

**Studies on the biology of *Antrocephalus hakonensis*
(Hymenoptera: Chalcididae)**

**A pupal parasitoid of *Opisina arenosella* the coconut
caterpillar**

U. C. ABDURAHIMAN, U.V.K. MOHAMED and O. K. REMADEVI

Division of Entomology, Department of Zoology University of Calicut, Kerala-673 635, India.

ABSTRACT

Observations are given relating to the biology, post-embryonic development and reproductive behaviour of *Antrocephalus hakonensis* (Ashmead), a pupal parasitoid of *Opisina arenosella* Walker, the black-headed caterpillar pest of coconut.

The adult, before its escape from the host pupa emerges from its own pupal covering. In the laboratory, adult females, when fed on 50% honey, lived for a maximum of 90 days while the males survived only for 46 days. Copulation was preceded by specific courtship displays. For oviposition, the females accepted both naked pupae as well as those within the cocoon inside the galleries of the host; younger pupae however were preferred by the parasite. A female lays only one egg at each act of oviposition, with an average of three eggs per day.

INTRODUCTION

Antrocephalus hakonensis (Ashmead) (= *Antrocephalus renalis* Watersoon = *Stomatocerus sulcatiscutellum* (Girault) is one among several pupal parasitoids of *Opisina arenosella* Walker (= *Nephantis serinopa* Meyrick), a leaf eating caterpillar pest of coconut. However Boucek (personal communication), a specialist on this group of insects, states that several points need clarification regarding the synonymy of these three forms.

Rao (1926) reported that *S. sulcatiscutellum* was the only parasite observed at Mangalore in 1922 - '23 and that it was also recorded at Coimbatore, Samalkota and Salem. It was also reported as the only natural enemy parasitising the pupae of *N. serinopa* at Mangalore in 1924 (Jayaratnam, 1941) and as a parasite of *Nephantis serinopa* in Cochin (Venkatasubban, 1932). Nirula (1956) stated that *S. sulcatiscutellum* was found all over the coconut caterpillar infested areas in South India and also that it was present throughout the year on the West and East coasts of South India. Joy and Joseph (1972) described *S. sulcatiscutellum* and pointed out that the description given by Rao *et al.* (1948), actually refers to a *Brachymeria* sp.

U. C. ABDURAHIMAN, U. V. K. MOHAMED AND O. K. REMADEVI

Antrocephalus sp. is polyphagous and attacks many pupae other than *O. arenosella*. Rao and Bennett (1969) reported that *A. renalis* Waterston, released as a control agent, caused 19.18% parasitism of *Hypsipyla* sp. Bennett and Yaseen (1972) reported that though *A. renalis* was released in St. Vincent, St. Lucia and Trinidad to Control *Hypsipyla* sp., it failed to establish. Sathiamma et al. (1972) observed that *Antrocephalus* together with other natural enemies checked the infestation of *Contheyla rotunda* Hampson in West India.

MATERIALS AND METHODS

The laboratory stock of *A. hakonensis* was built up from parasitised pupae of *O. arenosella* collected from the field. Each pair of parasites was kept in glass tubes 2.5 cm x 5 cm plugged with cotton wool. They were fed with 50% honey placed on polythene strips. Of the many alternate hosts tested in the laboratory, the pupae of *Spodoptera mauritia* Boisid, *Anadevidia peponis* (Fabr.), *Corecra cephalonica* Staint and *Arginia syringa* Clerk were found suitable for breeding this parasite in the laboratory. For laboratory studies the host pupae were exposed to the parasites in glass tubes. Each tube contained one pupa. When parasitized the pupa was immediately removed to avoid superparasitism and a fresh one provided. The parasitised pupae were dissected to determine the developmental stages of the parasite.

OBSERVATIONS

Description of the adult

The entire body is black; eyes brownish black; and the antennae each composed of 10 segments, inserted near the edges of the mouth is reddish black. Wings are hyaline. The veins of the fore wings are brown except for the submarginal which is pale; and the postmarginal vein is longer than the marginal vein. Legs are black with the outer margin of the hind femora minutely serrated. Thorax is black and shiny with rather small pits on dorsal side. Abdomen is black and shiny. In the female the abdomen is pointed whereas in male it is blunt. The male is smaller than the female. The average length of a female (Fig. 1) is 5.3 mm and the male 3.8 mm.

