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SCIENTIFIC NOTE

Biology of the tea mosquito bug (*Helopeltis theivora* Waterhouse) on *Chromolaena odorata* (L.) R.M. King & H. Rob.

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Helopeltis theivora Waterhouse, pest of tea, is emerging as a commonly occurring major pest of cashew (*Anacardium occidentale* L.) in recent times. The field observation revealed *Chromolaena odorata* (L.) R.M. King & H. Rob. weed support as an alternate host of this pest during off season of cashew. Biology of *H. theivora* on this weed was studied for the first time. The incubation period of eggs was 10.5 ± 1.2 d. The 1st, 2nd, 3rd, 4th and 5th nymphal instar developmental times were 36.11 ± 9.52, 43.29 ± 7.35, 27.15 ± 8.41, 41.31 ± 10.13, and 73.91 ± 5.67 h, respectively. Survival percentage of eggs was lower (60.53%) than nymphal instars. Adult females and males lived for 22.6 ± 3.29 and 11.8 ± 1.64 d, respectively. Females showed dynamic patterns of fecundity with the number of eggs laid per female ranging 19 to 34. Longevity and fecundity of *H. theivora* on this weed were significantly lesser when compared on cashew. Egg parasitoids *viz*., *Telenomus* sp., *Chaetostricha* sp. and *Erythmelus helopeltidis* Gahan were recorded from *H. theivora* eggs on *C. odorata* for the first time. For better management decisions, it is important to know about this mirid biology, particularly their life cycle on their alternate hosts so that the right assessment can be made before taking up spray.

Key words: Biological parameters, *Chromolaena odorata,* egg parasitoids cashew, *Helopeltis theivora*.

INTRODUCTION

Cashew (*Anacardium occidentale* L.) is one of the important export commodities of India. The increase in productivity of cashew is marginal during last decade in spite of introduction of high yielding varieties. One of the reasons for this condition is the lack of adoption of management strategies for controlling the common pest at cashew plantations *i.e.* *Helopeltis* spp. (*Helopeltis antonii*, *Helopeltis bradyi*, and *Helopeltis theivora*). Among these, *H. theivora* is a major pest of cocoa and tea in India and Asia. It also has been reported damaging other economically important plants such as black pepper, camphor, cashew and cinchona (Stonedahl, 1991). Additional host plants of this species were given by Miller (1941) and Das (1984).

Chromolaena odorata (L.) R.M. King & H. Rob. (formerly*: Eupatorium odoratum* L.), herbaceous perennial belongs to the family Asteraceae (=Compositae), is recorded as the alternate host of *H. theivora* in the cashew plantations. It is primarily a noxious weed in cashew, rubber, and coconut plantations, grazing land and disturbed forest areas (Subbaiah, 1992). It was reported that removal of the alternate host of *H. theivora*, thoroughwort (*Eupatorium* sp.), Fragrant thoroughwort (*Eupatorium odoratum*), from in and around tea plantations would give a good control of this pest in tea (Somnath et al., 2009).

Chromolaena odorata from its original point of introduction as an ornamental plant in northeastern India in the mid nineteenth century has spread throughout Southeast Asia, into parts of Oceania (Muniappan and Marutani, 1988; McFadyen, 1989; Waterhouse, 1994), and into West and Central Africa (Gautier, 1992; Prasad et al., 1996). It grows to a height of 3 m in the open situation and up to 8 m when assumed a scrambling habitat in the interior forests. It is native to Mexico, the West Indies, and tropical South America; it was spread widely by early navigators. It is widespread in the Western Ghats region covering Karnataka, Goa, Kerala, and Tamil Nadu states. This weed offer excellent hiding places and serve as alternate host of *H. theivora*.

Plants grow vigorously throughout the wet season and flowering is initiated by a decrease in both day length and rainfall (Sajise et al., 1974; Gautier, 1993). *Chromolaena odorata* grows extensively with vegetative growth and flowers throughout the year during June-December. The build-up of populations of *H. theivora* commences on *C. odorata* during August and reaches peak during September-November and thereafter declines. The population of *H. theivora* was completely absent from December to July on *C. odorata* while it was maximum

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on cashew during December-January coinciding with flushing and flowering on of cashew. The flowers of *C. odorata* are also visited by insects and *C. odorata* is an important honey plant in Thailand (Thapa and Wongsiri, 1997).

