Ceylon Cocon. Q. (1980) 31, 119–126
Printed in Sri Lanka

BIOLOGY AND BEHAVIOUR OF *TRICHOSPILUS PUPIVORA* (HYMENOPTERA: EULOPHIDAE) WITH A NOTE ON ITS FIELD PARASITISM OF *NEPHANTIS SERINOPA* (LEPIDOPTERA: XYLORICTIDAE)

O. K. REMADEVI, U. C. ABDURAHIMAN, U. V. K. MOHAMED and C. G. BEENA
Department of Zoology, University of Calicut, Kerala

ABSTRACT

Remadevi, O. K., Abdurahiman, U. C., Mohamed, U. V. K. and Beena, C. G. (1980). Biology and behaviour of *Trichospilus pupivora* (Hymenoptera: Eulophidae) with a note on its field parasitism of *Nephantis serinopa* (Lepidoptera: Xyloryctidae). *Ceylon Cocon. Q.*, 31, 119–126.

The pupal parasite, *Trichospilus pupivora* Ferr. is widely used for the biological control of the coconut caterpillar pest, *Nephantis serinopa* Meyr. The life history and behaviour of this parasite are studied in some detail. The eggs are tiny, measuring $183 \pm 15\,\mu$ in length and $65 \pm 8\,\mu$ in width. The incubation period is 24 to 30 hours. The larval period extends for 5 to 6 days and the pupal period for 7 to 8 days. Mating takes place before the emergence from the host pupa. In addition to the 30 or more hosts already reported, this insect was also found to parasitise *Udaspes folus*, *Anigraea albomaculata* and the prepupae and pupae of Vespidae and Sphecidae. The number of eggs laid by a single parasite in one *N. serinopa* pupa varies from 22 to 162. In larger hosts more eggs are laid. Females predominate in the sex-ratio. Parthenogenesis is arrhenotokous. The incidence of parasitism in the field is also studied.

INTRODUCTION

Since many years, *Trichospilus pupivora* Ferr., a polyphagous multivoltine parasitoid has been employed for the biological control of the coconut caterpillar pest, *Nephantis serinopa* Meyr. Hutson (1920) was the first to observe the species as a pupal parasitoid of *N. serinopa* in Ceylon, and later (1925) from India it was obtained from Cochin and Mangalore areas. The species was described by Ferriere (1930). The influence of weather conditions in the breeding of the parasite was studied by Ananthanarayanan (1929). In 1934, he also made a brief study of its bionomics. During their intensive studies on the biological control of *N. serinopa*, Jayaratnam (1941), Rao *et al.* (1948), Dharmaraju (1952, 1963) and Nirula (1956) observed some of the biological aspects of *T. pupivora*. Kabeerathumma and Nair (1973) studied the details on the optimum superparasitism in the mass breeding of this eulophid. Dharmaraju and Pradhan (1976) have assessed the factors affecting the maximum realisation of biotic potential of this insect. The behaviour of this eulophid in relation to its parasitic life has not yet been studied. This paper is a brief account on the observations of the biology and behaviour of *T. pupivora* conducted in the laboratory, with a note of assessment on the occurrence of the parasite in the field.

MATERIALS AND METHODS

A culture of *T. pupivora* was maintained in the laboratory under a temperature of 28 ± 1°c. The adult insects were reared in glass tubes of 10 X 2.5 cm, plugged with cotton balls. In addition to *N. serinopa,* a variety of host pupae like *Spodoptera mauritia* Boisd., *Lamida moncusalis* (Walk.), *Corcyra cephalonica* Staint., *Anadevidia peponis* Fabr., etc. were provided into the tubes for parasitisation. Adult insects were fed on solutions of honey, sugar or dextrose placed as droplets on polythene strips and introduced into the tubes. The parasitised pupae were taken out and the immature stages were observed after dissecting the host pupa. The fully developed pupae of the parasitoid thus obtained were kept separate in tubes. When emerged, the male and female were introduced together into a tube to observe mating.