Egg

The eggs are deposited singly in the host pupa and remain free in its body fluid. The egg (Fig. 2a) is typically hymenopteriform, translucent and whitish. It measures 0.88 mm in length and 0.24 mm in width. The incubation period ranges from 36 to 41 hours at 29°C. The developing embryo, visible through the transparent chorion, occupies the mid region of the egg. The larva emerges from the anterior broad end of the chorion.

Larva

The newly hatched larva lies free in the body fluid of the host pupa. It is translucent and whitish. Soon after hatching it ingests the host haemolymph by pharyngeal pumping. The larva (Fig. 2) bears 13 body segments in addition to the head. As it matures the colour of the larva changes to brown. The larval period lasts from six to eight days. On the day before pupation the larva stops feeding, voids its meconium and becomes pale yellow. This phase can be designated as the prepupal stage (Fig. 2c).

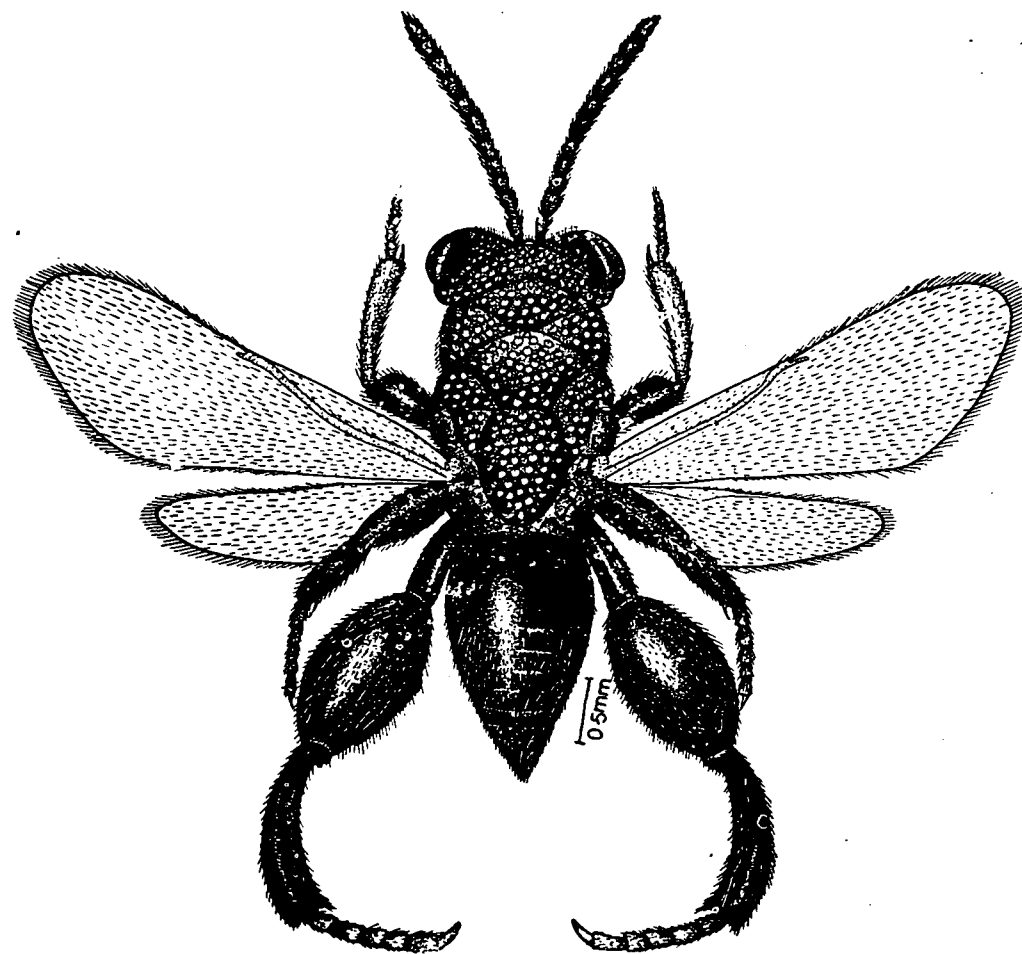


Fig. 1. *Antrocephalus hakonensis*: adult female

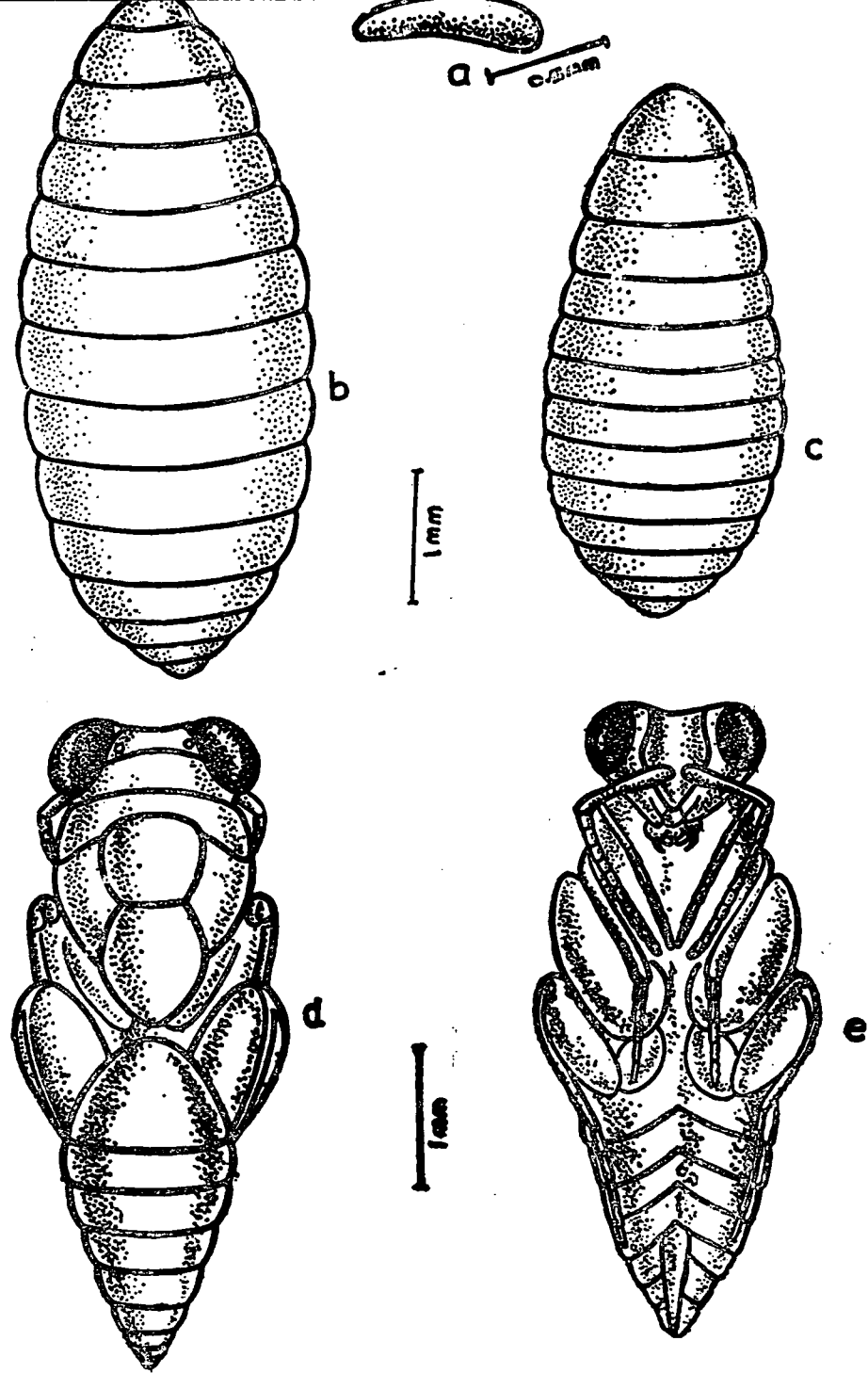


Fig. 2. *A. hakonensis*: a, egg; b, larva; c, pre-pupa; d, pupa dorsal view; e, pupa, ventral view

Studies on the biology of Antrocephalus hakonensis

Pupa

Pupa (Figs 2d and 2e) is pale yellow in colour upon pupation. The body is demarcated into head, thorax and abdomen. On the following day a honey brown colour develops at the base of the appendages, while the eyes acquire a more brownish colouration. Next day, the whole body turns to brown. The darkening begins to appear from the anterior end and extends gradually to the posterior side. However, the dorsal side of the thorax and the first abdominal segment develop a black colour only in the mid-dorsal region, while the lateral and ventral sides of the body are not darkened. Subsequently, the pupa turns completely black. The pupal period extends from 8 to 11 days.

