24.48–30.84 °C, relative humidity from 32.42–70.35%, and weekly total rainfall from 0.00–31.60 mm. The maximum population density was observed in the 12th SMW (third week of March), reaching 13.5 beetles/plant.

In the second year (2023), infestation began earlier, with 1.3 beetles/plant recorded in the 6th SMW (first week of February). The population increased gradually, reaching a peak of 15.3 beetles/plant in the 13th SMW (fourth week of March), when the temperature was 30.21 °C, relative humidity 61.14%, and rainfall 0.00 mm. Higher infestation levels were consistently observed between the 8th and 16th SMW (third week of February to third week of April).

The pooled data from both years revealed that the red pumpkin beetle remained active throughout the bottle gourd growing season (Figure 1). Infestation commenced at 0.65 beetles/plant in the 6th SMW (first week of February). Elevated population levels, ranging from 10.20–13.30 beetles/plant, were observed between the 10th and 13th SMW (first to fourth week of March), when temperatures ranged from 24.59–29.01 °C, relative humidity from 54.39–65.61%, and rainfall from 0.00–15.80 mm. The highest population density (13.30 beetles/plant) was recorded in the 13th SMW (fourth week of March).

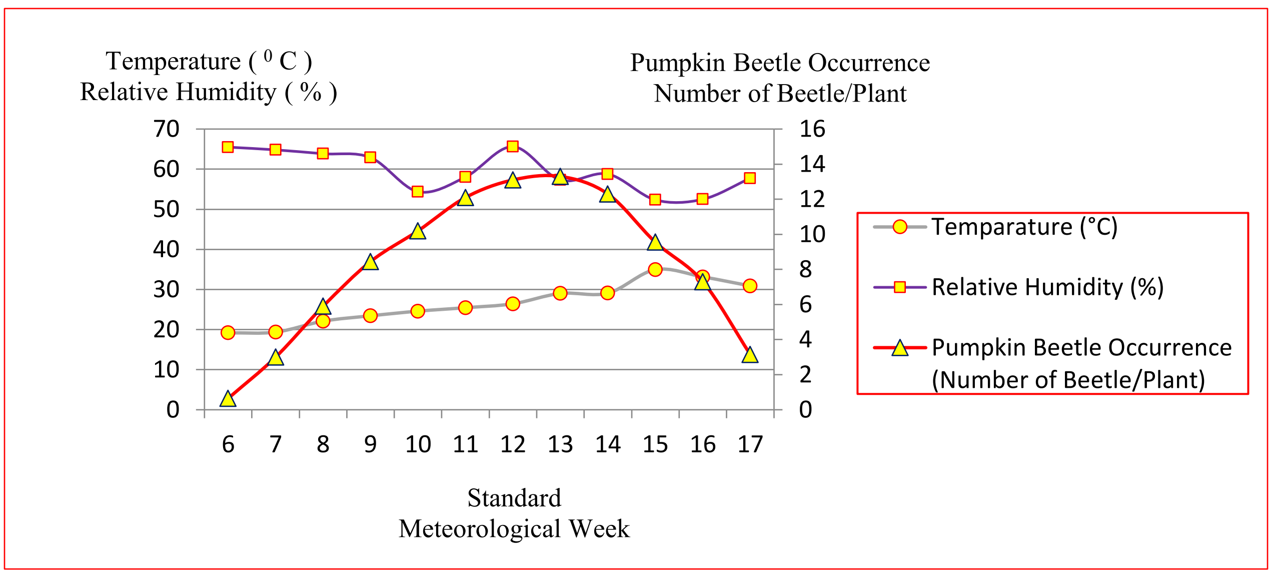

Figure 1: Seasonal occurrence of red pumpkin beetle incidence

These findings corroborate earlier reports. Kumar and Kumar (2002) observed that red pumpkin beetle activity commenced in February on cucumber. Similarly, Johri and Johri (2003) and Ghathala and Bajpai (2007) reported peak beetle populations on bottle gourd during March–April.

Correlation co-efficient between red pumpkin beetle incidence and meteorological parameters

Pumpkin beetle incidence (Table 1) exhibited a positive correlation with maximum temperature (r = 0.436), minimum temperature (r = 0.383), and average temperature (r = 0.415). Conversely, it showed a negative correlation with maximum relative humidity (r = –0.368), minimum relative humidity (r = –0.211), average relative humidity (r = –0.327), and weekly total rainfall (r = –0.378).

These results indicate that beetle incidence increased with rising temperatures, whereas higher relative humidity and rainfall suppressed beetle populations. The present findings are consistent with those of Kumar and Saini (2018), who reported that red pumpkin beetle occurrence on cucumber was positively correlated with temperature and negatively correlated with relative humidity and rainfall. Similarly, Rajak (2000) observed that beetle incidence on muskmelon was positively associated with temperature and negatively with relative humidity.

Table 1: Correlation co-efficient between red pumpkin beetle incidence and meteorological parameters

Meteorological parameters	Correlation co-efficient (r)
Maximum temperature (^{0}C)	0.436*
Minimum temperature (^{0}C)	0.383
Average temperature (^{0}C)	0.415
Maximum relative humidity (%)	-0.368
Minimum relative humidity (%)	-0.211
Average relative humidity (%)	-0.327
Weekly total rainfall (mm)	-0.378

*Significant at 5% level of significance;

Conclusion

The red pumpkin beetle (*Aulacophora foveicollis* Lucas) was identified as a serious insect pest of bottle gourd cultivation at Changuria village, Mallickpur Gram Panchayat, District Birbhum, West Bengal. The beetle remained active throughout the crop cultivation season, causing significant damage to plants. Meteorological parameters such as temperature (°C), relative humidity (%), and weekly total rainfall (mm) were found to influence the population build-up of the pest. Beetle incidence increased with rising temperatures, while higher relative humidity and rainfall suppressed its activity.

This study shows the relationship between pest incidence and climatic factors, providing valuable insights for forecasting outbreaks and designing location-specific integrated pest management (IPM) strategies. By understanding the seasonal dynamics of *A. foveicollis*, farmers and extension workers can adopt timely interventions to minimize crop losses. The findings also contribute to climate-resilient agriculture by highlighting how weather variability affects pest populations, thereby supporting sustainable production of bottle gourd and other cucurbitaceous crops in similar agro-ecological zones.

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First Report of Silkworm (*Antheraea mylitta* Drury) on Almond Tree (*Terminalia catappa*) from Telangana, India

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Abstract

A solitary larva of the tropical tasar silkworm, *Antheraea mylitta* Drury, was observed feeding on the foliage of almond (*Terminalia catappa*) at the National Institute of Plant Health Management (NIPHM), Hyderabad, Telangana, in October 2025. The larva successfully completed its development from feeding to pupation and adult emergence, forming a compact whitish-grey cocoon on the same host. This observation constitutes the first confirmed record of *A. mylitta* utilizing *T. catappa* as a host plant in Telangana, indicating a potential shift in host adaptability and suggesting the ecological expansion of this wild silkworm species.

Key words: *Antheraea mylitta, Terminalia catappa*, almond, Telangana, Silkworm

Introduction

The tropical tasar silkworm (*Antheraea mylitta* Drury) is a wild, sericigenous lepidopteran of considerable economic and ecological importance in India. This species exhibits wide genetic and ecological diversity, with several geographically distinct eco-races that have evolved under varying climatic conditions and host plant preferences (Suryanarayana & Srivastava, 2005). Traditionally, tasar culture has been concentrated in the forested regions of Jharkhand, Odisha, Chhattisgarh, Bihar, Uttar Pradesh, and Telangana, where *Terminalia arjuna*, *T. tomentosa*, and *Shorea robusta* serve as its principal host plants (Jolly *et al*., 1974).

Recent field reports, however, have revealed that *A. mylitta* can also feed and develop on *Terminalia catappa* (Indian almond) in parts of south-eastern Karnataka (Ravi Kumara *et al*., 2022; Ravi Kumara, 2024). Such findings indicate the species' ability to utilize alternative, non-traditional hosts beyond its conventional range. The present note documents, for the first time, the occurrence and complete development of *A. mylitta* on *T. catappa* in Telangana, thereby extending its known host spectrum and suggesting ongoing ecological adaptation.

Materials and Methods

During routine monitoring at the National Institute of Plant Health Management (NIPHM), Hyderabad (17.355°N, 78.472°E), in October 2025, a single larva of *A. mylitta* was found feeding on the leaves of *T. catappa*. The larva was initially observed on 6 October 2025 (**Fig. 1**). It reached the prepupal stage on 11 October 2025 (**Fig. 2**), formed a cocoon on 13 October 2025 (**Fig. 3**), and the adult moth emerged on 5 November 2025 (**Fig. 4**).

The cocoon was compact, oval, and whitish grey in colour, and was firmly attached to a twig of the same host plant. No additional larvae or defoliation symptoms were observed on adjacent trees, suggesting that this was an isolated occurrence rather than part of a larger infestation.

Results and Discussion

The detection of *A. mylitta* on *T. catappa* within Telangana is of considerable interest, as this plant has not been previously reported as a host in the region. When viewed alongside the earlier reports from Karnataka, the present finding supports the hypothesis that *A. mylitta* exhibits ecological plasticity, allowing it to exploit a wider range of host plants.

In Telangana, tasar silkworm populations are typically associated with *T. arjuna* and *T. tomentosa*. The occurrence of a solitary larva on *T. catappa* may represent a random oviposition event by a stray female moth, or possibly an early sign of adaptive behaviour in response to local host availability. Given that host adaptability plays a critical role in sericigenous insect evolution, further investigations involving detailed field surveys, molecular identification, and host suitability assessments are warranted. Such studies will clarify whether T. catappa can sustain stable silkworm populations or merely supports incidental feeding.

Conclusion

This study provides the first confirmed report of Antheraea mylitta Drury feeding and completing its development on almond (*Terminalia catappa*) in Telangana, India. The formation of a whitish-grey cocoon on this non-traditional host plant broadens the known variation in cocoon characteristics and host associations within the species. Continued ecological monitoring and experimental rearing trials will be essential to determine the long-term adaptive and sericultural implications of this host expansion.

