CHELISOCHES MORIS F. (FORFICULIDAE: DERMAPTERA), A PREDATOR ON EGGS AND EARLY INSTAR GRUBS OF THE RED PALM WEEVIL *RHYNCHOPHORUS FERRUGINEUS* F. (CURCULIONIDAE : COLEOPTERA)

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ABSTRACT

Rhynchophorus ferrugineus F. is a serious pest of the coconut palm. No effective biological control agent of this pest has been reported so far. *Chelisoches moris* F., a species of earwig, is commonly met with on the crown of coconut palms infested by red weevil. Its life history and feeding habits on the eggs and early instar grubs of red palm weevil were studied. Eggs are laid in clusters. The average incubation period was 6·5 days. There were four nymphal instars and the average total nymphal period was 45·6 days. The adults lived for 66·8 days and the total life cycle lasted for 69–153 days. On an average one earwig in its life period consumed as many as 662·4 eggs or 633·5 early instar grubs.

INTRODUCTION

Rhynchophorus ferrugineus, is a serious tissue borer pest of the coconut palm. So far, an effective agent of biological control has not been reported in India. But Nirula (1956) observed that a uropodid mite killed pupae under laboratory conditions. *Chelisoches moris*, a species of earwig, is commonly seen on the palm infested by red palm weevil. This predaceous insect was studied for its life history, and feeding rate and the results are reported here.

MATERIALS AND METHODS

Full grown male and female adults of *C. moris* collected from the crowns of coconut palms were caged in specimen tubes (size 8 × 3 cm) provided with bits of peeled coconut petiole. Eggs and early instar grubs of red weevil were provided as food. As soon as the eggs were laid in the tubes, the male earwigs were removed. The females were kept in the tubes until nymphs were 4–5 days old. When the parental care ceased nymphs were separated and reared in individual specimen tubes. When fully grown each female was caged with one male and after egg laying they were separated.

Feeding trials were conducted separately with eggs and first instar grubs of red palm weevil. For this, five insects in two sets were caged in separate tubes and in one set early first instar grubs and in the other set eggs alone were supplied as food. Known number of eggs or grubs were provided daily and the number consumed was recorded the next day.

RESULTS AND DISCUSSION

Habit and Habitat

Earwigs are found in most of the tropical and subtropical countries. They are omnivorous predators. According to Wood (1968), several species of earwigs including *Chelisoches moris* F. occur in oil palms in Malaysia bu he was not sure about their feeding habits and food preferences. In Kerala, *C. moris* is a common insect seen in debris and on the crowns of coconut palm. These thin flat insects crawl into narrow cracks and crevices in the palm trunk, in the leaf axils, etc. The red palm weevil lays eggs in the leaf axils and mechanically injured portions of young palms. These eggs then become accessible to the earwigs. The earwigs are timid and

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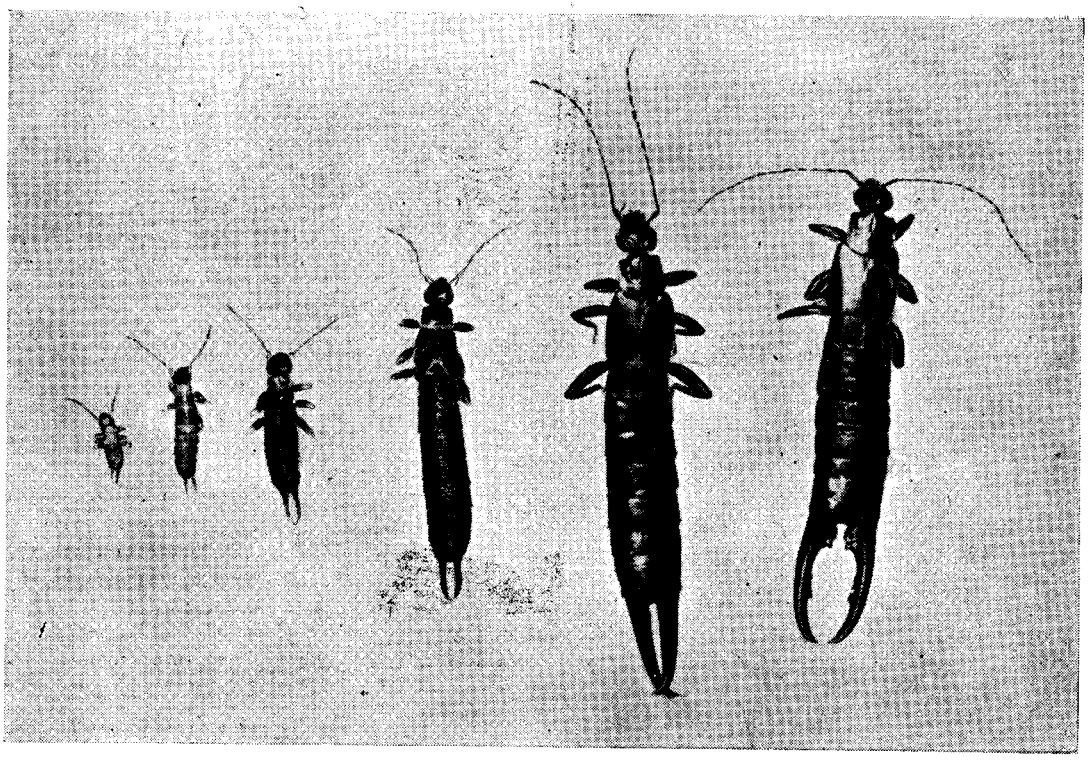