Survey of *N. serinopa* infested areas in Kerala and collection of its pupal stages from these areas enabled us to evaluate the occurrence of *T. pupivora* in the natural conditions. The infested trees in a particular plot were located and the pest-affected leaflets from different trees were cut and brought to the laboratory. The pupae of *N. serinopa* were taken out from the galleries and kept in conical flasks stoppered by cotton plugs and the daily emergence of the parasites as well as the moths were recorded. The percentage of parasitism by each parasite was calculated from the data thus gathered.

OBSERVATIONS

Developmental biology

The eggs are tiny, measuring 183 ± 15 μ in length and 65 ± 8 μ in width. They are hymenopteriform and are laid freely into the body fluid of the host pupa. The larvae hatched out from the eggs begin to feed on the body fluids and gradually assume a pink colouration due to the presence of pinkish gut contents. The fully fed larvae excrete the meconium and enter the pre-pupal stage. The pre-pupa is white and the body is demarcated into head, thorax and abdomen. The pupa is exarate, naked and white. After about 2 to 3 days of pupation, the eyes and ocelli, which were initially whitish, acquire a slight red colouration which gradually deepens to red and then to dark red. By the 4th or 5th day of pupation, the body also begins to darken. The head and thorax become brownish while the darkening of the abdomen takes place gradually and spreads from posterior to anterior end. By the 7th day, the pupa becomes fully dark brown. The measurements and developmental duration of the immature stages are given in Table 1. The adults make holes at any region on the host puparium and come out. The number of holes may vary from 1–5 or more. It takes a long time for the adults to come out of the host after the emergence from their pupal skin.

Table 1. *Details of the developmental stages of Trichospilus pupivora*

Stage	*Measurements* *Length*	*Width*	*Developmental period*
Egg	183 ± 15μ	65 — 8μ	24–30 hours
1st instar larva	0.248 mm	0.111 mm	5–6 days
Final instar larva	1.247 mm	0.408 mm	
Pre-pupa	1.281 mm	0.429 mm	24 hours
Pupa	1.258 mm	0.416 mm	7–8 days

