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DESCRIPTION OF LARVA OF *APHANOCEPHALUS*
HEMISPHERICUS WOLLASTON, WITH THE
 RELATIONSHIP OF THE RELATED GENERA
 (Coleoptera: Notiophygidae)

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The Notiophygidae is primarily tropical in distribution, with a few species occurring in the Temperate Zone. Though it has generally been referred to Colydiidae together with Ceryloninae, widely different views have hitherto been proposed with regard to the systematic position. However, modern tendency is to give family rank to this group on the basis mainly of the peculiar coxal structure, but there is no general agreement on the definition and phylogeny of the family. Among recent taxonomic works, the most important account is that of John (1954) which deals with the world's genera and species, but his classification is based primarily on morphological characters of the adults. While referring to the larva, there have been only three genera (i. e. *Notiophygus*, *Discoloma* and *Cassidoloma*) adequately described by van Emden (1932, 1938, 1957).

The purpose of the present paper is to describe the larva of *Aphanocephalus hemisphericus* Wollaston and to review the larval morphology of the Notiophygidae.

Before going further, I wish to express my sincere thanks to Professor Hajime Uchida of Hirosaki University and Professor Michio Chûjô of Kagawa University for their kind guidance in the course of the present study.

Mature larva of *Aphanocephalus hemisphericus* Wollaston

General features. Length up to 2.8 mm., maximum breadth 1.7 mm. Body elliptical, limpet-like; dorsal surface gently convex, dirty yellowish gray, with irregular lines and groups of microscopic granules, forked hairs and deciduous funnel-shaped scales; the inner half of thoracic outer part and the anterior part of abdominal segments 8-9 dirty yellowish brown; meso- and metanota each with a pair of paramedian, pale-coloured patterns (Text-fig.). Ventral surface flat or slightly convex, dirty white; cuticle densely clothed with microscopical granules and provided with a few extremely short, fine setae sparsely; segmental sutures indistinct.

Head. Head completely unseen from above. Wider than long and less depressed, widest behind middle, with moderately rounded sides. Clypeus round trapezoid in form, with a transverse row of four setae (Pl. 1, Fig. 7). Labrum distinctly separated from clypeus, semi-elliptical (Pl. 1, Fig. 2); anterior margin with dense minute setae; each anterior angle with a few inwardly directed stiff

setae; disc with eight pairs of long setae. Epicranial suture lyre-shaped, its hind margin reaching to occipital suture; metopic branch absent. Posterior area of epicranium with about four setae in a longitudinal row and anterior area with a few scattered, short setae on each side. Frons furnished with eight setae along antero-lateral margin and its anterior angles feebly projected.

Ocelli three on each side, of these, two being arranged in a longitudinal line near the base of antenna, and the remaining one placed on the ventral side of the antennal base. Antenna two-segmented, rather long, placed on a large circular basal process; 1st segment short and robust; 2nd long and spindle-shaped, having a spiniform appendage and three minute conical processes apically; the relative length of its segments as 5:18. Mandible (Pl. 1, Fig. 6) symmetrical; incisor lobe consisted of three pointed teeth; molar lobe quadrate, with about six transverse rows of granules and its asperities not extending to inner part of ventral surface; the base of mola fringed with several setae; prostheca broad and hyaline, with a distal part acutely pointed. Maxilla (Pl. 1, Fig. 3) with cardo subquadrate. Stipes triangular, with two setae near outer margin ventrally; mala slender, tapering apically and somewhat curving inwards, with inner margin slightly concave. Lacinia undeveloped, only represented by a slender cleft, bearing five long setae and a short spine on its inner margin. Galea rounded, with about 10 stout setae on its distal part, one seta near palpiger, and two setae dorsally near middle. Maxillary palpiger distinct, with one seta ventrally. Maxillary palpus three-segmented; 1st segment short and reduced; 2nd cylindrical, slightly attenuated and turning inwards to the apex, bearing four setae on the ventral side, one of these on antero-lateral part, extending beyond the 3rd segment; 3rd subequal in length to the 2nd, tapering apically and somewhat curved inwards, with a short seta on the dorsal base. Labial sclerome)(-shaped (Pl. 1, Fig. 4), bearing three pairs of setae on the basal part. Submentum and mentum not clearly demarcated; the former connected with the broad maxillary stipes and bearing a few setae on the anterior half, of which the paramedian pair the longest. Prementum consisted of an inverted triangular median part and the separate basal segments of the

