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On the Larva of a Predaceous Endomychid, *Saula japonica* GORHAM (Coleoptera)

Hiroyuki SASAJI

Biological Laboratory, Fukui University, Fukui 910, Japan

Synopsis The mature larva of *Saula japonica* GORHAM (Col., Endomychidae), a predator of scale insects and phytophagous mites, is described. Its morphology is compared with other known larval forms of the families Endomychidae and Coccinellidae. Despite its similarity in predacious habits to Coccinellidae, the fundamental characters of *Saula* are well fitted with those of Endomychidae. Its general appearance and some detailed structures are, however, much different from the other known endomychid larvae.

The morphological investigations of the immature stages are often of great importance for determining the taxonomic position of the insects, as have been emphasized by many entomologists such as VAN EMDEN (1957) and KLAUSNITZER (1970). About the larval structures of Endomychidae, several studies have been reported but those are fragmental. The larva of *Saula japonica* GORHAM, which is first described here, is quite different from all the known forms of endomychid larvae in its general appearance. So far as known, almost all the endomychid beetles are fungivorous in both adult and larval stages, and usually found on or within roten wood, herbs or fungi. On the other hand, a few species are collected on leaves of living plants. *Saula japonica* is an example of the latter, and its feeding habit was reported as predaceous, feeding on *Unaspis yanonensis*, *Panonychus citri* and *Icerya purchasi* at citrus groves in both adult and larval stages (NAKAO, 1964; NOHARA, 1963). The predaceous habit of this beetle is very interesting because Endomychidae have close affinity with Coccinellidae in the phylogenetic line.

The purpose of the present paper is, first, to show the systematic relation of the genus *Saula* among the family Endomychidae, second, to discuss the relationship between this beetle and the Coccinellidae, and third, to supply the identification feature for field entomologists.

Before going further, I express my deep thanks to Mr. K. NOHARA of Hagi Citrus Experimental Station, for his kind gift of the material.

Description of Mature Larva of *Saula japonica* GORHAM

Material examined. 3 mature larvae, Hagi, Yamaguchi Pref., Japan, 12. vi. 1968, K. NOHARA leg.

Body length: 3.9–4.8 mm, width: 1.5 mm, in living material.

Body shape (Fig. 1A) subcylindrical and somewhat flattened with weakly

arcuate sides. Coloration of dorsum reddish brown in general, head and dorsal sclerotized plates of thorax and abdomen dark reddish brown, and legs pale brown. Underside of body slightly paler than dorsum.

Head (Fig. 1C) transverse oval, 0.85 mm wide and 0.72 mm long in frontal aspect, provided with about 40 long setae and many minute ones together; the long setae are usually simple at basal part and sharply pointed at tip, and 3 pairs of them at lateral part are beared on each a short projection of head capsule; the minute setae are simple at basal part and thickened at tip when observed undr high magnifying power. Frontal suture distinct except its anterior end, and U-shaped without any epicranial stem. Clypeus about one-third as wide as head capsule, not defined from frons by a distinct clypeo-frontal suture. Four ocelli (Fig. 1B) exsisting at each lateral side of head capsule, anterior three of them are arranged in a row and posterior one is remotely situated.

Antennae (Fig. 1C & D) about one-third as long as head width, three-segmented and relatively slender; the basal segment shorter than wide; the second about 3.5 times as long as the basal, nearly cylindrical and weakly narrowing apically; the apical segment minute, about 15 μm in length and 24 μm in thickness; preapical seta of antenna fairly long and strongly thickened at basal part.

Labrum (Fig. 1E) strongly transverse with a weakly arcuate anterior margin. Mandible (Fig. 1E) very stout, especially at basal half; molar with a long and weakly arcuate inner edge; apical half of mandible relatively narrow and multi-denticulate near the tip; prostheca membraneous, provided with an apical sclerotization which consists of two rows of small denticles. Maxilla (Fig. 1F) relatively large; cardo distinctly defined from stipes by a distinct suture; mala about 2.5 times as long as wide, parallel-sided with an obliquely truncate apex; the distal end of mala bearing several thick and short setae arranged as figured; apical one-third of mala well sclerotized and dark coloured; maxillary palpus short, not beyond the tip of mala, three-segmented; the apical segment of maxillary palpus about twice as long as wide and distinctly narrowing apically. Labium (Fig. 1F) weakly sclerotized at median part; mentum well defined from prementum; labial palpus two-segmented, the apical segment of labial palpus relatively large, somewhat smaller than that of maxillary palpus. Chaetotaxy of maxilla and labium is as figured. Sclerotization of hypopharynx as shown in Fig. 1E.

