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MORPHOLOGY OF THE LARVA OF ISOTENES MISERANA (WALKER) (LEPIDOPTERA : TORTRICIDAE)

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SUMMARY

The larval stage of the orange fruit borer (*Isotenes miserana* (Walker)) is described and figured in detail, with comparisons between first and later instars. Post-embryological changes are discussed for the head, spiracles, anal shield, anal fork, crotchets and setae.

I. INTRODUCTION

The orange fruit borer (*Isotenes miserana* (Walker)) has a wide host range in Queensland, including macadamia nuts. On these hosts it has previously been regarded as a pest of only minor importance. With increased interest in the macadamia industry, insect pests are of greater significance and amongst these *I. miserana* has assumed increased pest status.

The adult was first described as *Teras miserana* by Walker in 1863; however, it was not until 1910 that the original larval description was published (Meyrick 1910). The only other larval description (Moore 1963), unfortunately in common with that of Meyrick, was limited to only general characters such as shape and colour.

To enable field distinction of the larvae of *I. miserana* from related lepidopterous species feeding on macadamia trees, a complete morphological study of all larval stages has been made.

II. MATERIALS AND METHODS

The specimens used in these studies were obtained from a second generation laboratory culture established from material collected on *Macadamia integrifolia* Maiden and Betche from a farm on the Blackall Range in south-eastern Queensland.

Whole specimens were examined in 70% alcohol while more detailed examinations were made of slide mounts of larval skins prepared according to the technique outlined by Common (1965). First instar larvae were mounted whole in Hoyer's medium. Camera lucida illustrations were made of slided material and an eyepiece micrometer grid and squared paper were used in figuring all other structures.

The terminology and notation for lepidopterous larvae established by Hinton (1946) were used for both cranial and body setae of the larvae of *I. miserana*. The diagnostic characters for the larvae of Tortricidae as defined by Mackay (1959) were adopted as the basis for descriptions.

III. LARVAL DESCRIPTION

Body colour

Mature larvae are opaque with a body colour greenish-brown dorsally and light-grey to cream ventrally. Two longitudinal, dorso-lateral brown stripes extend from the mesothorax to the posterior end of the body, these enclosing a mid-dorsal greyish-brown or red-brown band. The head capsule is dark brown to black and the prothorax yellow-brown with dark brown lateral areas and a light grey anterior margin. Both the mesothoracic and the metathoracic segments have a dorsal, transverse, dark brown stripe which is more prominent on the mesothorax.

Mature larvae vary from 20 to 24 mm in length.

