

The Species-group of *Arge aenea* (Insecta, Hymenoptera, Argidae)

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Abstract The species-group of *Arge aenea* (Hymenoptera, Argidae) is proposed for three new species from East Asia: *A. aenea* sp. nov. from Japan (Hokkaido, Honshu, Shikoku and Kyushu), Russia (Khabarovskij Kraj and Primorskij Kraj), Korea and China (Shaanxi Province), *A. tuberculata* sp. nov. from China (Shaanxi Province) and *A. fulvicauda* sp. nov. from China (Shaanxi and Sichuan Provinces). This species-group is characterized by the peculiar structure of the seventh and eighth abdominal terga of the males; the seventh tergum has a small swelling posteromedially and the eighth tergum has a shallow and wide depression at middle. These character states are unique to the three species in the Argidae and support the monophyly of the species-group. Descriptions of the three new species are given. The larva of *A. aenea* sp. nov. is a leaf-feeder on *Betula*.

Key words: Hymenoptera, Argidae, *Arge*, *Arge aenea* group, new species, East Asia.

Arge is a large genus of the sawfly family Argidae (Hymenoptera, Symphyta). It is distributed mainly in the Holarctic, Oriental, and Ethiopian regions with more than 300 described species (Takeuchi, 1939; Smith, 1989, 1992; Wei *et al.*, 2006). In East Asia, about 120 species of the genus have been recognized (Gussakovskij, 1935; Takeuchi, 1939; Wei *et al.*, 2006).

In the following lines, we will describe three new species of *Arge* from East Asia and propose to treat them as representing a species-group of their own, the *A. aenea* group. The *A. aenea* group is regarded as monophyletic, because they share peculiar structure of the seventh and eighth abdominal terga of the males in addition to the very close general resemblance in color and structure. *Arge aenea*, described below, was known as “*Arge metallica*” in previous Japanese literature (see Hara and Shinohara, 2006, and discussion below).

All the material used in this work is kept in the National Museum of Nature and Science, Tokyo, unless otherwise indicated. Abbreviations for the

depositories are: DEI–Deutsches Entomologisches Institut, Müncheberg; EU–Ehime University, Matsuyama; HU–Hokkaido University, Sapporo; KU–Kobe University, Kobe; OMNH–Osaka Museum of Natural History, Osaka; OPU–Osaka Prefecture University, Sakai; YC–M. Yamada Collection, Kuroishi.

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Species-group of *Arge aenea*

Diagnosis. Eye with vertical diameter 1.5–1.6× horizontal diameter in female, 1.4–1.5× in male (Figs. 16–17). Postocellar area weakly convex, with anterior margin slightly furrowed (very rarely flat and not furrowed in male); lateral furrow obscure (Figs. 18–19). Supraclypeal area medially carinate or not carinate, with side slope rounded or nearly flat, and punctate and usually longitudinally rugulose (Figs. 21, 23–24). Clypeus usually flattened lateroventrally, with ventral margin incised medially in frontal view. Right mandible without notch on inner margin (Figs. 21, 24).

In forewing, cell 1Rs2 with anterior length slightly narrower or longer than posterior length; crossvein 3r-m angularly or roundly curved (Figs. 1–2, 8–9, 11–12). In both wings, wing margin between veins Rs and Cu glabrous, with marginal glabrous part wider than width of vein M, and setae near apical wing margin generally very minute, at most about as long as width of vein M (Figs. 31–32).

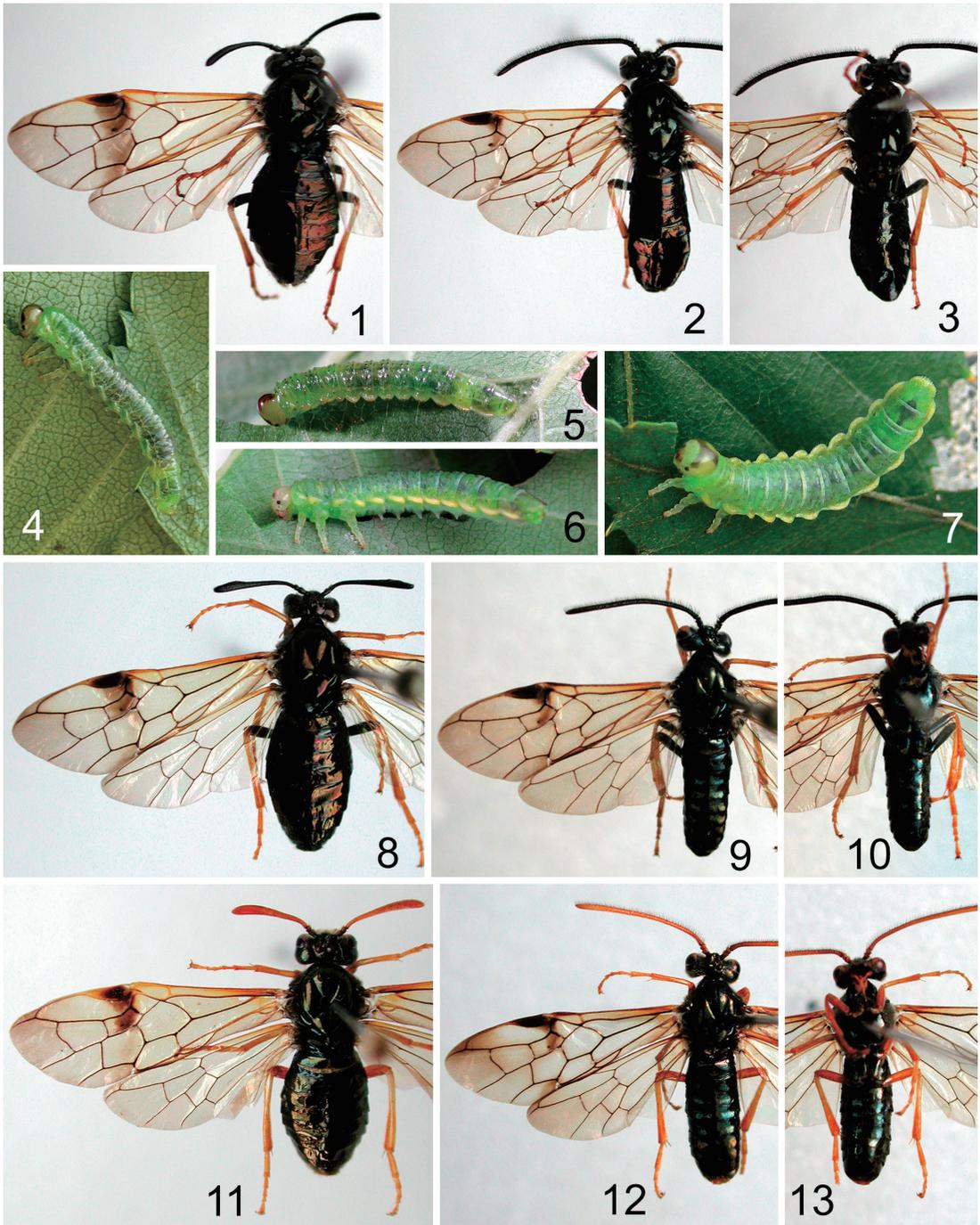
In female abdomen, second to fourth terga almost glabrous except for narrow setose lateral parts, fifth to seventh terga with very sparse minute setae except for narrow setose lateral parts (seventh rarely narrowly setose at middle), and eighth to tenth terga setose (Fig. 33). Seventh sternum with posterior margin strongly and roundly convex (Figs. 34, 39). Sawsheath in posterodorsal view broad, with medial lobe very short and located at base of sawsheath (Figs. 35, 37, 40), in lateral view with ventral margin, except for basal convexity, not indented (Figs. 36, 38, 41); inner side spinose. Lance with apical crest distinct and weakly serrate on dorsal margin, several narrow membranous parts on middle annuli and groups of minute setae at intervals along ventral margin, and dorsobasally with scale like sculptures (Figs. 42–43). Lance with middle and apical annuli weakly arched toward base of lance, without spines, and almost wholly annulated except for basal membranous part; dorsal margin narrowly membranous, with minute setae

at intervals; marginal sensilla long; row of setae absent before first annular plate (short row present in one female of *A. fulvicauda* sp. nov.) (Figs. 44, 49, 52, 55).

In male abdomen, second to fourth terga nearly glabrous except for narrow setose lateral parts, fifth to seventh terga with sparse minute setae except for narrow lateral parts, eighth tergum setose except for medial part with sparse minute setae (Figs. 58–60, 62); seventh tergum posteromedially with small swelling, often very weak; eighth tergum medially shallowly and widely depressed except for narrow posterior margin. Subgenital plate in dorsal or ventral view rounded apically (Figs. 58, 60, 62). Gonostipes in ventral view not widened apically, with apical width about as long as basal width of harpe (Figs. 64–65, 67, 69). Harpe in ventral view widest near base, narrowing apically. Valviceps long, apically reaching to or near level of apex of harpe, with anteroventral lobe large and lateral lobe indistinct (Figs. 63–73).

