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A Survey on *Helopeltis antonii* Signoret Infesting Indian Almond, *Terminalia catappa* L.

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Abstract

Roving survey was carried in Dharwad and Belagavi districts of Karnataka between July and November, 2023 to record the incidence and damage caused by tea mosquito bug, *Helopeltis antonii* on Indian almond, *Terminalia catappa* and found that regional variations in incidence and infestation levels. Dharwad location recorded highest bug population (4 adults or nymphs 10^{-1} trees) with 40% of infested trees. However, Garag location recorded lowest bug population (1 adult or nymph 10^{-1} trees) with 10% of infested trees. Intriguingly, tea mosquito bug completes its biology on Indian almond, with an average life cycle period of 38.30±4.37 days and the range 31.5 to 43.5 days. However, egg hatching rate was 74.68% with a varied survival rate of nymphal instars and adult was recorded. In essence, this research not only provides crucial insights into incidence and damaging symptoms caused by *H. antonii* on Indian almond but also on biology of tea mosquito bug on *T. catappa*.

Keywords: Survey, biology, helopeltis, survival rate, symptoms, terminalia

1. Introduction

In India, three types of tea mosquito bug were identified: *Helopeltis antonii* Signoret, *Helopeltis bradyi* Waterhouse and *Helopeltis theivora* Waterhouse (Stonedahl, 1991). *H. antonii* stands out as the prevailing species among them (Sundararaju and Bakthavatsalam, 1994). The tea mosquito bug is a versatile insect that poses a serious threat to a wide range of plants. This pest has been documented on 17 different plant species belonging to 13 families. Among these, economically significant crops like tea (*Camellia sinensis*) (Roy et al., 2015), cashew (*Anacardium occidentale*) (Saroj et al., 2016), cocoa (*Theobroma cacao*) (Alagar and Bhat, 2017), guava (*Psidium guajava*) (Visalakshy and Swathi, 2016), neem (*Azadirachta indica*) (Aravinthraju et al., 2023), black pepper (*Piper nigrum*) (Kalita et al., 2018), avocado (*Persea americana*), camphire (*Lawsonia alba*), and grapes (*Vitis vinifera*) are particularly susceptible. Additionally, it has been reported on various other plants including the quinine bark tree (*Cinchona rubra*), allspice (*Pimenta dioica*), annatto (*Bixa orellana*), apples (*Malus domestica*), Pomogranate (*Punica granatum*) (Jayanthi et al., 2016), mangoes (*Mangifera indica*) (Ramegowda et al., 2022), drumstick (*Moringa oleifera*) (Aravinthraju et al., 2023), eggplant (*Solanum melongena*) (Sivakumar and Yeshwanth, 2019), amaranth (*Amaranthus* sp.) rose apples (*Eugenia jambos*), cotton (*Gossypium* spp.), mahogany (*Swietenia mahagoni*), redgram (*Cajanus cajan*), *Annona* spp., and *Eucalyptus* sp. This extensive range of host plants has been documented across multiple studies (Devasahayam and Nair, 1986; Onkarappa and Kumar, 1997; Reddy, 2009 and Siswanto et al., 2008).

Previous research indicates that these insects primarily feed on young and tender plant parts *viz*., leaves, shoots, inflorescence and premature fruits (Ramegowda et al., 2022). Their feeding method, characterized by piercing and sucking, often results in the desiccation of newly formed shoots, leading to a distinctive burnt or scorched appearance on the affected plants (Srikumar and Bhat, 2012). Damage inflicted on flowers and premature fruits may manifest as shrinkage or the premature dropping of nuts, as observed in cashew plants (Singh and Pillai, 1985), the development of scab-like lesions on guava fruits (Patil and Naik, 2004) or the leaves of the affected neem trees turned brown and the whole tree appeared as burnt and lifeless (Handa et al., 2022). Furthermore, the established association with die back causing pathogens like *Botryodiplodia theobromae* (Varma and Balasundaran, 1990) and phytopthora (Handa et al., 2022) in pomegranate and neem plants, respectively could pose a significant threat by causing die-back disease. This result in 30 to 50% yield loss in cashew (Anonymous, 1984 and Anonymous, 1984), drying in infected trees varied from 50 to 80% (Handa et al., 2022) and loss of fruits to an extent of 60 to 70% in guava (Anandkumar et al., 2022)