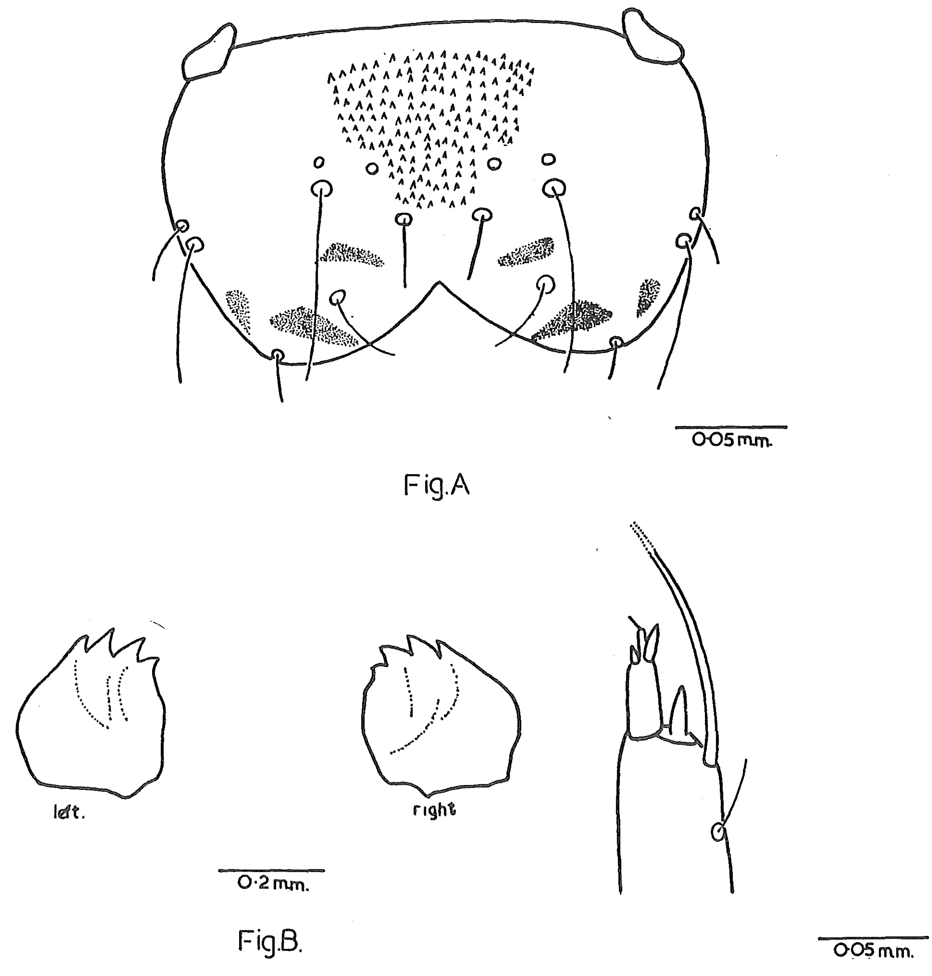


Fig. 1.—A, labrum of final instar larva. B, mandibles of final instar larva. C, antenna of final instar larva.

Head

Mouth parts.—The labrum (Figure 1,A) is a simple bilobed plate overlying the bases of the mandibles, separated from the clypeus by a small membranous area, and bearing 12 setae which appear to arise from definite tubercles. On the inner surface or epipharynx are six sensilla basiconica, three on each side, the centre one of the three being the largest.

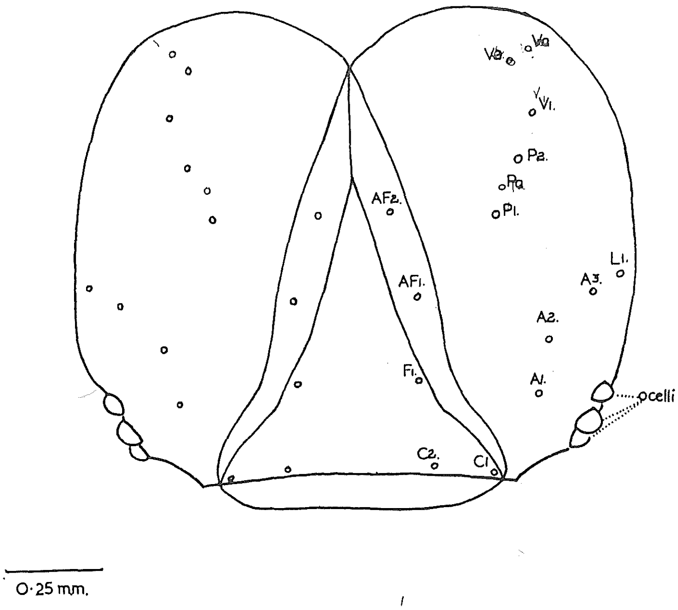
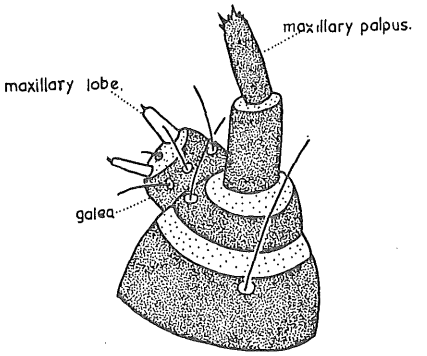


Fig. A



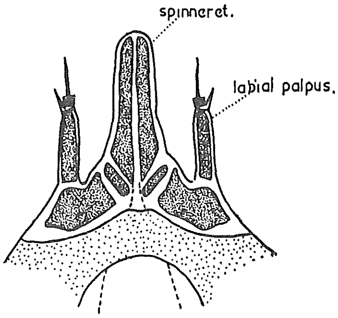


Fig. B

0·05 mm.

Fig. C.

Fig. 2.—A, dorsal view of head of final instar larva. B, maxilla of final instar larva. C, spinneret of final instar larva.