Fig. 1. Larva of *Antheriya mylitta*

Fig. 2. Pre-pupal stage of *Antheriya mylitta*

Fig. 3. Pupal stage of *Antheriya mylitta*

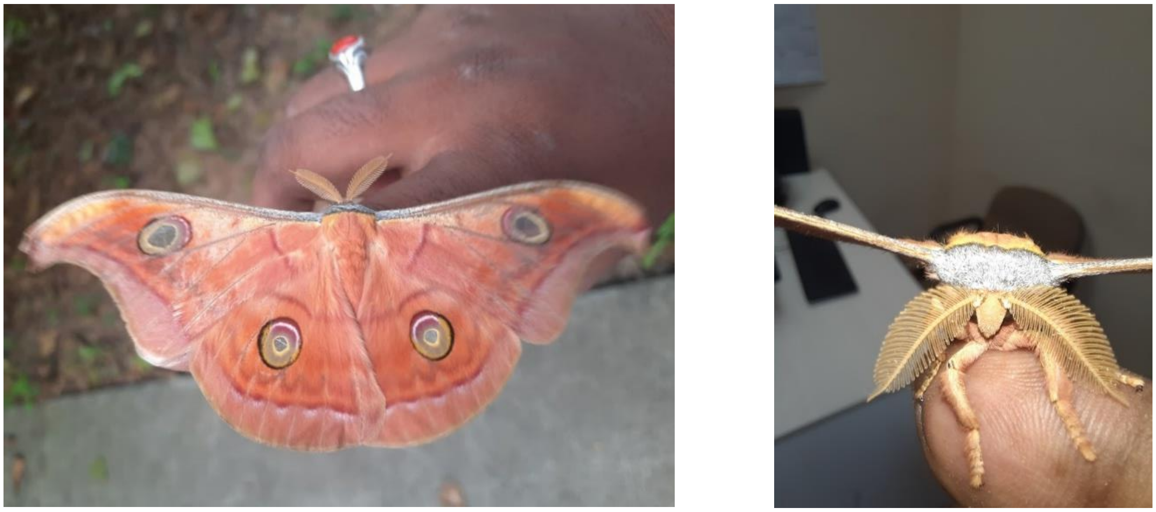

Fig. 4. Adult stage of *Antheriya mylitta*

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Review articles

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Parasitic Manipulation: Unravelling the Ecological Impact of *Ophiocordyceps* on Host Behavior and Ecosystem Dynamics

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Abstract

Parasitic manipulation of host behavior is a fascinating phenomenon that enhances parasite transmission and reproductive success. This review focuses on the mechanisms and ecological impacts of such manipulations, particularly concerning the fungal parasite *Ophiocordyceps unilateralis*, which alters the behavior of *Camponotus* ants. Utilizing strategies such as neuroactive metabolite production and circadian rhythm disruption, *Ophiocordyceps* directs ant behavior to optimize conditions for its lifecycle and sporulation. Additionally, we highlight the role of parasitic fungi in regulating insect populations and shaping community dynamics, positioning them as important natural pest control agents. Comparative analyses with *Beauveria bassiana* reveal distinct behavioral alterations, demonstrating the adaptiveness of parasitic strategies. Furthermore, we explore the diverse species complex of *Ophiocordyceps*, underscoring its implications for understanding host-parasite interactions across various ecological contexts. This review emphasizes the intricate relationships that influence ecosystem dynamics and calls for further research into these complex interactions.

Keywords: *Ophiocordyceps unilateralis, Beauveria bassiana,* manipulation and host behavior

Introduction

The idea that parasites can modify host phenotype whether by altering behavior or appearance is no longer speculative but a well-established principle in behavioral ecology and parasitology. Early studies on amphipods infected with larval acanthocephalans revealed striking behavioral and coloration changes that made the hosts more susceptible to predation, thereby enhancing parasite transmission (Hindsbo, 1972; Holmes and Bethel, 1972). Since then, host manipulation by parasites has been documented in hundreds of hosts–parasite associations across virtually all major biological phyla (Moore, 2002). These manipulations are typically highly specific and evolved to enhance parasite fitness, often by increasing the likelihood of transmission to subsequent hosts. Such behaviors, termed parasite-extended phenotypes, represent expressions of the parasite's genes manifested through the host, often to the host's detriment (Dawkins, 2004). These differ fundamentally from general sickness behaviors, which result from immune responses or physiological stress due to infection (Neto *et al*., 2019).

From a taxonomic perspective, manipulation has been observed in diverse parasitic groups including Platyhelminthes (Trematoda, Cestoda), Acanthocephala, Nematoda, Nematomorpha, Arthropoda, fungi, viruses, bacteria, and protozoans (Moore, 2002). In some phyla, such as Acanthocephala and Nematomorpha, behavioral manipulation is widespread and may be a common trait among most species (Moore, 1984; Hanelt *et al*., 2005). Striking examples illustrate the breadth of this phenomenon. The trematode *Dicrocoelium dendriticum* induces ants to climb vegetation and remain immobile, increasing their chance of ingestion by herbivorous mammals—the parasite's definitive host (Carney, 1969). Parasitic wasps like Glyptapanteles cause caterpillars to guard the parasitoid pupae after larval emergence (Grosman *et al*., 2008). The fungus *Ophiocordyceps unilateralis* forces infected ants to bite vegetation in microhabitats optimal for fungal reproduction (Hughes *et al*., 2011). Baculoviruses alter caterpillar behavior, prompting them to climb high before dying and liquefying, thereby maximizing viral spread (Hoover *et al*., 2011). These cases exemplify convergent evolution in parasitic strategies, underscoring the ecological and evolutionary significance of host manipulation.

Ecological roles Of *Ophiocordyceps* and parasites

Parasitic organisms significantly influence ecological interactions by manipulating host behaviors, which can affect mobility, reproduction, and survival, resulting in broader ecological impacts (Moore, 2002). Infected insects may exhibit altered behaviors that disrupt predation patterns and pollination services, regulating host population densities and influencing the abundance of other species. This manipulation represents an evolutionary strategy where parasites co-opt host neural and hormonal systems for their lifecycle needs (Dawkins, 2004). For example, parasitic wasps induce caterpillar hosts to act as bodyguards for their pupae, showcasing a precision likely shaped by long-term natural selection. The enduring relationship between hosts and parasites, evident for over 400 million years, reflects a continuous evolutionary arms race, with hosts evolving defences like immune priming, while parasites develop tactics to evade immunity or manipulate cognition (Poinar & Poinar, 2000). This interplay highlights the complexity of ecological networks shaped by parasitism.

Parasitic fungi exert strong ecological control over insect populations by infecting, killing, and often manipulating the behaviour of their hosts. In forest and agricultural systems, fungi such as *Beauveria bassiana* and *Metarhizium anisopliae* naturally infect pest insects, helping regulate their numbers without harming non-target species. Fungi like *Ophiocordyceps* and *Entomophthora* go further, inducing host behaviours such as elevated death or attachment to substrates that favour fungal reproduction. These infections can shape insect community composition and influence the timing and success of pollination, decomposition, and prey-predator cycles. Their ecological roles extend beyond pathology—they are critical agents of natural population control and potential allies in sustainable pest management (Roy *et al.*, 2006).

Behavioral and neurological manipulation by *Ophiocordyceps*

Perhaps the most iconic example of behavioral control is the "death grip" induced by *Ophiocordyceps unilateralis* in *Camponotus* ants. Remarkably, the fungus manipulates ant behavior without invading the brain. Instead, fungal cells infiltrate the ant’s thorax, surrounding muscles and ganglia while leaving the brain structurally intact (Fredericksen *et al.*, 2017). The infected ants climb to a specific height, bite onto a vein of a leaf or twig, and die in a place perfectly positioned for fungal growth and spore release. Beyond insects, other parasites manipulate host neurochemistry to facilitate trophic transmission. The trematode *Euhaplorchis californiensis*, for instance, infects killifish and modulates their serotonin and dopamine levels. This causes the fish to exhibit conspicuous flashing and jerking movements near the surface, increasing the likelihood of predation by shorebirds–the parasite’s definitive host (Shaw *et al.*, 2009).

Toxoplasma gondii is another master manipulator. In rodents, it increases dopamine levels in the amygdala via expression of tyrosine hydroxylase-like genes, which blunts the innate fear of cat odours and promotes predation by felines (McConkey *et al.*, 2013; Ingram *et al.*, 2013). Such manipulation not only illustrates neurochemical control but also highlights parasites' ability to reshape host ecology by altering predator-prey interactions. Manipulation may also extend to the host's internal biological clock. Infected ants consistently die around solar noon, when humidity and temperature are ideal for fungal development. Transcriptomic analysis revealed disruption in both ant circadian genes and fungal clock-like genes, indicating synchronized molecular crosstalk (De Bekker *et al*., 2014). This level of coordination suggests an evolved capacity to exploit the host's temporal biology for parasite benefit.

Fungal strategies and molecular mechanisms

One molecular mechanism used by fungal parasites is the production of neuroactive secondary metabolites. *Ophiocordyceps* species produce aflatrem-like indole-diterpenes, which are known to cause tremors and muscular dysfunction in vertebrates and insects alike (De Bekker *et al*., 2015). These compounds may interfere with ion channels or neuromuscular signaling in infected ants, leading to their rigid, biting death posture. High-throughput RNA sequencing has revealed that *Ophiocordyceps* expresses a diverse set of small secreted proteins (SSPs), enterotoxin-like genes, and immune-suppressing molecules during host infection (Loreto and Hughes, 2019). Many of these effectors resemble bacterial virulence genes, suggesting either convergent evolution or lateral gene acquisition. These molecules are likely responsible for subduing the host immune system, facilitating tissue infiltration, and possibly manipulating neural pathways.

Endocrine disruption is another common tactic. Baculoviruses, which infect lepidopteran larvae, produce ecdysteroid UDP-glucosyltransferase (EGT), a molecule that inhibits molting and prolongs the larval stage, allowing the virus more time to replicate. These infected caterpillars climb to elevated positions before dying, enhancing viral dispersal (Hoover *et al*., 2011). Similar hormonal interference, particularly with juvenile hormone pathways, has been hypothesized in *Ophiocordyceps*, although direct evidence is still emerging.

