

Immature stages of *Pseudopsycha* and *Austrapoda* (Lepidoptera, Limacodidae)

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Abstract Immature stages of two limacodid genera, *Pseudopsycha* Oberthür, 1879 and *Austrapoda* Inoue, 1982, are described. Larvae of *Pseudopsycha endoxantha* Püngeler, 1914 are slug-like, with a smooth body, and are very similar to those of *Austrapoda hepatica* Inoue, 1987 and *A. dentata* Oberthür, 1879. The type species of the genus *Austrapoda* is *A. hepatica*, which was misidentified as *Limacodes dentatus* sensu Inoue, 1982, [nec Oberthür, 1879] in the original designation.

The genus *Pseudopsycha* was erected by Oberthür (1879). The type species is *Pseudopsycha dembowskii* oberthür, 1879 by monotypy, and the family *Pseudopsychidae* was established in the same paper. Staudinger and Rebel (1901) placed the genus in the Zygaeninae of Zygaenidae, while Jordan (1907), followed by Bryk (1936), transferred it to the Phaudinae of Zygaenidae. In the revisional paper on the Zygaenidae, Alberti (1954) considered *Pseudopsycha* a member of the family Cochlidiidae (=Limacodidae) and assumed a close relationship between Zygaenidae and Cochlidiidae. In a separate paper, Alberti (1955) discussed the systematic position of *Pseudopsycha*, and illustrated the male and female genitalia of *P. dembowskii*, comparing it with those of *Doratifera oxlei* (Cochlidiidae), *Phauda kantonensis* (Phaudinae, Zygaenidae) and *Pryeria sinica* (Zygaeninae, Zygaenidae). He showed that most adult features of *P. dembowskii* (he found it in the Püngeler Collection, Zoologisches Museum, Berlin). The cocoon was sturdy and oval with a cut-off lid, which is of a well-known cochlidiid type. Alberti (1955) stressed that the larva of *Pseudopsycha* should be examined.

In field research on phytophagous insects at Doto Station, Hokkaido Forestry Research Institute, central Hokkaido, one of us (Hara) found interesting limacodid larvae on *Betula platyphylla* var. *japonica*, in summer, 1991, which were slug-like and smooth. Fortunately secured a pair of imagines was identified as *Pseudopsycha endoxantha* Püngeler, 1914 by Owada. Therefore, we started a cooperative study on the external morphology of immature stages.

Zygaenid larvae are characterized by the mouthlike gland near the second and seventh spiracle, the prolegs with crochets in a uniordinal meso-series, and so on, while limacodids do not have the glands and are characterized by the prolegs that are suckerlike oval lobe without crochets (Steh, 1987). In immature stage, *Pseudopsycha endoxantha* do not agree the characters of zygaenids, but shares the autapomorphies of limacodids which are discussed by Epstein (1996), i.e., crochets absent, pupal maxilla extended, cocoon hard and ovoid, and lid invisible when unenclosed.

In the course of this study, we became aware of the fact that the larva of *P. endoxantha* is very similar to those of *Austrapoda*, and found a unique character in the chaetotaxy of these species. In this paper we will describe the immature stages of *Pseudopsycha endoxantha*, *Austrapoda hepatica*, and *A. dentata*, with some taxonomic and nomenclatural notes.

Before going further, we express our hearty thanks to Dr Harald Fänger, Zoologisches Forschungsinstitut und Museum Alexander Koenig, Bonn, Dr Hiroshi Inoue, Iruma, and Dr Shun-Ichi Uéno, National Science Museum, Tokyo, for their invaluable advice and reading the manuscript of this paper.

Pseudopsyche endoxantha Püngeler (Figs 1 - 3, 5 - 6, 8 - 9, 12, 14, 16, 19, 21, 23, 25 - 26)

Middle instar larva (Fig. 1). Coloration and general form as in final instar larva detailed below, with setae longer.

Final instar larva (Fig. 2). Body translucent yellowish green, with a pair of yellow dorsal lines and many yellowish spots. Setae blackish brown, narrow ones brown.