Basal parts of the maxillae and labium are united and the hypopharynx is connected to the anterior wall of the labium. The spinneret (Figure 2,C) located at the tip of the labium is approximately four times as long as wide and anteriorly bluntly rounded. The two-segmented labial palpi are approximately half the length of the spinneret; the basal segment is by far the longer with a seta arising from the tip. The distal segment bears a terminal seta.

Maxillae (Figures 2,B and 6,B) consist of a well-differentiated cardo and stripes, galeae and three-segmented palpi. At the distal end of the second palpal segment are several microscopic projections which are probably sensory in function. The large basal segments of the galeae arise mesad of the basal segments of the maxillary palpi. The tip of each galea bears two maxillary lobes and four sensory papillae.

The mandibles (Figure 1,B) are well developed and possess four denticles.

Antennae.—The antennal base arises from a pit in the head capsule. In frontal view these pits are closed in the midplane by the bases of the mandibles, while laterally they extend almost to the ocelli. The three-segmented antennae each distally bears three sensory structures (Figure 1,C).

Ocellar area (Figure 5,B).—In the ocellar area is a darkly pigmented band extending along the postero-ventral margins of ocelli II, III, IV and V.

Ocelli.—Convex, regular in outline; ocelli II, III, IV, V circular; ocelli I and VI more elliptical than circular; II closer to III than to I with III closer to IV than to II; ocelli III, IV and V almost continuous.

Ocellar setae (Figure 5,B).—Seta O_1 is either closer to ocellus III than to ocellus II or equidistant from both; O_2 postero-ventrad from ocellus I at a distance equal to two-thirds the greatest diameter of ocellus I.

Adfrontal sclerite.—Attenuated posteriorly.

Posterior and adfrontal setae (Figures 2,A and 6,A).—Seta P_1 closer to P_2 than AF_2 and equidistant from AF_2 and AF_1; P_1 positioned at the apex of a slightly obtuse angle formed with P_2 and AF_2; ratio of distance between AF_1 setae and distance between AF_2 setae is 5:2.

Anterior setae (Figures 2,A and 6,A).—Seta AF_2 is slightly closer to A_1 than A_3.

Frontal and clypeal setae (Figure 2,A).—Distance between the F_1 setae approximately equal to, or less than that between the C_2 setae; both distances greater than between F_1 and C_2.

Thorax

Prothorax.—Prothoracic spiracle circular; seta SD_1 on the prothoracic shield slightly closer to XD_2 than to SD_2 (Figure 3); the distance between D_1 and D_2 equal to that between the D_1's (Figure 5,A); D_1 setae slightly posterior to, or on a straight line joining the D_2 setae; L_1 postero-dorsal to L_2 and L_3 (Figure 5,C).