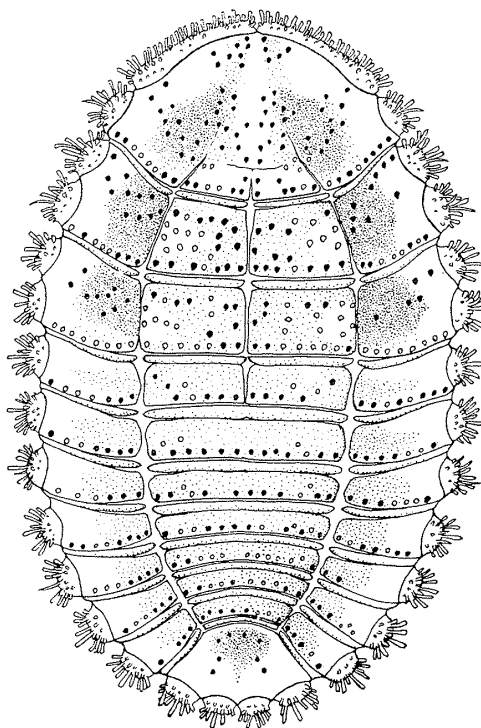


Fig. 1. Larva of *Aphanocephalus hemisphericus* Wollaston. Dorsal view.

labial palpi; the median part bears a pair of setae near distal margin. Ligula with the front margin feebly rounded, bearing a transverse row of about fourteen short spines. Labial palpus 3-segmented, 1st segment fairly developed and extended posteriorly, provided with 3-4 setae on the ventral surface; 2nd relatively short, broader than long and smooth; 3rd narrow and a little longer than the 2nd, with several sensory setae. Epipharynx (Pl. 1, Fig. 5) with four inwardly directed spines on either side of the anterior margin, and with about ten minute spinules along anterior margin; anterior part with two pairs of paramedian longitudinal series of short spines, and dotted with five pairs of small sensory spots arranged in two transverse arcs; each lateral side bears two cornuted processes; posterior part with a V-shaped cluster of spines, medially bearing two sensory spots and a longitudinal row of minute spines; epipharyngeal sclerite H-shaped and well developed. Hypopharynx coarsely clothed with scattered, inwardly directed spines on both sides, and median region transversely rugose.

Thorax. Pronotum semicircular in outline, with sides gradually converging anteriorly, and bearing the marginal rims divided into two parts in approximate ratio of 3:1; the posterior margin moderately rounded, with hind angles rather acutely protuberant; disc incompletely divided by two paramedian sutures for basal two-fifths, which are evanescent anteriorly; median suture undeveloped, visible only near base. Mesonotum, metanotum and abdominal segments 1-7 each completely divided into a median part and two lateral parts. Mesothoracic median part trapezoid, and metathoracic one quadrate in shape. And moreover, prothoracic postnotum, meso- and metathoracic nota and postnota each divided into two parts by a median suture. Legs well-developed and placed widely apart (Pl. 1, Fig. 11); coxa stout and long when compared with other segments; femur cylindrical, with several spines; tibiotarsus as long as femur, slender and attenuated apically, bearing one or more rows of stout spines along inner side; claw long and slightly curved, with a single short seta near its base.

Abdomen. Tergites and posttergites of abdominal segments 1-7 undivided (except for the posttergite of the 1st segment). Abdominal tergites 1-7 each with a transverse row of funnel-shaped scales along the posterior margin; lateral side of every segment feebly concave.

Marginal rims. All around the body furnished with marginal rims: which on each thoracic segment consists of two parts, on each of the abdominal segments 1-7 of one, and on the fused 8th and 9th segments of two pairs.

