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***Cover Page:**
Melon Fruit fly, *Zeugodacus cucurbitae*
Host: Chayote (chow chow), *Sechium edule*
Photo by Dr. M. A. Rashmi

(For more details refer IE Blog No. 240
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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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Author guidelines

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

Volume 28 (1) March, 2025

IE Blog Contents

Sl. No.	Author/Authors	Date	Title of the blog
1	Abraham Verghese and Rashmi M.A	05.01.2025	Welcome to the First Blog of 2025: Highlights from IE 27(4)2024
2	Abraham Verghese and Rashmi M.A	12.01.2025	Apiculture in Rubber Plantations of Kerala, South India
3	Abraham Verghese and Rashmi M.A	19.01.2025	AVIAN Trust Awards 2024: Celebrating Deservingness
4	Abraham Verghese and Rashmi M.A	26.01.2025	Cattle Egret: A Key Bird in Conservational Biocontrol
5	Abraham Verghese and Rashmi M.A	02.02.2025	Nesting Niche Limitations for the Rock Bee, Apis dorsata
6	Abraham Verghese and Rashmi M.A	09.02.2025	Blooming Love: Pest Free Compliant Rose Exports
7	Abraham Verghese and Rashmi M.A	16.02.2025	Midge Infestation rising in Tuberose & Jasmine spp in South India
8.	Abraham Verghese and Rashmi M.A	23.02.2025	Control of Fruit Fly in Chayote (Chow Chow)
9.	Abraham Verghese and Rashmi M.A	02.03.2025	Second International Conference on Biological Control
10.	Abraham Verghese and Rashmi M.A	09.03.2025	Rashvee Plant Health Clinic: Leading in Biocontrol Extension
11.	Jayalaxmi Ganguli	15.03.2025	Establishment of Biocontrol Laboratory at College of Agriculture & Research Station, Surgi, Rajnandgaon
12.	Tintumol. K, and M.S. Uma	20.03.2025	The Buzz of Bees in Coffee

Editorial

This quarter has been rather turbulent!

To begin with, the weather- January's global average temperature increased by a striking 1.7°C, as reported by weather agencies. Across India, winter seemed to transform into an early summer, leaving no trace of spring in the air.

The turbulence extended to the geopolitical arena as well. The dramatic return of Mr. Donald Trump as President of the United States of America has shifted equations both within the U.S. and across the globe. Geo-boundaries may change, and Google Maps might need to catch up with these shifts. We look forward to remarkable advancements in science and technology, including entomology, in the years ahead under Mr. Trump.

This issue marks the beginning of the 28th volume, and as we reflect on our journey, we express our heartfelt gratitude to the authors who have richly contributed to the field of entomological sciences. Some of these esteemed contributors are no longer with us, and we reverentially remember them for their invaluable contributions.

In this context, I fondly recall the late Dr. K. L. Chadha, former Director of ICAR-IIHR and DDG Horticulture, who passed away this quarter. His tremendous encouragement and support during the formative years of Insect Environment were instrumental in shaping its vision, and his legacy continues to inspire us.

This issue features outstanding articles and reviews poised to advance insect science and pest management. Notably, the article on *Bracon* by Dr. T.M. Manjunath, a super-specialist in biocontrol, provides thoughtful direction to young professionals pursuing careers in this field. Additionally, there are several fascinating articles that highlight the nuances of insect diversity and bioecology. For example, one article discusses the landing of *Oryctes* species on moringa, a testament to the journal's commitment to recording unique insect behaviors. We eagerly anticipate more such valuable contributions in the future.

The *Insect Environment* team has discovered a glaring gap: India lacks proper documentation of extinct insects. While the estimated number of extinct insects is around 200, we may be off the mark. We urge everyone to contribute to creating a comprehensive red list of rare and extinct insects of India.

Insect Environment continues to serve authors passionate about the natural history and management of insects. Our authors are invaluable, as they lead the charge in this field. With the support of AI and a robust network of advisors and reviewers, our editorial office ensures quality and timeliness. Special thanks to Dr. M. A. Rashmi, Dr. S. Deepak (Delhi), and Ms. Salome (Muscat) for their dedication and hard work.

As part of our policy, we avoid pretentious claims of "high standards" or reliance on dry, machine-generated data, which we believe stifles the essence of natural science in entomology. We hope our authors and readers understand and appreciate this approach.

Abraham Verghese

Editor-in-Chief

IE team (from left) Dr. S. Deepak, Dr. Abraham Verghese, Dr. Subramanian Sevgan, Principal Scientist and Head of Environmental Health International Centre of Insect Physiology and Ecology (ICIPE), Kenya and Dr. M. A. Rashmi

Research Articles

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The *Bracon brevicornis and B. hebetor* complex: Reliable identification required for proper utilization and evaluation of their role in biological control

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Abstract

While once considered as one species, more detailed investigations have confirmed that *Bracon brevicornis and B. hebetor* are two distinct species based on their external genitalia and also that they do not interbreed. Besides, the two species differ in their natural habitat and host preference. The activity of *B. hebetor* is generally confined to closed environment like godowns/warehouses where they primarily parasitize the pyralid moth larvae infesting stored grains. On the other hand, *B. brevicornis* is known to prefer the lepidopteron larvae infesting several crops. Thus, the natural habitat of *B. hebetor* is indoor while that of *B. brevicornis*, is outdoor. Because of this, the choice of *B. hebetor* for augmentative biocontrol of certain field pests like the coconut black-headed caterpillar may not be appropriate, especially as it is not arboreal. Such a choice is often due to confusion regarding the correct identification of the species. Therefore, there is a need to develop reliable tools to distinguish between *B. hebetor and B. brevicornis* so as to resolve this long pending issue. These issues are discussed.

Key words: Biocontrol, *Bracon brevicornis, B. hebetor*, male genitalia, coconut caterpillar, natural habitat.

There has always been confusion with regard to the reliable identification of *Bracon brevicornis* Wesmael and *B. hebetor* (Say) (Hymenoptera, Braconidae) for several decades in India and also other countries. Because of their close external similarities, one is mistaken for the other. Unless there is clarity, their correct choice and performance in biological control cannot be properly evaluated.

Early background

As early as in 1956, Puttarudraiah and Chenna Basavanna mentioned that the differences in colour, relative proportions of antennal joints and punctation on the abdomen which were considered until then as the distinguishing characters between *Bracon hebetor* and *B. brevicornis*, are not reliable as these were found to be variable. They particularly mentioned that there is a wide range of variation in the number of antennal joints even within the progeny of a single pair of parents. They further stated that the two species interbreed and give rise to fertile offspring and, therefore, opined that there is no ground to treat them as two distinct species, at least so far as the Indian specimens are concerned, for which *Bracon hebetor* is the valid name. However, Narayanan *et al.* (1958), who reviewed the views of all the previous authors and conducted their own studies, concluded that based on their detailed morphological investigation on external male genitalia which they illustrated, the two species are distinct and it was further strengthened by their biological experiments which revealed that they do not interbreed. Like others, they also found that there was inequality in the number of antennal segments within and between the species and suggested that the reason for this complex issue needs thorough studies.

In the United States, *B. hebetor* is known almost exclusively as a parasitoid of the stored-grain infesting phycitine moths (Lepidoptera, Pyralidae) including the Indian meal moth *Plodia interpunctella* (Hubner) and the Mediterranean grain moth *Cadra* (*Ephestia*) *cautella* (Walker) (Richards and Thomson, 1932; Antolin and Strand, 1992; Brower *et al.,* 1996). However, host records from the Middle East, Africa, India and Japan indicate that *B. hebetor* attacks a number of non-pyralid Lepidoptera and occurs in both grain storages and field habitats (Whiting, 1949; Puttarudriah and Chenna Basavanna, 1956; Harakly, 1968; Gerling, 1971; Youm and Gilstrap, 1993). Based on more detailed observations made in the following years, it appears that such contrasting host records are due to some confusion in distinguishing one parasitoid species from the other.

Here is an example. A species of *Bracon* reared from the larvae of *Helicoverpa* (then *Heliothis*) *armigera* (Hubner) (Lepidoptera, Noctuidae) in India was sent from the Commonwealth Institute of Biological Control (CIBC), Bangalore, India, to the Caribbean island of Barbados during 1970–1975 for field releases against *Heliothis virescens* (Fabricius) (Cock, 1985). Since its specific identification was not confirmed at that time, it was just indicated as *Bracon* sp. The Barbados authorities sent the specimens to U.S. Dept. of Agriculture Systematic Entomology Laboratory and the species was identified as *B. hebetor* as narrated by Heimpel *et al*. (1997).

This caused confusion. *B. hebetor* was considered endemic to Barbados prior to this introduction, but was known only from the stored-grain habitats (Tucker, 1952). In the United States also it was known exclusively as a parasitoid of stored-grain pests. But, in contrast, the host of the newly identified *B. hebetor* is a field pest *i.e*., *H. armigera*. Therefore, in order to get the clarification, a series of laboratory experiments was conducted to determine whether the introduced species represented (i) a strain of *B. hebetor* that attacks noctuids in the field or (ii) a distinct species from *B. hebetor* (Heimpel *et al*., 1997).

Reciprocal crosses between the Barbados strain (introduced from India) and *B. hebetor* (local) showed that the two populations were reproductively isolated. No mating was observed during a series of reciprocal crosses, and the crosses produced only male offspring. Examination of each female's spermatheca confirmed that females were not fertilized. Sequence analysis of a 517-bp fragment of the mitochondrial 16S rRNA gene revealed that the two populations of *B. hebetor* from the laboratory were identical, but differed in sequence by 2% from the Barbados strain. Collectively, the results indicated that the Barbados strain was a distinct species from *B. hebetor* (Heimpel *et al*., 1997).

. It's not surprising that the *Bracon* species sent from India to Barbados was a distinct species from *B. hebetor.* In fact, under an exclusive project for survey of natural enemies of *Helicoverpa* in India, CIBC recorded a number of natural enemies of *H. armigera* collected from various fields across the country during the 1960s which also included two species of *Bracon* as larval parasitoids. These were subsequently identified as *Bracon* sp. (very rare) and *B. brevicornis* (also rare, but relatively more common). I had also worked closely on this project and am one of the coauthors of a detailed paper on it (Achan *et al*., 1968). We did not record *B. hebetor* as a parasitoid of *H. armigera* in India. Thus, it was not surprising that the findings of Heimpel *et al.* (1997) confirmed that the parasitoid received from India was a distinct species from *B. hebetor*. It was most probably *B. brevicornis.*

Thus, the identification of *B. hebetor* and *B. brevicornis* always caused some confusion. In a further attempt to resolve this issue, recently Rebecca Kittel & Kaoru Maeto (2019) obtained specimens of both *B. hebetor* and *B. brevicronis* from all over the world, including Barbados, and carried out detailed studies regarding their identification. Based on substantial molecular data, they reiterated that *Bracon* (earlier known as *Habrobracon*) *brevicornis* and *B. hebetor* are indeed two different species. They further stated that the cryptic species referred to by Heimpel et at. (1997) which was introduced from India, was in fact *B. brevicornis.* This, as I mentioned, is as expected.

Bracon **against the coconut black-headed caterpillar, *Opisina arenosella***

Another long-standing instance where there appears to be an uncertainty with regard to the correct identification of *B. brevicornis and B. hebetor* is related to their use in biological control of coconut black-headed caterpillar, *Opisina arenosella* (Walker) (Lepidoptera, Xylorictidae) which is a serious defoliator of coconut palms in India, Sri Lanka and a few other Asian countries. While *Goniozus* *nephantidis* (Muesbeck) (Hymenoptera, Bethylidae) is the most common parasitoid, both *B. brevicornis* and *B. hebetor* have also been reported as its larval parasitoids. While some data are available on the natural parasitism of *O. arenosella* by *B. brevicornis* in India (Kapadia, 1987; Desai *et al*., 2003) and Sri Lanka (Dharmaraju, 1963), no such natural field data are available for *B. hebetor*. However, both *B. brevicornis* and B. *hebetor* along with *G. nephantidis* have been mass-produced and utilized in augmentative biological control since the 1950s and it is claimed these releases resulted in significant decrease in the level of pest infestation (Dharmaraju, 1963; Sathiamma *et al*., 1996; Venkatesh *et al*., 2006; Chalapathi Rao *et al*., 2018). However, the extent of parasitism by each of these species following such releases was not indicated as a result the contribution of each could not be assessed.

Venkatesan *et al*. (2009) who carried out lab studies on competitive parasitism between two parasitoids, used *G. nephantidis* and *B. brevicornis*, not *B. hebetor* which is commonly reported as being used for field releases. They found *G. nephantidis* to be more dominant, but this again shows the uncertainty of identification between *B. brevicornis* and *B. hebetor*.

Chalapathi Rao and his team are continuing their efforts during 2024-25 also, making periodical sizeable releases of *G. nephantidis* and *B. hebetor* and at times *B. brevicornis* also in the East Godavari district of Andhra Pradesh (periodical messages posted by Chalapathi Rao in Biocontrol WhatsApp group). Their sustained efforts in the mass-production of biocontrol agents and their field releases involving the concerned farmers are commendable. While their choice of *G. nephantidis* is fine as it is a specific and consistent parasitoid of *O. arenosella,* the same cannot be said about *Bracon,* especially if it is *B. hebetor* as it is not arboreal. Is it really *B. hebetor* or *B. brevicornis?* The clarity with regard to the specific identification is very important in view of their different habitats as well as host preferences as earlier explained. As of now, the confusion between *B. hebetor* and *B. brevicornis* is still prevailing. It deserves to be resolved as otherwise any wrong choice will lead to unproductive efforts and unreliable results in biocontrol.

Discussion and Conclusion

The morphological similarities between *Bracon brevicornis* and *B. hebetor* are so close that there has been confusion with regard to their correct identification, for decades.