Emergence

The adult parasite before escaping from the host pupa emerges out from its own pupal covering. This is preceded by slight movements inside the pupal covering. The covering of the abdominal region is pushed back by the hind legs; that of the head is removed by the legs and by movements of the head itself. Finally the pupal covering of the antenna is removed by the fore legs. The adult then emerges from the host through an exit hole at the anterior end.

Temperature influenced the development of the insect. During the hot seasons of the year, development was completed in 15 to 18 days, whereas in the cold seasons it took 17 to 21 days.

In the laboratory the adults were fed with 50% honey. Females lived longer than the males. Maximum longevity observed for a female was 90 days ranging from 21-90, with a mean of 56 ± 15.87 ($X \pm S.D.$) for a sample of 25 females. For a similar sample of 25 males the maximum longevity was 46 days, ranging from 4-46, with a mean of 18 ± 15.07 ($X \pm S.D.$). When starved the female lived only three days. Feeding on the host was not observed.

Courtship and Mating

Mating in *A. hakonensis* took place on the day of emergence. As with many hymenopterans copulation was preceded by elaborate species specific courtship displays. The male's role included the movements of antennae, head, wings and legs. A typical courtship sequence was as follows: Male mounts female —> male moves into courtship position —> male displays —> female signals indicating receptivity copulation —> male moves away.

The male of *A. hakonensis* upon perceiving a female moves to and mounts the female (Fig. 3a). He moves anteriorly and assumes the courtship position, with the head slightly protruding over the female's head. The first pair of legs were placed on the lateral sides of her antennae just above the compound eyes. The second pair of legs rested just behind her head capsule. The position of hind legs may vary; they may rest either on the metathorax, the hindlegs, or the wings of the female. The female remains in her resting position, with her antennae extended horizontally (Fig. 3b).

U. C. ABDURAHIMAN, U.V.K. MOHAMED AND O. K. REMADEVI

The male performs the courtship displays by quickly swaying his head sideways thereby sweeping the antennae of the female with his antennae (Fig. 3c). If the female is receptive she lowers her antennae, simultaneously exposing her genital tract (Fig. 3d). The male then moves back quickly and introduces the aedeagus into the female's genital tract. Copulation lasts for 28 to 36 seconds. Once in the copulatory posture the male releases its hold on the female and the pair is attached only by the genitalia. The male lies behind the female, with his ventral side up and supported by the tarsi of the hindlegs. During mating the male jerks its body 30-35 times, simultaneously vibrating his wings sideways. Copulation lasts for 28 to 36 seconds. When copulation is over, the male withdraws his genitalia and falls backwards while the female moves away. The sequence of the courtship behaviour is represented as a reaction chain in Fig. 4. A female mates only once in her life time, whereas the males are polygamous.

Oviposition

The females have a pre-oviposition period of five to seven days. They will oviposit in naked pupae and pupae within the cocoon inside the galleries. If the host is inside its galleries and the female parasite is unable to extend her ovipositor to the host surface, she will cut open the gallery and the cocoon, and enter the cocoon. When inside the cocoons the parasite moves towards the host with outstretched antennae. She usually bends her abdomen and probes the host with her ovipositor to determine the suitability of the host. The eggs are laid through the intersegmental regions. During actual oviposition the female holds the host with her tarsi, the antennae are directed downwards and the wings are held parallel to its body.

Pupae of *Spodoptera mauritia*, *Anadevidea peponis*, *Corcyra cephalonica*, *Argania syringa* were successfully parasitised by *A. hakonenis*. Small and large healthy pupae, irrespective of size were accepted for oviposition but diseased and desiccated hosts were rejected. In the laboratory, the females showed a preference for young pupae. Although six to eight days old pupae of *O. arenosella* were successfully parasitised by *A. hakonenis*, the individuals developing from them were often small in size. This may be due to the lack of food available in the advanced stage of the pupa. The females were unable to discriminate between parasitised and unparasitised hosts and often laid more than one egg into the same pupa. In such cases, irrespective of the size of the host, only one parasite completed its development. The size of the host was important. Adults emerging from large pupae were definitely larger in size and the host still contained a lot of uncaten tissue. Small pupae yield small parasites. Eggs laid in host pupae, in a very advanced stage of development (i.e. one to two days before its emergence) did not develop into adults. Salt (1938) was of the view that the mouth parts of the young larva were inadequate to deal mechanically with solid tissue and the larva may not have been able to chemically liquify the solid parts of the host.