It is important to understand the biology of the pest in their alternate hosts to understand the mode and degree of its population growth. Although, the reports of occurrence and epidemics of *H. theivora* have been documented on various hosts (Stonedahl, 1991), details of the biological parameters were not explored. Since, life history and pattern of biological activities of an insect may vary in its different host plants, laboratory studies have become essential. Studies conducted in the laboratory using *C. odorata* shoots with tender leaves with detailed observations of reproductive and developmental stages of *H. theivora* formed the basis for the present study. Prevention methods are the most important key that should be applied regularly to protect cashew plants from the pest infestations. This study therefore, was sought to determine the biological parameters and natural enemies (egg parasitoids) of *H. theivora* on *C. odorata*, which may facilitate in recognizing the carry over potential of this pest in cashew ecosystem. That aid in formulating the Integrated Pest Management (IPM) for *H. theivora* on cashew.

MATERIALS AND METHODS

Biology of *H. theivora* on *C. odorata*

Biology of *H. theivora* was studied under laboratory conditions at Directorate of Cashew Research, Puttur, Karnataka (12.45° N, 75.4° E; 90 m a.s.l.), India. Adults of *Helopeltis theivora* were collected using long test tubes from cashew fields. Nylon mesh sleeve cages (170 cm long × 30 cm diameter) were used to confine these adult bugs after pairing adult bugs on tender flushing shoots of *C. odorata* in the field during July-December of 2011. Both ends of the cage were securely tied to prevent the insects from escaping. The shoots were kept in their natural position by tying the upper part of the sleeve cage to a stake and lower part to the twigs. The sleeve cages were labeled with oviposition date and precautions were taken to prevent the disturbance from ants.

The presence of a pair of fine respiratory filaments projecting from the surface of the plant tissue was indicative of the presence of eggs embedded in the shoot. Such shoots were brought to the laboratory from fifth to seventh day after oviposition. Immediately after hatching, nymphs were transferred individually in nymphal rearing cages (size: 15 × 15 × 20 cm and thickness: 18 gauge) developed by Sundararaju and John (1992). Four glass vials of 5 mL capacity fixed on a small aluminum stand with a handle of 15 cm height fixed at the centre were placed in each rearing cage. The fresh *C. odorata* shoots kept in water filled vial were supplied as feed on every alternate day. Observations were made on the changes that took place during incubation period and duration of nymphal instars. Further, the newly emerged males and females were paired and enclosed in the sleeve cages in fresh tender shoots of *C. odorata* in the field. Observations were made on varies biological parameters *viz.*, incubation period of eggs, duration of nymphal instars, percentage survival, longevity of adults and fecundity.

Study of egg parasitoids of *H. theivora* on *C. odorata*

Surveys were made for *H. theivora* damaged *C. odorata* weeds in the cashew plantations. Eupatorium damaged stems containing eggs of *H. theivora* were collected from the cashew plantations. The exposed respiratory horns of egg cap are similar in appearance to the short downy white hairs on stems of *C. odorata* fairly making them virtually difficult to see. The eggs were counted under zoom microscope and treated in carbendazim (methyl benzimidazol-2-ylcarbamate, 0.1%) solution for 10 min. After treatment, samples were dried to remove the dampness of carbendazim solution. Dried eggs were kept separately on large glass tubes wrapped with black cloth expect the top region. Eggs were collected and observed from July to December of 2012.

Comparative biology of *H. theivora* on *C. odorata* and *A. occidentale*

The biological parameters of *H. theivora* on *C. odorata* were compared with that on cashew (Srikumar and Bhat, 2012). Data were analyzed using ANOVA F-test.

RESULTS AND DISCUSSION

During the period of studies, no incidence of *H. theivora* was seen on *C. odorata* from December onwards. This may be attributed to the non-availability of preferred stage of host plant and further the migration of the pest to its main host cashew. These results are in line with Sudhakar (1975), who noticed the peak incidence of the *H. antonii* during October on guava. The report of Onkarappa and Kumar (1997) revealed the incidence of the pest was seen from July to October. Das (1984) also reported that in the tea growing regions of north-east India, *H. theivora* reaches peak abundance in the period from June to September; with population levels gradually declining in November as cooler weather conditions prevail. The spread of pest symptoms from *C. odorata* to cashew was clearly observed during the present study (Figures 1 and 2).

