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Biology of *Helopeltis theivora* (Heteroptera: Miridae) on tea (*Camellia sinensis*) in the sub Himalayan region

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Tea (*Camellia sinensis* L. O' Kuntze) as a plantation crop was introduced in Darjeeling hills in 1852, but with time, it has spread over vast stretches of the sub Himalayan foothills and the adjoining regions of North Bengal. While quality clones of Chinary and Assam types are grown more in higher elevations, more of high-yielding tea clones with Assam and Cambode blood are planted in lower slops that continue to the Terai plains of the river basins.

Insect and mite pest activity in the sub Himalayan foothills and plains, that comprise the Dooars and Terai regions, has been reported to be high (Sannigrahi and Talukdar, 2003). These pests cause 11 to 55 % loss in yield. Tea mosquito bug, *Helopeltis theivora* Waterhouse (Heteroptera: Miridae) is considered as one of the severe pests causing considerable economic loss from 25 to 50 % (Prasad, 1992; Barbora and Singh, 1994; Subramaniam, 1995). Earlier studies on biology of *H. theivora* is available from Assam region (Das, 1965) of North East India, but no comprehensive information on its biology is documented from the sub Himalayan agroclimate, specially that of Terai and the Dooars. Besides this, the insect is expected to have adaptive changes particularly to the changed climatic factors, during the last 50 years (Mukhopadhyay and Roy, 2009). This study, therefore, seeks to determine the recent trend of biology of the pest.

Five hundred nymphs of *H. theivora* (mostly advanced instars) were collected from different tea estates of the Dooars tea plantations located 26^0.16' to 27^0.0' N and 88^0.4' to 89^0.53'' E with a variable altitude between 90 m and 1750 m in the sub Himalayan region of West Bengal, India. The nymphs were kept in groups of five in hurricane lamp glass chimneys (Gope and Handique, 1991). In each chimney, 10 nymphs were allowed to feed on TV1 shoots, the bases of which were kept in a water field vial. Shoots were renewed daily and the glass chimney was replaced everyday with new glass chimney. While replacing the vial, the nymphs on the shoot were carefully removed by single hair brush and introduced on a new shoot. This was continued until the emergence of adults. Twelve hours after adult emergence, they were sexed relying on size difference, shape of abdomen and presence of ovipositor on the sixth abdominal segment of the females. Five males and five females were then kept in transparent nylon mesh cages with wooden frame, measuring 60 x 45 x 45 cm, and fed with tender TV1 tea shoots. After mating, females were allowed to oviposit in the shoots and the egg laden shoots were removed based on presence of extra choronic process of eggs. Twigs containing eggs were inserted to a 5 ml glass tube containing water. The egg-laden shoots were kept in an upright position in such a way that the stem portions, which contained egg, did not touch the water. As a prophylactic measure water in the glass vials was mixed with carbendazim (0.1%) to prevent fungal growth on the shoots. After a few hours of hatching, newly emerged first instar nymphs were transferred to petri dish (12 cm diameter) individually by hair needle and provided with tender host shoots moistened with wet cotton around petiole daily. Ten nymphs were reared in each petri dish. Ten such rearing replications were accomplished every month. Upto 3^{rd} instar stage the nymphs were maintained in the petri dish, but on reaching 4^{th} instar stage, the nymphs were transferred to hurricane lamp glass chimney-culture and maintained till the emergence of adult. Each chimney contained ten individual and ten such replications were studied in every month.

Data regarding pre-oviposition, oviposition, post oviposition, fecundity, nymphal duration and number of nymphs attaining adult stage were recorded. The data of biological parameters were subjected to analysis with help of the computer program, "GrahPad InStat".

Duration of the developmental stages of *H. theivora* varied widely in different months (Table 1). The lowest incubation period was noticed during September and October i.e. 5.6 to 5.8 days. The incubation period was 6 - 8 days during the months from April to August and about two weeks or more during the winter months of December to February. In March, i.e. at the onset of spring the incubation period of was an average of 10.9 days.