The first solution was offered by Puttarudraiah and Chenna Basavanna (1956) as early as mid-1950 who found that certain morphological features like the antennal joints are inconsistent even within the population of the same parent and that the two species interbreed and produce a fertile progeny and, therefore, suggested that the two species can be synonymized as one and be known as *B.*

hebetor. However, Narayanan *et al.* (1958) who thoroughly reviewed the views of previous authors and conducted their own detailed studies, did not agree. They emphasized that their investigation with regard to the external male genitalia revealed that the two species are distinct and it was further supported by their biological studies that they do not interbreed. Nevertheless, the external appearance of the two species are so identical that they cannot be readily distinguished and, therefore, one is mistaken for the other. For example, a species of *Bracon* sent from India to Barbados during the 1970s for trial against *Heliothis virescens* was first identified as *B. hebetor* while in reality it turned out to be *B. brevicornis* (Heimpel *et al*., 1997; Rebecca Kittel & Kaoru Maeto, 2019). This reflects the extent of confusion. It is further complicated by the fact that in India, both *B. hebetor* and *B. brevicornis* (along with *G. nephantidis*) have been mass-produced and released for control of the coconut black-headed caterpillar for decades (Dharmaraju, 1963; Sathiamma *et al*., 1996; Venkatesh *et al*., 2006; Chalapathi Rao *et al*., 2018) without any concrete evidence with regard to their specific identification. Thus, there is a need to resolve this long pending issue. We need to go beyond taxonomy and look into the preferred natural habitats and hosts of these species.

Natural habitats and hosts: The activity of *B. hebetor* is generally confined to closed environment like godowns/warehouses where they primarily parasitize the pyralid moth larvae infesting stored grains. It does not naturally parasitize crop pests. Further, those of us who have been working on biological control have realized that it is *B. hebetor* that often enters into the *Corcyra* (rice moth) (Lepidoptera, Pyralidae) breeding units in biocontrol labs and completely disrupts the production plans by heavily parasitizing the larvae. Thus, we are forced to develop technologies that prevent its entry into the culture units or to take suitable control measures to protect our *Corcyra* culture in the lab (Manjunath, 2014). In the USA, Barbados, etc. *B. hebetor* is known as an exclusive parasitoid of stored grains. However, the literature in India and a few other countries shows several field pests also as its hosts. Such records on field pests seem to be more due to confusion in its identification, but it is to be ascertained.

On the other hand, *B. brevicornis* is known to prefer the lepidopteron larvae infesting several crops in the fields. Thus, unlike *B. hebetor*, it is active outdoor. For example, it is recorded on larvae of the False American Bollworm (*Helicoverpa armigera*) infesting tomato and other crops; European corn borer *Ostrinia nubilalis* (Hubner) (Lepidoptera, Crambidae) on maize; coconut black-headed caterpillar *(Opisina arenosella*) infesting coconut leaves; tobacco cutworm *Spodoptera litura* (Fabricius) (Lepidoptera, Noctuidae) attacking various crops, etc. It is also reported on stored grain pests, but apparently these are not the preferred hosts.

Thus, the most important difference between the two is that the natural habitat of *B. hebetor* is indoor while that of *B. brevicornis*, it is outdoor. *B. hebetor* is not arboreal and, therefore, its choice for releasing in coconut gardens for control of coconut black-headed caterpillar may not be appropriate.

Those who are mass-producing *B. hebetor* or *B. brevicornis* or both, should get the species authentically identified, as otherwise, their choice of species may be faulty. A word of caution. Those who are engaged in producing both *B. brevicornis* and *B. hebetor* will have to be careful. In the first place, please ensure that the identifications are correct. Secondly, if you are culturing both, keep them in separate rooms as otherwise, *B. hebetor*, being more aggressive indoor, may displace *B. brevicornis* without your knowledge. Thirdly, to ensure the purity of cultures, periodically carry out the reciprocal crossing experiments between the two species. If they do not interbreed, the two species are intact.

When releases of biocontrol agents are made, the best way to assess their performance is to estimate the level of parasitism by each species. Often, the assessments are made based on the increase or decrease in the level of infestation/damage. This may not be reliable as the infestation levels may vary due to various other factors including the season. Regarding the identification of *B. brevicornis* and *B. hebetor*, here is an opportunity for taxonomists to utilize the latest techniques and come out with dependable tools to distinguish between the two. The correct identification, appropriate choice of the species and proper utilization of natural enemies are very important for reliable evaluation of biological control.

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Incidence of brinjal shoot and fruit borer, *Leucinodes orbonalis* Guenee (Lepidoptera: Pyralidae) on potato in Biswanath district, Assam, India

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Abstract

Potato (*Solanum tuberosum* L.), known as the 'King of Vegetables,' is a crucial food crop in India, rich in essential nutrients and valuable for industrial use. However, over 100 insect pest species attack potato plants, significantly reducing their yield potential. Among these pests, the brinjal shoot and fruit borer, *Leucinodes orbonalis* Guenee, has emerged as a destructive and ubiquitous pest in recent years, causing heavy yield losses. This study reports the occurrence of *Leucinodes orbonalis* on potato plants in the Biswanath district of Assam, India. During a field experiment conducted at Biswanath College of Agriculture, Assam, during the rabi season of 2022-23, the pest was observed infesting true potato seeds, previously unreported in this region. The study highlights the need for extensive surveys and intensive research to understand the pest's biology, population dynamics, and effective management strategies on potato crops. The findings underscore the significance of adopting sustainable pest management practices to mitigate yield losses and ensure the quality of potato produce.

Introduction

Potato (*Solanum tuberosum* L.), popularly known as 'The king of vegetables,' is one of the most important food crops in India, following rice, wheat, and maize. It is rich in vitamin C, vitamin B1, and various minerals. Additionally, it is a good source of carbohydrates (20.6%), protein (2.1%), fat (0.3%), crude fiber (1.1%), and ash (0.9%) (Kumar et al., 2011). Industrially, potatoes are valued for their starch (farina) in textile mills and the alcohol industry (Singh et al., 2018).

More than 100 species of insect pests attack potato plants, lowering yields and preventing crops from reaching their full potential (Chandel *et al*., 2013). These insect pests can significantly reduce plant establishment, plant populations, and subsequent yield potential. Among these pests, the brinjal shoot and fruit borer, *Leucinodes orbonalis*, has recently become the most destructive and ubiquitous pest, causing heavy yield losses in potato crops. The pest was first reported on potato in Karnataka as early as 1965 (Nair, 1967). Similarly, it was reported from Ranchi on potatoes grown during the rainy season, where shoot damage varied from 36% to 42% (Mishra and Mishra, 1996). The pest is also known to feed on potato foliage in Africa and South Asia (Hill, 1993). As a monophagous pest, it can cause significant yield losses ranging from 55-65% or even up to 100% without control measures, impacting both the yield and marketable quality of brinjal (Rahman, 2007). In India, losses have been recorded up to 95% (Naresh et al., 1986). This cosmopolitan pest also attacks other solanaceous crops like potato and tomato (Lall and Ahmad, 1965).

Material and Methods

A field experiment conducted during the rabi season of 2022-23 at the Post Graduate experimental plot of Biswanath College of Agriculture, Biswanath Chariali, Assam, reported four soil insect pests (Dutta *et al.*, 2024). During this investigation, in addition to these soil insect pests, the brinjal shoot and fruit borer, *Leucinodes orbanalis* Guenee (Lepidoptera: Pyralidae), was also observed as a pest on potato plants. These potatoes, planted in the first week of October 2022, were infested during the investigation period (Plate 1). Previously, Boopal *et al.* (2013) confirmed that potato is a suitable alternative host for the brinjal shoot and fruit borer. Infested true potato seeds were collected from the field and kept in the laboratory for the emergence of adult insects. The emerged moths were dirty white with dull yellow-black forewings, brown markings, and hind wings with black lines (Plate 2), confirming the pest to be *L. orbonalis*.

Plate 1. True potato seed infested by brinjal shoot and fruit borer

Plate 2. Adult moth of brinjal shoot and fruit borer

Conclusion

This report highlights the occurrence of brinjal shoot and fruit borer infestation on potatoes in the rainfed upland areas of Biswanath district, Assam. No previous reports from this region have been recorded. Surveys must be conducted in different regions of the state to study the extent of pest infestation on potatoes. Although extensive studies on this pest are available for brinjal, its preferred host, intensive research is needed to understand the biology, population dynamics, nature of damage, extent of infestation, and effective management strategies for this pest on potatoes in this region.

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Common lepidopterans in and around NPKL 4th Block Lake, Bheemanakuppe, South Bengaluru

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Insects play a vital role in maintaining ecological balance, contributing to more than half of all the species on Earth (Prabakaran *et al.*, 2014). Among them, Lepidoptera exhibit remarkable diversity, with over 150,000 species documented globally (Nieukerken, 2009). This diverse order includes approximately 17,500 species of butterflies, of which 1,500 species are native to India (Kunte *et al*., 2024). Likewise, out of the estimated 160,000 species of moths worldwide, India is home to around 10,000 species (Sondhi et al., 2023).

Butterflies being the most extensively studied group within Lepidoptera (Robbins and Opler, 1997), are considered essential indicators of the ecological conditions of their habitats (Tekulsy, 2015). Their presence and diversity provide valuable insights into habitat health and biodiversity.

The current study focuses on the short-term documentation of Lepidopteran species in and around Nada Prabhu Kempegowda Layout (NPKL), 4th Block Lake, located in Bheemanakuppe, South Bengaluru (coordinates: 12.91442265419682, 77.4342195876245). This lake spans an area of approximately 32,750 square meters, as determined using Google Earth Pro.

Previous research in nearby localities, such as Asirvanam, documented 12 species of Lepidoptera (Kumar *et al*., 2023). These findings underscore the importance of continued documentation and research to better understand the Lepidopteran diversity and its ecological significance in urban and semi-urban environments.

This study was conducted during the mid-winter season of 2024, spanning from 24th February to 31st April. The survey was carried out across three intervals: the morning session (10:00 AM to 12:00 PM), the evening session (2:30 PM to 4:00 PM), and the night session (7:30 PM to 8:30 PM). A random sampling method was employed for data collection. Mobile photography and DSLR cameras were utilized to capture images of Lepidoptera observed during the survey. Identification of the species was performed using a field guide by Tekulsy (2015).

A total of sixteen Lepidopteran species (Figs. 1–16) belonging to four families were recorded: Nymphalidae (62.5%), Papilionidae (12.5%), Pieridae (12.5%), and Erebidae

(12.5%). Among these, Nymphalidae emerged as the dominant family with ten species, while Papilionidae, Pieridae, and Erebidae each contributed two species.

Diversity indices calculated for the study revealed significant findings:

Simpson's Index (D): 0.0685

Simpson's Index of Diversity (1 - D): 0.9315

Shannon-H Index (H'): 2.476

Evenness Index (E): 0.893

These values indicate that the Lepidopteran species documented in the study area are both diverse and evenly distributed. The Relative Diversity Index (RDI) was highest for Nymphalidae, at 1.000.

The common flora in the area include *Pongamia pinnata*, *Ricinus communis*, *Lantana camara*, and *Ficus benghalensis*. Anthropogenic impacts were observed near the lake, as reported by Harrington and Jayshankar (2023) and Aleena et al. (2024).

This short-term study successfully recorded sixteen Lepidopteran species across four families. Notably, *Pachliopta hector* (Crimson Rose) and *Papilio castor* (Common Raven) were documented as Schedule II species under The Wildlife Protection Act, 1972. The findings highlight the need for further studies focusing on the spatiotemporal diversity of Lepidoptera to gain a more comprehensive understanding of their ecological roles.

S.no	Scientific Name	Common Name	Family	RDI	WPA, 1972	No of Sightings
1	*Danaus genutia*	Common Tiger	Nymphalidae	66.74	-	29
2	*Tirumala limniace*	Blue Tiger			-	17
3	*Euploea core*	Common Crow			-	54
4	*Phalanta phalantha*	Common Leopard			-	26
5	*Junonia lemonias*	Lemon Pansy			-	31
6	*Junonia iphita*	Chocolate Pansy			-	22
7	*Junonia hierta*	Yellow Pansy			-	34
8	*Hypolimnas bolina*	Blue Moon			-	29
9	*Ariadne merione*	Common Castor			-	34
10	*Acraea terpsicore*	Tawny Coster			-	31
11	*Atrophaneura hector*	Crimson Rose	Papilionidae	14.57	Sch II	48
12	*Papilio castor*	Common Raven			Sch II	19
13	*Eurema hecabe*	Common Grass Yellow	Pieridae	15.65	-	48
14	*Anthocharis cardamines*	Small Orange tip			-	24
15	*Creatonotos transiens transiens*	---	Erebidae	3.04	-	6
16	*Rajendra perrottetii*	---			-	8

Table 1. Details of butterflies sighted during the present observations

Fig 1. *Danaus genutia*

Fig 2. *Tirumala limniace*

Fig 3. *Euploea core*

Fig 4. *Phalanta phalantha*

Fig 5. *Junonia lemonias*

Fig 6. *Junonia iphita*

Fig 7. *Junonia hierta*

Fig 8. *Hypolimnas bolina*

Fig 9. *Pachliopta hector*

Fig 10. *Papilio castor*

Fig 11. *Ariadne merione*

Fig 12. *Acraea terpsicore*

Fig 13. *Eurema hecabe*

Fig 14. *Anthocharis cardamines*

Fig 15. *Creatonotos transiens transiens*

Fig 16. *Rajendra perrottetii*

This study highlights the diverse and evenly distributed Lepidopteran fauna around NPKL 4th Block Lake, with Nymphalidae emerging as the dominant family. The findings emphasize the importance of continued research to better understand their ecological roles and conservation needs.

