Morphological diversity, developmental traits and seasonal occurrence of looper pests (Lepidoptera : Geometridae) of tea crop

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ABSTRACT

Caterpillars of three major geometrid species such as, *Hyposidra talaca, H. infixaria* and *Buzura suppressaria* frequently attack tea plantations of sub-Himalayan plains of Terai and the Dooars region. The feeding activity of these pests often leads to heavy defoliation of tea bushes almost throughout the year. A clear understanding of the morphological diversity of these sympatric species is necessary at all life stages in order to contemplate their management strategies. Field observations indicated that amongst the loopers there is a dominance of *H. talaca* and *H. infixaria* at different seasons compared to the third species, *B. suppressaria*. Although a clear morphological difference of the adult moths of three concerned species was evident along with their distinct morphometry and weights, the larval instars of the congeners of *Hyposidra* were difficult to distinguish. However, a significant difference was observed in their development periods, which were 55 days for *H. talaca* and 48 days for *H. infixaria*. A clear distinction of the concerned species based on morphometrics and weight of pupa was also evident. In recent past, loopers have assumed the status of severe pest of tea in the sub- Himalayan plains mainly due to invasion of the two species of *Hyposidra* that have joined *B. suppressaria* in sharing the tea leaves as their ideal host. The newer pest species of *Hyposidra* otherwise known to occur on forest and fruit plants have of late turned to be a major defoliator of tea.

Key words: Crop pests, seasonal Occurrence, morphology, tea loopers, Darjellling terai

INTRODUCTION

Tea, *Camellia sinensis* (L.) O. Kuntze, is an intensively managed perennial monoculture crop cultivated on large- and small-scale plantations situated between latitudes 41^{o}N and 16^{o}S. It is grown on over 2.71 million ha in more than 34 countries across Asia, Africa, Latin America, and Oceania to produce 3.22 million metric tons of made tea annually (FAO, 2005). Globally, 1031 species of arthropods are associated with the intensively managed tea monoculture. All parts of the plant, leaf, stem, root, flower, and seed, are fed upon by at least one pest species, resulting in 11%–55% loss in yield if left unchecked (Hazarika *et al.*, 2009). Tea with perennial foliage is infested by about 167 insect species in the Northeastern tea growing regions of India (Mukhopadhyay and Roy, 2009) including the Dooars and Terai. Of these, six species have attained major pest status (Gurusubramanian *et al*., 2008). Among the lepidopterans attacking tea, *Buzura suppressaria* Guen was reported as a major tea pest in 1900 (Das, 1965). Initial migration of *B. suppressaria* to the tea plantations occurred from forest trees (Das, 1957). Recently two polyphagous geometrid folivores, commonly nick named black inch worms, *Hyposidra talaca* (Walker) and *Hyposidra infixaria* Walker are reported to feed on a number of forest plants and weeds from India, Malaysia and Thiland (Browne, 1968; Mathew *et al*., 2005; Winotai *et al*., 2005; Das and Mukhopadhyay, 2008; www.mothsof borneo.com). The looper stage of *Hyposidra* species have joined the band of defoliators in Darjeeling Terai and the Dooars causing substantial damage to the crop (Basumajumdar and Ghosh, 2004; Das and Mukhopadhyay, 2008, 2009). In the present work, seasonal occurrence of the three lepidopteron species was studied from Terai tea plantations along with their morphological distinctions and developmental traits.

MATERIALS AND METHODS

Field trips were undertaken monthly to study the seasonal occurrence of *B. suppressaria* and the two species of *Hyposidra*. Sampling was done from three tea plantations of Terai. Unit area of the size 10 sq.m. was sampled in three replicates from the selected tea plantations. Sampling was done in four seasons of a year such as spring (March-May), summer/rain (June-August), autumn

(September-November) and winter (December-February). Mean relative abundance of the different looper species was calculated based on six observations per season. Larvae collected from field were reared in the laboratory on tea twigs in transparent plastic containers (13 liter capacity). Male and female adults were weighed and their wing spans measured for all the three species.

To study developmental traits, the most dominant looper species such as, *H. talaca* and *H. infixaria* were released in large containers for mating and egg laying. Cotton plugs soaked in dilute honey were provided as feed and tissue paper strips were provided for egg laying. After hatching, larvae were maintained on tea twigs individually in plastic containers (6cm - 4cm diameter) with their mouths tied with fine cloths. Life cycle was studied at 24.94±2.31 ºC and 12.47±2.87 ºC. Duration of different life stages was documented. Total body length and body weights of larvae (Electronic balance BT 124 S, d=0.1mg, Sartorius), maximum thoracic width, abdominal width and length of pupae were measured. Data was subjected to ANOVA and Tukey's multiple comparison test and significances were expressed at 5% level.