The female lays only one egg at each act of oviposition. The maximum number of eggs laid in a day was five with an average of three eggs. A female lays eggs continuously for six to seven days. After a two to three day interval another batch of eggs are laid. Therefore a female may oviposit throughout its life time. A female having a life span of 75 days, therefore, has the potency to lay 150-160 eggs.

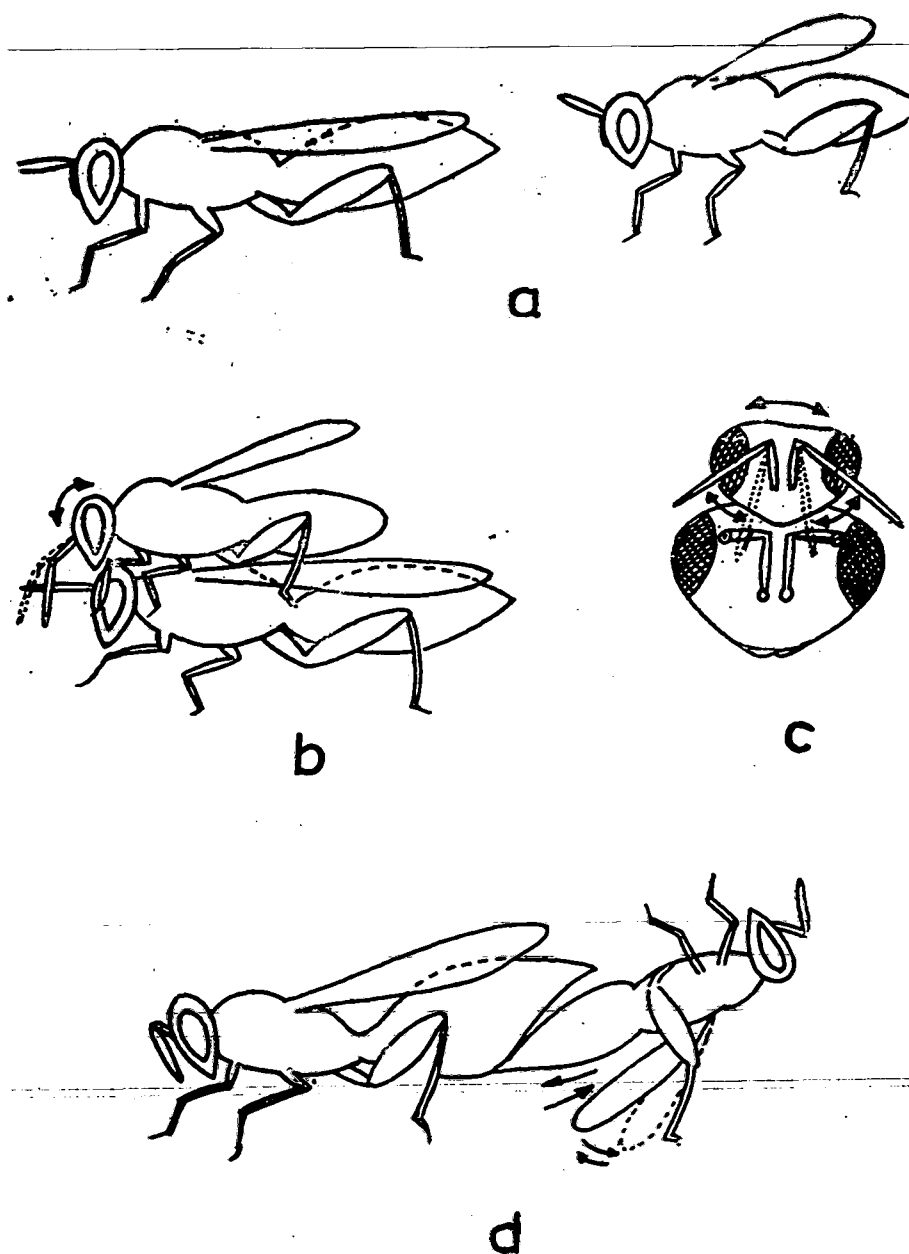


Fig. 3. Stages of courtship and mating behaviour in *A. hakonenis* a male approaching the female; b and c, courtship display and positions; d, copulation.