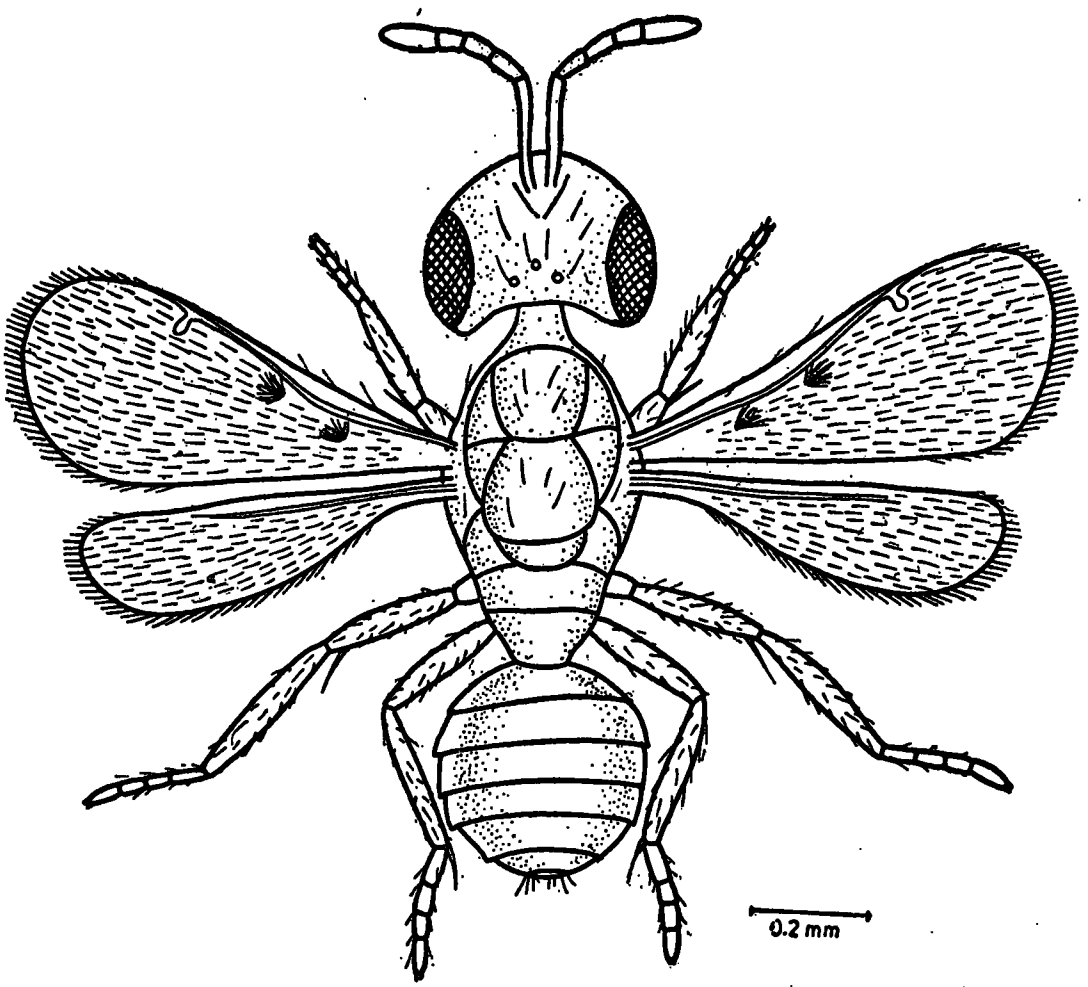

Fig. 1. Trichospilus pupivora: adult female.

The adult female (Fig. 1) is slightly larger than the male and has a comparatively darker brown colour body. The antennae of the males are smaller than those of the females. The males can also be distinguished by the white patch of colour present on the anterior end of the ventral side of the abdomen.

Nutrition and longevity

The adult insects have a short life span and do not feed on the host. Their longevity with various food regimes were tested. Laboratory feeding could increase the life span to some extent. The longevity of 1000 adults each fed on different food solutions is represented in Fig. 2. When starved, almost all of them died within 4 to 5 days...

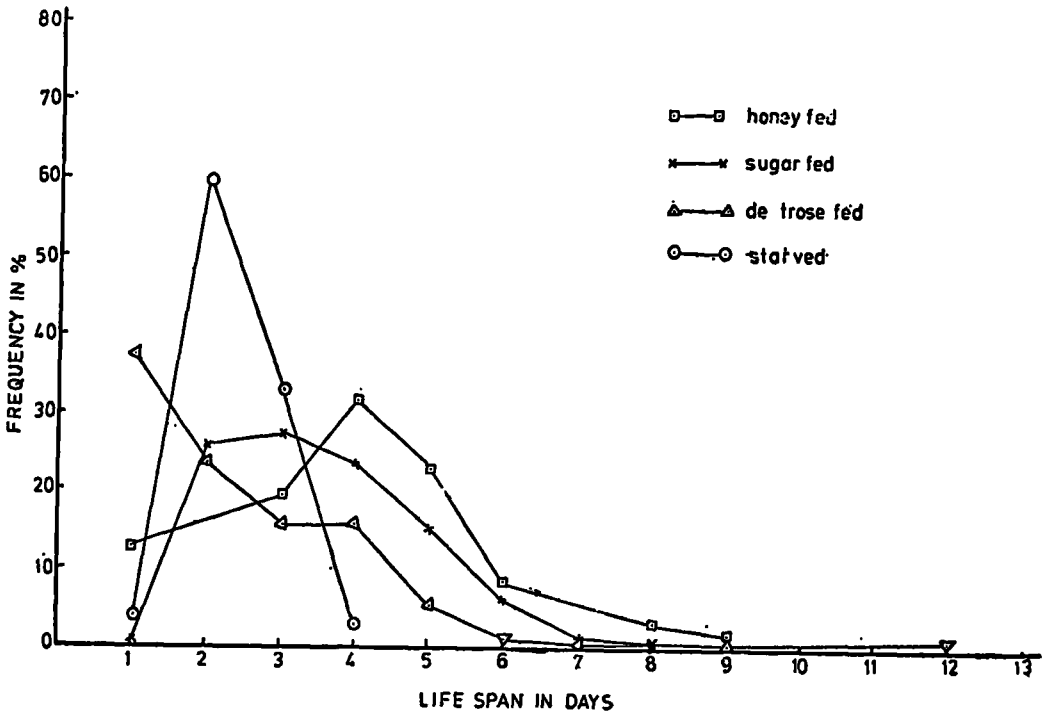

Fig. 2. Longevity of Trichospilus pupivora with different food regimes.