RESULTS AND DISCUSSION

Results clearly indicated the dominance of the two congeners of *Hyposidra* over the earlier known tea looper, *B. suppressaria*. Highest relative abundance of *B. suppressaria* (20.98%) was recorded during spring (Fig. 1), with generally four broods per year (Das, 1965). Whereas, *Hyposidra* spp. were found with at least eight broods per year having no obligatory diapause during winter. Prolonged winter diapause of *B. suppressaria* as sub-soil pupae was evident through it's almost 0% occurrence of looper stage during winter. *Hyposidra* usually known to occur on wild forest and fruit plants have of late turned as major defoliator of tea. Besides these three looper species, loopers of *Ascotis* and *Cleora* were also recorded from the Terai tea plantations which however, did not assumed major pest status.

Table 1. Adult morphology and measurements of three looper species (Mean ± SE, N=20)

Morphology		*B. suppressaria*	*H. talaca*	*H. infixaria*
Wing span (cm)	F	6.24 ± 0.23 ^{Aa}	5.208 ± 0.089 ^{Ab}	5.00 ± 0.084 ^{Ab}
	M	4.97 ± 0.117 ^{Ba}	3.65 ± 0.043 ^{Bb}	3.67 ± 0.057 ^{Bb}
Body weight (gm)	F	0.712 ± 0.030 ^{Aa}	0.218 ± 0.018 ^{Ab}	0.167 ± 0.007 ^{Ac}
	M	0.252 ± .013 ^{Ba}	0.072 ± 0.005 ^{Bb}	0.048 ± 0.002^{Bc}

Different capital alphabets in each column and different small alphabets in each row indicate significant difference when $P \leq 0.05$. F-Female M-Male

Table 2. Duration (in days) of different developmental stages of *H. talaca* and *H. infixaria* (Mean ± SE, N = 20)

Life stages	*H. talaca*	*H. infixaria*
Egg	6.0 ±0 ^{a}	8.0 ± 0 ^{b}
First instar	4.64 ± 0.125 ^{a}	5.44 ± 0.114 ^{a}
Second instar	3.25 ± 0.116 ^{a}	3.80 ± 0.092 ^{a}
Third instar	3.80 ± 0.141 ^{a}	3.96 ± 0.080 ^{a}
Fourth instar	4.41 ± 0.150 ^{a}	4.14 ± 0.105 ^{a}
Fifth instar	11.58 ± 0.335 ^{a}	10.38 ± 0.165 ^{b}
Pupa	18.94 ± 0.300 ^{a}	11.14 ± 0.203 ^{b}
Total development period	55.00 ± 0.28 ^{a}	47.82 ± 0.163 ^{b}

Different small alphabets in each row indicate significant difference when $p \leq 0.05$.

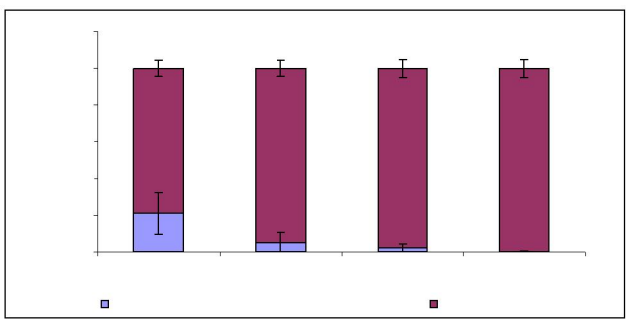

Figure 1. Seasonal occurrence of *Buzura suppressaria* and *Hyposidra* spp. (*H. talaca* and *H. infixaria*).

Adult *B. suppressaria* were morphologically very distinct from the two species of *Hyposidra* (Table 1). Larval stages of *B. suppressaria* were clearly distinguishable with their green to brown body colour, triangular head, prominent red spiracles, large body length (6.4 ± 0.089 cm) and heavier weights (1.674±0.064 gm) of the final instar larvae. Pupae were also with distinctly greater length (2.32 ±0.050 cm) and weight (0.876 ± 0.055 gm). *Buzura suppressaria* pupae had a characteristic pair of anterior ridges and posterior cremaster like process, which are absent in the pupae of *Hyposidra* species.