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Review articles & Short notes

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SPLAT: Cutting edge techniques for sustainable pest management

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Abstract

SPLAT (Specialized Pheromone and Lure Application Technology) is an innovative "matrix-type" or "monolithic" diffusion-controlled release system that encapsulates active ingredients within slow-release carrier materials. This eco-friendly technology is highly effective for pest management strategies, including mating disruption, attract-and-kill, and repellent approaches using selective insecticides. SPLAT offers significant advantages over conventional methods, as it is non-toxic, safe for humans, pets, and the environment, and supports sustainable agricultural practices. Field studies have demonstrated its efficacy across various crops and pests.

SPLAT-PBW, applied at 1250 g per acre, significantly reduced male moth trapping and locule damage in Bt cotton compared to conventional practices. SPLAT-BSFB, at 500 g per acre, showed superior results with minimal shoot and fruit damage in brinjal. In mango orchards, SPLAT-MAT spinosad ME provided season-long control of fruit flies without requiring lure replacement, proving to be an economical and effective solution. SPLAT-Verb protected trees within an 11-meter radius from mountain pine beetle attacks, while SPLAT-YSB demonstrated effective control of yellow stem borer in rice fields. This novel approach fills critical gaps in integrated pest management programs by effectively controlling dreaded pests. Its environmentally friendly formulation makes it a valuable tool for advancing sustainable pest management practices.

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Key words: SPLAT, Semiochemicals, SPLAT- PBW, SPLAT-BSFB, SPLAT- ME+ spinosad

Semiochemicals are species-specific substances that eliminate resistance and are approved for organic farming. They are safe for humans and the environment. For over a century, semiochemicals have been used to control insect pests. Insects release chemical substances called pheromones, which are semiochemicals that influence the behavior of other insects of the same species. Based on their impact on recipient insects, they are commonly classified as sex pheromones, aggregation pheromones, alarm pheromones, and trail pheromones.

The primary barrier to the widespread use of these technologies is the high cost of semiochemicals. They are generally very expensive. The economic infeasibility is not due to the original cost but the method of deploying them in the field (Karlson and Butenandt, 1959).

Synthetic pheromones and some insecticides require an appropriate delivery system to optimize and regulate their release, ensuring effective insect attraction for the desired period, as they are volatile. ISCA Technologies Incorporation, U.S.A. acquired Specialized Pheromone and Lure Application Technology (SPLAT) in 2004. In collaboration with colleagues in academia, government, and industry, ISCA Technologies developed SPLAT-based insect pest control products. SPLAT, used as a dollop, paste, or emulsion, releases semiochemicals at the optimal rate for the desired period while protecting active components from degradation. SPLAT formulations have been commercialized both domestically and internationally (Mafra-Neto et al., 2013).

What is SPLAT?

SPLAT is a specialized pheromone formulation that has a paste-like consistency. It is a non-Newtonian formulation, meaning its viscosity decreases when subjected to stress, such as stirring or pumping, and increases again when the stress is removed. The aqueous component of the formulation gives the product its liquid character, allowing it to flow. These products are designed to release semiochemicals for durations ranging from 2 weeks to 6 months (Mafra-Neto *et al*., 2013).

SPLAT, a controlled-release emulsion, is a versatile technology designed to deliver a wide array of compounds, including semiochemicals, pesticides, and phagostimulants. It safeguards these compounds from degradation under various environmental conditions. Since 2004, SPLAT® formulations have been effectively commercialized and implemented in pest management programs worldwide (Roy *et al.*, 2024).

Fig. 1. SPLAT applied at the base of petiole (Source: Kishore and Sowmya, 2024)

Mechanism of SPLAT

It is a unique controlled-release strategy which is designed to dispense and protect a wide range of active compounds, such as semiochemicals, pesticides, and phagostimulants, from degradation in various environments. The formulation involves embedding active ingredients within a carrier material that enables gradual release. In diffusion-controlled release devices, the release rate of the active compound is governed by its diffusion through the device. The movement of the active substance, dissolved in the matrix, occurs via diffusion and adheres to Fick's First Law. After applying SPLAT in the field, water evaporates, and the active ingredients are released at a steady rate over time (Mafra-Neto et al., 2014).

Applications of SPLAT for insect-pests management

1. Mating Disruption

The presence of artificial sex pheromones in the environment deters or prevents the mating of insects, reducing fecundity and subsequent populations. The artificial introduction of sex pheromones is required to achieve mating disruption, which results in a loss of fitness among females of the target species due to delayed mating. Examples include SPLAT-PBW for pink bollworm and SPLAT-BSFB for brinjal fruit and shoot borer.

Field studies have shown that SPLAT-BSFB, applied at 500 g per acre, was significantly superior to other treatments, resulting in less shoot and fruit damage, the lowest number of male moths trapped, and the highest yield in brinjal at Raichur, Karnataka (Shridhara, 2018). In Bt cotton at Raichur, Karnataka, the lowest number of male moths of pink bollworm were trapped, resulting in the lowest locule damage, the lowest green boll damage, and the highest cotton yield from plots treated with SPLAT-PBW at 1250 g per acre compared to farmers' practices (Shrinivas et al., 2019).

In Junagadh, Gujarat, plots treated with 1200 g of paste (uniformly distributed in 1000 dots between two branches) containing sex pheromones for brinjal shoot and fruit borer showed significantly superior results over farmers' practices, with the lowest male moths trapped and less shoot and fruit damage (Anonymous, 2020).

The SPLAT pheromone treatment effectively decreased pink bollworm infestation, reducing green boll damage and increasing seed cotton yield to 28.85 q/ha in 2018–19 and 26.50 q/ha in 2019–20, proving to be a financially feasible method for controlling pink bollworm in Bt cotton (Patil *et al.*, 2022).

The most effective dose of SPLAT-YSB for yellow stem borer was determined to be 10 g per hectare with 1000 source points, which uniformly saturated the field and assisted in the successful control of the yellow stem borer (Badari et al., 2023). The SPLAT formulation uses gossyplure pheromone in a wax-based paste applied as peanut-sized dollops (400–500 per acre) at predetermined intervals after sowing. These dollops emit high doses of pheromone, confusing male moths and interfering with mating. For best results, each location should cover at least 25 acres (Acharya *et al.*, 2023).

SPLAT-Tuta, applied at 500 g per acre in different areas, significantly reduced leaf damage (5.91% & 3.18%) and fruit damage (2.49% & 2.08%) by Tuta absoluta (Meyrick) compared to conventional farmers' practices (25.09% and 24.06%, respectively) (Sreenivas et al., 2023).

2. Attract and kill formulations

Attract and kill formulations attract males, females, or both sexes of an insect-pest species to an insect control agent (insecticide). Upon contact or ingestion of the toxicant, the target insect either dies or suffers injurious effects, resulting in a reduced population of insect pests. For example, SPLAT-MAT spinosad ME is used for fruit flies.

SPLAT-ME+ spinosad was found to be the most effective treatment, capturing the highest number of fruit flies in weeks 7 to 12, and compared favorably with the present standard of Min-U-Gel ME+ naled in a guava orchard in Hawaii (Vargas et al., 2008). SPLAT-MAT spinosad ME was found to be the most effective lure, providing season-long attraction of fruit flies without the need to change the lure throughout the entire fruiting season. This method proved superior to ME traps and ME+ DDVP traps. Using two traps per acre with SPLAT-MAT spinosad was found to be economical in a mango orchard at Raichur, Karnataka (Vanitha, 2014).

3. Repellent

Repellents are compounds that deter insects from finding, feeding and ovipositing on an attractive host. SPLAT is well-adapted for dispensing volatile insect repellents.

These chemicals are often best suited for controlling a limited number of insect species in specific crops. For example, SPLAT-Verb is used for mountain pine beetle control. Trees treated with SPLAT-Verb within an 11-meter radius avoided mass attacks by the mountain pine beetle, *Dendroctonus ponderosae* Hopkins, in the U.S.A. (Mafra-Neto et al., 2015).

Ambrosia beetles, vectors of laurel wilt in tree systems, were managed in avocado orchards using a synthetic push-pull approach. Verbenone, dispensed via the SPLAT matrix at the tree base, acted as a repellent ("push"), while ethanol-baited traps attracted beetles ("pull"). This method effectively removed beetles and increased trap-capture diversity, crucial for targeting multiple beetle species (Rivara et al., 2020).

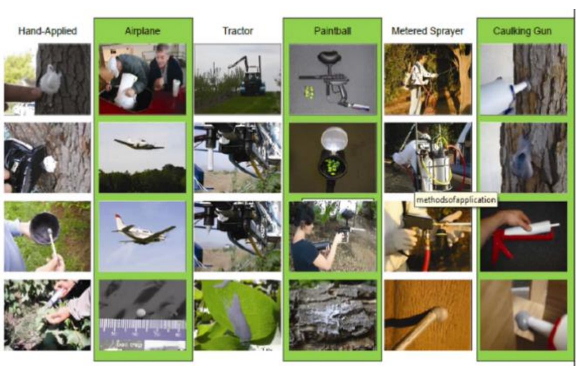

Fig. 2. Methods of application of SPLAT
(Source: Pawar *et al.*, 2022)

Methods of application of SPLAT

The most basic SPLAT applicator should be a stick, spatula or knife. More advanced manual applicators are syringes, grease guns and caulking guns. Mechanical applicators are motorized vehicles, like tractors, all-terrain vehicles and even motorcycles. It has also been applied aerially (Mafra-Neto *et al.*, 2013).

Advantages of SPLAT (Kumar *et al.*, 2023)

- There is no need of traps.
- It does not affect non-target species.
- Field activity is longer than any other technique available.
- No need to handle toxicants or other components for store or mix.
- Multiple methods are available for its application.
- It protects the attractant and toxicant components from environmental decay (*via* rain or UV light).
- It is non-toxic which is safe for humans, pets and the environment.
- It is certified by US EPA.
- There is a low risk of resistance development.

SPLAT offers several advantages over traditional pheromone dispensers, including versatile application methods suitable for both small-scale and large-scale operations. Its adaptable strategies allow the same amount of active ingredient to be used effectively in different scenarios. The formulation is rain-resistant, biologically inert, and biodegradable, ensuring environmental safety. Unlike conventional semiochemical dispensers, SPLAT is not limited to a fixed point source size. Any quantity of SPLAT can serve as a point source, offering flexibility to optimize application rates and field coverage effectively (Mafra-Neto *et al.*, 2015). Additionally, SPLAT provides season-long protection and other benefits, making it a reliable and efficient choice for pest management (Pawar *et al.*, 2022).

Table 1. Different products of SPLAT® available in market

	Registered product	**Target pests**
SPLAT for mating disruption	HOOK® TUTA	Tomato pin worm, *Tuta absoluta* (Meyrick)
	SPLAT® MAT CL	Melon fruit fly, *Bactrocera cucurbitae* (Coquillett)
	SPLAT® MAT TML	Mediterranean fruit fly, *Ceratitis capitata* (Wiedemann)
	SPLAT® SWD	Pomace fruit fly, *Drosophila suzukii* (Matsumura)
SPLAT for attract and kill	SPLAT® GM	Gypsy moth, *Lymantria dispar* (Linnaeus)
	SPLAT@YSB	Paddy yellow stem borer, *Scirpophaga incertulus* (Walker)
	SPLAT® Tuta	Tomato pin worm, *Tuta absoluta* (Meyrick)
	SPLAT® Cydia	Codling moth, *Cydia pomonella* (Linnaeus)
	SPLAT® OFM	Oriental fruit moth, *Grapholita molesta* (Busck)
	SPLAT® EC	Carob moth, *Ectomyelois ceratoniae*(Zeller)
	SPLAT ®OrB	Oriental Beetle, *Anomala orientalis*(Waterhouse)
	SPLAT® PBW	Cotton pink bollworm, *Pectinophora gossypiella* (Saunders)
	SPLAT® CLM	Citrus leaf miner, *Phyllocnistis citrella* Stainton
SPLAT as repellent	SPLAT® VERB	Mountain pine beetle, *Dendroctonus sponderosae* Hopkins
	Hook™ RPW	Coconut Red Palm Weevil, *Rhynchophorus ferrugineus* (Olivier)

(Source: Mafra-Neto *et al.*, 2014 and Pawar *et al.*, 2022)

Summary

SPLAT is highly effective for various management strategies, including monitoring and trapping programs, mating disruption, and attract-and-kill approaches using selective insecticides. It takes into account the behavior and ecology of target pests, non-target organisms, and host plants. SPLAT stands out among commercial semiochemical dispensers by providing a matrix capable of dispensing a wide range of active compounds, which can be applied using virtually unlimited manual and mechanical techniques. This novel technology helps to "fill in the gaps" in existing insect pest management programs. It offers an effective way to manage challenging pests like pink bollworm, fruit flies, and brinjal fruit and shoot borer without harming the environment.

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The role of insects in pollination of medicinal plants

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Abstract

Insects are vital pollinators for medicinal plants, playing a significant role in their reproduction and yield. This review highlights the essential contributions of various pollinators, including bees, butterflies, moths, and flies, in enhancing seed production, genetic diversity, and the production of valuable bioactive compounds. Pollinators such as *Apis* bees and non-*Apis* species have been shown to improve seed set in plants like basil, rosemary, and dill. However, declining pollinator populations, driven by habitat loss, pesticide use, and climate change, threaten the sustainability of medicinal plant cultivation. Conservation efforts, including habitat restoration and reduced pesticide use, are crucial to protect pollinators and ensure continued plant productivity.