Environmental influences and behaviour

Environmental cues such as light play a key role in manipulated behaviours. Ants infected by *Ophiocordyceps unilateralis* display positive phototaxis before death, climbing toward well-lit locations on the undersides of leaves or twigs. This behaviour ensures optimal light exposure for fungal fruiting body development (Loreto and Hughes, 2019). It is believed that the fungus manipulates the ant's visual or circadian systems to redirect locomotion toward light. Experimental studies suggest that infected ants exhibit disrupted expression of genes associated with their circadian rhythm and photoreception, supporting the idea that the fungus interferes with the ant's internal biological clock (De Bekker *et al*., 2017). Moreover, such light-oriented climbing behaviours are thought to synchronize with the environmental conditions most favourable for fungal sporulation and dispersal, which may also help avoid microclimates unsuitable for fungal growth (Mangold *et al*., 2019). These precise behavioural changes indicate a fine-tuned evolutionary adaptation, where environmental cues are hijacked to enhance the parasite's reproductive success.

The microclimate of the death site is carefully selected via manipulation. Infected ants tend to die in locations with stable humidity and temperatures typically around 95% relative humidity and 25–28°C ideal for fungal proliferation (Pontoppidan *et al*., 2009). These conditions are not accidental but a result of targeted host behaviour manipulated by the fungus, demonstrating an exquisite environmental integration in the manipulation process. Studies have shown that when infected ants are experimentally displaced from these optimal microhabitats, the fungal development is impaired or fails to reach the sporulation stage (Loreto *et al*., 2014). This indicates that *Ophiocordyceps* not only modifies host behaviour to secure transmission but also ensures the creation of a favourable abiotic niche for its own lifecycle completion.

Interestingly, *Ophiocordyceps* species in different environments exhibit distinct manipulative behaviours. In tropical forests, ants are guided to vegetation to bite; in temperate regions, they are manipulated to die in leaf litter or bark crevices, depending on local climate conditions and fungal development needs (Andersen *et al*., 2009; Araujo *et al*., 2018). This reflects evolutionary plasticity in parasitic strategies that are responsive to environmental heterogeneity.

Comparative infection: *Ophiocordyceps vs. Beauveria*

Zheng *et al*. (2019) examined the effects of the parasite fungus *Ophiocordyceps unilateralis* on ant behavior by the use of HPLC-MS/MS to analyze muscle metabolites. Compared to Beauveria bassiana-infected ants, infected ants had notable alterations in their global metabolome, including increased levels of sugars, purines, ergothioneine, and hypoxanthine. The results point to certain metabolic alterations connected to the fungus's modulation of behavior.

In comparison to healthy ants, we observed that *Ophiocordyceps*-infected ants exhibited arrhythmic activity patterns, were less likely to engage in productive foraging activities, and appeared to have a lower capacity for communication with their nestmates. Since these behavioral modifications lessen the likelihood of hostile interference from nestmates, we propose that they are adaptive to the transmission of Ophiocordyceps. Beauveria-infected animals did, in fact, continue to be rhythmic, but they also appeared to lose their capacity for optimum foraging, which may indicate that these behavioral alterations are just general behavioral side effects of infection. All things considered, this study contributes to future research on the behavioral ecology of infectious illnesses generally, additional parasite–host interactions, and parasitic tactics underpinning host manipulation (Trinh *et al*., 2021).

Global and local perspectives

A specific fungal parasite called *Ophiocordyceps unilateralis* (Ascomycota: Hypocreales) particularly affects and controls formicine ants in tropical woodlands. According to research conducted in Brazil, it is a species complex, with several fungal forms infecting different species of *Camponotus* ants. The physical and functional differences among each form indicate a significant degree of species diversity. The results show that fungal biodiversity, particularly among symbionts, is probably significantly undervalued and lend credence to the theory that hundreds of such species may exist worldwide (Evans *et al*., 2011).

They described 15 new species of Ophiocordyceps that only infect ants and have asexual forms that resemble hirsutella. They classified these as myrmecophilous hirsutelloid species, forming a monophyletic group. Additionally, they offer crucial morphological and ecological data for the first time and suggest novel pairings for species that were previously classified as varieties. The suggested species were gathered in Brazil, Colombia, the United States, Australia, and Japan. Using traditional taxonomic criteria, such as ascospore and asexual morphology, it was easy to distinguish between all species (Araújo *et al*., 2018).

Tang *et al*. (2023) identified six new species of Ophiocordyceps (zombie-ant fungi) from China using multi-gene phylogenetic analyses (SSU, LSU, TEF, RPB1, RPB2) and morphological features. The novel species—*O. acroasca, O. bifertilis, O. subtiliphialida, O. basiasca, O. nuozhaduensis*, and *O. contiispora*—belong to the *O. unilateralis* core clade and exhibit hirsutella-like asexual morphs that exclusively infect ants. Most were found in subtropical monsoon evergreen broad-leaf forests. This study shows that a single ant species can be infected by multiple fungal species, and vice versa. It enhances understanding of the evolutionary and ecological relationships between ant hosts and their fungal parasites. The researchers also developed a method to obtain and maintain living cultures, aiding future investigations into the *O. unilateralis* species complex.

Conclusion

Parasitic manipulation exemplifies how organisms like *Ophiocordyceps* can profoundly reshape host behavior and, in turn, influence ecological processes. By hijacking neural, hormonal, and circadian pathways, these fungi orchestrate precise behavioral changes that optimize their own reproduction while altering predator–prey dynamics and community balance. Such interactions highlight the evolutionary sophistication of parasites and their hidden yet powerful role in regulating insect populations, shaping ecosystem functions, and offering insights into sustainable pest management and ecological resilience.

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Innovations in Silk Science and Nanotechnology: Advancing Biomaterials, Smart Textiles and Biomedical Applications

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Abstract

Silk, a natural protein fibre produced mainly by *Bombyx mori* and non-mulberry silkworms, has transitioned from a luxury textile to a promising biomaterial with diverse applications in biomedicine, nanotechnology and advanced textiles. The inherent properties of silk-biocompatibility, biodegradability, mechanical strength and flexibility-make it an ideal substrate for nanomaterial integration. Recent advances in nanotechnology have enabled the functional enhancement of silk through the incorporation of nanoparticles, polymers, and hybrid nanostructures, imparting novel attributes such as wrinkle resistance, UV protection, antimicrobial activity, electrical conductivity and luminescence. This review highlights key innovations in silk nanocomposites, including those based on silica, carbon materials, metal oxides, gold nanoclusters, and conductive polymers, which expand silk's potential in smart textiles and wearable devices. Biomedical applications are emphasized, ranging from wound dressings, sutures, and medical textiles to tissue engineering scaffolds and drug delivery systems. Clinical studies demonstrate silk's effectiveness in dermatological therapy, bone and neural regeneration, cardiac repair and ocular scaffolds. Despite challenges related to scalability, long-term safety and regulatory approval, the convergence of silk science and nanotechnology positions silk as a frontier material for next-generation healthcare solutions and sustainable smart fabrics.

Keywords: Silk fibroin, Nanotechnology, Nanocomposites, Smart textiles, Tissue engineering, Drug delivery and Biomaterials

Introduction

Silk has fascinated humankind for millennia, not only as a luxury fibre but also as one of the strongest natural polymers. Produced primarily by *Bombyx mori* silkworms and several non-mulberry species such as *Antheraea assamensis* and *Philosamia ricini*, silk comprises two key proteins: fibroin, which provides structural strength and sericin, which acts as a glue-like coating (Altman *et al*., 2003). The remarkable combination of tensile strength, elasticity, biocompatibility and biodegradability makes silk highly valuable in biomedical engineering and material science.

The modern expansion of silk research has been driven by advances in nanotechnology, which involves manipulating materials at the molecular and atomic scales (1-100 nm). Nanotechnology allows the incorporation of nanoscale materials-such as nanoparticles, nanoclusters, nanofibers and carbon-based materials- into silk matrices, creating silk nanocomposites with superior or multifunctional properties. These hybrid materials combine silk's natural biocompatibility with enhanced strength, conductivity, antimicrobial activity and responsiveness to external stimuli (Abd El-Aziz *et al*., 2024).

Beyond textiles, silk has emerged as a high-value biomaterial in medicine. Silk fibroin scaffolds, hydrogels and films have been used in wound healing, drug delivery, tissue regeneration and as biosensing platforms (Vepari & Kaplan, 2007). Integration with nanomaterials has further accelerated silk's transformation into smart textiles, wearable electronics and next-generation biomaterials.

This review synthesizes recent innovations in silk science and nanotechnology, focusing on (i) silk nanocomposites, (ii) biomedical and medical textile applications, (iii) wound dressings and dermatological textiles, (iv) tissue engineering, (v) drug delivery systems and (vi) surgical sutures. Challenges and future prospects are also discussed, emphasizing silk's emerging role in sustainable and personalized healthcare solutions.

Nanotechnology and Silk Composites

Nanotechnology has emerged as a transformative tool in enhancing silk's functional performance. By embedding nanoscale materials into silk matrices, properties such as mechanical strength, wrinkle recovery, antimicrobial activity, and electrical conductivity are significantly improved (Narayanan *et al*., 2015). Silica (SiO_2) nanoparticles, for instance, form hydrogen bonds with fibroin, improving wrinkle resistance and UV protection. Crosslinking processes have been shown to result in more than a 16% improvement in wrinkle recovery angle, making these composites attractive for high-performance textiles (Abd El-Aziz *et al*., 2024). Carbon nanomaterials such as graphene, graphene oxide (GO) and carbon nanotubes (CNTs) have revolutionized silk's application in wearable electronics by enhancing electrical conductivity and tensile strength, enabling innovations such as silk-based epidermal tattoos, sweat sensors, strain sensors, and triboelectric nanogenerators (Cao & Wang, 2017; Liang *et al*., 2020; Ye *et al*., 2019). Similarly, metal oxides including ZnO, TiO_2

and Al_2O_3 impart UV resistance, radiative cooling, and antimicrobial activity, with covalent bonding ensuring durability without compromising breathability (Zhu *et al*., 2021). Gold nanoclusters (AuNCs) confer luminescent properties with approximately 8% quantum yield, enhance mechanical strength and find applications in anti-counterfeiting textiles, biosensors and optical devices (Zhang *et al*., 2015). More advanced hybrid composites incorporating MXenes and conducting polymers such as PEDOT: PSS have enabled silk-based ECG monitors, temperature sensors, and human-computer interfaces (Tseghai *et al*., 2020).

