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MATING BEHAVIOUR AND BIOLOGY OF *ELASMUS NEPHANTIDIS* ROHW. (HYMENOPTERA: ELASMIDAE), A PARASITOID OF *NEPHANTIS SERINOPA* MEYRICK*

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ABSTRACT

Courtship and mating behaviour of *Elasmus nephantidis* Rohw., the monophagous ectoparasitoid on the prepupal caterpillars of *Nephantis serinopa* Meyrick include wing vibration, licking the antennae of the female with mouth parts, antennal stroking, leg tapping and post-copulatory biting on the female's abdomen. The female adopts a copulation posture by raising the abdomen and exposing the genital pocket on receiving sexual stimulation from the courting male. Males are capable of mating at very close intervals. Females allow courtship even when they are non-receptive and actually do not require further matings. Eggs are laid inside the host's cocoon one by one in groups after stinging and paralysing the host. Egg to adult stages are completed in 11 days and longevity is shorter in summer than in winter. Sex ratio is normally female-biased. The merits and demerits of *E. nephantidis* as a biocontrol agent of *N. serinopa* are discussed.

INTRODUCTION

Elasmus nephantidis Rohw. (Hymenoptera: Elasmidae) is a gregarious, host and stage specific ectoparasite of the prepupal caterpillars of *Nephantis serinopa* Meyrick, a serious pest of the coconut palm. It is indigenous to Kerala, Karnataka, Tamil Nadu and Andhra Pradesh. Intensity of natural parasitisation of *N. serinopa* caterpillars by this parasitoid is comparatively higher than that of other species of larval parasitoids of the pest. Its natural population also is fairly high during summer season, which is the peak period of pest abundance.

Rao and Cherian (1927) studied the life history and habits of *E. nephantidis*. However, details on the courtship, mating and oviposition behaviour and biology of the parasite were lacking. Results of studies carried out on these aspects are reported here.

MATERIALS AND METHODS

E. nephantidis was reared in the laboratory as follows: one or two fully grown last instar caterpillars (prepupal stage) of *N. serinopa* were introduced into clean, dry glass vials (7.5 × 2.5 cm) and 1–2 day old *E. nephantidis* mated

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females (one or two) were released into the vials after the host larvae commenced spinning silken cocoons inside. After egg laying, the female parasites were transferred to other glass vials containing appropriate stage of the host caterpillars.

For fecundity studies host larvae were offered to female parasitoids kept singly in separate glass vials and the observations recorded till the death of the parasite. Mating behaviour and oviposition habits were studied with the aid of a binocular stereomicroscope.

RESULTS AND DISCUSSION

Courtship and mating behaviour

Adults of *E. nephantidis* usually emerge in the morning hours and majority of the parasites in a brood complete emergence within two hours. Few males which first emerge from a colony became sexually active within 45 minutes. Soon after emergence, they try to court the females which are in the process of emergence. They are sexually very vigorous and characteristically polygynous. The males mount, court and successfully inseminate about 15 females within a period of 30 minutes.

Females are sexually mature even at the time of their emergence. They are polyandrous and begin to mate within 15 minutes of emergence and mate up to six times or more. Thereafter they become non-receptive and do not mate further, but allow males to court. There is no selection of males for mating.

The male runs fast with vibrating wings to mount the female often chasing it and proceeds towards her head. The receptive female stops moving, generally keeps her antennae close to each other at an angle of 60°. The mail lick one of the flagella of the female's antennae upwards with the mouth parts and bows the head to repeat the act. By doing so, the branched antennae of the male strike at the tip of the female's antennae in a characteristic fashion. It vibrates the wings and taps with the mesothoracic legs on the lateral sides of the abdomen of the female or on the tibiae of the meso and metathoracic legs. Licking and stroking are continued at the rate of 3.5 times per second. Courtship leading to mating lasts only for 1-2 seconds and subsequent courtships without mating may last 1-7 seconds.

