KFRI Research Report 38

# STUDIES ON THE NATURAL ENEMIES OF THE TEAK PESTS, HYBLEA PUREA AND EUTECTONA MACHAERALIS

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PEECHI, THRISSUR

February 1986 Pages: 23

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## ABSTRACT

Information on the natural enemies of the teak pests, *Hyblaea puera* and *Eutectona machaeraiis* was collected from three plantation sites at Nilambur, during April 1983 to April 1985.

The natural enemies of *H. puera* recorded include five parasites *Brachymeria Iasus* (Walker), *Palexorista solennis* Walker, *Sympiesis* sp. and two species to unidentified ichneumonid wasps; two insect predators - *Cantheconidea furcellata* wolft and *Parena nigrolineata* Chd.; four species of birds- *Corvus macrorhynchos* (Jungle Crow), *Acridotheres tristis* (Common Mynah), *Dicrurus adsimilis* (Black Drongo) and *Turdoides striatus* (Jungle Babbler); and a species of bacterial pathogen *Enterobacter aerogenes* (Kruse) Hormaeche and Edwards Among the natural enemies, the parasite *Sympiesis* sp., the bird predators and the bacteria are new records on *H. puera*. Both the insect predators are new records from Nilambur.

Other than the pupal parasite *B. lasus* all parasites recorded were found infesting the larval stages of the pest. *P. solennis* was the only parasite consistently recorded from all the study sites during the peak pest infestation period. Though noted during the same period, the distribution of the ichneumonid wasps was found restricted to only one of the study sites. *Sympiesis* sp. was recorded only during the second half of the season, when the pest population was generally very small. The overall percentage parasitism due to all parasites ranged from 0 to 28 in 1983 and 0 to 26 in 1984, but during the first epidemic of the pest in each year it was very low or almost absent.

Incidence of predation by *C. furcellata* and *P. nigrolineata* was recorded only rarely. Among the birds, the contribution of *C. macrorhynchos* (Jungle crow) was substantial.

The bacterial pathogen *E. aerogenes* isolated from field-infested *H. puera* larvae was found to be an efficient mortality factor under laboratory conditions.

As no major incidnce of *E. machaeralis* occurred during the study period very little information could be gathered on its natural enemies. Five species of parasites recorded include, *Apanteles* sp., *Brachymeria hime atteviae* Joseph *et al.*, *Phanerotoma hendecasisella* Cam. and two species of unidntified ichneumonid wasps.



Key words: Teak pests, *Hyblaea puera* and *Eutectona machaeralis*, Natural enemies, Seasonal incidence..

# 1. INTRODUCTION

*Hyblaea puera* Cramer (Lepidoptera, Hyblaeidae) and *Eutectona machaeralis* (Walker) (Lepidoptera, Pyraustidae) are the two serious lepidopteran pests of teak in India.

In Kerala, *H. puera* infestation is a regular annual phenomenon. During severe infestations large area of plantation remains with leaves completely stripped of within 4-5 days since the beginning of the attack. The frequency of such serious defoliation usually varies from one to three with the first peak in the third week of April, third week of May or first to second week of June. Our previous studies (Nair and Sudheendrakumar, 1985) showed that epidemic infestation in an area is due to migration of the moths which begin in April-May and end by June-July in most years. In some -years another wave of migration may take place in August-September. Thereafter there is no epidemic and the larvae are believed to exist in very small numbers until the next flushing season.

Defoliation by *H. puera* has always been suspected to cause loss of volume increment. In field studies conducted at Nilambur during 1978 - 1982, we found (Nair *et al.,* 1985) that the impact of *H. puera* defoliation on volume increment of teak is of high economic significance, since about 44% of the potential increment was lost.

Epidemic infestation of *E. machaeralis* has been reported to occur in Southern India towards the end of the growing season and lowlevel infestation in May - June (Beesoq, 1941; Khan and Chatterjee, 1944; Patil and Thontadarya, 1983). Field studies conducted at Nilambur during 1978 - 1982 (Nair *et al.,* 1985) showed that defoliation by *E. machaeralis* is not a regular annual phenomenon in Kerala and did not lead to any significant loss of volume increment.

The present study was undertaken to gather information on the natural enemies of *H. puera* and *E. machaeralis* in three selected teak plantations at Nilambur.

Extensive surveys have been made in the past to gather information on the interrelationship between the teak pests, their natural enemies and other caterpillar hosts of the natural enemies. Stebbing (1908a) recorded from Nilambur three species of parasites- *Glypta* sp., *Pimpla* sp. (Ichneumonidae) and *Mascicera* sp. (Diptera), infesting *H. puera* larvae. Inthe same year (1908b) he recorded a species of ichneumonid and an unidentified fungus infesting *E. machaeralis.* Based on studies conducted in

different parts of the country, Beeson and Chaterjee (1935a,b,c) reported 15 species parasites infesting *H.puera* and 31 species of parasites infesting *E.machaeralis*. In 1939, Beeson and Chatterjee published a brief account of the parasites of *H. puera* and *E. machaeralis* recorded from Nilambur during 1937 and 1938. Among the parasites of *H.puera*(Table 1) the tachinid fly *Palexorista solennis* which caused parasitism ranging from 8 to 59% was the dominant species in the year 1937. However In 1938 the ichneumonid *Eriborus gardeneri* which caused an average parasitism of 30% was the dominant parasite. Among the 14 species of parasites of *E.machaeralis* (Table 1) except *Cremastus hapaliae* (Ichneumonidae) which caused parasitism ranging from 8 to 24%, the incidence of all others were less than 30%. Chatterjee and Misra (1974) listed out a

Table 1, Parasites of *H. puera* and *E. machaeralis* recorded from Nilambur during 1937-1938 by Beeson and Chatterjee (1939)

| Species | Order | Family |
|---|---|---|
| Parasites of *H. puera* | | |
| 1. *Exorista civiloides* Bar. | Diptera | Tachinidae |
| 2. *Palexorista Solennis* Walker (*Sturmia inconspicuella* Bar.) | ,, | ,, |
| 3. *Winthemia albiceps* Mall. | " | " |
| 4. *Goniozus montanus* Kieff. | Hymenoptera | Bethylidae |
| 5. *Elasmus hyblaea* Ferr. | " | Elasmidae |
| 6. *Eriborus gardeneri* Cush. | " | Ichneumonidae |
| Parasites of E. *machaeralis* | | |
| 1. *Carcelia octava* Bar. | Diptera | Tachinidae |
| 2. *Dolichocolon orbitale* Bar. | " | " |
| 3. *Sturmia parachrysops* Bezzi | " | " |
| 4. *S. nigribarbis* Bar. | " | " |
| 5. *Apanteles machaeralis* Wlkn. | Hymenoptera | Braconidae |
| 6 *Phanerotoma hendecasisella* Cam. | " | " |
| 7. *Microgaster indicus* Wlkn. | " | " |
| 8. *Brachymeria hearseyi* Var. *Xanthoterus* Waterston | Hymenoptera | Chalcididae |
| 9. *B. nephantidis* Gahan | ,, | " |
| 10. *Elasmus brevicornis* Ferr. | ,, | Elasmidae |
| 11. *Angitia argentiopilosa* Cam. | ,, | Ichneumonidae |
| 12. *Apatagium melleum* Cush. | ,, | " |
| 13. *Cremastus hapaliae* Cush. | ,, | " |
| 14. *Xanthopimpla* sp. | ,, | |