Silk in Medical Textiles

Silk fibroin is widely recognized as a versatile biomaterial for sutures, hydrogels, and scaffolds (Babu *et al*., 2024). Its ability to support cellular adhesion and proliferation makes it useful across multiple medical domains. In skin regeneration, silk fibroin supports fibroblast and keratinocyte proliferation, aiding wound healing, while silver oxide-embedded silk exhibits antibacterial effects and DermaSilk® fabrics help manage atopic dermatitis (Hung *et al*., 2019). Transparent silk membranes have been successfully used as ocular scaffolds, promoting corneal epithelialization with minimal immune rejection (Harkin *et al*., 2011). In dental regeneration, silk scaffolds promote odontogenic differentiation for pulp and mineralized tissue repair (Jindal *et al*., 2014). Hybrid silk–hydroxyapatite scaffolds improve osteoconductivity and vascularization in bone grafting applications (Moses *et al*., 2018). CNT-silk hydrogels enhance electrical conductivity and cardiomyocyte alignment, making them promising cardiac scaffolds (Cetin *et al*., 2021). For neural regeneration, silk supports axonal growth, while graphene oxide composites further enhance neuronal alignment (Yang *et al*., 2015). Silk microspheres have also been explored as liver scaffolds, aiding hepatocyte culture and vascularization (Babu *et al*., 2024).

Silk in Wound Dressing

Electrospun silk nanofibers and hydrogels have emerged as promising materials for wound care, combining moisture regulation, biodegradability and mechanical strength. Recent innovations have further enhanced their therapeutic potential. Silver nanoparticle-embedded silk dressings exhibit potent antibacterial activity, reducing infection risk and supporting faster healing (Xia *et al*., 2009). Multilayer silk systems have been shown to accelerate collagen deposition and epithelialization, thereby promoting tissue regeneration and reducing recovery time (Chouhan *et al*., 2020). In addition, polyvinyl alcohol (PVA)-silk composite mats have demonstrated particular effectiveness in managing chronic wounds such as those associated with diabetes, offering improved healing outcomes through enhanced biocompatibility and structural support (Chouhan *et al*., 2018). Together, these advances highlight silk's versatility as a next-generation biomaterial for wound dressings, capable of addressing both clinical and functional challenges in regenerative medicine.

Silk Garments for Dermatological Applications

Silk garments, owing to their smooth surfaces and inherent antimicrobial properties, have proven effective in managing atopic dermatitis. Clinical trials have demonstrated that patients wearing silk-based fabrics experience reduced itching, inflammation, and microbial colonization, with significant improvements in skin barrier function (Agner, 2010; Macias *et al*., 2011). These highlight silk's potential as a therapeutic textile for dermatological care, offering comfort and clinical benefits simultaneously.

Silk-Based Tissue Engineering

Silk fibroin derived from *Bombyx mori* and wild silks such as *Antheraea* and *Philosamia* is being actively developed for reconstructive applications in tissue engineering. Electrospun silk mats have been shown to support keratinocyte adhesion, making them suitable for skin grafts (Chauhan *et al*., 2017). In bone regeneration, silk-hydroxyapatite composites improve integration and osteoconductivity (Meinel *et al*., 2006). For cardiac repair, silk-cECM composites mimic the structural and functional properties of heart tissue (Stoppel *et al*., 2015). Similarly, braided silk scaffolds provide the tensile strength required for ligament and tendon reconstruction (Altman *et al*., 2002). Collectively, these applications underscore silk's versatility as a biomaterial for regenerative medicine.

Silk in Drug Delivery

Silk fibroin has emerged as an adaptable carrier for drugs, proteins, and genes, offering controlled release and biocompatibility (Seib, 2018). Cisplatin-loaded silk scaffolds have been explored for cancer therapy (Wenk *et al*., 2009), while curcumin-silk nanoparticles show promise in tumour treatment (Gupta *et al*., 2009). Adenosine-loaded silk films have demonstrated efficacy in epilepsy management (Wilz *et al*., 2008), and doxorubicin–silk nanoparticles have been applied in chemotherapy (Wang *et al*., 2015). Additionally, BMP-2 silk microspheres have been developed for osteochondral repair, enhancing bone and cartilage regeneration (Wang *et al*., 2009). These examples highlight silk's adaptability in diverse therapeutic contexts.

Silk Sutures

Silk continues to be widely used in surgery due to its ease of handling and knot security. Innovations such as chitosan-coated braided silk sutures have demonstrated improved antibacterial activity and mechanical strength (Viju & Thilagavathi, 2013). Clinical trials further show that Monocryl® Plus sutures reduce microbial colonization compared to traditional black silk within the first 72 hours post-surgery (Sala-Perez *et al*., 2015). These advances reinforce silk's enduring relevance in surgical applications.

Challenges and Future Perspectives

Despite the promise of silk nanocomposites and biomedical applications, several challenges remain. Scalability and reproducibility of hybrid materials continue to be costly, while the long-term biocompatibility and safety of nanoparticle-based silk systems require rigorous in vivo testing. Regulatory approval processes for biomedical applications also pose significant hurdles. Looking ahead, future directions include the development of recombinant silk proteins, advances in 3D bioprinting, bioinspired silk designs, and AI-assisted material optimization. Integrating sustainable production practices and circular bioeconomy strategies will further enhance silk's role as a frontier material in smart textiles and biomedical innovations.

Conclusion

Silk has evolved from a luxury fibre to a multifunctional biomaterial at the crossroads of nanotechnology and biomedical engineering. Innovations in silk nanocomposites, wound dressings, tissue engineering and drug delivery highlight its transformative potential. The integration of nanoscale materials with silk fibroin has produced composites with remarkable mechanical, electrical, and biological properties, positioning silk as a cornerstone material for smart textiles, regenerative medicine and sustainable healthcare. Overcoming scalability and regulatory challenges will pave the way for silk's global adoption in next-generation biomedical devices and functional textiles.

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Short notes

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Walnut Trees (*Juglans* spp.) as Mating Grounds for *Holotrichia longipennis* (Blanchard) (Coleoptera: Scarabaeidae: Melolonthinae): Evidence of Plant Volatiles Guiding Reproductive Behavior

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Abstract

Plant-emitted volatiles provide spatial cues that guide insects to suitable habitats, often facilitating encounters with potential mates. In this study, volatiles from walnut trees (*Juglans* spp.) were observed to function as navigational signals for *Holotrichia longipennis* (Blanchard), directing males to areas where receptive females were present. Adult beetles began emerging around 7:30 PM, followed by intense flight activity exhibited by both sexes. Mating subsequently occurred, with copulation lasting an average of 2.28 hours. These observations suggest that walnut tree volatiles may play a crucial role in guiding adults to conspecifics for mating. Future research should focus on identifying the specific volatile compounds involved in eliciting this behavioral response and evaluating their potential synergistic effects with sex pheromones.

A distinct buzzing sound, characteristic of insect activity, was unexpectedly detected at approximately 19:30 hours on 30 June 2025 in the residential colony of the Mountain Agricultural Research and Extension Station, CSK HPKV, Salooni (32°43′16″ N, 76°3′2″ E), Chamba (Himachal Pradesh), India. Field observations confirmed intense flight activity of hundreds of male and female *Holotrichia longipennis* (Coleoptera: Scarabaeidae) adults, primarily concentrated in the mid to upper canopy of walnut trees (*Juglans* spp.).

H. longipennis is typically found in the Himalayan regions of northern India and Pakistan, at elevations ranging from 700 to 2500 meters above mean sea level (Thakur, 2000). It has been documented as a significant pest of both fruit and forest trees throughout the northwestern Himalayas, including Himachal Pradesh (Chandel *et al.,* 1997; Dixit and Sharma, 2010). Scarab beetles generally exhibit such flight activity prior to mating or copulation (Rodrigues *et al.,* 2014. As members of Scarabaeidae, adults display nocturnal behaviour, emerging from the soil during dusk hours in response to pre-monsoon and monsoon showers (Pathania *et al.,* 2016).

Systematic observations over two consecutive days recorded the flight activity and subsequent mating behaviour of *H. longipennis* (Fig. 1A–F). Adult emergence began after 19:30 hours, with peak emergence between 19:45 and 19:55 hours (Fig. 1A–B). Following emergence, both sexes exhibited intense flight activity around the middle and upper canopy of walnut trees. Several adults collided with branches and foliage, fell to the ground, but quickly resumed flight. Peak flight activity occurred between 19:55 and 20:03 hours, declining markedly by 20:10 hours.

Around 20:00 hours, females began settling predominantly on the upper canopy of walnut trees for mating, coinciding with ongoing adult emergence. Upon settling, females initiated calling behaviour, which attracted conspecific males. Prior to copulation, males were observed antennating and grooming the female's abdomen. Mating commenced at approximately 20:05 hours and peaked around 20:20 hours. Copulation lasted for 2.25–2.40 hours, with a mean duration of 2.28 hours (n = 14).

During mating, females continued feeding on leaf margins while males remained attached in an end-to-end position without feeding (Fig. 1E). Just prior to termination of mating, both sexes displayed abdominal jerking behaviour. Post-copulation, males and females fed voraciously side by side along the leaf margins of walnut trees, continuing until morning (Fig. 1F).

Volatile compounds emitted by plant structures such as leaves, fruits, and flowers play a crucial role in guiding phytophagous insects to their host plants (Xu and Turlings, 2018). These volatiles serve not only as indicators of nutritional resources but also as cues for locating conspecifics of the opposite sex, as host plants often act as suitable mating sites. This phenomenon may also apply to *H. longipennis*, where aggregation of males and females post-emergence appears to be facilitated by volatiles emitted by walnut trees, thereby increasing the likelihood of mate encounters. Similar behaviour has been documented in other members of Scarabaeidae (Ruther *et al.,* 2001; Reinecke *et al.,* 2002). Further systematic investigation is warranted to identify the specific volatile components of walnut trees responsible for this attraction and to evaluate their potential role in enhancing sex pheromonal communication in this species.