Introduction

Insects like bees (Chetan and Vijayakumar, 2024) and syrphid flies (Netwal *et al.*, 2024) play a crucial role in the pollination of many plant species, facilitating the reproduction of plants that are essential for both ecological balance and human use (Kalita and Das, 2023). Among these, medicinal plants hold particular significance due to their widespread use in traditional and modern medicine, contributing to the treatment of various ailments and forming the foundation of many pharmaceutical products (Suntar, 2020). Pollinators like bees, butterflies, and moths are commonly associated with agricultural crops, their contribution to the pollination of medicinal plants (Mazumdar *et al.*, 2024) is equally important but often underappreciated. This review explores the pivotal role of insects in pollinating medicinal plants, examining their impact on plant reproduction, the production of valuable bioactive compounds, and the broader implications for the medicinal plant industry

Importance of Medicinal Plants

Medicinal plants are increasingly recognized globally for their therapeutic benefits and minimal side effects, making them an appealing alternative to synthetic medications (Zahra *et al*., 2020). These plants hold significant ethnopharmacological importance and are vital for healthcare, particularly in India, which hosts a wide variety of medicinal plants. These plants produce secondary metabolites essential for environmental adaptation and are extensively used in pharmaceuticals (Srivastava et al., 2020). The reproductive biology of many medicinal plants relies on insect pollinators (Xiao *et al.,* 2020) or other mechanisms (Rashid *et al*., 2023) for fruit set. A study by Venkatesh et al. (2024) found that different bee species could increase seed set in Lamiaceae plants by up to 64%.

Insects Involved in Pollination

Bees play a crucial role in the pollination of medicinal plants, particularly in the Lamiaceae family. Venkatesh et al. (2024) reported that hymenopteran visitors significantly increased seed set in these plants. Similarly, Apis species pollinate plants like *Eleutherococcus trifoliatus* and Berberis spp. (Xiao *et al*., 2020; Badoni and Arya, 2022). Solitary bees, such as *Melissodes*, have shown a high pollination efficiency in *Echinacea angustifolia* (Anon, 2012). Additionally, Megachile spp. emerged as the dominant non-Apis pollinators of medicinal plants (Abrol *et al*., 2024). Moths and butterflies also contribute significantly, especially to night-blooming flowers like Caribbean sage (*Salvia arborescens*, Lamiaceae) (Reith and Zona, 2016). Their long proboscis allows them to access nectar from deep corollas (Mazumdar *et al*., 2024). The genus Berberis in Nainital revealed Lepidoptera as the dominant pollinators (Badoni and Arya, 2022). Although lavender is visited by hymenopterans, dipteran flies, and lepidopterans, bees had higher visitation rates (Benachour, 2017). Dipteran flies are significant pollinators, available year-round, unlike bumblebees and honeybees (Mitra *et al*., 2005). Mitra *et al*. (2005) identified 38 species of dipteran pollinators associated with medicinal plants in India. Xiao *et al.* (2020) reported syrphids and tachinids visiting *Eleutherococcus trifoliatus*, while dipterans also visited Berberis. Floral scents attract pollinating beetles, which favor dull-colored flowers (Paul *et al*., 2022).

Pollinators and yield in medicinal plants

Pollinators are vital for the growth and reproduction of medicinal plants, facilitating pollen transfer and enhancing seed production and genetic diversity. Approximately 85% of medicinal plants benefit from insect pollination, which is critical for their reproductive success (Kozuharova *et al*., 2020). Diverse bee species, including *Apis* and non-*Apis* bees, significantly increase seed set in plants like basil (*Ocimum basilicum*), catnip (*Nepeta cataria*), *Leucas aspera*, and rosemary (*Rosmarinus officinalis*). Open pollination, facilitated by these pollinators, leads to a substantial increase in seed production—up to 64% compared to bagged conditions (Venkatesh *et al*., 2022).

Open pollination in dill (*Anethum graveolens*), supplemented with a 10% jaggery solution, resulted in the highest seed yield of 1505.63 kg/ha, a 57% increase over control plots. This method also improved the thousand-seed weight by 96% and essential oil content by 27%. The study identified diverse pollinators, including *Apis florea, A. dorsata, A. mellifera*, and various flies, emphasizing the importance of conserving pollinator habitats for high seed yields and quality (Meena et al., 2022).

Coriander plants pollinated by honeybees had a 29.70% higher seed yield compared to those not pollinated by any insects. Significant improvements were observed in the flowering period, shading time, number of capsules, thousand kernel weight, and total seed yield per hectare with honeybee pollination (Tesfaye *et al*., 2020). In Assiut Governorate, Egypt, the efficiency of honeybees in pollinating anise plants was studied during the 2008 and 2009 seasons. Open pollination produced the highest seed yield of 1024.12 kg/feddan, followed by honeybee-mediated pollination at 781.55 kg/feddan. The lowest yield, 300.24 kg/feddan, was recorded under insect exclusion conditions (Abd *et al*., 2011).

Cause for pollinator decline and conservation efforts

Pollinator declines, caused by habitat loss and pesticides, threaten biodiversity and agricultural productivity (Kozuharova *et al.*, 2020). Pesticides can cause direct mortality, but even sub-lethal doses can harm bees and other pollinators by impairing their navigation and foraging abilities (Mullin *et al.*, 2010). Introduced plants and animals can harm pollinator habitats (Green, 2016). Non-native shrubs like autumn olive and multiflora rose can overrun open fields, displacing essential wildflowers. Japanese barberry shades native plants that feed bumble bees, while non-native garlic mustard attracts West Virginia white butterflies, leading to poor caterpillar development. Additionally, European honey bees may compete with native bees for pollen and nectar (Dar *et al.,* 2017). Research indicates that climate change is expected to disrupt the intricate relationship between insect pollinators and the plants that rely on them for reproduction (Goulson, 2003).

To enhance foraging habitats, incorporate a variety of plants that bloom at different times, ensuring a continuous supply of nectar and pollen throughout the seasons (Sidhu *et al*., 2016). Establish nesting areas with suitable soil conditions or by incorporating tunnel-filled wood and appropriate nesting materials (Dar, 2016). Minimize threats to bees posed by insecticides and herbicides, as these can directly harm pollinators or the plants they depend on (Dar et al., 2017). Conservation of pollinators can also be achieved through beekeeping, where beekeepers manage honey bees to maintain healthy colonies, fulfill pollination contract standards, or produce marketable quantities of quality honey. Additionally, bumblebees can be cultivated in boxed colonies for use in greenhouse and field pollination (Wojcik, 2021).

Conclusion

Insects play a pivotal role in the pollination of medicinal plants, which is essential for their growth, reproduction, and genetic diversity. The intricate relationship between medicinal plants and their insect pollinators not only ensures effective pollen transfer but also enhances seed production and the quality of bioactive compounds. However, the decline in pollinator populations due to habitat loss, pesticide use, and climate change poses a significant threat to the sustainability of medicinal plant cultivation. Therefore, it is imperative to implement conservation strategies such as habitat restoration, reduced pesticide use, and the promotion of beekeeping and other pollinator-friendly practices. By safeguarding pollinator populations, we can ensure the continued productivity and health of medicinal plants, which are invaluable for their therapeutic benefits and ecological contributions

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Self-medication: An alternative defense mechanism in insects

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Abstract

It is commonly known that animals such as chimpanzees, dogs, cats, and elephants use medicinal plants to heal themselves when they encounter microorganisms. Insects are similar to other living things in many ways. Insects such as fruit flies, bees, ants, and butterflies feed and collect non-medical compounds that serve as both preventative and therapeutic treatments for their illnesses. In social insects, self-medication not only benefits the individual but also boosts the colony's immune system. According to recent study, self-medication may be both an innate and a learning habit. Previously, it was thought to be a learnt behavior acquired *via* experience. Furthermore, insects may use self-medication as an alternative defense mechanism to shield themselves from any microbial invaders when other defense systems are ineffective.

Keywords: Self- medication, insect, defense, behavior

Introduction

Ever wonder what would happen if we took medication without consulting a doctor? It will be considered as substance abuse. However, things work quite differently in the world of insects, and, astonishingly, they don't require medical consultation as we do. What occurs, then, when they fall sick?

Insects and other animals have developed their own way of medication, often without the need for any medical consultation. This phenomenon is known as *zoo-pharmacognosy*, a term coined in 1987 by researchers Eloy Rodriguez and Richard Wrangham. Originally, it referred to the use of medicinal plants by animals, but recent studies have broadened the scope to include a variety of non-food substances like clay, soil, and insects to treat illness or infections. For example, chimps consume *Aspilia* plants, which have anti-parasitic properties, to eradicate parasites or rub insects on wounds when they become infected (Huffman 2001; Bakalar 2022). It was reported that Mahale's sick chimpanzees when consumed the medicinal herb *Vernonia amygdalina* (Compositae), their health was significantly improved, leading to the hypothesis that chewing bitter piths of *Vernonia amygdalina* had therapeutic advantages. In similar manner citrus and citronella are used by capuchin monkeys for self-cleaning and pest defence (Santos 2019). The "anting" activity of birds, in which the bird intentionally rubs ants into its feathers, is the best example of topical application. Ants may be protecting themselves from ectoparasites as a result of this activity (Wolf and Clayton 1993).

According to recent research by Hawley (2021), the primary goal of zoo-pharmacognosy is to preserve intestinal health through oral consumption and topical application of non-substance material. Self-medication in animals is typically aimed at improving their health, particularly by addressing parasitic infections. It is defined as the use of substances to treat or alleviate symptoms of a disease and may involve both ingestion and topical applications. The substances used in self-medication can come from various sources, such as plants, microorganisms, fungi, or other animals. For instance, male Great Bustards hunt blister beetles before the mating season to lessen the intestinal bacteria that cause sexually transmitted diseases and other conditions when given in the right quantity (Bravo 2014). Brazilian female woolly monkeys consume leaves to increase their levels of progesterone and estrogen, which they subsequently use as a form of birth control or, under ideal circumstances, to promote conception (Shurkin 2014).

Criteria for Self-Medication

For a behavior to be considered true self-medication, it must meet three basic criteria, according to researchers Clayton and Wolf (1993):

1. The substance must be deliberately chosen.
2. The substance must harm one or more parasites.
3. The harm to the parasites must improve the host's fitness (i.e., help the host survive or recover).

The first criterion distinguishes self-treatment behavior from other phenomena, such as the role of enemy-free space in determining niche breadth and tritrophic interactions (Ode, 2006), The other two, however, are self-evident: a substance cannot be deemed therapeutic if it does not improve host fitness and reduce parasite fitness. The three criteria listed above are insufficient because they fail to account for the impact of ingested organic substances that are not always produced from plants (Singer *et al*. 2009). It led to the formulation of the fourth criterion *i.e* the substance must have a harmful effect on the host if used inappropriately or without a parasitic infection. This helps differentiate self-medication from simple dietary choices, where substances may be ingested without any harmful effects unless consumed in large quantities (Singer *et al*., 2009).

In self-medication both qualitative and quantitative behavioral responses are possible. Quantitatively, where the individual utilizes more of the substances found in their natural environment to make up for the loss of or to resist disease, as opposed to qualitatively, when the individual adopts new substances into their behavior (Lozano 1998).

Self-Medication in Insects

Insects, like other animals, engage in two main types of self-medication:

a) Prophylactic medication

b) Therapeutic medication

Prophylactic medication-

Prophylactic medication means self-treatment before infection, similar to how social insects gather resin before becoming ill or diseased to increase immunity in the colony (de Roode and Hunter 2018). Resin has been shown to reduce the bacterial load in bee colonies (Simone *et al*., 2009). Monarch butterflies choose the ovipositional location which is rich in cardenolides to limit parasites (virulent protozoan *Ophryocystis elektroscirrha*) (Hoogshagen *et al*., 2023). Uninfected monarchs also contribute to parasite protection in their progeny through prophylaxis and by trans generationally treating their offspring when they get infected with parasites. Both male and female butterflies provide cardenolides to eggs, which then shield the hatchlings from parasite infection (Lefèvre *et al*. 2010).

Therapeutic self-medication-

Medication administered after an insect has been parasitized or infected is known as therapeutic self-medication example sick *Drosophila melanogaster* selects rotting fruit with a particular proportion of alcohol for oviposition and endoparasitoid wasps infected larvae preferentially consume toxic levels of alcohol to which might be harmful to the healthier ones to get rid of parasitization (Kacsoh *et al*., 2013). Collected alcohol kills the wasp larvae by interfering with their growth in order to protect the fruit flies (Ferreira 2015). Similar to this, it has been observed that *Drosophila melanogaster* exposed to the parasitoid wasps *Leptopilina boulardi* and *L. heterotoma* prefer foods with high alcohol content (Milan *et al*., 2012). When fed a diet rich in protein, *Spodoptera literolis* and *S. exempta* both showed resistance to NPV (Lee *et al*., 2006; Povey *et al*., 2014). Additionally, *Grammiain corrupta* Edwards (Lepidoptera: Arctiidae) feeds on a variety of plants to produce pyrrolizidine alkaloids (PAs), which are poisonous to species that lack adaptation (Hartmann 1999) and its preference for pyrrolizidine rises when it is parasitized (Smilanich *et al*., 2011).

Behaviour in genes

For a long time, it was thought that self-medication was a learned behaviour rather than an innate one, but de Roode contends that monarch butterflies do not need to be aware of the fact that their offspring's genetic propensity toward healing plants increases the likelihood that they will also possess it and have a greater survival probability because the behaviour will pass on to the next generation because it is in the genes (Shurkin, 2014).