Scales and hairing. Dorsal surface of the rim with many scattered microscopic granules, funnel-shaped scales, forked hairs and clubbed scales (Pl. 1, Figs. 1, 9, 10). Posterior margins of thoracic nota and abdominal tergites 1-7 each with a transverse row of funnel-shaped scales, and moreover, disc of thoracic nota and abdominal tergites 8-9 with scattered similar scales (Pl. 1, Fig. 8).

Spiracles. Spiracles annular, situated on ventral surface of mesothorax and of the first eight abdominal segments; chamber furnished with several short spines along the inner margin.

Glandular orifices. Glandular orifices three on each side, present only on post-notum of prothorax and posttergites of the first and fourth abdominal segments, situating on lateral edge as in *Cassidoloma*.

Material studied: 8 specimens, Jūniko, Aomori Pref., Japan, August 15, 1964, A. Fukuda leg. All specimens collected on a fungus, *Favolus arcularius* (Fr.) Ames (Japanese name: Amisugitake) growing on the stem of a decayed coniferous tree.

Bionomics

A complete biology is not yet known for any species of Notiophygidae. According to my investigations, this species is fungivorous and rather active in both larval and adult stages. The larvae crawl on the surface of fungi and frequently into the lamellae, but they do not burrow or excavate galleries as in the case of Staphylinids. When growing to the full, they enter the soil for pupation, and it seems probable that one generation is produced in a year.

Comparison of the larvae of four genera of Notiophygidae

Concerning the Notiophygid larvae, our knowledge is still very fragmentary. Van Emden (1932) is the first to describe the larva of the Notiophygidae (*Discoloma cassideum*), and, in the second paper (Emden 1938), he reported the larva of the genus *Notiophygus* (*N. hessei*). Later, the larvae of species of two genera, *Notiophygus* (*N. piger*) and *Cassidoloma* (*C. angolense*), were described with a key to three genera by the same writer (Emden 1957). In the following table, the larva of *Aphanocephalus** will be compared with those of the genera mentioned above.

John (1954), in his excellent revision of this family, proposed a system in which he recognized five subfamilies, seven tribes and fifteen genera as enumerated below. But, his classification is almost entirely based on the adult characters of these beetles.

Family NOTIOPHYGIDAE

I. Subfamily NOTIOPHYGINAE

- i) Tribe Notiophygni: *Notiophygus*, *Holophygus*, *Parmaschema*,
Praviclava
- ii) Tribe Pachyplacini: *Pachyplacus*
- iii) Tribe Dystheamononi: *Dystheamon*

II. Subfamily DISCOLOMINAE

- iv) Tribe Discolomini: *Discoloma*, *Cassidoloma*

III. Subfamily APHANOCEPHALINAE

- v) Tribe Aphanocephalini: *Aphanocephalus*, *Fallia*, *Parafallia*, *Solitarius*,
Profallia

* It is widely distributed in both hemispheres (Asia, America, Pacific islands, Australia and Africa).

Table 1. Comparison of the larvae of four genera of *Notiophygidae*.

Charac- ter Genus	Maxillary lobe	Notum	Tergites 8 and 9	Glandular orifice	Scaling and hairing	Habitat or host plant	Source
<i>Notiophygus</i>	Lacinia and galea completely fused	Undivided	Separated	Present on tergites 4-8	Dorsum with funnel-shaped scales	Unknown	van Emden (1938, 1957)
<i>Cassidoloma</i>	Lacinia and galea fused, but cleft at apex	Undivided	Fused	Present only on postnotum of prothorax and posttergites of first and fourth abdominal segment	Tergites with simple hairs, but without club-shaped scales on disc	Under bark of dead tree	van Emden (1957)
<i>Discoloma</i>	Lacinia and galea separated	Meso- and metanotum divided into a median part and outer part; pronotum undivided	Fused	Present on all segments, situated near hind margin of pronotum and near front margin of meso- and metanotum and the tergites	Tergites with forked hairs and club-shaped scales on disc	In crevices in the bark of <i>Diospyros</i>	van Emden (1932)
<i>Aphanocephalus</i>	Lacinia and galea separated	Meso- and metanotum divided as in <i>Discoloma</i> ; pronotum incompletely divided	Fused	Present only on postnotum of prothorax and posttergites of first and fourth abdom- inal segments	Tergites with forked hairs and funnel- shaped scales, but without club-shaped scales on disc	<i>Favolus arcularius</i> (Fr.) Ames, growing on the stem of a decayed coniferous tree	Fukuda (1969)

