Density, diversity and differential feeding potentials of aphidophagous insects in the tea ecosystem

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ABSTRACT

The aphid, *Toxoptera aurantii* (Boyer de Fonscolombe) is an important pest of tea infesting tender leaf and shoot from March to October with density of 200 of the tea twig. Such severe infestation leads to delayed recovery of the plant with the consequent effect on poor crop productivity. Periodical sampling revealed the occurrence of five species of predatory syrphids *viz., Paragus serratus* Fabr., *Episyrphus balteatus* (De G), *Betasyrphus serarius* (Weid), *Metasyrphus confrater* (Weid) and *Ischiodon scutelleris* (Fabr.); four species of coccinellids viz. *Coccinella septempunctata* L., *C. transversalis* Fabr., *Oenopia sexareata* (Mulsant) and *Coleophora bisselitta* Mulsant and a neuropteran, *Micromus timidus* Hagen along with the colony of *T. aurantii*. Seasonal abundance of predators synchronized with the pest with a maximum occurrence during September. Correlation between the density of aphid and its predators revealed a significant positive relation and the feeding rate of different predatory species ranged from 136 to 460 aphids per larva. Of which *C. septempucta* recorded the maximum of 460 aphids and *E. balteatus* with 136 aphids per larva. Though the feeding propensity of the predators differs from species to species, their presence in the field prevents the aphids from becoming a serious pest.

Key words: Tea aphid, *Toxoptera aurantii,* Aphidophagous insects, coccinellids, syrphids, predators and natural enemies

INTRODUCTION

The tea aphid, *Toxoptera aurantii* (Boyer de Fonscolombe) infests tender shoot and foliage of the tea plant. Its continuous feeding makes the leaf wrinkled forming a boat shaped structure and at times result in retarded growth of the plant. Severe infestation leads to delayed recovery of the plant with the consequent effect on poor crop productivity (Muraleedharan, 1991). Detailed aspects of aphids infesting tea under the climatic conditions of Southern India have been studied by Radhakrishnan and Muraleedharan (1986, 1993). But studies on the pest biology, pest incidence, infestation period, natural enemies and their influence on aphid population are lacking from the tea ecosystems of NE India in general and Manipur in particular. Hence the present study is carried out to fill the lacuna.

MATERIALS AND METHODS

Biology of Aphid

Studies on the duration of life cycle and fecundity rate of *Toxoptera aurantii* were assessed at different season by rearing aphids on tea foliage under the indoor rearing conditions (Table 1). Aphid infested tea shoots were collected from the field and a stock culture was maintained in the laboratory. Fresh tea shoot was taken and the cut end was dipped in glass vial (3.5×1.5 cm) containing water and the mouth of the glass vial was plugged with cotton. Freshly laid nymphs were picked up from the stock culture using a fine camel hair brush and released on the tea shoot and was kept in a plastic container (25×11 cm). The mouth of the container was covered with a muslin cloth to prevent the escape of insect. There were five replications and the data were recorded on daily basis and the shoots were changed whenever necessary. Laboratory temperature and relative humidity were recorded and the mean values were used for statistical analysis. Moulting of the aphid was noted by the presence of cast skin of the nymphs. Total development and reproductive period, fecundity rate and adult longevity were recorded carefully and continuously.

Population assessment

A field survey was conducted during 2006 and 2007 at Jaja Tea and Plantations Pvt. Ltd. Hengbung village, Senapati District (1300 m above MSL). The tea plants of that estate are primarily of Tocklai released clones. The experimental site was kept free from pesticide application. To assess aphid population 400 bushes were marked, of which 40 bushes were randomly selected for sampling at an interval of 15 days. Aphids were counted on 5 cm length of the twigs of the selected plants at the plucking level of the tea bush. Data related to climatic factors like temperature, relative humidity and rainfall were recorded

from the nearest meteorological observatory of Regional Tasar Research Station (Central Silk Board), Mantripukhri.

Feeding efficiency of the predators

Feeding efficiency of the predators associated with tea aphid was assessed by rearing individuals from their early stage separately on plastic petridish (8.5 cm diameter) and fed *ad libitum* by providing known number of aphid infested twigs. Daily prey consumption was quantified by counting the left over aphids in each twig. Totally five replications were maintained for each predatory species.