Head capsule as in Fig. 5. Fifth stemma removed from fourth stemma by about two-thirds of stemma width (Fig. 6); sixth stemma obsolete, closer to fifth stemma than to first stemma, closer to fourth stemma than to fifth stemma; only S1 seta present, proximate to third stemma. Labrum with M1 - 3 and L1 - 2 setae (Fig. 8; in only one specimen, additional M seta observed near M3 seta in left side); bottom of anteromedial incision located anteriorly to level of base of M3 setae. Epipharynx with large spinules along anterolateral margins that are directed inward (Fig. 9); epipharyngeal setae relatively narrow; anterior epipharyngeal seta rather apart from anterior margin of epipharynx. Mandible with four weak distal teeth and one wide truncate inner tooth (Fig. 12). Spinneret widened apically (Fig. 14).

Body smooth, nearly elliptical in dorsal view, semielliptical in lateral view; from mesothorax to eighth abdominal segment each angularly convex laterally in dorsal view (Fig. 2); ninth abdominal segment angularly convex posterolaterally in dorsal view (Figs 2, 19). Only primary setae present, short and simple (Figs 16, 19, 23); setae on mesothorax to ninth abdominal segments relatively thick and arising from conical warts that are not pigmented and not sclerotized, except for L setae that are narrow and do not arise from warts. Cuticles of thorax and abdomen covered with conical or hemispherical granules dorsally and laterally (Figs 16, 19). Longest setae of thoracic legs apically pointed, about as long as or slightly longer than tarsal claw (Fig. 21); tarsal claws each with well-developed axial seta. Ventrums flexible, with oval suckers on second to seventh abdominal segments respectively (Fig. 23); its lateral part internally with rod-like apodeme on mesothorax and anchor-like apodemes on metathorax and first to eighth abdominal segments respectively; crochets absent.

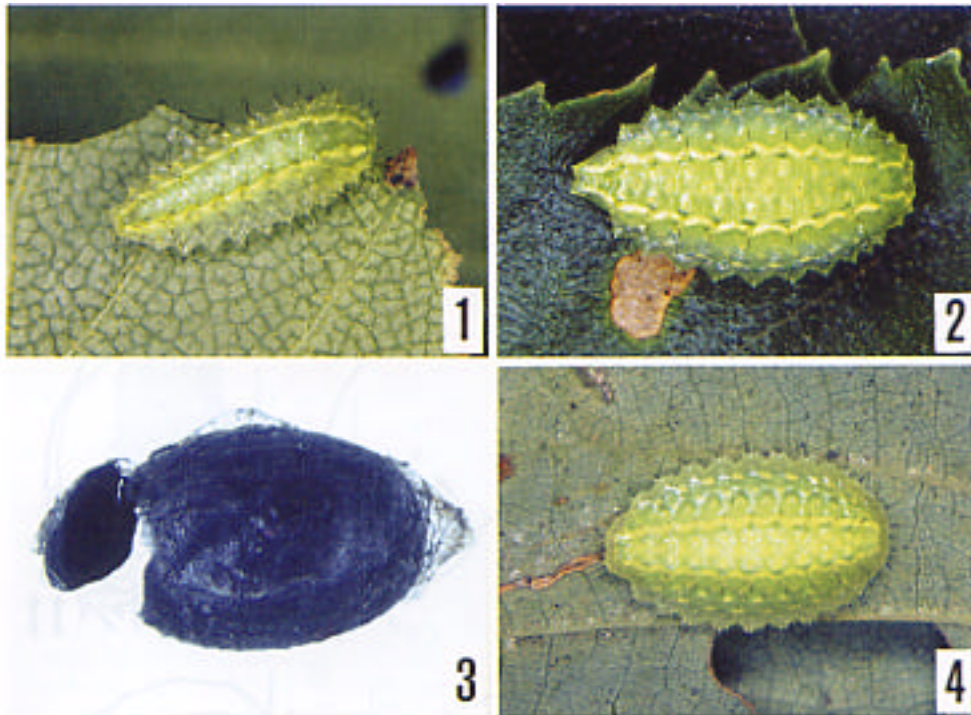
Chaetotaxy of thorax and abdomen (Figs 19, 23, 25). Prothorax with XD1 - 2, D1 - 2, minute MXD1, SD1 (SD2 sometimes present as in Fig. 24), L1 - 3, SV1 - 2 setae; meso- and metathorax with D1 - 2, SD1 - 2, L1 - 2, MSD1, L1 - 2 setae; first to eighth abdominal segments each with D1 - 2, SD1 - 2, L1 - 2 setae; ninth abdominal segment with D1 - 2, SD1 - 2, setae (SD2 setae omitted in Fig. 19, located anteroventrally to SD1 setae); anal proleg with seven setae on lateral lobe and one seta on mesal lobe, frass-flipping setae absent.