the parasites and predators infesting *H.puera* and *E. machaeralis* as well as their alternate hosts. According to them in India *H. puera* and *E. machaeralis* are known to be infested by 45 and 60 species of parasites respectively. Based on a survey conducted on the natural enemies of *E. machaeralis* in the State of Karnataka, Patil and Thontadarya (1983a) reported 43 species of parasites, 60 species of predators, a fungal pathogen and two bacteria. An updated list of natural enemies of *H. puera* so far reported from India consists of 48 species of insects, 4 species of birds and a bacterium (Appendix I) and that of *E. machaeralis* consists of 105 insects, 38 spiders, 2 fungal pathogens and a bacterium (Appendix 11).

Attempts were made in the past by Forest Research Institute, Dehra Dun towards biological control of *E. machaeralis* and *H. puera* (Beeson, and Chatterjee, 1939), Two species, *Cedria paradoxa* Walker (Hymenoptera, Braconidae) and *Trichogramma minutum* Riley (Hymenoptera Trichogrammatidae) were released against *E. machaeralis* at Nilambur during 1937. The stock material of *C. paradoxa* was abtained from Dehra Dun and multiplied at Nilambur. During August - November 1937, 16000 parasites were released at Nilambur in compartments where *E.machaeralis* was beginning to increase. Later, the recovery of the parasite cocoon on fallen teak leaves suggested that the parasite had passed through several generations, after the liberation of the initial colonies. The nuclear culture of the egg parasite *Trichogramma minutum* was obtianed from Mysore and multiplied at Nilambur, About 9250 adults were released in four localities during October - November, 1937.

*Trichogrammatoidea* sp. (Hymenoptera, Trichogrammatidae) and *Apanteles maleavolus* Wlkn. (Hymenoptera, Braconidae) were the two parasites rcleased against *H.puera* at Nilambur during 1938. The nuclear culture of both species were obtained from Burma. During the same period, attempts were made to breed the braconid parasite, *Apanteles machaeralis* and the tachinid, *Bessa remota* obtained from Burma on *H.puera* larvae. However, this was not successful as majority of the host larvae died due to some disease. None of the above biocontrol studies was later repeated or continued.

Based on information on the abundance and host range of the insect parasites associated with *H. puera* and *E. machaeralis*, Beeson (1941) suggested a scheme for the biological control of the teak pests using silvicultural measures to augumeat the efficacy of natural enemies by maintaining natural enemy reserves. His suggestions included subdivision of the planting area into blocks of 8 to 16 hectare and maintaining strips of existing forests in between as natural enemy reserves, improvement of these reserves by promoting desirable plant species and eliminating undesirable ones and maintaining a varied flora of desirable species under teak canopy. Desirable plants are thosewhich support alternate hosts of the parasites of teak pests and

undesirable ones are those which serve as alternate hosts of the teak pests themselves. Another proposal made in the scheme was the introduction of selected species of natural enemies in localities, where there is a deficiency in the natural enemy complex. This scheme of biological control was not tested experimentally or practiced, because of various practical difficulties. During 1942-43, Khan and Chatterjee (1945) studied the role of undergrowth in teak plantations as a factor encouraging parasites of *H. puera*. Rate of parasitism of *H.puera* in a selected plantation having an abundant undergrowth of beneficial plants and in another plantation having a scanty growth of these plants was compared. Though not conclusive, their study indicated better parasite efficiency in areas with abundant undergrowth which supports alternate hosts of the parasites.

Based on recent laboratory studies conducted in Karnataka on the egg parasites of *E. machaeralis*, Patil and Thontadarya (1983 b) reported the host acceptance behaviour of ten species of *Trichogramma*. All the ten species studied were found to accept and successfully complete their development on the eggs of *E. machaeralis*. In 1984, they further reported the field efficacy of three exotic species of *Trichogramma* viz., *evanescence* Westwood, *brasiliensis* Ashmead, and *pickel* (hybrid). The study was conducted by releasing 5000 parasites of each species in a plantation of 5 hectare. *T. pickel*, *T. brasiliensis* and *T. evanescence* survived for 105, 90 and 60 days respectively, after their release in the field. This indicated their potential for establishment and survival in the field when released in large numbers.

## 2. MATERIALS AND METHODS

The study was carried out during April 1983 to April 1985 in teak plantations of Nilambur Forest Division, The observations were made in three plantation sites- Nedungayam in the Karulai Range and Kariem-Muriem and Aravallikavu in the Nilambur Range. At each site about 10 hectare of the plantation were under observation.

Fortnightly surveys were conducted in each site as per details given below, during the same period, with a difference of one or two days.

### 2.1. THE PESTS

Information on the seasonal incidence of *H. puera* and *E. machaeralis* and the intensity of defoliation were collected. The intensity of defoliation, expressed as the percentage foliage loss, was estimated using a visual scoring system:- Score I indicated absence of defoliation (0%); 2: 0 to 5% leaf loss; 3 : 6 to 25% 4 :26 to 50%; 5 : 51 to 75%; and 6 : 76 to l00%. The midpoint of the range was used to convert the score to percentage foiliage loss. The visual scoring in each observational site was applicable either to that whole area or to a large patch within it.

### 2.2. PARASITES

A sample of the available pest stages was collected from each site to- gather information on the parasites. At each site about one hour was spent for collection of the pest stages of each pest. Pest stages were collected randomly from different parts of the observational site. The materials brought from different sites were separately observed in the laboratory. Dead and inactive forms were individually kept in separate containers, Live larvae were kept in breeding cages and fresh teak leaves were provided and those found dead or inactive at any stage of their development were sorted out from the cages. Parasities emerging from each sample were collected and the percentage parasitism was estimated.

### 2.3. PREDATORY INSECTS

Only qualitative observations were made. The predators were collected when they were observed feeding on the host stages. The chance of seeing the act of predation was very small as both the species of the predators of *H.puera* encountered during the study were found feeding on the larvae within the teak leaf folds. Further the observation was restricted to day time and it was not sure whether the predators were active during night.

