Bull. Natl. Mus. Nat. Sci., Ser. A, **34**(3), pp. 141–155, September 22, 2008

Taxonomy, Distribution and Life History of *Betula*-feeding Sawfly, *Arge pullata* (Insecta, Hymenoptera, Argidae)

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Abstract The adult and immature stages of *Arge pullata* (Zaddach, 1859) are redescribed. *Arge nyemitawa* Rohwer, 1925, described from the Russian Far East, is newly synonymized with *A. pullata*. The previous and new information on the distribution, life history, and economic importance of the species is reviewed and discussed. The first definite record of *A. pullata* from Hokkaido, Japan, is given. In Sapporo, Hokkaido, *A. pullata* probably has two generations a year, whereas the species has been reported to be univoltine in Honshu, Japan, and China.
Key words: Hymenoptera, Argidae, *Arge pullata*, new synonymy, distribution, life history.

An argid sawfly, *Arge pullata* (Zaddach, 1859) is widely distributed in Europe, through Siberia, China to Japan (Takizawa, 1962; Li and Yuan, 1993; Zhelochovtsev and Zinovjev, 1995) and is known as a leaf feeder injurious to *Betula* in Europe, China and Honshu, Japan (Escherich, 1942; Takizawa, 1962; Li and Yuan, 1993). The larvae have a toxin called lophyrotomin, and sheep, cattle and dogs are reported to have been poisoned by the ingestion of the larvae in Denmark (Brummerstedt *et al*., 1987; Thamsborg *et al*., 1987; Kannan *et al*., 1988).

In Japan, this sawfly is little known. Takizawa (1962) first recorded the sawfly from Japan and observed its mass occurrence on young trees of "*B. tauschii*" [=*B. platyphylla* var. *japonica*] in Sugadaira, central Honshu. Togashi (1974, 1982) gave collection records of this species from two localities also in central Honshu. These are the only literature containing the original information on the sawfly in Japan. In 2001, a severe defoliation of *B. platyphylla* var. *japonica* by the larvae of this species was found in Sapporo, Hokkaido, and we have thereafter found the larvae commonly occurring on the birch trees planted in the parks and gardens in the urban areas of the city.

In the following lines, we will give descriptions of the adult, larva and cocoon of *A. pullata*, and synonymize *Arge nyemitawa* Rohwer, 1925, originally described from the Russian Far East, with *A. pullata*. We will also review and discuss the already published and new information on the distribution, life history, and economic importance of this sawfly.

The material used in this work is kept in the National Museum of Nature and Science, Tokyo, unless otherwise indicated. Abbreviations for the other depositories are: BC–S. M. Blank collection, Müncheberg; HU–Hokkaido University, Sapporo; KU–Kobe University, Kobe; OMNH–Osaka Museum of Natural History, Osaka; OPU–Osaka Prefecture University, Sakai.

We wish to thank the following persons for making the material, literature and information for the present study available: S. M. Blank and A. Taeger (Deutsches Entomologisches Institut, Müncheberg), V. M. Ermolenko (Schmalhausen Institute of Zoology, Kiev), K. Hashiba (Ebetsu), T. Hayashi (National Institute of Infectious Dis-

eases, Tokyo), T. Hirowatari (OPU), F. Koch (Museum für Naturkunde, Berlin), R. Matsumoto (OMNH), K. Mizuno (Kyoto), T. Naito (KU), M. Ohara (HU), T. Otsuka (Foundation for Riverfront Improvement and Restoration, Tokyo), D. R. Smith (National Museum of Natural History, Washington, D.C.), and S. Tsuyuki (Yokohama). This study is partly supported by the Grant-in-aid for Scientific Research No. 20580165 from the Ministry of Education, Culture, Sports, Science and Technology.

Arge pullata (Zaddach, 1859)

[Kanba-ruri-churenji]

(Figs. 1–7)

Hylotoma pullata Zaddach, 1859: 5; Zaddach, 1864: 87; Snellen van Vollenhoven, 1879: 7.

Hylotoma ventriosa Zaddach, 1864: 93.

Arge pullata: Konow, 1890: 243; Enslin, 1917: 594; Gussakovskij, 1935: 268; Takeuchi, 1939: 404; Escherich, 1942: 239; Lorenz and Kraus, 1957: 247; Takizawa, 1962: 340; Togashi, 1965: 254; Okutani, 1967: 47; Togashi, 1974: 12; Togashi, 1982: 56; Austara *et al*., 1984: 14; Zhelochovtsev, 1988: 35; Abe and Togashi, 1989: 543; Li and Yuan, 1993: 18; Zhelochovtsev and Zinovjev, 1995: 400; Taeger *et al*., 1998: 68; Taeger *et al*., 2006: 405; Wei *et al*., 2006: 514; Nuorteva and Nuorteva, 2007: 313.

Arge ventricosa [misspelling]: Konow, 1890: 243; Konow, 1892: 211 [synonym of *A. pullata*].

Arge nyemitawa Rohwer, 1925: 3. **Syn. nov.**

Arge neymitawa [misspelling]: Gussakovskij, 1935: 285; Zhelochovtsev and Zinovjev, 1995: 400 [with question mark].

(Only selected references are given from Europe.)

Description (female and male). [Conditions of holotype of *Arge nyemitawa* (female, Fig. 1A) in brackets.] Length 9.0–13.5 [11.0] mm in female, 7.5–9.5 mm in male. Black with generally bluish reflection, violaceous on basal abdominal terga (Fig. 1A–C, E). Mandible apically reddish brown. Palpi dark brown. Wings dark brown, distinctly pale beyond level of stigma; veins and stigma black (in 1♀ from Sugadaira, apical 2/3 of vein C, vein Sc, section of vein R1 basal to stigma and crossvein 1r-rs brown, and stigma brown, marginally dark). In female, cercus dark, and subanal area entirely yellowish white to yellow (Fig. 1D), rarely with transverse dark line between cerci. Setae dark.

Surface generally smooth and shining; punctures on anterior part of head distinct, generally separated from each other.

Head strongly inflated laterally and dorsally behind eyes (Fig. 2A–D). Eye with vertical diameter 1.6–1.8 [1.8]× horizontal diameter in female, 1.4–1.5× in male. Distance between eyes 1.5–1.7 [1.5]× vertical diameter of eye in female, 1.4–1.6× in male. Postocellar area convex, slightly furrowed at anterior margin (Fig. 2E–F); lateral furrow indistinct. Ocellar area slightly concave between hind ocelli, slightly raised at front ocellus (Fig. 2E–H). Frontal area short, with medial concavity shallow. Median fovea shallow. Interantennal area with lateral carinae dorsally separated from each other, ventrally disappearing below level of antennal sockets (Fig. 2G–J). Supraclypeal area medially rounded, with side slope rounded and punctuated, not rugulose. Malar space 1.0–1.7 [1.1]× width of front ocellus in female, 0.9–1.1× in male. Clypeus not flattened, with ventral margin roundly incised medially (Fig. 2I–J). Antennal length 1.1–1.4 [1.2]× maximum width of head in female, 1.7–1.9× in male; flagellum nearly club-like, rounded apically, and not compressed in female (Fig. 2L–M), nearly of same thickness throughout and not compressed in male (Fig. 2N–O). Right mandible with inner margin not notched (Fig. 2K). Mesoscutellum in lateral view with dorsal margin roundly convex, or flat or slightly roundly convex anteriorly and roundly or angularly curved below posteriorly, with acute, right or obtuse angle [roundly convex]. In forewing, cell 1Rs2 with anterior length 1.0–1.5 [1.3]× posterior length, crossvein 3r-m roundly arched weakly or strongly (Fig. 1A–B, E); in both wings, wing margin between veins Rs and Cu glabrous, with marginal glabrous area slightly wider than width of vein M and setae near apical wing margins at most about as long as width of vein M (Fig. 2P).

