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Arge naokoae n. sp. (Hymenoptera, Argidae) Feeding on *Spiraea dasyantha* in Japan

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Abstract *Arge naokoae* n. sp. is described from Honshu and Shikoku, Japan. Larvae are external leaf feeders on *Spiraea dasyantha* Bunge (Rosaceae), feeding in a small group in early instars and solitarily in late instars. Field observations and rearing experiments showed that this species has a multivoltine life cycle. This is the first record of an argid sawfly associated with *Spiraea*.
Key words: Argidae, *Arge naokoae*, new species, *Spiraea dasyantha*, Japan.

Introduction

While sorting and identifying *Arge* specimens deposited in the Museum of Nature and Human Activities, Hyogo, Sanda (MNHAH), we discovered a female specimen of an undescribed species collected in Takedao, Takarazuka City, Hyogo Prefecture, Honshu, on June 4, 2002. In spite of its rather common superficial appearance, the ovipositor of this specimen was quite peculiar. We were not able to find any additional specimens of this species in the collections of various museums and universities.

Our first visit to Takedao on June 18, 2012, in an attempt to obtain additional adult specimens or the larvae of this sawfly, was surprisingly successful. We found a series of unknown argid larvae feeding on *Spiraea dasyantha* Bunge (Rosaceae), a plant growing mainly in rocky places such as limestone areas in western Japan. The larvae were reared in Tokyo, and the first adult, a female, emerged on July 7, 2012. It was conspecific with the female specimen in MNHAH. We obtained additional larvae in Takedao on July 25 and October 8, 2012, and on Mt. Shippo-zan, Mitoyo City, Kagawa Prefecture, Shikoku, on October 9 and 10, 2012, and obtained a series of adults by rearing.

Here we describe and illustrate the new species under the name of *A. naokoae* and give notes on its life history. It is a multivoltine species with gregarious early-instar and solitary late-instar larvae. This is the first record of Argidae feeding on *Spiraea*.

Materials and Methods

The material used in this work is kept in the National Museum of Nature and Science, Tsukuba, unless otherwise stated. Our interpretation of *A. pilopenis* Wei, 2012, is based on the original description (in Wen and Wei, 2002) and a pair of the specimens identified by M.-C. Wei (1♀, "Hebei, Wulingshan, Ximenkou, 2007. VI. 16, Li Zejian, N. 40°36.089′, E. 117°25.937′, Altitude 832 m"; 1♂, "Hebei, Wulingshan, Yungougu, 2007. VI. 15, Li Zejian, N. 40°37.330′, E. 117°22.584′, Altitude 485 m").

Observations of morphology were made with an Olympus SZ60 stereo binocular microscope and measurements of each structure were taken with an ocular micrometer. Photographs were taken with digital cameras, Canon EOS Kiss Digital and Ricoh Caplio GX100, and Keyence Digital Microscope VHX-900 and AnMo Electronics Dinolite digital microscope. The digital images were processed and arranged with Adobe Photoshop Elements 2.0 software.

Rearings were made in an air-conditioned room in Tokyo by Shinohara. In the rearing room, the temperature was usually 18–25 degrees C and the light was usually on for about 16 hours a day.

For the scientific names of plants, we followed Yonekura and Kajita (2012).

Results

Arge naokoae n. sp.

[Japanese name: Shimotsuke-churenji]

(Figs. 1A–G, I, 2–5, 7–9; Tables 1–3)

Female (Fig. 1A–C). Length 6.5–9.5 mm. Black, with weak dark bluish reflection; frontal area, clypeus and labrum with slight coppery reflection; subanal area whitish, blackish ventrally. Antenna black; flagellum sometimes with slight brownish tint. Mandible apically reddish; palpi dark brown to black. Legs black, with faint dark bluish reflection; front tibia sometimes partly obscurely whitish or brownish; mid tibia with base whitish (1/2–4/5 in Takedao specimens, only narrowly at base in Mt. Shippo-zan specimens); hind tibia with basal 2/3–4/5 whitish; tibial spurs dark brown to black. Wings hyaline, slightly yellowish basally and slightly darkened apically; forewing with black band below stigma extending to posterior wing margin, covering most of cells 1Rs and 2M; stigma and veins black, yellow to pale brown on C, Sc, extreme base of stigma and adjacent part of basal section of R1; apical section of R1 beyond stigma often pale brown; vein C slightly darkened along anterior margin. Setae whitish, brownish on sawsheath and mesoscutellum and their adjacent areas; setae on wings blackish, yellowish on basal membranous areas.

