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Arge indicura n. sp. Feeding on *Potentilla* and *Sanguisorba* (Insecta, Hymenoptera, Argidae) from Japan

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Abstract A new argid sawfly, *Arge indicura*, is described from Japan. It was identified with *Arge nigrovaginata* Malaise, 1931, described from the Russian Far East, for more than seven decades, but a recent examination of Malaise's type material has revealed the misidentification. Previously unknown immature stages are described, new host plant records are given, and the distribution and life history are discussed based on the specimens examined and rearing experiments. The mostly greenish, solitary and cryptic larvae feed on the leaves of *Potentilla* and *Sanguisorba* (also *Fragaria* and *Duchesnea* in the laboratory), all belonging to the clade Sanpotina of the Rosaceae. *Arge indicura* probably has three generations a year in the lowland of central Honshu.
Key words : Argidae, *Arge indicura*, new species, *Potentilla*, *Sanguisorba.*

In the course of our revisionary works on the sawfly genus *Arge* of Japan and adjacent regions, we have found that the Japanese species previously determined as *Arge nigrovaginata* Malaise, 1931, had been misidentified. *Arge nigrovaginata* was first proposed under the name of *Arge pagana* var. *nigrovaginata* by Malaise (1931) based on a single specimen from Suchan, Primorskij Kraj, the Russian Far East. Takeuchi (1932) upgraded it to the species level and identified his specimens from Japan with *Arge nigrovaginata*. Takeuchi's interpretation of the species was based only on Malaise's (1931) short diagnosis of *Arge pagana* var. *nigrovaginata*. Gussakovskij (1935) identified his female specimen from Motohakone, central Honshu, Japan, with *A. nigrovaginata*, also without seeing the holotype or any other material from Russia. Ever since these works, the Japanese species has always been treated as *A. nigrovaginata* (Takeuchi, 1939; Shinohara, 2000; Naito *et al.*, 2004; Yoshida, 2006; etc.) and Japan has been included in the distribution of *A. nigrovaginata* (Zombori, 1974; Lelej and Taeger, 2007).

Our examination of the holotype of *Arge pagana* var. *nigrovaginata* has revealed that the Japanese species does not belong to Malaise's taxon. We will describe the Japanese species as new and give notes on its distribution and life history below.

The material used in this work is kept in the National Museum of Natural History, Tokyo, unless otherwise indicated. Acronyms for other depositories are: AKC, A. Kawazoe Collection, Inabe; HSC, H. Suda Collection, Sakura; HYC, H. Yoshida Collection, Kobe; KKC, K. Kubo Collection, Yokohama; MNHAH, Museum of Nature and Human Activities, Hyogo, Sanda; MTC, M. Tanaka Collection, Gifu; MYC, M. Yamada Collection, Kuroishi; NAC, N. Aoki Collection, Abiko; NRMS, Swedish Museum of Natural History, Stockholm; OMNH, Osaka Museum of Natural History, Osaka; OPU, Osaka Prefecture University, Sakai.

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Arge indicura n. sp.

[Japanese name: Shiriguro-churenji]

(Figs. 1–9; Table 1)

Arge nigrovaginata: Takeuchi, 1932: 41; Gussakovskij, 1935: 245, 410; Takeuchi, 1939: 410; Takeuchi, 1948: 57; Takeuchi, 1949: 50; Okutani, 1982: 413; Togashi, 1983: 12; Abe and Togashi, 1989: 543; Nambu, 1998: 17; Togashi and Yamamoto, 2000: 707; Shinohara, 2000: 297; Kubo, 2000: 288; Naito *et al.*, 2004: 12; Nagase, 2004: 1244; Shinohara, 2005: 230; Yoshida, 2006: 25; Shinohara *et al.*, 2008: 278. Not Malaise, 1931, in part.

Female (Fig. 1A–B). Length 6.5–9 mm. Head and thorax black with bluish reflection. Antenna black; mandible dark brown, black basally and dark ferruginous apically; palpi blackish brown. Legs black; femora with faint bluish luster and hind tibia partly blackish brown. Wings rather strongly infuscated with black; apical part slightly paler and very dark cloud present below stigma; stigma and all veins black. Abdomen orange, with first tergum marked with blackish brown and sawsheath entirely bluish black; usually entire ninth tergum and often dorsal median parts of second to eighth terga narrowly or widely blackish.

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

Head in dorsal view (Fig. 1E) distinctly dilated (sometimes not dilated) behind eyes, in lateral view (Fig. 1F) with anterior margin convex below antenna. Distance between eyes 1.2–1.4× vertical diameter of eye; eye with vertical diameter 1.7–1.9× horizontal diameter. Postocellar area very weakly convex, anterior and lateral furrows indistinct (Fig. 1E). Ocellar area scarcely concave between ocelli. Frontal area anterolaterally raised and widely and usually shallowly furrowed along mid line (Fig. 1I, K); this furrow extending anteriorly to punctiform or often tubercular median fovea; distance between median fovea and front ocellus about 2× diameter of front ocellus. Interantennal area nearly flattened on ventral part, with lateral carinae sharply defined, dorsally separated from each other, ventrally fused with each other above middle of supraclypeal area (Fig. 1I, K). Supraclypeal area with median ridge sharply carinate, with side slope almost flattened (Fig. 1I, L). Malar space 0.8–1.1× width of front ocellus. Clypeus flattened but convex along dorsal margin, with ventral margin very broadly roundly or subtriangularly incised medially (Fig. 1I, L). Antennal length 1.3–1.8× maximum width of head; flagellum rather thin, not compressed, weakly curved basally and narrowly rounded at apex (Fig. 1A). Right mandible with distinct rounded inner tooth basally (Fig. 1L).

In forewing, cell 1Rs2 with anterior length 1.1–1.6× posterior length, and crossvein 3r–m usually strongly curved in anterior part; in both wings, wing margin between veins Rs and Cu ciliate, with marginal glabrous area much narrower than width of vein M and marginal setae much longer than width of vein M (Fig. 1M).

Abdomen with second to fourth terga glabrous, except for lateral parts; fifth (medial part nearly glabrous) and more posterior terga setose. Seventh sternum with posterior margin weakly roundly produced at middle. Sawsheath in posterodorsal view (Fig. 1N) subtriangular in outline, with lateral margin weakly roundly convex, and apex very narrowly rounded; dorsomedial ridge sharp basally and its lateral slope rounded; in lateral view (Fig. 1O), ventral margin, except for basal convexity, very weakly roundly convex, dorsal margin nearly straight, and apex narrowly rounded; inner surface spinose.

Lance (Fig. 2A, F) strongly sclerotized and pigmented, with inconspicuous annuli and some linear membranous areas midapically (Fig. 2B) and without group of minute setae along ventral margin; apical crest developed, finely serrate on dorsal margin (Fig. 2F). Lancet (Figs. 2C, 3)