RESULT AND DISCUSSION

Biology

Toxoptera aurantii reproduces parthenogenetically and lays the nymph viviparously. The developmental period was minimum in spring followed by summer and autumn. The fecundity rate was 61, 54 and 40 during spring, autumn and summer with the reproductive period of 9, 8 and 5 days. The adult longevity ranged from 9.6 days in summer to 15 days during spring and autumn, respectively. Spring was ideal and conducive season for the growth and development of *T. aurantii* (Table 1).

Population dynamics of aphid and its predators

Aphid incidence was correlated with predators (r=0.95) as well as climatic factors such as minimum temperature (r=0.12), maximum temperature (r = -0.33), relative humidity (r=0.19) and rainfall (r = 0.06). Correlation between the density of aphid and its predators revealed a significant positive relation with Syrphids (r = 0.95); Coccinellids (r = 0.97) and neuropteran larvae ((r = 0.92) ($P < 0.05$). This indicated significantly high positive correlation with predators and weak correlation with climatic factors. The data on the incidence of tea aphids showed almost similar trend during the experimental period. The aphid density during the period of maximum abundance ranged from 150 (March / April) to 200 (September) individuals per 5 cm length of twig. However, the aphid density is appreciably high during August and September, it is presumed that the climatic conditions prevailed during that period 20±2^{0}C to 29±2^{0}C; 78±2% and 15-20 cm for mean temperature, RH and rainfall, respectively seems to be conducive to enhance the aphid population on tea. Moreover, the incidence of significantly high aphid population in April may be due to the availability of more number of young shoots since April is said to be the rush season of the crop. On the other hand, reduction in aphid population during June-July could be due to heavy rainfall within a short span during that period.

Table 1. Biology of the Tea aphid at different season.

Season during which Aphids reared	Mean Temperature		R.H (%)	life cycle duration (days)	Fecundity per female	Reproductive period (days)	Adult longevity (days)
	mini-mum (^{0}C)	maxi-mum (^{0}C)					
Spring	18±0.5	25±0.6	57±2	6.2^a	61.4^c	9.4^b	15.8c
Summer	24±0.1	27±0.4	55±1	7.4^b	40.4^a	5.2^a	9.6^a
Autumn	19±0.3	24±0.6	52±1	8.8^c	54.2^b	8.4^b	14.2^b
C.D. at 5% (ANOVA)	-	-	-	0.49	0.62	0.40	0.27

Figures followed by different alphabets in a vertical column are significantly different at 5% level (ANOVA).

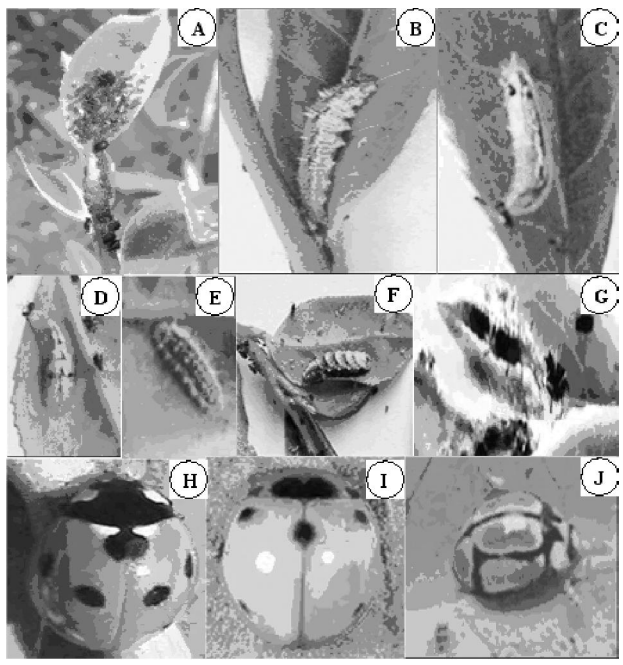

Plate 1. Tea aphid and Aphidophagous insects

A- Colony of Tea aphid; B- *B. serarius*; C- *E. balteatus*; D- *I. scutellaris*; E- *P. serratus*; F- *M. confrater*; G- *M. timidus* feeding on tea aphid; H- *C. septempunctata*; I- *C.bisselita* ; J- *O. sexareta*.

