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LARVAL MORPHOLOGY OF *OGYGIOSES CALIGINOSA* FROM TAIWAN (LEPIDOPTERA: PALAEOSETIDAE)

J. B. HEPPNER,[1] M. A. BALCÁZAR-L.,[1,3] AND H. Y. WANG[2]

[1]Florida State Collection of Arthropods,
DPI, FDACS, P. O. Box 147100, Gainesville, Florida 32614, USA; and
[2]Taiwan Museum, Siangyang Road, Taipei 100, Taiwan

ABSTRACT.– The 1st instar larva of *Ogygioses caliginosa* Issiki & Stringer is described from Taiwan. This is the first information on larvae of the family Palaeosetidae, being only the second family in Hepialoidea where such data are known. Special features of *Ogygioses* larvae include a prognathous head with a clypeus protruded over the labrum, stemmata numbering only 3, and compact antennae recessed into circular cavities. Also unusual are the circular spiracles with encircling rings. Larval characters conform to Hepialoidea, although more specialized. In comparison to Palaeosetidae larvae, larval characters are summarized for other families of primitive Lepidoptera where larvae are known.

KEY WORDS: Acanthopteroctetidae, Agathiphagidae, Anomosetidae, Asia, Assam, Australia, behavior, chaetotaxy, Chile, ecology, Eriocraniidae, Europe, *Genustes*, habitat, Hepialidae, *Hepialus*, Heterobathmiidae, India, Lophocoronidae, Micropterigidae, Mnesarchaeidae, moss, Neopseustidae, Neotheoridae, Neotropical, Oriental, *Palaeoses*, Prototheoridae, Queensland, rainforest, thanatosis.

The family Palaeosetidae is one of the rarer families of Lepidoptera and one for which the immature stages have been unknown. The family is represented by only 6 species: 4 in Asia, 1 in Australia, and 1 in the Neotropics (Chile). The only biological reports on *Ogygioses* have been that of an earlier paper by the senior author (Heppner, 1987) and a report by Kuroko (1990) on the adult behavior of the Taiwan species, *Ogygioses caliginosa* Issiki & Stringer. The earlier paper (Heppner, 1987) reported on moths studied in July 1985, at Fennchihwu, Chiayi Co. (1450m elev.). The moths also occur in late March and again in early May at lower elevation near Liukuei, Kaohsiung Co., indicating a multivoltine life history; this attribute interesting for a primitive moth, since the norm is a single generation per year in other families such as Eriocraniidae.

Notes published on *Palaeoses scholastica* Turner indicate preference for similar habitats in rainforests at about 1000m in Queensland, Australia (Turner, 1922). Issiki and Stringer (1932) named both Taiwan species of *Ogygioses*, as well as the Indian *Genustes* from Assam, but gave no biological data. The adults of this family have the unusual behavior of resting upside down under various leaves in shady forested streamside areas of high humidity; they also feign death (thanatosis) by dropping to the ground litter when frightened (Heppner, 1987).

After numerous trips to Taiwan since 1982, a few sites have been discovered where adults of this and a related Taiwan species (*Ogygioses eurata* Issiki & Stringer) can regularly be found. In 1989, the senior author succeeded in obtaining eggs from live females of *O. caliginosa*, with subsequent emergence of 1st instar larvae. Adult females of *O. caliginosa* were collected in early May 1989 at Shanpen Forest Station, near Liukuei, Kaohsiung Co., southcentral Taiwan (elev. 700m). Adults of both sexes congregated along moss-covered banks along a streamside trail, with water seepage and spray to keep most moss wet. Females laid eggs on May 8, 1989, and the larvae hatched within a few days. The larvae were offered various primitive foodplants, but only mosses appeared to be acceptable. Larvae appeared to feed on mosses, with growth observed in two larvae, but further rearing of these larvae was not successful, possibly due to the rearing techniques: the wet moss made tracking of larvae difficult and they were lost in the masses of moss. It is possible that these larvae bore into the hostplant or feed on the roots like Hepialidae, but a search of the moss used proved unsuccessful in locating the missing larvae. The actual hostplants of this species may, however, be among more advanced plants, since some known primitive moths also feed on such higher plants as oaks (e.g., Eriocraniidae).

A few 1st instars were preserved in alcohol, along with eggs, and this report is based on these specimens. The black eggs will be reported on, along with the larva, by D. R. Davis, Smithsonian Institution, in another paper (Davis *et al.*, 1995). In the present paper, descriptions and line drawings are by J. B. Heppner, while larval preparation and SEM photographs are by M. A. Balcázar.

FIRST INSTAR LARVA

The SEM photographs show the main features of the 1st instar larva of *O. caliginosa*. The larval specimens were not in the best condition and critical point drying was used to prepare them for

1. Contribution No. 824, Section of Entomology, Division of Plant Industry, Florida Dept. of Agriculture & Consumer Services, Gainesville, FL.