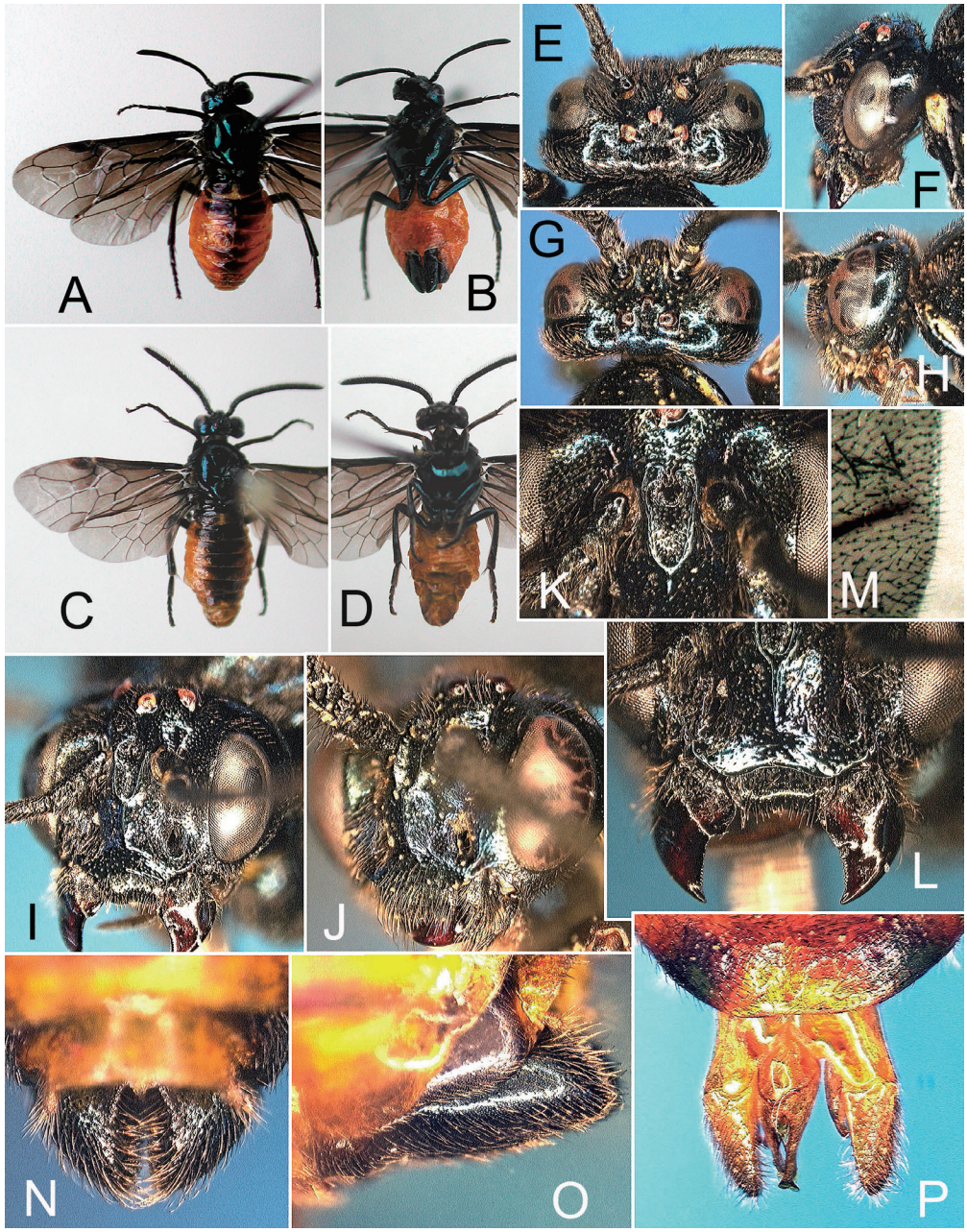

Fig. 1. *Arge indicura*, adults, holotype female (A–B, E–F, I, K–L), paratype female, Abiko (M–O), paratype male, Abiko (C–D), and paratype male, Kowashimizu (G–H, J, P). —— A–D, Entire insects; E, G, heads, dorsal view; F, H, do., lateral view; I–J, do., laterofrontal view; K, frontal and interantennal areas, dorsofrontal view; L, supraclypeal area to mouth parts, frontal view; M, outer margin of forewing around apex of vein M; N, sawsheath, posterodorsal view; O, do., lateral view; P, subgenital plate and genital capsule, ventral view.

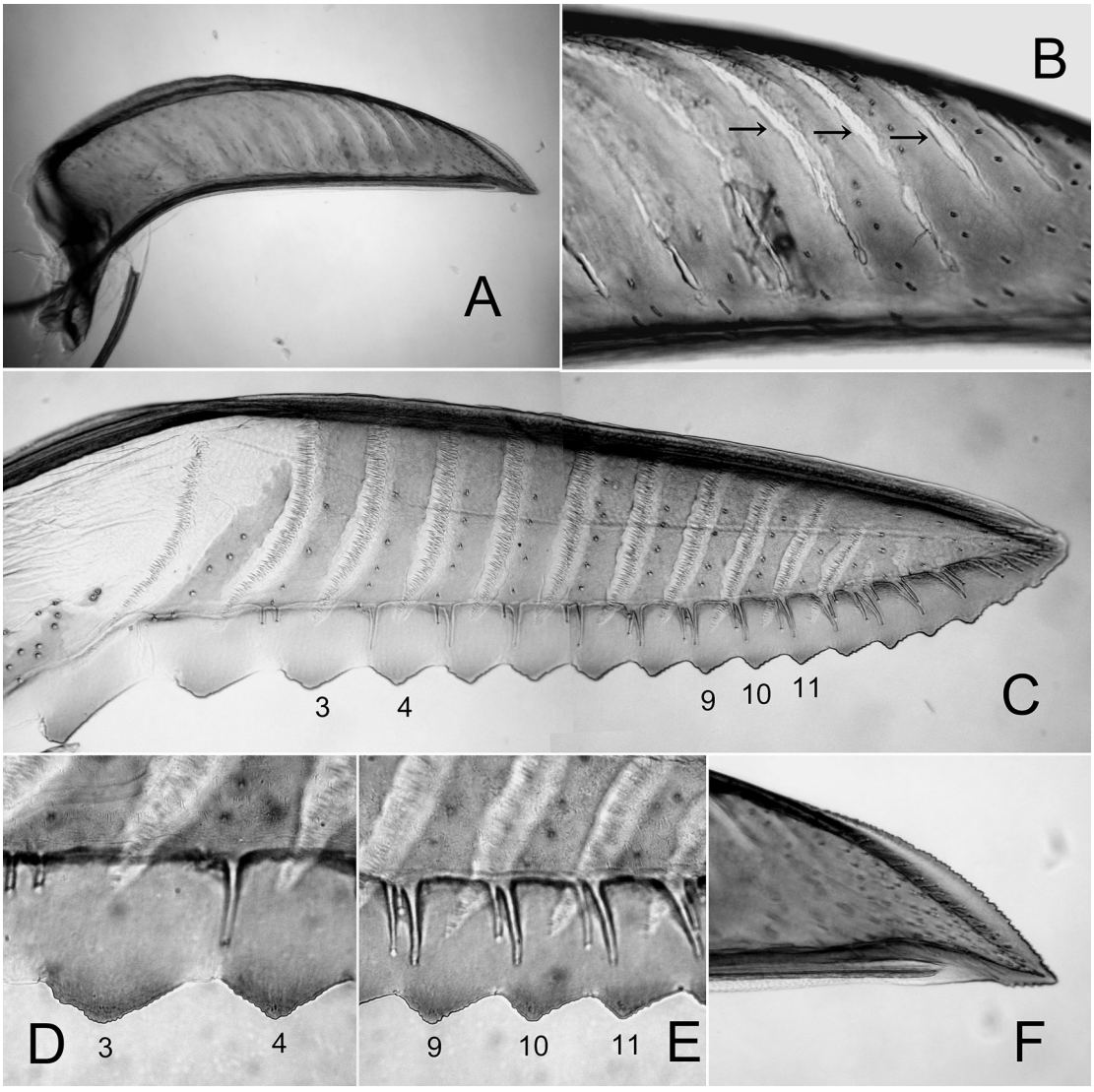

Fig. 2. Ovipositor, holotype. —— A, Lance, lateral view; B, anterior median part of lance, lateral view, arrows showing membranous areas; C, lancet, lateral view; D, third and fourth serrulae of lancet; E, ninth to 11th serrulae; F, lance, apical part, lateral view.

strongly sclerotized and pigmented, dorsal margin nearly straight or very slightly roundly convex and ventral margin roundly convex midapically, with about 18 serrulae and narrow non-annulate area dorsoapically; marginal sensilla long, those of the median annuli directed ventrally; dorsal margin with membranous areas not setose; longitudinal rows of setae between annular plates present from first annulus; annular plates rather broad, narrowed at middle, without rough areas; first annular plate large, extending over midline dorsally but not reaching dorsal margin of lancet; pore of sensillum absent in dorsal part of each annular plate; serrulae angularly convex (Fig. 2D–E).

Male (Fig. 1C–D). Length 5–8 mm. Coloration similar to female. Genital capsule entirely orange, very rarely apically brownish.