Larva (based on *A. aenea*). Middle to final instars yellowish green (Figs. 4–7); head with dark mark. Antenna rather flattened (Figs. 77–78). Clypeus with two pairs of setae (Fig. 79). Labrum with two pairs of setae. Mandible with 8–10 setae on outer surface. Maxillary palp four-segmented; palpifer with 4–6 setae. Labial palp three-segmented. In semifinal instar (Figs. 5, 74–75), dorsal side of trunk with setae arising on small slightly dark spots, whereas in final instar (Figs. 6–7, 80–84), small dark spots absent and almost entire surface covered with distinct setae. First to ninth abdominal segments each with three annulets. Prolegs on second to sixth and tenth segments (Figs. 6, 74). Pair of slightly pigmented circles present on venter of ninth abdominal segment (Fig. 86). Tenth tergum in dorsal view rounded apically (Fig. 84).

Remarks. The species of the *A. aenea* group are characterized by the seventh abdominal tergum with a small swelling posteromedially and the eighth abdominal tergum with a shallow and wide depression medially in the male. These characters are unique to this species-group in the



Figs. 1–13. *Arge aenea* sp. nov., female (paratype, Shikaribetsu-ko) (1), male (holotype) (2–3), larvae (4–7), *A. tuberculata* sp. nov., female (paratype, Mt. Taibaishan) (8), male (holotype) (9–10), *A. fulvicauda* sp. nov., female (holotype) (11), and male (paratype, Mt. Taibaishan) (12–13). — 1–2, 8–9, 11–12, Dorsal view; 3, 10, 13, ventral view; 4, middle instar (offspring of female of Fig. 1), 15. VII. 2006; 5–6, semifinal and final instars (offspring of HH040621A, Shikaribetsu-ko), 15 mm long, 9. VII. 2004, and 18 mm long, 13. VII. 2004; 7, final instar (offspring of female of Fig. 1), 19. VII. 2006, 16 mm long. Figs. 4–7, photographed by H. Hara in the laboratory in Bibai.

Argidae and support the monophyly of the group.

Smith (1989) divided Nearctic *Arge* into four species-groups, *Arge ochropa* group, *A. humeralis* group, *A. pectoralis* group, and *A. clavicornis* group. In both the keys to the adults and larvae given by Smith (1989), species of the *A. aenea* group would run to the couplet 3, that contains the *A. pectoralis* group and the *A. clavicornis* group. In the adults, the *A. aenea* group is distinguished from the *A. pectoralis* group by the lancet without a large gap between the second and third serrulae and the valviceps with a large anteroventral lobe (the lancet has a large gap between the second and third serrulae, and the valviceps lacks a distinct anteroventral lobe in the *A. pectoralis* group), and from the *A. clavicornis* group by the gonostipes relatively narrow, the harpe apically tapering and basally about as wide as the apical width of the gonostipes, and the valviceps without a lateral lobe (the gonostipes is wide, the harpe is apically broadened and basally narrower than the apical width of the gonostipes, and the valviceps has a lateral lobe in the *A. clavicornis* group). In the larvae, the *A. aenea* group is distinguished from the *A. pectoralis* group by the antenna rather flattened, the body with very small dark spots if any, and the head with dark marking (the antenna is conical, the body has large dark spots or tubercles, and

the head is usually uniformly colored in the *A. pectoralis* group), and from the *A. clavicornis* group by the seventh and eighth abdominal segments without prolegs (the seventh or the seventh and eighth abdominal segments have prolegs in the *A. clavicornis* group).

Togashi (1992) defined the *A. mali* group, though it was only characterized by the coloration. The *A. aenea* group differs from the *A. mali* group by the tibiae entirely pale and the female abdomen not pale-marked except for the sawsheath (the tibiae are darkened apically and the female abdomen is pale on the middle segments in the latter).

In general appearance, the members of the *A. aenea* group are recognized by the combination of the following characters: Head and body black, dorsally with distinct bronzy to brassy reflections at least on parts of head and thorax and posterior abdominal terga; setae on mesopleuron whitish; tibiae and tarsi yellow to orange, at most apices of claws brownish; wings hyaline with dark mark below stigma, glabrous along apical margins, and with setae near apical wing margins minute; abdomen glabrous or only with sparse minute setae on second to seventh terga (except for narrow lateral parts) in female, and on second to seventh terga (except for narrow lateral parts) and medial part of eighth tergum in male.

Key to the species of the *Arge aenea* group

1. Female. 2
– Male. 4
2. Flagellum and middle and hind femora orange (Fig. 11). Sawsheath orange, ventrobasally black (Figs. 39–40). *A. fulvicauda* sp. nov.
– Flagellum and middle and hind femora black (Figs. 1, 8). Sawsheath entirely black (Figs. 34–35, 37). 3
3. Serrulae rounded apically; basal and middle serrulae with apices usually close to anterior ends, and generally not angulate near posterior ends (Figs. 44, 49). *A. aenea* sp. nov.
– Serrulae somewhat angular apically; basal and middle serrulae with apices relatively distant from anterior ends, and generally angulate near posterior ends (Fig. 52). *A. tuberculata* sp. nov.
4. Flagellum and middle and hind femora orange (Figs. 12–13). *A. fulvicauda* sp. nov.
– Flagellum and middle and hind femora black (Figs. 2–3, 9–10). 5
5. Posteromedian swelling on seventh abdominal tergum low and rounded, sometimes indistinct (Fig. 58). Gonostipes in ventral view with inner margin deeply and angularly concave apically

- (Figs. 64–65). Valviceps with anteroventral lobe knob-like (Figs. 64–65, 70–71)... *A. aenea* sp. nov.
- Posteromedian swelling on seventh abdominal tergum conspicuous, triangularly raised and pointed at apex in lateral view (Figs. 60–61). Gonostipes in ventral view with inner margin scarcely concave apically (Fig. 67). Valviceps with anteroventral lobe nearly flattened, not knob-like (Figs. 67, 72). *A. tuberculata* sp. nov.

Arge aenea sp. nov.

[Japanese name: Akagane-churenji]

(Figs. 1–7, 14–23, 25–29, 32, 33–36, 42–51, 58–59, 63–65, 70–71, 74–87)

Arge metallica: Okutani, 1955: 14; Okutani, 1974: 197; Togashi, 1997: 1 [partim]; Naito *et al.*, 2004: 11; Yoshida, 2006: 24.

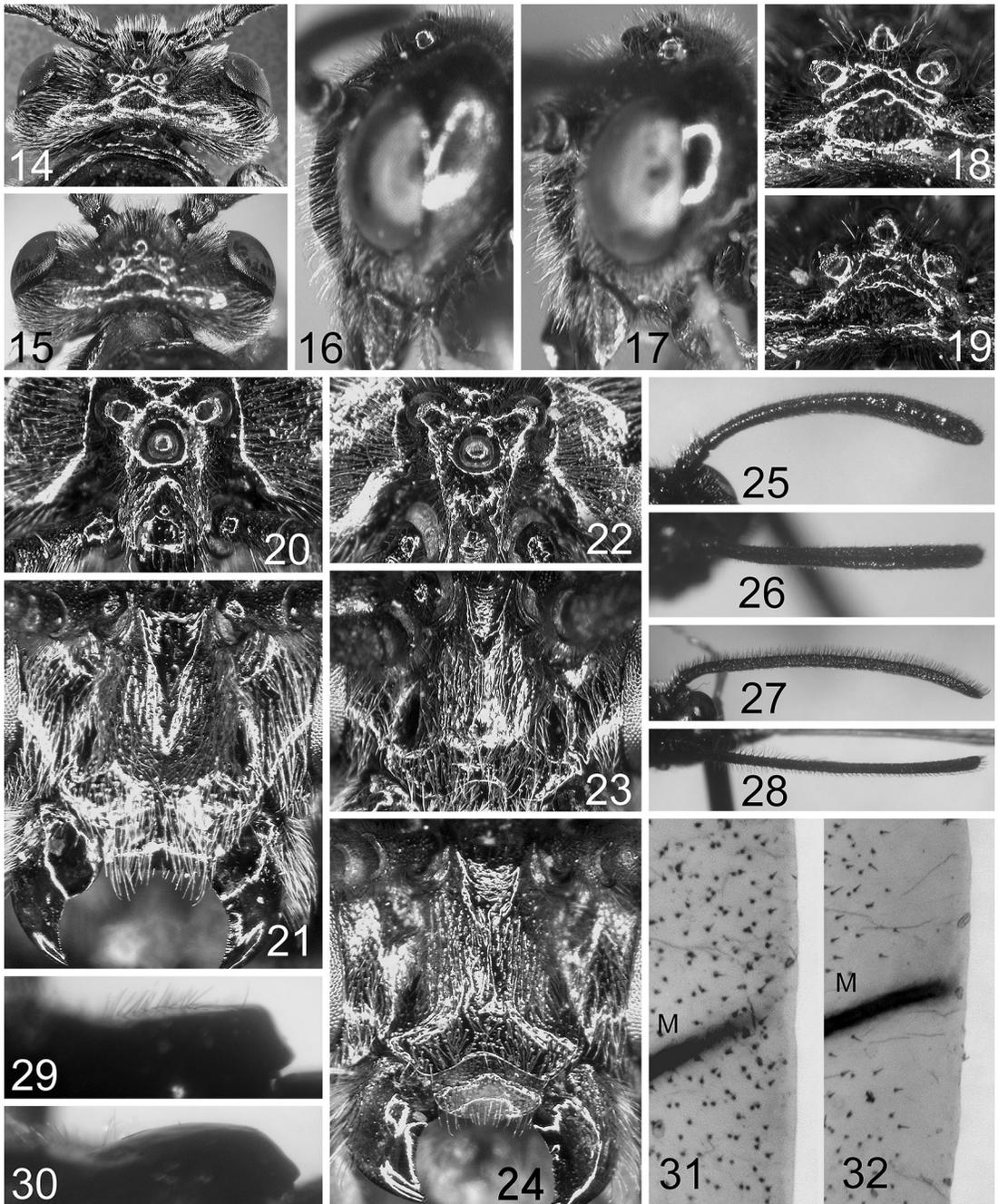
Description (female and male). [Conditions of holotype (male, Fig. 2) in brackets.] Length 8.5–11.5 mm in female, 9.5–11.5 [10.0] mm in male. Black with reflections generally bronzy above and generally green blue beneath (Figs. 1–3). Flagellum black, in female rarely apically brownish. Labrum often apically brown [black]. Mandible apically reddish. Maxillary palp yellow on apical two to three segments. Labial palp yellow to orange on apical one to three segments, rarely entirely dark [apically pale]. Legs orange on apical third to half of fore femur, apex of mid femur, tibiae, tibial spurs and tarsi; mid and hind tibiae basally whitish yellow; claws orange, apically brownish. Seventh abdominal sternum orange along posterior margin in female. Wings slightly yellowish hyaline, faintly brownish apically, with dark transverse band below stigma in female (Fig. 1) (dark band sometimes obsolete in cell 2M as in Fig. 8, or very rarely completely absent in cell 2M), with dark spot below stigma in male (Fig. 2); veins mostly dark; in forewing, cells C and Sc distinctly yellow, and veins C and Sc, part or most [most] of section of vein R1 basal to stigma, apical section of R1, and base or most [most] of vein A yellow to orange; vein C rarely darkened apically [not darkened]; crossvein 1cu-a often pale [pale]; stigma mostly dark, rarely widely pale in female as in Fig. 11. Setae whitish, dorsally generally brownish; wing with setae dark, but yellowish on vein C and cells