In recent times, a noticeable trend has emerged within the realm of phytophagous insects: an uptick in host-shifts. This phenomenon has led to an expansion of host ranges among certain insect species. Host-shifts refer to the adaptation of an insect species to utilize a new host plant, often alongside their original hosts. Despite the shift, these insects manage to maintain their fitness levels, indicating a remarkable adaptability and resilience in the face of ecological changes (Diegisser et al., 2009). Our paper presents the documentation of the mirid bug, *H. antonii*, on the Indian almond tree, *Terminalia catappa* L. This discovery showcases the bug's adaptability to a new host plant, expanding its dietary preferences. This shift could impact agricultural and ecological systems, potentially threatening Indian almond plants and natural ecosystems.

2. Materials and Methods

2.1. Roving survey and incidence of H. antonii on T. catappa

The infestation of *H. antonii* was firstly observed on *T. catappa* at University of Agricultural Sciences (UAS), Dharwad, Karnataka, India lies at 15.489356°N and 74.987692°E. Subsequently, investigation took place in the Dharwad district, focusing on Indian almond trees planted between July and November, 2023. Field photographs of *H. antonii* and its associated damage were taken using a DSLR Canon 7D camera. Additionally, specific images were captured using a Leica M205 stereo zoom microscope equipped with an MC190 camera.

Observations were made on per cent damage inflicted by the bug on various parts of the plant. Ten plants were randomly selected in a location and five branches were selected in each plant. Using sweep method, the adult and nymphal populations were also assessed by making 5 sweeps tree^{-1} using hand net. Observations were made on total number of both affected and healthy parts *viz*., young leaves and fruits of the plants. The observations were recorded on, total number of bugs (Adult+Nymph) five sweeps^{-1}, total number of young leaves branches^{-1}, total number of affected young leaves branch^{-1}, total number of fruits branches^{-1}, total number of affected fruits branches^{-1}. The data so obtained was converted into per cent damage using following formula:

Per cent pest damage =(No.of young leaves/fruits damaged)/(Total no.of young leaves/fruits observed)×100

2.2. Biology of H. antonii on T. catappa

The mass rearing methods outlined by Sundararaju and John (1992) were employed, with slight modifications, for cultivating the tea mosquito bug. Utilizing Indian almond twigs as the primary feeding material, continuous provision of tender shoots and seedlings from Indian almond facilitated the feeding and developmental stages of the tea mosquito bug. The initial culture of tea mosquito bugs was sourced from Guava orchards at the UAS, Dharwad, Karnataka, India. Subsequently, these bugs were introduced into an insect cage measuring 45 ×45×60 cm^3, equipped with Indian almond twigs ranging from 12–15 cm in length, adorned with a few tender leaves. The cut ends of the twigs were submerged in water within compact vials measuring 5 cm in diameter and 6 cm in height to uphold turgidity. The twigs were securely anchored by sealing the vial openings with cotton plugs. Each morning, the twigs were substituted with fresh ones to serve as sustenance. Gravid females were relocated to the oviposition cage, permitting them to deposit eggs on tender shoots or seedlings of the Indian almond. Following six to seven days of oviposition, the Indian almond shoots housing the eggs were relocated to a nymphal rearing cage measuring 60×60×75 cm^3. Newly emerged nymphs were provided with fresh tender shoots as their food source, and this practice continued until the all nymphs to be emerged. Starting from the third or fourth day, the number of nymphs in each nymphal rearing cage was limited to 10-15 nymphs. To facilitate this, a single tender shoot was placed upright inside individual vials (5 cm diameter×6 cm height), with a small hole made in the lid, and the vial was filled with water. This method ensured a controlled environment for nymphal development and sustenance. Inside the nymphal rearing cage, initially, four tender shoots were introduced. On the following day, an additional set of four fresh tender shoots was carefully placed beside the existing ones, ensuring minimal disruption to the nymphs feeding on the shoots from the previous day. This daily routine was consistently repeated, facilitating the nymphs' smooth transition to new tender shoots with minimal disturbance. Every third day, the tender shoots from the first day, along with their vials, were systematically removed after a thorough examination to confirm the absence of nymphs. This systematic process continued daily until the emergence of the adult stage. The observation on fecundity, egg hatching (%), larval period, pupal period and adult longevity along with survival rates of all the life stages were recorded.