Surface generally smooth and polished; punctures on anterior part of head relatively dense, generally separated from each other.

Head in dorsal view (Fig. 2A) very slightly concave at outer orbits, with width across eyes about as long as or slightly narrower than width at genae. Distance between eyes 1.1–1.2 × vertical diameter of eye; eye with vertical diameter 1.7–1.8 × horizontal diameter. Postocellar area weakly convex or nearly flattened, sometimes medially very shallowly furrowed, with anterior furrow rather distinct and lateral furrow indistinct, often distinct anteriorly (Fig. 2A). Ocellar area not concave between ocelli (Fig. 2D). Frontal area slightly raised anteriorly and widely shallowly concave in front of median ocellus; lateral ridges low, weakly converging anteriorly; anterior margin transversely weakly ridged (Fig. 2B). Distance between median fovea and front ocellus 2.1–2.3 × width of front ocellus. Median fovea usually punctiform (Fig. 2B, E). Interantennal carinae sharp, dorsally becoming dull and low and connected with lateral ridges of frontal area (Fig. 2B), ventrally fused together into median supraclypeal carina at middle of supraclypeal area (Fig. 2E). Supraclypeal carina sharp, with side slope weakly rounded (Fig. 2E). Malar space 0.4–0.7 × width of front ocellus. Clypeus distinctly sunk below supraclypeal carina (Fig. 2F); ventral margin roundly incised at middle (Fig. 2E). Antennal length 1.3–1.7 × maximum width of head; flagellum (Fig. 2I, J) slightly compressed, weakly curved basally and narrowly rounded or pointed at apex. Right mandible incised on inner margin (Fig. 2E).

In forewing, cell 2Rs with anterior length 1.1–1.5 × posterior length and crossvein 3r-m usually strongly curved in anterior part and almost straight in posterior part (Fig. 1A); in both wings, wing margin between veins Rs and Cu ciliate, with marginal glabrous area narrower than width of vein M and length of marginal setae about 2 × width of vein M (Fig. 2M).