Host-parasite relationships

T. pupivora is polyphagous and about thirty lepidopteran hosts have already been recorded as being parasitised by this. In addition to these, it was noticed in the present studies that two more pests, *Anigraea albomaculata* Hamps. and *Udaspes folus* Cr. were accepted as hosts. Obviously any pupae of Lepidoptera which have a thin and soft puparium are selected for oviposition. Besides, the prepupae and pupae of Sphecidae and Vespidae (Hymenoptera) were also found to be successfully parasitised in the laboratory conditions.

Mating and Oviposition

Under normal conditions mating occurs prior to their emergence from the host pupa and hence no mating pairs were seen in the culture of *T. pupivora*. However, the process can be observed when they are artificially removed from the host puparium during their pupal stages so that the behaviour of the adults can be followed soon after their emergence. The number of males are few and each male fertilises many females. The male often exhibits courtship behaviour to subdue the female. He moves his head and body over the female in a specific manner and the female responds by raising her head and abdomen indicating receptivity. The female oviposits a few hours after emergence. The duration of oviposition may last upto 2 to 2½ hours. 3–5 pupae are parasitised by a female in her life time. The details of the mating and oviposition behaviour are given by the same authors (Beena *et al.*, 1980).

Fecundity, Parthenogenesis and Sex-ratio

The size and age of the host pupa greatly influence the number of eggs deposited in them by the parasite. These factors have also got an impact on the number of eggs that complete the development. The number of individuals produced is directly proportional to the size and inversely proportional to the age of the host pupa. The number of eggs laid by a single female on one pupa of the different hosts like *Nephantis serinopa, Corcyra cephalonica, Lamida moncusalis* and *Spodoptera mauritia* were studied (Table 2.). When eggs were laid by many females, a single *S. mauritia* pupa yielded a mean of 428 adults while *L. moncusalis* pupa produced a mean of 510 adults.

Table 2. *Number of eggs laid on different hosts*

Name of the host	*Number of observations*	*Number of eggs laid on 1 host*	
		Range	*Mean*
Nephantis serinopa	30	22–162	86
Corcyra cephalonica	20	20–150	70
Lamida moncusalis	10	87–154	133
Spodoptera mauritia	10	60–176	104

The parthenogenesis is arrhenotokous. The males produced from a single *N. serinopa* by arrhenotoky varied from 60–104. the mean being 76 (10 observations). The chances of parthenogenesis are rare since almost all females are fertilized prior to their emergence from the host pupa.

The predominance of female sex is noted in the population. The ratio of the percentages of female : male is 93.18 : 6.82 (mean of 15 cases). Though not in strict proportion, the number of males increases when more females are produced.

Field parasitism by *Trichospilous pupivora*

Collections of the larval and pupal stages of *Nephantis serinopa* from different places throughout Kerala were made during the period from July 1977 to June 1980. The availability of *T. pupivora* in the field-collected host materials depended on the season of the year and also on the availability of the pupal stages of the pest population. From the extensive surveys and collections so far conducted, *T. pupivora* was recovered only from very few places. The percentage of parasitism of *T. pupivora* in these places and other pupal parasites was calculated and the details are given in Table 3. Out of the total 5482 pupae collected from various regions, 114 were parasitised by *T. pupivora*, yielding an aggregate pupal parasitism of 4.14%, which is next to the highest parasitisation of 5.26% by *Brachymeria nephantidis*.