Conclusion

The present observations provide novel insights into the mating ecology of *Holotrichia longipennis*, highlighting the role of walnut trees (*Juglans* spp.) as aggregation and mating sites. The synchronized emergence, intense flight activity, and prolonged copulation behaviour suggest that plant volatiles may act as critical cues guiding beetles to suitable habitats for reproduction. This first detailed documentation of mating behaviour in *H.*

longipennis underscores the importance of host plant volatiles in scarab beetle ecology and calls for further research to isolate and characterize the compounds involved. Such knowledge could contribute to the development of pheromone–plant volatile synergistic strategies for sustainable pest management in Himalayan agroforestry systems.

Figure 1: Sequential process of mating in *Holotrichia longipennis*: (A) and (B): emergence of beetle, (C) and (D) during copulation, (E) Termination of mating, (F) feeding of beetle pair on walnut leaves after mating

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First Record of *Entomophthora* sp. Infecting *Cyrtorhinus lividipennis* Reuter (Hemiptera: Miridae), a Predator of Brown Planthopper (*Nilaparvata lugens* Stål) in Rice from Telangana, India

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Introduction

The mirid bug *Cyrtorhinus lividipennis* Reuter (Hemiptera: Miridae) is an important natural predator of the brown planthopper (*Nilaparvata lugens* Stål), a major pest of rice. During routine field observations in October 2024 (Kharif season) at the research fields of Agricultural College, Adilabad, Telangana, adult populations of *C. lividipennis* were found infected by a fungal pathogen belonging to the genus *Entomophthora*. This note documents the incidence, level of natural infection, and its potential impact on predator efficacy.

Materials and Methods

The study was conducted during the Kharif season of 2024 in the research fields of Agricultural College, Adilabad, Telangana, where rice was transplanted in late July. Observations were made between October and November, following the peak infestation of brown planthopper (*Nilaparvata lugens*) in September. To assess the incidence of fungal infection in *Cyrtorhinus lividipennis*, data were collected from ten quadrats at fortnightly intervals. Within each quadrat, the total number of *C. lividipennis* adults and those infected by the entomopathogenic fungus *Entomophthora* sp. were recorded to estimate the level of natural infection. The fungus was subsequently isolated from naturally infected hosts and identified to the genus level using standard mycological procedures.

Results

Brown planthopper (*Nilaparvata lugens*) infestation in rice fields began in August and reached its peak in September during the tillering stage, crossing the economic threshold level (ETL). Populations of *Cyrtorhinus lividipennis* were observed actively predating on *N. lugens* during this period. However, between October and November, adult *C. lividipennis* were found infected by the entomopathogenic fungus *Entomophthora* sp. The level of natural infection was estimated at 12.82% of the predator population (**Table 1**). Although the infection did not result in a major epizootic, it appeared to reduce the efficacy of the predator, which in turn contributed to a rise in *N. lugens* populations in the field.

Table. 1. **Natural infection of *C.lividipennis* adults by *Entomophthora* sp.**

Quadrat	Nymphs observed*	Nymphs infected*	Mean Infection (%)
Q1	121	23	19.01
Q2	156	27	17.31
Q3	278	23	8.27
Q4	134	22	16.42
Q5	187	17	9.09
Q6	201	23	11.44
Q7	206	19	9.22
Q8	119	12	10.08
Q9	151	22	14.57
Q10	219	28	12.79
		Mean	**12.82**

*Mean of four fortnightly counts

Discussion

Entomopathogenic fungi typically kill their hosts within 3–5 days after conidial contact (Brobyn and Wilding, 1983). The present finding aligns with earlier reports: Chunsheng (2011) documented *Entomophthora erupta* infecting *C. lividipennis* in Guangdong, China, with infection levels ranging from 2–14%. Zeev et al. (2011) observed *E. erupta* and *E. helvetica* colonizing the abdomen and sporulating dorsally before host death. Elya and Licht (2021) further demonstrated the unique adaptations of *Entomophthora* for exclusive insect parasitism, including wall-less hyphal bodies and specialized proteases for cuticle penetration.

The infection of *C. lividipennis* in Telangana, though moderate, highlights the potential role of entomopathogenic fungi in influencing predator-prey dynamics in rice ecosystems. Reduced predator efficiency due to fungal infection may indirectly favor pest resurgence.

Conclusion

This study reports, for the first time, the natural occurrence of *Entomophthora* sp. infecting *Cyrtorhinus lividipennis* in rice fields of Telangana State, India. The fungus infected 12.82% of the predator population, potentially reducing its effectiveness against *Nilaparvata lugens*. Such findings are significant for understanding biotic interactions in rice agroecosystems and emphasize the need to consider natural enemies' health when designing integrated pest management (IPM) strategies.

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Occurrence of the Painted Grasshopper *Poekilocerus pictus* in Chithalapakkam Lake, Chennai, Tamil Nadu, India

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Introduction

The painted grasshopper, *Poekilocerus pictus* (Fabricius), also known as the aak grasshopper, is a brightly coloured pyrgomorphid species commonly associated with milkweed plants (*Calotropis* spp.). It sequesters toxic cardiac glycosides (cardenolides) from its host plants, which serve as a chemical defense mechanism against predators. Although primarily restricted to *Calotropis*, occasional feeding on agricultural crops such as cowpea, okra, castor, and citrus has been reported from northern and western India. Documenting its presence in new habitats provides valuable information on its distribution and potential pest status.

Observation

During a routine visit to the Chithalapakkam Lake plantations (12.916° N, 80.143° E) in September 2025, several adult *P. pictus* individuals were observed feeding on *Calotropis gigantea* plants growing along the lake margin. Both male and female adults were identified by their characteristic bright yellow, blue, and green coloration with red markings on the hind wings. No visible damage to nearby ornamental or crop plants was noted at the time of observation. The abundance of *C. gigantea* around the lake provides a suitable habitat for the multiplication of this species, and its occurrence in this urban peri-urban ecosystem suggests adaptability to semi-natural habitats around Chennai.

Previous records of *P. pictus* in Tamil Nadu have been mainly from Chengalpattu and Madurai districts. This report represents the first confirmed observation from the Chithalapakkam area, thereby expanding the known distribution of the species in coastal Tamil Nadu. Although currently confined to *Calotropis*, the species has the potential to spill over into adjacent vegetation during population surges. Regular monitoring of *Calotropis* stands near cultivated areas is recommended to prevent possible crop infestation.

Fig. 1 Painted grasshopper, *Poekilocerus pictus*, from Chithalapakkam Lake (12.916° N, 80.143° E)

Summary

This note documents a new locality record of the painted grasshopper, *Poekilocerus pictus*, from Chithalapakkam Lake plantations in Chennai District, Tamil Nadu. The observation highlights the adaptability of the species to peri-urban ecosystems and underscores the importance of monitoring its populations, especially in areas where *Calotropis* grows close to agricultural fields. Such records contribute to understanding the distribution dynamics of *P. pictus* and provide baseline information for assessing its potential pest status in the northeastern agro-climatic zone of Tamil Nadu.

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Selected Insect Environment Blogs

Insect Environment Blog

Rashvee Novel Climate-resilient Products Win National Recognition

Winner of Confederation of Indian Industry Award for Best Women-Led Innovation

30 November 2025

Prathika R

Rashvee International Phytosanitary Research & Services Pvt. Ltd. (R-IPRS) has achieved a proud milestone with national recognition at the ICONN Summit 2025, Hyderabad, India on 24th November 2025. Dr. Rashmi M.A., CEO, was honored with the prestigious Best Women-Led Innovation Award by the Confederation of Indian Industry (CII). This award celebrates the pioneering work of R-IPRS in developing advanced, climate-resilient, and ecologically sustainable plant protection and phytosanitary solutions, with a dedicated focus on empowering farmers in multi-crop systems.

The award was presented by eminent leaders including Dr. Suchitra Ella, Co-Founder & Managing Director of Bharat Biotech International Limited, Dr. Kris Gopalakrishnan, Chairman CII, Centre of Excellence for Innovation, Entrepreneurship and Startups (CIES) Advisory Board, and Mr. Sanjay Kumar (IAS), Special Chief Secretary, ITE&C, Government of Telangana.

The ICONN Summit 2025 was held under the theme *"Synergy for Scale: Corporate–Startup Partnership for National Impact."* It brought together thought leaders, entrepreneurs, and policymakers to explore how collaborations between corporates and startups can accelerate innovation and create transformative impact across India.

Rashvee's eco-friendly product portfolio reflects its commitment to sustainability and farmer empowerment. The non-insecticidal climate-resilient liquid lure for fruit flies (*Bactrocera* spp. on fruits and vegetables) integrates anti-evaporants, hooded trap cap with rain guards and which withstands high wind and harsh weather conditions. The Rashvee herbal liquid soap adjuvant with neem oil masks fruit/ vegetable odour, reducing pest attraction naturally. The Rashvee Tab for stored grain pests and bioprotectant for termites further strengthens integrated pest management strategies. Together, these innovations align with the United Nations Sustainable Development Goals (SDGs), particularly those addressing zero hunger, responsible consumption and production, climate action, and life on land.

been instrumental in shaping India's industry development journey. As a non-government, not-for-profit, industry-led organization, CII drives innovation, competitiveness, sustainability, and inclusive growth across sectors. Through its Centre of Excellence for Innovation, Entrepreneurship & Startups (CII-CIES) at T-Hub, Hyderabad, it empowers startups to move research from lab to market, access mentorship, and scale successfully.

This recognition is not just an award but a testament to Rashvee's mission of bridging science, sustainability, and farmer empowerment. It reflects the collective effort of the team, the trust of exporters, and the inspiration drawn from farmers. As R-IPRS continues its journey, the focus remains on scaling climate-smart solutions, strengthening biosecurity, and safeguarding both livelihoods and ecosystems for a resilient future.

We gratefully acknowledge the support of BIRAC-DBT, DST-NIDHI, RKVY, ICAR-NBAIR, UAS-GKVK, ICAR-IIHR, SINE, IIT Bombay, Siddaganga Technology Business Incubator, Krushik Business Incubator, UAS-Dharwad, and BESST-HORT ICAR-IIHR. We also extend our sincere thanks to our mentors, farmers, and exporters, whose guidance, cooperation, and contributions were invaluable to this achievement.

