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BIOLOGY OF *CHRYSOPA MADESTES* BANKS
(NEUROPTERA : CHRYSOPIDAE)

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The insects belonging to the family Chrysopidae are on the whole useful species as they destroy numerous harmful insects such as the aphids, coccids, plant lice, spiders and mites. These chrysopids, however, are harmful to the lac insect, *Kerria lacca* (Kerr). The only other instance on record of this family doing any harm was that in California, where the larvae were reported by Essig (1911) as destroying the larvae of ladybird beetles which had been introduced to combat scale insects.

Out of a total of approximately 580 species of *Chrysopa* recorded from all over the world, only about 20 have so far been recorded from India, Pakistan, Burma and Ceylon and little attention has been paid towards the study of their biology. Rahman (1940) studied, briefly, the life history of *Chrysopa scelestes* Banks. Later Nasir (1947) studied detailed bionomics of the same species. This paper reports the results of studies carried out on the biology of *Chrysopa madestes* Banks, the larvae of which were found preying upon different stages of the lac insect at Namkum and Hesal (Ranchi District), Kundri and Orea (Palamau District) and several other parts of Bihar State. Samples of lac received from Karnal (Punjab) had also a few egg-shells of the lacewing fly, thereby indicating a wider distribution of this predator.

In 1930 and 1931 the larvae of this predator were observed only on *Katki* and *Aghani* lac crops. During the present studies in 1950-52 and thereafter all the stages of *C. madestes* were collected from all the four lac crops of the two strains of lac insect from various hosts, such as *kusum* (*Schleichera oleosa* (Lour.) Oken.), *palas* (*Butea monosperma* (Lamk.) Taub.), *ber* (*Zizyphus mauritiana* Lamk.), *sandan* (*Ougeinia oojeinensis* (Roxb.) Hochreut), *Albizia lucida* Benth., *bhalia* (*Moghanià macrophylla* (Willd.) O. Ktze) and *arhar* (*Cajanus cajan* (Linn.) Millsp.)

MATERIAL AND METHOD

The material used in these studies was collected in all stages from the lac-bearing *S. oleosa* trees at Hesal plantation (Ranchi) and from *S. oleosa*, *Z. mauritiana*, *B. monosperma* and *O. oojeinensis* at Namkum plantation. The

adults were located by stirring the branches and easily collected with hand nets while flying or with widemouth tubes while resting after the disturbance. Adults thus collected, were sorted out into males and females and a pair was put in glass battery jars (3" x 3") or glass tubes (5" x 2") covered with wire net at the open ends and fed on water, sugar solution, honey solution and honey-dew solution absorbed in cotton wool and on moistened open raisins. The larvae were put separately, one in each tube, to avoid cannibalism which was found prevalent in captivity. They were chiefly fed on lac insects in various stages of development *in situ*, supplemented with liquid food used for adults, supplied every day during summer and on alternate days during winter.

DESCRIPTION OF VARIOUS STAGES AND THEIR PERIOD OF DEVELOPMENT

(i) Egg

The egg of *C. madestes* resembles those of other species described by Smith (1922) and that of *C. scelestes* described by Nasir (*loc. cit.*). The egg and stalk of *C. madestes* are slightly bigger than those of *C. scelestes*. Egg measures 0.75-0.95 mm. in length (mean of 156 eggs 0.83 mm.) and 0.33-0.41 mm. in width (mean of 156 eggs 0.38 mm.). Stalk is shortest when drawn on the thorns of *Z. mauritiana* (maximum length 4.0 mm., minimum 0.4 mm., average of 30 stalks 1.8 mm.) or any other similar projection and longest when drawn on a flat surface (maximum 7.0 mm., minimum 5.0 mm., average of 50 stalks 6.6 mm.).

Development of the embryo : The freshly laid egg is yellowish or light green without any visible embryo (Plate I, 1), which stands out only after about 10 hours as a curved light green form against the dark green of the rest of the egg. During 10-36 hours (Plate I, 2-4) the yellow embryo, turned inwards at both the poles, can be clearly distinguished from the bluish green yolk-mass. The end of the embryo destined to be the head, lies at the micropylar end. The segmentation can be made out from dull red spots and streaks. During 36-60 hours, (Plate I, 5-7) the embryo becomes brownish yellow and the yolk-mass, dark bluish green; body segments are marked by incomplete brown bands, generally 8 in number on dorsal side and in between the turned ends and 4 on turned tail end. During 60-84 hours, (Plate I, 8-10) the segments are marked by complete brown bands, the yolk-mass is contracted to a longitudinal yellow streak surrounded by dark green; legs are faintly visible as brown vertical lines ventrally; the egg burster appears as a small brown line on the ventral side between the eyes, brown ocelli are also visible and the chorion is laterally and longitudinally depressed. During 84-108

hours, the yellow streak of the yolk-mass disappears and only dark green is visible; legs are distinctly visible. During 108-132 hours, the brown segments darken, the yolk-mass turns light brown and the ocelli turn black after which the larva hatches.