Prothorax broad and strongly transverse in dorsal view, with a pair of large sclerotized plates which cover almost all the dorsal surface except a narrow median line and a narrow posterior part. Each prothoracic plate bearing many setose projections, which are especially distinct near the lateral margins. Mesothorax slightly wider than and shorter than prothorax, also provided with a pair of large sclerotized plates; lateral side of each plate distinctly projecting and forming a parascolus, surface of each plate provided with a relatively strong setose process near inner margin and many weak ones. Lateral area of mesothorax divided into anterior and posterior subareas by a groove, and each subarea roundly convex and

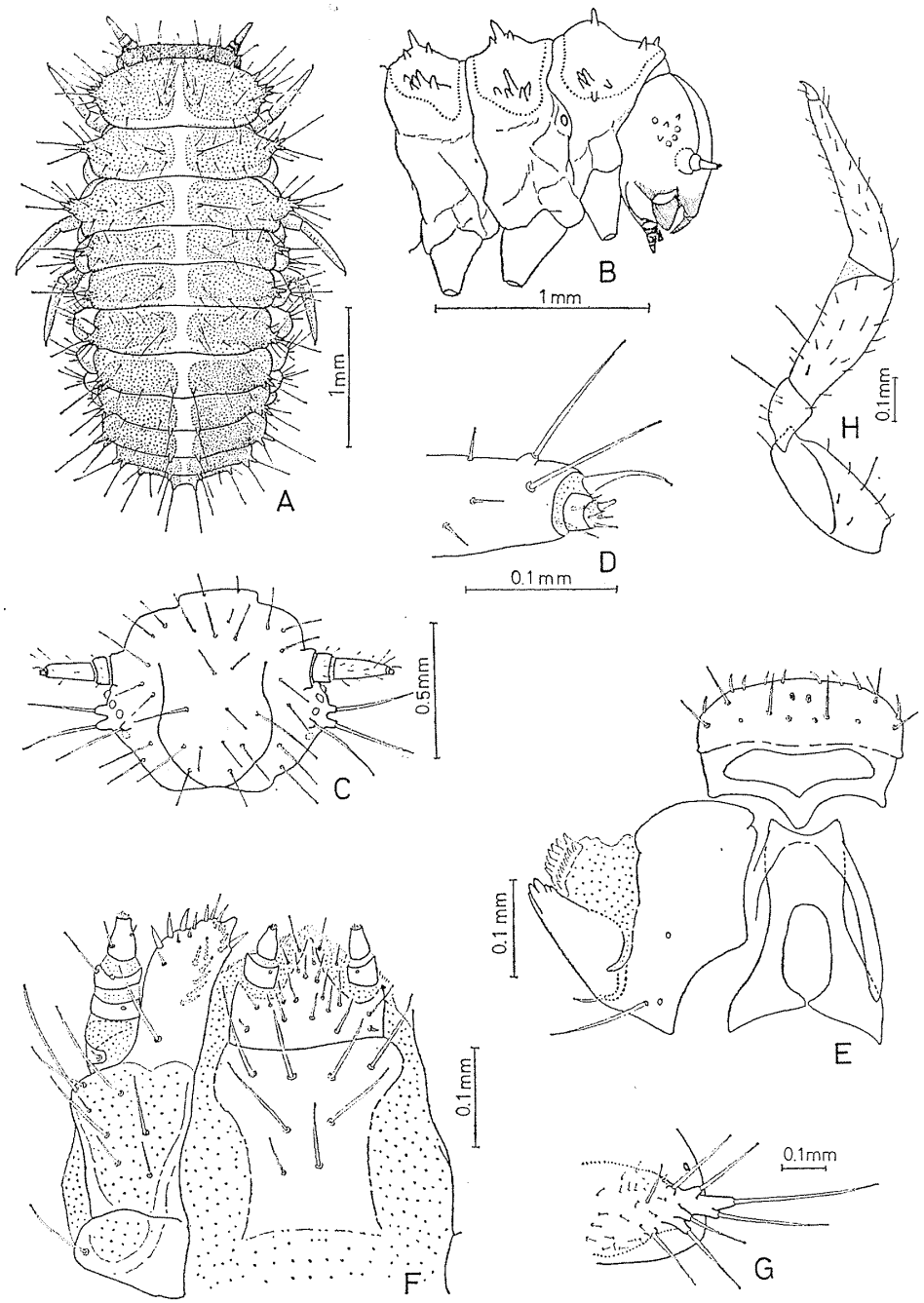

Fig. 1. Mature larva of *Saula japonica* GORHAM.
A. Dorsal view. B. Lateral view of head and thorax. C. Head, frontal view. D. Apex of right antenna. E. Mandible, labrum and hypopharynx, ventral view. F. Maxilla and labium, ventral view. G. Lateral part of dorsum of 3rd abdominal segment. H. Fore leg.

entirely soft without any distinct sclerotized process or strong seta. Metathorax nearly equal to mesothorax, though slightly broader.