3. MANUEL BALCÁZAR, present address: Depto. de Zoologia, Inst. de Biologia, Universidad Nacional Autónoma de México, A. P. 70-153, Mexico City, 04510 D.F., Mexico.

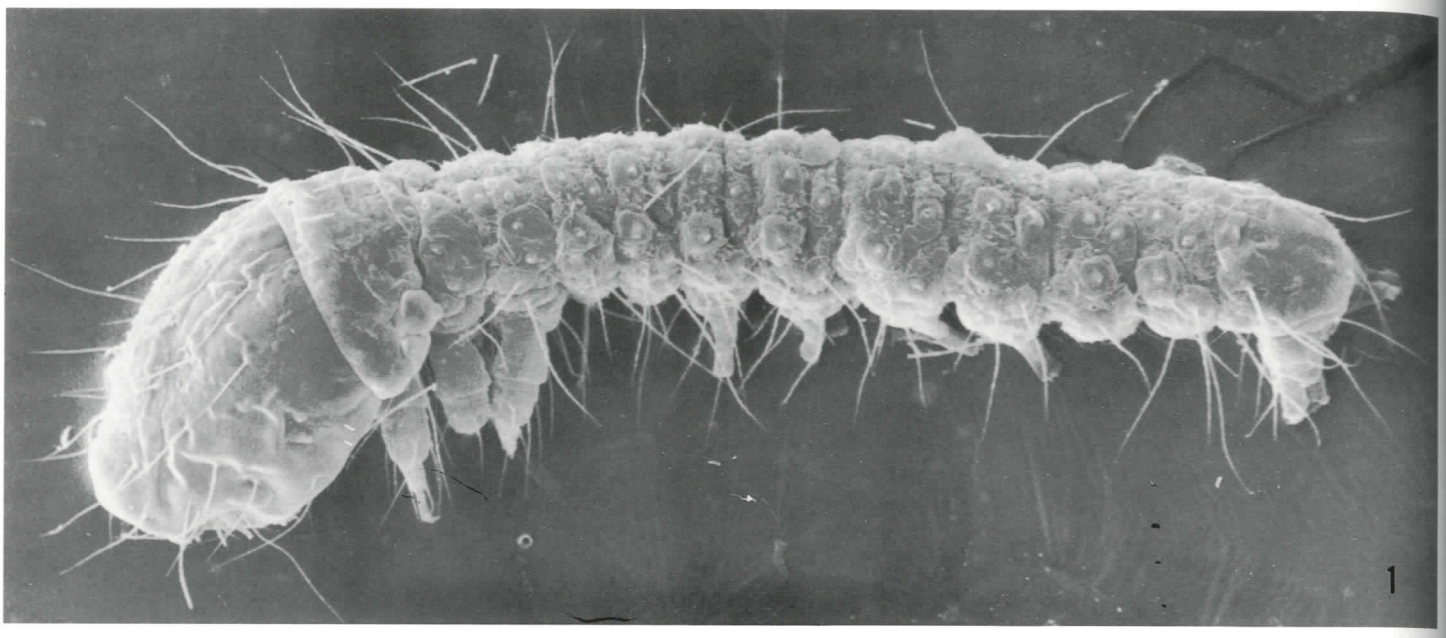

Fig. 1. First instar larva of *Ogygioses caliginosa*: lateral view (length = 1.4mm) (155x).

SEM study. The line drawings show the head and body chaetotaxy of the larva more clearly. The overall length of the larvae studied averaged 1.4mm (these are larvae that have just emerged and not increased in size by any feeding). Larvae observed on moss, which had apparently fed, grew to about 3mm before being lost. Coloration of living larvae is a pale and translucent tan color, becoming somewhat more orange after feeding.

HEAD: prognathous (Fig. 2-3, 10), large, dorso-ventrally relatively flattened but rounded in front view, with clypeus extended over labrum; epicranial suture thick, about half length of head; frons to one-third of head length, with frons seta F1; adfrontal area wide and undulated; 2 adfrontal setae close together; clypeus very wide and merged with head laterally, with seta C1 each side of clypeus and C2 on lower frons; labrum simple and relatively short, partially hidden under clypeus; mandible large (unstudied); maxillae and labium (Fig. 4) large, with long maxillary seta; stemmata (Fig. 5) apparently 3, with stemma 1 and stemma 2 large and touching, and stemma 3 small; antenna (Fig. 5) very compact and extremely recessed within a circular cavity near stemmata 1 and 2; head setae with A1 near stemma 1, A2 between adfrontal suture and A1, and A3 shifted distant to near P2, forming an oblong triangle; setae P1 and P2 nearly in line with epicranial suture and close thereto; seta S2 stemmata 1-2, S3 distant to posterior, and S1 near the antennal cavity; seta SS1 near stemma 3, SS2 to ventrad posterior of S3, and SS3 posterior to SS2; seta L1 distant from S2 and S3.