The parasites and predators were identified by the Commonwealth Institute of Entomology, London. Some specimens could be identified only up to the genetic level and some parasites belonging to the family Ichneumonidae have not yet been authentically identified. The latter are referred to in this report by code letters like Ichenumonid sp. A, sp. B etc.

## 2.4. BIRDS

Qualitative observations were made on different species of birds feeding on *H. puera* larvge, during the peak pest infestation period (April-July). The birds were identified with the field assistance of Shri. Ravisankar, an amateur bird watcher and a graduate student of M. E. S. College Mampad (Nilambur).

## 2.5. BACTERIAL DISEASE

The bacterial organisms infesting *H. puera* larvae were studied with the help of Pathology Division of KFRI. The study involved collection of diseased larvae from the field, isolation and identification of the pathogens and confirmation of pathogenicity. The causative organisms were isolated using standard Nutrient Agar. The most consistently isolated organism' was authentically identified by Commonwealth Institute of Mycology. Pathogenicity trials were conducted by spraying a turbid suspension of bacteria (1 OD at 425 nm) grown on Nutrient Agar for 36- 48 hours on teak leaves. Later the leaves were air-dried and medium sized larvae were allowed to feed on the treated leaves. Untreated controls were also maintained. Attemps were made to reisolate the pathogen from the dead larvae.

# 3. RESULTS

## 3.1. SEASONAL 1NCIDENCE OF THE PESTS

Seasonal incidence of *Hyblaea puera*

Fig. 1. shows the seasonal incidence of *H. puera* in the observational sites during March, 1983 to February, 1985.

In 1983, there were two major peaks of defoliation in all the three sites. The first epidemic occurred at Kariem-Muriem in the last week of May and at Nedungayam and Aravallikavu in the third week of June. The percentage defoliation during this period ranged from 63 to 98% at different sites. The second epidemic occured in July in all the sites, though the time of defoliation within the month varied at different sites.

In 1984, the number of major peaks of defoliation ranged from two at Nedugayam and Aravallikavu to three at Kariem-Muriem. The first peak occurred uniformly in April which resulted in about 85% leaf loss. The second peak at Kariem-Muriem was in May 38% and at other two sites in June (38 to 85%). A third peak occurred only at Kariem-Muriem leading to about 85% leaf loss in July. Except for the occurrence of small peaks in September and 'October at Kariem-Muriem and in September at Nedungayam, the pest population was very low or absent from August to March next year.

Seasonal incidence of *Eutectona machaeralis*

During the study period there was no major defoliation in any of the observational sites or adjacent plantations. However, measurable defoliation occurred at Aravallikavu on two occasions (September 1983 and April 1985 which resulted in about 15% leaf loss. Larvae were available in small numbers in May 1983 (Nedungayam and Kariem-muriem), October to December, 1983 (Aravallikavu) and January 1984 (Aravallikavu).

## 3.2. RECORD OF NATURAL ENEMIES

A list of natural enemies of *H. puera* and *E. machaeralis* recorded in the present study is presented below. The species are arranged according to their importance.

Natural enemies of *H. puera*

A. Parasites

1) *Palexorista solennis* Walker (Diptera, Tachinidae)
2) *Sympiesis* sp. (Hymenoptera, Eulophidae)

3) Ichneumonid sp. A (Hymenoptera, Ichneumonidae)
4) Ichneumonid sp. B (Hymenoptera, Ichneumonidae)
5) *Brachymeria lasus* Walker (Hymenoptera, Chalcididae)

B. Insect predators
1) *Cantheconidea furcellata* Wolft (Hemiptera, Pentatomidae)
2) *Parena nigrolineata* Chd. (Coleoptera, Carabidae)

C. Bird predators
1) *Corvus macrorhynchos* (Jungle Crow)
2) *Acridotheres tristis* (Common Mynah)
3) *Dicrurus adsimilis* (Black Drongo)
4) *Turdoides striatus* (Jungle Babbler)

D. Disease organism (Bacteria)
1) *Enterobacter aerogenes* (Kruse) Hormaeche & Edwards

Natural enemies of *E. machaeralis*
Parasites
1) Ichneumonid sp. C (Hymenoptera, Ichneumonidae)
2) Ichneumonid sp. D (Hymenoptera, Ichneumonidae)
3) *Apanteles* sp. (Hymenoptera, Braconidae)
4) *Phanerotoma hendecasisella* Cam. (Hymenoptera, Braconidae)
5) *Brachymeriahime atteviae* Joseph *et al.* (Hymenoptera, Chalcididae)

## 3.3. SEASONAL INCIDENCE AND DISTRIBUTION OF THE NATURAL ENEMIES

Natural enemies of *H. puera*
Parasites

Fig. 1 gives an overall picture of the seasonal incidence of *H. puera* and its parasites during the entire observation period. The distribution of the parasites in the three observational sites is shown in Table 2.

1) *Palexorista solennis* Walker (Diptera, Tachinidae)

This parasite usually infested late larval stages and occasionally the prepupal stages of *H. puera.* In most cases a single parasite and rarely two developed in a host.

The incidence of *P. solennis* in different observational sites during the two year study period is presented in Tables 3a, 3b and Fig. 1. This species was recorded from all the study sites. The rate of parasitism during the first epidemic infestation of the pest ranged from 0 to 6% in 1983 and 0.6 to 3% in 1984 in the different sites. During the second infestation peak the rate of

parasitism ranged from 6 to 38% in 1983 and 5.3 to12% in 1984. When the pest population was very low (August-November) this parasite was generally absent, although a high level incidence was recorded at Nedungayam in September 1983 and at Kariem–Muriem in October 1983.