C and Sc of forewing and wing bases.

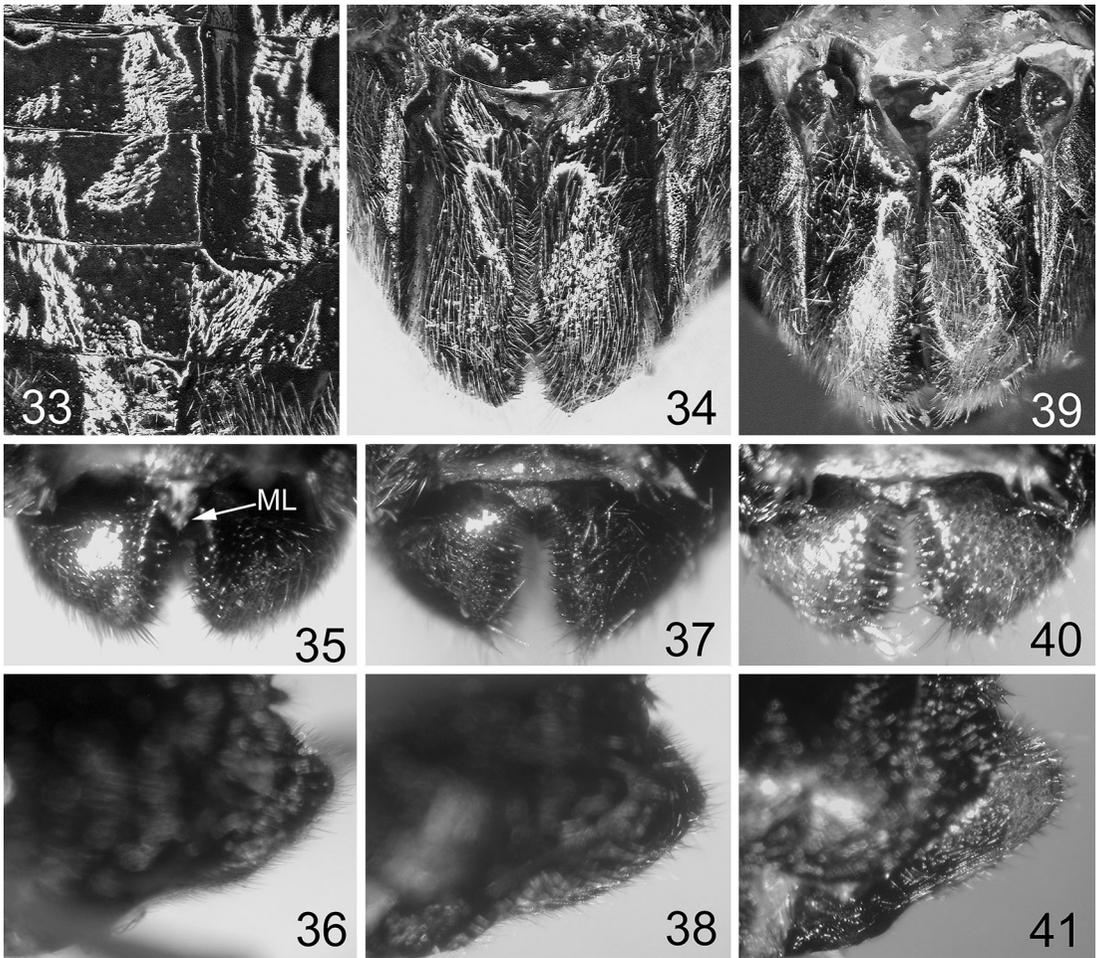
Surface smooth and shining; punctures very fine, relatively distinct on head, pronotum and mesoscutum; apex of abdomen very finely coriaceous laterally and ventrally.

Head in dorsal view slightly dilated behind eyes, rarely not dilated in female (Fig. 14), slightly narrowing in male (Fig. 15), in lateral view with anterior margin roundly convex below antenna, very slightly concave at clypeus (Figs. 16–17). Distance between eyes 1.2–1.5× vertical diameter of eye in female, 1.0–1.3 [1.3]× in male. Ocellar area concave between ocelli, slightly raised at anterior ocellus (Figs. 20, 22). Frontal area with lateral ridges distinct throughout, though weakened posteriorly (very rarely indistinct posteriorly in female), and medial depression narrowing and deepening anteriorly. Median fovea rather deep. Interantennal carinae sharp, ventrally converging and usually fused with each other about center of supraclypeal area [fused]. Supraclypeal area with median ridge carinate or not carinate [carinate] (Figs. 21, 23). Malar space 0.5–1.6× width of front ocellus (usually more than 0.8) in female, 0.4–1.1 [0.9] × in male. Antennal length 1.4–1.6 × maximum width of head in female, 2.2–2.6 [2.6] × in male; flagellum nearly club-like, rounded apically, and not compressed in female (Figs. 25–26), slightly tapering apically in lateral view, nearly of same thickness throughout in ventral view and slightly compressed in male (Figs. 27–28). Mesoscutellum in lateral view with dorsal margin nearly flat or slightly roundly convex [nearly flat], posteriorly strongly curved below (Fig. 29). Hindwing with cell 1M $\frac{3}{5}$ – $\frac{4}{5}$ [$\frac{2}{3}$] of cell 1Rs in length.

In female abdomen, sawsheath in posterodorsal view sunk basally, with medial ridge sharp basally, rarely dull, lateral slope from medial



Figs. 14–32. *Arge aenea* sp. nov., female (paratype, Shikaribetsu-ko) (14, 16, 18, 20–21, 25–26, 29), male (holotype) (15, 17, 19, 22–23, 27–28, 32), and *A. fulvicauda* sp. nov., female (paratype, Mt. Taibaishan) (24, 30–31). — 14–15, Head, dorsal view; 16–17, head, lateral view; 18–19, postocellar area, dorsal view; 20, 22, frontal area, anterodorsal view; 21, 23–24, medial part of head below antenna, anterior view; 25–28, antenna, lateral and ventral views; 29–30, mesoscutellum, lateral view; 31–32, apical margin of forewing (reversed). Abbreviation: M—vein M.



Figs. 33–41. Female abdomens, *Arge aenea* sp. nov. (paratype, Shikaribetsu-ko) (33–36), *A. tuberculata* sp. nov. (paratype, Mt. Taibaishan) (37–38), and *A. fulvicauda* sp. nov. (paratype, Mt. Taibaishan) (39–41). — 33, Medial parts of fifth to eighth abdominal terga; 34, 39, seventh sternum and sawsheath, ventral view; 35, 37, 40, sawsheath, posterodorsal view; 36, 38, 41, ditto, lateral view (38, reversed). Abbreviation: ML—medial lobe.

ridge somewhat steep, lateral margin roundly convex, and apex narrowly rounded (Fig. 35), in lateral view with ventral margin, except for basal convexity, more or less rounded, dorsal margin nearly straight, and apex rounded (Fig. 36). Lancet with about 18–20 serrulae (Figs. 44, 49); first annular plate narrowing or disappearing dorsally; second and third annular plates narrowing dorsally, rarely not narrowing (Figs. 44–45, 49); serrulae distinctly convex, apically rounded (Figs. 47–48, 50–51); basal and middle serrulae with apices usually close to anterior ends, gener-

ally not angular near posterior ends.