In female abdomen, second to fourth terga

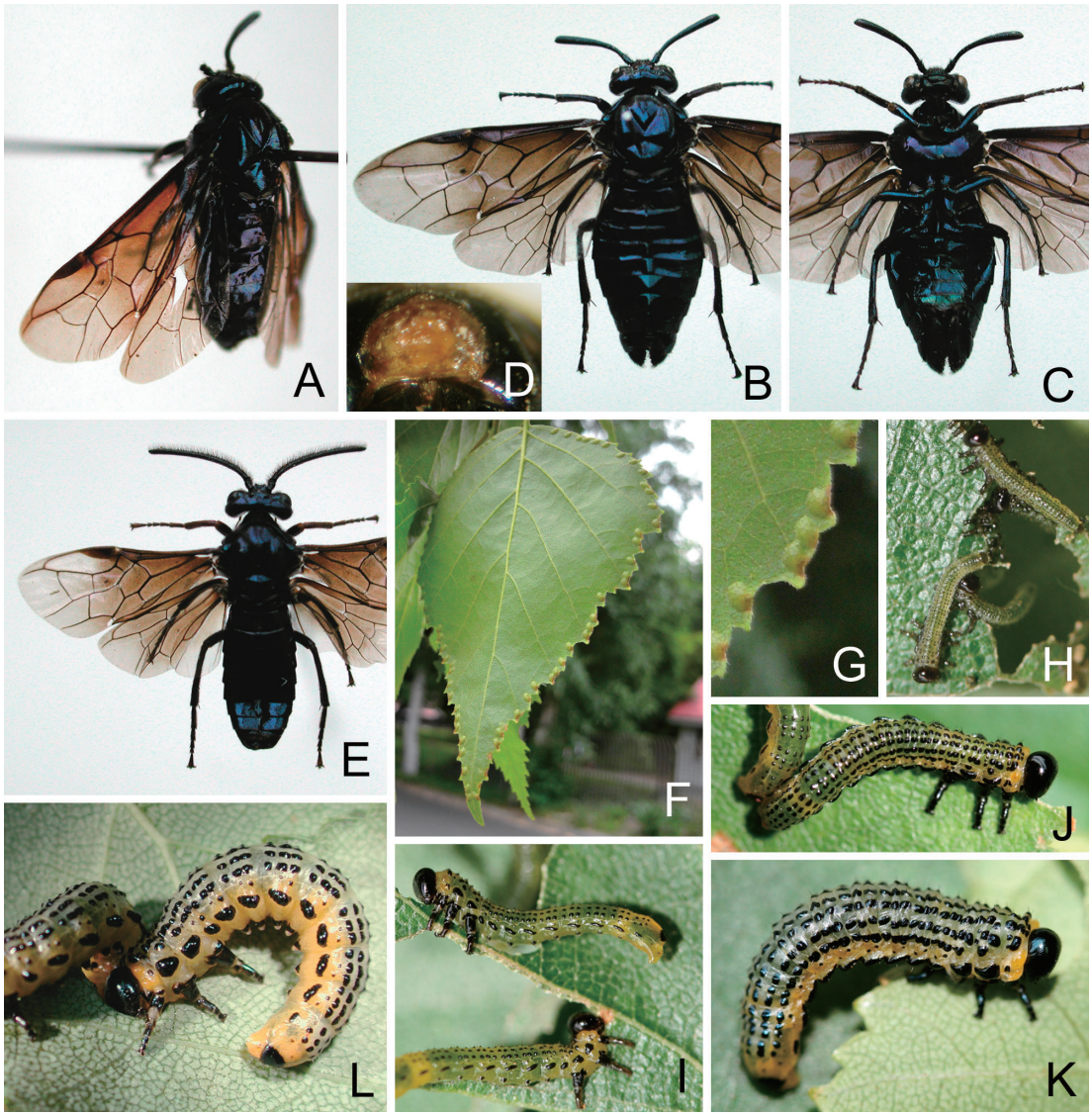


Fig. 1. *Arge pullata*.—A, Holotype of *Arge nyemitawa*, female; B, female (Sapporo, Hokkaido, HH040713A), dorsal view; C, ditto, ventral view; D, ditto, subanal area, posterior view; E, male (HH040713A), dorsal view; F–G, eggs on *Betula platyphylla* var. *japonica*, June 28, 2007 (Sapporo, Hokkaido, AS070628B); H, first instar larvae, July 2, 2007 (AS070628A); I, middle instar larvae, July 13, 2007 (AS070628B); J, late instar larva, July 18, 2007 (AS070628B); K, final instar larva, July 26, 2007 (AS070628B); L, final instar larva, 22 mm long, July 24, 2004 (HH040713A). H–L, Host plant: *B. platyphylla* var. *japonica*. F–K, Photographed by A. Shinohara; H–K, photographed in the laboratory in Tokyo; L, photographed by H. Hara in the laboratory in Bibai.

with very sparse setae except for narrow lateral setose parts, fourth tergum sometimes medially setose, fifth tergum and more posterior terga setose, sometimes wide medial part of fifth and anteromedial part of sixth nearly glabrous [medial part of fifth nearly glabrous] (Fig. 3A). Seventh sternum with posterior margin roundly convex medially, with posteromedial part glabrous and weakly sclerotized (Fig. 3D). Sawsheath in posterodorsal view (Fig. 3B–C) broad, sunk basally,