THORAX (Fig. 11): thoracic legs (Fig.) normal, each with large terminal claw; prothorax with large dorsal shield, with setae lined along the anterior margin, with apparent D1, XD1, XD2 and SD1 setae; L-group trisetose with L1 and L3 near to spiracle, L2 distant anteriorly, all seemingly on pinaculum fused with dorsal shield (this remains unclear); spiracle a simple circle with an encircling ring; SV group as three setae, with SV1 and SV3 closer to spiracle than anteriorly distant SV2; apparent V group as single seta near coxa; meso- and metathorax with D1 and D2 near each other, SD seta singular, L1 a single seta about in spiracle position, and SV single near coxa.

ABDOMEN (Fig. 1, 11): chaetotaxy with D1 closer to mid-line than D2 on segments A1-9 and on pinacula based on larger body plates (except on A9, where only the pinacula are evident); SD setae singular (on pinacula and body plates as dorsal setae); L setae evident as singular on A1-2 and A9, bisetose on A3-8 (on pinacula); SV setae singular, except for A3-6 where they are trisetose (on pinacula); segment A10 (Fig. 9) normal, with 2 prominent lateral setae and triangular, flat anal plate; prolegs (Fig. 7) long and slender on segments A3-6 and A10, each with uniordinal crochets few in number in uniserial circles, except for anteriorly directed penellipse on A10 prolegs; spiracles (Fig. 8) a simple circular opening on a flattened ring, present on A1-8, with spiracle on A8 slightly larger than on other body segments.

REMARKS

Among the most striking features of the larva of *Ogygioses* are the form of the head and its morphology, plus the unusual spiracles on the body. The head has a peculiar protrusion of the clypeus over the somewhat retracted labrum, reminding one of some of the leaf-mining larvae, but none has such a distinctive configuration, since usually the labrum is more prominent. The compact and recessed antennae are another unusual feature, being similar only in Agathiphagidae and Acanthopteroctetidae, among primitive families where the larvae are known. Eriocraniidae also have larval antennae in compact form, but they are not recessed (Davis, 1978). The most primitive Lepidoptera, Micropterigidae, contrarily have very long larval antennae (Davis. 1987). The compact antennal complex, being recessed, would indicate that *Ogygioses* larvae may be borers, although many borers among more advanced families do not have recessed antennae. However, the long legs would indicate external leaf feeding. Among Hepialoidea, only the Hepialidae and Palaeosetidae larvae are now known, and in Hepialidae the larval antennae are normal (i.e., similar in length to higher Lepidoptera). However, 1st instars of Hepialidae appear similar to the *Ogygioses* 1st instar (compare

Fig. 2-5. Larval morphology of *Ogygioses caliginosa*: 2) head and thorax, lateral view (245x); 3) head, frontal view (285x); 4) labium and maxillae, ventral view (650x); 5) close-up of antenna and stemmata (1380x).