IV. Subfamily CEPHALOPHANINAE

vi) Tribe Cephalophanini: *Cephalophanus*

V. Subfamily PONDONATINAE

vii) Tribe Pondonatini: *Pondonatus*

According to him, the genera *Discoloma* and *Cassidoloma* are treated to be assigned to the same subfamily Discolominae on the basis of adult morphology. However, so far as the structure of the larval notum and maxillary lobe are concerned, the genus *Discoloma* has closer affinities to *Aphanocephalus* than to *Cassidoloma*. On the other hand, the relationship between *Cassidoloma* and *Aphanocephalus* is indicated in the similarity of the glandular orifices. Besides, in view of the characteristics of maxilla, notum and tergite, it may be supposed that the *Cassidoloma* and *Discoloma* form two connecting links between the primitive *Notiophygus* and the highly specialized *Aphanocephalus*. It is accordingly conceivable that the larval evolution in the Notiophygidae has been directed to (1) the development of the glandular orifices on the thorax, (2) the division of the notum sclerites, (3) the separation of the maxillary lobe and to (4) the fusion of the 8th and 9th tergites.

Family characters of Notiophygid larvae

The larvae of Notiophygidae may be characterized as follows: Body onisciform, with a marginal fringe of short scales; dorsal surface with granular asperities and various types of scales. Head and legs completely hidden by the body and unseen from above. Antenna two-segmented. Mandible almost symmetrical, with a finely sculptured mola, a prosthema and a three-toothed incisor part. A subtriangular area present between stipes, cardo and labium. Maxillary lobe simple or bilobed; maxillary palpus three-segmented, with 1st reduced. Labial palpus three-segmented. Ocelli three on each side, of which two situated on dorsal and one on ventro-lateral surface. Epicranial suture without a metopic branch. Dorsum with paired glandular orifices on lateral edge. Leg four-segmented, with a well-developed claw; tibia and tarsus being fused into a tibiotarsus. Cerci absent.

References

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Explanation of Plate 1

Larva of *Aphanocephalus hemisphericus* Wollaston.

1. Marginal rim. (cs, club-shaped scale; fh, forked hair; fs, funnel-shaped scale). 2. Labrum, dorsal view. 3. Left maxilla, ventral view. (c. cardo; mxl, maxillary lobe; st, maxillary stipes; 1, 2, 3, segments of maxillary palpus). 4. Labium, ventral view. (gu, gula; ls, labial sclerome; m, mentum; pm, prementum; sm, submentum). 5. Epipharynx. 6. Right mandible. (mo, mola; pr, prostheca). 7. Head, dorsal view. (am, basal articulating membrane of antenna; 1, 2, segments of antenna). 8. A part of integument. (ga, granular asperities; fh, forked hair; fs, funnel-shaped scale). 9. Funnel-shaped scale, lateral view. 10. Forked hair, lateral view. 11. Metathoracic leg. (cl, claw; cx, coxa; fe, femur; tr, trochanter; tt, tibiotarsus).