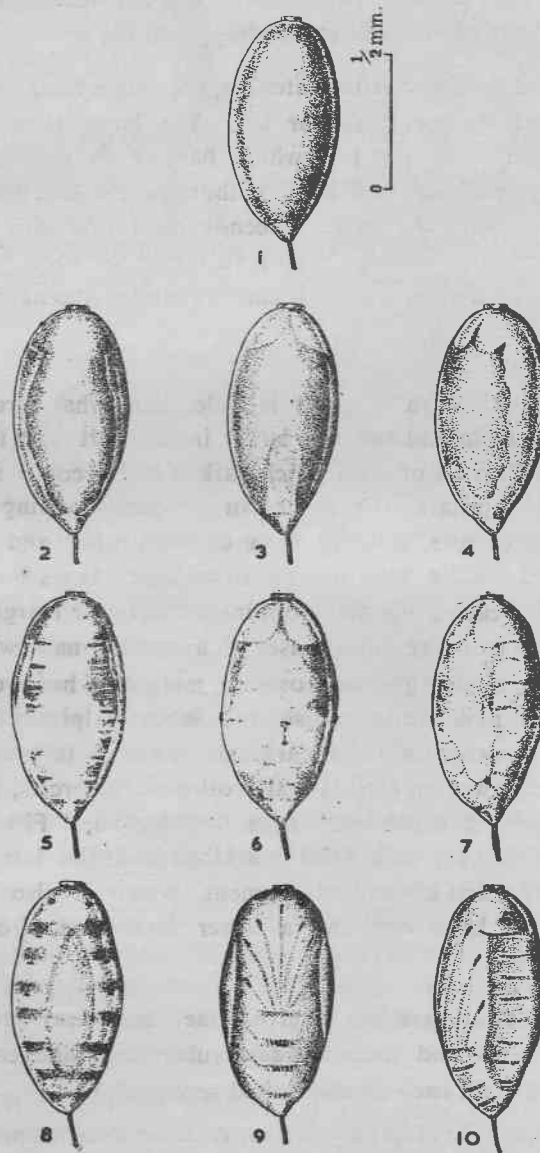


Plate 1. Development of embryo of *Chrysopa madestes* Banks. 1. Freshly laid egg. 2-4. Dorsal, ventral and lateral views of 10 to 36 hour-old egg. 5-7. Ditto 36 to 60 hour-old egg. 8-10. Ditto 60 to 84 hour-old egg.

Duration of egg stage and hatching : In winter the egg stage of *C. madestes* lasts for 1 to 12 days while in summer it lasts 2 to 6 days. The contraction and expansion of the larval body presses the egg burster on the chorion which ruptures longitudinally, near the micropyle end and the thorax is visible through it. The head and gradually the abdomen comes out. The egg-shell is pure white with the embryonic skin and the egg burster protruding from the rent.

Descent from the egg : After hatching, the whole body of the larva stands in the air anchored by the posterior tip. The larva then starts moving the antennae, mouth parts and the legs which harden on exposure to the air. It then holds the egg-shell with the legs, withdraws the tail, goes round the egg-shell and having discovered the stalk, descends head first with the help of the tail and claws. The larva immediately begins to search for food. If unhatched eggs or larvae of its own kind are available it shows cannibalistic nature.

(ii) Larva

The first instar larva (Fig. 2) is pale, somewhat translucent with faint markings which darken in 2nd and 3rd larval instars. It has three pairs of light brown bands on the dorsum of head which darken and become more prominent in the 2nd and 3rd larval instars : the inner pair of bands arising on inner sides of antennae at the base of jaws, bending towards each other and stopping at about the middle of head ; middle pair arising from inner bases of antennae bending less sharply towards each other and stopping at posterior margin of head capsule ; the outer pair arising from the outer bases of antennae, narrowing and converging still less sharply and stopping at the posterior margin of head capsule. Mandibles are amber coloured and the antennae and labial palpi are hyaline. Thoracic segments are light brown with faint markings. Lateral tubercles are prominent ; setae long and stout, two on each lateral prothoracic tubercles, three on each lateral meso- and meta-thoracic tubercles. Legs are hyaline. First seven abdominal segments are light brown with faint markings and the last three segments are hyaline. No setae on first abdominal segment, which is also without tubercles ; two setae, an upper large one and a lower small one, from each abdominal tubercle 2 to 7.