Structure generally similar to female. Head not dilated behind eyes (Fig. 1G). Distance between eyes 1.1–1.3× vertical diameter of eye; eye with vertical diameter 1.6–1.8× horizontal diameter. Malar space 0.4–0.7× width of front ocellus. Antennal length 1.6–2.2× maximum width of

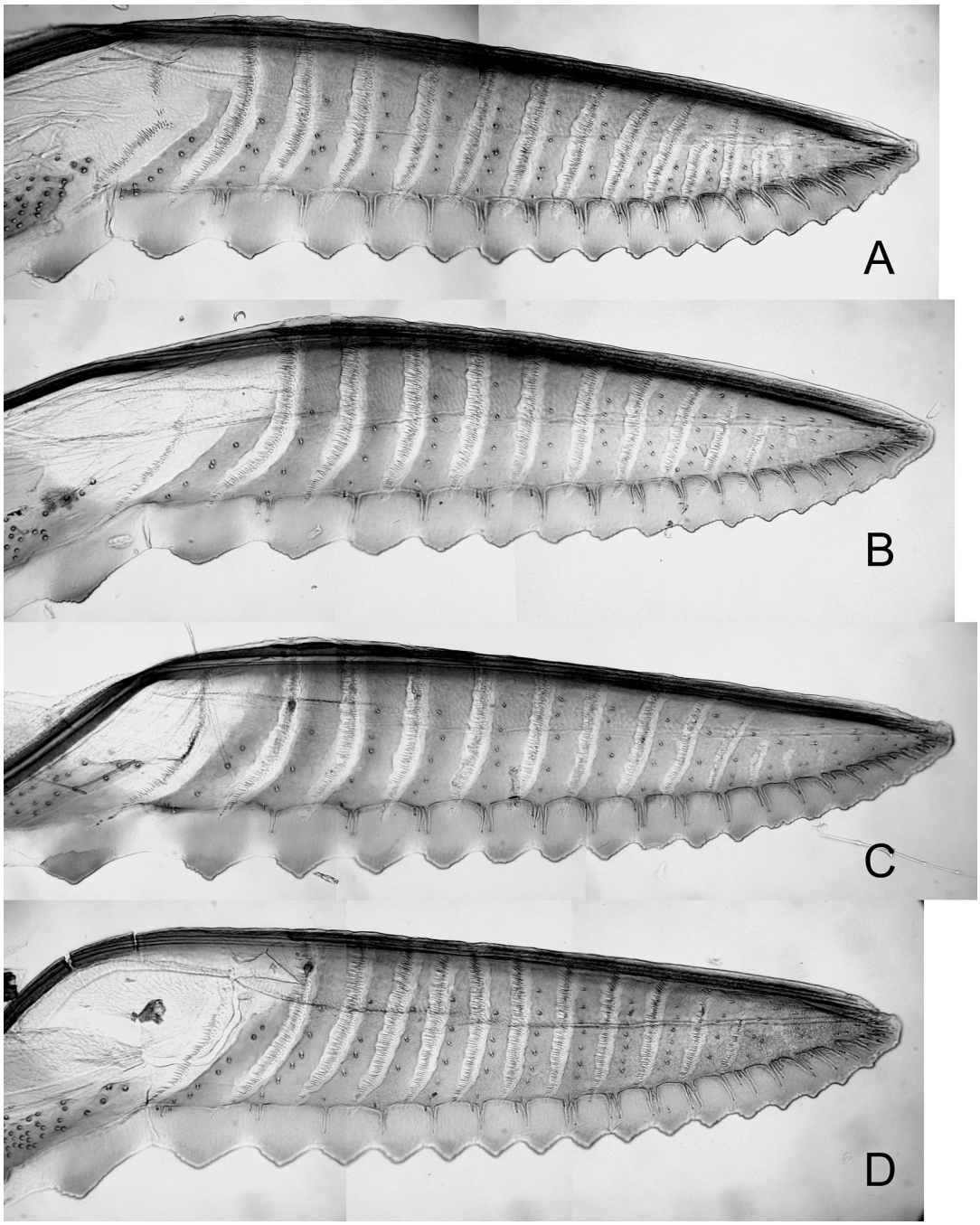

Fig. 3. Lancets. —— A, Abiko, Chiba Pref., Honshu; B, Oume-shi, Tokyo, Honshu; C, Kowashimizu, Nagano Pref., Honshu; D, Kobayashi, Miyazaki Pref., Kyushu.

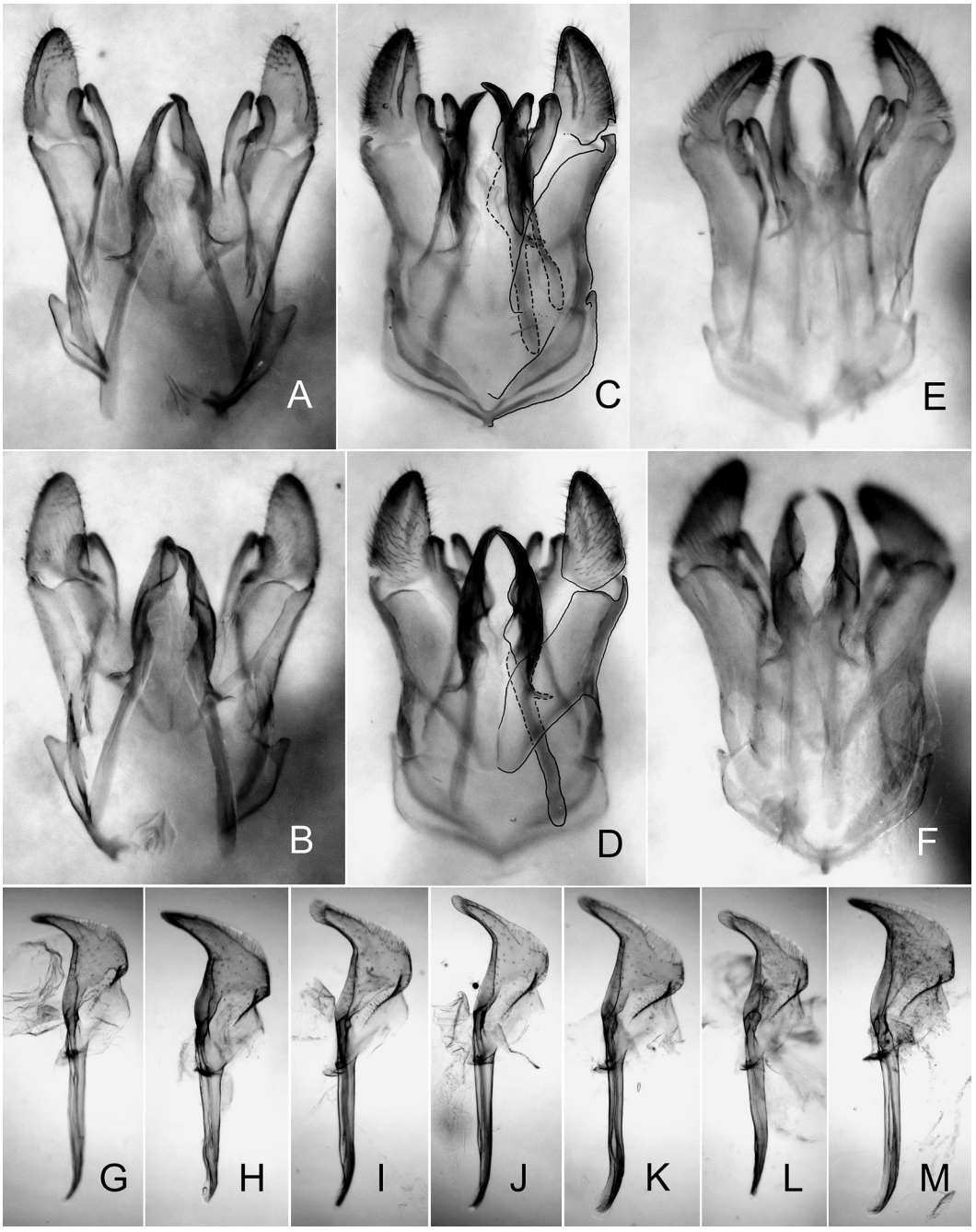

Fig. 4. Male genital capsules, dorsal (A, C, E) and ventral (B, D, F) views, penis valves, lateral view, left dorsal (G–M). —— A–B, G, Kuroishi, Aomori Pref., Honshu; C–D, H, Abiko, Chiba Pref., Honshu; E–F, M, Kuju, Oita Pref., Kyushu; I, Imperial Palace, Tokyo Met., Honshu; J, Kirigamine, Nagano Pref., Honshu; K, Kowashimizu, Nagano Pref., Honshu; L, Kyoto, Kyoto Pref., Honshu.

head (often across eyes); flagellum slightly curved, weakly compressed. Cell 1Rs2 in forewing with anterior length 1.0–1.6× posterior length. Abdomen with second to fourth terga nearly glabrous above; other terga with minute setae. Subgenital plate (Fig. 1P) with lateral margins strongly convergent posteriorly, apically broadly rounded or nearly truncate or often slightly concave. Gonostipes in ventral view narrowing apically with apical width about as long as basal width of harpe and with median margin nearly straight (Fig. 4B, D, F). Harpe gradually narrowing towards apex. Penis valve with valviceps flat in dorsal view (Figs. 1P, 4A–F) and subtriangular in lateral view with long and narrow process dorsoapically (Fig. 4G–M).