In male, seventh abdominal tergum with small and round swelling posteromedially (Fig. 58). Gonostipes in ventral view with medial margin posteriorly deeply and angularly concave (Figs. 64–65). Valviceps with anteroventral lobe knob-like, and lateroventral lobe very small and located near apex of valviceps (Figs. 64–65, 70–71).

Larva (Figs. 4–7, 74–86). Final instar 18 mm long. Yellowish green; head with dark inverted Y-shaped mark as in Fig. 7, dorsally and laterally pale ochreous to greenish yellow; frons and its

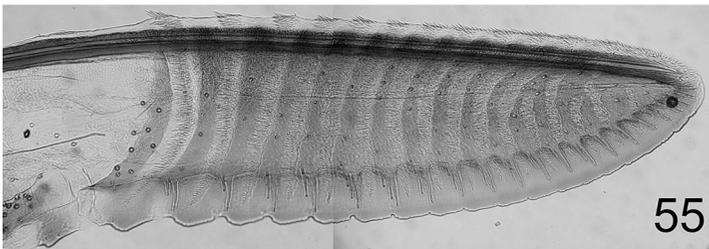
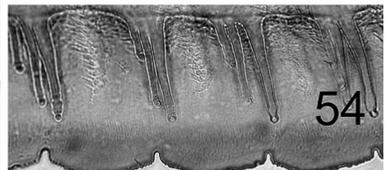
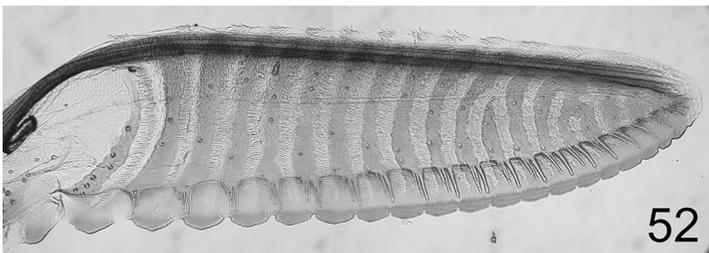
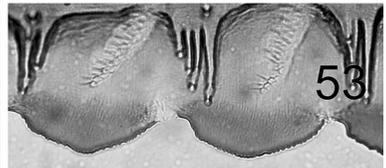
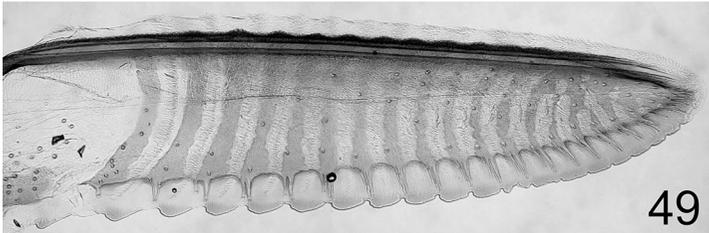
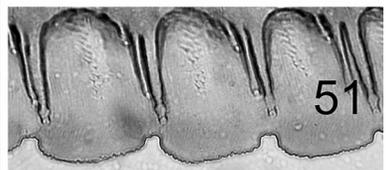
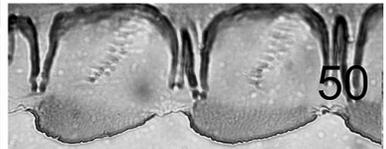
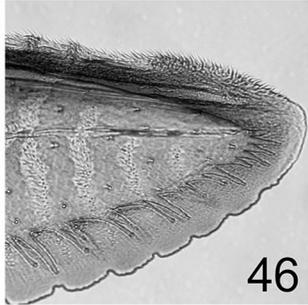
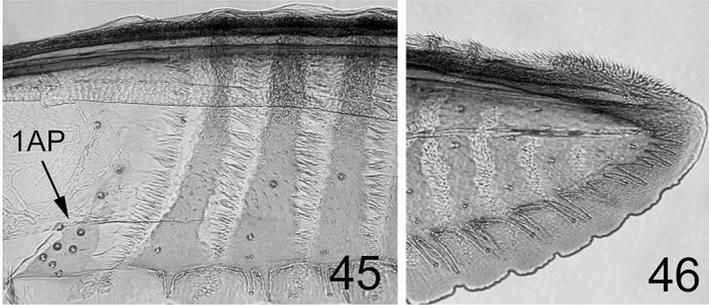
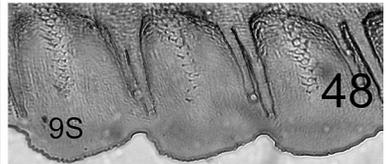
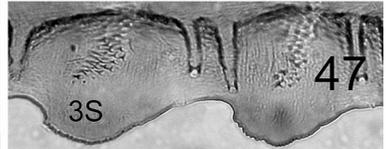
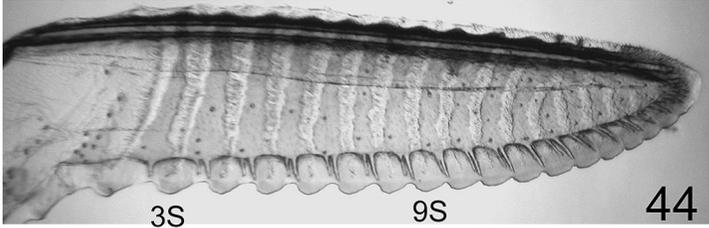
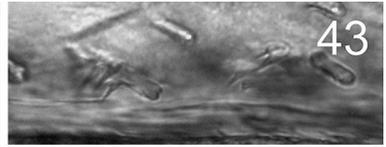
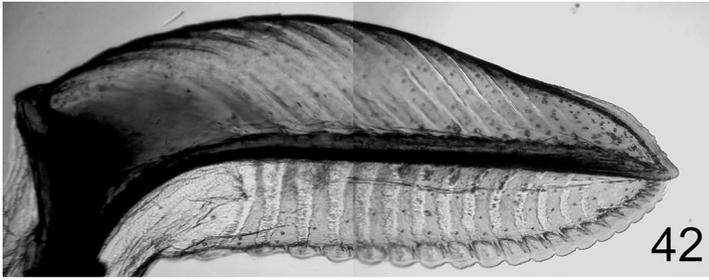
surrounding areas whitish green; thorax and abdomen with subspiracular lobes concolorous with body in middle instars, yellow in final instar; legs slightly brownish apically; tenth abdominal tergum apically slightly yellowish. For more characters, see under the species-group.

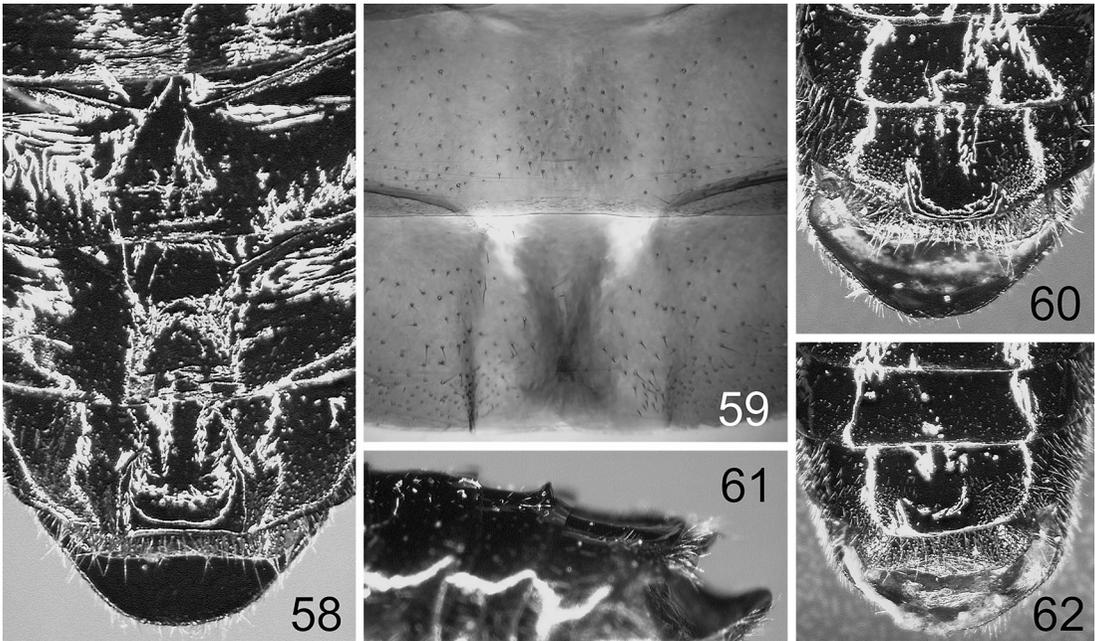
Distribution. Japan (Hokkaido, Honshu, Shikoku and Kyushu); Russia (Khabarovskij Kraj and Primorskij Kraj); Korea; China (Shaanxi Province) (Fig. 87).