FIG. I. Different stages of *Chelisoches moris* F.

Left to right : 1–4. Four nymphal instars of *Chelisoches moris* F.
5. Adult Female.
6. „ Male.

generally do not come out during daytime. When disturbed, they hide in the cracks or crevices on the stem or in the leaf axils of the palm. They are agile and are characterised by their brisk movement. They fly only occasionally.

Description of Various Stages

Eggs.—Eggs are spherical and smooth with light yellowish colour and have a sticky surface.

Nymphs.—The body of the first instar nymph is 3 mm long and 1 mm wide. Head and portions of abdomen are brownish black in colour and thorax is brown.

Head.—Transversely oval, mouthparts protruding, palpi brown, antenna yellowish, filiform, 8-jointed, scape, pedicel and six-jointed flagellum, last flagellar joint black, first joint nearly one and a half times the scape, second flagellar and following joints as long as scape, flagellar joints nearly cylindrical. Eyes small and bare.

Thorax.—Thoracic segments nearly of equal size. Legs, colour of coxa dark brown, trochanter brown, basal portion of femur black, apex brown, tibia light brown, tarsi yellowish brown.

Abdomen.—As long as the thorax, 10 segments visible. Forceps-like appendages simple and more or less styliform present at the apex of abdomen, length half of the abdomen, with no visible dentation and light brown in colour.

Body of second instar nymphs about 5 mm long and 1·25 mm wide.

Head.—Obovate, somewhat flattened viewed from above, broader than the thorax, smooth and shiny with no marked sculpture.

Antenna 3–5 mm in length, filiform, 11 segments, yellowish brown, the apical two joints dark brown to black, third joint from the apical end dark brownish black. Remaining joints light brown, with their apical ends slightly darker, basal joints setaceous with somewhat moniliform appearance, generally

light brown, basal segments light in colour, first flagellar joints long, next 4 short, last 5 much longer than the rest. Eyes small, disposed laterally just behind the antennae, bare and somewhat bulging. Mouthparts—labial palpi, light brown, one-fourth size of antennae, mandibles brownish black and maxillary palpi light brown.

Thorax.—Prothorax slightly narrow, light brown, nearly as long as broad, mesothorax dark brown to black particularly at the lateral aspects nearly of the same width as the prothorax, metathorax light brown, as broad as abdomen.

Legs.—Brown, coxal and basal half of femur dark brown, apical half of femur, tibia and tarsi light brown.

Abdomen.—Dark brown, 10 segments visible, first segment light brown and remaining ones dark brown, forceps reddish brown, 1–5 mm long. Apex of abdomen with few setaceous hairs of which two are prominent. Inner dentation in forceps slightly visible in males. Apex of abdomen with a palpiform protrusion medially placed.

Body length of third instar nymph without the forceps is 8 mm, with forceps 10 mm in female and 9·8 mm in male. Body colour brownsh black except for mouth parts, portions of antennae, pro- and meta-thorax and portions of legs.

Head.—Nearly round with an obovate appearance, slightly longer than broad, with a clearly marked and protruding frons. Vertex nearly flattened with a slight median depression, ocelli absent. Superlinguae distinct, ligula bilobed. Antennae 6 mm long in female and 5 mm long in male, filiform, laterally disposed 15-jointed in female and 14-jointed in male. Scape and first six flagellar joints light brown, 7th to 11th brownish-black, 12 and 13 white. 14th and 15th concolorous in female (in male 13th joint of right antennae and 12th of left antennae white) first flagellar slightly longer than the scape and nearly equal to 2nd, 3rd and 4th flagellar combined. Rest of the flagellar joints gradaully increase in length, but the last 4 nearly equal. Eyes small, circular, black and disposed on either side of the face nearly smooth and shiny.