Kin Medication

Self-medication isn't just an individual behavior; it can also benefit the entire community. This practice is known as *kin medication* and is especially common in social insects. like bees, which gather propolis to fend off illness (Simone-Finstrom and Spivak, 2012). In order to prevent infection when, bees become infected with fungus, they gather a lot of antifungal plant extracts and seal their hives with them (Welsh, 2012). This behaviour serves more as a preventative than a therapeutic tool. According to reports, *Varroa destructor* infestations in *Apis mellifera* colonies cause an increase in resin foraging rates (Pusceddu *et al*., 2017) as raw propolis had a narcoleptic effect on phoretic mites (Pusceddu *et al*., 2018). Similar behaviour has also been seen in wood ants, which gather resin not for therapeutic purposes but rather as a preventative measure to protect the colony from disease and boost social immunity (De Roode and Hunter, 2018). *Formica fusca* workers exhibit self-medication behavior when exposed to a very low lethal dose of *Beaveria bassiana* infection there was no significant effect on ant foraging in case of both infected and uninfected workers (Rissanen, 2022). It has been proposed that evolution might favour preventive medicine becoming a set behavior in ants. In case of the wood ant *Formica paralugubris*, workers actively collect large amounts of resin from coniferous trees, which they bring back to their nest and place near their brood (Brütsch & Chapuis, 2014).

Self-Medication as an Alternative Defense Mechanism

An insect's first line of defense against infection includes its cuticle, peritrophic matrix, and behavioral strategies such as avoidance (Lundgren and Jurat-Fuentes 2012). Once the cuticle is breached, the innate immune system activates, producing antimicrobial peptides, followed by melanization and encapsulation (Merkling and van Rij, 2012). When these defenses are insufficient, insects may resort to self-medication as an alternative means of protection. This remarkable phenomenon showcases the adaptability and resourcefulness of insects in defending against threats.

Multi-Trophic Self-Medication

Insects can also engage in self-medication through intricate, multi-trophic systems. For example, the ant species *Lasius platythorax* utilizes an ant-pathogen-aphid-plant interaction to self-medicate within a natural environment. In this system, the extra-floral nectaries (EFNs) of aphid-infested broad bean plants (*Vicia faba*) provide ants with the opportunity to consume nectar produced in response to the aphid stress. These aphidstressed plants generate systemic levels of reactive oxygen species, which the ants use as a form of self-medication (Rissanen, 2020).

Conclusion

Self-medication in insects stands as a noteworthy testament to the evolution of unique behaviors that bolster survival. The formidable force of natural selection should never be underestimated; even the simplest creatures can develop instinctual behaviors over time. Insects, in particular, have perfected self-medication strategies that protect them from various parasites which might otherwise diminish their fitness. This behavior is not solely learned but also deeply embedded in their genetics, transmitted across generations to enhance their survival prospects. Self-medication emerges as an alternative mechanism to thwart infections, especially when the insect's physical defenses (such as its exoskeleton) and behavioral defenses (like evasion) fail to shield it from harmful invaders. This review has significant practical implications for sustainable agriculture. By understanding how insects self-medicate, we can develop eco-friendly pest management strategies that align with natural processes. Further investigation is required to comprehensively understand the full extent and mechanisms of self-medication in insects.

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Empowering biodiversity conservation: The role of citizen science in monitoring invasive species and insect populations

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Abstract

Insects play a significant role in ecosystem functionality but are rarely considered in measuring–ecological rarity. Citizen science has emerged as a key platform for tracking the occurrence of invasive alien species and insects. It involves public participation in data collection, enabling regular monitoring of species distribution and invasive alien species, which provides valuable information for management efforts. However, challenges such as data access, species identification difficulties, and accuracy issues persist in citizen science programs, particularly across Europe and North America.

Evidence highlights the successful non-citizen participation in observing populations of invasive species, such as the brown marmorated stink bug and ladybird beetle. This demonstrates the potential of citizen science in effectively monitoring invasive species. Additionally, citizen science enables researchers to document both changes in insect populations and developments in environmental impact, contributing to insect conservation. Biodiversity monitoring has significantly benefited from citizen science initiatives, and upcoming technological advancements are likely to further enhance its potential.

Keywords: Citizen science, biodiversity monitoring, invasive species, insect conservation, data accessibility, species identification and ecological monitoring.

Introduction

Insects and small animals often go unnoticed despite their crucial roles in pollination, decomposition, and nutrient cycling (Knapp, 2019). Many invasive alien species (IAS) within these groups pose significant challenges to global biological conservation. Monitoring invasive species has become a priority due to amplification from human activities, climate change, and land-use shifts, receiving attention from both the public and governments. Citizen science has emerged as a valuable tool in biodiversity monitoring, aiding the detection, control, and management of IAS.

Historically rooted in entomology, citizen science thrives on public participation, enabling large-scale data collection and conservation efforts. Farmers, species managers, and amateur naturalists have collaborated to shape modern entomology, a tradition now enriched by expanding technologies and diverse social group involvement (Gardiner *et al*., 2022). Citizen science, also known as community science, participatory monitoring, or volunteer monitoring, has shown transformative potential in tracking global biodiversity, especially for invertebrates, birds, and plants across Europe and North America (Chandler *et al.*, 2017; Gardiner and Roy, 2022). However, its application remains uneven across regions and taxa.

This article aims to review the role of citizen science in raising awareness of biodiversity, focusing on bio-invasion and insect conservation, while addressing associated challenges.

The Rise of Citizen Science and Its Potential

Over the last two decades, citizen science has emerged as a prominent technique for data collection across diverse fields, ranging from environmental studies to health research. This growth has been driven by the increasing use of the internet for data sharing and advancements in web mapping technologies. Applications like iNaturalist have made it easier for users to contribute large-scale geospatial data, combining scientific engagement with public participation (Adriaens *et al*., 2015; Goodchild, 2007; Price-Jones et al., 2022). These tools empower participants to document biodiversity, monitor species distributions, and report invasive species efficiently and cost-effectively (Goodchild, 2007).

In environmental contexts, citizen science has shown particular success in addressing biological invasions. The early detection and assessment of invasive alien species (IAS) are critical for mitigating their impacts. Citizen scientists have provided valuable data on IAS distribution and behavior, facilitating early detection efforts and informing management models (Adriaens *et al*., 2015; Johnson *et al*., 2020; Price-Jones et al., 2022; Roy *et al*., 2018).

One notable initiative is the European COST Action CA17122, launched in 2018, which focuses on leveraging citizen science to enhance data flow and expand knowledge of alien species (Roy *et al*., 2018). This approach enables citizens to support governments and scientists in gathering timely and comprehensive data to address challenges posed by biological invasions.

Case Studies of Successful Citizen Science Projects

Several CSPs have been implemented for the successful involvement of the public in the area of biodiversity monitoring, with special reference to invasive alien species. An example is the brown marmorated stink bug *Halyomorpha halys*, this is an invasive species that has over 30000 research grade observations on iNaturalist. This Asian species has been established in multiple continents with substantial social and biological consequences mainly in the United States and parts of Europe (Leskey and Nielsen, 2018). Reporting on this species has been high on citizen science platforms to give out information on where it exists and the effects it has.

One of the success stories is the UK Ladybird Survey ongoing since 2005 and having over 48, 510 records of the harlequin ladybird *Harmonia axyridis* in the UK. This project has offered all the necessary data concerning distribution and distribution of both native and non-indigenous ladybird species and their effects on the affected ecosystem by the invaders. To increase primarily public involvement, the survey introduced in 2013 an iRecord Ladybirds smartphone application that also ably enhanced public participation and reporting. However, the project targeting only female users began with a newer app in 2019, known as the European Ladybird App that enlarged the project's scope and designed for users across Europe (Skuhrovec *et al*., 2021).

In Argentina, the *Vaquita asiatica* multicolor project, 2018 has been using citizen science to track *H. axyridis* across the country. This project engages the participants to report the sightings through a number of means; through the certified iNaturalist app, through online forms and through social media accounts such as Facebook, Instagram and WhatsApp. During the first year of operation, the project received 370 records of which 93% of reports were associated with *H. axyridis*. This project is mainly focused on the ability in using them as citizen science tools especially in the situations where access to dedicated social media platforms may not be easy (Werenkraut *et al*., 2020).

The Epicollect5 app, a mobile data gathering tool, has also been used to facilitate citizen science in the monitoring of biocontrol agents. For example, researchers used Epicollect5 to collect data on the spread of the biocontrol bud-galling wasp *Trichilogaster acaciaelongifoliae* in Portugal. This project demonstrates how citizen science can contribute to the long-term monitoring of biocontrol agents, which is often underfunded or neglected in traditional research efforts (Lopez-Nunez *et al*., 2021).

The Role of Citizen Science in Disease Vector Monitoring

Apart from biodiversity data collection, citizen science has proved as primary application of citizen science within the observation of the emergence of diseases spread by mosquitoes is the Mosquito Alert project, (Walther and Kampen, 2017). On a large scale, citizen science could gather geo-tagged mosquito photographs through a smart app that would give enormous surveillance data on disease vector species like *Aedes albopictus* for chikungunya, dengue or Zika. While the imagery posted by ordinary citizens is often of poor quality, professional entomologists verify such images, and machine learning algorithms for image classification are being developed. This approach shows how citizen science can enhance the capacity to scale up the surveillance of diseases and pass valuable information to public health organisations, as suggested in Pataki *et al*., (2021).

In the same way, GLOBE (Global Learning and Observations to Benefit the Environment) a long-standing citizen science programme has also contributed in controlling the mosquitoes in Africa. Citizen scientists have provided the most useful information identifying breeding mosquitoes in Senegal for health workers to focus on the control process (Low *et al*., 2021). As a result, data on vector species have been collected from the general public by the citizen science projects and thereby filling the surveillance gap between formal surveillance and practical realities of large-scale diseases.

Insect conservation and the role of citizen science

Insects are disappearing globally at an alarming rate, driven by climate change, habitat destruction, chemical use, mechanical measures like pesticides and others. This decline endangers the crucial lives of insects that have important duties in pollination and decomposition among others. Because of such emerged pressing issues, the control of insect numbers in ecosystems is now viewed as critically important for conservation activities (Gardiner *et al*., 2022). Citizen science has however been revealed as one of the valuable tools in this regard as it allows huge data accumulation about the existing general insect populations, effects of urbanization, pesticide application, and habitat fragmentation.

Online projects like that of eButterfly in North America, BugGuide.Net and Monarch Watch have demonstrated the feasibility and usefulness of documenting insect populations and adding to knowledge of changes in biological diversity. For instance, data collected under the citizen science gave valuable information on the movement of the monarch butterfly, *Danaus plexippus* and the factors affecting its survival including its movement season (Prudic *et al*., 2017). In the same way, community science has demonstrated how different factors, particularly urbanisation, affect insect conservation. Biodiverse studies clearly demonstrated that urban gardens have higher abundance of species such as butterflies and pollinators that could mean local sustainable management practices reduce some of the negative impact of urbanisation as pointed by Palmer *et al*., (2017).

Challenges in citizen science data collection

Nevertheless, citizen science appears to have significant potential for use in the monitoring of biodiversity; however, and many issues that may be associated with this approach, including data access and accuracy, are present. Even data hubs like the global biodiversity information facility (GBIF) promote the data findability, accessibility, interoperability and reusability (FAIR) principles that improve data use (Encarnacao *et al*., 2021; Johnson *et al*., 2020). Despite these practices, there is still more hindering the realization of open citizen science data and effective use of the data by researchers. It is noteworthy that despite some citizen science projects accumulating large datasets, not all of this information is incorporated into scientific analysis due to issues with data quality and inconsistency resulting from the use of various methodologies by participants of these projects (Encarnacao *et al*., 2021; Price-Jones *et al*., 2022; Theobald *et al*., 2015). Invasive alien species citizen science projects, for instance, most of them using web-based tools coupled with smartphone apps. There are platforms that are exclusive to IAS, for instance the European Alien Species Information Network, EASIN which was developed to support the European Union Regulation 1143/2014 and then there is the natural history oriented palaeobiological and general biodiversity portals such as the iNaturalist online application. These will be large collection platforms but a major constraint is how citizens can easily identify species. The species involved in these projects are, in many cases, unknown to most people and the means and ways used to ensure that volunteers are able to properly identify and sort the species are crucial. This is especially important in enhancing the effectiveness of information gathered by citizens through participatory science (Lemmens *et al*., 2021; Newman *et al*., 2012).

Conclusion

Citizen science is emerging as a transformative approach to biodiversity monitoring, especially in invasive species management and insect conservation. By involving the public in data collection, it facilitates large-scale, real-time tracking of species distributions and environmental changes, providing critical insights for conservation strategies. While challenges like data accuracy and species identification persist, successful case studies highlight its potential to achieve meaningful ecological impacts. The proliferation of mobile apps and digital platforms has further simplified participation, improving data quality and fostering public engagement. As technology continues to advance, citizen science is set to become an indispensable tool in combating biodiversity loss and safeguarding ecosystems, offering a sustainable bridge between natural and human-influenced environments.

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Electromagnetic radiation: Hidden risks to pollinators and ecosystems

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Abstract

Insects play a vital role in ecosystem functioning by contributing to pollination, seed dispersal, soil health, and serving as an essential food source for numerous organisms. However, they face significant threats, including climate change, intensive agricultural practices, habitat loss, and diseases. The impact of electromagnetic radiation (EMR) from sources such as cell phones, towers, and transmission lines are an emerging concern that remains underexplored. EMR, an invisible form of energy, has the potential to interact with biological systems. While direct evidence linking EMR to insect population declines is limited, the possibility of subtle, long-term effects cannot be overlooked. The observed decline in certain bird species, partially attributed to EMR exposure, underscores the potential for cascading impacts on ecosystems. This highlights the need for greater research into the effects of EMR on insects to better understand and mitigate these potential risks.

Key words: Cell phones, decline, EMR, insect, stressor, pollinator

Introduction

Smartphone's have become an integral part of our lives, but their convenience often overshadows potential risks. They emit electromagnetic radiation (EMR) in the form of microwaves (frequencies of 900–1,800 MHz). EMR, produced when electric and magnetic fields interact, is absorbed by biological cells and can have harmful effects. It has been linked to cancer, central nervous system changes, DNA transcription impacts, and an increased risk of brain tumors (Morgan *et al*., 2015; Del Re, 2019).