Larva (Figs. 5C–K, 6). First instar (Figs. 5C, 6B): Greenish white (infested greenish leaf inside visible from outside), with head black; prothoracic shields, cervical sclerite, coxae of thoracic legs, subspiracular, suranal and subanal lobes, prolegs, and scattered small spots on each segment of trunk blackish brown to black; thoracic legs, except for coxae, more or less darkened; head and trunk covered with long blackish hairs. Second and third instars (Fig. 5D–E): Similar to the first, but head blackish to dark brown and dark parts on trunk paler. Fourth instar (Fig. 5F): Head dark grayish brown; trunk pale green, with dorsal and lateral areas, except for broad middorsal line, covered with numerous minute whitish spots, subdorsal areas almost entirely whitish; cervical sclerite and coxae of thoracic legs blackish; thoracic legs, except for coxae, pale brown. Fifth and sixth instars (Figs. 5G–I, 6A, C–H): Length about 17 mm in fifth and about 19 mm in sixth; head and thoracic legs very pale greenish brown, except for pale greenish coxae; trunk pale green, with dorsal and lateral areas, except for broad middorsal line, covered with numerous minute whitish spots, subdorsal areas almost entirely whitish; head and trunk covered with rather dense brownish or blackish hairs; antenna long, conical (Fig. 6H); clypeus with two pairs of setae; labrum with two pairs of setae; mandible with four to 13 setae on outer surface; maxillary palp four-segmented; palpifer with seven to nine setae; labial palp three-segmented; first to ninth abdominal segments each with three annulets; prolegs on second to sixth and 10th segments, those on second to sixth elongate; 10th tergum in dorsal view very broadly rounded or nearly truncate apically.

Cocoon (Fig. 5L). Length 9.5–11 mm in female, 8.5–9.5 mm in male. Pale ochreous. Elongate oval, double walled; outer wall netted and inner wall parchment like.

Distribution (Fig. 7). Japan (Honshu, Shikoku, Kyushu).

Holotype (Fig. 1A–B). ♀, Shibazaki, Abiko, 10 m, 35-52-44N 140-1-54E, Chiba Pref., Honshu, Japan, larva coll. 10. X. 2008, mat. 17. X., em. 3. XI. 2008, AS081010D, Host: *Potentilla freyniana*, A. & N. Shinohara. Deposited in the National Museum of Nature and Science, Tokyo (NSMT-I-Hym 41669).

Paratypes. JAPAN: HONSHU: Aomori Pref.: 1♀, Mt. Ikazuchi, Kuroishi, 1. VI. 1958, M. Yamada (MYC); 1♂, Kaname (Kuroishi), flw. Nurude, 10. VIII. 1991, M. Yamada (MYC). Iwate Pref.: 2♀, Koiwai, 1. IX. 1922, K. Sato. Miyagi Pref.: 1♀, Naruko-onsen, Osaki-shi, 2. VIII. 2006, H. Hara. Saitama Pref.: 1♀, Kinshozan, Ogawa, 23. IX. 1995, T. Nambu; 1♂, Shimofukudera (Takinoiri), Ogawa, 23. V. 1998, T. Nambu; 1♂, Tajima, Urawa, 23. V. 1998, T. Nambu. Chiba Pref.: 1♀, Mitsuishi road, Kazusa Town, 9. IX. 1969, H. Suda (HSC); 1♂, Namiki, Kouzaki, Katori, 29. IV. 1998, H. Suda (HSC); 1♀, Abiko, 13. IX. 2008, N. Aoki (NAC); 1♀, Shibazaki, Abiko, 10 m, 35-52-44N 140-1-54E, larva coll. 7. X. 2008, mat. 11. X., em. 25. X. 2008, oviposited on *Fragaria vesca* 26–27. X., Host: *Potentilla freyniana*, AS081007D, A. & N. Shinohara; 1♀, same locality, host and collectors, larva coll. 7. X. 2008, mat. 14. X., em. 1. XI. 2008, AS081007D; 3♀, same locality, host and collectors, larvae coll. 7. X. 2008, mat. 13–14. X., em. 27–31. X. 2008, AS081007F; 3♀, same locality, host and collectors, larvae coll. 10. X. 2008, mat. 15. X., em. 1. XI. 2008, AS081010B; 2 late instar larvae, same locality, host and col-

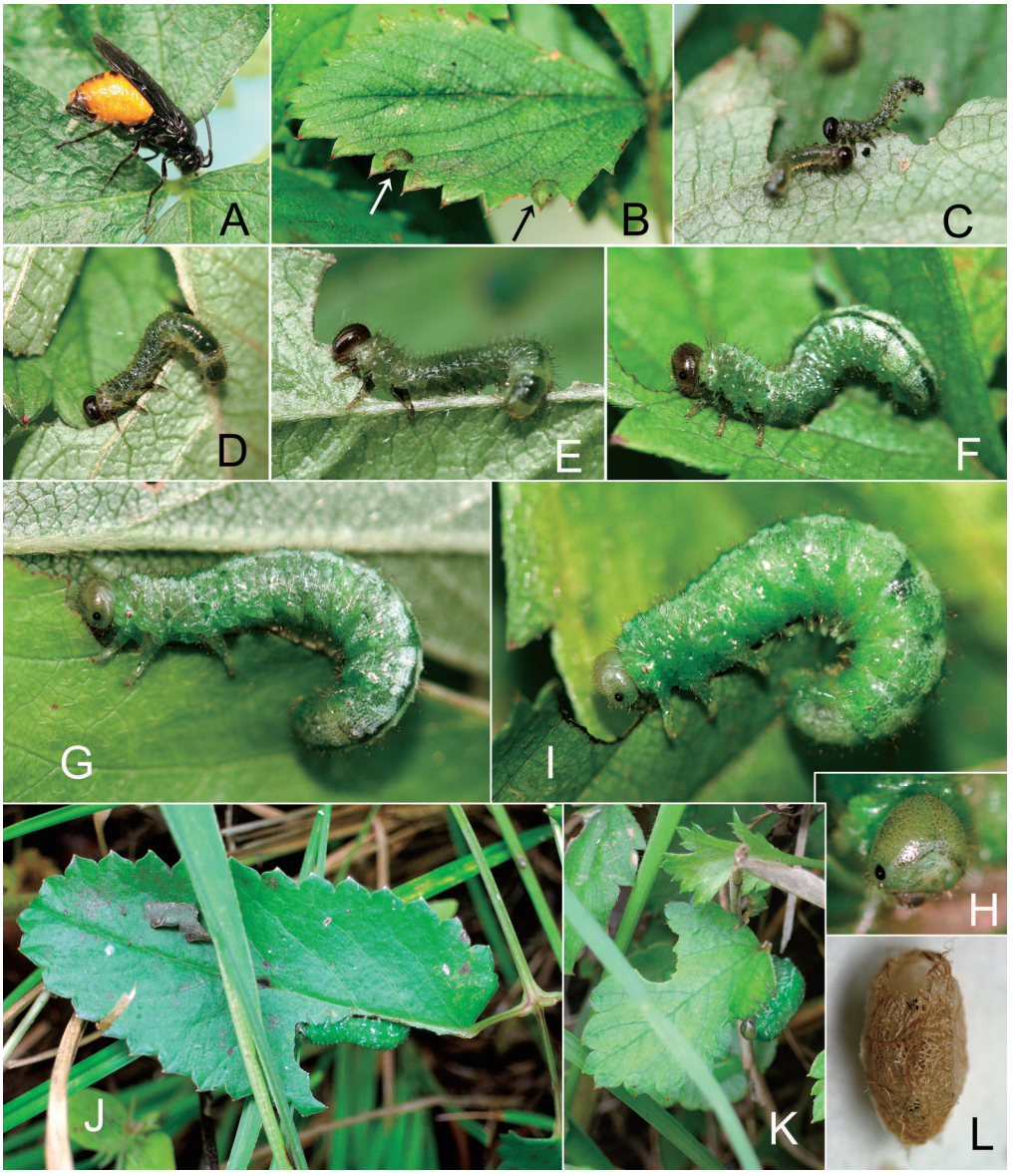

Fig. 5. *Arge indicura*. —— A, Female ovipositing on leaf margin of *Potentilla freyniana*; B, two eggs (arrowed) on leaf margin of *Potentilla freyniana*, AS080809B; C, first instar larvae, AS080809B; D, second instar larva, AS080822A; E, third instar larva, AS080809B; F, fourth instar larva, AS080809B; G, fifth instar larva, AS080809B; H, do., head; I, sixth instar larva, AS080809B; J, late instar larva feeding on *Sanguisorba officinalis*, AS081007C; K, late instar larva feeding on *Potentilla freyniana*, AS081007D; L, empty cocoon after adult emergence, AS081010D. —— Photographs taken by A. Shinohara in a laboratory in Tokyo on November 1 (A), August 16 (B), August 18 (C), August 28 (D), August 24 (E), August 26 (F), August 30 (G–H), September 4 (I) and November 6 (L) and in Abiko, Chiba Prefecture, on October 7 (J–K), all in 2008.