Mean developmental periods of first, second, third, fourth and fifth instars were 36.11 ± 9.52, 43.29 ± 7.35, 27.15 ± 8.41, and 41.31 ± 10.13, and 73.91 ± 5.67 h, respectively, i.e., the developmental period of third instar nymphs of *H. theivora* were shorter (1.0-2.0 d) compared to first instar (1.16-2.25 d), second instar (1.29-2.13 d), fourth instar (1.00-2.33 d) and fifth instar nymphs

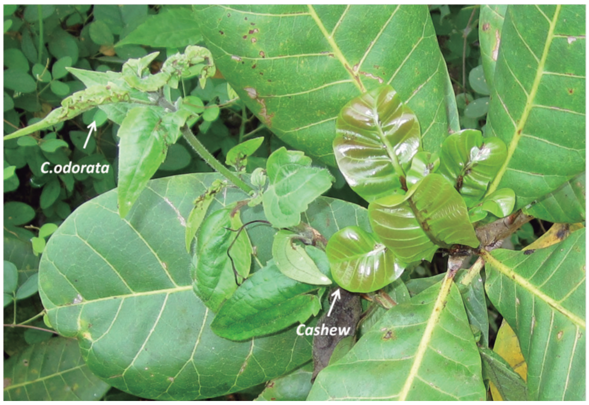
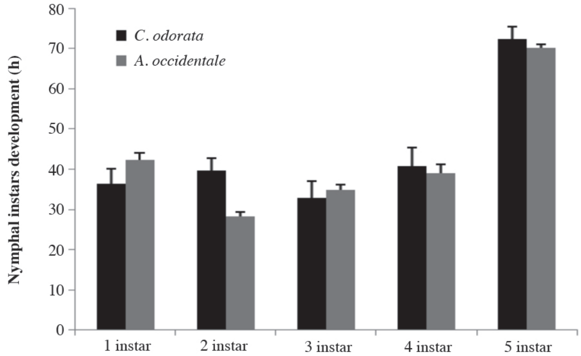


Figure 1. Damage spread from *Chromolaena odorata* to *Anacardium occidentale*.



Data are mean ± SE. Total developmental periods were non significant according to F-test (P < 0.05).

Figure 3. *Helopeltis theivora* nymphal instars development on *Chromolaena odorata* and *Anacardium occidentale*.

(2.71-3.83 d) (Table 1). *Helopeltis theivora* reared on *C. odorata* under laboratory conditions had developmental periods of 233.26 ± 21.39 h for males and 219.27 ± 1.62 h for females. The total developmental period on *C. odorata* was not significant (P < 0.05) when compared with that on cashew (Figure 3).

The total developmental period of a closely related species *H. antonii* reared under constant temperature of 19 to 35 °C on cashew flushing shoots was 231.37 h (Srikumar and Bhat, 2011). It was observed in the present work that the 5th instar nymphal life span was highest for *H. theivora*. This is in accordance with Smith (1979), who recorded longest development period of fifth instar for *H. clavifer*.

While the survival of first, second and third instars were 93.33%, 92.87%, and 97.43% respectively, the fourth and fifth instars had only 89.47% and 73.52% survival (Table 1). The survival rates were higher for first and second and third instar nymphal stages. The decline in survival rates for subsequent instars might, therefore, be attributed to additional nutritional requirement during the instar development. However, 73.52% survival in the fifth instar nymphal stage signified that *C. odorata* weed as an alternate host of *H. theivora*. Moreover, this result is quite comparable with the study of Somnath et al. (2009), who recorded 66.6-70.6% of survival of *H. theivora* nymphs on tea.

Table 1. Biological parameters recorded of *Helopeltis theivora* on *Chromolaena odorata*.