Body length, 10 - 14 mm.

Pupa. Jead as in Fig. 26; frons without setae; labial palpus long, relatively narrow; maxillary lobe very short, with apex angular, with wide and long additional lobe contiguous with labial palpus, with small lateral extension. Cremaster hooks absent.

Cocoon (Fig. 3). Dark brown, hard and ovoid. Length except for lid, width and height, 7.6, 5.6, 5.0 mm in female, 5.8 - 6.2, 4.7 - 5.3, 3.7 - 4.1 mm in male.

Material examined. 1 ♂, Hokkaido, Tokachi, Shintoku, reared from middle instar larva, col. 2. VII. 1991, cocoon. 21. VII. 1991, em. 14. III. 1992, *Betula platyphylla* var. *japonica*, H. Hara; 1 ♀, ditto, but reared from larva, col. 1. VIII. 1991, em. 14. III. 1992; 4 final instar



larvae, ditto, but reared from middle instar larvae, col. 12. VII. 1993, *Betula verrucosa*, M.

Figs 1 - 4. Larvae and cocoon: 1, *Pseudopsyche endoxantha*, young larva, 6 mm long; 2, ditto old larva, 11 mm long; 3, ditto, eclosed cocoon, 6 mm long; 4, *Austrapoda dentata*, old larva, 11 mm long.

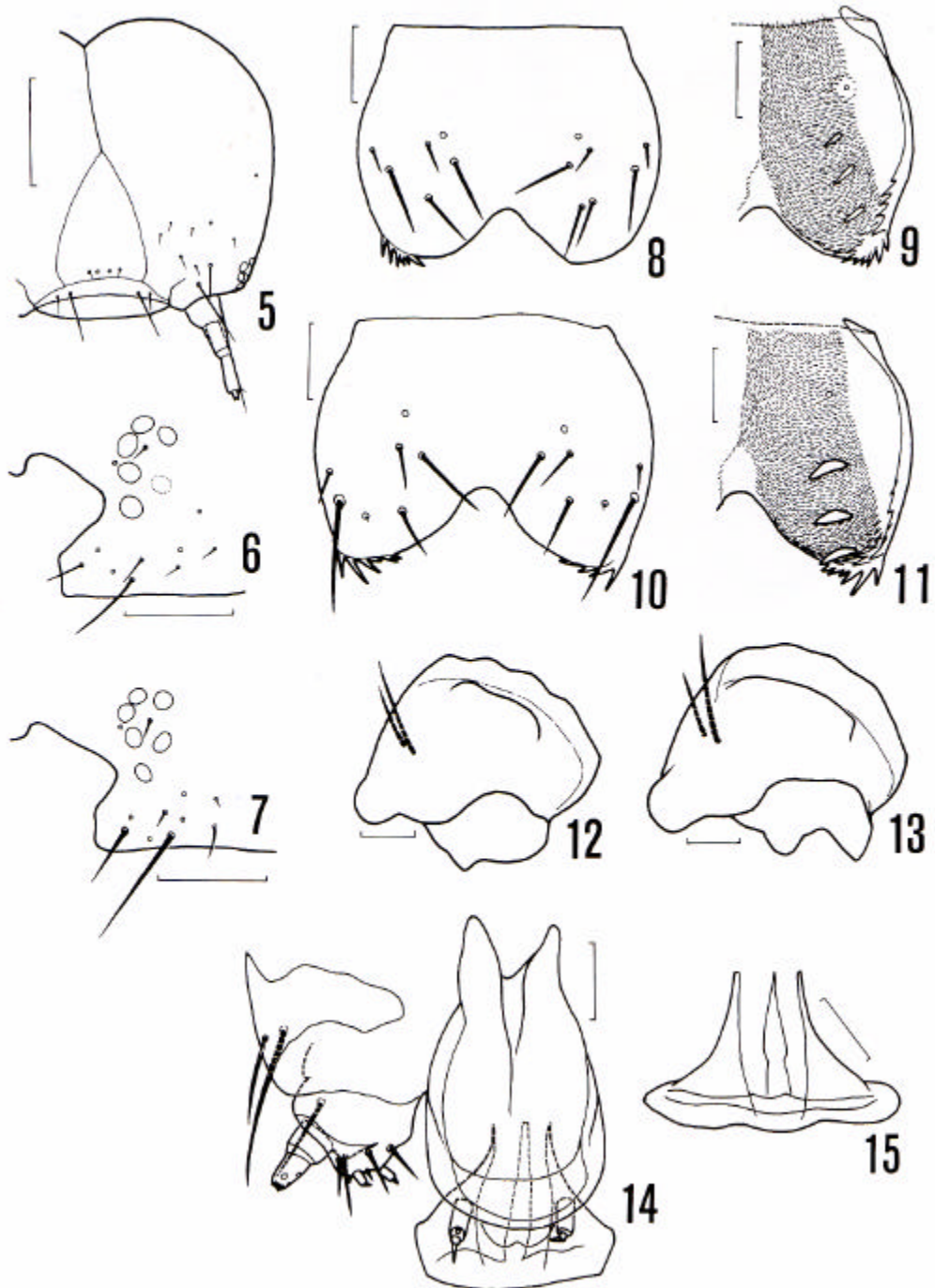
Owada and H. Hara; 1, ditto, but reared from larva, col. 27. VII. 1993, cocoon. 8. VIII. 1993, em. 4. V. 1994, *Betula ermanii*, H. Hara; 1 VII ditto, but reared from larva, col. 24. VII. 1993, cocoon. 30. VII. 1993, em. 5. V. 1994, *Populus maximowicziana*