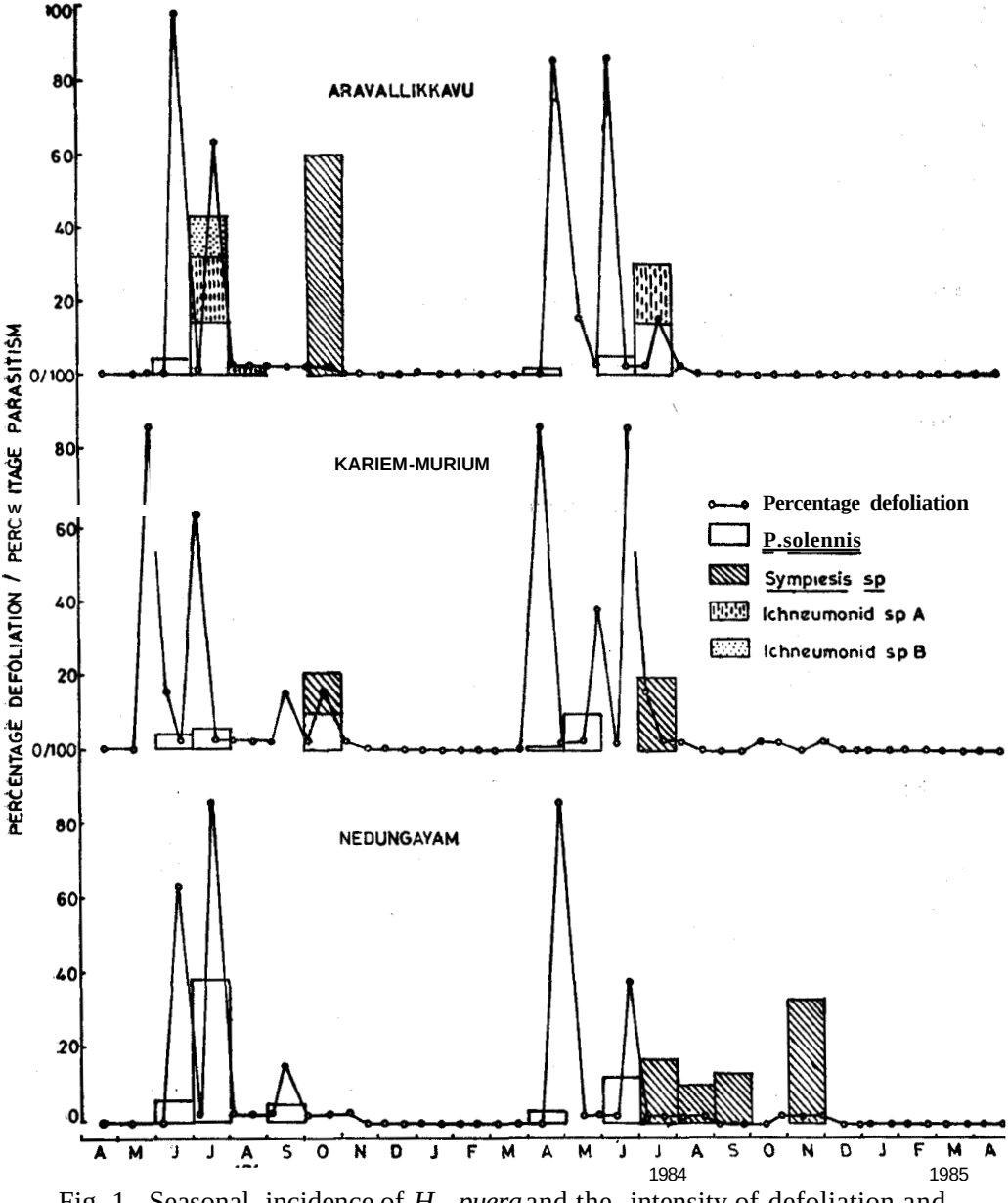


Fig 1. Seasonal incidence of *H. puera* and the intensity of defoliation and percentage parasitism caused by different parasites in the three observational sites during April 1983 to April 1985.

Table 2: Distribution of the parasites of *H. Puera* in the three observational sites.

| Locality | Parasites | | | | |
|---|---|---|---|---|---|
| | *P. selennis* | *Sympiesis* | Ich sp. A | Ich sp. B | *B. lasus* |
| Nedungayam | + | + | | | |
| Kariem-Muriem | + | + | | | |
| Aravallikkavu | + | + | + | + | + |

Table: 3a: Percentage parasitism of *H. puera* due to *Palexerista solennis* in April-December 1983.

| Year | Month | Study sites | | |
|---|---|---|---|---|
| | | Nedungayam | Kariem-Muriem | Aravallikkavu |
| 1983 | April | NA | NA | NA |
| | May | NA | + 0 (120) (20P) | NA |
| | June | + 6.0 (100) | 4.0 (75) | + 4.0 (130) |
| | July | ++ 38.0 (150) | ++ 5.0 (125) | ++ 13.8 (89) |
| | August | 0 (3) | 0 (3) | 0 (161) |
| | September | 5.0 (38) | 0 | 0 (13) |
| | October | NA | 11.3 (71) | 0 (10) |
| | November | NA | NA | NA |
| | December | NA | NA | NA |

NA-no pest available. + First infestation peak of *H. puera;* ++ Second infestation peak. Figures within paruntheses indicate total number of larvae collected in a month.

Table : 3b : Percentage of Parasitism of *H. puera* due to *Palexerista solennis* during January 1984 to April 1985

| Year | Month | Study sites | | |
|---|---|---|---|---|
| | | Nedungayam | Kariem-Muriem | Aravallikkavu |
| 1984 | January to March | NA | NA | NA |
| | April | + 3.0 (155) | + 0.6 (163) | + 1.6 (126) |
| | May | 0 (10) | ++ 5.0 (79) | 0 (100) |
| | June | ++ 12. 0 (76) | +++ 0 (105) | ++ 5.0 (202) |
| | July | 0 (6) | 0 (54) | 14.0 (85) |
| | August | 0 (10) | NA | NA |
| | September | 0 (15) | NA | NA |
| | October | NA | 0 (13) | NA |
| | November | 0 (6) | 0 (4) | NA |
| | December | NA | NA | NA |
| 1985 | January to April | NA | NA | NA |

NA-no pest available. + First infestation peak of *H. puera;* ++ Second peak; +++ Third peak. Figures within parantheses indicate total number of larvae collected in a month.

2) *Sympiesis* sp. (Hymenoptera: Eulophidae)

This is a new parasite reported from *H. puera*. Adult wasps measure 1to 1.5 mm in length. Early stage host larvae measuring less than 10mm in length were usually found parasitised. A single egg was usually deposited on a host larva. Incubation period was about a day. Total developmental period from egg to adult was 9-11 days.

The seasonal incidence of *Sympiesis* sp. in the different observational sites is presented in Fig. 1 and Tables 4a and 4b. This parasite was recorded from all the observational sites. In October 1983, seven out of the 71 larvae collected from Kariem-Muriem and six out of the ten larvae collected from Aravallikkavu were parasitised, In 1984, the parasite activity was noted in July (Nedungayam and Kariem-Muriem), August, September and November (Nedungayam). The percentage parasitism during these periods ranged from 10 to 33 in different months at different sites. Though the percentage parasitism due to *Sympiesis* sp. was comparatively high, the incidence was noted only during the period when the pest population was small.

Table: 4a: Perecntage parasitism of *H. puera* due to *Sympiesis* sp. in 1983

| Year | Month | Study sites | | |
|---|---|---|---|---|
| | | Nedungayam | Kariem-Muriem | Aravallikkavu |
| 1983 | April | NA | NA | NA |
| | May | NA | 0 (140) | NA |
| | June | 0 (100) | 0 (75) | 0 (130) |
| | July | 0 (150) | 0 (123) | 0 (89) |
| | August | 0 (3) | 0 (3) | 0 (161) |
| | September | 0 (38) | 0 (76) | 0 (13) |
| | October | NA | 10.0 (71) | 60.0 (10) |
| | November<br>December | NA | NA | NA |

NA- no pest available. Figures within parantheses indicate total number of larvae collected in a month.