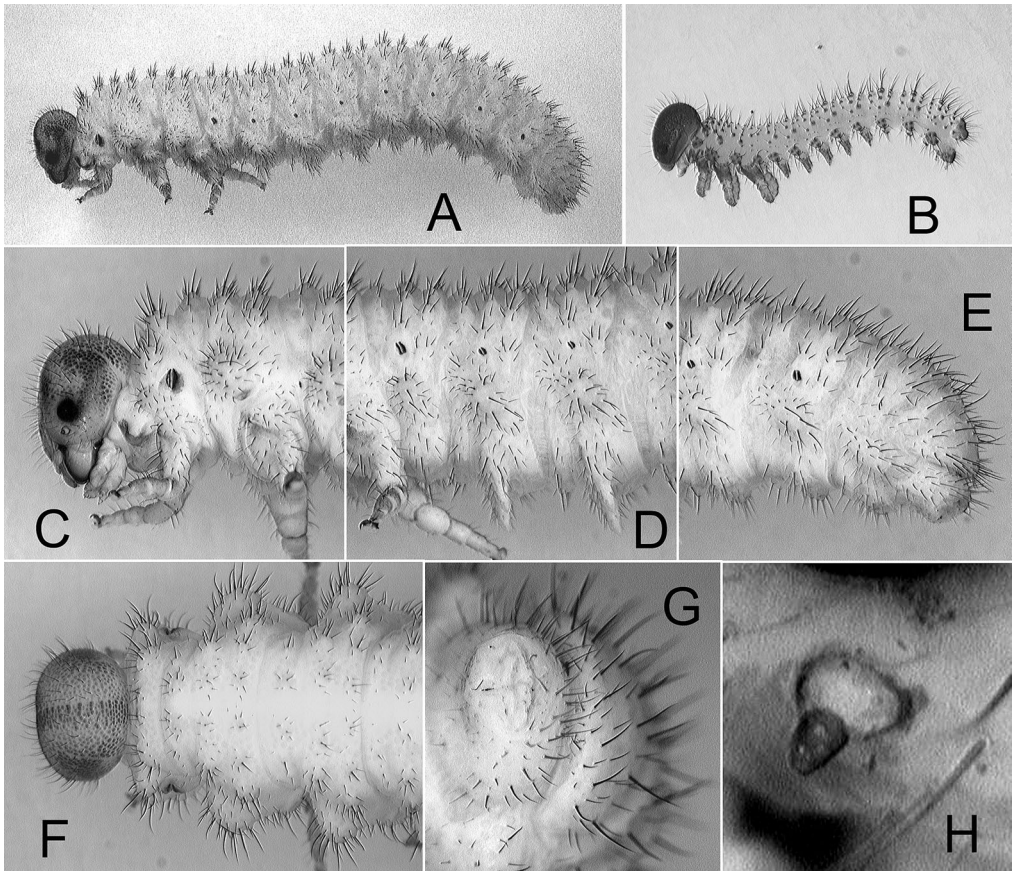

Fig. 6. Fifth instar (A, C–H) and first instar (B) larvae. —— A–B, Entire insect, lateral view; C, head and thorax, lateral view; D, first three segments of abdomen, lateral view; E, caudal segments, lateral view; F, head and thorax, dorsal view; G, caudal part, posterodorsal view; H, antenna, lateral view.

lectors, coll. 10. X. 2008, fixed 12. X. 2008, AS081010B, C; 3♂, same locality, host and collectors, larvae coll. 10. X. 2008, mat. 15–16. X., em. 28. X.–5. XI. 2008, AS081010D; 3♀, same locality, host and collectors, larvae coll. 10. X. 2008, mat. 15–18. X., em. 31. X.–3. XI. 2008, AS081010E; 1♀, same locality, host and collectors, larva coll. 10. X. 2008, mat. 25. X., em. 11. XI. 2008, AS081010F; 1 late instar larva, same locality, host and collectors, coll. 10. X. 2008, fixed 22. X. 2008, AS081010F; 29 first and second instar larvae, eggs deposited by a female emerged on 25. X. 2008 (AS081007D; see above), hatched 7. XI., fixed 7–11. X. 2008, Host: *Fragaria vesca*, AS081007Da. Tokyo Met.: 1♂, Fukiage Gyoen, Imperial Palace, 15. V. 1996, M. Tomokuni; 1♂, same locality, 9–27. VIII. 1996, Malaise trap, K. Konishi; 1♀, same locality, 20. V.–19. VI. 1996, Malaise trap, K. Konishi; 4♂, same locality, 27. IV. 1999, A. Shinohara (cited by Shinohara, 2000); 1♂, same data except 14. V. 1999; 1♂, same locality, 17. V. 2004, T. Nambu; 1♂, Akasaka Imperial Gardens, 29. IV.–13. V. 2003, Malaise trap, M. Owada (cited by Shinohara, 2005); 1♂, same data except 14. V.–4. VI. 2003, Malaise trap, M. Owada (cited by Shinohara, 2005); 1♂, 25. VI.–1. VII. 2003, Malaise trap, M. Owada (cited by Shinohara, 2005); 1♂, Akasaka Imperial Gardens, 30. IV. 2002, M. Owada; 1♀, Gotenyama, Musashinoshi, 4. V. 2001, H. Takahashi; 1♀, Mure, Mitakashi, 6. V. 1998, H. Takahashi; 1♀, Hodokubo,

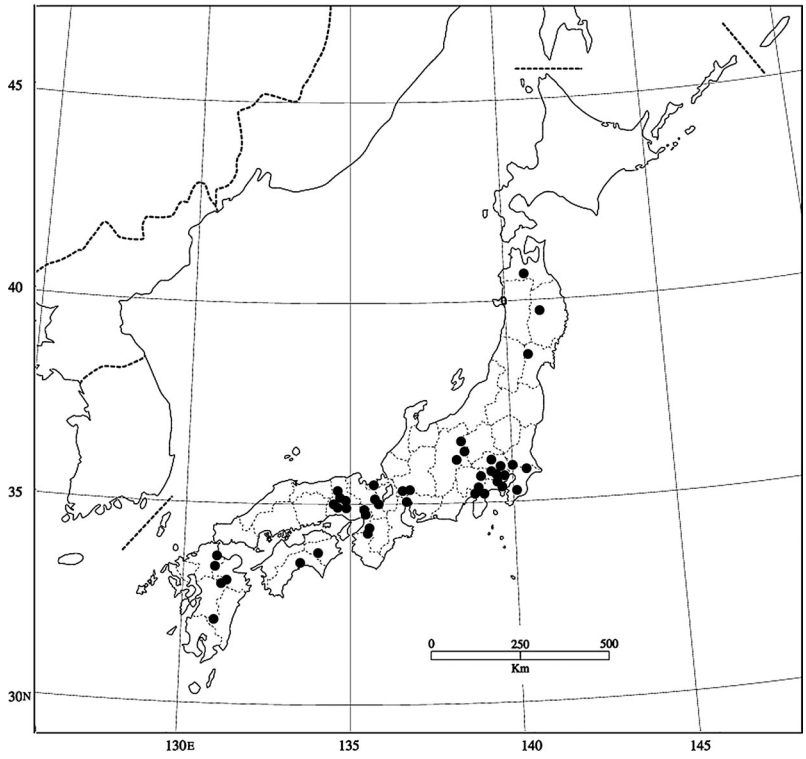

Fig. 7. Distribution of *A. indicura* based on the specimens examined (some overlapping plots omitted).