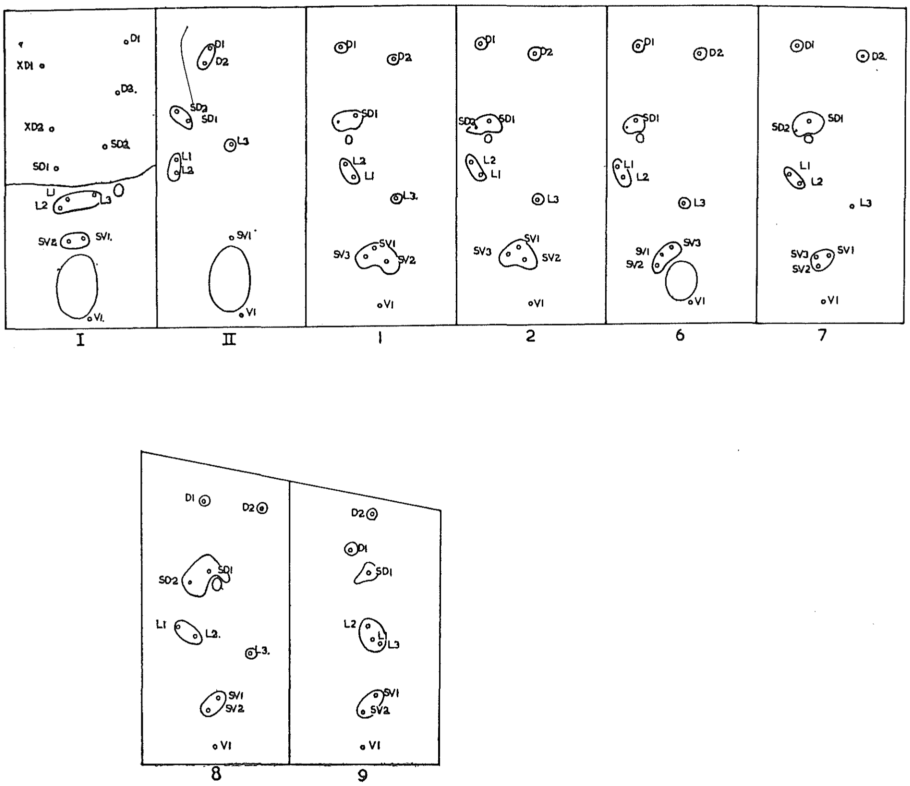


Fig. 3.—Setal map of final instar larva.

Mesothorax and metathorax (Figures 3, 4,A and 4,B).—Seta D_1 dorsad of D_2 and on the same pinaculum; setal base of SD_2 only slightly smaller than that of SD_1; SD_2 antero-dorsad of SD_1; SD_1 and SD_2 on the same pinaculum; L_1 and L_2 also on a common pinaculum; L_3 on a separate pinaculum and positioned postero-ventral from SD_1, postero-dorsal from L_1 and directly above SV_1; L_3 closer to SD_1 than L_1. Coxa of metathoracic legs much less than their diameter apart; tarsal claws of thoracic legs slender, only slightly curved, tarsal setae equal in length, dorsal to and shorter than the claw (Figures 4,A and 4,B).

Abdomen (Figures 3, 4,C, 4,D and 5,D)

On abdominal segments 1 to 8, the microscopic seta SD_2 is consistently situated on the SD_1 pinaculum.

All spiracles are circular and with the exception of that on segment 8 all are slightly larger than a setal base; spiracle on segment 8 situated midway between the anterior and posterior margins of the segment. Seta SD_1 antero-dorsal to this spiracle and less than the spiracular diameter from it; SD_2 microscopic, situated anterior to and slightly dorsal from the spiracle on the same pinaculum as SD_1; SD_2 anterior to and slightly ventral from SD_1; on abdominal segments 1-8, L_1 and L_2 situated below the spiracle with L_2 slightly anterior to a vertical line drawn through the spiracle L_1 postero-ventral to L_2; on segment 9, D_1, D_2 and SD_1 on separate pinaculae, D^2 postero-dorsad of D_1 which is antero-dorsad to SD_1; the lateral group of setae on this segment consists of three setae sharing a common pinaculum; L_2 the most dorsal and anterior of the three, L_3 the most ventral and posterior; L_1 slightly closer to L_3 than L_2 and antero-dorsad of L_3.

On abdominal segments 1, 2, 7, 8 and 9 the SV group consists of 3, 3, 3, 2 and 2 setae respectively; on abdominal segments 1 and 2 little change in the relative positions of SV_1, SV_2 and SV_3, with SV_1 *postero-dorsad* of SV_3 and antero-dorsad of SV_2, and SV_3 anterior to and slightly dorsal from SV_2.

On segment 6, however, SV_3 is postero-dorsad of both SV_1 and SV_2. A line drawn through the three setae forms an anteriorly directed arc with SV_3 at the top of the arc and SV_2 at the bottom. On segment 7 the relative positions of the SV setae are again changed:—SV_3 almost directly anterior to SV_1 and dorsal to SV_2. On segments 8 and 9 the SV group consists of only SV_1 and SV_2 with SV_1 postero-dorsad of SV_2; on segment 9, V_1 setae more or less as far apart as those on segments 7 and 8.