Table : 4b ; Percentage parasitism of *H. puera* due to *Sympiesis* sp. in 1984

| Year | Month | Study sites | | |
|---|---|---|---|---|
| | | Nedungayam | Kariem-Muriem | Aravallikkavu |
| 1984 | January, February, March | NA | NA | NA |
| | April | 0 (155) | 0 (163) | 0 (126) |
| | May | 0 (10) | 0 (79) | 0 (100) |
| | June | 0 (76) | 0 (105) | 0 (202) |
| | July | 16.7 (6) | 20.0 (54) | 0 (85) |
| | August | 10.0 (10) | NA | NA |
| | September | 13.3 (15) | NA | NA |
| | October | NA | 0 (13) | NA |
| | November | 33.0 (6) | 0 (4) | NA |
| | December | NA | NA | NA |

NA- no pest available. Figures within parantheses indicate total number of larvae collected in a month.

3) Ichneumonid sp. A (Hymenoptera, Icheumonidae)

The seasonal incidence of this parasite is presented in Fig. 1. This parasite usually infested middle stage larvae of *H. puera*. A single parasite developed within a host larya.

This species was recorded only from Aravallikavu in both years (Fig. 1). In July of both the years about 18% of parasitism was noted and in August 1983, the percentage parasitism was only 2.5.

4) Ichneumonid sp. B (Hymenoptera, Ichneumonidae)

This species is parasitic on middle stage larvae of *H. puera*. A single parasite developed from a host.

The incidence of this parasite was noted only in July 1983, at Aravallikkavu (Fig. 1). About 11% of the larval sample collected (N=85) were parasitised.

5) *Brachymeria lasus* Walker (Hymenoptera, Chalcididae)

This is the only pupal parasite recorded during the present study. It was noted at Kariem-Muriem in July 1983 and April 1984 causing less than 1% parasitism.

Overall Parasitism

Table 5 gives the overall parasitism of *H. puera* by all the above parasites in the years 1983 and 1984. The average monthly parasitism (based on the total number of larvae collected during a month from the three observational sites (weighted average) ranged from o to 28% in 1983 and 0 to 26% in 1984. In both years the highest rate of parasitism was recorded in the month of July.

Predators

1) *Cantheconidea furcellata* Wolft (Hemiptera, Pentatomidae)

This predatory bug was recorded from Aravallikkavu and Kariem-Muriem only on two occasions. Both the adult and nymph of the bug feed on the body juice of the host larva. Feeding usually took place under concealed condition within the leaf fold made by the host larva. Predation was recorded in the months of October and July.

2) *Parena nigrolineata* (Chd.) Coleoptera, Carabidae)

This predatory beetle was recorded from Kariem-Muriem and Nedungayam on three occasions. Both adult and larva of the beetle feed on the body juice of the host larvae. Predation was recorded in the months of June, July and September.

Bird predators

During the present investigation four species of birds viz., Jungle crow *(Corvus macrorhynchos)* ,Common Mynah *(Acridotheres tristis)* ,Black Drongo *(Dicrurusadsimilis)* and Jungle Babbler *(Turdoides striatus)* were recorded as predators of *H . puera* larvae,

On 1st July 1983, a large area of the plantation at Kariem-Muriem was found infested by middle stage larvae of *H.puera*. All the above species of birds were observed feeding on the larvae, the Jungle Crow being the dominant. Crows numbering over 100 were present in the area distributed over many trees. Very few larvae were seen in this plantation when observed two days later and the crows present were also fewer.

Diseases

On some occasions, a laage number of *H.puera* larvae were found dead in the field particularly during rainy periods. Similar deaths were also noticed in field-

Table: 5: Overall parasitism (caused by all the five species of parasites) of *H.puera* in 1983 and 1984

| Year | Month | Study sites | | | Average Parasitism* |
|---|---|---|---|---|---|
| | | Nedungayam | Kariem-Muriem | Aravallikkavu | |
| | April | NA | NA | NA | |
| | May | NA | NA | NA | |
| | June | 6.0 | 4.0 | 4.0 | 4.6 |
| 1983 | July | 38.0 | 5.0 | 43.2 | 28.0 |
| | August | 0 | 0 | 2.5 | 2.0 |
| | September | 5.0 | 0 | 0 | 1.6 |
| | October | NA | 21.0 | 60.0 | 26.0 |
| | November to March | NA | NA | NA | |
| | April | 3.0 | 2.6 | 1.6 | 3.0 |
| | May | 0 | 5.3 | 0 | 3.0 |
| | June | 12.0 | 0 | 6.0 | 6.0 |
| 1984 | July | 17.0 | 20.0 | 31.0 | 26.0 |
| | August | 10.0 | NA | NA | 10.0 |
| | September | 13.0 | NA | NA | 13.0 |
| | October | NA | 0 | NA | 0 |
| | November | 33.0 | 0 | NA | 20.0 |
| | December | NA | NA | NA | |

NB- no pest available, * weighted average.

collected larvae kept in the laboratory for parasite emergence. In these cases the dead larvae showed the symptoms of bacterial infection - discolouration, softening of the body with some black ooze and finally becoming black in colour.

In this study a species of Bactera, *Enterobacter aerogenes* (Kruse) Hormaeche & Edwards was foudd to cause death of *H. puera* larvae. This hod-shaped nonspore

forming bacterium (CMI No.B. 10740) was the most commonly isolated organism from dead larvae collected from the field. In pathogencity trials, 48 hours after treatment, 75-90% of the larvae showed symptoms of infection. They became inactive and died after 72 hours. The Pathogen could be reisolated from the dead larvae.

Natural enemies of *E. machaeralis*

Parasites

The distribution and seasonal incidence of the parasites of *E. machaeralis* are presented in Table 6.

1) Ichneumonid sp. C (Hymenoptera, Ichneumonidae)

This unidentified species was recorded from Aravallikkavu on two occasions. 12 out of the 52 larvae collected in September 1983 and 19 out of the 26 larvae collected in April 1985 were Parasitised.

2) Ichneumonid sp. D (Hymenoptera, Ichneumonidae)

This unidentified species was recorded from Aravallikkavu in September 1983. About 9%of the 52 larvae collected were parasitised.