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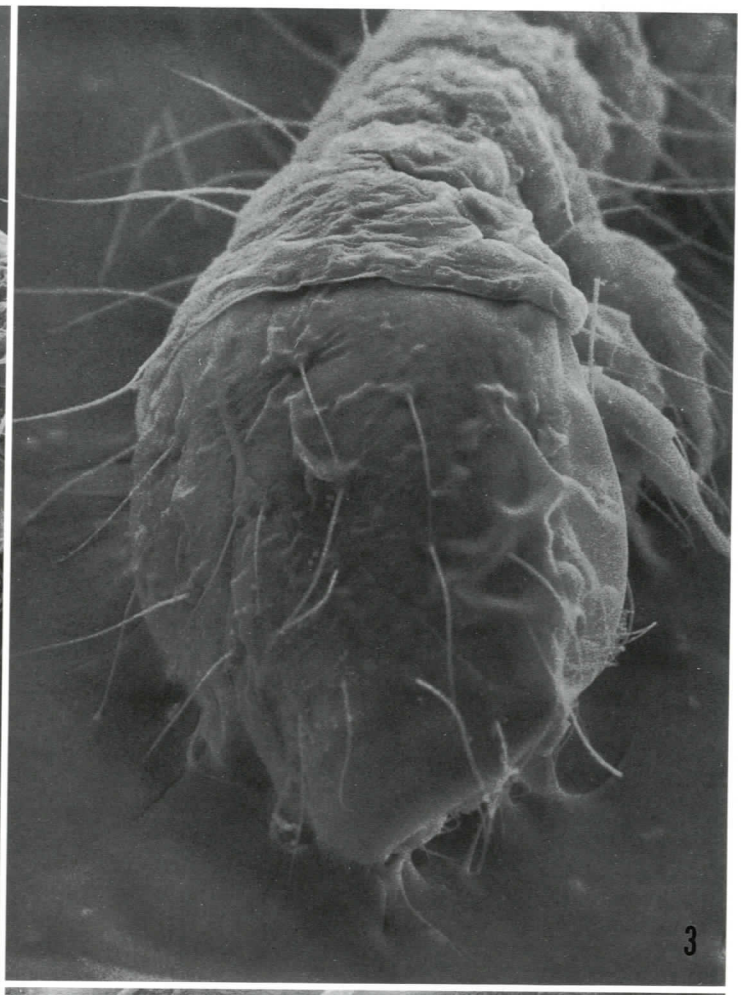
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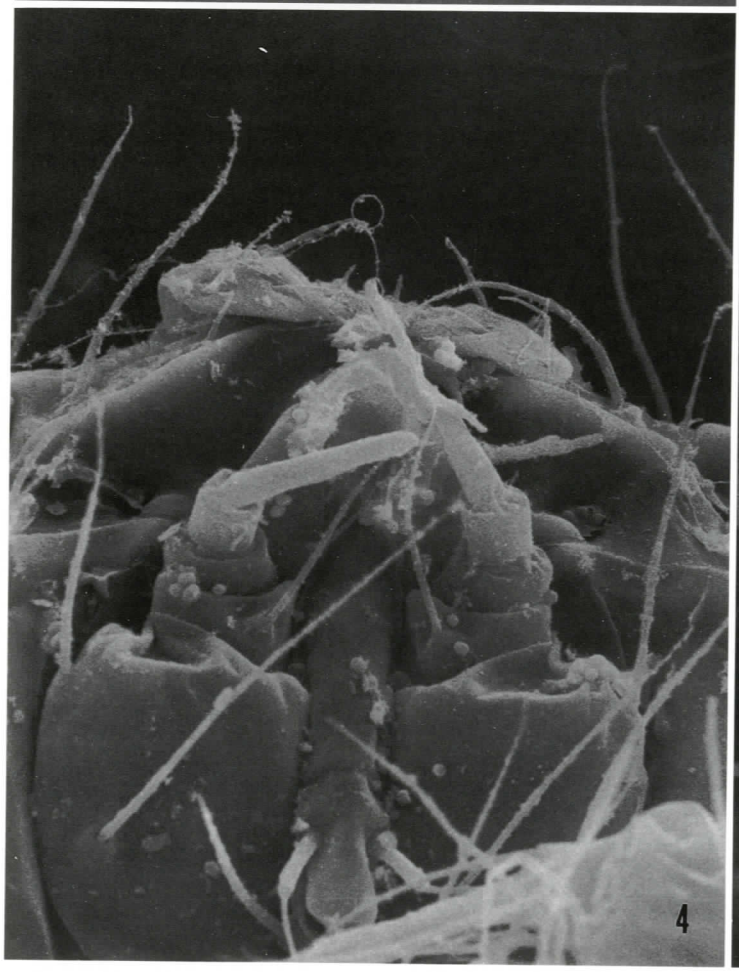