Material examined. Holotype: ♂, labeled "Japan: Hokkaido, Tokachi, Kamishihoro, Horoshika-touge, 24. VI. 2005, H. Hara". Deposited in the National Museum of Nature and Science, Tokyo. Paratypes: JAPAN: Hokkaido—2♂, Rishiri-to Is., Mt. Rishiri-dake, 26. VI. 1990, A. Shinohara; 1♀, Shari, Mt. Rausu-dake, 15. VII. 1966, Mita [cited by Togashi, 1997]; 1♀, same locality, 14–17. VII. 1980, T. Shimomura; 2♂, Nayoro, Mt. Piyashiri-dake, 26. VI. 2005, H. Hara; 1♀, "Daisetsu", 24. VII. 1957, K. Kamijo (HU); 1♂, Kamikawa, Ukishima-toge, 24. VI. 2003, A. Shinohara; 1♀, Kamikawa, Ginsendai, 12–14. VII. 2001, A. Shinohara; 1♂, same locality, 23. VI. 2003, A. Shinohara; 1♀, Kamikawa, Sekihoku-toge, 9. VII. 1996, A. Shinohara; 3♀, Kamikawa, Mikuni-toge, 21. VI. 1997, H. Hara and A. Shinohara; 1♂, Kamikawa, Aizankei, 19. VII. 1971, A. Shinohara; 1♀, same locality, 11. VII. 1972, A. Shinohara; 2♀, same locality, 19. VII. 1987, T. Naito (KU); 1♀, Higashikawa, Asahidake-onsen, 25–28. VI. 2001, A. Shinohara; 1♀, same locality, 24–26. VI. 2004, A. Shinohara; 1♀, same locality, 27–29. VI. 2005, A. Shinohara; 7♀, same locality, 23–27. VI. 2007, A. Shinohara; 1♀, Kamishihoro, Tokachi-mitsumata, 20. VI. 1980; 3♀2♂, Kamishihoro, Horoshika-toge, 28–30. VI. 1995, A. Shinohara; 1♀, same locality, 20–21. VI. 1996, A. Shino-

hara; 3♀1♂, same locality, 21–25. VI. 1997, A. Shinohara; 2♂, same locality, 27–28. VI. 1999, H. Hara and A. Shinohara; 2♂, same locality, 21–23. VI. 2000, H. Hara and A. Shinohara; 1♀6♂, same locality, 22. VI. 2003, H. Hara and A. Shinohara; 1♂, same locality, 20. VI. 2004, H. Hara; 3♀4♂, same locality, 23–24. VI. 2005, H. Hara and A. Shinohara; 1♀, Shikaoi, Yamada-onsen, 29. VI. 1995, H. Hara; 3♀, same locality, 20–21. VI. 1996, A. Shinohara; 1♀, same locality, 9–11. VII. 1996, H. Hara; 2♀, same locality, 21–24. VI. 1997, A. Shinohara; 1♀13♂, same locality, 20–21. VI. 2004, H. Hara and A. Shinohara; 1♀, same locality, 21. VI. 2004, H. Hara (No. HH040621A, laid 20 eggs on *Betula ermanii* in cage); 2 semifinal instar larvae and 1 final instar larva, offspring of HH040621A (Figs. 5–6, 74–86); 22♂, same locality, 23–25. VI. 2005, H. Hara and A. Shinohara; 2♂, Shikaoi, Shikaribetsu-ko, 19. VI. 1998, H. Hara; 4♂, same locality, 22–24. VI. 2000, H. Hara; 1♀4♂, same locality, 20–23. VI. 2002, H. Hara; 3♀, same locality, 23–25. VI. 2005, H. Hara; 1♀, same locality, 24. VI. 2006, H. Hara (No. HH060624A, laid 16 eggs on *Betula ermanii* in cage) (Figs. 1, 14, 16, 18, 20–21, 25–26, 29, 33–36, 42–48); 2 final instar larvae, offspring of HH060624A (Figs. 4, 7); 1♀, Yubari, Foot of Mt. Yubari-dake, 18. VI. 1996, H. Hara; 1♀, Kimobetsu, Nakayama-toge, 26. VI. 1991, A. Shinohara; 1♀, same locality, 4. VII. 1994, A. Shinohara; 4♀1♂, same locality, 13–15. VII. 1996, A. Shinohara; 1♀, same locality, 8. VII. 1996, A. Shinohara; 1♀, same locality, 26. VI. 1997, A. Shinohara; 2♀, same locality, 1–2. VII. 2006, A. Shinohara; 1♀2♂, Nanae, Mt. Yokotsu-dake, 19–20. VI. 2007, H. Hara. Honshu: Aomori Pref.—1♂, Iwaki, Mt. Iwaki-san, 16. VII. 1994, M. Yamada (YC); 1♀2♂, same locality, 28. VI.,

Figs. 42–57. Saws, *Arge aenea* sp. nov. (paratype, Shikaribetsu-ko) (42–48), same species (paratype, Mt. Taibaishan) (49–51), *A. tuberculata* sp. nov. (paratype, Mt. Taibaishan) (52–54), and *A. fulvicauda* sp. nov. (holotype) (55–57). — 42, Entire saw, lateral view; 43, ventral part of lance at level of basal end of apical crest (groups of minute setae), lateral view; 44, 49, 52, 55, lancet (44, 49, 55, reversed); 45, ditto, basal part (reversed); 46, ditto, apical part (reversed); 47, 50, 53, 56, third and fourth serrulae (47, 50, 56, reversed); 48, 51, 54, 57, ninth to eleventh serrulae (48, 51, 57, reversed). Abbreviations: 1AP—first annular plate, 3S—third serrula, 9S—ninth serrula.



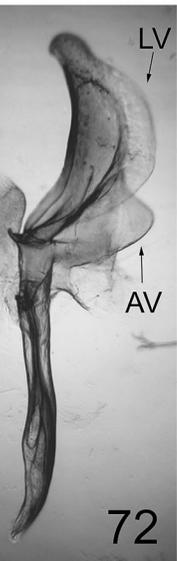
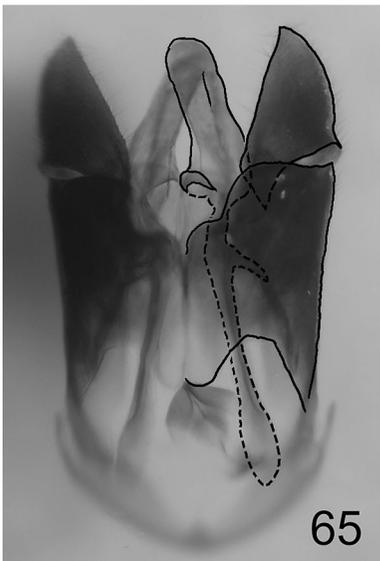
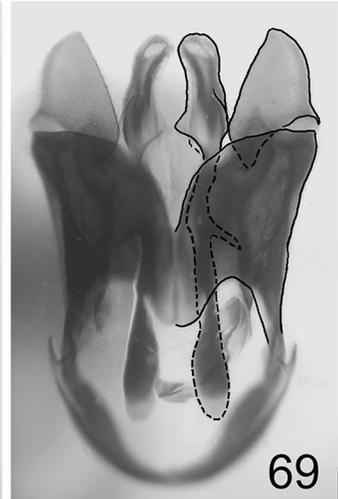
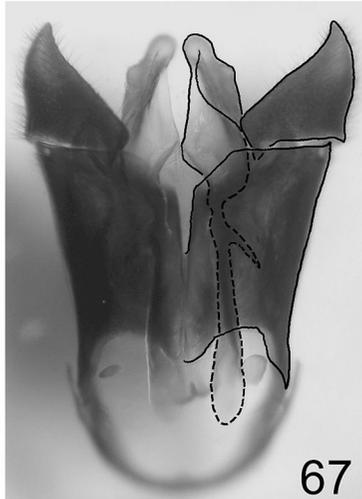
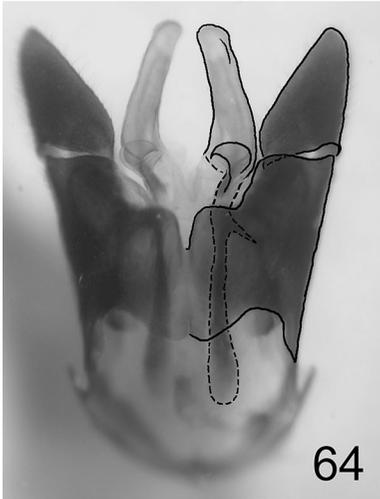
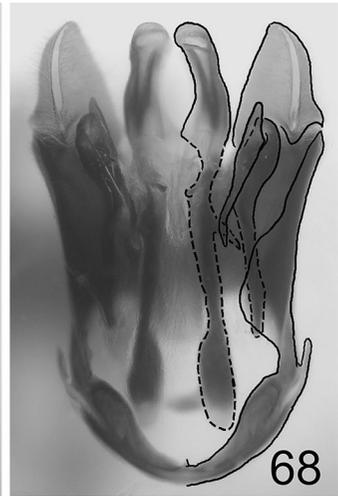
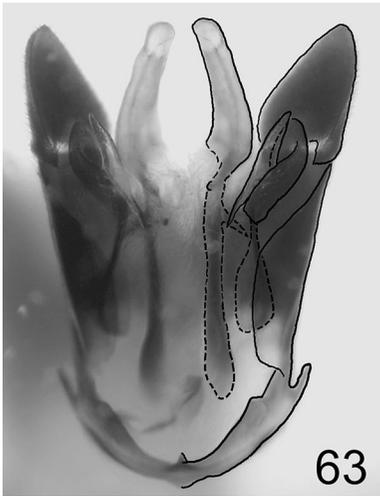