Particulars	Developmental period of instars					Total developmental period		Incubation period for eggs (d)
	First	Second	Third	Fourth	Fifth	Male	Female	
Mean ± SD, h	36.11 ± 9.52	43.29 ± 7.35	27.15 ± 8.41	41.31 ± 10.13	73.91 ± 5.67	233.26 ± 21.39	219.27 ± 1.62	10.5 ± 1.29
Range, d	1.16-2.25	1.29-2.13	1.0-2.0	1.00-2.33	2.71-3.83	8.29- 11	9.17- 9.45	9.0-12
Number of observations	45	42	40	39	35	15	11	75
Survival, %	93.33(9.66)	92.87(9.64)	97.43(9.87)	89.47(9.46)	73.52(8.57)	79.12(8.89)	81.43(9.02)	60.53(7.73)

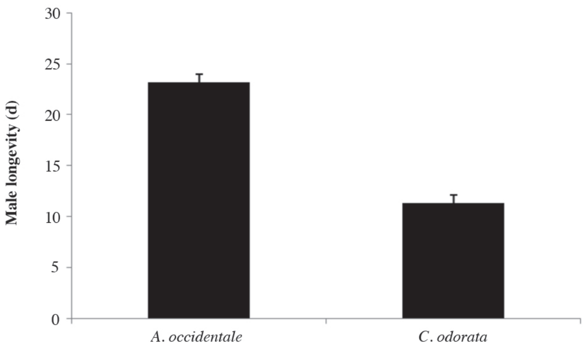
Values in parenthesis are square root transformed.

Figure 2. (a) *Helopeltis theivora* egg, (b) nymph and (c) adult on *Chromolaena odorata*.

The mean incubation period of eggs was 10.5 ± 1.29 (9-12) d with 60.53% survivals. Mean longevity of adult females was 22.6 ± 3.29 d with a range of 19-25 d.

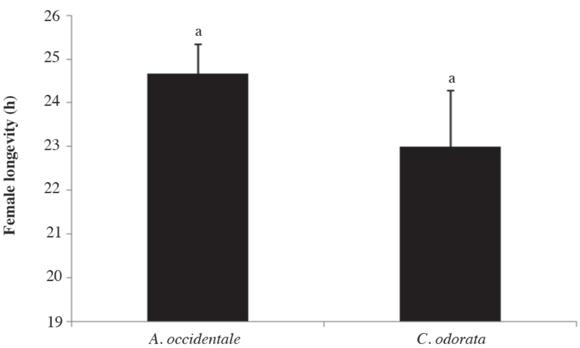
The male longevity was significantly ($P < 0.05$) lower on *C. odorata* than on cashew (Figure 4) and female longevity was not significantly different (Figure 5). The pre reproductive period varied from 4 to 6 d with a mean of 4.8 ± 0.84 d (Table 2). Fecundity was significantly ($P < 0.05$) lower (30.6 ± 6.50) on *C. odorata* when compared with cashew (Figure 6). Post reproductive period varied from 2 to 4 d. Adult males lived lesser than females with a mean longevity of 11.8 ± 1.64 d.

A total of 107 eggs of eupatorium were observed and the results indicated the existence of three species of egg parasitoids *viz*., *Telenomus* sp. (laricis group) (Hymenoptera: Scelionidae), *Chaetostricha* sp. (Hymenoptera: Trichogrammatidae) and *Erythmelus helopeltidis* Gahan (Hymenoptera: Mymaridae). Of these three species, *Telenomus* sp. was most frequently collected (Table 3 and Figure 7). For the first time, egg parasitoids were recorded from *H. theivora* eggs on *C. odorata*. Earlier *Telenomus* sp. has been reported in India on *H. cinchonae* Mann (Simmon, 1970), on *H. theobromae* Miller from Malaysia (Ibrahim, 1989) from cocoa, and both *Telenomus* sp. and *Chaetostricha* sp. on *H. antonii* Signoret from India (Sundararaju, 1993) from cashew. *Erythmelus helopeltidis* has been reported from *H. antonii* eggs by Devasahayam and Nair (1986) and



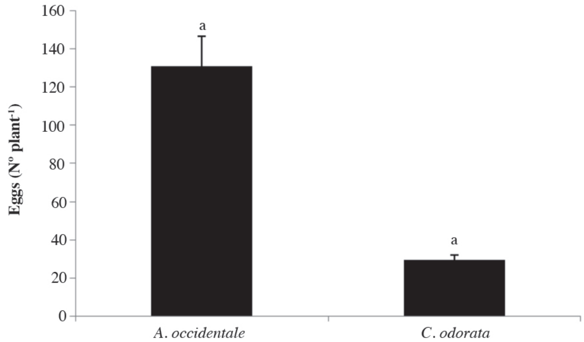
Data are mean ± SE.