Species diversity and richness of predators

Field assessment indicated the presence of three different groups of predatory insects like Syrphids, Coccinellids and Neuropterans (Plate 1). Of the three predatory groups, neuropteran larvae occurred sporadically, while syrphids and coccinellids were observed throughout the

period of aphid infestation. The predatory population followed almost similar trend with that of prey aphid and maximum density and diversity of the predators were noticed in the month of September (Figure 1). On the other hand, with abiotic factors, it showed a weak positive correlation as mentioned earlier. Comparative study of syrphids indicated that *P. serratus* was the predominant species both in terms of density and frequency of occurrence, followed by *M. confrater*, *E.balteatus*, *B. serarius* and *I. scutellaris*. Similarly, among the coccinellids, *C. septempuncta* outnumbered the other species like *C. bisselita, C. transversalis* and *O. sexareta*. Among the predators, *B. serarius* and *M. timidus* were alone observed almost throughout the period of aphid abundance. Simultaneous occurrence of prey and predators seems to be a common feature not only in tea ecosystem (Radhakrishnan and Muraleedharan, 1993) but also in other cropping systems like cabbage, mustard and oak plants (Chitra, 1998).

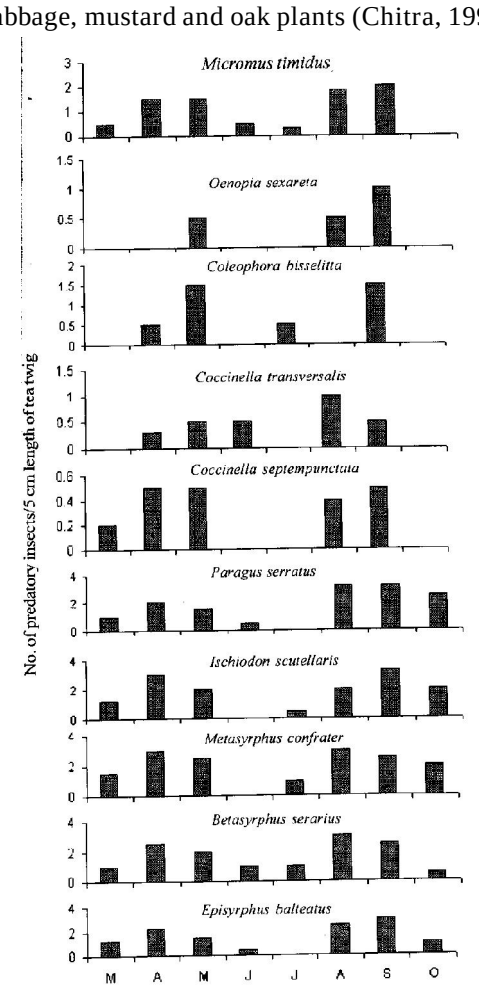

Figure 1. Seasonal abundance of predators of tea aphid

Table 2. Feeding efficiency and larval duration of the predators

Predadors	Larval duration (days)	No. of Aphids consumed / larva
Syrphids		
Episyrphus balteatus	10.4±0.2	136±12.5
Betasyrphyus seriarus	12.2±0.5	320±12.0
Metasyrphus confrater	15.0±0.8	452±8.0
Ischiodon scutellaris	13.0±0.5	321±10.5
Paragus serratus	15.1±0.2	200±5.8
Conccinellids		
Coccinella septempunctata	30.0±0.5	460±15.2
Coleophora bisselitta	25.2±0.8	420±10.0
Neuropteran		
Micromus timidus	15.2±0.6	250±5.8

Feeding efficiency of the predators

Comparative study on the feeding efficiency of different predators revealed variation in their voracity. For instance, *Episyrphus balteatus* and *Coccinellla transversalis* could feed on 136 and 460 aphids respectively. Syrphids were considered to be better predator both in terms of density and feeding efficiency in comparison to coccinellids. Among the syrphids, *Metasyrphus confrater* consumed a maximum of 452 aphids per larva. On the other hand, the neuropteran larvae, *Micromus timidus* was observed throughout the period of aphid occurrence and its feeding efficiency was 250 aphids / larva during its development (Table 2). Although the voracity varies with varied predators, *M. timidus* is considered here as efficient one in terms of density and feeding potential. Similarly, observation on *M. confrater* coincides with that of Agarwala and Saha. (1986) and Shantibala *et al*. (1995) wherein *M. confrater* devoured as much as 300 individuals of *Cervaphis quercus* and 886 individuals of *Aphis gossypii*. However, variation in consum ption rate could be attributed to variation in size of the nymphs, temperature and other rearing conditions (Veeravel and Bhaskaran, 1996). Therefore, considering the occurrence frequency, periodicity, diversity and feeding potentials of various predators, it becomes clear that they limit the density of the tea aphids under field condition to some extent.

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