The second instar larva has twelve setae on lateral prothoracic tubercles, thirteen each on meso- and meta-thoracic tubercles, nine each on abdominal tubercles 2 to 6 and eight each on abdominal segment 7.

The third instar larva has seventeen setae on lateral pro-thoracic tubercles, fourteen each on meso- and meta-thoracic tubercles, nine each on abdominal tubercles 2 to 6 and eight on 7.

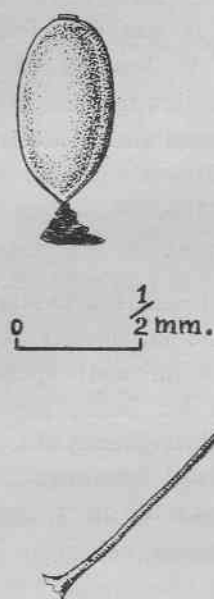


Fig. 1. Abnormalities in oviposition of *Chrysopa madestes* Banks.

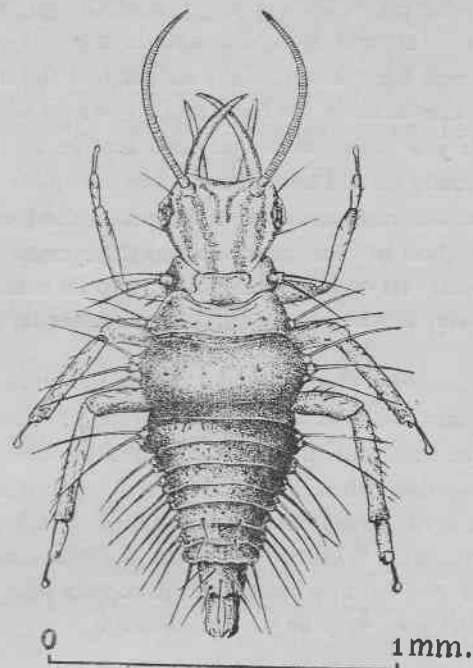


Fig. 2. Newly hatched first instar larva of *Chrysopa madestes* Banks.

Duration of larval instars : The duration of first larval instar varied from 2 to 24 days in winter, the maximum being in the month of December, while it varied from 2 to 12 days in summer, the maximum being in the month of August. The duration of 2nd larval instar varied from 2 to 27 days in winter and 2 to 10 days in summer. The duration of the 3rd larval instar upto the spinning of the cocoon varied from 3 to 26 days in winter. The total larval period before spinning may last for 9 to 60 days in winter and 16 to 22 days in summer.

Moulting : The larva of *C. madestes* moults three times, excluding the embryonic moult, like other chrysopid larvae. The debris carried on the back is also cast off with the skin and may be used again. Generally, it carries the hatched eggs, the exuviae, dead or killed larvae of its own kind, wax-filaments of the lac insect and pieces of bark and other plant tissues.

Habits : It is difficult to discover the larva because of the debris on the back which mingles with its habitat. The larva usually rests, with the head, legs and the tail drawn in, in the gaps in the lac encrustation, crevices of bark, on flowers, underside of leaves, or in between gaps of other coccids living or dead, or even among the exuviae of the coccid colony. It walks rapidly when disturbed.

Food : In nature, its food mainly consists of soft bodied insects, such as the lac insect, *Icerya aegyptiaca* Doug., *Pulvinaria* sp., *Aulacaspis* sp., *Aspidiotus* sp., fulgorid nymphs, aphids and its own kind in all stages of development except the cocoon. The author had the unpleasant experience of a larva sneaking to the back of his hand and trying to feed on the blood. It was the piercing of the jaw which attracted his attention and before it could be brushed off it had already settled and drawn a few droplets of blood visible through the jaws. In the laboratory, the larva fed on all the foods already mentioned under Material and Method besides protein food (Enzymatic hydrolysate of Brewer's yeast). A first instar larva killed anything upto 20 mature lac insect females per day, a second instar larva upto 24 and a third instar larva upto 74.