Abdomen with second to fourth terga nearly

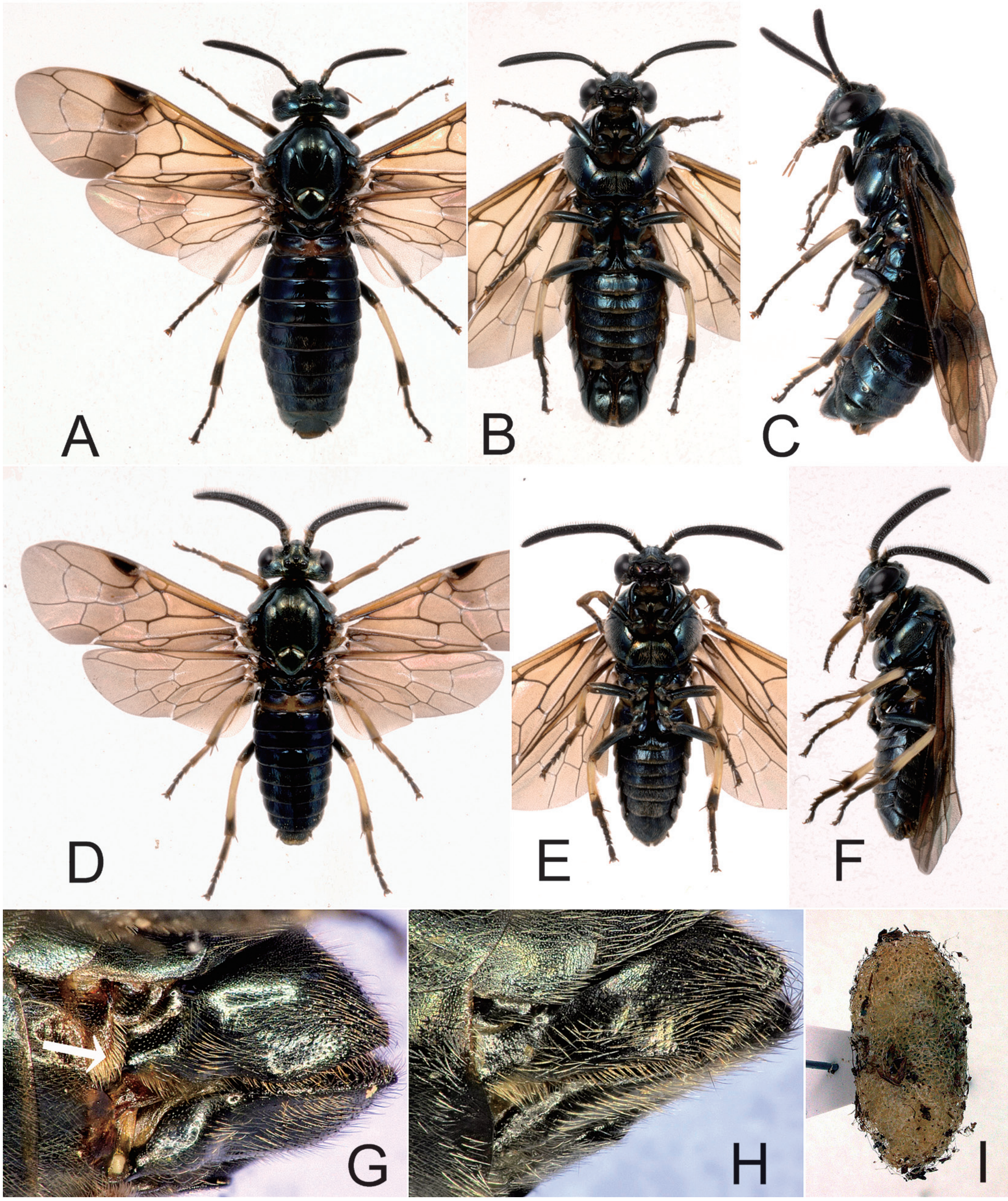


Fig. 1. *Arge naokoae*, paratypes, Takedao, Hyogo Pref. (A–G, I) and *A. aruncus* (H). — A, Female, dorsal view; B, do., ventral view; C, do., lateral view; D, male, dorsal view; E, do., ventral view; F, do., lateral view; G, female, apex of abdomen, ventrolateral view (setose lobe between seventh sternum and base of sawsheath arrowed); H, do.; I, cocoon. A–F photographed by F. Ito.

glabrous above; fifth tergum sparsely setose; sixth tergum to apex setose. Posterior margin of seventh sternum medially roundly convex and bent dorsally (Fig. 1G). Large conspicuous setose lobe present on each side between seventh sternum and base of sawsheath (Fig. 1G, arrowed) (usually largely concealed under seventh sternum in dried specimens). Sawsheath in