Thorax.—Length nearly half of the abdomen and nearly one-and-a-half times the width at the broadest part of the metathorax. There is a median line running longitudinally along the middle of the pro- and meso-thorax. Prothorax nearly rectangular ventrally a distinct neck is visible. Mesothorax slightly shorter than prothorax, but somewhat broader. Metathorax of nearly equal length as the mesothorax, but broader. Legs are yellowish brown except for the brownish black trochanter and basal half of femur, distinctly, but finely pubescent. Fore and mid legs equal in size, hind legs slightly bigger. Coxa inserted ventrolaterally at the distal end of the metathorax, coxa and trochanter combined 1/3rd the femur which is somewhat stout. Tibia slightly arched and 4/5th the femur and slightly longer than the tarsi combined. Tarsi 3-jointed, covered over by fine golden pubescence. Tarsal joints first and third of nearly equal length, claw simple.

Abdomen.—Black except the last tergite which is lighter and the dark reddish brown forceps. Very slightly longer than the thorax and nearly as broad as the metathorax. Tergites gradually become broader and then slightly narrow down. Ten segments distinctly visible. Tergites coriaceously sculptured with lethary appearance. First segment not very clear, second distinct, 3rd bigger than the 2nd, the rest gradually become shorter but slightly broader and then narrows down. The last abdominal tergite narrowed with a posteriorly projecting cone-like process with two apical hook like projections one on either side. Forceps which are the modified cerci are horny and finely curved with 13 serrations in each blade disposed to the inner side.

Fourth instar nymphs are brownish black and 13 mm in length.

Head.—Obovate, black, shiny, smooth and flattened, frons and vertex smooth and shiny. At the middle of the vertex there is a shallow depression. Mandibles reddish brown. Antennae filiform, 17-jointed in female including scape, 16-jointed in male, 11th and 12th flagellar joints white, rest brownish black, scape and pedicel reddish brown but the latter slightly paler, pedicel somewhat shorter than the scape, first few flagellar joints shorter than the rest, distal joints gradually become longer but last 5 nearly of the same size. Eyes are antero-laterally placed, just behind the mouth slightly bulging, black and bare.

Thorax.—Prothorax as long as broad with whitish margin and a few setaceous hairs, median longitudinal line distinct, Metathorax broader than long, hidden by elytral buds which are brownish black. Elytra cover metathorax except for the posterior middle part and extend slightly into first abdominal segment.

Legs are brownish black except for lighter femur and tibia and yellowish brown tarsik claws prominent.

Abdomen.—Brownish black with reddish brown hairs, 10 segments visible, first six nearly or the same length and the rest progressively become shorter but 9th slightly longer than the 8th. Forceps as long as the last four abdominal joints combined, laterally diverging and then converging; inner aspect of forceps with 16 or 17 very minute dentation. Apex of abdomen with a palpiform brownish-black process.

Adult Female.—Length of the body without forceps 19 mm, and with forceps 24 mm. Body colour black except for few white flagellar joints of antennae and reddish brown tarsi of all legs.

Head.—Nearly quadrate, slightly longer than broad with protruding frons, nearly smooth and shiny. Length nearly as long as prothorax, inserted on a distinct neck like prolongation of prothorax Vertex nearly flattened with a distinct median depression and no distinct carina at the posterior margin. Sparsely pubescent with few spinous setae in the posteriolateral aspect, ocelli absent. Mouth-parts reddish brown. Mandibles strong. Superlinguae distinct, ligula two-lobed. Antenna, 11–12 mm long, 20-jointed, filiform, inserted in foveae just in front of eyes. Scape thick, four times as long as broad. Flagellar joints gradually become longer, last ten nearly subequal, 13th–16th white, rest of them brownish-black. Eyes small, circular, black, bare and disposed on either side of the face; with a forwardly directed appearance.