During the summer months of May to October, nymphal development was completed within a short time i.e. 8.4 to 10.0 days, and the shortest being in August when it took only 8.4 days. The longest time (16.2 days) was required in the winter month of January (Table 1). It was noted that 66.6 to 70.6 percentage nymphs survived to reach to adult stage. No significant difference in the mortality percentage was observed during nymphal development period in different seasons. The pre oviposition period in *H. theivora* was noted to be on an average four days and oviposition period ranged from 24 to 36.8 days which varied significantly in different months of the year (Table 1).

The total number of eggs laid by a female was as high as 136.6 ± 18.68 in the month of September and as low as 73 ± 11.55 to 74.2 ± 12.97 during January to February (Table 1). During October and November, a high rate of egg laying to the extent of 127.0 ± 17.50 and 114.8 ± 8.25 eggs per female, respectively was observed. During the rest of the year, the mean fecundity ranged from 75 to 90 (Table 1).

Gope and Handique (1991) reported a short incubation period of five days in August to a prolonged one of 16 days in December in N.E India (Assam). Sundararaju and Sundara Babu (2000) and Sudhakaran (2000) reported that the incubation period gets prolonged in colder months and shortened during the wormer month. Gope and Handique (1991) observed that the longest nymphal developmental period was 29.6 days and which

Table 1. Life cycle pattern of *H. theivora* in the Dooars agro-climatic condition

Month	Egg stage	Nymphal stage		Total developmental period	Pre oviposition period	Oviposition period	Fecundity period
	IP (days) n = 20	ND (days) n = 10	NR (%)* n = 10	(days) n = 10	(days)* n = 10	(days) n = 10	(egg/female) n = 5
Jan.	16.6 ± 1.49 (14-18)	16.2 ± 3.51 (14-20)	66.6 ± 9.71 (60-77)	30.6 ± 2.34 (28-32)	4.2 ± 1.17 (3-5)	36.2 ± 4.05 (22-53)	73 ± 36.52 (39-111)
Feb.	17.4 ± 0.66 (14-21)	14.0 ± 1.71 (13-16)	69.2 ± 12.05 (60-83)	29.8 ± 3.35 (27-33)	4.2 ± 1.17 (3-5)	32.8 ± 6.74 (21-51)	74.2 ± 41.01 (49-123)
Mar.	10.9 ± 2.02 (9-15)	10.4 ± 2.91 (8-13)	67.8 ± 5.41 (63-73)	19.8 ± 4.27 (18-24)	4.2 ± 1.17 (3-5)	28.6 ± 4.93 (21-30)	71.4 ± 42.41 (33-109)
Apr.	7.8 ± 0.79 (7-9)	10.0 ± 2.43 (9-13)	68.0 ± 13.72 (60-80)	17.6 ± 2.12 (16-20)	4 ± 0.98 (3-5)	25.2 ± 4.81 (22-30)	75.4 ± 43.80 (44-121)
May	7.2 ± 0.41 (7-9)	9.8 ± 2.09 (8-12)	69.4 ± 7.24 (63-70)	17.2 ± 2.31 (16-20)	3.8 ± 0.63 (3-4)	26.2 ± 7.15 (21-32)	84.6 ± 66.12 (36-142)
Jun.	6.9 ± 0.85 (6-8)	9.0 ± 1.39 (8-10)	70.6 ± 12.33 (60-80)	15.6 ± 1.61 (14-17)	4.2 ± 1.17 (3-5)	25.2 ± 5.95 (20-30)	80.6 ± 45.57 (56-134)
Jul.	6.7 ± 0.82 (6-8)	8.6 ± 1.39 (8-10)	67.2 ± 7.68 (63-73)	15.2 ± 1.83 (14-17)	4 ± 1.39 (3-5)	24.0 ± 3.60 (21-27)	92.8 ± 49.33 (49-141)
Aug.	6.6 ± 1.17 (5-8)	8.4 ± 0.76 (8-9)	69.6 ± 6.10 (60-77)	14.8 ± 1.83 (13-16)	3.8 ± 0.63 (3-4)	24.8 ± 5.22 (24-30)	101.8 ± 56.98 (53-157)
Sep.	5.6 ± 0.98 (4-7)	8.6 ± 1.26 (8-10)	69.2 ± 9.87 (63-80)	13.2 ± 0.63 (13-14)	3.8 ± 1.17 (3-4)	28.8 ± 6.26 (21-37)	136.6 ± 59.07 (73-187)
Oct.	5.8 ± 1.14 (6-8)	9.0 ± 1.39 (8-10)	68 ± 16.06 (60-87)	15.4 ± 2.12 (13-17)	4 ± 1.71 (2-5)	30.4 ± 3.79 (22-42)	127 ± 55.34 (82-160)
Nov.	6.9 ± 1.08 (6-9)	10.2 ± 1.83 (9-12)	67.6 ± 8.57 (60-77)	17.4 ± 2.56 (15-19)	3.6 ± 1.61 (3-5)	34.2 ± 6.10 (21-41)	114.8 ± 26.09 (88-133)
Dec.	12.2 ± 1.74 (10-15)	12.8 ± 3.64 (9-16)	68.6 ± 7.65 (60-73)	23.8 ± 3.92 (21-28)	4 ± 0.98 (3-5)	36.8 ± 4.62 (23-50)	90.0 ± 46.39 (60-156)
CD (P = 0.05 %)	0.7061	1.8669		2.1945		4.42	41.002