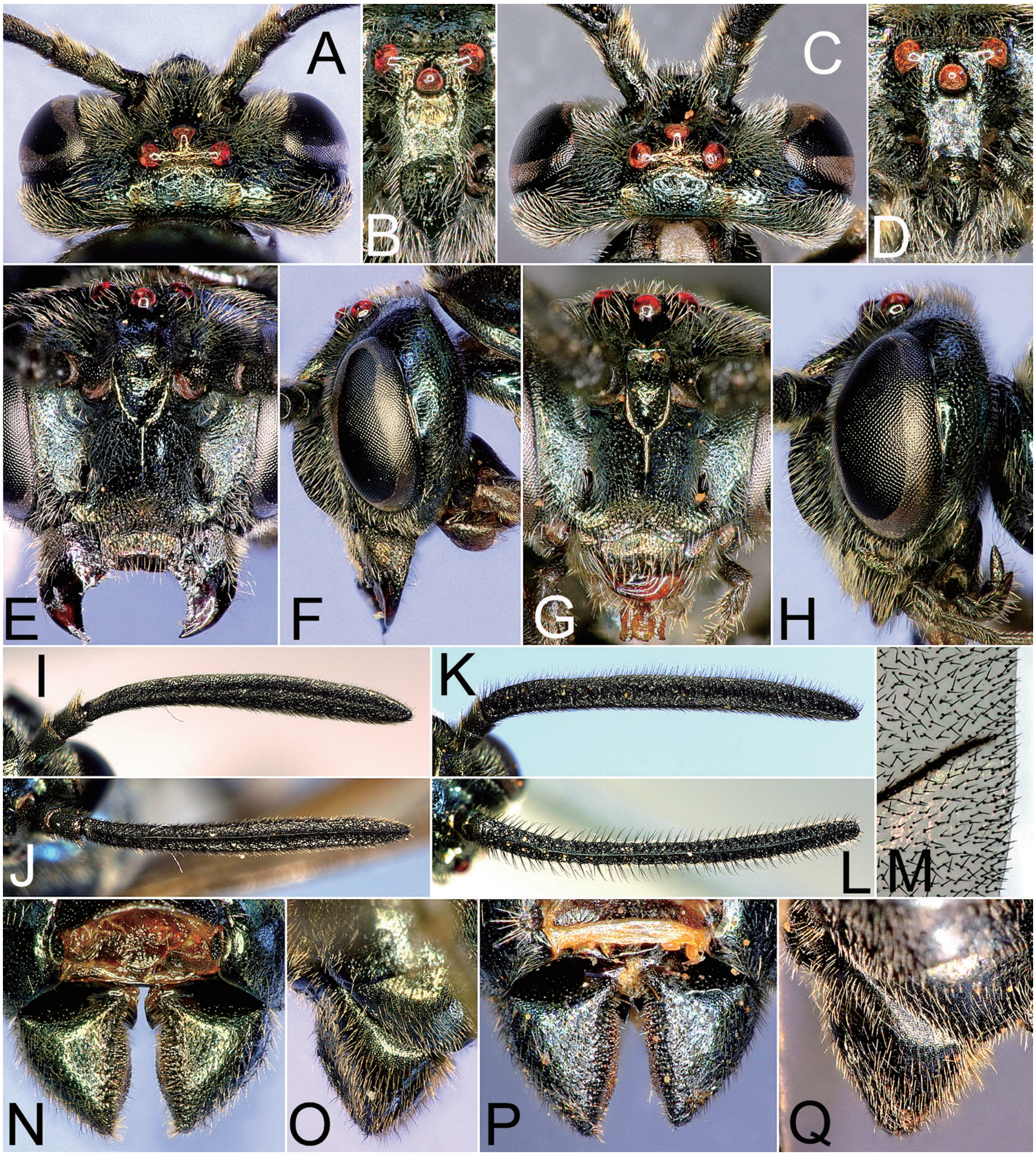


Fig. 2. Heads (A–H), antennae (I–L), apical margin of forewing (M) and sawsheaths (N–Q), holotype (A, B, E, F, I, J, M–O) and female (P, Q) and male (C, D, G, H, K, L) paratypes, Takedao, Hyogo Pref. — A, Dorsal view; B, frontal area, dorsofrontal view; C, dorsal view; D, frontal area, dorsofrontal view; E, frontal view; F, lateral view; G, frontal view; H, lateral view; I, K, lateral view; J, L, ventral view; M, dorsal view near vein M; N, P, dorsocaudal view; O, Q, lateral view.

posterodorsal view (Fig. 2N, P) longer than wide, subtriangular, lateral margin roundly convex basally, mesal margin slightly convex and spinose, and apex obtusely pointed; basal median lobe small; dorsal surface rather flattened or very feebly convex, strongly sunk basally; in lateral view (Fig. 2O, Q), dorsal margin very slightly convex, ventral margin, except for basal convexity, distinctly roundly convex at middle and slightly concave or straight midapically, and