Table: 6: Seasonal incidence and distribution of parasites of *Eutectona machaeralis*

| Study sites | Month/Year | Percentage of Parasitism due to | | | |
|---|---|---|---|---|---|
| | | 1ch.C | 1ch.D | *Apanteles* sp. | *Brachymeria hime atteviae* |
| Nedungayam | May 1983 | 0 | 0 | 20 (10) | 100 (1) |
| Kariem-Muriem | May 1983 | 0 | 0 | 4 (26) | 0 |
| Aravallikkavu | September 1983 | 12 (52) | 9 (52) | 0 | 0 |
| | October 1983 | 0 | 0 | 8 (13) | 0 |
| | December 1983 | 0 | 0 | 7 (15) | 0 |
| | April 1985 | 19 (26) | 0 | 0 | 0 |

Figures within parantheses indicate total number of larvae collected.

3) *Apanteles* sp. (Hymenoptera, Braconidae)

This species was recorded in 1983 from all the three sites. The percentage parasitism ranged from 4 to 20. About six parasites were found developing on a single medium sized host larva.

4) *Brachymeria hime atteviae* Joseph *et al*. (Hymenoptera, Chalcididae)

This parasite was recorded from only one pupa collected from Nedungayam in May 1983. A single parasiteideveloped in a host pupa.

5) *Phanerotoma hendecasisella* Cam. (Hymenoptera, Braconidae)

This parasite was recorded from Nedungayam in January 1982 before this study was initiated, 70% of the 130 larvae collected were parasitised. However this parasite was not found during the study period in any of the sites.

# 4. DISCUSSION AND CONCLUSION

This study conducted in the teak plantations at Nilambur has generated valuable nformation on the seasonal incidence of the teak pests- *H. puera* and *E. machaeralis* and the natural enemies of the former pest. While *H. puera* infestation occurred in both the years in all the study sites, no major infestation of *E. machaeralis* occurred during this period. Hence, the information on the natural enemies of *E. machaeralis* generated by this study remains incomplete.

The narural enemies of *H. puera* recorded include five species of parasites namely, *Palexorista solennis* Walker, *Sympiesis* sp., *Brachymeria Iasus* (Waker) and two unidentified species of Ichneumonid wasps; two species of insect predators namely, *Cantheconidea furcellata* Wolft and *Parena nigrolineata* Chd. ; four species of birds namely, *Corvus macrorhynchos, Acridotheres tristis, Dicrurus adsimilis* and *Turdoides striatus;* and a species of bacterial pathogen namely, *Enterobacter aerogenes* (Kruse) Hormaeche and Edwards.

Among the parasites, *Sympiesis* sp. is a new record from *H. puera*. *P. solennis* and *B. lasus* has already been recorded from Nilambur (Beeson, 1939, 1941).

Both the predatory insects are new records from Nilambur. The role of birds as predators of *H. puera* has been recognised in the literature, but no information was available on the identity of different species. The bacterial pathogen *E. aerogenes* is the first disease causing organism isolated from the field infested *H. puera* larvae.

Among the parasites, *P. solennis* and *Sympiesis* sp. were recorded from all the study sites. The distribution of the two species of ichneumonids and *B. lasus* was found limited to Aravallikkavu plantations.

*P. solennis* and the ichneumonids were the parasites recorded during the months of heavy pest incidence (Fig. 1). However, during the first epidemic infestation *P. solennis* was the only parasite which infested the pest larvae and in all the cases of its incidence the rate of parasitism was found to be very low. Low rate of parasitism during the early period of *H. puera* infestation has also been reported by Beeson and Chatterjee (1939). This can be well explained considering the scarcity of the pest larvae in the field during the off-season which limits the size of the parasite population. Thus, the number of parasites available to compete with the first epidemic population of the pest will be very small.

The overall rate of parasitism during the period of heavy pest incidence was found to be generally very low. Nevertheless, in some occasions contribution of *P. solennis* alone (Nedungayam, July 1983) or *P. solennis* and the ichneumonids together was significantly high (Aravallikkavu, June 1983). During the months of low pest incidence, *Sympiesis* sp. was found to be the regular parasite. Incidence of *P. solennis* was also noted during this period. In general, rate of parasitism was higher in these months than in the months of heavy pest incidence.

Table: 7: Seasonal incidence of the parasites of *H. puera*

| Month | PARASITES | | | | |
|---|---|---|---|---|---|
| | P. solennis | Sympiesis sp. | Ich. A. | Ich. B. | B. lasus |
| March | | | | | |
| April | + | | | | + |
| May | + | | | | |
| June | + | | | | |
| July | + | + | + | + | + |
| August | | + | + | | |
| September | + | + | | | |
| October | + | + | | | |
| November | | + | | | |
| December | | | | | |
| January | | | | | |
| February | | | | | |

The above assessment of the efficiency of the parasites in terms of the "Percentage parasitism value" needs some clarification. There is considerable variation in the stage of the host larvae selected for deposting egg by different species of parasites. Hence, the recovery of a particular parasite from a larval sample is dependent on the presence of appropriate larval stages in the sample. For example, *P. solennis* being a parasite infesting fourth instar larvae of *H. puera*, the chances of recovery of this parasite depends on the presence of fourth to fifth instar larvae in the sample. Similarly in a larval sample consisting of late larval stages only, the recovery of *Sympiesis* sp. cannot be expected, as this parasite infests only very young larvae. In the present study since the sampling was carried out at

fortnightly, only available pest stages could be collected. Especially during epidemic infestations, the pest larvae collected were mostly of the same age. Absence or low infestation of a particular parasite in a locality during a particular period as indicated by the data, should therefore be considered only of indicative value. However, the overall assessment is dependable as it is based on several samples collected over a period of two years. Another factor which might have interfered with the estimation of rate of parasitism, particularly of the endo-parasitic species (*P. solennis* and Ichneumonid spp.), is the high percentage of mortality of host larvae that occurred while rearing the field collected sample in the laboratory.

Though more than a dozen of parasites of *H. puera* is already on record from Nilambur, very little information is available on their efficacy as natural control agents. According to Beeson and Chatterjee (1939). of the 6 species of parasites recorded from the same locality, during 1937-38, *P. solennis* and the ichneumonid *Eriborus gardeneri* had an appreciable role in reducing the pest population. It may be seen from this study that *P. solennis* observed by them to be the only regular parasite during the period of peak pest incidence retains the same status now, about 45 years later.

The data on the predatory insects are not conclusive to comment on their role as natural enemies of *H. puera.* Similarly the promising role of bird predators particularly the Jungle Crow needs quatification.

The bacteria *Enterobacter uerogenes* isolated from dead larvae collected from the field, caused high mortality of larvae under laboratory conditions. Similar nonspore forming bacteria have been reported to be common in the digestive tracts of insects causing mortality whenever the insect is stressed by such factors as starvation, ingestion of contaminated food and mechanical rupturing of gut (Falcon, 1971). It is possible that the high effectiveness of this bacteria under laboratory condition may be due to such factors. Further studies are needed to establish the safety and efficacy of this pathogen as a microbial control agent under field conditions.