IE Blog No. 282
All IE blogs are available on website
https://insectenvironment.com

Insect Environment Blog

Birth Centenary Remembrance of Prof. T. N. Ananthakrishnan (1925-2025)

By the Insect Environment Editorial Team

Saluting Founder Patron of Insect Environment the Late Prof. T. N. A.

15 December 2025

The best way to honour the memory of a great entomologist on his 100th birth anniversary is to pay a visit to the very institution where he dedicated decades of his life. The *Insect Environment* team did exactly that.

15 December 1925 marks a landmark date in the annals of Indian entomology. On this day, Prof. T. N. Ananthakrishnan one of India's foremost entomologists was born in Palakkad, Kerala, India. On this day, 100 years later the quarterly *Insect Environment*, of which he was a Founding Patron, salutes his memory and celebrates his outstanding contributions to the science of insects.

Dr. T.N. Ananthakrishnan (1925-2015)
PC: https://zoosprint.org/

As a mark of respect to the memory of this great soul on the eve of his birth centenary year (14^{th} December 2025) the AVIAN Trust and the Insect Environment organized an award ceremony celebrating the achievements of entrepreneurs, environmentalists, teachers, students and farmers.

Participants of Conference at Loyola College (Chennai, India)

Last week, it was a privilege for IE to visit the Entomological Research Institute (ERI) at Loyola College, Chennai, India by Dr. Abraham Verghese and team as part of the two-day conference on *"Smart Farming: Sustainable Agriculture and Entomology"* (10–11 December 2025). This was a moving reminder of Prof. Ananthakrishnan's enduring legacy. Fittingly, the conference was organized by the Director and Staff of ERI an institute that was the brainchild of Prof. Ananthakrishnan, founded in 1963.

Today, ERI remains a thriving hub of entomological research. Hundreds of students have specialized in entomology here and gone on to productive careers in research, teaching, and even applied entomology.

Incidentally, Loyola College (Chennai, India) itself, where Prof. Ananthakrishnan spent many decades teaching and researching, was founded in 1925 and celebrated its centenary in 2025 making this year doubly significant.

Prof. Ananthakrishnan passed away in the USA in 2015, but his influence continues to inspire generations.

Dr. Abraham Verghese, who had the honour of serving as Chief Guest at the conference inauguration, paid rich tributes on the very campus where Prof. Ananthakrishnan had nurtured talent and advanced scientific inquiry in entomology.

As Chairman of the ICAR (ASRB) selection committee, Prof. Ananthakrishnan had selected Dr. Verghese into the Agricultural Research Service of ICAR in 1978, while he was the Director of the Zoological Survey of India for brief period.

Prof. Ananthakrishnan will be long remembered for his pioneering work on Thysanoptera, gall insects, and chemical insect ecology. *Insect Environment* reverentially pays homage to him on his birth centenary, celebrating a life devoted to science, education, and the nurturing of future talent.

Dr. Verghese with the photograph of Prof. T. N. Ananthakrishnan and staff of ERI, Chennai, India

Coincidentally, Prof. Ananthakrishnan's academic journey was contemporaneous with another towering ecologist, Dr. Edward O. Wilson of the USA, who also lived for over 90 years. Independently both their legacies remind us of the globally impacted entomology and ecology.

Acknowledgements

We thank Jesuit Fathers of Loyola College, Dr. K. Sivasankaran, Dr. V. Duraipandiyan and Dr. M. Muthipandi, and staff of Entomological Research Institute for the opportunity given to us to visit ERI.

We thank Dr. C.A. Viraktamath for officially releasing this blog on 14th December 2025.

IE Blog No. 282
All IE blogs are available on website
https://insectenvironment.com

Insect Environment Blog

Flying Toward Sustainability: Drone-Based Neem Intervention

Drone-Based Intervention: Ideal for Sugarcane

23 November 2025

Shravan Manbhar Haldhar, A K Kanojia and Raman Thangavelu

ICAR- National Research Institute for Integrated Pest Management, Rajpur Khurd, New Delhi, India

Sugarcane, a tall perennial grass with six species and numerous hybrids, is a vital cash crop in India and globally. Sugarcane thrives across India's tropical and subtropical belts, with Uttar Pradesh in India being the largest producer. The crop suffers 20–40% yield losses due to pests like the top shoot borer (*Scirpophaga excerptalis*) and leaf hopper (*Pyrilla perpusilla*), compounded by diseases and climate stress.

Top shoot borer (*Scirpophaga excerptalis*) *PC:* NRIIPM

Pyrilla perpusilla PC: **NRIIPM**

Conventional chemical control often leads to pest resistance, environmental degradation, and high labour costs. In response, the ICAR–National Research Centre for Integrated Pest Management (NRIIPM), New Delhi, launched a pioneering initiative under the 'Sugarcane-based IPM Model Village' project at Mandora village, Meerut district, Uttar Pradesh, India. This program marks a turning point in sustainable pest control "From Lab to Field: Drone-Based Neem Oil Spray for Sugarcane Top Shoot Borer and Hopper".

During a recent visit by Dr. Abraham Verghese, he witnessed a field demonstration led by Director Dr. Raman Thangavelu and his team. Using drone technology, scientists applied freshly prepared neem oil sprays (Azadirachtin-1000 ppm at 3 ml/litre) across dense sugarcane canopies. The drones ensured uniform coverage, overcoming limitations of manual or tractor-mounted sprayers. Farmers expressed visible satisfaction, reporting significant suppression of shoot borer and hopper populations and reduced reliance on synthetic pesticides.

Drone spraying in sugarcane, ***PC:*** **NRIIPM**

Neem oil acts as an antifeedant, repellent, and growth regulator, disrupting pest life cycles without harming beneficial organisms. Drone-spraying reduces labour dependency and enhances precision, making it a scalable solution for large farms. This integration of biopesticide efficacy with modern delivery systems exemplifies future eco-friendly pest management.

Beyond this initiative, NRIIPM is actively deploying natural enemies and ICT-based pest forecasting tools across cropping systems. The institute's vibrant team continues to translate IPM technologies into field-level impact, reinforcing its pivotal role in ecological pest regulation in several crops.

IE Editors appreciate the Director Dr. Raman Thangavelu and his dedicated team for their farmer-centric outreach that blends tradition, technology, and sustainability.

For more information/feedback connect with the author at *haldhar80@gmail.com*

IE Blog No. 281
All IE blogs are available on website
https://insectenvironment.com

Selected achievements and citations of AVIAN Trust awardees

Varsha Bioscience and Technology India Pvt.Ltd

Dr. John Peter, Chairman & Managing Director

Today we honor a company that has transformed Indian agriculture through science, innovation, and farmer-centric impact.

For over 23 years, *Varsha Bioscience and Technology India Pvt Ltd* has evolved from a small biological research initiative into a nationally recognized leader in sustainable agri-biotechnology. They have pioneered indigenous liquid biopesticides, launched India's first indigenous Bt formulation under 9(3), and developed breakthrough tree-oil biopesticide technology in collaboration with IFGTB. Their eco-innovations such as Omega Aqua for pond ecosystem restoration and Omega for stubble biodegradation have delivered measurable ecological outcomes—reducing pesticide residues, restoring soil carbon, and improving water quality.

With a portfolio of 45+ certified biological products, Varsha has built a trusted national brand, expanded exports, and partnered with leading institutions. Their farmer-centric initiatives have trained thousands of farmers and agricultural officers, enabling confident adoption of sustainable practices across diverse cropping systems.

What truly distinguishes Varsha is their combined approach of science-led innovation, regulatory leadership, field demonstrations, and farmer education—ensuring practical adoption and measurable outcomes. Their work is regenerating soil health, reducing dependence on synthetic inputs, improving livelihoods, and advancing India's transition toward sustainable, environmentally responsible agriculture.

It is with great pride that we present the Entrepreneurial Excellence Award in Agri & Life Sciences to *Varsha Bioscience and Technology India Pvt Ltd* for their outstanding contribution to building a healthier, resilient agricultural ecosystem."

Rynco Orchids, Perumchilambu, Kanyakumari, TN

S. Ramakrishnan, Proprietor

We are proud to recognize Rynco Orchids for their pioneering role in transforming orchid cultivation in India.

For over two decades, orchids were largely confined to hobbyists and small growers. Through sustained vision and innovation, Rynco Orchids has introduced high-quality Dendrobium and Phalaenopsis varieties and advanced cultivation technologies, shaping the modern orchid industry in our country.

Their venture addresses major pest challenges in orchid cultivation—mites, blossom midges, and slugs—by integrating scientific IPM protocols, precision climate management, and substrate-optimized cultivation. With high-tech greenhouse structures, controlled-environment systems, and pre-cooling units, they ensure superior plant quality, synchronized flowering, and predictable year-round yields.

Commercially, Rynco has expanded greenhouse capacity for large-scale production, achieving consistent turnover growth. Socially, as a B-to-B enterprise, they have encouraged many entrepreneurs—especially women—to enter the orchid business, creating inclusive opportunities.

What sets Rynco Orchids apart is their technology-driven approach, uncommon in India, combining environmental responsibility, scientific rigor, and social impact. Their innovations have elevated orchids from a niche hobby into a thriving commercial enterprise.

It is with great pride that we present the Entrepreneurial Excellence Award in Agri & Life Sciences to Rynco Orchids, Perumchilambu, Kanyakumari, Tamil Nadu for their outstanding contribution to sustainable innovation, commercial excellence, and inclusive growth in Indian floriculture."

Veeresh Technology Private Limited

Shivakumar H G, CEO

We are honored to present the *Entrepreneurial Excellence Award in Agri & Life Sciences* to Veeresh Technology Private Limited, a trailblazer in India's agricultural drone industry.

With a strong commitment to innovation and farmer empowerment, Veeresh Technology has become the nation's leading provider of agricultural drone parts and solutions. Their portfolio includes high-performance batteries, advanced sensors, precision cameras, and durable propellers—all designed to enhance efficiency and effectiveness in modern farming.

By addressing the challenges of manual pesticide spraying—labour shortages, health risks, non-uniform coverage, and chemical wastage—Veeresh Technology has revolutionized crop protection through agri-drones. These drones enable precise spraying, reduced chemical use, improved crop health, and significant time and labour savings.

The company has proudly served over 250 farmers across India, many of whom have adopted drones not only to protect their own crops but also to generate sustainable livelihoods by offering spraying services to neighboring farms.