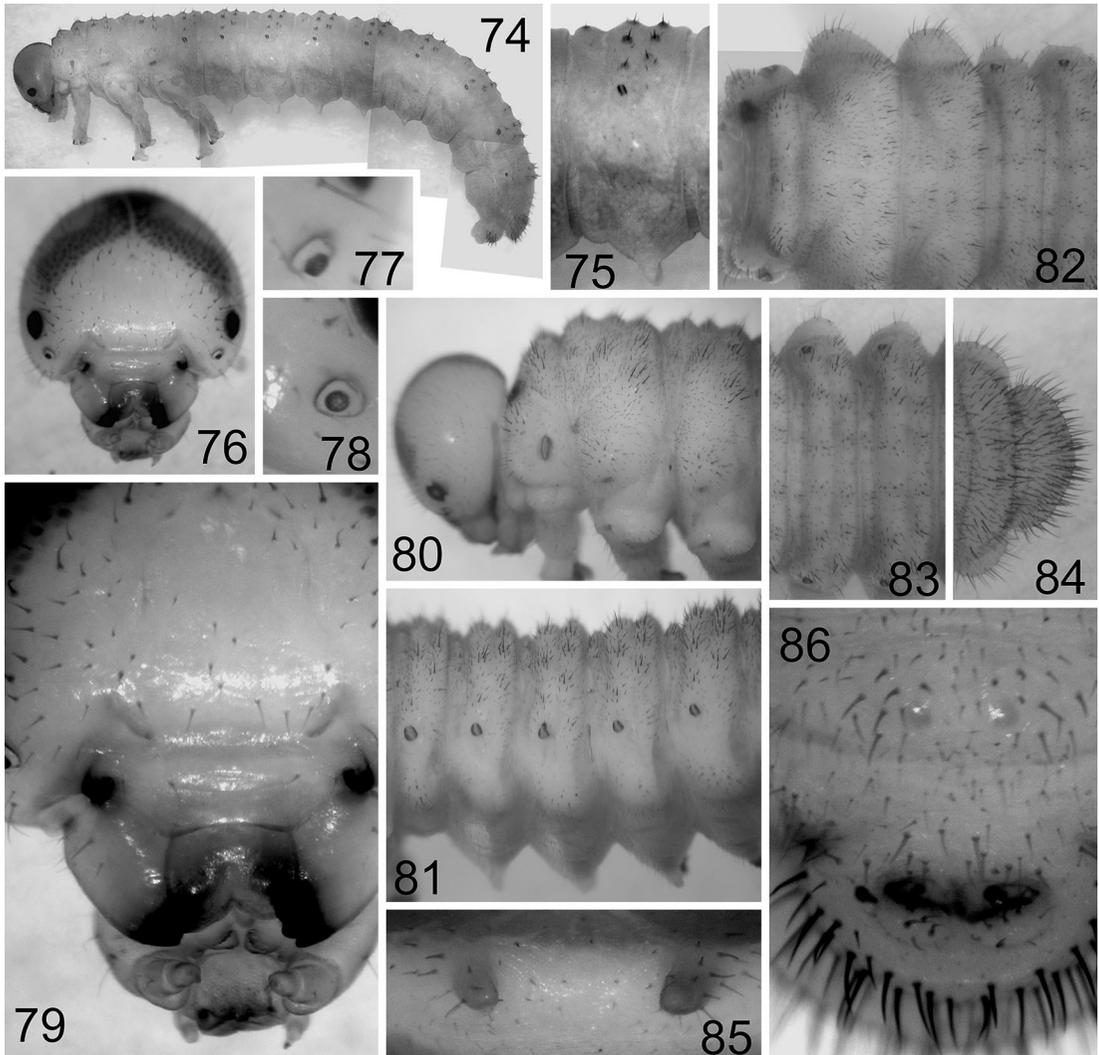
Figs. 58–62. Male abdomens, *Arge aenea* sp. nov. (holotype) (58), same species (paratype, Mt. Odaesan) (59), *A. tuberculata* sp. nov. (holotype) (60–61), and *A. fulvicauda* sp. nov. (paratype, Mt. Taibaishan) (62). — 58, Medial parts of fifth to tenth abdominal terga and subgenital plate; 59, medial parts of seventh and eighth abdominal terga (mounted on slide); 60, 62, seventh to tenth abdominal terga and subgenital plate; 61, sixth and more posterior abdominal segments, lateral view.

7. VII. 1995, M. Yamada (YC). Tochigi Pref.— 1 ♀, Nikko, Yumoto, 17. VI. 1973, T. Saito. Kanagawa Pref.— 2 ♂, Yamakita, “Nishitanzawa, Ootanasawa”, 8. V. 2005, M. Takakuwa. Nagano Pref.— 2 ♀, Kamikochi, 21–22. VI. 1951, Takeuchi, Nakane (OPU); 1 ♀, same locality, 21–23. VI. 1989, A. Shinohara; 5 ♀ 1 ♂, same locality, 18–23. VII. 1989, A. Shinohara; 4 ♀, Matsumoto, Shimashima-dani, 28. VI. 1976, A. Shinohara. Ishikawa Pref.— 1 ♀, Mt. Haku-san, Rokumanzan, 17. VI. 1973, T. Mikage. Osaka Pref.— 1 ♀, Kishiwada, Mt. Izumikatsuragi-san, 13. V. 2002, R. Matsumoto (OMNH) [cited by Yoshida, 2006]. Hyogo Pref.— 1 ♀, “Hyonosen, (Tazima)”, 27. V. 1953, T. Okutani (KU) [cited by Okutani,

1955, 1974, Naito *et al.*, 2004 (as ♂)]; 1 ♀, “Mt. Ogi”, 9. VI. 1963, T. Naito (KU) [cited by Okutani, 1974, Naito *et al.*, 2004 (as ♂)]. Shikoku: Ehime Pref.— 1 ♀, Omogo, Ishizuchi Mts., 23. V. 1999, M. Shiraishi; 1 ♀, Kihoku, Narukawa-keikoku, 5. V. 2005, A. Shinohara; 1 ♀, same locality, 8. V. 2006, A. Shinohara. Kochi Pref.— 1 ♀, Kuroson, 23. V. 1999, N. Ohbayashi (EU). Kyushu: Fukuoka Pref.— 1 ♂, Mt. Hiko-san, 10. V. 1986, A. Shinohara. Oita Pref.— 2 ♀ 2 ♂, Kuju, Mt. Kuro-dake, 16–24. V. 1986, A. Shinohara. Kumamoto Pref.— 1 ♀, Mt. Kunimi-dake, 24. V. 1952, Takeuchi, S. Issiki (OPU). RUSSIA: Khabarovskij Kraj— 2 ♀, Bol’shekhkhtsirskij Res., Sosninskij River, 14–15. VI. 1994, A. Shi-

Figs. 63–73. Male genitalia, *Arge aenea* sp. nov. (holotype) (63–64, 70), same species (paratype, Mt. Taibaishan) (65, 71), *A. tuberculata* sp. nov., holotype, (66–67, 72), *A. fulvicauda* sp. nov. (paratype, Mt. Taibaishan) (68–69, 73). — 63, 65–66, 68, Genitalia, dorsal view; 64, 67, 69, ditto, ventral view; 70–73, left penis valve, lateral view. In Figs. 70–73, the left is the dorsal side and the right is the ventral side. Abbreviations: AV—anteroventral lobe; LV—lateroventral lobe.





Figs. 74–86. Larvae of *Arge aenea* sp. nov. (offspring of HH040621A, Shikaribetsu-ko), semifinal instar (74–75) and final instar (76–86). — 74, Head to abdomen, lateral view; 75, third abdominal segment, lateral view; 76, head, anterior view; 77, antenna, anterior view; 78, ditto, lateroventral view; 79, frons to labium, anterior view; 80, head and thorax, lateral view (reversed); 81, first to fifth abdominal segments, lateral view (reversed); 82, thorax to second abdominal segments, dorsal view; 83, third and fourth abdominal segments, dorsal view; 84, ninth and tenth abdominal segments, dorsal view; 85, medial part of third abdominal segment, ventral view; 86, ninth and tenth abdominal segments, ventral view.

nohara. Primorskij kraj— 1 ♂, Sikhote-Alin., Biol. Station, 30km SE Chuguyevka, 31. V. 1993, A. Taeger (DEI). KOREA: Kangwon-do— 2 ♂, Mt. Odaesan, Mirugam, 1–2. VI. 1991, A. Shinohara; 2 ♂, same locality, 31. V. 1992, A. Shinohara; 1 ♀ 5 ♂, same locality, 28. V.–1. VI. 1993, A. Shinohara (Fig. 58); 3 ♂, same locality, 29. V.–1. VI.