The study indicates that combined action of parasites, predators and pathogen has a significant role in reducing *H. puera* population, although their action alone is not sufficient to bring down the pest population below economic injury level. It is obvious that, but for the restraining influence of the natural enemies the damage caused by this pest would have been much more serious.

In the light of the recent information on the economic importance of *H. puera,* developing an economical and environmentally acceptable pest management programme deserves serious consideration in future research. How far the natural

enemies can be manipulated in the war against this pest is a matter of further thought and study, particularly in view of the recent findings (Nair and Sudheendrakumar, 1985) indicating short-range migration of the newly emerged moths during the period of their abundance.

The information on the natural enemies of *E. machaeralis* gathered in this study would remain incomplete, as a typical pest problem did not arise during the study period. The parasites reported here include *Brachymeria hime atteviae, Apanteles* sp., and two unidentified species of ichneumonid wasps. *B. hime atteviae* is a new record from Nilambur, although this species has been reported to parasitise *H . puera* elsewhere (Joseph *et al*. 1973.) Comments on the ichneumonid parasites and the *Apanteles* sp. are reserved for want of their complete identity.

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# APPENDIX I

## Natural enemy complex of Hyblaea puera in lndia

### A. PARASITES

Order : Diptera

Family : Sarcophagidae

* 1. *Sarcophaga antilopa* Boettchera4

Family : Tachinidae

2. *Actia hyalinata* Mall. 4

* 3. *Bessa remota* Alders

* 4. *Carcelia kockiana* Tns. 4

* 5. *C. modicella* Wulp. 4

* 6. *Compsilura concinnata* (Wiedemann) 3

7. *D iglossocera bif'ida* Wulp.4

* 8. *Exorista civiloides* Bar. 2

* 9. *E. fallax* Meign. 3

+* 10. *Palexorista solennis* Walker 2

* 11. *Sturmia inconspicuoides* Bar. 3

12. S. *zebina* Walkers

* 13. *Winthemia albiceps* mall. 2

* 14. *W. dispar* Mac.3

* 15. *Zenillia fallax* Meign.3

Order : Hymenoptera

Family : Bethylidae

* 16. *Goniozus montanus* Kieff. 2

Family : Braconidae

17. *Apanteles hyblaea* Wlka.1

* 18. A. *machaeralis* Wlkn.1

19. A. *malaevolus* Wlkn.1

20. *A. puera* Wlkn. 1

Family : Chalcididae

21. *Brachymeria hearseyi* var. *xanthoterus* Waterston 2

*+ 22. *B. lasus* (Walker)3

Family : Elasmidae

* 23. *Elasmus brevicornis* Ferr. 3

* 24. E. *hyblaea* Ferr. 2

Family : Eulophidae

+ 25. *Sympiesis* sp.

Family : Ichneumonidae

26. *Apophua carinata* Morley4

27. *Echthromorpha notulatoria* Fabr 3

* 28. *Eriborus gardeneri* Cush. 2

29. *Theronia zebra* Voll. 4

+ 30. Unidentified species A

+ 31. Unidentified species B

Family : Scelionidae

32. *Telenomus usipetes* Nixon 4

Family : Trichogrammatidae

33. *Trichogramma minutum* Riley2

34. *Trichogrammatoidea nana* Zehnt.

### B. PREDATORY INSECTS

Order : Coleoptera

Family : Carabidae

1. *Anthia sexguttata* Fabr. 5

2. *Calleida rapax* Andr.4

3. *C. splendidula* Fabr.3

4. *C. splendidula* var. *rubricata* Mots.4

+ 5. *Parena nigrolineata* Chd. 3

6. *P. rubripicta* Andr.

Order : Dictyoptera

Family : Mantidae

7. *Creoboter apicalis* Sauss.4

8. C. *urbana*

9. *Dysaules himalayanw* Wood-Manson4
10. *Hestiasula brunneriana* Sauss3
11. *Hierodula ventralis* Tins.3

Order : Diptera

Family : Syrphidae

12. *Xanthandrus indica* Curran4

Order : Hemiptera

Family : Pentatomidae

+ 13. *Cantheconidea furcellata* Wolf.4
14. *Sycanus collaris* Fabr.3

C. PATHOGEN

+1. *Enterobacter aerogenes* (Kruse) Hormaeche and Edwards

D. BIRDS

+1. *Acridotheres tristis* (Common Mynah)
+2. *Corvus macrorhynchos* (Jungle Crow)
+3. *Dicrurus adsimilis* (Black Drongo)
+4. *Turdoides striatus* (Jungle Babbler)

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* Earier records from Nilambur; t Present record;

References- 1 Beeson and Chatterjee, 1935; 2 Beeson and Chatterjee, 1939; 3 Beeson, 1941: 4 Chatterjee and Misra, 1974; 5 Misra, 1975.

# APPENDIX II

Natural enemy complex of *Eutectona machaeralis* in India

## A. PARASITES

Order : Diptera

Family : Tachinidae

* 1. *Actia abberans* Mall. [2]
2. *A. hyalinata* Mall [6]
3. *Actia* sp.[7]
4. *Argyrophylax atropivara* R. D[4]
5. *A. nigritibialis* Bar. [7]
* 6. *Bactromyia fransseni* Bar.[6]
* 7. *Bessa remota* Aldr.[1]
8. *Cadurica wanderwulpi* Bar. [2]
* 9. *Carcelia modicella* Wulp[8]
* 10. *C. octava* Bar. [3]
11. *Compsilura concinnata* (Wiedemann)[7]
* 12. *Dolichocolon orbitale* Bar. [2]
13. *Euhapalivora indica* Bar.
14. *Exorista civiloides* Bar. [2]
* 15. *E. fallax* Meign.[4]
16. *E. hetrusiae* Coq.[4]
17. *Hapaliolaemus machaeralis* Bar. [2]
18. *Nemorilla floralis* Fall. [4]
19. *Palexorista laxa* Curran[7]
*20.* *P. solennis* Walkea[2]
21. *Ptychomyia remota* Adrich [7]
* 22. *Sturmia nigribarbis* Bar.[2]
* 23. *S. parachrysops* Bezzi[2]
24. *Sturmia* sp. [7]
25. *Zenillia roseanella* Bar. [4]
*26.* unidentified species[7]