Beyond innovation, Veeresh Technology stands out for its doorstep drone repair services, one-day spare-parts delivery, and complete technical support—ensuring farmers experience minimal downtime and maximum productivity. Their dedication to customer satisfaction, training, and farmer-centric solutions has made them a trusted partner in advancing sustainable agriculture.

For their pioneering role in transforming farming practices, empowering communities, and driving technological excellence, we proudly confer the Entrepreneurial Excellence Award in Agri & Life Sciences to *Veeresh Technology Private Limited.*"

Suja George

We are proud to honor Suja George, Headmistress and Educator at Vidya Niketan School, who has dedicated over 24 years to nurturing young learners through the National Institute of Open

Schooling curriculum. She leads the Section for Alternate Studies, empowering students pursuing sports, arts, and those with learning disabilities to complete education at their own pace with confidence.

Her work goes beyond teaching—she mentors, adapts, and encourages each learner, ensuring education becomes a path of transformation rather than standardization. With international exposure, including an educational visit to Helsinki, Finland, she has strengthened inclusive practices and built environments where every student feels valued and capable.

For her unwavering commitment to individualized support, holistic learning, and student empowerment, we proudly present the Star Educator Award for Excellence in Teaching to *Suja George.*

Dr. Sandeep Singh, Principal Entomologist (Fruits), Punjab Agricultural University, Ludhiana, Punjab

We are proud to honor a distinguished researcher who has developed 25 eco-friendly technologies, including the renowned PAU Fruit Fly Trap and Termite Trap, widely adopted by fruit growers across Punjab, Haryana, Rajasthan, Western UP, and Himachal Pradesh. he has also designed HMO and BIPM modules for managing major fruit pests and contributed 13 nationally recommended technologies under ICAR-AICRP on Fruits.

His impactful work extends to ICT-based e-pest surveillance projects in Haryana, providing real-time advisory services to farmers, and to the revival of historical trees in over 20 gurudwaras across six states of India. With several international awards and national honors, her contributions exemplify innovation, sustainability, and service to farming communities.

we proudly present the Excellence in Environmental Research Award in recognition of his outstanding achievements.”

Jagadeesh Giri G

Excellence in Environmental Research Award – Commercial Farming Category We are honored to recognize Jagadeesh Giri G, a Farmer and Senior IT Professional, who has successfully combined technology with agriculture to pioneer sustainable integrated farming practices. His model farm encompasses horticulture, fisheries, agro-forestry, floriculture, vermicomposting, rainwater harvesting, organic and regenerative agriculture, precision farming, poultry, and biochar preparation—creating a holistic ecosystem of productivity and sustainability.

Through innovations such as the Meadow Orchard method of high-density farming that increased yields by 20%, water conservation systems utilizing 90% of rainwater, zero-wastage composting, indigenous nematode management with neem and bioagents, drone-based spraying, and mobile-app weather sensors for proactive pest alerts, he has set new benchmarks in modern farming. His practices also include zero tillage, centralized drip irrigation, biochar integration, and mulching techniques that conserve resources and enhance soil health.

For his outstanding contributions, Jagadeesh has been honored with awards from IIHR Bangalore, GKVK UAS Bangalore during Krishi Mela, and the Taluk Award at Doddaballapur. His journey exemplifies how innovation, sustainability, and technology can transform commercial farming into an environmentally responsible enterprise.

It is with great pride that we present the Excellence in Environmental Research Award – Commercial Farming Category to *Jagadeesh Giri G.*"

INSECT LENS

Velvet Bean Moth, Anticarcia irrorata (Eribidae: Lepidoptera)
Author: *Dr. Nagaraj, D.N., Project Head (Entomologist) Ento. Proteins Pvt. Ltd., Mangalore*
Location: *Bengaluru*
Email: *nasoteya@yahoo.co.in*

Indian Common Club tail, Ictinogomphus rapax (Gomphidae: Odonata)
Author: *Dr. Nagaraj, D.N., Project Head (Entomologist) Ento. Proteins Pvt. Ltd., Mangalore*
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Chocolate Pansy, Junonia iphita (Nymphalidae: Lepidoptera)
Author: *Dr. Nagaraj, D.N., Project Head (Entomologist) Ento. Proteins Pvt. Ltd., Mangalore*
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Potter wasp, Delta pyriforme (Vespidae: Hymenoptera)
Author: *Dr. Nagaraj, D.N., Project Head (Entomologist) Ento. Proteins Pvt. Ltd., Mangalore*
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The Psyches, Leptosia nina (Pieridae: Lepidoptera)

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Masked Hunters/Assassin big nymph, Reduvius personatus (Reduviidae: Hemiptera)

Author: *Dr. Nagaraj, D.N., Project Head (Entomologist) Ento. Proteins Pvt. Ltd., Mangalore*
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Flesh flies, Sarcophaga sp. (Sarcophagidae: Diptera)
Author: *Dr. Nagaraj, D.N., Project Head (Entomologist) Ento. Proteins Pvt. Ltd., Mangalore*
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Flower Mantid, Creobroter gemmatus (Hymenopodidae: Mantodea)
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Porter Wasp, Phimenes sp. (Vespidae: Hymenoptera)
Author: *Dr. Nagaraj, D.N., Project Head (Entomologist) Ento. Proteins Pvt. Ltd., Mangalore*
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Assassin Bug, Cydnocoris sp. (Reduviidae: Hemiptera)
Author: *Dr. Nagaraj, D.N., Project Head (Entomologist) Ento. Proteins Pvt. Ltd., Mangalore*
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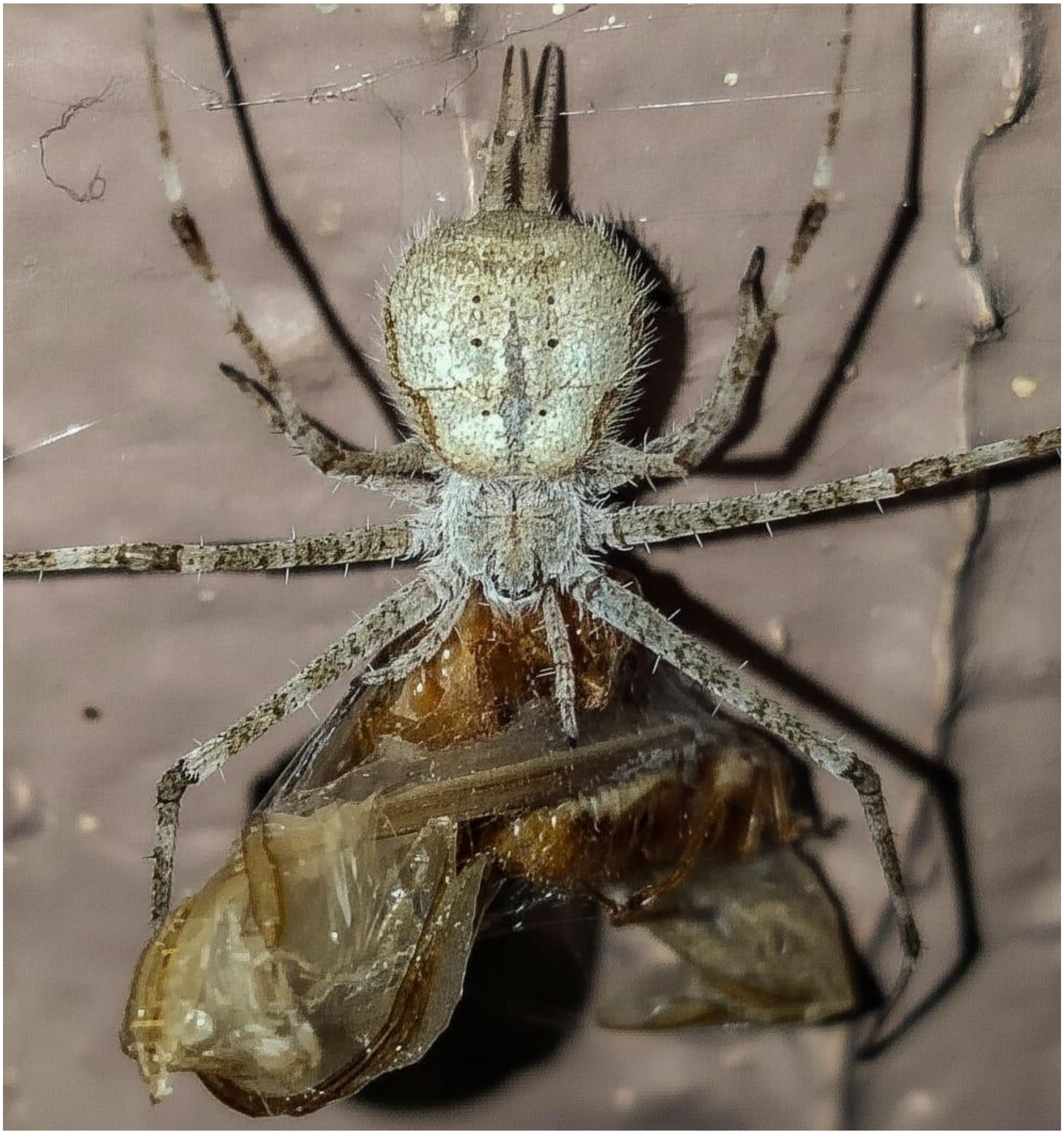

Two tailed Spider (termites packed neatly for tomorrow's lunch), Hersilia sp. (Hersiliidae: Araneae)