3. Results and Discussion

Identification of this pest, damage symptoms, biology and all the stages of life cycle as observed during the investigation are described in this paper.

3.1. Identification of H. antonii

Confirmation of the pest species identity unequivocally established it as *H. antonii*. Distinctive taxonomic features such as leg coloration, the structure of the female genital chamber and its associated structures, as well as the shape of the lobal sclerite in male vesicles, proved instrumental in this identification process (Srikumar and Bhat, 2012). Notably, both *H. antonii* and *H. bradyi* share similarities in the lobal sclerite of male genitalia, featuring a dense distribution of tubercles distally and sclerotized rings in the female genital chamber that are not fused posteriorly. However, a clear distinguishing factor lies in the hind femora, where *H. antonii* lacks a pale annulus basally, setting it apart from the externally similar *H. bradyi*.

3.2. Life stages of H. antonii

The mature insect deposits elongated and sausage-shaped eggs containing two filamentous long processes. These processes extend beyond the delicate plant tissue where the female embeds the eggs. Upon hatching, the nymphs exhibit a spider-like appearance, characterized by elongated appendages. Adult bugs are petite, agile, and possess a slender body measuring between 7 to 9 mm, featuring long legs and antennae. In their early nymphal stage, these insects are adorned with amber-coloured hair and closely resemble ants (Gundappa et al., 2018).

3.3. Damage symptoms of H. antonii on T. catappa

H. antonii indulges in feeding on the tender leaves, shoots, and fruits of plants. Both nymphs and adults of *H. antonii* prefer the new growth of plants, extracting sap from the leaves, particularly during the morning and evening hours. The characteristic feeding damage manifests as a discoloured, necrotic area or lesion surrounding the point where the bug's labial stylets penetrate the plant tissue. This discoloration intensifies with time as the bug introduces a toxin into the plant through its saliva while feeding. Consequently, affected leaves and shoots undergo a browning process, and the fruit surface develops black blisters, resulting in the production of blemished fruits. Additionally, the presence of rusty spots and the occurrence of corky growth or scabby lesions on fruits are commonly observed outcomes of *H. antonii* feeding. Infested leaves frequently exhibit curling and distortion, occasionally leading to their demise starting from the tips or edges and progressing inward. In instances of severe infestation, young shoots commonly undergo die-back, resulting in a scorched appearance as they dry up (Figure 1).