Figure 4. *Helopeltis theivora* male longevity on *Chromolaena odorata* and *Anacardium occidentale*.



Data are mean ± SE. Same letters are non significant according to F-test ($P < 0.05$).

Figure 5. *Helopeltis theivora* female longevity *Chromolaena odorata* and *Anacardium occidentale*.



Data are mean ± SE. Common alphabets are non significant according to F-test ($P < 0.05$).

Figure 6. *Helopeltis theivora* fecundity on *Chromolaena odorata* and *Anacardium occidentale*.

Table 3. Egg parasitoids recorded of *Helopeltis theivora* eggs on *Chromolaena odorata*.

Number of *Helopeltis* eggs observed	Percent parasitism (%)		
	Telenomus sp.	*Chaetostricha* sp.	*Erythmelus helopeltidis*
107	3.74	1.87	1.87

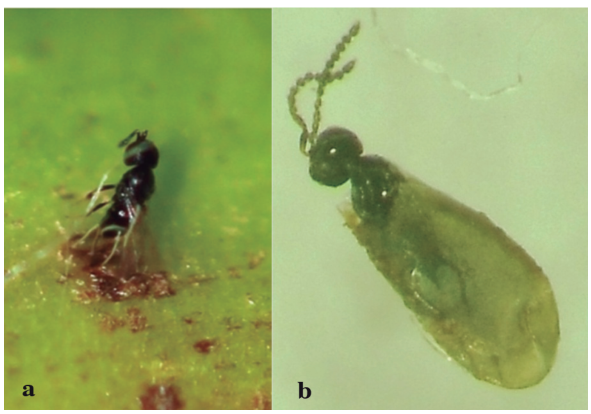


Figure 7. (a) *Telenomus* spp. parasitizing eggs (b) *Telenomus* spp. emerging from *Helopeltis theivora* egg.

Table 2. Reproductive parameters and longevity of *Helopeltis theivora* on *Chromolaena odorata*.

Particulars	Pre reproductive period[2]	Fecundity during effective reproduction[1]	Longevity		Post reproductive period[2]
			Male[1]	Female[1]	
Mean ± SD	4.8 ± 0.84	30.6 ± 6.50	11.8 ± 1.64	22.6 ± 3.29	2.8 ± 0.84
Range	4-6	19-34	9-13	19-25	2-4

[1]Based on 20 individuals; [2]based on 10 individuals.

Sundararaju (1993). *Erythmelus helopeltidis* was also reported on *H. theobromae* Miller in cocoa from Malaysia (Ibrahim, 1989).

Adult egg parasitoids must not only find hosts for reproductive purposes but also locate food to meet their short-term nutritional needs. Both host and host habitat characteristics can be learned when a parasitoid has a contact experience with host, host products, or host plants (Lewis and Tumlinson, 1988; Herard et al., 1988; Turlings et al., 1989); a broader understanding of tritrophic level interactions that encompasses parasitoid food considerations can enhance our ability to design effective biological control strategies.

CONCLUSION

The primary objective of this study was to understand the biological parameters of economically important pest, *Helopeltis theivora* on *Chromolaena odorata*. This weed acted as alternate host for build of population during July to December and no incidence of *H. theivora* was seen on eupatorium from December onwards; attributed to the non-availability of preferred stage of host plant and further the migration of the pest to its main host cashew. Survival percentage of eggs was lower than nymphal instars and survival percentage of 5th instar nymphs was lower compared to 1st, 2nd, 3rd and 4th instars. Males had shorter life span compared to females. Females showed dynamic patterns of fecundity. One silver line of the study was that *C. odorata* also acts as the reservoir for egg parasitoids of *H. theivora*. The knowledge of biology on *C. odorata*, might aid in taking appropriate decision in IPM of this mirid bug in main crop. Furthermore, the present study also highlights the essentiality of weed management in cashew plantations.

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