Biology. Host plant: *Betula platyphylla* Skatv. Var. *japonica* Hara, *B. ermanii* Cham., *B. verrucosa* Ehrh. (introduced species), Betulaceae, and *Populus maximowicziana* Henry, Salicaceae.

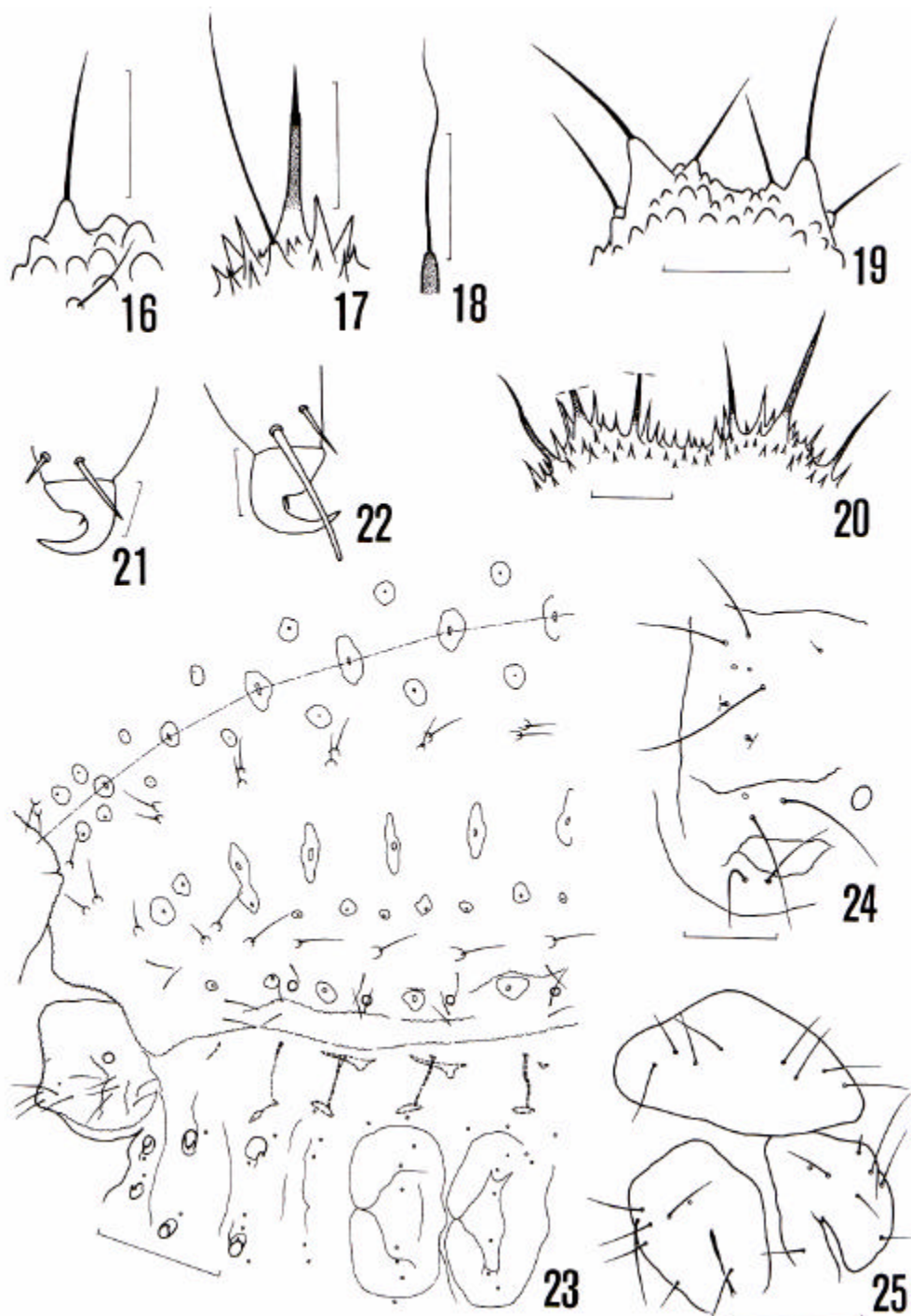
Larvae were solitarily found on leaves of *Betula* and *Populus* around July in Hokkaido. Larvae preferred feeding on old leaves. In the laboratory larvae spun cocoons from late July to early August and passed the winter. This species has a life cycle of one year.