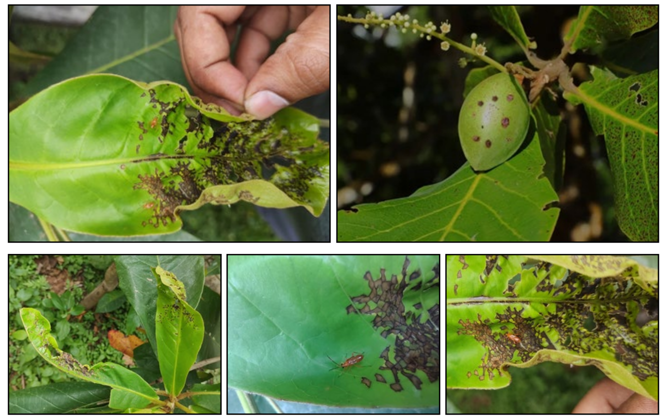

Figure 1: Leaf and fruit damage caused by *H. antonii* on *T. catappa*

3.4. Damage and pest status on Indian almond

After observing the incidence of *H. antonii* in University of Agricultural Sciences, Dharwad, roving survey was conducted in Dharwad and Belagavi to record its damage on leaf and fruits. The results found that, highest per cent damage of young leaf (3.12%) and fruits (2.17%) was recorded in UAS, Dharwad followed by Sogal, where 2.68 and 1.73% of young leaf and fruit damage was observed, respectively. However, among the ten locations, Garag recorded lowest leaf (1.05%) and fruits (0.00 %) damage (Table 1).

Table 1: Population density and per cent damage by *H. antonii* on *T. catappa* in different locations

Name of the place	Damage on young leaves (%)	Damage on fruits (%)	Adult or Nymphal population per 10 trees (5 sweeps per tree)
Dharwad	3.12	2.17	4
Mummigatti	1.23	0.28	2
Belawadi	2.45	0.10	1
Garag	1.05	0.00	1
Dodavad	2.07	1.12	2
Bailhongal	1.36	0.41	2
Sogal	2.68	1.73	3
Dhupdal	2.64	1.69	2
Munuvalli	1.34	0.39	2
Murgod	1.85	0.90	1

The observations on total number of bugs (Adult+Nymph) 10^{-1} trees by five sweeps per tree using aerial insect net and per cent infested plants among 10 observed plants was worked out. Dharwad location recorded highest bug population (4 adults or nymphs 10^{-1} trees) with 40% of infested trees followed by Sogal with 3 adult or nymph population 10^{-1} trees with 30% of infested trees. However, among the surveyed locations Garag, Belawadi and Murgod recorded lowest bug population ((1 adult or nymph 10^{-1} trees) with 10, 20 and 20% of infested trees, respectively (Figure 2).

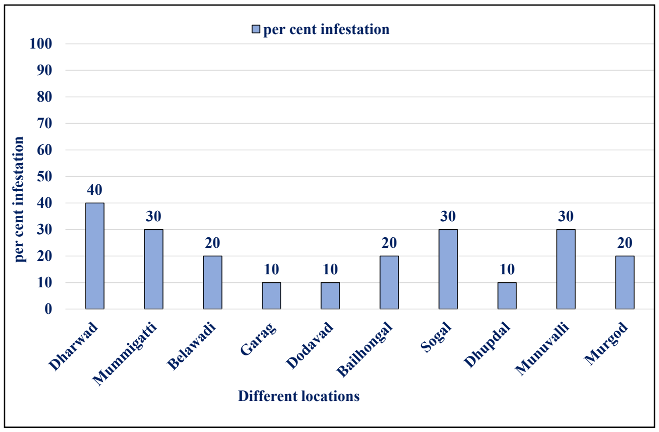

Figure 2: Per cent infestation of *H. antonii* on *T. catappa* in different locations

3.5. Biology of H. antonii on T. catappa

The *H. antonii* completed its life cycle on *T. catappa* and recorded all the three stages of the bug (Figure 3). The gravid female laid an average of 40.10±5.90 eggs with a range of 31.0-51.0 eggs $female^{-1}$. An average egg incubation period was 8.40±0.77 days with a range of 7.0 to 9.5 days and egg hatchability was 74.68%. It having five nymphal instars, wings development takes place externally and wing pads can be seen at the last nymphal instar. The nymphal period

Figure 3: Different life stages of *H. antonii* on *T. catappa* a) Egg b) Nymph c) Adult

of I, II, III, IV and V instar bug ranged from 2.0–3.0, 1.5–3.0, 1.5–3.0, 2.0–3.0 and 2.5–4.0 days with the varied survival rate of 65.62, 66.78, 71.93, 65.78 and 68.46%, respectively. However, the average nymphal period on *T. catappa* was 12.80±2.39 days with a range of 9.5 to 16.0 days. The adult longevity was 17.10±1.20 days with a range of 15.0 to 18.0 days and adult survival rate was 64.67% (Figure 4). Whereas, the *H. antonii* complete its life cycle on *T. catappa* with an average period of 38.30±4.37 days with a range of 31.5 to 43.5 days (Table 2).