TWO-STEM NEST OF *POLISTES CHINENSIS ANTENNALIS*

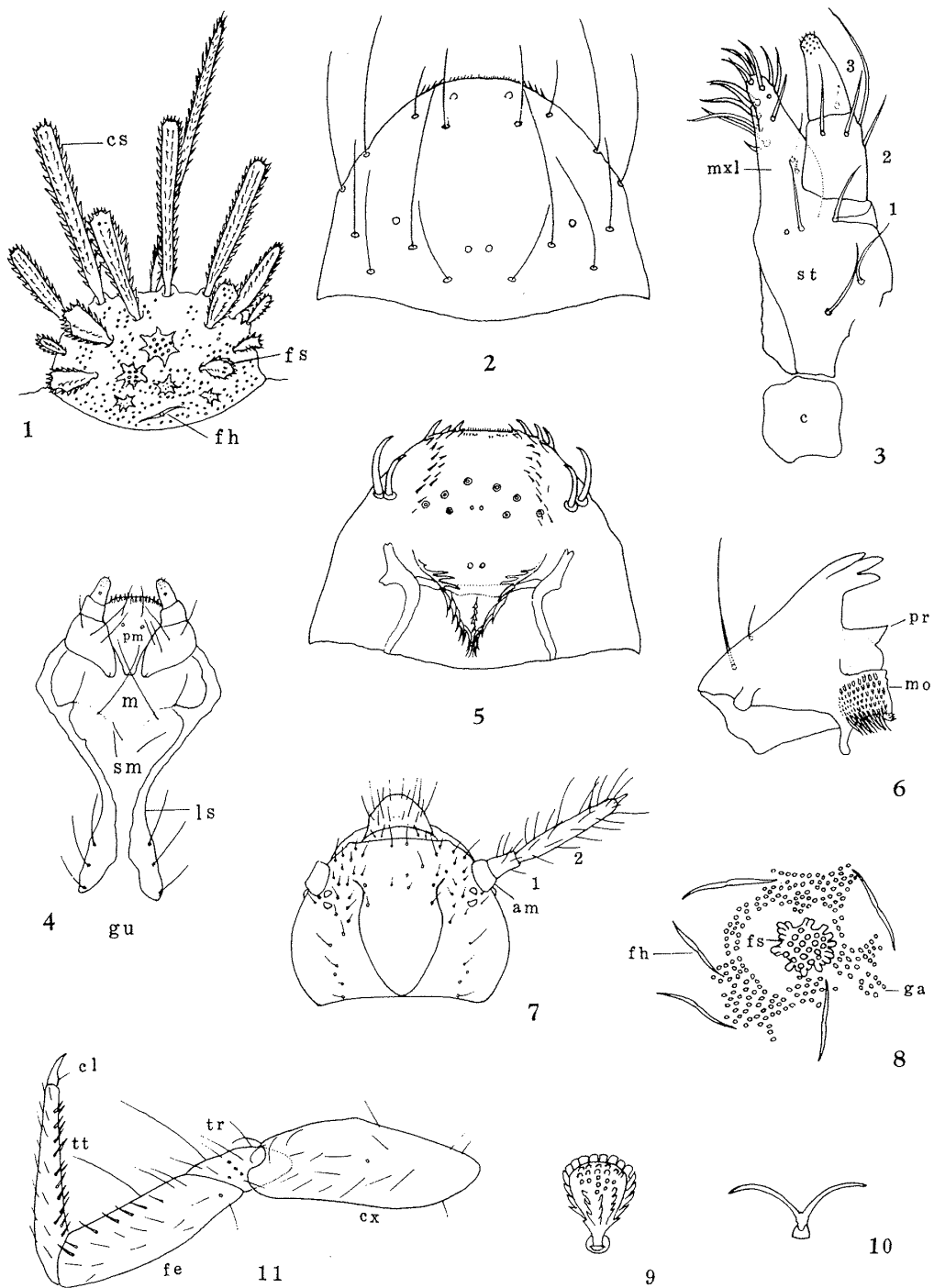
Naoyuki Endo

In the autumn of 1966, I happened to find a two-stem nest of *Polistes chinensis antennalis* Pérez (Hymenoptera, Vespidae) at Jyogawara, Akishima, Tokyo. It was found under the eaves of a house facing to the east.



The nest was rather large, which contained about 338 cells including incomplete ones. Cells were arranged in a plane which was elliptic in shape, measuring about 100 mm. in the longer axis and 70 mm. in the shorter one. As shown in the picture, one of the stems was placed approximately in the middle of the nest, and the other was about 10 mm. aside. Stems were robust, elliptical in their cross sections, being 5 mm. in the longer axis and 2 to 3 mm. in the shorter one. Stem which was nearer to the middle of nest was attached to the nest concentrically, but the other was at the right angle to the latter.

It is probable that the two-stem suspension was made because of the unbalanced weight distribution of the nest. Otherwise, no abnormality was observed.



Fukuda—Larva of *Aphanocephalus hemisphericus*.