Studies on the biology of Antrocephalus hakonensis

Parthenogenesis and sex-ratio

Parthenogenesis is arrhenotokous, the progeny consisting of only males. In the laboratory culture males predominated; the ratio of male to female was 3:2.

Field incidence of the parasite

Collections of *O. arenosella* were made from the infested coconut tracts throughout Kerala. Of a total 12.5% pupal parasitism, only 0.21% was produced by *A. hakonensis*. This parasite had a limited distribution and was found only in the Ernakulam and Trivandrum districts.

DISCUSSION

Though Chalcididae is a much studied family, biological observations with members of the genus *Antrocephalus* are scarce. *A. hakonensis*, a solitary pupal endoparasite of many lepidopteran pests, closely resembles the members of the genus *Brachymeria* in many physical and behavioural characteristics and has caused considerable confusion relating to these two groups. The description of *S. sulcatiscutellum* (= *A. hakonensis*) by Rao *et al.* (1948) actually referred to a *Brachymeria* sp. (Joy and Joseph, 1972). Like many species of parasites, *A. hakonensis* mates soon after emergence; lays eggs indiscriminately on parasitised and unparasitised host pupae but only one egg per host completes development. The courtship and mating behaviour of *A. hakonensis* is, however, distinct from *Brachymeria* spp.

We collected *A. hakonensis* only from South Kerala. However Joy and Joseph (1978) have recorded it from 2.6% of *N. serinopa* pupa collected from Calicut in 1971-72. It is a rare parasite in South Kerala.

ACKNOWLEDGEMENTS

This research was financed in part by a grant made by United States, Department of Agriculture 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., Beltsville, U.S.A. for all encouragements and useful suggestions in this research work and to Dr. E. E. Grissel, Systematic Entomology Laboratory of the same Institute for critically reviewing the manuscript. Thanks are also due to the Head of the Department for the facilities provided.

REFERENCES

- Bennett, F. D., and Yaseen, M. (1972). Parasite introduction for the biological control of three insect pests in the lesser Antilles and British Honduras. *PANS* 18, 468-474.
- Jayarathnam, T. J. (1941). A study of the control of the coconut caterpillar (*Nephantia serinopa* Meyr.) in Ceylon with special reference to its Eulophid parasite, *Trichospilus pupivora* Ferr. - *Trop Agric. (Ceylon)* 96, 3-21.

- Joy, P. J. and K. J. Joseph (1972). *Stomatocerus sulcatuscutellum* Girault, a pupal parasite of *Nephantis serinopa* Meyr. Some descriptions actually refer to *Brachymeria* species. *Indian J. Entomol.* 34, 359-360.
- Joy, P. J. and K. J. Joseph. (1978) Relative incidence of the pupal parasite infesting *Nephantis serinopa* Meyrick, the black headed caterpillar pest of coconut in Kerala. *Bull. Entomol.*, 19, 185-187.
- Nirula, K. K. (1956) Investigations on the pests of coconut palm; Part III *Nephantis serinopa* Meyrick *Indian Cocon. J.* 9, 101-131.
- Rao, Y. R. (1926). Control of Coconut caterpillar by its parasites. *Agric. J. India* 21, 452-459.
- Rao, Y. R., Chetian, M. C. and Ananthanarayanan, K. P. (1948). Infestation of *Nephantis serinopa* Meyrick in South India and their control by biological methods. *Ind. J. Entomol.* 10, 205-247.
- Rao, V. P. and Bennett, F. D. (1969). Possibilities of biological control of the Meliaceous shoot borers *Hypsipyla* spp. (Lepidoptera; Phycitidae). *Tech. Bull. Commonw. Inst. Biol. Control* 12, 61-81.
- Salt, G. (1938). Experimental studies on insect parasitism. VI - Host suitability. *Bull Entomol. Res.* 29, 223-246.
- Sathianna, B., Abraham, V. A. and Kurian, C. (1972). Slug caterpillar: a sporadic pest of coconut. *Indian Farming.* 21, 39-40.
- Venkatasubban, C. S. (1932). The coconut caterpillar in Cochin (*Nephantis serinopa* Meyr.). *Madras Agric. J.* 20, 192-138.