Beyond humans, EMR also affects animals and insects. Studies suggest altered sex ratios in rats, liver and lung damage in rabbits, and increased brain tumors due to inhibited immune cell infiltration (Vereshchako *et al*., 2014; Ouadah *et al*., 2018; Zhu, 2020). EMR may damage DNA, impair cell functions, and reduce reproductive abilities (Panagopoulos, 2008).

Insects, crucial for ecosystem functioning as well as stability, are particularly vulnerable (Reddy *et al*., 2024). EMR disrupts their navigation, affects honeybee populations, alters migratory patterns of monarch butterflies, and changes lipid and carbohydrate concentrations in cockroaches and fruit flies (Clarke *et al*., 2013; Panagopoulos, 2010). Sensory malfunctions due to EMR can interfere with hunting and navigation, while voltage-gated calcium channel activation and interference with cryptochrome—a protein involved in detecting magnetic fields—may further harm them.

With mobile device usage projected to reach 18.22 billion by 2025, the ecological risks associated with EMR are increasingly concerning, underscoring the need for deeper research and mitigation strategies.

Insect decline

As insects comprise about two third of all terrestrial species on Earth. In Sánchez-Bayo comprehensive review of 73 historical reports of insect declines from across the globe reported the dramatic rates of decline which included lepidoptera, hymenoptera and coleoptera majorly affected group followed by major aquatic taxa (Odonata, Plecoptera, Trichoptera and Ephemeroptera) which may lead to the extinction of 40% of the world's insect species over the next decade (Sánchez-Bayo, 2019). The 27-year long population monitoring study revealed a shocking 76% decline in flying insect biomass at several of Germany's protected areas (Hallmann *et al*., 2017). This represents an average 2.8% loss in insect biomass per year in habitats. A recent study from Puerto Rico has reported losses between 98% and 78% biomass for ground-foraging and canopy-dwelling arthropods over a 36-year period, with respective annual losses between 2.7% and 2.2% (Lister and Garcia, 2018).

Evidences of EMR effect on different insect group

An EMR exposure from cell phones was found to have had a considerable impact on *Drosophila melanogaster* generation time, which has a major impact on population dynamics (Fauzi, 2015). Radiations induce cell death and reduced *Drosophila melanogaster's* ability to reproduce by 50%–60% (Panagopoulos, 2010). The hematological profile and enzyme system of adult male cockroach (*Periplaneta americana*) exposed to electromagnetic radiation (EMR) from mobile phones long-term exposure indicated extensive impacts on the brain, neurons, developing cells, and enzyme systems (Syalima *et al*., 2017). Cell phones generate radiation in the radiofrequency which is a part of the electromagnetic spectrum, according to a paper from the national cancer institute of the United States cell phones of the second, third, and fourth generations (2G, 3G, and 4G) transmit radiofrequency between 0.7 and 2.7 GHz and cell phones of the fifth generation (5G) are projected to utilize the frequency range up to 80 GHz (Theilens *et al*., 2020).

Theilens *et al*. (2018) first described the electromagnetic radiation absorption in a variety of insect groups, including beetles, locusts, Western honey bees, and Australian stingless bees. All insects displayed a frequency-dependent dependency of the absorbed power. At and above 6GHz, all insects displayed a general increase in RF power absorption and dielectric heating. Monarchs use a time-compensated solar compass in their antennae to guide them on their 2,000-mile trek to their wintering habitats. When there are no daylight indications, migrants have been seen flying unexpectedly in the projected southerly direction. When monarchs are unable to use cues from daylight, it has been suggested that they use geomagnetic signals to guide them during their trip. Cell phone radiation is thereby interacting with sensors and causing changes in their migratory patterns. In addition to habitat loss and chemical spraying, wireless broadband radiation is becoming a concern to butterflies like the monarch (Beatty, 2020) which interfere the orientation. EMR affect the orientation in insects as in *Myrmica sabuleti* it is reported that in the presence of EMR ant lost its trajectory due to degradation of the alarm pheromone to lower quality (Cammaerts, 2014)

Effect of radiations on pollinators

Electromagnetic radiation (EMR) from telecommunication devices, including mobile phones, towers, and Wi-Fi networks, has been shown to influence the abundance and composition of wild pollinator populations in natural ecosystems (Lazaro *et al*., 2016). Pollinator declines in recent years are also attributed to a range of other factors, including intensive agricultural practices such as monoculture, pesticide use, habitat loss due to deforestation for agricultural expansion, urbanization, climate change, pest and disease pressures, and potentially the effects of EMR, especially in regions where the impact of EMR from mobile phones and associated infrastructure has not been thoroughly studied. The ecological role of pollinators, including approximately 20,000 species of wild and managed bees, is crucial for supporting plant reproduction (Vanbergen, 2021). Pollinators are responsible for facilitating the reproduction of crops valued between $235 billion and $577 billion annually (Marigoudar and Vijayakumar, 2024; Kumar e*t al*., 2011). Research indicates that these radiation can alter the behavior and physiology of honeybees, specifically by reducing the motor activity of worker bees on the comb, leading to mass migration. The presence of electromagnetic radiation from mobile phone towers has been shown to affect the behavior of *Apis cerana* colonies, particularly in the proximity of these towers. This exposure impacts several colony functions, including brood development, honey storage, pollen collection, and queen productivity (Taye, 2018). Moreover, active mobile phone use induces "piping signals," a behavior typically observed in colonies experiencing stress or preparing to swarm (Favrey, 2011).

In addition to honeybees, other natural pollinators, such as butterflies, hoverflies, beetles, and wasps, have also been reported to suffer from EMR exposure. Specifically, hoverfly populations have been shown to decline as a result of EMR exposure (Lazaro *et al*., 2016). Both acute effects and chronic disorientation due to EMR can lead to hive abandonment by honeybees (Engels et al., 2014). Electromagnetic fields, particularly those that oscillate weakly, may interfere with the functioning of cryptochromes—proteins involved in magnetic and solar navigation—potentially contributing to phenomena such as colony collapse disorder in honeybee populations.

Effect on circadian rhythm

The daily circadian clock affects a multitude of behaviors, including diapause, development, and finding the best flight path during long-distance migration. Insects frequently employ seasonal variations in day length to manage diapause (dormancy), migration, and other temporal changes and behaviors (photoperiod). Man-made radiofrequency (RF) electromagnetic fields have been discovered to have an impact on animal orientation responses at extremely low energies in the nano tesla range. RF fields affected the German cockroach's circadian cycle (*Blatella germanica*). Static MFs delayed the cockroach clock beat under low UV light (Bartos *et al*., 2019).

Key steps in magnetic field (MF) reception are thought to be mediated by Cryptochrome protein, and RF fields have been proposed to interfere specifically with the radical-pair (RP) magneto reception pathway. Gene silencing identified *Blatella germanica* Cry as essential for detection of directional changes in MFs. Additionally, Cry is recognized as a crucial component of the biological clock system.

Studies suggest that magnetic fields with intensities similar to the Earth's natural MF can alter the circadian rhythm in organisms like Drosophila (Bartos et al., 2019). This underscores the potential interplay between MFs, Cry-mediated pathways, and the biological clock system, warranting further investigation into these fascinating mechanisms (Bartos *et al*. 2019).

Conclusion

The biological impacts of electromagnetic radiation (EMR) are significant and often go unnoticed until ecosystems reach critical tipping points. To mitigate these effects, it is vital to enforce strict environmental regulations, establish long-term standards for low-level electromagnetic field (EMF) exposure, and promote research into its ecological consequences. By taking proactive steps, we can safeguard animal health, maintain biodiversity, and ensure ecosystem stability in the face of growing EMR challenges.

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Short Notes

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Initial documentation of rhinoceros beetle (*Oryctes* sp.) infestation in moringa (*Moringa oleifera*)

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Abstract: This communication marks the initial report of rhinoceros beetle (*Oryctes* sp.) infestation in moringa (*Moringa oleifera*). The observation was made on a five-year-old moringa tree at Palar Agricultural College, Koththamarikuppam, Ambur, Tamil Nadu. A total of 11 stem borers were manually removed from the affected tree, during which rhinoceros beetle grubs were also discovered inside the stem. The presence of frass, combined with a resin-like, slimy substance and the hollowing of the stem, indicated significant damage. This finding identifies moringa as a potential new host for *Oryctes* sp., highlighting the need for further investigation into the biology, pest dynamics, and management of these beetles in moringa.

Keywords: Moringa, *Oryctes sp.*, Rhinoceros beetle, Pest infestation, Host expansion, Tamil Nadu.

Introduction: Rhinoceros beetles (*Oryctes sp.*) are notorious pests of palms and other woody plants, causing considerable economic losses in tropical and subtropical agricultural systems. These beetles primarily damage plants by boring into stems and crowns, leading to structural weakening and reduced productivity. Despite being a resilient and multipurpose tree, moringa (*Moringa oleifera*) has not been previously reported as a host for *Oryctes sp*. This communication provides the first report of rhinoceros beetle infestation in moringa, observed in Koththamarikuppam, Tamil Nadu, and discusses its implications for pest management.

Materials and Methods: The affected moringa tree, approximately five years old, was located on the premises of Palar Agricultural College, Koththamarikuppam, Ambur, Tamil Nadu. Symptoms of infestation included significant stem damage and the accumulation of frass (sawdust-like material) around the base of the tree. Manual dissection of the damaged stems was performed to identify and remove the pests. The collected frass and associated resin-like substances were analyzed for their physical characteristics to better understand the extent of the infestation.


Scarabaeiform ‘C’ shaped grub, stout and sub-cylindrical. Well developed with short thoracic legs.

Results: A total of 11 stem borers were manually extracted from the infested tree. Among these, rhinoceros beetle (*Oryctes* sp.) grubs were identified cohabiting within the stems. The frass, which was dark brown and mixed with a resin-like, slimy substance, indicated active larval activity. The hollowing of the stems due to pest activity significantly compromised the structural integrity of the tree. These observations suggest that the infestation may involve multiple pest species, highlighting a complex pest-host interaction.

Discussion: The occurrence of *Oryctes* sp. in moringa represents a potential expansion of host range, posing a threat to moringa cultivation in the affected regions. The combination of rhinoceros beetle grubs and stem borers exacerbates the damage, emphasizing the need for further research into their interactions and collective impact. Similar host expansions have been documented in other crops, indicating adaptability in pest behavior due to environmental and ecological factors. Studies focusing on the biology, seasonal incidence, and effective control measures for *Oryctes* sp. in moringa are essential for developing integrated pest management strategies. Understanding these factors will aid in mitigating the risk posed by these pests and improving overall plant health.

Conclusion: This study reports the first documented instance of rhinoceros beetle (*Oryctes* sp.) infestation in moringa (*Moringa oleifera*). The findings underscore the importance of vigilant pest monitoring and proactive management to prevent further damage and potential spread. Future research should focus on understanding the pest's life cycle in moringa and identifying effective biological and chemical control measures. By addressing these challenges, it will be possible to safeguard moringa cultivation and ensure the sustainability of this valuable crop.

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Prevalence of Ectoparasites in Pet Animals in Bengaluru: A Comprehensive Survey

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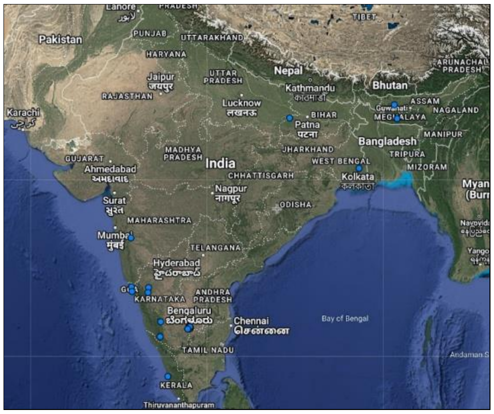
Introduction

Ectoparasites are a significant concern for pet owners and veterinarians worldwide due to their impact on animal health, welfare, and zoonotic potential (Giannelli et al., 2024). These parasites, which include ticks, fleas, lice, and mites, not only cause discomfort to companion animals but also serve as vectors for various pathogens. Recent studies highlight the widespread prevalence of ectoparasites among pets, underscoring the importance of effective management strategies. In urban centers like Bengaluru, the dense human and animal populations create a conducive environment for the proliferation of ectoparasites. Despite advancements in veterinary medicine, gaps persist in awareness and routine practices for ectoparasite control among pet owners.

Materials and Methods

This study aimed to assess the knowledge, prevalence, and preventive measures adopted by pet owners in Bengaluru using a combination of online and field-based surveys. Responses to an online survey via a questionnaire were received from different parts of Bengaluru as well as across India (Maps 1 and 2). An offline survey using the same questionnaire was conducted with pet owners in Cubbon Park (12.97318° N, 77.59154° E). Additionally, a one-on-one extended interaction was conducted with a pet owner residing near St. Joseph's University (12.96231° N, 77.59527° E), Richmond Town, who had experience in rescuing dogs.

A three-hour offline survey was conducted from 7:30 to 10:30 am at Cubbon Park on 14th November 2024. Online survey forms were circulated and kept accessible for 5 days in early November. Both offline and online surveys were carried out using a Google Forms structured questionnaire. Offline surveys focused more on additional information provided by pet owners.



Map 1: Online responses indicated in blue dots across India as well as parts of Bengaluru

Map 2: Offline responses from Cubbon Park area of Bengaluru as well as other areas involved in online survey within Bengaluru.