Hino-shi, 24. IV. 2002, H. Takahashi; 1♂, Yokosawairi, Itsukaichi, 22. IX. 1994, H. Takahashi; 1♂, Yokota, Honmachi, Musashimurayama-shi, 3. VII. 2008, H. Takahashi; 1♀, Shinmachi, Oume-shi, 29. VI. 1991, H. Takahashi. Kanagawa Pref.: 1♀, Nagatsuda, 4. V. 1933, K. Sato; 1♀, Hakone, 21. VI. 1937, K. Takeuchi (OPU); 1♀, Nokendo, Kanazawa-ku, Yokohama, 24. IX. 1989, K. Kubo (KKC; cited by Kubo, 2000); 1♂, same data except 25. IV. 1999 (KKC); 1♂, Oyato, Hitorizawa, Kanazawa-ku, Yokohama, 23. IX. 1992, K. Kubo (KKC; cited by Kubo, 2000); 1♂, Segami, Kamigo, Kanazawa-ku, Yokohama, 26. IX. 1999, K. Kubo (KKC; cited by Kubo, 2000). Shizuoka Pref.: 1♀, Jyurigi-kougen, Susono City, 11. VIII. 1973, T. & H. Suda (HSC). Yamanashi Pref.: 1♀, Saihara, Uenohara Town, 6. VII. 1978, H. Suda (HSC); 1♂, Hirano — Mt. Hirao, 27. VIII. 2007, H. Takahashi. Nagano Pref.: 2♂, Kazawa, 3. VIII. 1929, K. Takeuchi (OPU); 1♀, Karuizawa, 2. VI. 1932, K. Sato; 1♀, Sugadaira, 30. VII. 1932, H. Sugiura; 5♂, Kirigamine, 1680m, 36-5-53N 138-10-12E, 4. VIII. 2008, A. and N. Shinohara; 17♀ (including two mothers of AS080809B) 40♂, Kowashimizu, Kirigamine, 1630 m, 36-5-56N 138-9-30E, 8–9. VIII. 2008, A. and N. Shinohara; 4♀8♂, same data except 15. VIII. 2008; 1♀, same data except 22. VIII. 2008; 3♀1♂, same locality, eggs deposited (by two females collected 9. VIII.) 10. VIII. 2008, hatched 18. VIII., mat. 1–3. IX., em. 12–15. IX. 2008, Host: *Potentilla freyniana*, AS080809B, A. & N. Shinohara; 1 fifth instar larva, same locality, egg coll. 22. VIII. 2008, hatched 24. VIII., fixed 4. IX. 2008, Host: *Potentilla freyniana*, AS080822A, A. & N. Shinohara; 1♀, same locality, egg coll. 22. VIII. 2008, hatched 26. VIII., mat. 12. IX., em. 25. IX. 2008, Host: *Potentilla freyniana*, AS080822B, A. & N. Shinohara. Gifu Pref.: 1♀, Gifu, 20. VI. 1919, K. Takeuchi (OPU); 1♀, Dodogamine, Gifu-shi, 30. IX. 2003, M. Tanaka (MTC); 1♂, same data ex-

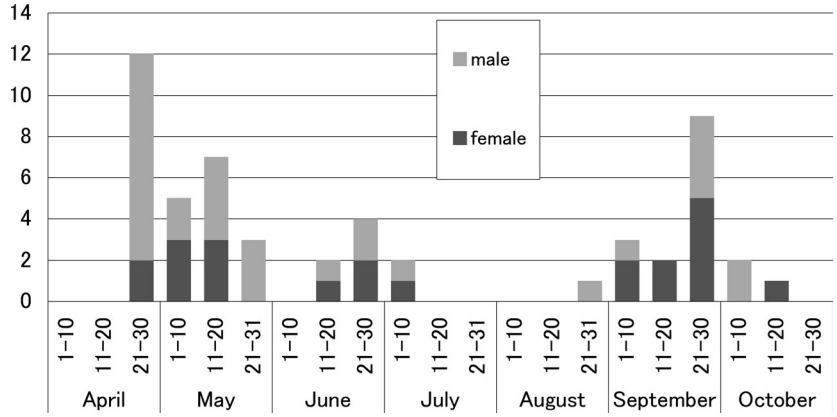

Fig. 8. Number of the adult specimens collected in the lowlands of central Honshu (from the localities roughly under 500 m in altitude in Kanto, Chubu and Kansai regions) for every 10/11 days in April to October. For collection data of the specimens included, see the list of paratypes.

cept 4. X. 2003 (MTC); 1♂, same data except 7. X. 2003 (MTC); 1♀, Mitabora, Dodogamine, Gifu-shi, 19. V. 2004, M. Tanaka (MTC); 1♂, same data except 21. V. 2004 (MTC); 1♂, same data except 17. VI. 2004 (MTC); 1♂, same data except 27. VIII. 2004 (MTC); 1♂, same data except 28. IV. 2005 (MTC); 1♀, same data except 30. IV. 2005 (MTC); 1♀1♂, Katayama, 5. IX. 1920, K. Takeuchi (OPU). Mie Pref.: 1♂, Kisosaki, Kantakuchi, 21. VI. 2008, A. Kawazoe (AKC). Kyoto Pref.: 1♀, Kyoto, 20. X. 1928, K. Takeuchi (OPU); 1♀, same data except 15. IX. 1929 (OPU); 1♂, same data except 27. IV. 1930 (OPU); 1♀, same data except 23. IX. 1937 (OPU); 1♂, same data except 1. V. 1938 (OPU); 1♀, Ushio, 15. V. 1932, K. Takeuchi (OPU); 1♂, Kurama, 19. V. 1940 (OPU). Osaka Pref.: 1♀1♂, Minoo, 20. IX. 1931, K. Takeuchi (OPU); 2♀, Minomo [=Minoo], N. Tosawa (OMNH); 1♂, Mt. Kongo, 3. V. 1916, K. Takeuchi (OPU); 1♂, Mt. Iwawaki, Kawachi, 27. IV. 1952, S. Ito (OPU); 1♀, same locality, 22. VI. 1958, O. Sato; 1♂, Nishi-Nakajima, Yodogawa-ku, Osaka-shi, 30. VI. 2000, H. Yoshida (HYC; cited by Yoshida, 2006). Hyogo Pref.: 1♀, Sugigasawa-kogen, 700 m, Sekinomiya-cho, Yabu-gun, 22. VII. 1992, Y. Yoshida (MNHAH; cited by Naito *et al.*, 2004, B1-212611); 1♂, same data (MNHAH; cited by Naito *et al.*, 2004, as *A. nipponensis*, B1-212614); 1♀, Tonomine-kogen, 700 m, N3509 E13442, Okawachi-cho, Kanzaki-gun, 13. VII. 1994, Y. Ueda (MNHAH; cited by Naito *et al.*, 2004, B1-294018); 1♂, Ruridera, 300 m, N3506 E13425, Nankou-cho, Sayou-gun, 3. V. 1995, I. Takenaka (MNHAH; cited by Naito *et al.*, 2004, as *A. pagana*, B1-341017); 1♂, Umiuchi, 240 m, N3505 E13424, Sayou-cho, Sayou-gun, 3. V. 1995, T. Morita (MNHAH; cited by Naito *et al.*, 2004, as *A. pagana*, B1-341016); 1♂, Matoba, 180m, N3504 E13452, Kami-cho, Taka-gun, 3. V. 1996, S. Mizuno, (MNHAH; cited by Naito *et al.*, 2004, as *A. pagana*, B1-354459); 1♂, Kohata, 210m, N3501 E13448, Ichikawa-cho, Kanzaki-gun, 11. V. 1996, H. Sasai, (MNHAH; cited by Naito *et al.*, 2004, as *A. pagana*, B1-354460); 1♀, "Yachiyo, Mt. Kasa [?=Mt. Kasagatayama], 7. VI. 59, K. Okamoto" "Ryoichi Inomata Collection" (MNHAH, B1-298088); 1♀, "Yachiyo, Mt. Kasa, 7. VI. 59, R. I." "Ryoichi Inomata Collection" (MNHAH, B1-298089). Fukui Pref.: 1♀, Ikonokouchi, Obama, 18. V. 1986, T. Ito. SHIKOKU: Tokushima Pref.: 1♂, Mt. Tsurugi, 3. VI. 1930, K. Takeuchi (OPU). Kochi Pref.: 1♂, Uizuki, Kochi-shi, 17. VI. 1934, Okubo (OPU). KYUSHU: Fukuoka Pref.: 1♀1♂, Yukuhashi, 2. V. 1932, H. Sugiura; 1♂, "Hikosan (Buzen), 29. iiiv [!]. 1950, K. Yasumatsu" "*Arge nigrovaginata* m., ♂, R. Malaise

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Etymology. The species epithet, *indicura*, meaning blue tail, refers to the blue black saw-sheath of the new species.