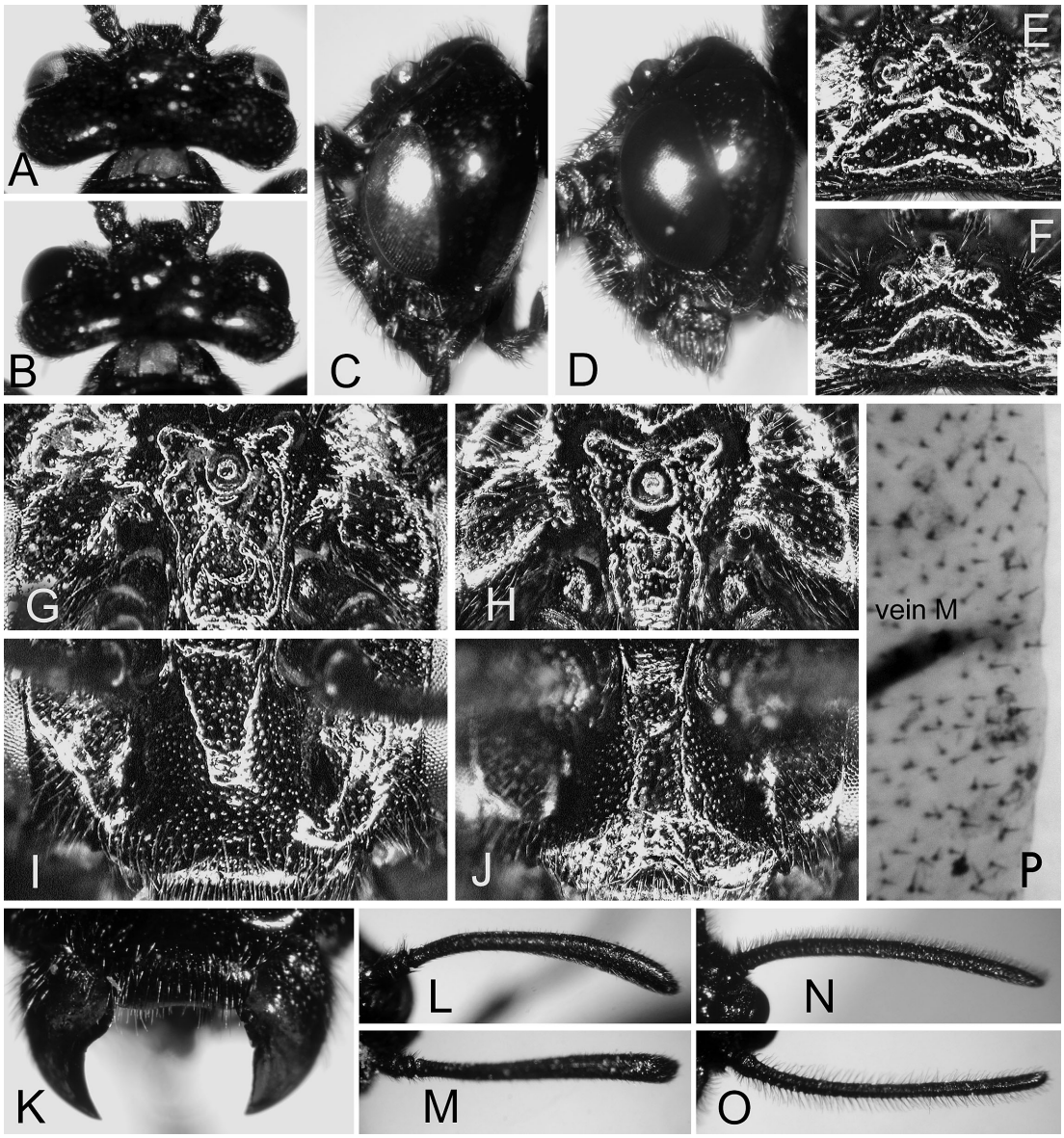


Fig. 2. Head and thorax (Sapporo, Hokkaido, HH040713A).—A, Head, dorsal view, female; B, ditto, male; C, head, lateral view, female; D, ditto, male; E, postocellar area, female; F, ditto, male; G, ocellar and frontal areas, female; H, ditto, male; I, supraclypeal area to labrum, female; J, ditto, male; K, mandibles, female; L–M, antenna, lateral and ventral views, female; N–O, ditto, male; P, outer margin of forewing around apex of vein M, female.

with medial lobe very short and located at base of sawsheath, dorsomedial ridge dull, and dorsal area nearly flat or gently sloping [sloping], lateral margin roundly convex and apex narrowly rounded; in lateral view (Fig. 3E), with ventral margin, except for basal convexity, slightly roundly convex, dorsal margin slightly concave or substraight [concave], and apex rounded, rarely obtusely pointed; inner side spinose. Lance (Fig. 3F) with apical crest well developed, roughly serrate on dorsal margin, with several very narrow membranous areas on middle and with groups of rudi-

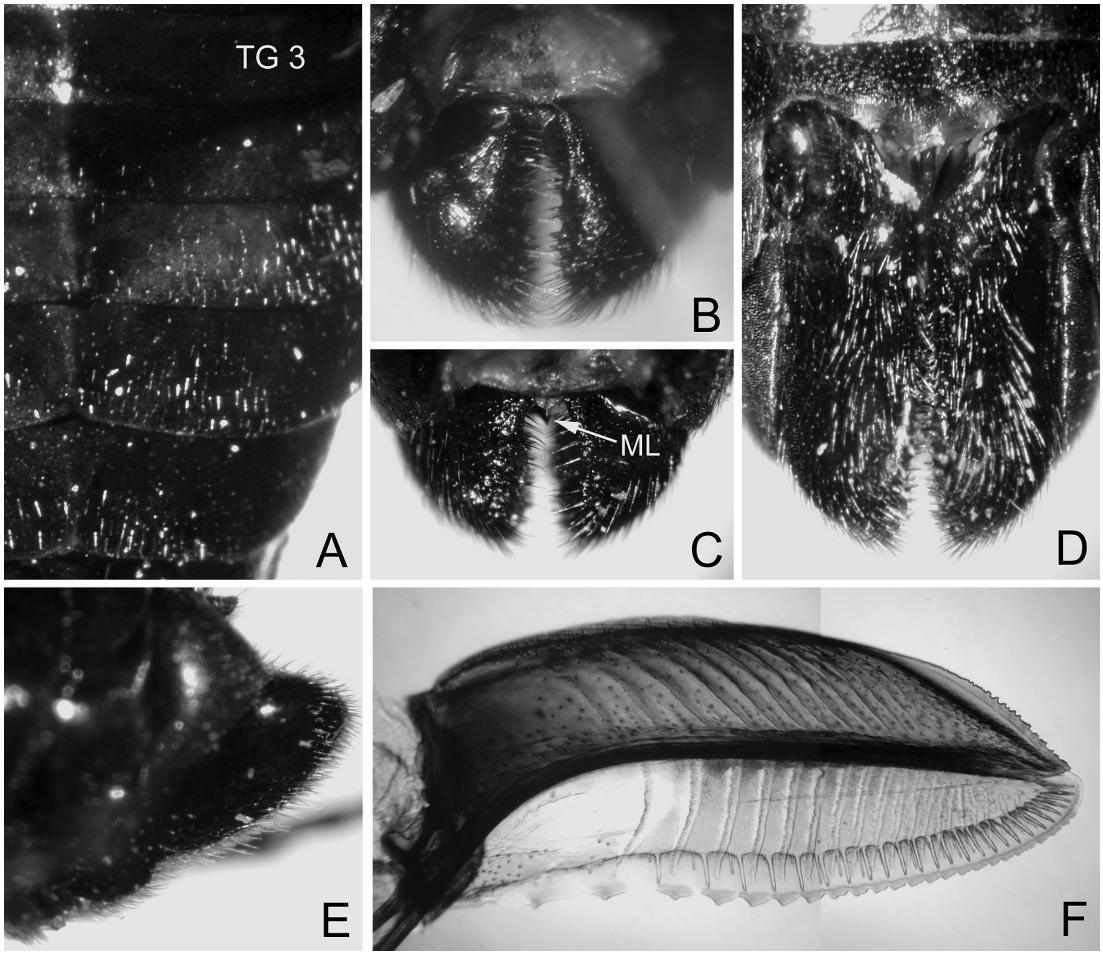


Fig. 3. Female abdomen.—A, C–F, Specimens from Sapporo, Hokkaido (HH040713A); B, holotype of *Arge nyemitawa*. A, Third to seventh terga; B, sawsheath, posterodorsal view; C, ditto; D, seventh sternum and sawsheath, ventral view; E, sawsheath, lateral view; F, saw. TG3: third tergum; ML: medial lobe.

mental setae at intervals along ventral margin, dorsobasally with scale-like sculptures. Lancet with about 22–24 serrulae, long marginal sensilla, and non-annulate area dorsoapically (Fig. 4); dorsal margin with membranous areas and group of minute setae at intervals; annuli nearly straight, basal ones arched toward apex of lancet; transverse rows of setae between annular plates present from second annulus; first annular plate dorsally far apart from dorsal margin of lancet; serrulae angular apically; second and third serrulae widely separated from each other.