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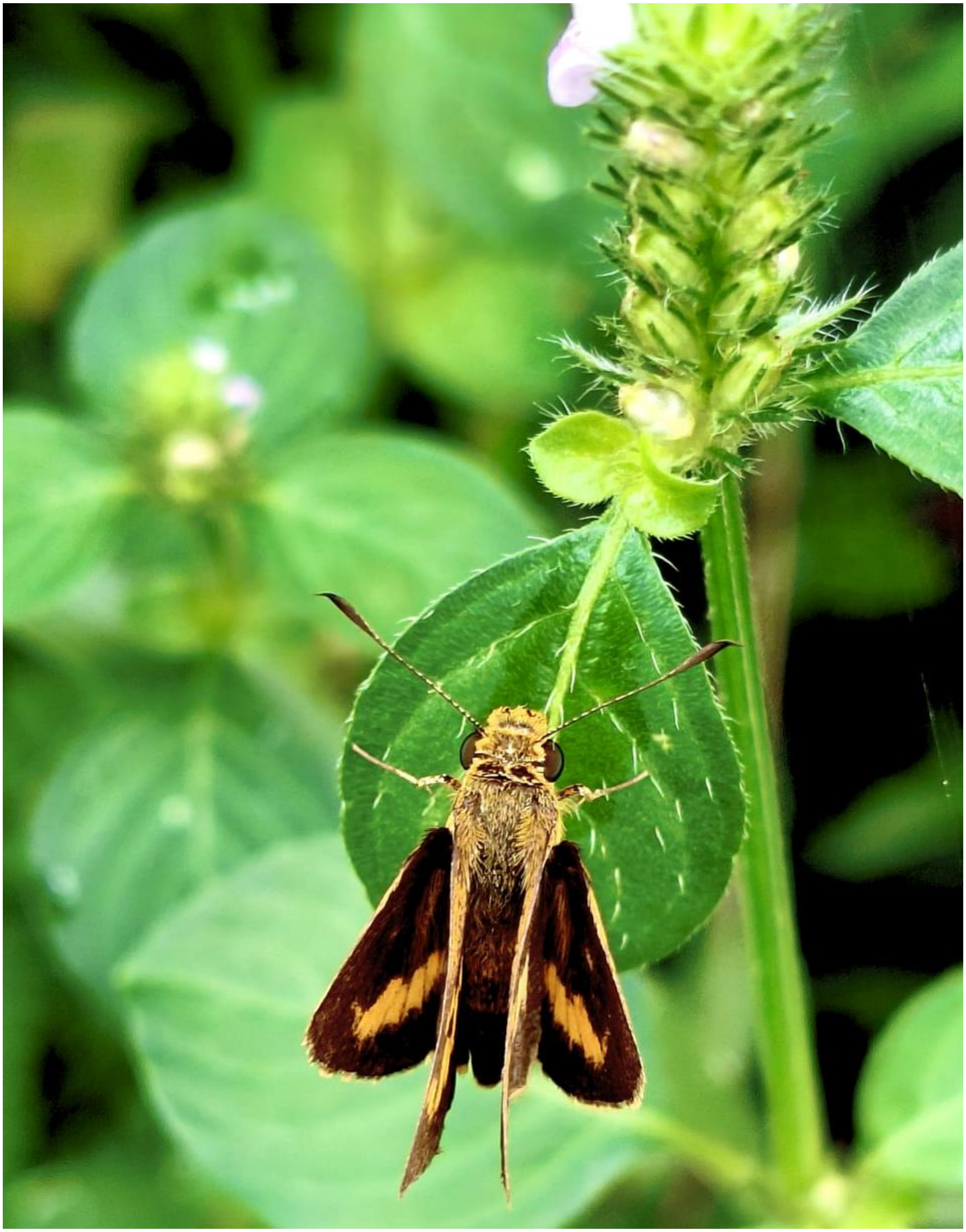

Common Dartlet, Oriens goloides (Hesperiidae: Lepidoptera)

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Common Grass Yellow, Eurema hecabe (Pieridae: Lepidoptera)
Author: *Dr. Nagaraj, D.N., Project Head (Entomologist) Ento. Proteins Pvt. Ltd., Mangalore*
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Leaf cutter Bee, Megachile sp. (Megachilidae: Hymenoptera)
Author: *Dr. Nagaraj, D.N., Project Head (Entomologist) Ento. Proteins Pvt. Ltd., Mangalore*
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Email: *nasoteya@yahoo.co.in*

Paper wasp, Ropalidia sp. (Vespidae: Hymenoptera)
Author: *Dr. Nagaraj, D.N., Project Head (Entomologist) Ento. Proteins Pvt. Ltd., Mangalore*
Location: *Bengaluru*
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Lygaeid seed Bug, Graptostethus sp. (Lygaeidae: Hemiptera)

Author: *Dr. Nagaraj, D.N., Project Head (Entomologist) Ento. Proteins Pvt. Ltd., Mangalore*
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Email: *nasoteya@yahoo.co.in*

Blue Banded Bee, Amegilla cingulata (Apidae: Hymenoptera)

Author: *Dr. Nagaraj, D.N., Project Head (Entomologist) Ento. Proteins Pvt. Ltd., Mangalore*
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Email: *nasoteya@yahoo.co.in*

Drain fly, Clogmia albipunctata (Psychodidae: Diptera)
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Tobacco Cut worm, Spodoptera litura (female) (Noctuidae: Lepidoptera)
Author: *Dr. Nagaraj, D.N., Project Head (Entomologist) Ento. Proteins Pvt. Ltd., Mangalore*
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Email: *nasoteya@yahoo.co.in*

IE Extension

Dr. Abraham Verghese Felicitated by Organizers of Biopesticide Conference at Kanyakumari, India on September 26-27, 2025

Dr. Abraham Verghese with delegates of Biopesticide Conference at Kanyakumari September 26-27, 2025

Dr. Abraham Verghese interacting with N. C. Patel at his farm in Nagadasanahalli, Dodaballapura, Karnataka

Bagging practice in guava variety 'Diamond' demonstrated by a farmer during interaction with the Rashvee team

Dr. Abraham Verghese and Dr. Rashmi interacting with N. C. Patel at his jamun farm in Nagadasanahalli, Dodaballapura, Karnataka.

Dr. Abraham Verghese being felicitaed by Home Minister, Karnataka, India on 14th Octorber 2025

Dr. Abraham Verghese with members of the Research Advisory Committee, ICAR–National Research Institute for Integrated Pest Management (NRIIPM)

Dr. Abraham Verghese in a sugarcane field with farmers and scientists at Meerut, Uttar Pradesh, India

Rashvee Team Participated in the Vigilance Awareness Programme Conducted at RPQS Bengaluru on 19th September 2025

IE Team with Staff of **Entomological Research Institute (ERI)** at Loyola College, Chennai, India

Dr. Abraham Verghese with the Participants of Conference on *"Smart Farming: Sustainable Agriculture and Entomology"* (10–11 December 2025)

Dr. Abraham Verghese as Chief guest of the two-day Conference on *"Smart Farming: Sustainable Agriculture and Entomology"* (10–11 December 2025) at **Entomological Research Institute (ERI)** at Loyola College, Chennai, India.

Best Women-Led Innovation Award from Confederation of Indian Industry (CII) at ICONN Summit 2025, The award was presented at Hyderabad by Eminent Leaders: Dr. Suchitra Ella, Co-Founder & Managing Director, Bharat Biotech International Limited Dr. Kris Gopalakrishnan, Chairman, CII Centre of Excellence for Innovation, Entrepreneurship and Startups (CIES) Advisory Board Mr. Sanjay Kumar (IAS), Special Chief Secretary, ITE&C, Government of Telangana on 24th November 2025

IE Team with Dr. C. N. Manjunath, Member of Parliament for Bangalore Rural, on 19th October 2025, during the NBAIR Foundation Day celebrations

IE team with NBAIR scientists at Butterfly Garden, NBAIR, Yelahanka campus, Karnataka, India

Dr. Abraham Verghese Presenting on "Customized Biological Control in Commercial Horticulture" at the 11th Indian Horticulture Congress and International Meet 2025, held at GKVK, Bengaluru and Being Felicitated by Dr. N. K. Krishna Kumar on 8th November 2025

IE Team with Dr. Sanjay Kumar Singh DDG Horticulture and ICAR Scientists at 11th Indian Horticulture Congress and International Meet 2025, held at GKVK, Bengaluru on 8th November 2025

IE Team at 11th Indian Horticulture Congress and International Meet 2025, held at GKVK, Bengaluru on 8th November 2025

Dr. Abraham Verghese with his classmates at the Golden jubliee celebration of Agriculture graduation from UAS, GKVK, Bengaluru on 14th October 2025

Shreenidhi Plant Health Clinic awarded by FMC India ltd in October 2025, India

Interacting with farmers at National Agriculture startup Expo organized by Krishik UAS, Dharwad on 6th December 2025

Dr. M A Rashmi with the Agriculture commissioner Sri P.K. Singh, Dr. Dolli, Head Krishik Agri Business Incubator and other dignitaries at the National Agriculture startup Expo organized by Krishik UAS, Dharwad

Dr. Rashmi MA, spoke at MLA (Maharani Lakshmi Ammanni) College for Women in Bangalore, Karnataka, on Entrepreneurship in Life Sciences, Inspiring Students on Sustainable Innovation in 11th October 2025

Dr. Rashmi MA, with Agriculture Commissioner, Secretary APEDA and other dignitaries and startups at FICCI, New Delhi on 31st October 2025

Our Extension Team at Shreenidhi Plant Health Clinic, Vijayapura, Devanahalli, Karnataka, India

Dr. Prakash visited Rashvee IPRS and formally inaugurated the newly established semi-automated filling facility at RASHVEE IPRS, Bengaluru on 25th October 2025

Dr. Abraham Verghese Chairing the technical session on Challenges in Agricultural and allied sector and pathways for empowerment and entrepreneurship at National Conference on Challenges and New Frontiers in Agriculture, Sericulture and Allied Sectors (CHANAS) College of Sericulture, UAS (B), Chintamani, Karnataka, India

Dr. Rashmi, M.A. Delivering lead Lecture at Challenges in Agricultural and Allied Sector and Pathways for Empowerment and Entrepreneurship

Rashvee Team with delegates and staff at at National Conference
on Challenges and New Frontiers in Agriculture, Sericulture and Allied Sectors (CHANAS) College of Sericulture, UAS (B), Chintamani, India on 23rd December 2025

Dr. M. A. Rashmi receiving the Appreciation Certificate for Rashvee IPRS from the Federation of Indian Chambers of Commerce & Industry (FICCI) under the "Best Biologicals Startup" category. The certificate was presented by Shri Prabhath Kumar, Horticulture Commissioner, Government of India at New Delhi on 20th December 2025

Dr. M. A. Rashmi with Sri BioAesthetics Private Limited team at FICCI Startup Summit

Glimpses of AVIAN Trust Award Ceremony 2025


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14th December 2025
Venue: Regional Plant Quarantine Station, Bengaluru, Karnataka
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