These results are in line with the findings of Damasia et al. (2020), as they recorded fecundity range of 22 to 45 eggs with an average of 29.64±5.65 eggs $female^{-1}$ when reared on cashew. Similarly, an average fecundity of 45.8±4.87 with a range of 41 to 53 on Singapore cherry (Srikumar and Bhat, 2013) was recorded. Total nymphal period varied from 10 to12 days with an average of 11.71±0.51 days on Singapore cherry (Srikumar and Bhat, 2013), 13.20±1.04

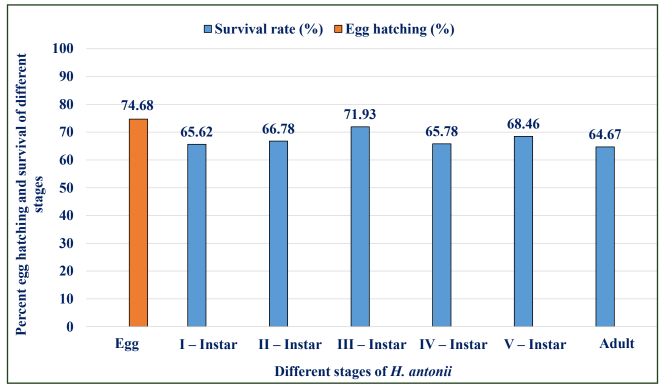

Figure 4: Per cent egg hatching and survival of different stages of *H. antonii* reared on *T. catappa*

Table 2: Biology of *H. antonii* reared on *T. catappa*

Life stages of *H. antonii*		Indian almond Mean±SD (Range)
Egg Incubation period (Days)		8.40±0.77 (7.0-9.5)
Nymphal period (Days)	I – Instar	2.30±0.35 (2.0-3.0)
	II – Instar	2.35±0.53 (1.5-3.0)
	III – Instar	2.45±0.64 (1.5-3.0)
	IV – Instar	2.55±0.44 (2.0-3.0)
	V – Instar	3.15±0.58 (2.5-4.0)
Total Nymphal period (Days)		12.80±2.39 (9.5-16.0)
Adult longevity (Days)		17.10±1.20 (15.0-18.0)
Fecundity/ female (Number)		40.10±5.90 (31.0-51.0)
Total life cycle (Days)		38.30±4.37 (31.5-43.5)

days (range of 11–16 days) on Cashew (Damasia et al., 2020) and 16.75 1.13 days on Moringa (Aravinthraju et al., 2023). Total life cycle of *H. antonii* was 27.45±2.09, 35.68±3.39 and 32.27±1.98 days when reared on Moringa, Singapore cherry and Cashew, respectively as recorded by Aravinthraju et al. (2023), Srikumar and Bhat (2013) and Damasia et al. (2020). However, survival percentage of different instars and adults reared on Indian almond are in line with the finding of Srikumar and Bhat (2013).

4. Conclusion

A comprehensive study identified *H. antonii* infestation on Indian almond, *T. catappa*. It characterized symptoms on leaves, shoots, and fruits, distinguished taxonomic features, and recorded the bug's life cycle (38.30±4.37 days). Varied survival rates were noted, with 74.68% egg hatching. Pest status varied across locations, with Dharwad exhibiting the highest damage. This marks the documentation of *H. antonii* infesting Indian almond in India, signalling potential agricultural threats. Further research on host compatibility and management strategies is crucial for mitigating damages.

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