1996, A. Shinohara; 3 ♀ 3 ♂, same locality, 27. V.–1. VI. 1998, A. Shinohara; 1 ♂, same locality, 2. VI. 2002, A. Shinohara. Kyongsangnam-do— 2 ♀, Mt. Jirisan, 27. V. 1987, A. Shinohara. CHINA: Shaanxi Prov.— 6 ♀ 2 ♂, Qinling Mts., Mt. Taibaishan, Kaitianguan, 31. V.–2. VI., 5–7. VI. 2004, A. Shinohara (Figs. 49–51); 5 ♀ 2 ♂,

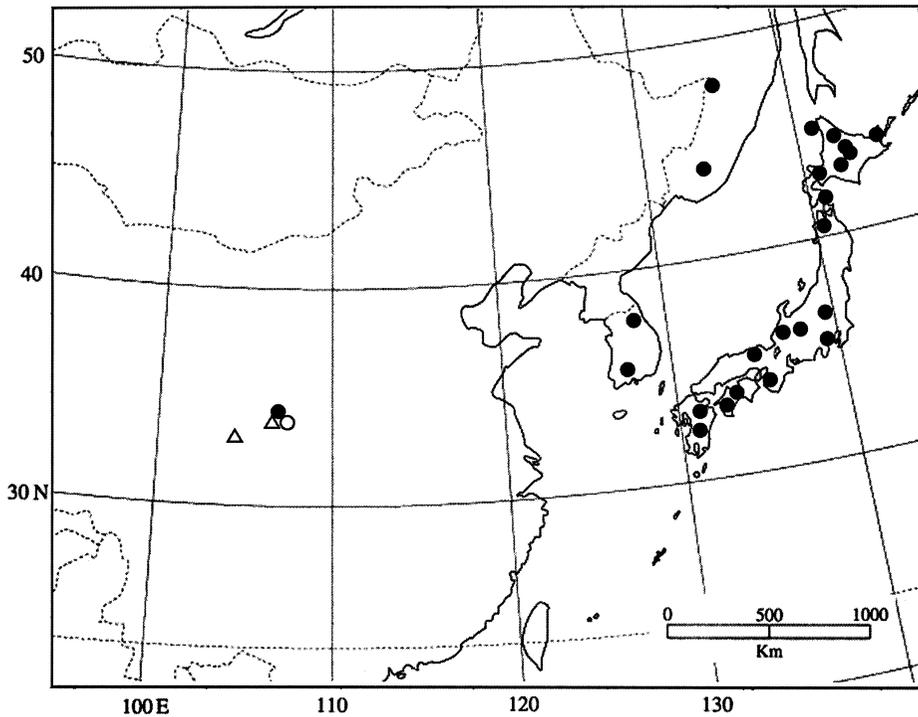


Fig. 87. Distributions of *Arge aenea* sp. nov. (●), *A. tuberculata* sp. nov. (○) and *A. fulvicauda* sp. nov. (△). Overlapping plots are omitted.

same locality, 29. V–10. VI. 2006, A. Shinohara (Figs. 65, 71); 4♀ 1♂, same locality, 2, 9. VI. 2007, A. Shinohara; 1♂, Qinling Mts., Mt. Taibaishan, Honghegu, 4. VI. 2004, A. Shinohara; 1♀, same locality, 4. VI. 2006, A. Shinohara.

Biology. Host: *Betula ermanii* Cham. (Betulaceae) in cage. In the laboratory, the female adults laid eggs on leaf margins of *B. ermanii* in irregular rows, and the larvae did not crowd together and somewhat lifted their abdomens when disturbed (Fig. 7).

Remarks. *Arge aenea* sp. nov. is very closely related to *A. tuberculata* sp. nov., but their males are easily separable as follows. The swelling in the posteromedian part of the seventh abdominal tergum is low and rounded, often inconspicuous in *A. aenea* (Fig. 58), while it is triangularly raised in lateral view with a transversely carinate top in *A. tuberculata* (Figs. 60–61); the medial margin of the gonostipes in ventral view is apically deeply concave in *A. aenea* (Figs. 64–65),

while it is not or slightly concave in *A. tuberculata* (Fig. 67); the anteroventral lobe of the valvipes is thick and knob-like and the lateroventral lobe is small in *A. aenea* (Figs. 64–65, 70–71), while the anteroventral lobe is nearly flattened and the lateral ventral lobe is large in *A. tuberculata* (Figs. 67, 72). On the other hand, the females of the two species are quite similar to each other and barely distinguishable by the slight differences in the lancet. The lancet of *A. aenea* has the basal and middle serrulae apically rounded, their apices usually close to the anterior ends and their posterior slopes generally not angulated near the posterior ends (Figs. 44, 47–51), whereas in *A. tuberculata*, the basal and middle serrulae are apically somewhat angular, their apices are relatively distant from the anterior ends, and their posterior slopes are generally angulated near their posterior ends (Figs. 52–54). Because females show little interspecific differences, we have selected male specimens as the holotypes of

these two new species.

For the comparison with *A. fulvicauda* sp. nov., see under the remarks of that species.

All the three new species, *A. aenea*, *A. tuberculata* and *A. fulvicauda*, run to “*A. dimidiata* ab. *unicolor* Gussakovskij, 1935” (=almost entirely dark form of *A. dimidiata* (Fallén, 1808)) or “*A. fuscipes* var. *expansa* (Klug, 1834)” (= *A. expansa* (Klug, 1834)) in the key to the Palearctic species of *Arge* given by Gussakovskij (1935), and to “*A. dimidiata* var. *flavomixta* (Ed. André, 1881)” (= *A. flavomixta* (Ed. André, 1881)) or “*A. metallica* (Klug, 1834)” (= *Spinarge metallica* (Klug, 1834)) in the key to the East Asian species by Takeuchi (1939). The three species of the *A. aenea* group will be distinguished from *A. dimidiata*, *A. expansa* and *A. flavomixta* by the bronzy reflections in addition to the peculiar structure of the seventh and eighth abdominal terga of the males and from *S. metallica* by the normal fifth abdominal tergum (the fifth abdominal tergum has a dark median line in the female and a median process in the male in *Spinarge*; see Hara and Shinohara, 2006).

Judging from the description, *A. minitincisita* Wei, 2002, from Henan and Hebei Provinces, China, comes close to *A. aenea* and *A. tuberculata*. These new species differ from *A. minitincisita* in having the lateral ridges of the frontal area recognizable (inconspicuous posteriorly in only one female of *A. aenea*), the malar space usually about as long as or longer than the front-ocellar diameter, the cell 1M in the hindwing much shorter than the cell 1Rs (Figs. 1, 8), and the posterior margin of the seventh abdominal sternum very widely rounded (Fig. 34). In *A. minitincisita*, the lateral ridges of the frontal area are absent, the malar space is about half as long as the diameter of an ocellus, the cell M in the hindwing is slightly shorter than the cell Rs, and the median half of the posterior margin of the seventh abdominal sternum is slightly elongated on both sides (Wei and Wen, 2002).

In Japan, three species of the Arginae are known to feed on *Betula*: *Arge pullata* (Zaddach, 1859), *A. solowiyofka* (Matsumura, 1911) and

Spinarge flavicostalis Hara and Shinohara, 2006. The larva of *A. aenea* is very similar to that of *A. solowiyofka* described by Hara *et al.* (2007). However, in the final instar, the head is greenish yellow to whitish green and the subspiracular lobes are yellow in *A. aenea*, while the head is pale brown and the subspiracular lobes are yellowish white in *A. solowiyofka*.

Some authors have recorded this species from Japan under the name of “*Arge metallica* (Klug, 1834)” (Okutani, 1955, 1974; Togashi, 1997; Naito *et al.*, 2004; Yoshida, 2006), but the latter species actually belongs to *Spinarge* and has not been found in Japan (Hara and Shinohara, 2006). Takeuchi (1939) recorded two females of “*Arge metallica*” from “Hakugan”, Korea. We have examined one female of his material kept in Osaka Prefecture University, Sakai, and found that it belongs to the *A. aenea* group; however, we were unable to determine whether it is *A. aenea* or *A. tuberculata*, because its serrulae are severely worn. Togashi (1997) gave collection records of two females of “*Arge metallica*” from Hokkaido, one from Mt. Rausu and another from Mt. Tomuraushi. We have studied the two specimens and found that the former is *A. aenea* and the latter does not belong to the *A. aenea* group. An examination of the specimens recorded as “*Arge metallica*” by Togashi (2002) and Nakamura (2003) has shown that they belong neither to the *A. aenea* group nor to *S. metallica*. The identity of these undetermined specimens will be discussed in separate papers.

Japanese names proposed for this species are “Akagane-churenji” (Okutani, 1955) and “Dougane-churenji” (Naito *et al.*, 2004). We prefer to use the former and older name.

Arge tuberculata sp. nov.

(Figs. 8–10, 37–38, 52–54, 60–61, 66–67, 72, 87)

Description (female and male). [Conditions of holotype (male, Fig. 9) in brackets.] Length 9.0–10.9 mm in female, 9.1–10.2 mm in male [9.1 mm]. Black with reflections generally

bronzy above and generally green blue beneath (Figs. 8–10); in male, reflections on basal abdominal terga often green blue [green blue]. Flagellum black, rarely partly or mostly dark brown [black]. Labrum often apically brown [brown]. Mandible reddish brown, except for basal part. Maxillary palp yellow on apical three or four segments. Labial palp yellow to orange on apical two or three segments. Legs yellow to orange on apical third or more of fore femur, apical fourth to half of mid femur, narrow apex of hind femur, tibiae, tibial spurs and tarsi; mid and hind tibiae basally whitish yellow; claws orange, apically brownish. Seventh abdominal sternum orange along posterior margin in female. Wings slightly yellowish hyaline, faintly brownish apically, with dark transverse band below stigma (inconspicuous in cell 2M) in female, with dark spot below stigma in male; veins mostly dark; in forewing, cells C and Sc distinctly yellow, and vein C, vein Sc, part or most of section of vein R1 basal to stigma, apical section of R1 and basal part or more of vein A yellow to orange; in male, vein C sometimes apically darkened [darkened]; stigma mostly dark. Setae whitish, dorsally generally brownish; wing setae generally dark, yellowish on vein C and cells C and Sc of forewing and wing bases, sometimes almost wholly dark in male [not wholly dark].