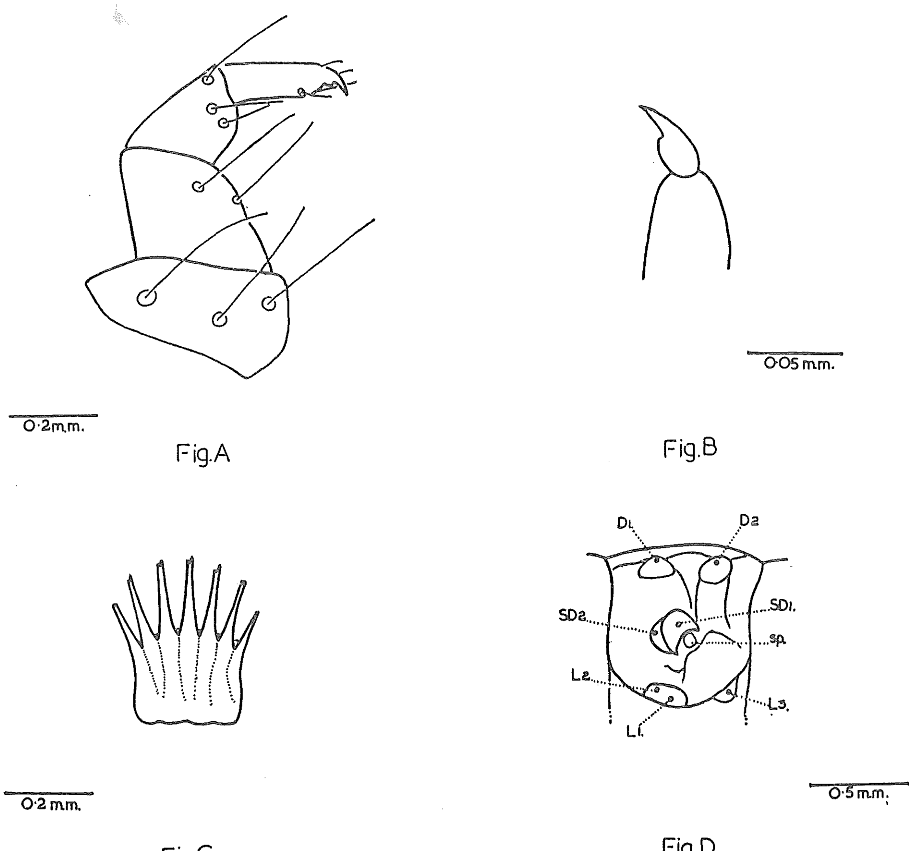


Fig. 4.—A, thoracic leg of final instar larva. B, tarsal claw of final instar larva. C, anal fork of final instar larva. D, lateral view of 8th abdominal segment of final instar larva.

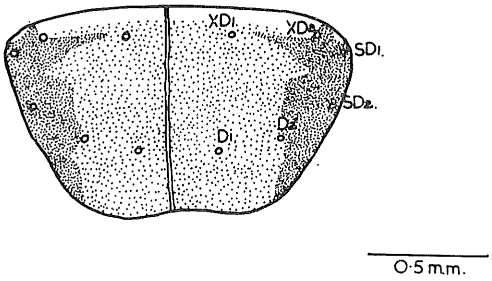


Fig.A.

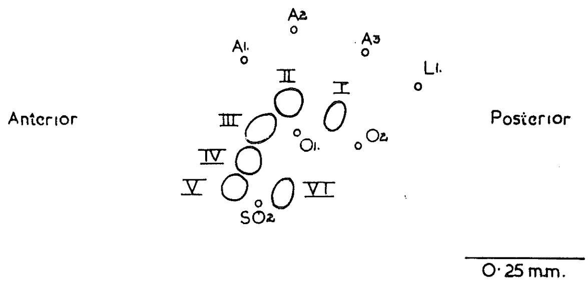


Fig.B.

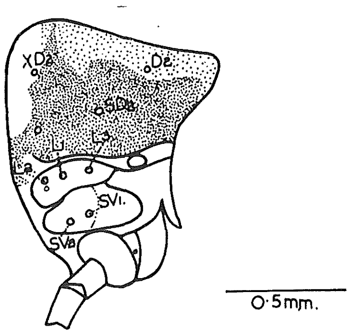


Fig.C..

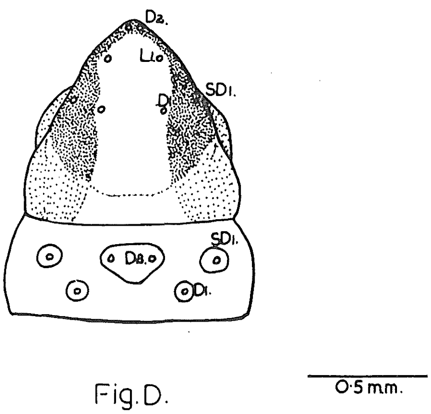


Fig.D.