IP - Incubation Period; ND - Total nymphal stages duration; NR - % of Nymphs reaching adult stage. ± Standard deviation (SD) of the mean of 10 replications. Figures within parenthesis represent the range values. *F value for treatment is not significant i.e. none of the months showed significant effect.

might extend exceptionally upto 39 days (Das, 1965). These findings deviate substantially from the current trends where a maximum developmental period of 16 days is recorded. This may be attributed to many factors, the primary one being the change of agro-climatic conditions especially raises in average maximum temperature by 2^0 C (Mukhopadhyay and Roy, 2009) and introduction of newer planting materials like high yielding clones which possibly might have given a higher sustenance to the nymph. Fecundity of *H. theivora* in the present study was relatively low as compared to the reports by Sudhakaran (2000) from South India, who noted that as many as 660 eggs were laid by a bug in September. But, the present finding recorded a maximum of 136.6 $\pm$ 18.68 eggs during September which corroborates with similar findings of Gope and Handique (1991) on tea, Sundararaju and Sundara Babu (2000) on cashew and Sudhakar (1975) on guava.

Temperature significantly affected the developmental period of eggs (incubation period) and nymphs (total nymphal duration), oviposition period, eggs laid per day (fecundity/oviposition period) and female longevity (Table 2). Among them, incubation period, total nymphal duration and oviposition period showed highly negative correlation with "r" values of -0.881, -0.916 and -0.864, respectively. But eggs laid per day were positively correlated (r = 0.864). The results of the present study are in general agreement with the previous reports on traits of *Helopeltis* species by Ambika and Abraham (1979) on cashew, Sudhakar (1975) on guava and Sudhakaran (2000) on tea of southern India. From the present study it was clearly evident that at high temperature, *H. theivora* laid more eggs per day but the longevity of females was reduced drastically; this was in line with the findings of Pillai *et al.* (1976). The influence of relative humidity was not found statistically significant with the concerned biological traits of *H. theivora* in the Dooars.

All these traits of *H. theivora* appeared to be tuned to exploit the maximum food resource available during summer months matching with the high flushing rate.

Table 2. Simple linear regression values: Effect of individual abiotic factor on the variable life cycle traits of *H. theivora* in the Dooars

Independent variable (abiotic factors)	Regression coefficient			
	Incubation period	Nymphal duration	Oviposition period	No of eggs laid / day
Mean temperature (^{0}C)	-0.881*	-0.916*	-0.864*	0.864*
RH Morning(%)	0.138 NS	0.152 NS	0.449 NS	0.071 NS
RH Afternoon(%)	0.083 NS	0.107 NS	-0.036 NS	-0.206 NS

*Significant at 5% level, NS = Not Significant

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