Host plants. Potentilla freyniana Bornm., *Sanguisorba officinalis* L. (Rosaceae). In the laboratory, also *Potentilla anemonifolia* Lehm., *Fragaria vesca* L., *Duchesnea chrysantha* (Zoll. et Moritzi) Miq.

Observations on life history. In 2008, Shinohara reared this species from eggs and larvae using material from Kowashimizu (1630 m alt.) in Nagano Prefecture and from Abiko (10 m alt.) in Chiba Prefecture, both in central Honshu. The rearing was made in a laboratory in Tokyo, where the room temperature was kept at about 25°C during the feeding period in August and September. In October to November, the room temperature was not controlled or the room was warmed when the temperature went down to 18°C; it was consequently kept at around 19–24°C. The day length was not rigidly regulated, but the light was usually on for about 16 hours a day.

1. Kowashimizu population

A. A number of adults were found on the flowers of *Angelica pubescens* Maxim. in an open field near the camping site on August 8, 9, 15 and 22. There were stands of *Malus*, *Prunus* and *Acer* trees in the field and the surface of the ground was partly covered with short plants including *Potentilla*, *Sanguisorba*, *Agrimonia* and *Rubus*. Two females collected on August 9 were kept alive in a plastic container with fresh leaves of *Potentilla*, *Agrimonia* and *Rubus* for two days, and the females deposited eggs only on *Potentilla freyniana* Bornm. on August 10. Intensive searches for eggs and larvae were made in the site on August 15 and 22 and September 5 focusing on these plants, but only two eggs were found on a leaf of *P. freyniana* on August 22 and no larvae were found.

B. A total of 10 eggs deposited by two females on August 10 (AS080809B, see above; Fig. 5B–C, E–I) hatched on August 18. Two died on August 19. Other eight molted on August 21–22, 23–24, 25–26, 28–29, and five of these had another molt on August 30–September 1. The eight larvae reached maturity on September 1–4 (one of them fixed in ethanol on September 4). From the two larvae which matured on September 1, one male emerged on September 12 and one female on September 15, and from the larvae which made cocoons on September 3, one female each emerged on September 14 and 15. Another larva died in the cocoon, while the remaining two still stay in the cocoon as of January 20, 2009.

C. One egg found on a leaflet of *P. freyniana* on August 22 (AS080822A; Fig. 5D) hatched on August 24. It molted on August 27, 29, 31 and September 3, and fixed in ethanol on September 4.

D. One egg found on a leaflet of *P. freyniana* on August 22 (AS080822B) hatched on August 26. It molted on August 29, 31, September 2 and 5 and matured on September 12. A female emerged on September 25.

2. Abiko population

A. On October 7, two solitary late instar larvae were found feeding on the leaflets of *Sanguisorba officinalis* L. (AS081007C, Fig. 5J). They spun cocoons on October 9 and 10, respectively, and leave in the cocoons as of January 20, 2009.

B. On the same day, ten solitary middle and late instar larvae were found on the leaflets of *P. freyniana* (AS081007D–F; Fig. 5K). Two larvae matured on October 9 (AS081007D–E), one on 10 (AS081007E), one on 11 (AS081007D), two on 13 (AS081007F), two on 14 (AS081007D, F), one on 16 (AS081007F), and one on 18 (AS081007F). From the larva which spun a cocoon on October 11, a female emerged on October 25, and this newly emerged female oviposited

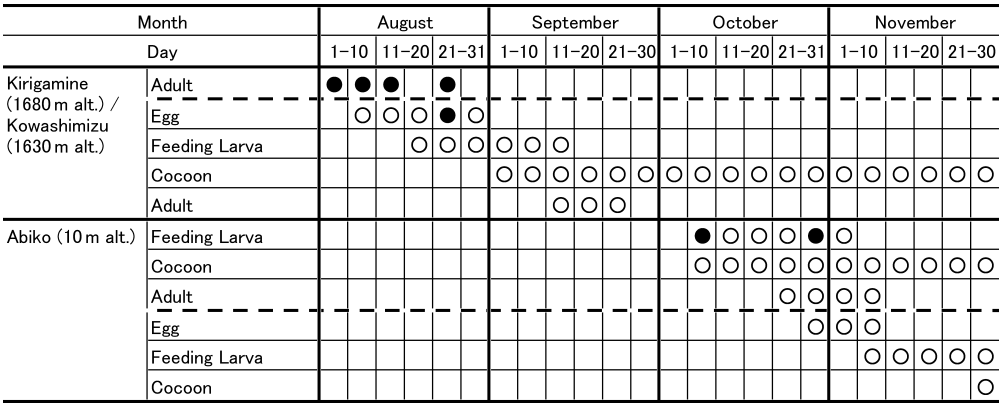

Fig. 9. Life cycle of *A. indicura* indicated by the occurrence of each stage of individuals in Kirigamine (Nagano Prefecture), Abiko (Chiba Prefecture) and in the laboratory in Tokyo in 2008 (see text for more information). ●: Observations in the field. ○: Observations in the laboratory in Tokyo.

on the leaflets of *Fragaria vesca* L. on October 26–27. From the larvae which matured on October 13, two females emerged, one on October 27 and the other on October 31, and from the two cocoons made on October 14, one female each emerged on October 31 and November 1. The remaining five larvae are in the cocoons as of January 20, 2009.

A total of 62 eggs deposited on October 26–27 by the female which emerged on October 25 (see above) hatched on November 7 (AS081007Da). The larvae fed on the leaves of *Fragaria vesca*, but 59 larvae died for unknown reasons on November 7–11 in the first or second instars. Two of the remaining three larvae died in the third instar and only one larva matured and made a cocoon on November 30.

C. On October 10, 28 solitary early to late instar larvae were found on *P. freyniana* (AS081010B–F). Except for three larvae fixed in ethanol on October 12 and 22, all larvae made cocoons, one on October 11 (AS081010C), one on 12 (AS081010B), three on 13 (AS081010B–C, E), four on 14 (AS081010B, D), six on 15 (AS081010B–E), three on 16 (AS081010C–E), three on 17 (AS081010D–E), and one each on 18 (AS081010E), 19 (AS081010F), 24 (AS081010F) and 25 (AS081010F). Eleven adults emerged, one male on October 28 from a cocoon made on October 15, one female on October 31 from a cocoon spun on October 15, one male on October 31 from a cocoon spun on October 17, three females on November 1 from the larvae which matured on October 15, one female on November 2 from the larva which matured on October 17, two females on November 3 from the cocoons made on October 17 and 18, one male on November 5 from the cocoon spun on October 16, and one female on November 10 from a cocoon spun on October 25. The other 14 larvae stay in the cocoons as of January 20, 2009.

D. On October 26, 17 solitary middle and late instar larvae were found on *P. freyniana* (AS081026A–E). One larva matured on October 28 (AS081026C), four larvae on October 30 (AS081026A, C–D), seven larvae on October 31 (AS081026A, D–E), one larva each on November 1 (AS081026A) and 3 (AS081026A), two larvae on November 4 (AS081026B), and one larva on November 5 (AS081026B). All larvae stay in the cocoons as of January 20, 2009.

For the three late instar larvae (AS081026B), only the leaves of *Potentilla anemonifolia*, *Fragaria vesca* and *Duchesnea chrysantha* were given for three days, and they fed on these plants and grew without problems. The same larvae were kept with only the leaves of *Rosa* and *Rubus* for one day, but they never ate the plants.

Oviposition and larval behavior. The female lays one or a few eggs, but not in a group, into

the tissue of the margin of a leaflet (Fig. 5A–B). The larvae are quite immobile and not gregarious even in early instars. On maturity, the larva makes a cocoon among the tissue papers in the laboratory usually after actively searching for an appropriate site for several hours.