In male abdomen, second to fourth terga with very sparse setae except for narrow lateral setose parts, fourth tergum sometimes medially setose, fifth tergum and more posterior terga setose, sometimes wide medial part of fifth nearly glabrous (Fig. 5A). Subgenital plate in dorsal or ventral view widely truncate, rarely rounded apically (Figs. 1E, 5B). Gonostipes in ventral view basally narrowly connected with each other, not widened apically, with apical width about as long as basal width of harpe (Fig. 5D). Harpe in ventral view with basal half nearly same width throughout (Fig. 5C–D). Valviceps simple, with anteroventral lobe small and located far apart from ergot anteriorly (Fig. 5 E–F).

Larva. Early and middle instars (Fig. 1H–I):

Pale green, in middle instars with trunk yellowish on both ends; head, cervical sclerite, legs, spiracles, small dorsal spots and large lateral blotches of trunk, lateral areas of prolegs, and apical part of tenth abdominal tergum black; setae black. Late and final instars (Figs. 1J–L, 6) as in early and middle instars, but trunk whitish gray above level of spiracles, yellow ventrally and on anterior part of prothorax and tenth segment, and in final instar black areas with blue reflections.

Final instar about 22 mm long (Figs. 1K–L, 6). Antenna conical (Fig. 6C). Clypeus with two pairs of setae. Labrum with two pairs of setae. Mandible with two setae on outer surface. Maxillary palp four-segmented; palpifer with two setae. Labial palp three-segmented. First to ninth abdominal segments each three-annulated. Black dorsal spots more or less tuberculate; tubercles except for those on first annulets of abdominal segments and small ones each with one large seta. Lateral lobes with some large setae and several minute setae. Prolegs on second to eighth and tenth abdominal segments; pair on eighth not protruding, almost rudimentary (Fig. 6I, K). Tenth tergum in dorsal view broadly rounded apically (Fig. 6J).

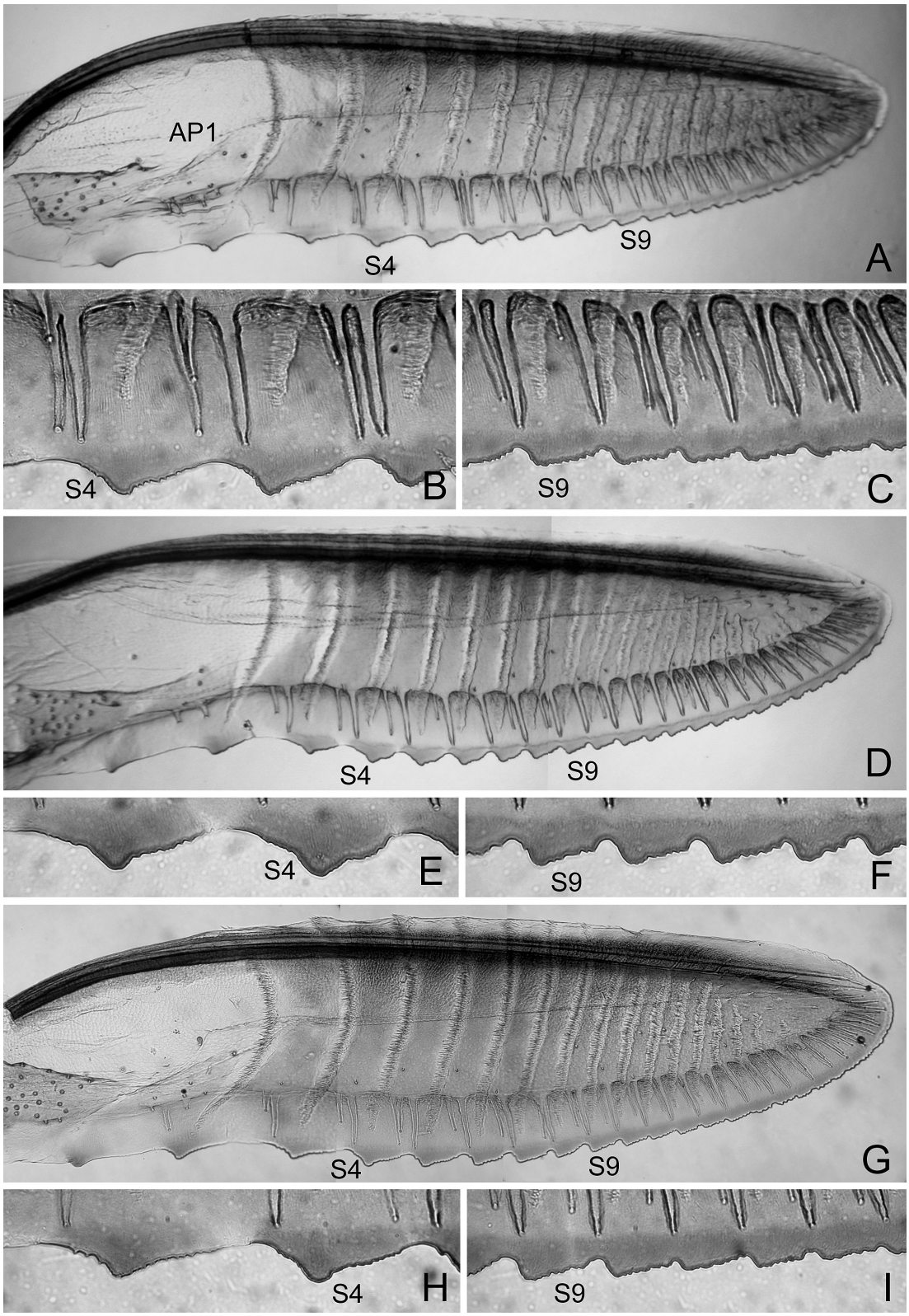
Cocoon. Length 12.5–15.5 mm in female, 10.5–11.5 mm in male. Creamy. Elongate oval, double walled; outer wall netted and inner wall parchment like.

Distribution. Japan (Hokkaido, Honshu) (Fig. 7); Europe, Armenia, west and east Siberia, the Russian Far East (Primorskij kraj, Sakhalin), and China (Gansu, Qinghai) (Li and Yuan, 1993; Zhelochovtsev and Zinovjev, 1995; Taeger *et al*., 2006).

Type material examined. Holotype of *Arge nyemitawa* Rohwer, 1925 (Figs. 1A, 3B, 4A–C): ♀ labeled "Okeanskaya, Siberia, Cockerell, August 1923", "Type No. 27615, U.S.N.M." and "*Arge nyemitawa*, Type ♀ Roh." Kept in the National Museum of Natural History, Smithsonian Institution, Washington, DC.