Results

The most common pets noted were dogs (85.7%) followed by cats (26.2%), with some respondents having both dogs and cats as pets. 78.6% of pet owners were aware of ectoparasites infecting pets. Ticks were identified as the most common ectoparasite in this survey. 54.8% of pets (dogs and cats) had experienced infestations, though one respondent's pet had an infestation without the owner being aware of common ectoparasites. The most common symptoms observed by pet owners included itching (77.1%) and visible parasites (48.6%), followed by skin problems. Veterinary check-ups varied from once per week (4.8%) to rarely (52.4%). Irregular veterinary check-ups were a significant barrier to identifying parasite infestation. Some owners were unaware of infestations until a veterinarian informed them. The most common treatment provided to infested pets was skin care products, followed by oral medicines and natural remedies (e.g., turmeric powder, oil massage). The most common preventive measure was flea-tick treatment (83.3%), with powder forms of medication being most preferred. Regular bathing was found to be the most common preventive measure (56.4%). Pet owners also emphasized monitoring pet strolling grounds and avoiding intermingling with ectoparasite-infested stray dogs in parks. A balanced diet of essential oils, vitamins, proteins, minerals, and fibers was also deemed crucial for enhancing a pet’s immunity against ectoparasites.

Conclusion

The survey's results demonstrated significant awareness of ectoparasites among Bengaluru pet owners, with ticks being the most common parasite. However, the study also identified deficiencies in ectoparasite control procedures and routine veterinary examinations. Infrequent check-ups remain a significant obstacle to early detection and prevention, even though many pet owners use flea/tick medications and practice regular bathing. These findings highlight the necessity of increased awareness, routine veterinary care, and widespread adoption of preventive measures to effectively reduce ectoparasite infestations. Future research should focus on a larger sample size and propose suitable solutions to enhance pet health and reduce zoonotic risks.

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Baffling nesting behaviour of blue banded bee, *Amegilla sp.* (Apidae: Hymenoptera)

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Abstract

The blue-banded bee (*Amegilla* sp.) is a solitary, ground-nesting native species recognized for the striking iridescent blue bands on its abdomen. These bees thrive in diverse habitats and are particularly active during warmer days. Unlike honeybees, they do not construct large hives but instead build individual nests in soil. Blue-banded bees play a vital role in the pollination of both agricultural and horticultural crops, making them a promising alternative to honeybees in sustainable agriculture. In addition to their natural nesting behaviour, these bees exhibit adaptability by constructing nests in artificial environments, such as potted plants. Our observations at Annamalai University, Tamil Nadu, India, in 2024 revealed a notable preference for nesting in the potting mixture of Aglaonema plants compared to other ornamental plants. These findings underscore the potential for leveraging the nesting preferences of blue-banded bees to promote pollination in managed environments.

Introduction

Bees, belonging to the order Hymenoptera with over 20,000 described species, are responsible for pollinating 90% of wild flowering plants (IPBES, 2016). These include both social and solitary species, with solitary bees making up 75% of all bee species. Unlike social bees, solitary bees individually construct nests on land surfaces, stems, or wood, using various substrates, and take sole responsibility for raising their offspring by stocking brood cells with pollen and nectar (Michener, 2007; Dicks *et al*., 2015).

Solitary bees are categorized as above-ground or below-ground nesters based on nesting location. Below-ground nesters, which constitute over 64% of bee species (Cane & Neff, 2011), excavate soil to build their nests. Their foraging ability in spite of their below-ground dwelling is well known. Foraging plays a significant role in the successful survival of insects in any ecosystem (Abraham, 2022). These bees are efficient pollinators of a wide array of crops, including apples, tomatoes, and squash, contributing to biodiversity and agricultural productivity (Garratt *et al*., 2016). Among them, blue-banded bees (*Amegilla* sp.), with their striking iridescent blue abdomen, are particularly notable for their role in pollinating solanaceous crops, showcasing their importance in both natural and managed ecosystems (Sandeep & Muthuraman, 2018).

Table 1: Preference of blue banded bees towards different potted plants

S.no	Plants	Number of nests	
		Potting mixture	Red soil
1	Arrow head plant (*S. podophyllum*)	6.33 ± 066	1.33±1.33
2	Shield aralia (*P. scutellaria*)	9.33±088	3.66±0.33
3	Aglaonema (*Aglaonema sp.*)	22.33±2.72	8.33±1.45

Values are represented as mean± SE

Material and Methods

Field observations were conducted to document the nesting behaviors and activities of blue banded bees (*Amegilla* sp.). Key parameters observed included:

1. **Nest Structures**: Nests were identified by the presence of tumuli (soil heaps) and, occasionally, turrets (extended mud structures). The internal tunnels were lined with hydrophobic materials, likely secretions from the abdominal Dufour's gland (Hefetz *et al*., 1979; Cane, 1981).

2. **Brood Cell Construction**: Each brood cell was provisioned with a pollen and nectar ball, into which a single 'C'-shaped egg was laid (Michener, 2007).

3. **Behavioral Observations**: Defensive behavior was noted, where females blocked the nest entrance to guard against intrusions. Presence of live and dead females within destroyed nests was recorded.

4. **Impact in Urban Gardening**: Pots with good drainage and exposed root systems were examined for nesting activity, while signs of leaf cutter bees constructing brood cells were also documented.

Conservation-friendly interventions such as using plant covers, incorporating soil amendments, and disturbing bee nests with watering (Cranshaw, 2008) were implemented to study relocation patterns.

Results and Discussion

Nesting Behavior:

Blue banded bees excavated below-ground nests, creating tumuli and, in some cases, turrets. Tunnels were lined with hydrophobic materials and brood cells were well-provisioned with pollen and nectar.

Reproductive Cycle:

Adults mated post-floral visits. Larvae developed in individual brood cells, feeding on stored provisions until pupation and eventual emergence.

Defensive Behavior:

Females exhibited guarding behaviors by blocking the nest entrance. Observations revealed live and deceased females inside destroyed nests. Similar parental care was observed in pipe-organ mud- daubing wasp (Balaji and Kumaraswamy, 2023).

Nesting in Pots:

Preferences for potting mixtures with good drainage and loose soil were observed. The nesting disrupted root systems, impacting plant growth in urban terrace gardens.

This study underscores the ecological importance of blue banded bees (*Amegilla* sp.) and leaf cutter bees as effective pollinators in urban ecosystems. Their preference for nesting in loosened, well-drained soils of potted plants highlights their adaptability to urban environments. However, their tunneling behavior poses challenges to urban terrace gardening by affecting root systems and drainage.

Misconceptions about these pollinators often lead to harmful pest control practices. It is crucial to educate gardeners about conservation-friendly techniques like using soil amendments, applying plant covers, and disturbing nests with watering to relocate bees rather than resorting to insecticides (Cranshaw, 2008). Proper awareness initiatives, as emphasized by Fetridge *et al*. (2008), can help sustain these vital pollinators in fragile urban environments.

Conclusion

The findings reveal that *Amegilla* sp**.** prefers potting mixtures with loosened, well-drained soils and exposed spaces for effective nesting. Their ecological role as pollinators outweighs the minor inconveniences posed to urban gardening. Awareness campaigns and sustainable gardening practices are critical to ensuring their conservation and in turn the sustainability of their ecosystem. Conservation-friendly approaches should replace harmful pest control practices to foster coexistence with these beneficial pollinators. Even in urban ecosystems, suitable crop diversification along with provision of suitable habitat, as like an apiary in an agricultural ecosystem, will envisage the successful survival of these bees and in turn successful gardening.

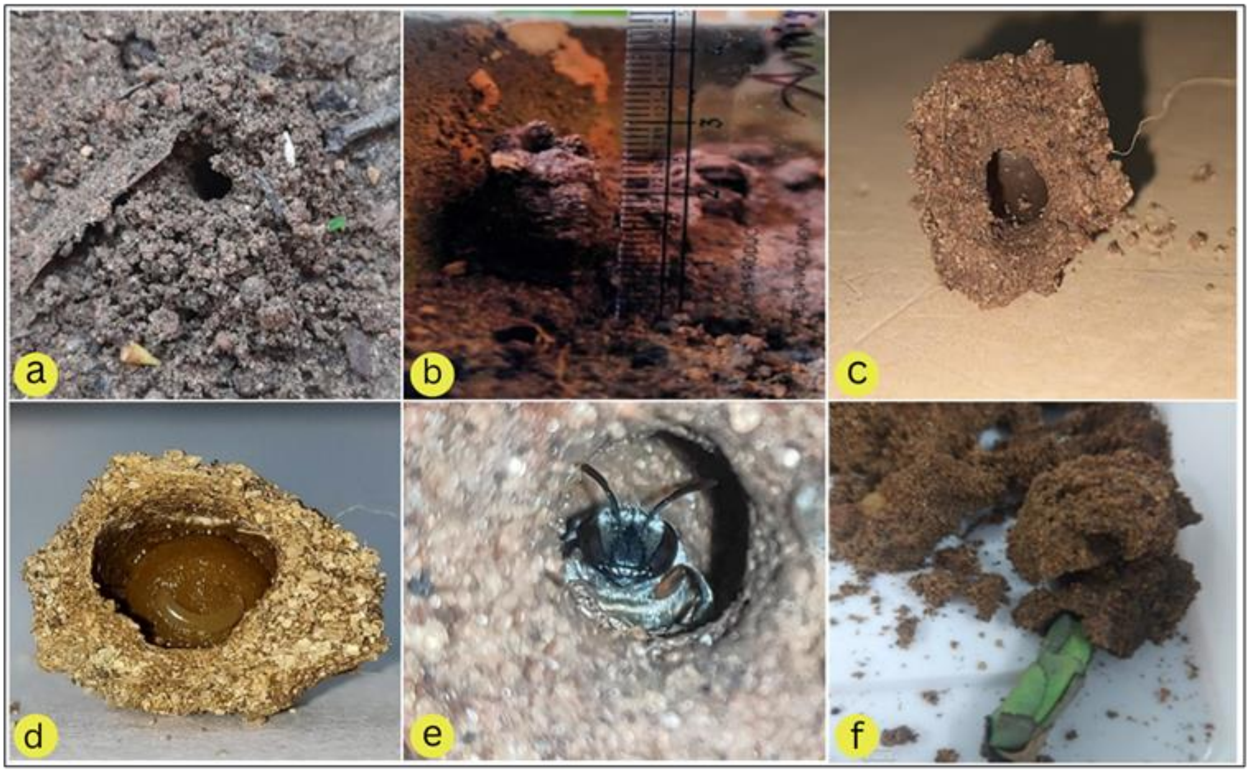

Fig:2 a) Tumulus, **b)** Turret, **c)** Brood cells coated with hydrophobic material, **d)** 'C' shaped larva feeding on pollen ball, **e)** Guarding behavior of female at entrance, **f)** Presence of mud brood cells and leaf brood cells inside the potting mixture

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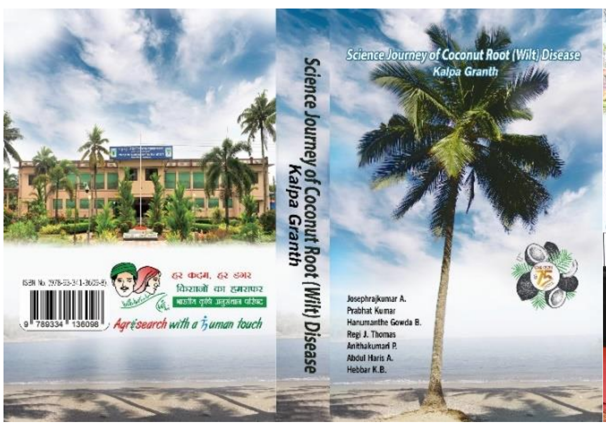
Book Review

"Science Journey of Coconut Root (Wilt) Disease-Kalpa Granth"

The book, with ISBN No. 978-93-341-3609-8, titled “Science Journey of Coconut Root (Wilt) Disease-Kalpa Granth,” edited by Josephrajkumar A., Prabhat Kumar, Hanumanthe Gowda B., Regi J. Thomas, Anithakumari P., Abdul Haris A., and Hebbar K.B., is a comprehensive compilation of the history and research at ICAR-Central Plantation Crops Research Institute (CPCRI), Regional Station (RS), Kayamkulam. The focus is on the coconut root (wilt) disease, which has been a significant concern since its first research project in 1937, funded by the Imperial Council of Agricultural Research.

The book highlights the institute's accomplishments since its foundation in 1947, including archival images of laboratories, field trials, and key events such as Kalpa Vajra celebrations. Released during the National Seminar on “Climate Smart Agriculture for Sustainable Soil and Plant Health in Plantation Crops” in June 2024, the book is published by ICAR-CPCRI with support from the Coconut Development Board.



Comprising twelve chapters by ICAR-CPCRI experts, the book covers:

1. History and research milestones
2. Coconut's ecological services
3. Host plant resistance and pollination techniques
4. Agro-techniques for production and diversification
5. Climate-smart farming and carbon sequestration
6. Customized nutrient mixtures
7. Microbiological investigations for palm health
8. Pest suppression through biological agents

9. Etiology and management of root (wilt) disease
10. Phyto-parasitic nematodes and novel delivery methods
11. Technology transfer for affected farming communities
12. Digital technologies in coconut farming

This book is a valuable resource for students, researchers, and professionals in the plantation sector. It presents a holistic approach to managing coconut root (wilt) disease, emphasizing eco-friendly pest control, sustainable farming practices, and modern technology adoption. Written in clear and accessible language, it is an essential read for anyone involved in coconut cultivation and disease management.

Overall, the book stands as a testament to the dedication and expertise of the contributors, offering a beacon of knowledge and innovation for the coconut farming community and paving the way for future advancements in sustainable agriculture.