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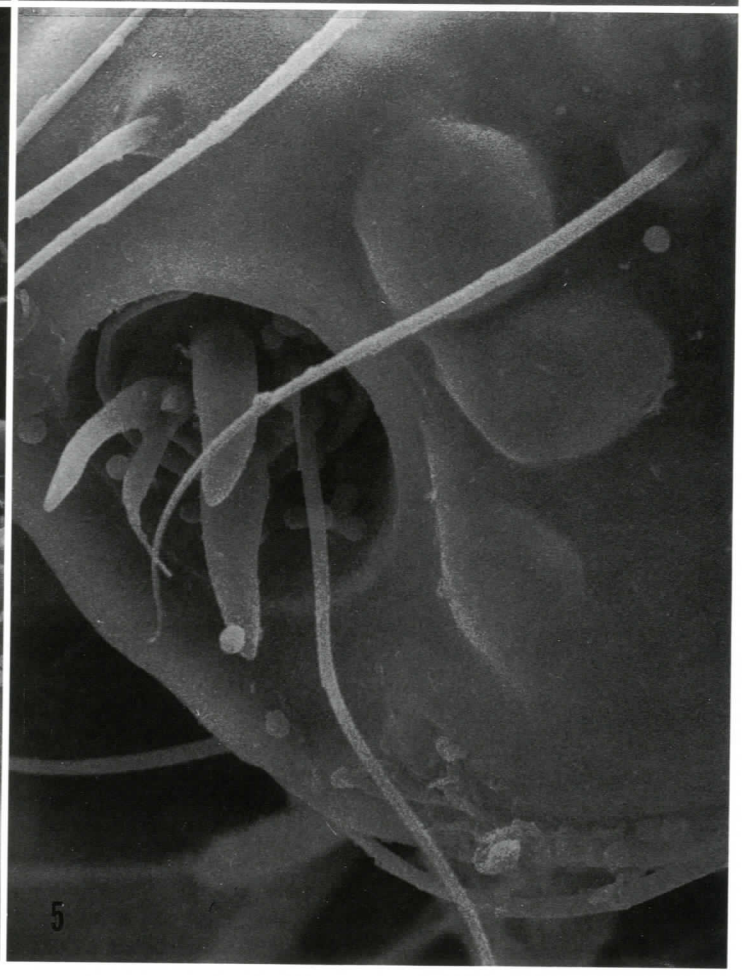
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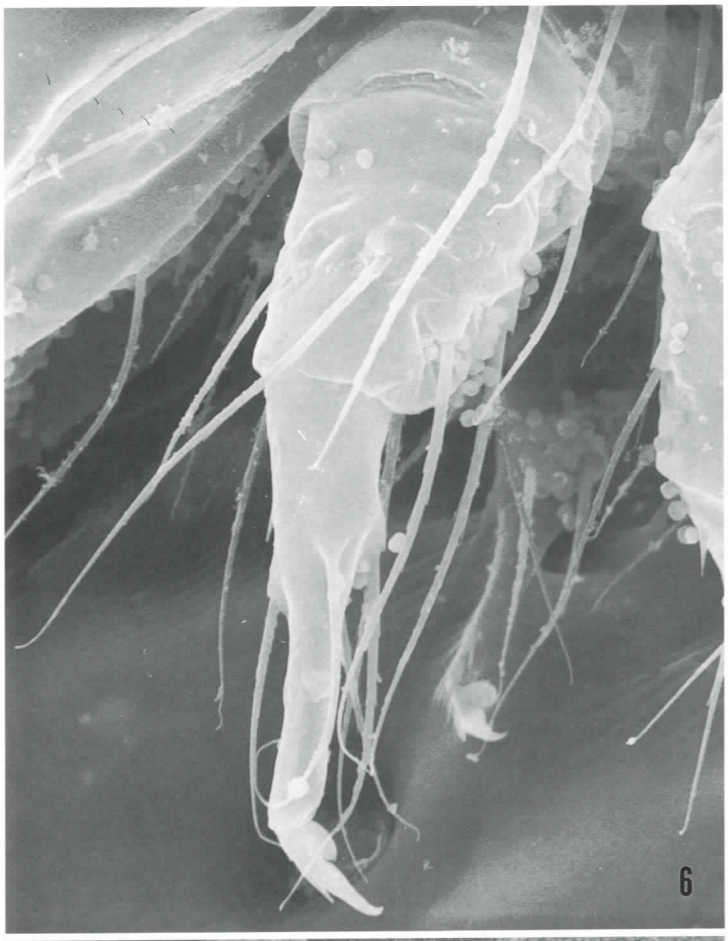