Other material examined. GERMANY: 1♀, München. AUSTRIA: 1♀, Vitis, Gebhartsteich, coll. larvae 24. VIII. 1993, em. 27. VI. 1994, host: *Betula verrucosa*, Altenhofer (BC); 1♀1♂, Vitis, coll. larvae VIII–IX. 1993, em. 13, 28. VI. 1994, host: *Betula verrucosa* (BC); 1♂, "Arge pullata, Betula verruc." (BC). POLAND: 2♀4♂, "Polen, Jüni[sic] 1937, T. Uchida" (HU). LATVIA: 1♀, "Kurland, Jolowka-Lepel, 28. VI. 1917, S. G. Bischoff" (Fig. 4G–I); 1♂, "Kanjersee, 20. VI. 1937, N. W. Grünwaldt" (Fig. 5F). UKRAINE: 1♂, "Kievskaja o., Yagotinskij r., c. Panfily, 24. VI. 1959, V. Dolin"; 1♀, "Kievskaja o., g. Yagotin, 15. VII. 1959, V. Dolin". RUSSIA–SAKHALIN: 1♀, "Kitakarafuto, Kono, Tamanuki", "Nuiho, Aug 1922" (HU). JAPAN–HOKKAIDO: 1♀, Kushiro, Teshikaga, Atosanupuri (43-39-30 N/144-27-06 E), 4. VII. 2005, R. Matsumoto (OMNH); 1♂, "Hokkaido, Yasui", "Tokachidake, 7–25, 1927" (HU); 1♀, Iwamizawa, Manji, 23. VII.–7. VIII. 2003, by Malaise-trap, H. Hara and N. Ishihama; 1♀, Sapporo, Hokkaido University, on leaf of *Betula platyphylla* var. *japonica*, 25. VI. 2004, H. Hara; 18♀6♂, same locality, 76 eggs coll. 25. VI. 2004, hatched 29. VI. 2004, coc. 20–30. VII. 2004, em. 13–19. VIII. 2004, host: *Betula platyphylla* var. *japonica*, HH040713A, H. Hara (Figs. 1B–E, 1L, 2, 3A, 3C–F, 4D–F, 5A–E, 6); 3 final instar larvae in ethanol, same data except fixed 26. VII. 2004; 1♀6♂, same locality, 80 larvae coll. 26. VIII. 2004, coc. 27. VIII.–1. IX. 2004, em. 9–21. V. 2005, host: *Betula platyphylla* var. *japonica*, HH040826A, H. Hara; 3♂, same locality (43-04-50N/ 141-20-23E), eggs coll. 28. VI. 2007, hatched 5. VII. 2007, coc. 28–31. VII. 2007, em. 16–26. VIII. 2007, host: *Betula platyphylla* var. *japonica*, AS070628B, A. Shinohara; 5 late instar larvae in ethanol, same data except "fixed 29. VII. 2007"; 2♀, Sapporo, Hokkaido

Fig. 4. Lancet, lateral view.—A–C, Holotype of *Arge nyemitawa*; D–F, specimen from Sapporo, Hokkaido, HH040713A; G–I, specimen from "Kurland". A, D, G, Entire lancet; B, E, H, basal serrulae; C, F, I, middle serrulae. AP1: first annular plate; S4: fourth serrula; S9: ninth serrula.


AP1
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government office (43-03-47N/141-20-56E), 28. VI. 2007, A. Shinohara; 3♀, Sapporo, Maruyama, 26. VI. 2006, H. Hara. HONSHU: Gunma Pref.: 1♀, "9. VII. 1951, Ozegahara", "Syoziro Asahina Collection". Yamanashi Pref.: 1♀, Daibosatsu, Hikawa-rindo, 19. VI. 1982, S. Tsuyuki; 1♀, Masutomi, 6. VIII. 1986, A. Shinohara. Niigata Pref.: 1♂, "15. VII. 1927, Akakura, Takeuchi" (OPU). Nagano Pref.: 1♀1♂, Sugadaira, 2. VII. 1952, J. Minamikawa (KU); 1♀, "26-VIII-56 L., 15-VI-57 A., Shirakanba [= *Betula platyphylla* var. *japonica*], Sugadaira?" (OPU); 1♀, "Sugadaira, 1956. 8. 26, S. Takizawa", "Emerged 1957. 6. 15, Host: Shirakanba" (OPU); 1♀, same data except "Emerged 1957. 6. 21" (OPU); 1♂, same data except "Emerged 1957. 6. 23" (OPU); 2♂, "12. VI. 1957, Sugadaira, S. Takizawa", "Host: Shirakanba" (OPU); 1♀, same data except "17. VI. 1957" (OPU); 1♀, same data except "18. VI. 1957" (OPU); 1♂, "14. VI. 1957, Sugadaira, S. Takizawa", "Host: Shirakanba", "Larva collected at Yanohara and Sanbonmatsu, Sugadaira, Osa-mura, Chiisagata-gun, Nagano-ken, 26. VIII. 1931" (OPU). Nara Pref.: 1♀, Ominesan, Mt. Daifugendake, 28. VI. 1985, K. Mizuno.

Host plants. *Betula* spp. (Betulaceae): *B. platyphylla* var. *japonica* in Japan (Takizawa, 1962); *B. pubescens*, *B. platyphylla*, *B. pendula* in Europe (Taeger *et al*., 1998); "Red Birch *Betula utilis* var. *sininsis*[*sic*]" in China (Li and Yuan, 1993).

Observations on biology. The following observations were made on the populations inhabiting the urban areas in Sapporo, Hokkaido, in the last several years.

A) In the middle to late October, 2001, the larvae of this species caused damages to the foliage of *Betula platyphylla* var. *japonica* in Chuo-ku, Sapporo (K. Hashiba, personal communication). Hara reared the larvae and they spun the cocoons but no adults emerged.

B) On August 24, 2003, Hara found three groups of middle instar larvae and one late instar larva on the leaves of *Betula platyphylla* var. *japonica* in the Hokkaido University campus, Sapporo. Attempts to rear them failed.

C) On June 25, 2004, Hara found a group of 76 eggs on the leaf of *Betula platyphylla* var. *japonica* in the campus of Hokkaido University, Sapporo (HH040713A). They hatched on June 29 and spun cocoons on July 20–30 in the laboratory. A total of 18 females and 6 males emerged during the period of August 13–19 of the same year. Others died.

D) On August 26, 2004, Hara collected a total of 80 late instar larvae from the leaves of *Betula platyphylla* var. *japonica* in the campus of Hokkaido University, Sapporo (HH040826A). They reached maturity and made cocoons in the period from August 27 to September 1, 2004, and one female and six males emerged on May 9 to 21, 2005 in the laboratory. Others did not survive.

E) On September 12, 2006, Hara observed that one tree of *Betula platyphylla* var. *japonica* (about 5 m high) had been almost completely defoliated by the larvae of *A. pullata*. The feeding season was close to the end, and only two late instar larvae were found.