Thorax.—Pronotum large somewhat smaller and narrow as compared to mesonotum, quadrangular. Mesonotum roughly rugosely sculptured with few scattered shallow punctae. Metanotum (postnotum) not distinct as the mesonotum and is fused with the abdominal tergum. The tegmina are short truncated structures, devoid of veins and extend backwards covering the first abdominal and anterior 1/3rd of the 2nd abdominal segment. Hindwigs are large semicircular and almost formed of the greatly extended anal area. The preanal portion is chitinized and contains radius and cubitus. The greater part is supported by a series of radially directed branches. The hind wing is folded longitudinally in a fan-like manner accompanied by two folds in the transverse direction and while folded tucked beneath the small tegmina. Fore and middle legs nearly equal in size and hind leg slightly bigger. Legs pubescent; with a few stiff spines mostly disposed in the basal 1/3rd of the femur and claw simple,

Abdomen.—11-segmented, the first tergum fused with the metathorax and the 11th is represented by the rudimentary pygidium. Sternites 2–7 clearly visible. Eighth and 9th terga are greatly reduced and almost invisible, smooth and shiny with shallow rugose punctae found mostly at the sides. First sternum wanting, 2–7 clearly visible 10th represented by a pair of plates at the base of forceps and completely conceals 8th and 9th sternums. Forceps 5 mm long, smaller than that in the male. Nearly unarmed, but except for 16 serrations visible in the inner aspect of the inwardly bent lateral halves of the horny forceps.

Adult male.—Length of the body 19 mm without forceps, 27 mm with forceps. Colour black except for white flagellar joints of antennae and reddish brown tarsi of all legs.

Head.—Nearly quadrate, very slightly longer than broad with protruding frons. Nearly smooth and shiny with a rough coriaceous sculpture particularly in the lateral aspect. Length of head slightly less than phothorax. Insertion of head same as in female. Vertex nearly flattened with two shallow and broad foveae starting from the middle of vertex and running anteriolaterally ending near the antennal insertion just in front of the eyes; no distinct carina at the posterior margin; ocelli absent. Mouth-parts dark reddish brown to black. Mandibles strong, superlinguae distinct, ligula two-lobed. Antenna 12–13 mm long, 19-jointed, filiform. Antennal scape somewhat thick, four times as long as broad and nearly equal to the first three flagellar joints combined. Flagellar joints gradually become longer. Last nine nearly subequal. Antennal joints 12th and 13th on the right and 11th and 12th on the left are white, rest of them brownish black. Eyes same as in female.

Thorax:—Pronotum large somewhat narrow as compared to mesonotum. Nearly quadrangular except the poster or aspect which is nearly semicircular, lateral and front aspects bounded by a carina, anterior part nearly smooth and shiny with a median longitudinal foveae and two lateral depressions between the foveae and lateral carina one on either side. The posterior aspect with a rough faint leathery sculpture. There is an inverted 'V'-shaped carinate marking in the middle of prothorax which runs to the posterior aspect of the prothorax as a faint line. Mesonotum larger and broader than pronotum, nearly 1½ times as long as broad; smooth and shiny with an indistinct sculpture. Metanotum (post-notum) not distinct and is fused

with the first abdominal tergum. The tegmina are short truncated flaps devoid of veins and extend backwards covering the first and nearly the whole of the second abdominal segment. Hind wings same as in female. Fore and middle legs nearly equal in size. Hind leg slightly bigger. Legs pubescent with few stiff spine like setae, claws simple.

Abdomen.—11-segmented, 8 segments clearly visible and 11th is represented by rudimentary pygidium. Tergites somewhat smooth and shiny. Tergites rugosely punctate except the 9th First sternum wanting. Sternites 2 to 9 clearly visible. 9th overlies the 10th, the latter being represented by a pair of plates at the base of the forceps. Forceps 8 mm long, much larger than in the female. Armed with a tridentate expansion towards the inner aspect of the base of forceps and a strong tooth beyond the middle directed posteriorly and a few serrations at its base.

Life History

The females lay eggs in clusters of 38 to 89 eggs per brood. In the field eggs were found deposited inside the pockets of leaf axils. The eggs in a cluster are arranged in pyramid-shaped heaps. Eggs adhere to each other as the egg shell is sticky. If disturbed they stumble down loose. But the mother earwig will soon collect the eggs and keep them in the proper position. Even if they are left undisturbed, the mother would periodically be rearranging the eggs in the brood. The red palm weevil eggs, which are elongate oval and creamy white when supplied as food in the cage, were also sometimes seen to be collected along with the eggs of the predator. The mother earwig remains near the eggs all the time, presumably to protect them from the enemies. Not even other earwigs are permitted to come near the eggs. They keep the eggs and the surroundings of the egg cluster scrupulously clean, free from dust, etc.

The eggs hatch in 6–7 days and the young nymphs invariably feed on the empty egg shell. The newly hatched young ones remain always near the mother and the latter protects the former from all possible dangers. This parental care however lasts for only 4–5 days after the emergence.