Remarks. The larva of *P. endoxantha* slightly differs from those of other limacodids. The longest setae of the thoracic legs are apically pointed in *P. endoxantha*, while these are apically blunt or capitate in other limacodids (Epstein, 1996).

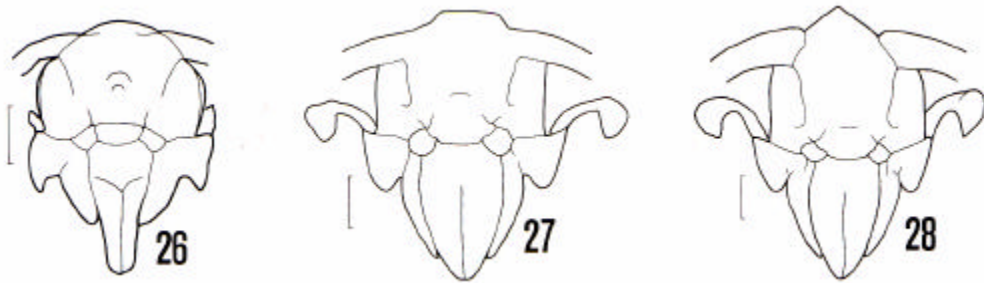
P. endoxantha is very similar to *Austrapoda* in the larval stage. The larvae of *Pseudopsyche* and *Austrapoda* are characterized by the presence of only one seta on the mesal lobe of the anal proleg. Epstein (1996) mentioned that the mesal lobe has two setae in the Limacodidae and its sister group, the Dalceridae. Therefore, one seta on the mesal lobe may be apomorphic with respect to the Limacodidae, and may suggest the close relationship between these two genera.



Figs 5 - 14. Larvae of *Pseudopsyche endoxantha* (5 - 6, 8 - 9, 12, 14) and *Austrapoda dentata* (7, 10 - 11, 13, 15). 5, Head capsule in frontal view; 6 - 7, ventral part of head capsule in lateral view; 8, 10, labrum; 9, 11, epipharynx; 12 - 13, left mandible in dorsomedial view; 14, maxilla, spinneret and labium in ventral view; 15, spinneret in ventral view. Scales are 0.5 mm in fig. 5, 0.25 mm in figs 6 - 7, 0.1 mm in figs 8 - 15.