Table 3. *Field parasitism by T. pupivora*

Names of the places surveyed and date		*Names of the pupal parasites collected*	*% pupal parasitism by each parasite*	*Total pupal parasitism in %*
Tanur, Mukkola (Malappuram)	October. 1977	*Trichospilus pupivora*	0.83	
		Other pupal parasites	0.00	0.83
	July, 1978	*Trichospilus pupivora*	0.00	
		Meteoridea hutsoni	9.68	16.13
		Brachymeria nephantidis	6.45	
Nileswaram, (Cannanore)	Kanjangaad, June, 1978	*Trichospilus pupivora*	0.00	0.00
		Other pupal parasites	0.00	
	January, 1979	*Trichospilus pupivora*	31.82	
		Brachymeria nephantidis	10.10	47.48
		Xanthopimpla punctata	5.56	
Valanjabalam, Puthuvypeen (Ernakulam)	Vypeen, and December 1979	*Trichospilus pupivora*	11.48	
		Brachymeria nephantidis	5.62	
		Brachymeria nosatoi	2.34	22.96
		Tachinid sp.	1.64	
		Antrocephalus hakonensis	1.41	
		Xanthopimpla punctata	0.47	
	February, 1980	*Trichospilus pupivora*	0.00	
		Brachymeria nephantidis	1.38	
		Brachymeria nosatoi	0.92	2.72
		Eurytoma albotibialis	0.42	
Quilon, Neendakara (Quilon)	February 1980	*Trichospilus pupivora*	0.51	
		Brachymeria nosatoi	13.33	22.04
		Brachymeria nephantidis	8.20	

Collections made from Tanur and Mukkola during October, 1977 revealed that 0.83% of the pupae of *N. serinopa* were parasitised by *T. pupivora*. No other pupal parasite was obtained. Collections from the same area in July, 1978 yielded 16.13% parasitised pupae, but none by *T. pupivora*. Pupae of *N. serinopa* collected from Kanjangaad and Nileswaram areas in June, 1978 yielded no *T. pupivora*; while in January, 1979, out of the 47.48% pupal parasitism, 31.82% was by *T. pupivora*. So, out of the total parasitised pupae, 67% was by *T. pupivora*. The field pupal parasitism in Valanjambalam, Vypeen and Puthuvypeen areas in December, 1979 is 22.96%, out of which 11.48% was by *T. pupivora*. So, 50% of the parasitised pupae was by *T. pupivora*. The collections from the same area in February, 1980 yielded a total pupal parasitism of 2.72%, in which none was by *T. pupivora*. The pupal parasitism by *T. pupivora* in Quilon and Neendakara during February, 1980 was 0.51% where the total pupal parasitism was 22.04%.

DISCUSSION

Trichospilus pupivora, a gregarious internal pupal parasite differs in habit from the members of the other genera of the sub-family Elachertinae, which are external larval parasites. In *T. pupivora* mating occurs while the adults are still inside the host pupae and the females, after emergence, begin to oviposit within a few hours. So, it is conceivable that soon after emergence the adults are reproductively mature and require no pre-oviposition period. Many species of the genus *Melittobia* oviposit likewise (Clausen, 1940). The unmated females readily oviposited producing a progeny of exclusively males. But Anantanarayanan (1934) and Jayaratnam (1941) believed that unmated females do not oviposit at all. *T. pupivora* is not species-specific in host selection as it oviposits even on prepupae and pupae of Sphecidae and Vespidae (Hymenoptera) when provided, and such eggs successfully complete their development in them. However, this may not occur in natural conditions. As the females often lay many eggs on a single host pupa, the chances of their oviposition in many host pupae are reduced. Owing to this behaviour, the number of hosts actually killed by the parasite is very much low. However, because of the fact that many females lay eggs on a single host, many individuals are produced and so mass breeding is easy. Kaberathumma and Nair (1973) have observed that the utilisation of 10 females per pupa yield the best result in the rate of multiplication. Even with feeding, *T. pupivora* could not live very long and the short life span is a handicap to their field efficacy.