Fig. 5.—A dorsal view of prothoracic shield of final instar larva. B, ocelli and associated setae of final instar larva. C, lateral view of prothorax of final instar larva. D, dorsal view of anal shield of final instar larva.

D

Anal Shield (Figure 5,D).—Tapered posteriorly; length of seta L_1 approximately twice that of the anal segment, the distance between the L_1 setae slightly less than that between those of D_1; distance between L_1 and D_1 equal to that between the L_1 setae; length of SD_1 greater than that of D_1; the D_1 setae slightly anterior to and closer to the midline than SD_1; the length of D_2 approximately half that of L_1.

Crotchets.—Uniserial, multiordinal.

IV. DISCUSSION

As now generally accepted, the family Tortricidae contains two subfamilies, Olethreutinae and Tortricinae. According to present knowledge these cannot be separated on larval characters alone (Mackay 1962). The subfamily Tortricinae includes among others the tribes Archipini and Sparganothini, which are considered by Mackay (1963) to be the more highly specialized. On the basis of adult characters *I. miserana* belongs to the tribe Archipini, but on larval characters past workers could not readily separate the Archipini and Sparganothini and this difficulty is typified by the larva of *I. miserana.*

Two characters which have been used to distinguish these two tribes are the positions of the V_1 setae on segment 9 in relation to those on segments 7 and 8 and to a lesser degree the position of P_1 on the head in relation to AF_2 and P_2 Typical archipine larvae have V_1 setae on segment 9 more or less as far apart as those on segment 8, but if farther apart than those on segment 7 then only slightly so; and P_1 on the head is at the apex of an acute angle formed with P_2 and AF_2 and is either equidistant from P_2 and AF_2 or closer to AF_2. Larvae of *I. miserana* have the V_1 setal character but the position of P_1 in relation to P_2 and AF_2 is typically that of a sparganothine; i.e. P_1 is at the apex of an obtuse angle formed with P_2 and AF_2 and seta P_1 is closer to P_2 than AF_2. Mackay (1962) found similar inconsistency in several other species of the tribe Archipini.

The following characters nevertheless leave no doubt that *I. miserana* belongs to the Archipini: Seta SD_2 on abdominal segments 1–8 on SD_1 pinaculum; seta D_1 on segment 9 on its own pinaculum; SV setal group on abdominal segments 1, 2, 7, 8 and 9 usually 3:3:3:2:2. The tapered anal shield, generally found associated with a leaf rolling habit, is also typical of the Archipini.

V. COMPARATIVE MORPHOLOGY OF FIRST AND LATER INSTAR LARVAE

Following on the statement by Mackay (1963) that a true understanding of the evolution of the morphological characters of the tortricid larva and hence of the phylogeny of the various species requires a study of the early as well as the late instars, postembryological changes in larvae of *I. miserana* are discussed for the head, spiracles, crotchets, anal shield, anal fork and setae.

The ocellar areas of the first instar head appear to be as angular as those in later instars, and their relative size and position in the first instar indicate their size and position in the final instar. Also there is very little if any change in the relative positions of the ocellar setae from first to final instar (Figures 6,A and 6,B).

The relative length of the spinneret remains constant through several larval instars of *I. miserana*. In some noctuid larvae silk-spinning was not equally developed in all instars and this corresponded to an unequal development of the spinneret (Ripley 1923). This would indicate that the silk-spinning habit in *I. miserana* is equally developed in all larval stages.

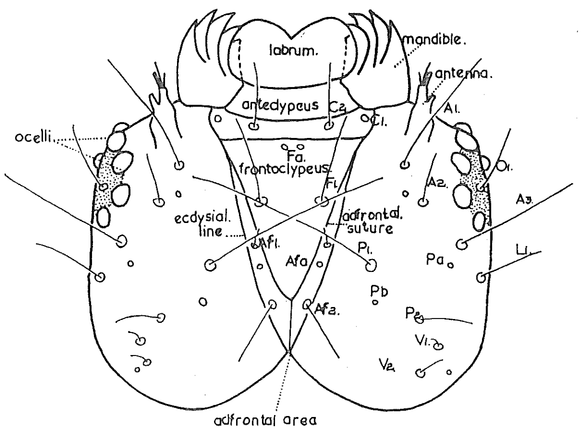
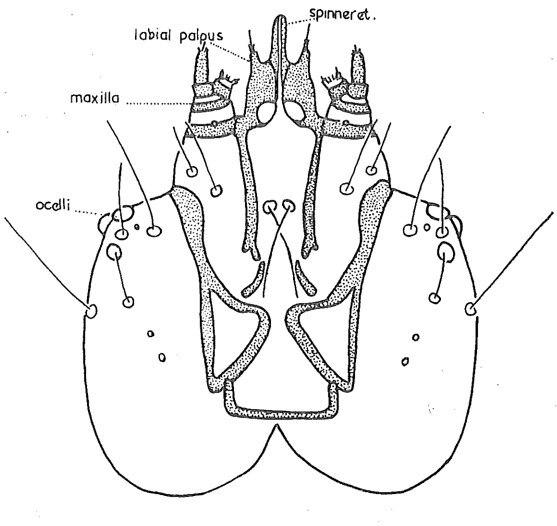