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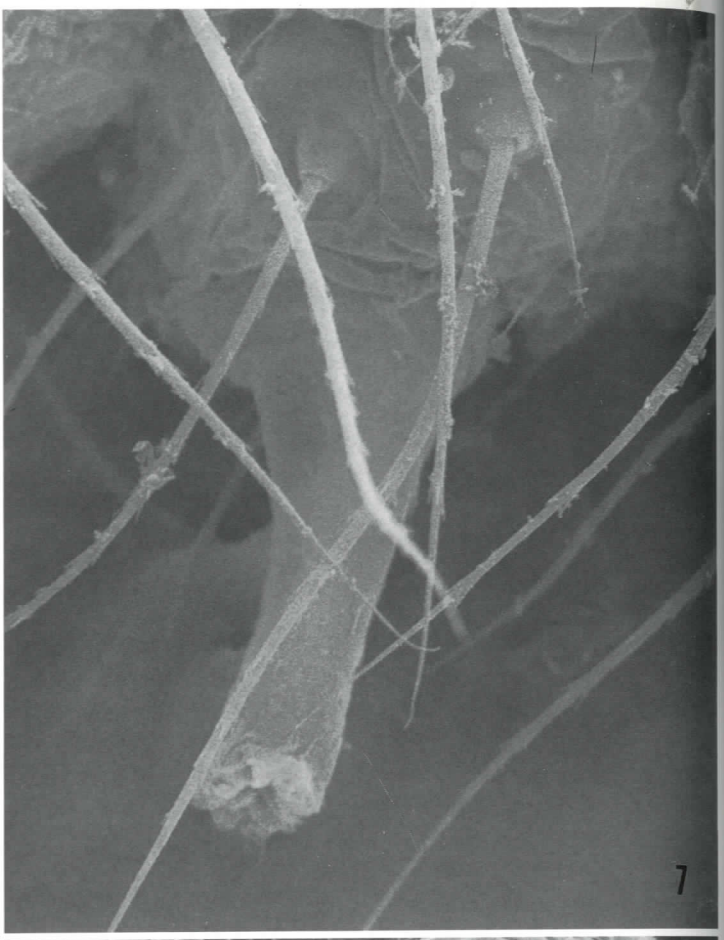
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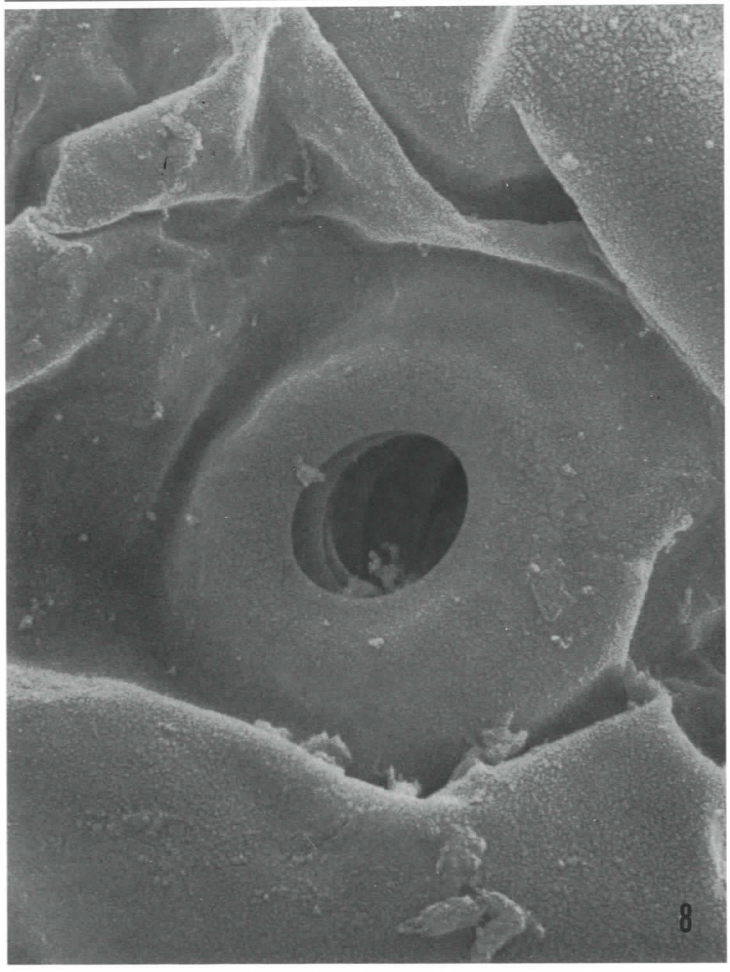