F) On June 28, 2007, Shinohara found a large number of eggs along the margin of a leaf of *Betula platyphylla* var. *japonica* in the garden of the Hokkaido government office, Sapporo. The eggs hatched on July 2 (AS070628A, Fig. 1H), but all the larvae died in a few days. The leaf with the eggs or the leaves nearby may possibly have had insecticide treatments after the oviposition.

G) On the same day, Shinohara found about 70 eggs along the margin of a leaf of *Betula platyphylla* var. *japonica* (AS070628B, Fig. 1F–G) in the campus of Hokkaido University and they hatched on July 5. In the laboratory, only 12 larvae survived to the last instar, of which five larvae were fixed in ethanol on July 29. Two larvae spun cocoons on July 28, three larvae on July 31, and one larva each on August 3 and 7. One male each emerged on August 16, 19 and 26, 2007, while the others died with mold.

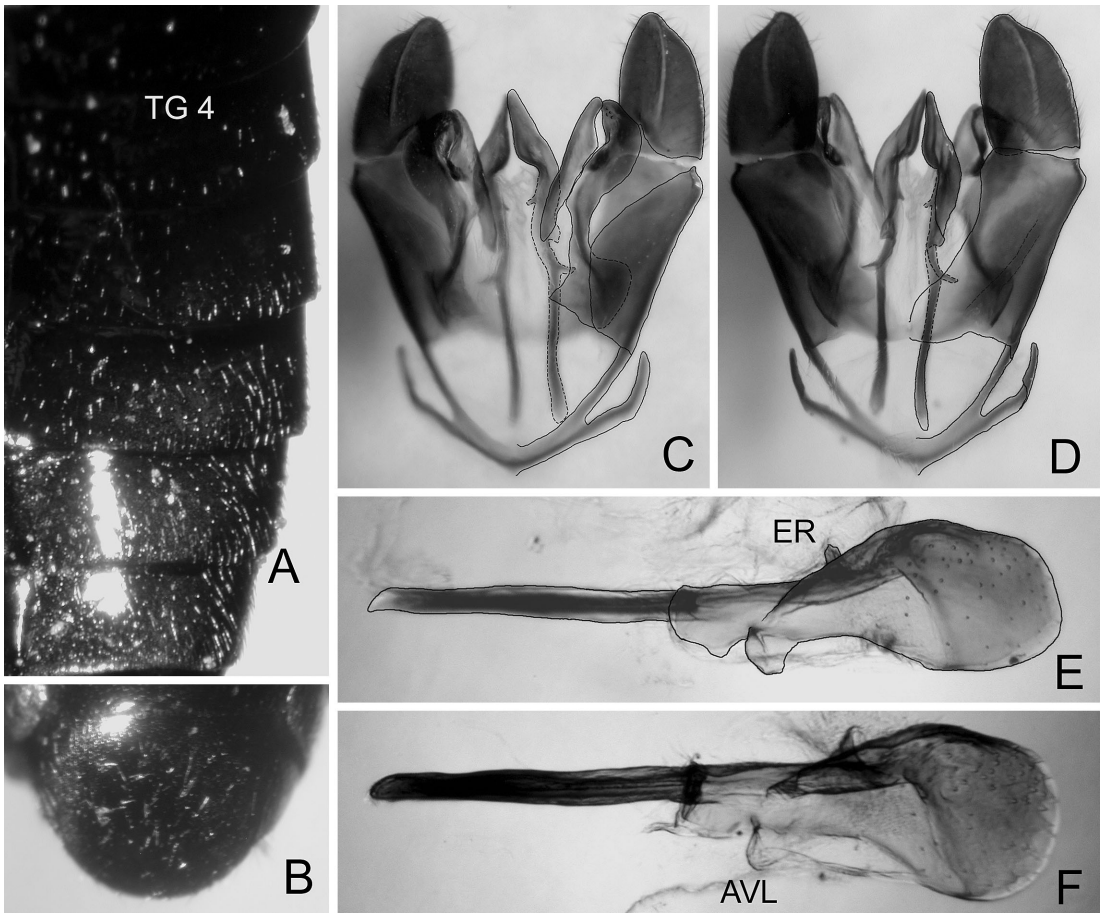


Fig. 5. Male abdomen and genitalia.—A–E, Specimens from Sapporo, Hokkaido, HH040713A; F, specimen from "Kanjersee". A, Fourth to eighth terga; B, subgenital plate, ventral view; C, genitalia, dorsal view; D, ditto, ventral view; E–F, left penis valve, lateral view. TG4: fourth tergum; AVL: anteroventral lobe; ER-ergot.

Discussion

Comparison with the Related Species

The adults of *A. pullata* are well characterized by the entirely bluish black body, legs and wings, the broadly rounded, not carinate medial part of supraclypeal area, the rather weakly infuscated apical 1/3 of the wings (distinctly less blackish than basal 2/3), the entirely glabrous narrow apical margins of the wings, and the normal, not pincer-shaped sawsheath of the female. *Arge enodis* (Linnaeus, 1767) shares these character states with *A. pullata*, but *A. enodis* is distinguished from *A. pullata* by the posterior part of the head (vertex and temples) not strongly inflated in dorsal and lateral views, the crossvein 3r-m rather short and straight, usually subparallel with 2r-m or weakly converging above with it, and the partly blackish "subanal area" in the female (see Shinohara *et al*., 2007, for more details). For separating *A. pullata* from other Palearctic congeners, keys by Enslin (1917), Gussakovskij (1935), and Zhelochovtsev (1988) may be useful.

The larvae of *A. pullata* are typically aposematic and gregarious even in late instars. The late instar larvae are well characterized by their color pattern (Fig. 1J–K, 6; see description above), particularly the feebly bluish luster on the black

parts of the head and the trunk. The larvae of the other *Arge* species feeding on *Betula* in Japan, e.g. *A. solowiyofka* (Matsumura, 1911) and *Arge aenea* Hara and Shinohara, 2008, are more or less cryptic and solitary in the late instar (Hara *et al*., 2007; Hara and Shinohara, 2008). In color pattern, the larvae of these species differ from those of *A. pullata* in the pale greenish or brownish ground color of the head with a dark mark, similarly pale color of the legs and greenish trunk without distinct dark spots. The larvae of *Spinarge flavicostalis* Hara and Shinohara, 2006, also feed on *Betula* gregariously, but the final instar larvae are entirely pale (Hara and Shinohara, 2006).

Arge pullata is generally similar to the members of the Nearctic *A. pectoralis* group defined by Smith (1989). The adults of the group are characterized by the straight crossvein 3r-m (curved in *A. pullata*), the anteriorly not widened 3rd cubital cell (widened in *A. pullata*), the rounded and usually punctured supraclypeal area, without a median carina, the broad sawsheath, the usually broad lancet without stout spines and dorsally projecting hairs, with relatively straight annuli and a larger gap between the second and third serrulae than between others (gap between the first and second serrulae also large, even larger than between the second and third in *A. pullata*), the narrow gonostipes, and the flat and oblong valviceps without a lateral lobe. The anteroventral lobe of the valviceps is absent in the *A. pectoralis* group (Figs. 54–59 of Smith, 1989), but it is present in *A. pullata* although it is very small. The larvae of the *pectoralis* group are characterized by the setae usually confined to the sclerotized plates on the body, the first to ninth abdominal segments with three annulets, the usually uniformly colored head, the large dark spots or tubercles on the trunk, the conical antenna, the apically rounded tenth abdominal tergum and the prolegs on the second to sixth (the second to seventh or eighth in *A. pullata*) and tenth abdominal segments.