Figs 16 - 25. Larvae of *Pseudopsycha endoxantha* (16, 19, 21, 23, 25), *Austrapoda dentata* (17, 20, 22, 24) and *A. hepatica* (18). 16 - 17, SD1 - 2 setae of first abdominal segment in ventral view; 18, SD1 seta; 19 - 20, apical part of abdomen (ninth segment) in dorsal view; 21 - 22, prothoracic leg; 23, prothorax to third abdominal segment; 24, dorsal and lateral parts of prothorax; 25, tenth abdominal segment. Scales are 0.5 mm in figs 16 - 20, 24 - 25, 0.05 mm in figs 21 - 22, and 1 mm in fig. 23.



Figs 26 - 28. Heads of eclosed pupae in frontal view. 26, *Pseudopsyche endoxantha*; 27, *Austrapoda dentata*; 28, *A. hepatica*. Scales are 0.5 mm.

The larva of *P. endoxantha* is distinguished from those of *A. dentata* and *A. hepatica* by the condition of parts where setae occur. The warts of *P. endoxantha* are concolorous with the body and not sclerotized (Figs 16, 19), while those of *A. dentata* and *A. hepatica* are darkened and well sclerotized (Figs 17 - 18, 20). In fine structure, the final instar larva of *P. endoxantha* differs from that of *A. dentata* as follows: head capsule with stemma 6 obsolete and S1 seta located near stemma 3 (Fig. 6); labrum with anteromedial incision relatively shallow, without L3 setae (Fig. 8), with narrower epipharyngeal setae, of which anterior ones are apart from anterior margin of epipharynx (Fig. 9); spinneret (Fig. 14) angulate laterally; granules on thorax and abdomen conical or hemispherical; longest seta of each thoracic leg apically pointed, about as long as or slightly longer than the tarsal claw (Fig. 21).

The pupa of *P. endoxantha* is easily distinguished from the two *Austrapoda* species by the maxillary lobe angulated apically, with a small lateral extension.

Austrapoda dentata (Oberthür) (Figs 4,7,10 - 11, 13, 15, 17, 20, 22, 24, 27)

Limacodes dentatus Oberthür, 1879, *Diagnose Espèces nouv. Lepid. Lépid. Île Askold* 8.

Thosea nitobeana Matsumura, 1931, *Insecta matsum.* 5: 107, pl. 2, fig. 4.

Austrapoda nitobeana: Inoue, 1982, *Moths Japan* 1: 299, 2: 221, pl 34, fig. 39 (), pl. 297, figs 3,4 (genitalia).

Austrapoda dentata: Inoue, 1987, *Yugato* (108): 43, fig. 4 (holotype of *L. dentatus*), synonymy of *L. dentatus* and *Th. nitobeana*

Middle instar larva. Coloration and general form as in final instar larva, with setae longer.

Final instar larva (Fig. 4). Differing from that of *Pseudopsyche endoxantha* as follows.

Fifth stemma removed from fourth stemma by about stemma width (Fig. 7); sixth stemma distinct, almost equidistant to first of fifth stemma; S1 equidistant to first to fourth or sixth stemma. Labrum (Fig. 10) with M1 - 3 and L1 - 3 setae; L3 seta very minute; bottom of anteromedial incision relatively deep, located posteriorly to level of base of M3 seta. Epipharynx (Fig. 11) with thick epipharyngeal setae; anterior epipharyngeal seta located near anterior margin of epipharynx. Mandible with distal teeth very weak (Fig. 13). Spinneret not angulate laterally (Fig. 15).

From mesothorax to eighth abdominal segment each roundedly convex laterally in dorsal view (Fig. 4); ninth abdominal segment roundedly convex posterolaterally in dorsal view (Fig. 20). Setae of mesothorax to ninth abdominal segment, except for SD2 setae of abdomens and L setae, each arising from long slender sclerotized blackish brown wart (Fig. 17); these setae usually straight and short, and about half as their basal warts; D1 seta of mesothorax

and MSD1 setae of meso- and metathorax long and waved, arising from short warts; D2 and SD1 setae of ninth abdominal segment relatively long, about as long as basal warts (Fig. 20). Longest setae of each thoracic leg apically blunt, longer than tarsal claw (Fig. 22).

Body 11 - 12 mm long.

Pupa. Head as in Fig. 27; frons without setae; labial palpus long and wide; maxillary lobe very short, with apex rounded, with slender and very long additional lobe contiguous with labial palpus, with large lateral extension. Cremaster hooks absent.