The studies from the field surveys show that *T. pupivora* is not uniformly prevalent throughout the infested areas in Kerala, and wherever they occur, their population is not maintained in equilibrium. The parasites were available in the field in the cooler months of the year. So the reason for the absence and also for the variations in distribution may be due to lack of tolerance to the unfavourable climatic conditions. The studies of Anantanarayanan (1929) showed that the parasite flourished abundantly during the months of August-November. Based on the observations on the field incidence of the parasite, Joy and Joseph (1978) have pointed out that they thrive successfully only during the cooler months of the year. Though in individual collections the pupal parasitism by *T. pupivora* ranged from 0.51 to 31.82%, in the aggregate pupal parasitisation from the various regions of Kerala, the percentage by them was reduced to 4.14. The reduction in percentage is due to their random distribution in relation to locality and season, but even then they come next to *Brachymeria nephantidis* in the level of highest parasitism. The evidences of their high percentage occurrence, in at least certain localities, show their efficiency of high parasitisation and this indicates that mass colonization of these in the favourable seasons will certainly help in replenishing them in the field and thereby cause the effective control of *N. serinopa* during those seasons.

ACKNOWLEDGEMENTS

This research has been financed in part by a grant made by the U.S.D.A. under P.L. 480. We are thankful to Dr. Lloyd Knutson, Co-operating Scientist of our project and Chairman, Insect Identification and Beneficial Insect Introduction Institute, U.S.D.A. U.S.A., for all encouragements and useful suggestions in this research work.

REFERENCES

Anantanarayanan, K. P. (1929). Notes on the influence of weather conditions in the breeding of a eulophid in the laboratory – Calicut. *Madras Agric. J.,* **17,** 287–288.

Anantanarayanan, K. P. (1934). On the bionomics of an eulophid *Trichospilus pupivora* Ferr., a natural enemy of the coconut caterpillar, *Nephantis serinopa* Meyr., in south India. *Bull. Ent. Res.,* **25,** 55–61.

Beena, C. G., Mohamed U. V. K., Abdurahiman, U. C., and Remadevi, O. K. 1980. Mating and oviposition behaviour of *Trichospilus pupivora* Ferr. (Hymenoptera : Eulophidae). *Jour. Sci. Res.*, 2 (2) 115–117.

Clausen, C. P. 1940. *Entomophagous Insects.* Hafner Publishing Company, New York. 688 pp.

Dharmaraju, E. 1952. The biological control of the black headed caterpillar *Nephantis serinopa* M., in the East Godavari district of Madras State. *Indian Cocon. J.*, 4, 171–176.

Dharmaraju, E. 1963. Biological control of coconut leaf caterpillar (*Nephantis serinopa* Meyrick) in Ceylon. *Bull Coc. Res. Inst. (Ceylon)*, 21, p. 46.

Dharmaraju, E. and Pradhan, S. 1976. Factors affecting the realisation of the biotic potential in *Perisierola nephantidis* Muesebeck and *Trichospilus pupivora* Ferriere, parasites of the coconut leaf caterpillar, *Nephantis serinopa* Meyrick. *Indian J. Ent.*, 38, 370–376.

Ferriere, C. (1930). Notes on Asiatic chalcidoidea,. *Bull. Ent. Res.*, 21, 358.

Hutson, J. C. (1920). Report of the entomologist. *Ceylon Dept. Agric Administr. Rpts.* for 1919, C8 – C10.

Jayaratnam, T. J. (1941). A study of the control of the coconut caterpillar, *Nephantis serinopa* Meyr. in Ceylon with special reference to its eulophid parasite, *Trichospilus pupivora* Ferr. *Trop. Agriculturist*, 96, 3 – 21.

Joy, P. J. and Joseph, K. J. (1978). Relative incidence of the pupal parasites infesting *Nephantis serinopa* Meyrick, the blackheaded caterpillar pest of coconut in Kerala. *Bull Ent.*, 19, 185 – 187.

Kabeerathumma, S. and Nair, M. R. G. K. (1973). Optimum superparasitism for the mass breeding of *Trichospilus pupivora* F. *Agric. Res. J. Kerala*, 9, 101–102.

Nirula, K. K. (1956). Investigations on the pests of coconut palm. Part III. *Nephantis serinopa* Meyrick, Control. *Indian Cocon. J.*, 9 : 174–201.

Rao, Y. R., Cherian, M. C. and Anantanarayanan, K. P. (1948). Infestations of *Nephantis serinopa* Meyr., in South India and their control by the biological method. *Indian J. Ent.*, 10, 205–247.