Fig. A.



0·05mm.

Fig.B.

Fig. 6.—A, dorsal view of head of first instar larva. B, ventral view of head of first instar larva.

The spiracles on abdominal segments 2 to 8 of the first larval instar are circular in shape. On segments 2 to 7 they are larger than a setal base, but on segment 8 the diameter is approximately twice that of a setal base.

The crotchets of the first instar are uniordinal and consist of eight small sclerotized hooks.

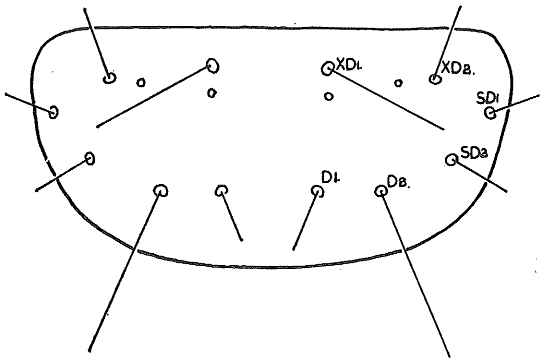


Fig. A

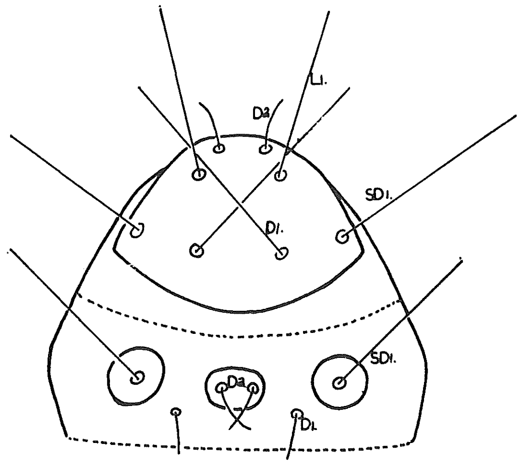


Fig. B.

0·05 mm.

Fig. 7.—A, dorsal view of prothoracic shield of first instar larva. B, dorsal view of anal shield of first instar larva.

The anal shield (Figure 7,B) is tapered in the final instar but does not appear so in the first instar, in which it is rounded posteriorly.

The anal fork is present and well developed in all larval instars. It is used in ejecting frass from the feeding shelters.

The primary setae, i.e. the setae which are present on both the first and final instars, occupy the same relative positions in all instars. The sub-primary setae, i.e. the setae which are absent on the first instar but present on later instars, are as follows:—

SUB PRIMARY SETAE		
Thorax ..	.. Prothorax ..	.. L_3
	Mesothorax ..	.. L_2 and L_3
	Metathorax ..	.. L_2 and L_3
Abdomen	.. Segment 1 ..	.. L_3 and SV_3
	Segment 2 ..	.. L_3 and SV_3
	Segment 3 ..	.. L_3 and SV_3
	Segment 4 ..	.. L_3 and SV_3
	Segment 5 ..	.. L_3 and SV_3
	Segment 6 ..	.. L_3 and SV_3
	Segment 7 ..	.. L_3 and SV_3
	Segment 8 ..	.. L_3
	Segment 9 ..	.. L_3 and SV_2

The microseta SD_2 is primary and on the same pinaculum as SD_1. On abdominal segments 1 to 9 the SD_2 setae are minute and not as prominent as the SD_2 setae present on the thorax.

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