Feeding method : When the larva is hungry but not weak due to starvation, it moves about quickly in search of food. On finding the lac insects it selects one, finds out the apertures and pierces generally through the anal opening but sometimes through the brachial openings as well. If the lac insect happens to be very young and its resin still soft it may be pierced through anywhere on the dorsum. While feeding on a loose insect without a hard covering, the larva pierces through a suitable place with one jaw and holds it with the other. Sometimes both jaws may be pierced through.

Anal proleg : The anal proleg, or tail, is a disc-like ending of the abdomen. It is applied to the supporting surface and a sticky substance is exuded which enables it to hold fast. It is in use throughout the life of the larva. It is always used in locomotion except when the larva is running very fast ; is specially used while climbing up or down a surface or to brace the body when handling a loose victim or while moulting and spinning a cocoon.

Excrement : The larval excreta are of two kinds : (i) clear gelatinous fluid secreted through the anal tip, described above, and (ii) black bean-shaped excrement retained in the mid-intestine throughout the life of the larva, as the larva has no posterior opening, and is voided just after the emergence of the adult.

(iii) Prepupa and Pupa

On reaching maturity, the third instar larva usually seeks more or less a protected place and spins a cocoon of white silk in which it transforms into a pupa. Prior to spinning it becomes less active and darker in colour while the abdomen bulges out laterally and the larva appears rather flattened. Finally, 24 hours before spinning, the abdomen becomes lighter in colour again.

The part of the life of the third instar larva passed inside the cocoon, from the time of spinning to the time of its transformation into the pupa, which can be inferred by the appearance of a black disc on one pole of the cocoon, is designated as the prepupal stage. This stage lasts for about 2 to 15 days in winter and about 2 to 4 days in summer. The combined prepupal and pupal stages inside the cocoon lasts for 6 to 24 days in winter and 8 to 14 days in summer.

The cocoon : On the lac bearing trees, the larva usually spins a cocoon in the gap of the lac encrustation, camouflaged with the debris it is carrying, so that it becomes extremely difficult to locate it. It may also spin in the crevices of the rough and old bark, angle of the stem and petiole, under-side, folds and ribs of the leaf and in the midst of a coccid colony or its mass of exuviae. The process of spinning the cocoon is similar to that by any other chrysopid species. The cocoon is slightly elongated in shape, pure white in colour and measures 2.5 to 3.5 mm. at longest diameter.

The pupa : The change from the light yellowish coloured prepupa to green pupa can be faintly seen through the cocoon. The pupa of *C. madestes* resembles that of *C. scelestes* except in the following points. It is light green (creamy in *C. scelestes*) with prominently yellow dorsal streak, the eyes are maroon (dirty yellow in *C. scelestes*); and the antennae are colourless (white in *C. scelestes*). The pupa on emergence from the cocoon holds on to any rough surface, even to its own cocoon, and sheds the skin.

(iv) Adult

Just after emergence from the pupal moult, the adult moves about and tries to spread its wings. When it has gained its normal size and condition, it voids the black bean-shaped mass of the larval excreta.

The adult is light green in colour with a yellow dorsal median streak. The males are smaller than the females. The mesothoracic wing expanse of the male measures 18-22 mm., the metathoracic 15-25 mm. and the body 6-10 mm. while the corresponding measurements for the females are 20-28 mm., 15-26 mm. and 6-11 mm.

Food : It is not known for certain what the adults in nature feed on but since they frequent the lac bearing trees and blossoming non lac-bearing trees, such as mango (*Mangifera indica* Linn.), jamun (*Syzygium cuminii* (Linn.) Skeels), jack fruit (*Artocarpus integrifolia* L. f.), lichi (*Litchi chinensis* Sonn.) and guava (*Psidium guajava* Linn.), honey dew and nectar may be stated to be two of the natural foods. In laboratory, the adults readily fed on foods described earlier

besides on chopped fruits of *Z. mauritiana*. They, however did not feed on lac larvae when offered *in situ* or crawling.

Flight and activity : The flight is slow and awkward due to its comparatively heavy body and large wings. The adult shuns light and hides on the trees with dense foliage and comparatively shady. Thus most of the adults for study were collected from lac-bearing *S. oleosa* trees, few from *B. monosperma* and none from *Z. mauritiana*.

Copulation : The adult *C. madestes*, whether emerged in laboratory or collected from the field did not copulate in captivity, when kept in cages of various sizes and exposed to different coloured lights or kept in darkness even though fed on protein food.