Surface smooth and shining; punctures very fine, relatively distinct on head, pronotum and mesoscutum; apex of abdomen very finely coriaceous laterally and ventrally.

Head in dorsal view not dilated or slightly narrowing behind eyes in female, slightly narrowing in male, in lateral view with anterior margin roundly convex below antenna, very slightly concave at clypeus. Distance between eyes 1.2–1.4× vertical diameter of eye in female, 1.0–1.1 [1.0]× in male. Ocellar area concave between ocelli, slightly raised at anterior ocellus. Frontal area with lateral ridges distinct throughout, though weakened posteriorly, and medial depression narrowing and deepening anteriorly. Median fovea deep. Supraclypeal area with median ridge rounded and not carinate in female, sharply cari-

nate or rounded in male [carinate]. Interantennal carinae sharp, ventrally fused with each other about center of supraclypeal area. Malar space 0.8–1.0× width of front ocellus in female, 0.5–0.6 [0.6]× in male. Antennal length 1.4–1.6× maximum width of head in female, 2.4–2.8 [2.4]× in male; flagellum nearly club-like, rounded apically, and not compressed in female, slightly tapering apically in lateral view, nearly of same thickness throughout in ventral view, and slightly compressed in male. Mesoscutellum in lateral view with dorsal margin slightly roundly convex or nearly flat [convex], posteriorly strongly curved below. Hindwing with cell 1M $3/5$ – $3/4$ [$2/3$] of cell 1Rs in length.

In female abdomen, sawsheath in posterodorsal view sunk basally, with medial ridge sharp basally, sometimes dull, lateral slope from medial ridge somewhat steep, lateral margin roundly convex, and apex narrowly rounded (Fig. 37), in lateral view with ventral margin, except for basal convexity, more or less rounded, dorsal margin nearly straight, and apex rounded (Fig. 38). Lancet with 18–21 serrulae (Fig. 52); first annular plate narrowing or disappearing dorsally; second and third annular plates not or slightly narrowing dorsally; serrulae convex, with bluntly angulate apex (Figs. 53–54); basal and middle serrulae with apices relatively distant from anterior ends, generally distinctly angulated near posterior ends.

In male, seventh abdominal tergum with distinct swelling posteromedially, its apex transversely carinate and pointed in lateral view (Figs. 60–61). Gonostipes in ventral view with medial margin posteriorly bent laterally, not or slightly concave (Fig. 67). Valviceps with flat anteroventral lobe and very large lateroventral lobe (Figs. 67, 72).

Distribution. China (Shaanxi Province) (Fig. 87).

Material examined. Holotype: ♂, labeled “[CHINA: Shaanxi], Kaitianguan 2000m, 34 00N 107 51E, Mt. Taibaishan, Qinling Mts., 31. V. 2006, A. Shinohara”. Deposited in the Institute of Zoology, Chinese Academy of Sciences, Bei-

jing. Paratypes: CHINA: Shaanxi Prov.—19 ♀ 6 ♂, Qinling Mts., Mt. Taibaishan, Kaitianguan, 31. V.–2. VI., 5–7. VI. 2004, A. Shinohara; 2 ♀, same locality, 22–25. V. 2005, A. Shinohara; 15 ♀ 3 ♂, same locality, 30. V.–10. VI. 2006, A. Shinohara (Figs. 8, 37–38); 2 ♀, same locality, 10. VI. 2007, A. Shinohara (Figs. 52–54); 2 ♂, Qinling Mts., Mt. Taibaishan, Honghegu, 29. V. 2005, A. Shinohara.

Remarks. This species is very similar to *A. aenea* sp. nov. For comparisons with *A. aenea*, *A. fulvicauda*, and other related species, see under the remarks of the two species.

Arge fulvicauda sp. nov.

(Figs. 11–13, 24, 30–31, 39–41, 55–57, 62, 68–69, 73, 87)

Description (female and male). [Conditions of holotype (female, Fig. 11) in brackets.] Length 9.9–10.3 [10.3] mm in female, 9.5 mm in male. Black with reflections green blue, dorsally bronzy to brassy at least on parts of head and thorax and posterior abdominal terga (Figs. 11–13). Antenna orange, darkened on scape and pedicel or on basal half of scape [basal half of scape]. Labrum orange. Mandible orange, apically dark red, basally narrowly darkened. Palpi orange, basally somewhat darkened. Legs yellow to orange; coxae black, except for medial part of fore coxa; mid and hind tibiae basally yellowish white; trochanters and trochantelli partly black; claws apically brownish. Wings yellowish hyaline in female, clear hyaline in male, apically brownish and with dark mark below stigma posteriorly extending to vein M; veins mostly blackish brown; in forewing, cells C and Sc yellow, and veins C and Sc, most or apical part of section of vein R1 basal to stigma, most of apical section of R1, and base or most of vein A yellow; in male, vein C of forewing darkened apically; stigma blackish brown, in female widely pale apically. In female, wide posterior margin of seventh abdominal sternum orange; sawsheath, except for ventrobasal part, orange; cercus and subanal plate orange to brown. In male, apex of subgenital

plate and harpe orange. Setae generally whitish in both sexes, dorsally brownish in female; wing setae dark, yellowish on veins C and Sc, cells C and Sc, and wing bases.

Surface smooth and shining; punctures very fine, relatively distinct on head, pronotum and mesoscutum; apex of abdomen very finely coriaceous laterally and ventrally.

Head in dorsal view not dilated behind eyes in female, slightly narrowing behind eyes in male. Distance between eyes 1.2–1.3 [1.2] × vertical diameter of eye in female, 1.1 × in male. Ocellar area weakly concave between ocelli, slightly raised at anterior ocellus. Frontal area with lateral ridges distinct throughout, though weakened posteriorly, and medial depression narrowing and deepening anteriorly. Median fovea rather deep. Interantennal carinae sharp, ventrally fused with each other about center of supraclypeal area. Supraclypeal area with median carina sharp or weak [sharp] (Fig. 24). Malar space 0.7–0.9 [0.9] × width of front ocellus in female, 0.6 × in male. Antennal length 1.5–1.7 [1.5] × maximum width of head in female, 2.6 × in male; flagellum nearly club-like, rounded apically, and not compressed in female, nearly of same thickness throughout and slightly compressed in male. Mesoscutellum in lateral view with dorsal margin slightly roundly convex, posteriorly strongly curved below (Fig. 30). Hindwing with cell 1M 2/3 of cell 1Rs in length.

In female abdomen, sawsheath in posterodorsal view sunk basally, with medial ridge dull, lateral slope from medial ridge gentle, lateral margin roundly convex, and apex narrowly rounded (Fig. 40), in lateral view with ventral margin, except for basal convexity, more or less rounded, dorsal margin nearly straight or slightly rounded, and apex rounded (Fig. 41). Lancet with 19–21 [19] serrulae (Fig. 55); first annular plate narrowing dorsally; second and third annular plates not narrowing dorsally; serrulae as in Figs. 55–57; apical serrulae weakly convex, generally distinctly notched at boundaries.

In male, seventh abdominal tergum with round and small swelling posteromedially (Fig. 62).

Gonostipes in ventral view with medial margin posteriorly rounded (Fig. 69). Valviceps in ventral view with anteroventral lobe nearly flat, and lateroventral lobe small and located near base of valviceps (Figs. 69, 73).

Distribution. China (Shaanxi and Sichuan Provinces) (Fig. 87).

Material examined. Holotype: ♀ labeled “[CHINA: Shaanxi], Kaitianguan 2000 m, 34 00N 107 51E, Mt. Taibaishan, Qinling Mts., 5–7. VI. 2004, A. Shinohara”. Deposited in the Institute of Zoology, Chinese Academy of Sciences, Beijing. Paratypes: CHINA: Shaanxi Prov.—1 ♂, Kaitianguan 2000 m, 34 00N 107 51E, Mt. Taibaishan, Qinling Mts., 31. V. 2006, A. Shinohara; 1 ♀, same locality, 7. VI. 2006, A. Shinohara (Figs. 24, 30–31, 39–41). Sichuan Prov.—1 ♀, Jiuzhaigou, 3. VIII. 1993, T. Naito (KU).

Remarks. This species is similar in structure to *A. aenea* sp. nov. and *A. tuberculata* sp. nov., but it is easily distinguished from the two species by the orange flagellum, mostly orange femora, apically orange sawsheath, apically orange subgenital plate and orange harpe. The female of *A. fulvicauda* also differs from those of *A. aenea* and *A. tuberculata* in having the lancet with the apical serrulae relatively weakly convex (compare Figs. 55, 57 with Figs. 44, 48–49, 51–52, 54). In male genitalia, *A. fulvicauda* is similar to *A. tuberculata* in having the medial margin of the gonostipes not concave in ventral view and the anteroventral lobe of the valviceps nearly flat, but is distinguished from the latter species by the shape of main body of the valviceps (compare Figs. 69, 73 with Figs. 67, 72). For comparisons with other related species, see under the remarks of *A. aenea*.

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