Previous authors differ in the interpretation of the number of prolegs of this species. Zaddach (1859) noted that the larva had 22 "Füsse", indicating that the prolegs are eight pairs, whereas, according to Zaddach (1864) and Lorenz and Kraus (1957), the larva had seven pairs of prolegs. The larva actually has eight pairs of prolegs on the second to eighth and tenth abdominal segments, although those on the eighth segment are not protruding, almost rudimentary.

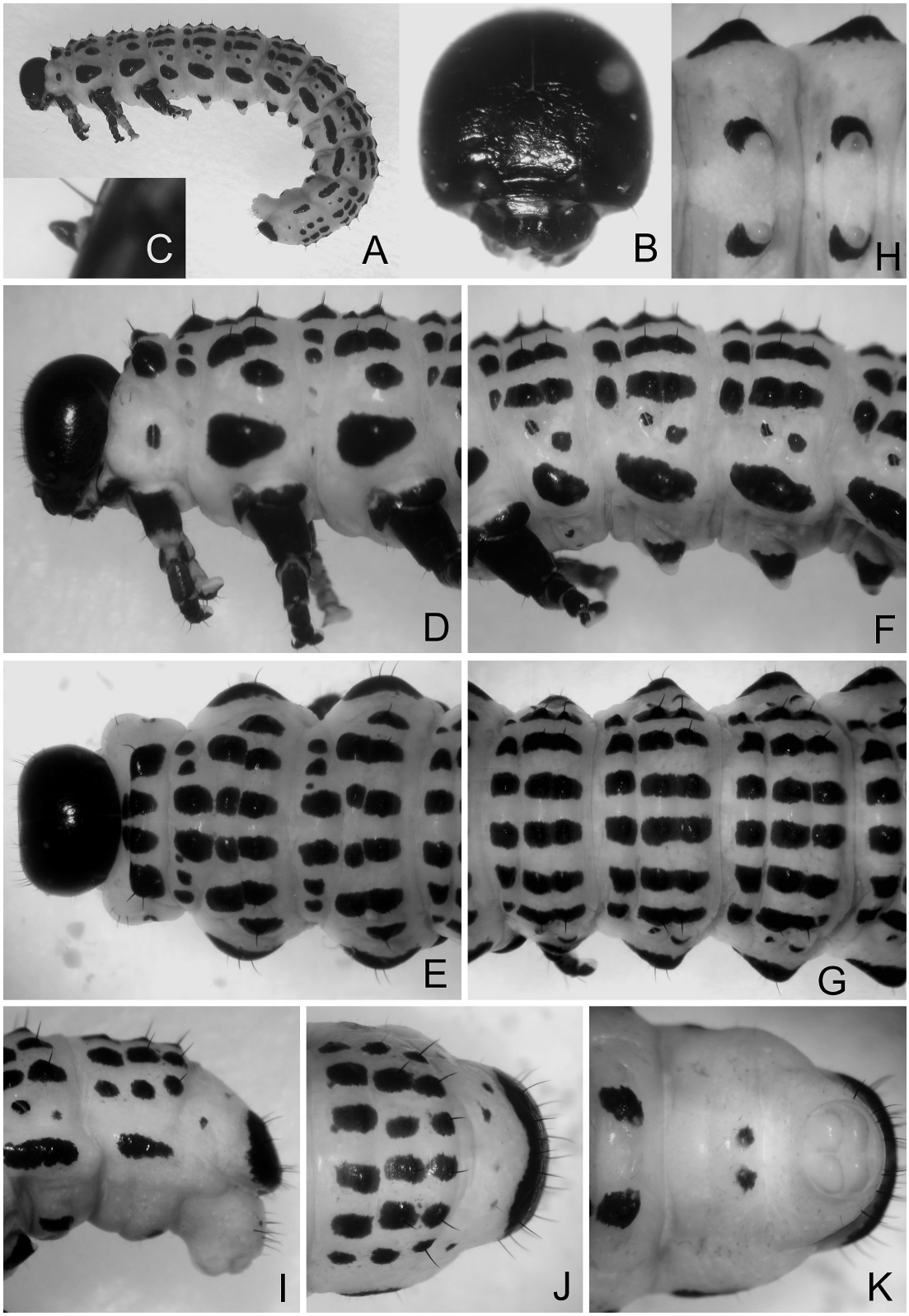
Arge nyemitawa, *a Junior Synonym of* A. pullata

Arge nyemitawa Rohwer, 1925, was described on the basis of one female from "Okeanskaja, Siberia", which is in the northeastern end of the city of Vladivostok, Primorskij kraj. It is a little known taxon. Gussakovskij (1935) did not include it in his key to the Palearctic species and Zhelochovtsev and Zinovjev (1995) put a question mark on it in their list of Symphyta of Russia and adjacent territories. An examination of the holotype deposited in the National Museum of Natural History, Washington, D.C., has revealed that the holotype is a normal female of *A. pullata*. We therefore propose to treat *Arge nyemitawa* Rohwer, 1925, as a junior synonym of *Arge pullata* (Zaddach, 1859).

Distribution in Japan

There are only a few published collection data of *A. pullata* from Japan. Takizawa (1962) reported on a mass occurrence of *A. pullata* in Sugadaira, Nagano Prefecture, central Honshu. This was the first record of this sawfly from Japan. Togashi (1965) showed a photograph of this species and gave Honshu as the distribution of this species. The same author recorded this species from Mt. Rokuman-zan, Ishikawa Prefec-

Fig. 6. Final instar larva (Sapporo, Hokkaido, HH040713A).—A, Whole body, lateral view; B, head, anterior view; C, antenna, ventral view; D, head and thorax, lateral view; E, ditto, dorsal view; F, first to third abdominal segments, lateral view; G, ditto, ventral view; H, second and third abdominal segments, ventral view; I, eighth to tenth abdominal segments, lateral view; J, ninth and tenth abdominal segments, dorsal view; K, eighth to tenth abdominal segments, ventral view.


C
A
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ture (Togashi, 1974) and from Renge-onsen, Niigata Prefecture (Togashi, 1982), both in central Honshu (Fig. 7).

Figure 7 shows the distribution of *A. pullata* in Japan based on the specimens examined and previously published records. This species is usually rare but seems to have a fairly wide distribution range in Hokkaido and on mountains of Honshu. In Hokkaido, the name of *A. pullata* was first given in a list of insects collected in Abashiri in 1993 (near Shinbashi in Abashiri City, on September 17; see Anonymous, 1996), although this is an anonymous record without definite credibility. There are no other published records, but the species sometimes occurs in great numbers on the birch stands in the urban areas of Sapporo in recent years as noted below (see also Anonymous, 2006).

Life History

Life histories of *Arge* species are often quite complicated (Shinohara *et al*., 2007; Shinohara and Hara, 2008) and *A. pullata* is no exception.