Cocoon. Dark brown, hard and ovoid. Length except for lid, width and height, 6.6, 6.0, 4.9 mm in male.

Material examined. 1 and 5 final instar larvae, Hokkaido, Sorachi, Bibai, reared from middle instar larva, col. 30. VIII. 1994, cocoon. 11 - 16. IX. 1994, em. 5. VI. 1995, *Prunus avium*, H. Hara.

Biology. Host plant: *Prunus avium* Linn. (introduced species), Rosaceae. The previous records for host plants need reconfirmation (Inoue, 1982).

Hara collected seven middle instar larvae on a tree of *Prunus avium* Linn. at Bibai, Hokkaido in late August, 1994, solitarily feeding on the leaves. In the laboratory they became final instar larvae in early September, of which two selected were reared continuously and spun cocoons in middle September. These cocoons passed the winter in the room without air conditioner. From March 1, 1995 they were kept in the room where the temperature was 20 °C. After three months one male emerged. The very long period until adult emergence in the high temperature suggests that adults occur in summer under the natural condition. Therefore, this species probably has a life cycle of one year in Hokkaido.

Remarks. The larva and pupa of this species is similar to those of *Pseudopsycha endoxantha*. The larva is easily distinguished from that of the latter by the mesothorax to ninth abdominal segments that are each roundedly convex laterally in dorsal view, the thorax and abdomen covered with sharp spinules dorsally, the setae of the mesothorax to ninth abdominal segment, except for SD2 setae of the abdomens and L setae, each arising from a slender sclerotized blackish brown wart. The pupa differs from *P. endoxantha* in having the large lateral extension of the maxillary lobe.

***Austrapoda hepatica* Inoue (Figs 18, 28)**

Austrapoda dentata: Inoue, 1982, *Moths Japan* 1: 299, 2: 220, pl. 228, figs 7- 8 (and), pl. 297, figs 5 - 6 (genitalia), nec Oberthür, 1879. Misidentification.

Austrapoda hepatica Inoue, 1987, *Yugato* (108): 40, 43.

Immature stages.

Cochilidion dentatus Kawada, 1957, *Illust. Insect Larvae Japan*: 193 (mature larva), pl. 3 (mature larva in colour), nec Oberthür, 1879.

Apoda dentatus: Mizuno, 1960, *Publ. Ent. Lab. College Agr. Univ. Osaka Pref.* (5): fig. 3e (mature larva); Hattori, 1969, *Early Stages Jap. Moths Colour* 2: 52, pl. 25, fig. 100 (mature larva); nec Oberthür, 1879.

Austrapoda nitobeana: Nakatomi, 1987, *Larvae larger Moths Japan*: 17, pl. 2, fig. 3; Takizawa, 1991, *Insect Pest Garden Forest Trees*: 104, pl. 24, fig. 4; nec Oberthür, 1879.

Final instar larva. Only exuviae examined. The D1 - 2 and SD1 setae are blackish brown, waved, and each arise from a dark brown small cylindrical wart (Fig. 18).

Pupa. Head as in Fig. 28; frons without setae; labial palpus wide and long; maxillary lobe very short, with apex rounded, with slender and very long additional lobe contiguous with labial palpus, with large lateral extension. Cremaster hooks absent.

Cocoon. Dark brown, hard and ovoid. Length except for lid, width and height, 8.0 - 9.5, 7.0 - 7.1, 5.4 - 5.7 mm in male, 8.5, 8.0, 6.0 mm in female.

Material examined. 1 ♂, Hokkaido, Sorachi, Bibai, reared from larva, col. 21. VIII. 1963, cocoon. 17. IX. 1963, em. 22. IV. 1964, *Populus nigra*, K. Kamijo; 1 ♀, ditto, but reared from old larva, col. 26. IX. 1963, cocoon. 26. IX. 1963, em. 16. IV. 1964; 1 ♂, ditto, but reared from old larva, col. 16. IX. 1964, cocoon. 25. IX. 1964, em. 31. V. 1965; 1 ♀, ditto, but reared from old larva, col. 3. X. 1964, cocoon. 10. X. 1964, em. 27. V. 1965.

Biology. Host plant: *Populus nigra* Linn. (introduced species), Salicaceae. The previous records for host plants need reconfirmation (Inoue, 1982).