The sexually stimulated female raises her abdomen and exposes the genital pocket. The male either bends his abdomen through the side of the female and mates or takes up position behind the raised abdomen of the female and holding firmly the abdomen on the ventral side and mates. The male terminates mating, moves backward and remains there for a second or two. The female also rests in the place of mating. Then the male vigorously fanning his wings suddenly jumps forward and bites on the tip of the abdomen of the female to drive her away. The abdominal bite appears to be an unusual post-copulatory behaviour and the female waits for the bite from the male after copulation. Copulation lasts 1-4 seconds. Minimum

gaps between matings are ten seconds to one minute for males and ten seconds to three minutes for females. Peak sexual activity was observed in the cooler hours of the day, especially in the early morning hours immediately after emergence.

Within 1–2 hr of emergence the female parasite would have mated up to six times. They do not require further matings, but the males go on mounting and coaxing them. The female now keeps her antennae apart in a raised position. The male licks and strokes them, but the female will soon change the position of the flagellum or lower it indicating non–receptivity. At this time the male may either dismount or may try to find out the receptivity of female and finding non–receptive it dismounts and searches for other females. The non–receptive mated female will generally settle on the glass vial touching her mouth on the substratum, arching her abdomen downwards and places the anteriorly projected antennae horizontal to the head and thorax. The female may also walk off carrying the male on the back. Within two days, the courtship vigour of males is reduced considerably.

When there are more number of males some deviations from the normal courtship behaviour like male mounting on female in reverse position or female not waiting for abdominal biting after mating are noticed.

When a two–hour–old male was introduced into a glass vial with 12 half–an–hour–old female parasites, first mating took place immediately after one second's courtship, and within 4.5 minutes the male mated 7 times with an average gap of 35.7 seconds between matings. The same male resumed mating after 12 minutes and again within 4.5 minutes it mated five times.

Oviposition behaviour

E. nephantidis is a highly host and stage specific parasitoid. It parasitises the caterpillars which are preparing for pupation after spinning the silken cocoons. Once the host is located the parasitoid gives a few stings with the ovipositor standing over the cocoon. The ovipositor is withdrawn from the body of the caterpillar within a few seconds and may extend up to three minutes. The stinging is done at the base of the legs, thoracic segments or in the abdomen. The prepupa is paralysed in an hour, while the active last instar caterpillar is paralysed in three hours. When a host within the cocoon is left with several female parasitoids, a few of them sting to paralyse it and begin to oviposit within 15 minutes, even before the caterpillar shows any symptom of paralysis. Some hosts in the glass vials may leave their cocoons after receiving a few stings to escape further ovipositor thrusts. They remain paralysed later on outside the cocoons they had spun, and the parasitoids lay eggs on the cocoon or near the host and the hatching parasitoid larvae being very mobile locate the host.

Prior to oviposition the female parasitoids scan the suitability of hosts with their ovipositors. In the laboratory many females may oviposit on a host. Eggs are laid singly or in groups. Each

group may consist of 3-46 or more eggs. Generally 10-18 eggs are found in a group. Eggs are laid anywhere on or near the paralysed host, on its bristles or on the outer walls of the silken cocoon spun by the host larva.

Standing over the cocoon the female parasite arches its abdomen backwards, the tip of the ovipositor is fixed at the desired spot, then the abdomen is brought to a position horizontal to the thorax and head, thrusts the ovipositor deep into the cocoon; the areas around the ovipositor are brought to the shape of a funnel and the dorsal side of the parasitoid assumes the shape of a country canoe. The antennae are projected forward and held horizontal to the head or slightly raised. The wings are kept folded. The eggs are brought down to the ovipositor one by one in quick succession. When an egg reaches the middle of the ovipositor, the narrow posterior end of the egg protrudes outside vertically and after reaching the tip of the ovipositor its position is quickly changed and is placed parallel to the ovipositor with the broader anterior end pointing downwards. Then the egg is gently placed on the pre-selected area within 5-25 seconds. Eggs are placed in two ways: (1) When the egg rests on the tip of the ovipositor, the latter is bent in semicircle and the egg is placed on the inner wall of the cocoon of the host larva. Bringing down the eggs on the tip of the ovipositor, and placing them on the inner wall of the cocoon are continued upto the end of oviposition. (2) The ovipositor is placed over the preselected spot and the eggs are deposited there one after the other without moving the ovipositor. On an average, one egg is laid in every 35 seconds, the minimum period being 15 seconds. There is no definite pattern for egg laying and may be placed in a haphazard way.