According to Takizawa's (1962) observations in Sugadaira (about 1,100 m alt.), central Honshu, this species had a univoltine life cycle, with the adult emergence in late July to early August (more abundant in late July). The adult specimens from Takizawa's collection we have examined were mostly reared and the emergence dates on the labels are middle or late June; this early emergence is probably because of the laboratory conditions. The eggs were laid into the tissue of the leaf in a row along the leaf margin. The clutch size was 24–50. The incubation period was about 10 days, and the larvae began to feed from the beginning of August. The larvae were gregarious. The larval feeding period was about 30–35 days and the mature larvae went into the soil in late August to early September to make cocoons.

Our observations in Sapporo, Hokkaido, as outlined above, suggest a different pattern of life cycle. In Sapporo, there are probably two generations a year, with the adult emergence in late June and late August, as indicated by the observations C, F and G and perhaps also A. The collection data of several adult females in late June (see *material examined*) should support this hypothesis. On the other hand, the middle and late instar larvae were also found in late August to early September (observations B, D, E). These larvae could be interpreted as the late occurrence of the first generation of the year (the offspring of the spring adults) or an early occurrence of the second generation. If the former is the case, then the polymodal occurrences of the adults of the hibernated larvae may be involved, as in the case of *Arge suzukii* (Matsumura, 1912) (Knerer, 1993; Shinohara and Hara, 2008), and such stragglers may not produce another generation within the same year (e.g. observation D).

In Sapporo, the oviposition site on the leaf and larval gregarious habits were the same as in Sugadaira, but the clutch size was larger (70–80, observations D, E, H) and the larval feeding period was shorter (21–33 days, observations D and H).

The collection data of the adults in Honshu (see material examined), though small in number, do not always agree with the univoltine life cycle described by Takizawa (1962). Particularly the early collection date (middle June) of the female in Hikawa-rindo, in central Honshu (ca. 1,100–1,600 m alt., on June 19) would suggest the occurrence of bivoltine life cycle also in Honshu.

The life history of this species has not been well documented in Europe (Zaddach, 1859, 1864; Snellen van Vollenhoven, 1879; Escherich, 1942), while Li and Yuan (1993) reported on a univoltine life cycle in central China.

Economic Importance

Arge pullata seems to be usually uncommon throughout its distributional range, but the mass occurrence of the larvae causing damages to the birch stands has been recorded in Europe (Snellen van Vollenhoven, 1879; Escherich, 1942; Austara *et al*., 1984; Nuorteva and Nuorteva, 2007), China (Li and Yuan, 1993), and Japan (Takizawa, 1962).

Takizawa (1962) reported on the heavy infesta-

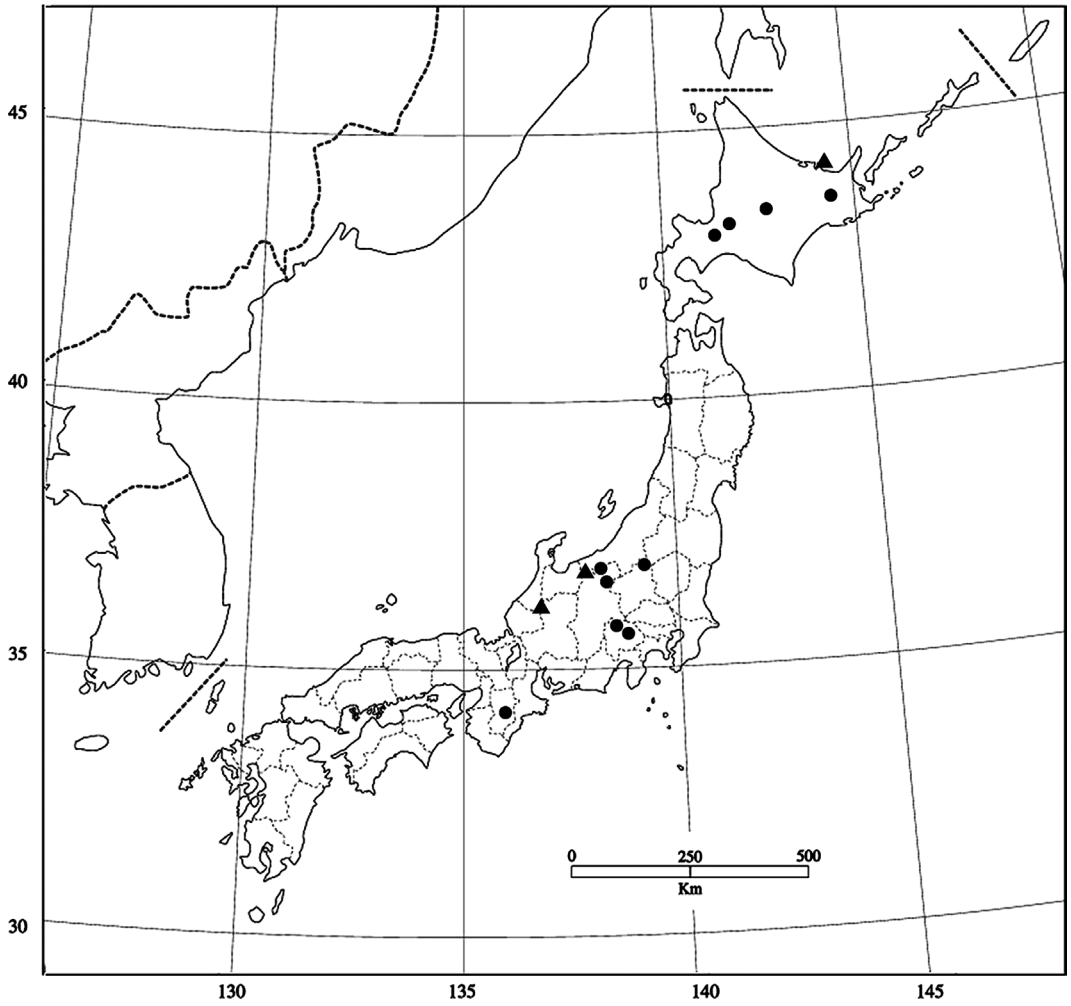

Fig. 7. Distribution of *A. pullata* in Japan. Some overlapping plots are omitted. ●: specimens examined; ▲: after Togashi (1974, 1982) and Anonymous (1996).

tion of birch forest by this sawfly in Sugadaira, Nagano Prefecture, central Honshu, based on the observations during 1956 to 1961. The damaged forest is situated at the altitude of 1,100 meters on the western slope of a mountain and composed of 5–30 year-old trees, of which about 70% were younger trees of 5–10 years old. The infestation was prominent on such younger trees; some of them were completely defoliated and died after a continuous attack years over. There are no subsequent reports on the outbreak of this sawfly from Honshu. In Hokkaido, the larvae of *A. pullata* often occur in great numbers on the birch trees in the city of Sapporo in recent years (see our observations given above). It was reported (Anonymous, 2006) that the larvae of this sawfly (identification by the cited photograph) were very common on birch trees in a park in Sapporo in early August and that numerous cocoons had been found in the sandbox in autumn (probably of the preceding year).

The larvae of *A. pullata* are known to have caused poisoning of sheep, goats, and puppies in Denmark (Brummerstedt *et al*., 1987; Thamsborg *et al*., 1987) when they occur in outbreak proportions on birch trees in pastures. The conse-

quent loss of livestock has economic impacts, though such economic damages caused by this sawfly have not been reported since.

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