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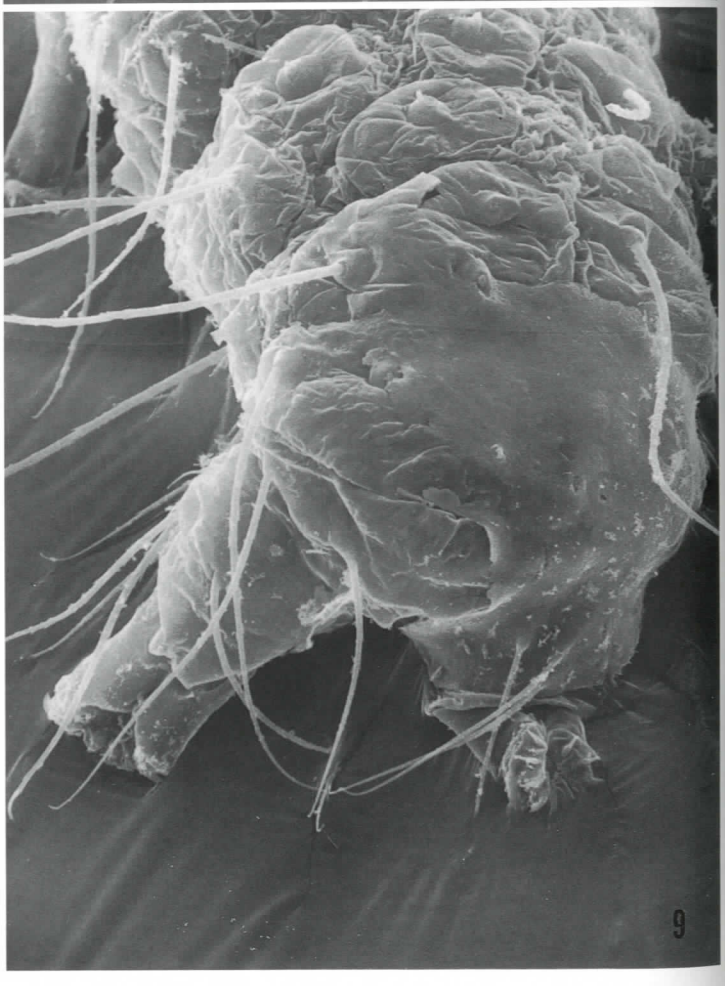
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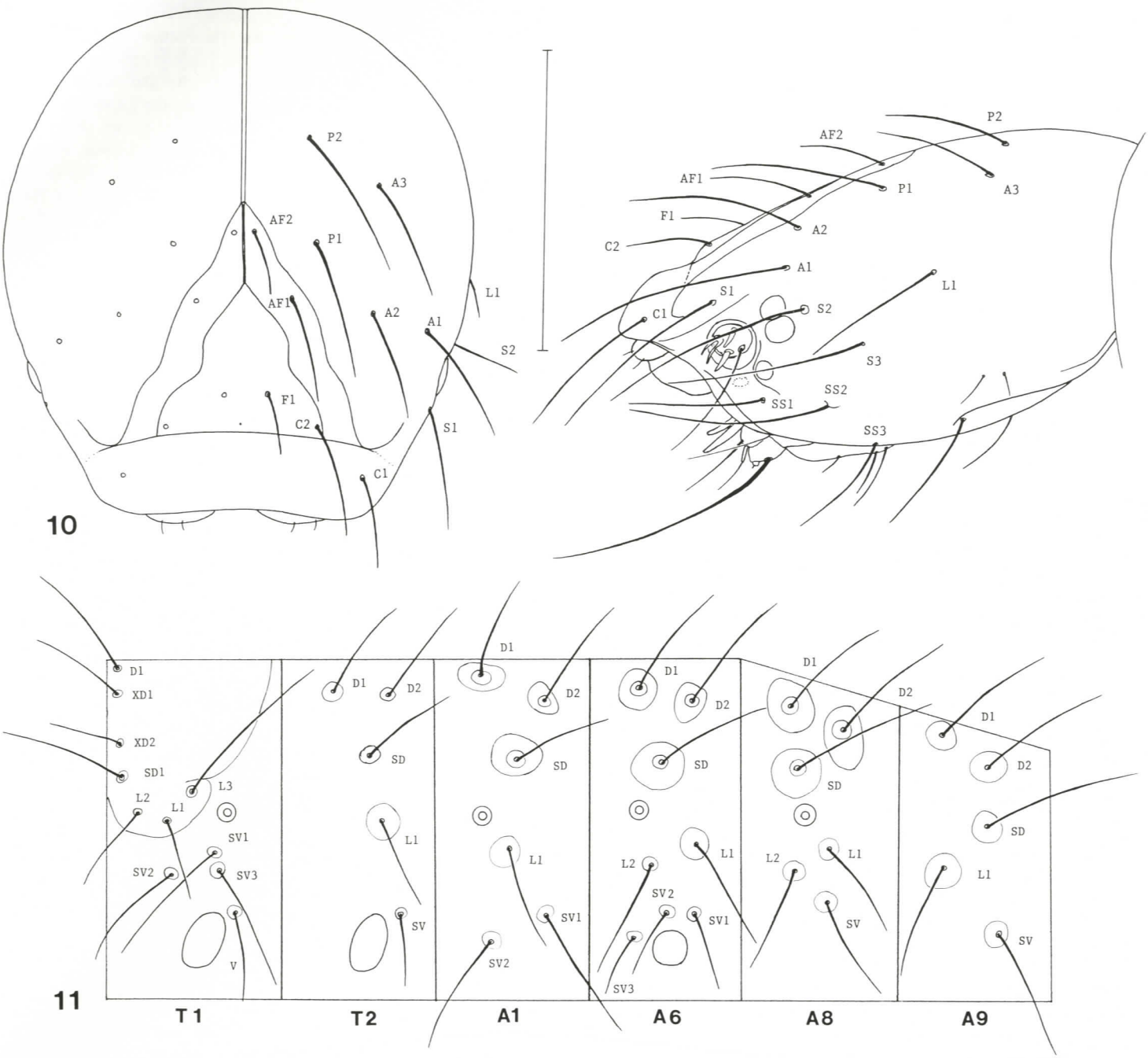