Abdominal segments, except the ninth, similar to each other in their structure; namely a certain segment provided with a pair of large sclerotized plates which cover large part of both dorsal and dorso-lateral areas, a pair of distinct projections on lateral areas and three pairs of simple setae on ventral area; each dorsal plate of abdominal segments similar to those of mesothorax, as shown in Fig. 1G; lateral projection hardly sclerotized, bearing a strong seta at the pointed tip and several rather short setae near it. The ninth abdominal segment very short and ring-shaped, bearing several pairs of setae on dorsal side. Cuticle of thorax and abdomen minutely and densely granulate, and bearing short hairs sparsely in addition to distinct setae described above; tip of the short hair on cuticle minutely but distrinctly globular when observed under high magnification.

Legs slender and relatively short; all the legs similar to each other in their structure and size. Fore femur nearly cylindrical, weakly thickening apically. Fore tibiotarsus distinctly longer than femur, 0.45 mm in length, about half as long as the head width, distinctly narrowing apically, sparsely bearing short and pointed setae, without any modified seta. Claw rather simple, broadening at base where bears a single seta. Spiracles existing at anterior end of lateral area of mesothorax and anterior part of dorso-lateral areas of first to eighth abdominal segments. Shape of spiracle annular.

Comparative Notes

Endomychidae are usually divided into four subfamilies, Sphaerosomatinae, Mycetaeinae, Trichoideinae and Endomychinae (s. lat.), and STROUHECKER (1953) further divided the last subfamily in the above-mentioned system into three subfamilies, Stenotarsinae, Eumorphinae and Endomychinae (s. str.).

Sphaerosomatinae are treated as a separate family Sphaerosomatidae by some authors (SASAJI, 1971; SEN GUPTA and CROWSON, 1973), and Mycetaeinae may include some heterogenous genera (SASAJI, 1970). The genus *Saula* belongs to Stenotarsinae of STROHECKER's system. But, the phylogeny of Endomychidae will be necessary to be revised from a wider viewpoint including morphology of immature stages. Our knowledge on larval characters of Endomychidae is too poor to be discussed their phylogenetic relationships, but, at least, the larvae of *Sphaerosoma* described by PEYERIMHOFF (1913) and of *Mycetaea* by HINTON (1945) are distinctly different from those of Endomychinae (s. lat.) in the number of ocelli, the terminal structure of abdomen, etc. The larva of *Mychothenus* which was recently discovered has also particular features.

The larva of *Saula* described here is inclusive within the subfamily Endomychinae (s. lat.) and distinctly separated from the Coccinellidae in its fundamental characters, for instance, having four ocelli, the long antennae which are inserted remotely from mandibles, the cardo distinctly divided from stipes and the stout mandibles with a large prostheca. In spite of its predaceous habit similar to Coccinellidae, the

mouth parts and other structures of the *Saula* larva are not very differenciated from other fungivorous forms of Endomychidae and do not show any convergence to Coccinellidae. This fact suggests that the origin of the predaceous habit in this beetle was not very old, and was relatively recently drived from a certain fungivorous form. Among the endomychid larvae, this is somewhat related to that of *Lycoperdina* (Eumorphinae in STROHECKER's system) in their general shapes, in contrast to the flattened forms of *Eumorphus, Ancylopus*, etc. But, the dorsal sclerotization and the structures of mandibles and antennae of this larva are rather dissimilar to *Lycoperdina*. The larva of *Stenotarsus* (Stenotarsinae) is a broad flattened type with broad lateral (dorso-lateral?) lobes and much dissimilar to that of *Saula*. As far as the known larvae are concerned, it is difficult to find the closest relatives of *Saula*. The larva of *Saula* has many specific structures such as the well-developed dorso-lateral projections of abdomen and the setae beared on a distinct projection at the lateral part of head. The structures of the mandible and the maxilla in this larva appear to show also characteristic features, compared with the other larvae of endomychids.

In pratical identification, the *Saula*-larva is easily distinguishable from coccinellid or other coleopterous larvae living on trees by the forms of darkened sclerotized plates on the dorsum and the number of ocelli.

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