Order : Hymenoptera

Family : Braconidae

27. *Apanteles glomeratus* Linn.[7]
* 28. ***A.*** *machaeralis* Wlkn. [1]
29. *A. mycetophylus[7]*
*30.* ***A.*** *ruidus* Wlkn.[1]
+ 31. *Apanteles* sp.
32. *Bracon desertor* Linn. [6]
33. *Cedria anomala* Wlkn. [1]
34. *C. paradoxa* Wlkn. [1]
35. *Cremnops articornis* Smith[7]
36. *Iphialux* sp. [7]
* 37. *Microfaster indicus* Wlkn. [3]
38. *Micropiitis maculipennis Szepligeti* [7]
* 39. *Phanerotoma hendecasisella* Cam. [3]
40. *Phanerotoma* sp. [7]
41. Unidentified sp. [7]
42. Unidentified species [7]
43. Unidentified species[7]

Family : Bethylidae

44. *Goniozus montanus* Kieff. [6]

Family : Chalcididae

45. *Brachymeria circulae* (Kohl)[7]
+ 46. ***B.*** *hime atteriae* Joseph *et al.* [5]
* 47 *B. hearseyi* var. *xanthoterus* Waterston[3] (= *B. euploeae* Westwood)
* 48. *B. nephantidis* Gah. [3]

Family : Elasmidae

* 49. *Elasmus brevicornis* Ferr. [3]

Family : Encyrtidae

50. *Litomastix* sp. [7]

Family : Eulophidae

51. *Trichospilus pupivora* Ferr.[6]

Family : Scelionidae

52. *Telenomus usipetes* Nixon[1]

Family Trichogrammatidae

53. *Trichogramma evanescens* Riley[6]
54. *T. minutum* Riley[7]
55. *Trichogrammatoidea nana* Zehnt.[4]

Family : Ichneumonidae

* 56. *Angitia argentiopilosa* Cam.[3]
* 57. *Apatagium melleum* Cush.[3]
58. *Clatha longipes* Cam.[6]
* 59. *Cremastus hapaliae* Cam.[3]
60. *Diadegma* sp.[7]
61. *Echthromorpha notulatoria* Fabr.[4]
62. *Eriborus trochanteratus* (Morley):
63. *Goryphus zonalis* Townes & Gupta[7]
64. *Microtoridea secunda* Cush.[7]
65. *Mesostenus* sp[7]
66. *Trathala flavoorbitalis* (Cam.)[7]
67. *Trichomma nigricans* Cam-[6]
68. *Trophocampa indubia* Morley[4]
* 69. *Xanthocampopiax nigromaculata* Cam.[1]
70. *Xanthopimpla cera* Cam.'
* 71. *Xanthopimpla sp.*[3]
72. Unidentified species[7]
\+ 73. Unidentified species
\+ 74. Unidentified species

## B. PREDATORY INSECTS

Order - Coleoptera

Family : Carabidae

2. *Calleida splendidula* Fabr.[4]
3. *C. splendidula* var. rubricata Mostchs[7]
4. *Chlaenius rayotus* Bates[4]
* 5. *Parena nigrolineata* Chd.[4]
6. *P. rubripicta* Andr.[4]

Family : Coccinellidae

7. *Jauveria sorror* (Weise)[7]
8. *Sticholotis binotata* (Gorham)[7]

Order : Dictyoptera

Family : Mantidae

9. *Creoboter apicalis* Sauss.[4]
10. *C. urbana* Fabr.[6]
11. *Deiphobe infuscata* Sauss.[6]
12. *Dysaules himalayanus* Wood-Manson4
13. *Euantissa ornata* Werner[7]
14. *Gonypeta punctata* Hean'
15. *Hierodula ventralis* Giglio-Tos[4]
16. *Hierodula sp.*[7]
17. *Humbertiella* sp.[7]

Family : Hymenopodidae

18. *Ephestiasula* sp.[7]
19. *Hestiasula* sp.[7]

Order : Hemiptera

Family : Pentatomidae

20. *Acanthapsis flavipes Stal.*[6]
21. *Cantheconidea furcellata* Wolf.[4]

Family : Reduvidae

22. *Alcmena* sp.[7]
23. *Ectomocoris cordiger* Stal.[7]
24. *Cydnocoris gilvus* (Burm.)[7]
25. *Oncocephalus impudicus* Reut[7]
26. *Sycanus collaris* Fabr [4]
27. *Sycanus* sp.[7]

Order : Hymenoptera

Family : Formicidae

28. *Camponotus cericeus* (Fabr.)[7]
29. *Camponotus* sp.[7]
30. *Pheidole* sp.1[7]
31. *Pheidole* sp.2[7]

## C. SPIDERS

Family : Arnaeidae

1. *Leucauge tessellata* (Thore1l)7
2. *Neoscona achine* (Simon)7
3. *N. excelsus* (Simon)7
4. *N. theis* (Walckenaer)7
5. *N. lugbris* (Wa1ckenaer)7
6. *N. rumpfi* (Thore1l)T

Family : Clubionidae

7. *Cestineira* sp.7
8. *Chiracanthium* sp.7
9. *Clubiona* sp.7

Family : Heteropodidae

10. *Heteropoda* sp.7

Family : Linyphiidae

11. *Linyphis urbase* Tikader7

Family : Oxyopidae

12. *Oxyopes birmanicus* Thorell7
13. *Oxyopes* sp.
14. *Peucetia latika* Tikader7

Family : Pisauridae7

*Tinus sikkimensis* Tikader7

Family :Salticidae7

16. *Harmochirus brachiatus* (Thorell)7
17. *Marpissa bengalensis* Tikader7
18. *M. culcuttaensis* Tikader7
19. *M. decorata* Tikader7
20. M. *dhakuriaensis* Tikader7
21. *Maripissa* sp.7
22. *Myrmarachne* sp.7
23. *M. orientale* Tikader7
24. *M. bengalensis* Tikader7
25. *Phidippus bengalensis* Tikader7
26. *P, pateli* Tikader7
27. *P. punjabensis* Tikader7
28. *Plexippus paykulli* (Aud.)7

Family : Sparasidae7

29. *Sparassus lamarki* Latreille7
30. *S. wroughtoni* Simon7
31. *Sparassus* sp.7

Family : Theridiidae

32. *Argyrodes andamansis* Tikader7
33. *Argyrodes* sp.7
34. *Dryapetisca sp.*7
35. *Theridion* sp.7

Family : Thoinicidae

36. *Thomisus dhakuriaensis* Tikader7
37. *T. shillongensis* Sen7
38. *Thomisus sp.*7

## D. PATHOGENS

1. *Bacillus cereus* Frankland7
2. *Serratia marcescens* Bizzio7
3. *Beauveria bassiana* (Bals.) Vuil.7

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* Earlier records from Nilambur; + Present record.

References - 1 Beeson and Chatterjee 1935a & b; 2 Beeson and Chatterjee, 1935c; 3 Beeson and Chatterjee, 1939; 4 Beeson, 1941; 5 Joseph *et al.,* 1973; 6 Chatterjee and Misra, 1974; 7 Misra, 1975; 8 Patil and Thontadarya, 1983.