Insect Environment Blogs

Second International Conference on Biological Control: A Catalyst for Future Biocontrol Research and Application

02 March 2025

Abraham Verghese and M. A. Rashmi

The Second International Conference on Biological Control (2ICBC 2025) took place from 25–28 February 2025 at the Radisson Blu Atria Bengaluru, India. This significant event brought together a diverse group of international and national entomologists, setting the tone for the future of biological control research and application. Participants hailed from seven countries, including experts like Dr. Raghu Sathyamurthy, President of the International Organization for Biological Control (IOBC-Global), CSIRO, Australia, Dr. R. Muniappan, Professor, Virginia Tech, Prof. Dr. Johannes A. Jehle, Head of Institute at the Institute for Biological Control in Germany; and Dr. Shiroma Sathyapala, Forestry Officer at the Food and Agriculture Organization of the United Nations in Rome (FAO), Dr. Subba Reddy Palli, University of Kentucky, USA and Dr. T. M Manjunath, seniormost biocontrol specialist of India and founder member of Society for Biocontrol Advancement Dr. P. K. Singh, Agriculture Commissioner, Dr. Poonam Jasrotia, ADG, ICAR and Dr. Archana Sinha, Secretary (CIB&RC), DPPQS.

Typically, such conferences focus heavily on parasitoids, predators, their searching ability, feeding potential, mass multiplication and tricho cards. However, this conference marked a notable departure. In addition to plant protection scientists, industry start-ups and tech innovators participated.

The conference themes centered around various cutting-edge topics such as chemical ecology, pheromones, electronic integration in pest detection, nanosensors, and multiple dimensions of omics. These advancements highlight the future trajectory of biocontrol, emphasizing its potential to revolutionize pest management.

One of the pivotal sessions, "Panel Discussion: Potential of Biological Control to Gradually Replace Chemical Control — Myth or Reality?", underscored the importance of ensuring the availability of biocontrol agents in input retailing while not doing away with the insecticides. This step is crucial to facilitate the practical application of biocontrol solutions.

We are proud to announce that our Rashvee International Phytosanitary Research and Services team was recognized for their extension efforts during this international conference.

Our heartfelt congratulations go out to the Dr. S.N Sushil, Director, ICAR-NBAIR and Dr. Prakya Sreerama Kumar, for their visionary leadership. We also acknowledge the contributions of the staff of ICAR-NBAIR and Society for Biocontrol Advancement.

IE Blog No. 241
All IE blogs are available on website
https://insectenvironment.com

Rashvee Plant Health Clinic: Leading the Way in Modern Biocontrol Extension

08 March 2025

Abraham Verghese and M. A. Rashmi

The Rashvee Plant Health Clinic stands out as the sole input-delivering and product-developing clinic in India, driven by a team of agricultural professionals dedicated to farmer outreach. Located in a hamlet in Devanahalli and primarily serving South India, the clinic focuses on horticulture and supports over 3,000 progressive farmers, covering more than 8,000 acres of farmland.

At the recent International Biocontrol Conference held at the Radisson Blu in Bangalore, the Rashvee team was honored with the SBA Extension Team Award for their outstanding promotion of biopesticides. We thank Dr. S.N. Sushil, Dr. Chandish Ballal and the jury members. The clinic emphasizes pre-harvest management of insects using market-available biopesticides to produce residue-free, export-quality fruits such as mangoes, pomegranates, grapes, guavas, tomatoes, and bananas.

Despite the fact that biological control has only been adopted on less than 5% of the agricultural area due to the limited availability of commercialized macrobials and inadequate extension, Rashvee has taken advantage of microbial biocontrol products available on the market. We have developed a new extension paradigm to accelerate the transfer of biocontrol microbial products, which involves starting a start-up and interfacing it with the plant health clinic (PHC) and providing a single window all inputs supply to farmers.

This approach is backed by strong farmer-involved extension activities such as field demonstrations, farmer feedback, and efficacy and quality testing of biocontrol commercial products. Additionally, we have organized several posters, weekly blogs, quarterly journal, YouTube channel, farm visits, invites to the plant health clinic, and farm melas to transfer biocontrol technologies and other related Integrated Nutrient Management (INM), Integrated Disease Management (IDM), and seeds with strong marketing support.

The impact of these efforts has shown that farmers are increasingly convinced in residue-free and exportable fruits production. The limitations of non-availability of quality products have been successfully overcome, resulting in biocontrol adoption in major horticultural crops in South Karnataka districts being ten times higher than the national average of 3%.

For details of the Rashvee Plant health clinic contact us. *einsectenvironment@gmail.com*

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All IE blogs are available on website
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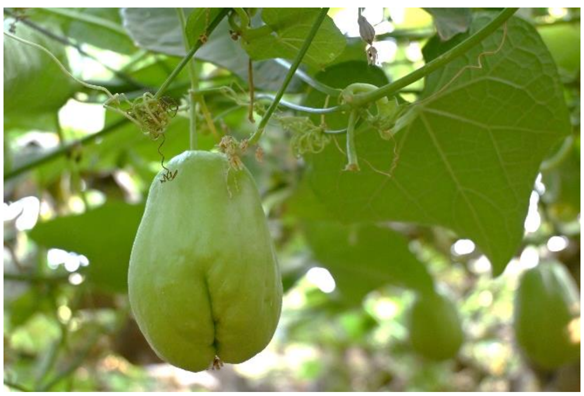
Control of Fruit Fly in Chayote (Chow Chow)

A Success Story of Rashvee Integrated Fruit Fly Management Technology

23 February 2025

Abraham Verghese and M. A. Rashmi

Chayote, also known as chow chow, has become an important cucurbit, fetching excellent returns for farmers. However, the main limitation in its cultivation is the fruit fly, *Zeugodacus cucurbitae*, which causes about 70% loss according to farmers, despite 3-4 insecticidal sprays between fruit set and harvest. An added disadvantage is the residue that accumulates in the fruits.



The Rashvee IPRS team introduced the liquid lure trapping system in many fields between peri-urban Bengaluru and Kolar. Along with the liquid lure, an ovipositional deterrent spray of Rashvee Herbal liquid Soap Adjuvant (RHLSA) was applied, followed by a Rashvee Phytofer bait splash on the lower leaves.

This approach achieved 100% control in all the fields, and farmers expressed their high satisfaction. The results can be seen in YouTube link provided below. Interestingly, some studies have shown that fruit flies readily infest chayote but often fail to develop into third instar larvae. This may be a deterrence to subsequent generations. However, chayote fields are often interspersed with other susceptible cucurbit fields, such as bitter gourd and cucumber, from which fresh fruit fly infestations can migrate to the chayote fields.

Because of the success of fruit fly management technology by Rashvee, farmers saved 4-5 insecticide sprays, thus enhancing their income, increasing pollinators and reducing the residue in the vegetable. This successful Rashvee Integrated Pest Management technology is being promoted by Shreenidhi Plant Health Clinic, Devanahalli, Karnataka. See the feedback of farmer in the link given below: https://youtu.be/YebHoiD6x80

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INSECT LENS

Atlas moth, Attacus atlas (Saturniidae: Lepidoptera)

Author: *P. Nithin Sugas, Research Scholar at Department of Entomology, Coimbatore*
Location: *Thadiyankudisai, Dindigul, Tamil Nadu, India*
Email: nithinkcp123@gmail.com

Castor semi-looper, Achaea janata (Erebidae: Lepidoptera) caterpillar parasitized by a wasp

Author: *P. Nithin Sugas, Research Scholar at Department of Entomology, Coimbatore*
Location: *Thadiyankudisai, Dindigul, Tamil Nadu, India*
Email: nithinkcp123@gmail.com

Grey Swallowtail Moth, Micronia aculeata

Author: *Dr. Nagaraj, D.N., Project Head (Entomologist) Ento. Proteins Pvt. Ltd., Mangalore*
Location: *Vardamoola village, Sagara, Shivamogga Dist. Karnataka*
Email: nasoteya@yahoo.co.in

Nymph of Euantissa pulchra

Author: *D. Bakthavatsalam*
Location: *Alapuzha, Kerala*

The common silverline, Cigaritis vulcanus (Lycaenidae: Lepidoptera)

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

Male and female moths of a defoliator recorded on a mango tree

Author: *Dr. Jasvir Singh., Retd. Joint Director (E), DPPQ&S, Faridabad*
Location: *Faridabad*
Email: singh.jasvir@nic.in

Paper wasps, Ropalidia sp. (Vespidae: Hymenoptera)

Author: *Dr. Abraham Verghese*
Location: *Bengaluru*
Email: abrahamavergis@gmail.com

Carpenter bee, Xylocopa sp. (Apidae: Hymenoptera)

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

Nest of Stingless bees, Trigona sp. (Apidae: Hymenoptera)

Author: *Dr Stephen Devanesan*
Location: *Thiruvananthapuram, Kerala*
Email: fiaapis7@gmail.com

Indian honey bee, Apis cerana (Apidae: Hymenoptera) on super

Author: *Dr. Stephen Devanesan*
Location: *Thiruvananthapuram, Kerala*
Email: fiaapis7@gmail.com

Red dwarf honey bee, Apis florea (Apidae: Hymenoptera)

Author: *Dr Stephen Devanesan*
Location: *Thiruvananthapuram, Kerala*
Email: fiaapis7@gmail.com

Fly (unidentified)

Author: *Rushikesh Rajendra Sankpal*
Location: *Pune, Maharashtra*
Email: rushisankpal@gmail.com

Weaver ant, Oecophylla (Formicidae: Hymenoptera)

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

IE EXTENSION

Dr. M A Rashmi in Siddaganga Institute of Technology delivering an invited talk at the National Startup Day celebration at Siddaganga Incubation Foundation on 16th January 2025.

With Dr. M. Ajoy Kumar, Mr. Puneeth S. and Mr. Jagan Karthick, Siddhaganaga TBI

National Startup Day celebration at Siddaganga Incubation Foundation, Siddaganga Institute of Technology, Tumkuru

Dr. M A Rashmi Honored with Udyami Vokkalliga Award for Entrepreneurial Achievements at FC Expo-2025, Agri Meet on FPO Way Ahead, 4th January 2025, Palace Grounds, Bengaluru

Dr. M A Rashmi with Farmer Producer Organization Heads and Dr. Narayana Gowda, Former Vice Chancellor, UAS Bangalore, at FC Expo-2025, Agri Meet on FPO Way Ahead, 4th January 2025

Rashvee-IPRS collaborating with rose exporters to facilitate compliance with international standards and promote seamless trade of pest and disease-free roses

Dr. M A Rashmi with Dr. Ramegowda, Joint Director Agriculture Department and Dr. A. B Patil, Agriculture Advisor Govt of Karnataka at International Fair of Organic and Millets 2025 International Trade Fair - Organic and Millets 2025

Dr M A Rashmi with Dr. Naganagouda Reddy, Joint Director Agriculture Department and KAPPEC MD, Dr Shivakumar at B2 B sessions in International Fair of Organic and Millets 2025 International Trade Fair - Organic and Millets 2025

Dr. M A Rashmi Invited as Chief Guest at the Women's Day Celebration Organized by the College of Agriculture, Chintamani

Rashvee International Phytosanitary Research & Services team with Chief Guest, Dr. Ashok Dalwai, IAS, Chairman of Karnataka Agriculture Price Commission and Dr. S. N. Sushil, Director, ICAR-NBAIR

Second International Conference on Biological Control:
Biocontrol Contributions to One Health (2icbc2025) held at the Radisson Blu, Bangalore, the Rashvee International Phytosanitary Research & Services team was honored with the prestigious SBA Extension Team Award by the Society for Biocontrol Advancement (ICAR-NBAIR). The award was presented by Chief Guest, Dr. Ashok Dalwai, IAS, Chairman of Karnataka Agriculture Price Commission and other dignitaries, Dr. Chandish R. Ballal, Dr Surendra Dara., Dr Subba Reddy Palli, Dr S.N. Sushil, Dr S.N. Puri, Dr R. Muniappan

Rashvee Team with Dr. Archana Sinha, Secretary, Central Insecticides Board and Registration Committee (CIB&RC), Directorate of Plant Protection, Quarantine & Storage (DPPQS)

Rashvee Team with Dr. P.K. Singh, Agriculture Commissioner, Ministry of Agriculture & Farmers Welfare, Government of India

Rashvee Team Participated in the Panel Discussion on Potential of Biological Control to Gradually Replace Chemical Control — Myth or Reality? At The Second International Conference on Biological Control:
Biocontrol Contributions to One Health (2icbc2025) held at The Radisson Blu, Bangalore

IE Team with Dr. Nagaraju, D.K. Joint Director, RPQS, Bengaluru, DPPQS, and Dr. Shreedevi, Scientist, ICAR-NBAIR, and other Scientists

IE Team with Dr. Dr Subramanian Sevgan, Principal Scientist and Head of Environmental Health International Centre of Insect Physiology and Ecology (ICIPE), Kenya

IE Team with Dr. Chalapathi Rao, DRYSRUH, Ambajapeta and Dr. Sairam Kumar, Acharya N G Ranga Agricultural University, Agricultural College, Bapatla

IE team with Dr. Prof. Johannes A. Jehle, Head of Institute, Institute for Biological Control, Germany

IE team with Dr. Raghu Sathyamurthy (CSIRO, Australia), Dr. D. K Nagaraju, Joint Director, DPPQS, and Dr. K. Sreedevi, ICAR-NBAIR

Dr. M A Rashmi presenting on Transforming Entomology into a Thriving Agri-Business through Startup Integrated with Plant Health Clinic at National Conference for Zoological Sciences-2025, organized by St. Joseph's University, Bengaluru

Dr. M A Rashmi with the Escorts Kubota Ltd. Team at Farmer Producer Organization Mela 2025, organized by University of Agricultural and Horticultural Sciences, Bagalkot, Bengaluru campus February 1, 2025

Dr MA Rashmi participated in workshop cum training on Phytosanitary aspects including implementation of GAP, Inspection and Treatment for Export of Mangoes.

Rashvee IPRS participated in Interaction with Woman Entrepreneurs on the eve of International Woman's Day Celebration at APEDA with Chief Guest: Smt. Rohini Sindhuri, IAS, Special Secretary, Food Processing and Harvest Technology, Govt. of Karnataka