In Hokkaido larvae were collected from late August to early October. In the laboratory larvae cocooned from middle September to early October and passed the winter.

Remarks. The larva of this species is very similar to those of *Pseudopsycha endoxantha* and *Austrapoda dentata*, but is distinguished from them by the condition of the setae and their basal tubercles (cf. Fig. 18 with Figs 16 and 17). The pupa is indistinguishable from that of *A. dentata*, but differs from that of *P. endoxantha* in having the large lateral extension of the maxillary lobe.

Many authors have provided figures or photographs of larvae under the Japanese name of "MURASAKI-IRAGA" (Kawada, 1957, scientific name, *Cochlidion dentatus*; Mizuno, 1960 and Hattori, 1969, *Apoda dentatus*; Nakaomi, 1987 and Takizawa, 1991, *Austrapoda nitobeana*). All of their larvae, however, are undoubtedly of *Austrapoda hepatica* (Japanese name, "USUMURASAKI-IRAGA"), because they have thin black setae arising from short black warts (Mizuno, 1960, fig. 3e; Hattori, 1969, fig. 15) or appear to have basally-swelling black setae (Kawada, 1957, p. 193, pl. 3; Hattori, 1969, pl. 25, fig. 100; Nakaomi, 1987, pl. 2, fig. 3; Takizawa, 1991, pl. 24, fig. 4). The larva of *A. dentata* have short black setae arising from slender black warts and at first sight appear to have long thick black setae.

Austrapoda Inoue, 1982, *Moths Japan* 1: 300.

Type species: *Limacodes dentatus* sensu Inoue, *ibid.* 1: 299, 2: pl. 228, figs 7-8, pl. 297, figs 5-6, [nec Oberthür, 1879], by original designation, misidentification, = *Austrapoda hepatica* Inoue, 1987, *Yugato*(108): 40, 43.

Inoue (1982) established the genus *Austrapoda* on the basis of two species, *A. dentata* (Oberthür) and *A. nitobeana* (Matsumura), and designated the former as the type species. He found his misidentification of *Limacodes dentatus* Oberthür, 1879, by his examination of the type specimen, and "*A. dentata* sensu Inoue, 1982" was named as a new species, *Austrapoda hepatica*, and *A. nitobeana* (Matsumura) was synonymized with *A. dentata* (Oberthür) (Inoue, 1987). Although he did not expressly refer to the misidentification of the type species of the genus *Austrapoda* in the same paper, his nomenclatural action is considered to be the fixation of the type species to *Austrapoda hepatica* Inoue (= *A. dentata* sensu Inoue, 1982). Taking this opportunity, we confirm Inoue's designation of the type species of *Austrapoda* as above.

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摘要

大和田守・原秀穂：キンケウスバイラガとムラサキイラガ属の幼生期

キンケウスバイラガ *Pseudopsycha endoxantha* Püngeler, 1914, ムラサキイラガ *A. dentata* Oberthür, ウスマラサキイラガ *Austrapoda hepatica* Inoue, 1987 の幼生期を記載した。

キンケウスバイラガは幼虫の腹脚が吸盤状で鉤爪を欠くこと、蛹の小脛が長く伸張すること、繭が俵形で、成虫が羽化するまでふたの開孔部がみとめられないことといったイラガ科の固有新形質を持つ。幼虫はムラサキイラガやウスマラサキイラガの幼虫と非常によく似ている。両属は尾脚の中央部 (mesal lobe) 刺毛が1本という特徴を共有する (他のイラガ科や近縁な科の幼虫では2本)。

これら3種の幼虫は胸腹部背面の刺毛の状態などにより識別できる。刺毛は突起から生じているが、この突起はキンケウスバイラガでは小さな円錐形で体と同色である。ムラサキイラガでは突起は黒く細長く、その先に比較的短い刺毛が生ずる。肉眼では太い剛毛のようにみえる。ウスマラサキイラガでは突起が黒く短い。肉眼では刺毛の根元が膨らんでいるようにみえる。これまで図鑑などで「ムラサキイラガ」として図示された幼虫は、すべてウスマラサキイラガ *A. hepatica* Inoue である。

なお、*Austrapoda* Inoue, 1982 の属のタイプ種はウスマラサキイラガ *Austrapoda hepatica* Inoue, 1987 である。