Oviposition : Oviposition is similar to that described for various species by several writers, notably, Fitch (1855), Mueller (1872-73), Vine (1895), Girault (1907), Smith (*loc. cit.*) and Nasir (*loc. cit.*). A female with much swollen abdomen, lowers the abdomen, touches the substratum, secretes a drop of transparent gelatinous substance and pulls out a uniform stalk by raising the abdomen in 8 to 15 seconds. Immediately the egg appears, micropylar end last. It is attached to the stalk, held there for 20 to 60 seconds to let the stalk harden and then the genitalia are withdrawn with a jerk. The field collected gravid females always laid eggs during night or when protected from light during the day. A few gravid females kept exposed to 100 watt electric light during the night did not lay eggs, but they readily did so, when the light was switched off or they were shaded from it.

Abnormalities in oviposition : Though the eggs are deposited singly, abnormalities are not uncommon. Sharp (1895) has described abnormalities in *C. aspersa*, Smith (*loc. cit.*) in *C. nigricornis* Burm. and *C. oculata* Say and Nasir (*loc. cit.*) in *C. scelestes*. In *C. madestes* a case was observed where the female failed to draw the stalk and the egg was attached to a mass of gelatinous substance deposited on the substratum. Abnormally attached eggs are a common feature (Fig. 1).

Location of eggs : The eggs are deposited on any part of the lac-bearing tree, viz., stem, leaves, petioles, thorns etc. but generally near the lac encrustation. On the non lac-bearing trees they were generally deposited on or near the inflorescence.

Fecundity : Since the laboratory bred females did not lay eggs, the available record pertains only to the field collected females. The average number of eggs laid by a female was 26 (range 4 to 81).

Longevity : Generally the adults lived longer in winter than in summer. The adults collected from field lived up to 83 days in winter (average of 25 adults 41.52 days), and up to 45 days (average for 21 adults 16.23 days) in summer. The adults bred in the laboratory lived up to 65 days in winter (average for 19 adults 27.1 days) and upto 47 days in summer (average for 8 adults 15.0 days). Females lived for 2 to 65 days in winter and for 2 to 47 days in summer. Males lived for 2 to 46 days in winter and for 1 to 13 days in summer.

Sexes : In winter the sexes were almost equally represented in the field collections (11 males and 14 females) but in summer there was one male for every two females (7 males and 14 females).

NATURAL ENEMIES

The egg and cocoon of *C. madestes* were found parasitized in nature by hymenopterous insects.

Egg-parasites : *Telenomus* sp. (Scelionidae) was the only egg-parasite reared during these studies. Parasitized eggs were found to change in colour from smoky to black with the maturity of the parasite inside. The adult parasite emerged through an irregularly cut hole in the side of the egg. 7.69 per cent to 23.94 per cent of the field collected eggs were found parasitized by this species.

Cocoon-parasites : *Anagyrus greeni* How., *Cheiloneurus* sp., *Leptomastix* sp. (identification doubtful), and *Ooencyrtus* sp. (identification doubtful) (Encyrtidae), *Conostigmus* sp. (Ceraphronidae) and *Brachycyrtus* sp. (? *eublemmae* Rao ; Gupta, 1964) (Ichneumonidae) were reared from the cocoon.

Parasite of the adult : One case of an immature stage of *Hexameris* sp. (Mermithidae) was collected for the first time from a field collected adult.

Predators : The caterpillars of *Eublemma amabilis* Moore and *Holcocera pulvereae* Meyr. were observed to cut through the cocoon and feed on the developing stage.

SUMMARY

The bionomics and life history of *Chrysopa madestes* Banks, a predator of *Kerria lacca* (Kerr), has been described in detail under the laboratory conditions. Four to 81 eggs were laid during the life of a female. The duration of different stages varied with the season. Thus the three larval stages up to the time of

spinning lasted for 2 to 24 days, 2 to 27 days and 3 to 26 days respectively in winter and 2 to 12 days, 2 to 10 days and 2 to 11 days respectively in summer; the total larval period for 9 to 60 days in winter and for 7 to 22 days in summer. The combined pre-pupal and the pupal stages inside the cocoon varied from 6 to 24 days in winter and 8 to 14 days in summer. The complete life cycle from egg to adult occupied from 21 to 80 days in winter and 19 to 34 days in summer. Adult lived longer in winter (upto 65 days) than in summer (upto 47 days). One egg-parasite and six cocoon-parasites were recorded.

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