Female parasites often enter inside the loosely spun cocoons in glass vials. Slightly lowering the ovipositor from the resting position, she may bring eggs one after another in quick succession and keeps them at the tip of the ovipositor, and with one hind leg the group of eggs is removed and placed over other eggs or on the body of the paralysed host larva.

One interesting aspect with *E. nephantidis* is that the female parasitoid generally stops egg laying in a host within 2-3 hr of commencement of oviposition, thereby all the hatching young larvae get equal opportunity for feeding on the host and for further development.

The females can paralyse and oviposit on hosts in darkness also.

Males are darker and smaller. A host caterpillar could give emergence of 50-60 adult parasites. If more than 50-60 eggs are laid on a host caterpillar the number of male parasites emerged will be more and in such cases the parasites will be comparatively smaller. Preoviposition period is 1-2 days.

Eggs are white, cylindrical, translucent, anterior end broader and slightly curved, surface smooth and shining. As the embryonic development progresses

eggs become transparent, and a milky white area appears longitudinally about half the length of the egg. Movement of the parasitoid larva will be noticeable inside the egg 1-1½ hr prior to hatching. After 20 hr of egg laying the larva breaks loose the chorion by contraction and relaxation of its body, searches out the paralysed host, sticks to it and feeds from a suitable place.

Newly hatched larvae are white with their anterior ends broader. When the larva starts feeding, its colour changes to light pink. First instar larvae can be found all over the body of the host and the developing larvae quickly feed from different places. All stages of the larvae are mobile. All larvae stop feeding more or less simultaneously, absorb the food for a period of 1.15 days and then expel the waste products. If the host larva lies outside the cocoon, the parasite larvae after completing their feeding leave the host, assemble at a few places in a circular or cluster form. After absorption of the food, chocolate coloured, solid, shiny waste products are expelled uninterruptedly and these accumulate nearby. Once the waste products are expelled the colour of the parasite larva becomes creamy. The larva pupates in another 12 hr. Average larval period is 3.5 days. The newly formed pupa is creamy, which soon changes into light brown, and then dark after four days of pupation.

Under field conditions the parasite larvae pupate inside the host's cocoon and the emerging adults come out by making openings in them. The pupal period is 6.5 days. The emergence of adults from a brood is completed within 1-3 hr. Egg to adult stages are completed in 11 days.

Fecundity and sex ratio

E. nephantidis has low reproductive potential. Fertilized females laid 27-79 eggs with an average of 57 eggs per female parasitoid. Unmated females laid 28-30 eggs each and the progenies were all males. Longevity of adult is 12-13 days in summer and 30-60 days in winter.

Sex ratio was normally female-biased. Ten female parasites produced 574 adult parasitoids, of which 48 were males and 526 females providing a sex ratio of 1:11 (male : female).

Host killing capacity of *E. nephantidis* ranged between 1-5 hosts per parasite with an average of three hosts per parasite.

Hyperparasites

Rao, Cherian and Ananthanarayanan (1948) recorded *Pleurotropis* sp. (Hymenoptera: Eulophidae) as a hyperparasite of *E. nephantidis*. An unidentified hyperparasite has been reared by the authors from the pupae of *E. nephantidis* collected from Alleppey, Kerala, India. The overall intensity of hyperparasitism was, however, observed to quite negligible.

Role of E. nephantidis *in the biological suppression of* N. serinopa

The merits of *E. nephantidis* as a biocontrol agent of *N. serinopa* include its searching ability and capacity to locate and parasitise host larvae remaining inside silken galleries, its

adaptation to thrive during the summer season when the population of other larval parasitoids would be comparatively low and its monophagous habit. It never lays eggs on hosts in which the parasites are developing. Hyperparasitism, though present, is only very negligible.

The major disadvantages are its low fecundity, lower rate of host killing capacity, rigidity in acceptance of host stage which is of very short duration, possibility of failure of all the females emerged from a brood to find out ideal host stages and lack of higher degree of natural parasitisation.

As this parasitoid is amenable to laboratory culturing, it can be mass reared and released in *Nephantis* infested fields and its population could be augmented considerably.

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