A detailed life cycle of *H. talaca* and *H. infixaria* were studied. The postembryonic development periods of the two species were similar until 4th instar stage. However, significant difference could be recorded in the duration of final larval instar and pupa (Table 2). *Hyposidra talaca*

Table 3. Growth parameters of *H. talaca* and *H. infixaria* at different developmental stages (DS) (Mean ± SE, N=20)

Life stages		Body length (cm)		Body weight (mg)	
		H.talaca	*H.infixaria*	*H.talaca*	*H.infixaria*
First instar		0.2	0.2	--	--
Second instar		0.43 ± 0.008	0.39 ± 0.006	--	--
Third instar		0.73 ± 0.017	0.77 ± 0.018	2.92 ± 0.180	2.43 ± 0.173
Fourth instar		1.325 ± .023	1.290 ± 0.027	20.1 ± 0.894	18.00 ± 0.671
Fifth instar	Female	2.411 ± 0.110	2.341± 0.085	116.0 ± 8.273 ^{Aa}	93.0 ± 4.249^{Ab}
	Male	2.250 ± 0.098	2.112 ± 0.072	80.0 ± 4.226^{Ba}	69.0 ± 2.460^{Bb}

Different capital alphabets in each column and different small alphabets in each row indicate significant difference when $P \leq 0.05$.

exhibited a development period that was longer by eight days on an average than *H. infixaria*. Shorter development period of *H. infixaria* might be resulting in more number of broods during winter months than *H. talaca*. Generally, five larval instars were recorded for the two species of *Hyposidra* under the study conditions. However, a small percentage of *H. talaca* loopers (8%) resorted to an additional instar. This might be due to the fact that the decision to pupate often depends on attainment of some minimal body weight (Slansky, 1982). In fact, the larvae of *H. talaca* which entered sixth instar as final larval stage weighed significantly less in fifth instar when compared to those with fifth instar as final larval stage. When their body length was considered, almost a similar growth pattern was recorded in the larvae (Table 3). However, advanced female (F) and male (M) fifth instar larvae of both the species of *Hyposidra* differed significantly in their lengths. A marked difference in the measurement at the pupal stage could be recorded between the two species of *Hyposidra* (Table 4). Observation of the pupae and adults also showed a clear dimorphism, female pupae were longer and heavier than the males (Table 4) and female adults had much heavier bodies and wider wings (Table 1).

Morphologically the early larval stages of the two species of *Hyposidra* were similar having black body with white stripes, which gave them the common name “black inch worm”. However, final instar of *H. infixaria* is characterized by possessing paired lateral oblique black stripes extending from 1st abdominal segment to 3rd pair of thoracic legs which appear blackish than first two pair of legs. The trends of development in terms of body weight between the two species showed by and large insignificant

Table 4. Comparison of pupal morphology and morphometry between *H. talaca* and *H.infixaria* (N=20, Mean±SE)

Parts	Sex	*H. talaca*	*H. infixaria*
Thoracic width/ pupal length	Female	0.33 ± 0.004^{a}	0.30 ± 0.003^{b}
	Male	0.34 ± 0.004^{a}	0.29 ± 0.003^{b}
Abdominal width/ pupal length	Female	0.26 ± 0.004^{a}	0.25 ± 0.003^{b}
	Male	0.27 ± 0.004^{a}	0.23 ± 0.005^{b}
Weight (mg)	Female	327 ± 11 ^{Aa}	240 ± 8 ^{Ab}
	Male	72 ± 5 ^{Ba}	48 ± 2 ^{Bb}

Different capital alphabets in each column and different small alphabets in each row indicate significant difference when $P \leq 0.05$.

difference until forth instar. However, the two species were significantly different in their body weights at 5th instar larval, pupal and adult stages (Tables 1, 3, 4).

Buzura suppressaria, long known from tea plantations of Darjeeling foothills, has distinct larval and adult morphology from the other looper species. Similar morphological features, lengths and body weights of the early larval stages of the two congeneric species implied that they are close to one another. This is further supported by the observations of their common sharing of the same niche compared to the feeding on more mature tea leaves by *B. suppressaria*. The latter species therefore stands out as a more distinct ecological species than the two species of *Hyposidra*. Problems of distinguishing the earlier larval stages of the two species of *Hyposidra* was also encountered in the nymphs of several species of *Scolopostethus* by Eyles (1963) where they were not distinguishable in the field and the larval body measurements were similar in all the species studied under that genus. Almost a parallel example of this paradoxical situation was also noted in the immature stages of the two species of *Rhyparothesus*, *R. sparsus* and *R. bengalensis* that shared the same ecological niche wherein the first four instars showed very close similarities, even overlapping morphometrics (Mukhopadhyay, 1989). In the present condition and time, as regard to the occurrence of loopers in Terai and the Dooars area, a clear abundance of the *Hyposidra* spp. as compared to *B. suppressaria* might be the result of a better adaptation of the former spp. to tea bushes. The better adaptive strategy was evident through their faster growth, shorter life cycles and multivoltinism. Moreover, a continued population incidence with succession of the two *Hyposidra* species over most part of the year, especially during winter signified their adaptation to tropical weather changes and tolerance to a wide range of temperature and humidity. Their reported polyphagy, which includes many jungle plants and weeds, also provided them the opportunity for

better survival as compared to other oligophagous loopers such as *B. suppressaria* that are mostly confined to the shade trees and tea.

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