Discussion

Comparison with the Related Species

From the Japanese congeners with an orange abdomen, namely, *A. nipponensis* Rohwer, 1910, *A. suspicax* Konow, 1908, *A. pagana* (Panzer, 1798) and *A. nigronodosa* (Motschulsky, 1860), the new species is easily distinguished by the entirely blue black head, thorax and sawsheath, black legs and wings, and the sharply carinate supraclypeal carina.

The new species is very closely allied to *A. nigrovaginata* described from the Russian Far East, but *A. indicura* differs from *A. nigrovaginata* in the following characters (conditions in *A. nigrovaginata* in parentheses): Head, thorax and sawsheath with distinctly bluish metallic luster, Fig. 1A–D (bluish luster missing); sawsheath entirely bluish black, Fig. 1N–O (black, usually basally orange); frontal area long, distance between median fovea and front ocellus about 2× diameter of front ocellus, Fig. 1K (short, about 1.5×); lance with annuli inconspicuous and with some linear membranous areas midapically, Fig. 2A–B (annuli conspicuous and without distinct membranous areas); lancet strongly sclerotized and pigmented, Figs. 2C, 3 (rather weakly so), with dorsal margin nearly straight or very slightly roundly convex (distinctly roundly convex) and ventral margin roundly convex midapically (nearly straight); annular plates often narrowed at middle (not narrowed at middle); first annular plate large, extending over midline dorsally (small, not extending over midline dorsally); marginal sensilla of the median annuli directed ventrally (directed posteroventrally); pore of sensillum absent in dorsal part of each annular plate (present). More discussion on *A. nigrovaginata* and the related species will be given in a forthcoming paper.

The larva of this species (Figs. 5–6) is of a cryptic type and well characterized by its hairy and almost concolorous body with whitish marking on the trunk in life in the late instars. The lack of distinct blackish marking on the head (Fig. 5H) will distinguish the late instar larva of *A. indicura* from those of other cryptic species, namely, *A. nipponensis* on *Rosa*, *A. rejecta* (Smith, 1874) on *Rubus*, *A. mali* (Takahashi, 1906) on *Malus*, *A. suzukii* (Matsumura, 1912) on *Abelia* (Shinohara and Hara, 2008; unpublished data). The very pale late instar larva of *A. suspicax* Konow, 1908, which feeds on *Sanguisorba*, has no black marking on the head (Shinohara *et al.*, 2008). The larva of *A. indicura* differs from such pale-colored larva of *A. suspicax* in having the head very pale greenish brown (pale brown in *A. suspicax*), the trunk in life marked with white (without distinct whitish marking in *A. suspicax*), and the small black spot at the base of each proleg missing (present in *A. suspicax*).

Distribution

Under the name of "*A. nigrovaginata*", this species was recorded from Niigata (Togashi, 1983), Saitama (Nambu, 1998), Kanagawa (Gussakovskij, 1935; Kubo, 2000; Nagase, 2004), Gifu (Takeuchi, 1932), Kyoto (Takeuchi, 1932), Osaka (Yoshida, 2006) and Hyogo (Naito *et al.*, 2004) Prefectures and Tokyo Metropolis (Shinohara, 2000, 2005) in Honshu and Ehime Prefecture (Togashi and Yamamoto, 2000) in Shikoku. Figure 7 shows the distribution of this species based on the material examined. This is the first record from Kyushu.

"*Arge nigrovaginata*" has been recorded also from China and Korea (Takeuchi, 1948; Zombori, 1974; Togashi, 1990; etc.). We were unable to examine any specimens of *A. indicura* from outside Japan.

Host Plants

Arge indicura is an oligophagous species associated with *Potentilla*, *Sanguisorba*, and possibly

Table 1. Duration of the "cocoon" period (prepupal, pupal and possibly very short adult periods in the cocoon) based on the rearing experiments in 2008. Larvae collected on October 26 (AS081026A-E) are not included.

		Number of adults emerged											
Months of rearing	Group code	Days after making cocoons											Total
		11	12	13	14	15	16	17	18	19	20	longer[C]	
August–September	AS080809B[A]	2			2							2	6
	AS080822B[A]			1									1
October–November	AS081007C[B]											2	2
	AS081007D[B]				1				1			1	3
	AS081007E[B]											2	2
	AS081007F[B]				1			1	1			2	5
	AS081010B[B]							3				4	7
	AS081010C[B]											4	4
	AS081010D[B]			1	1			1			1	2	6
	AS081010E[B]						3					2	5
	AS081010F[B]						1					3	4
Total		2		2	5		4	5	2		1	24	45

[A] Larvae reared from eggs in the laboratory. [B] Larvae collected in the field. [C] Over 85 days as of January 20, 2009.

also with *Fragaria* and *Duchesnea*, all within a clade Sanpotina in the Rosaceae (Eriksson *et al.*, 2003). In the field, the eggs and larvae have been found on the leaflets of *Potentilla freyniana* and *Sanguisorba officinalis*, and in the laboratory, late instar larvae also fed on the leaflets of *Potentilla anemonifolia*, *Fragaria vesca* and *Duchesnea chrysantha* and matured without problems. A female deposited eggs on *Fragaria vesca* and early instar larvae fed on this plant, though most of them died in the first or second instar for unknown reasons.

Takeuchi (1949) gave *Rosa* as a host plant of this species without any comments. Okutani (1967) pointed out that this host association had not been confirmed. Takeuchi's record is probably a mistake, because three larvae, which were reared with *Potentilla*, *Sanguisorba*, *Fragaria* and *Duchesnea* leaves in the laboratory, did never take *Rosa* leaves even though no other foods were available to them, as noted above. A newly emerged female easily oviposited on *Potentilla* and *Fragaria* (*Sanguisorba* and *Duchesnea* were not used for the experiment) but never on *Rosa*. It should be noted that the known host plants (*Potentilla*, *Sanguisorba*, *Fragaria* and *Duchesnea*) are closely related phylogenetically in the clade Sanpotina (Eriksson *et al.*, 2003), whereas *Rosa* does not belong to this monophyletic group.

Life History

The collection data given above show that the adults of *A. indicura* occur in the field in April to October, strongly suggesting a multivoltine life cycle as in other *Arge* species (Ii, 1934; Tokunaga and Tsujita, 1951; Hara and Shinohara, 2008; Shinohara and Hara, 2008). Figure 8 shows the number of the adult specimens collected in the lowlands of central Honshu (from the localities roughly under 500 m in altitude in Kanto, Chubu and Kansai regions) for every 10 or 11 days during the period. It indicates the existence of three peaks of adult emergence in these areas, two major peaks in April–May and September and a minor peak in June–July.

According to the rearing experiments made in August to November in 2008 in Tokyo (Fig. 9; see notes above), the egg period was eight days in August (AS080809B) and 11–12 days in

October (AS081007Da) and the larval period was 14–17 days in August to September (AS080809B, AS080822B). The length of the cocoon period varied greatly as shown in Table 1 and is irregular compared with, for instance, that of *A. suspicax* Konow, 1908 (see Shinohara *et al.*, 2008). The adult emergence is apparently polymodal (Knerer, 1993), because, out of 45 cocoons examined (Table 1), adults emerged from 21 cocoons in 11–20 days after they were spun whereas the remaining 24 larvae in the cocoons went into long diapause probably terminating in the next spring. One life cycle of this species is thus estimated to take 30–50 days when they do not enter diapause, and there are potentially up to four generations a year in the lowland of central Honshu. This observation generally agrees with the actual pattern of adult occurrence as shown in Fig. 8, except that the supposed third peak, which should exist in July–August, is totally missing, most probably due to the aestival diapause of the prepupae.

In higher places over 500 meters in altitude in central Honshu, the adults have been collected mainly in the end of July to the end of August; otherwise, only one female collected in Karuizawa (about 1000 meters high) in the beginning of June was available. We have obtained a long series of adults on the *Angelica* flowers in Kowashimizu (about 1630 meters high) in early to middle August, 2008 (Fig. 9). There should be only one or two generations a year in such cold localities.

The larvae of the genus *Arge* usually have five instars in males and six instars in females, but this is not always the case (Ii, 1934; Tokunaga and Tsujita, 1951; Petre *et al.*, 2007). In *A. indicura*, the female larva usually has five molts (six instars), but one female adult emerged from a larva which spun a cocoon when it was in the fifth instar (AS080811B).

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