Fig. 10-11. Larval morphology of *Ogygioses caliginosa*: 10. Head, front view (left) and lateral view (right). (scale = 0.25mm) (drawing JBH). 11. Chaetotaxy.

Hepialus hecta (Linnaeus), of Europe, as illustrated by Schierbeek, 1917; see Fig. 12 below).

The reduced stemmata number is also of particular interest, since the usual number is 6 in Lepidoptera and few other known families have larvae with a varied stemmata number. Eriocraniidae larvae have only a single stemma (Davis, 1978); Micropterigidae have 5, Heterobathmiidae have 7, and Agathiphagidae have no stemmata evident. Available larval specimens of *Ogygioses* appear to have only 3 stemmata but also show what appears to be a possible 4th stemma, although this is taken to be an artifact at this time; more specimens will be needed to clarify this.

Fig. 6-9. Larval morphology of *Ogygioses caliginosa*: 6) prothoracic leg (810x); 7) proleg on A3 (1050x); 8) close-up of spiracle on A1 (5670x); 9) posterior view of larva (485x).

The unusual spiracles of *Ogygioses* are small round openings, which are also common to other primitive families known, but in Palaeosetidae the added encircling ring is unusual (Fig. 8) (Davis, pers. comm., also reports seeing this in some Tineoidea).

The following is a brief overview of key larval features of primitive Lepidoptera families where larvae are known, listed in phylogenetic order (data summarized from Stehr (1987) and Heppner (1995), where further references to papers detailing characters are also noted).

MICROPTERIGIDAE: head somewhat prognathous; 5 stemmata; antenna long and exposed; prothoracic L-group unisetose; thoracic legs reduced (with large claws); prolegs reduced.

AGATHIPHAGIDAE: head prognathous; stemmata absent; antenna short and recessed; prothoracic L-group unisetose; thoracic legs reduced; abdomen apodous.

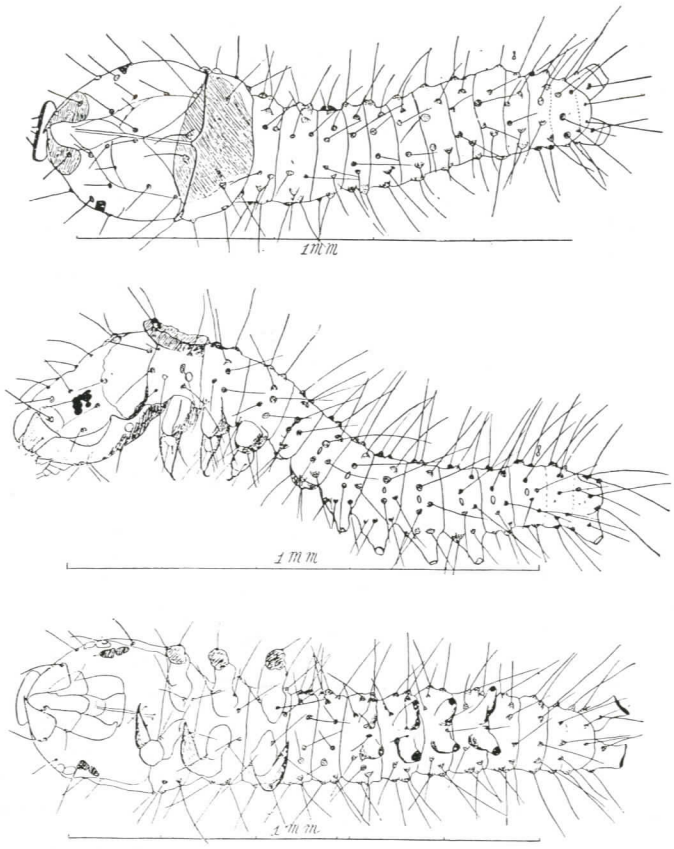

Fig. 12. *Hepialus hecta* (Linnaeus) (Hepialidae), Europe, 1st instars: dorsal view (top); lateral view (center); ventral view (bottom) (after Schierbeek, 1917).

HETEROBATHMIIDAE: head prognathous; 7 stemmata; antenna short; prothoracic L-group absent; thoracic legs short; prolegs reduced to calli.

ERIOCRANIIDAE: head prognathous; 1 stemma (rudimentary); antenna reduced and compact; prothoracic L-group trisetose; thoracic legs as calli; abdomen apodous (wart-like exoskeleton).

ACANTHOPTEROCTETIDAE: head prognathous; 6 stemmata; antenna compact and slightly recessed; prothoracic L-group bisetose; thoracic legs as calli; abdomen apodous except A10 (crochets absent).

HEPIALIDAE: head hypognathous (slightly prognathous); 6 stemmata; antenna short (normal; similar to higher Lepidoptera); prothoracic L-group trisetose (on dorsal shield); thoracic legs normal; prolegs normal, with multiserial crochets in uniordinal circles.

PALAEOSETIDAE: head prognathous; 3 stemmata (possibly 4); antenna compact and recessed; prothoracic L-group trisetose, appearing all on dorsal shield; thoracic legs normal (claw large); prolegs long and slender, with few uniserial crochets in uniordinal circles (except A10, with crochets in anteriorly directed penellipse).

Primitive families whose larval morphology and biology remain unknown include Lophocoronidae, Neopseustidae, Mnesarchaeidae, Neotheoridae, Anomosetidae, and Prototheoridae.

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