The first instar nymphs are very active. The sexes cannot also be differentiated. They do not feed on young grubs of the red palm weevil instead they thrive exclusively on their eggs. The first instar nymphal period varies from 6–10 days (average 8 days). Then ecdysis takes place by a longitudinal rupture of the exuvium and the cast skin may look like a dead nymph. The second instar period varies from 7–11 days (average 8·3 days). These nymphs feed well on eggs and also early first instar grubs of the red palm weevil. The third instar lasts for 9–19 days (average 12·7 days), and the fourth and final nymphal instar for 13–22 days (average 16·5 days). Thus the total nymphal period lasts for 45·6 days on an average with a range of 39–54 days.

The final moulting takes place after the completion of the fourth instar. Adults can be distinguished from the nymphs by the presence of well developed wings in the adults. Males are identified from the females by the presence in the males of well developed dentation in the inner aspect of the forceps and 19-jointed antenna whereas females has 20-jointed antenna.

Mating takes place at all times of the day. When more than one male is caged with a single female, they fight among themselves until only one male is left. The forceps are used as the chief weapons of defence and offence and while mating. One mating was found to be sufficient for the viable egg laying but more than one is not uncommon. Virgin females lay nonviable eggs. Males are usually seen with the females till the time of oviposition.

Preoviposition period was 20–24 days (average 21·5 days). Two to four clusters of eggs (average 3·8) were lain by these females. The first broods consisted of 65–89 (average 86·8) whereas the last brood consisted only 38 eggs. Total number of eggs laid by a single female was 114–219 (average 156 eggs). There was an interval of 20–29 days (average of 23·6 days) between subsequent broods. Postoviposition period was 11–28 days (average 18–6 days). The eggs were 90–98% viable (average 94·3%). Adult longevity varied from 22–114 days (average 66·8 days). The longevity of females was more than that of the males. Total life cycle lasted for 69–153 days (average 112·4 days). The female to male ratio was 3:2.

Feeding Rate

Rate of feeding by the predator on eggs and early instar grubs of the red palm weevil was studied and the data obtained are summarised in Table I.

Average daily consumption of eggs by the predator during its life period was 7·0, with 8·5 eggs during adult period and 5·3 eggs

TABLE I

Feeding rate of Chelisoches moris *F. on the eggs and early first instar grubs of red palm weevi*

	Average number of eggs and grubs consumed daily during different stages													
	Eggs							Grubs						
Sl. No.	1st instar	2nd instar	3rd instar	4th instar	Total nymphal period	Adult	Life period	1st instar	2nd instar	3rd instar	4th instar	Total nymphal period	Adult	Life period
1.	2·0	3·3	6·1	8·5	5·8	9·9	8·0	*	3·0	4·1	7·0	4·0	7·5	5·7
2.	1·7	3·0	4·1	7·9	5·0	10·2	7·8		3·4	4·6	8·8	4·6	6·9	6·0
3.	1·8	3·9	5·2	8·2	5·5	8·5	7·2		3·7	5·4	7·4	4·8	6·0	5·5
4.	2·0	3·2	4·6	7·9	5·2	6·9	6·1		3·8	4·1	6·4	3·8	6·2	5·4
5.	2·2	3·0	5·2	8·0	5·2	7·0	6·2		2·7	4·4	7·2	4·1	7·5	6·1
Average	1·9	3·3	5·0	8·1	5·3	8·5	6·2		3·3	4·5	7·3	4·2	6·7	5·7

* No feeding on the grubs during 1st instar.

during nymphal period 5·3 (*i.e.*, during first instar 1·9, second instar 3·3, third instar 5·0 and fourth instar 8·1). The total number of eggs consumed in its lifetime worked out to 662·4.

Average daily consumption on early first instar grubs by the predator during the entire life period was 5·7, adult period 6·7, nymphal period 4·2 (*i.e.*, nil by first instar, 3·3 by second instar, 4·5 by third instar, and 7·3 by fourth instar). Total number of early instar grubs of red palm weevil consumed worked out to 635·5 during the entire life period, *i.e.*, 442·4 during adult period, 191·2 during total nymphal period (*i.e.*, nil by first instar, 25·8 by second instar, 53·6 by third instar and 111·8 by fourth instar).

ACKNOWLEDGEMENT

Thanks are due to Shri K. V. Ahamed Bavappa, Director, Central Plantation Crops Research Institute, Kasaragod, and to Dr. (Mrs.) K. Radha, Joint Director, Central Plantation Crops Research Institute, Regional Station, Kayangulam, for the facilities provided for carrying out the studies.

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