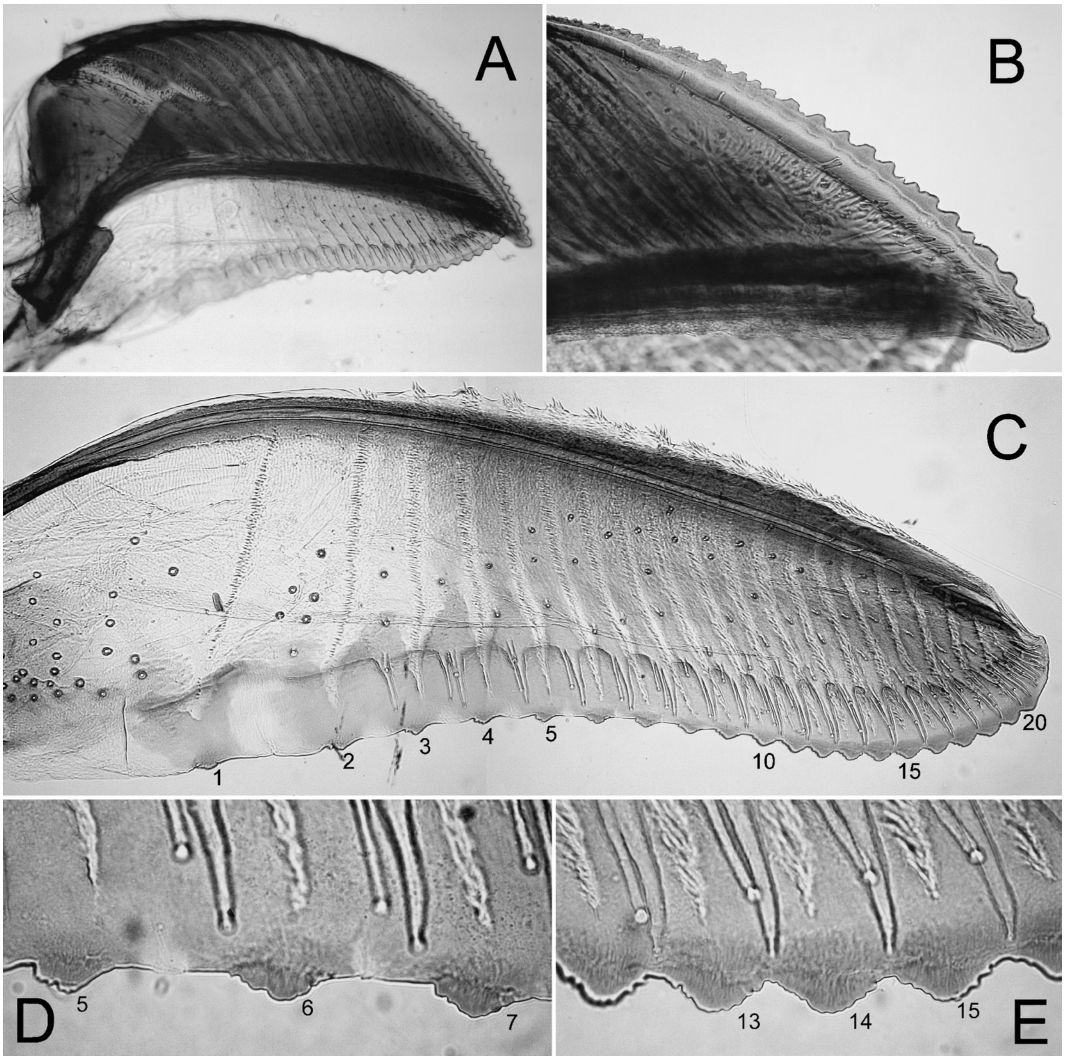


Fig. 3. Ovipositor, holotype, Takedao, Hyogo Pref. — A, Lance and lancet; B, apical part of lance; C, lancet; D, fifth to seventh serrulae; E, 12th to 15th serrulae. Numerals in C–E refer to the serrula numbers from the base of lancet.

apex rounded.

Lance without distinct linear membranous areas (Fig. 3A) and with groups of minute or inconspicuous setae along ventral margin; apical crest low, somewhat roughly serrate on dorsal margin (Fig. 3B). Lancet (Figs. 3C, 4) with dorsal margin weakly roundly convex and ventral margin roundly concave at middle and broadly rounded apically, annulated nearly to apex, without non-annulate areas and with about 20 (plus a few indistinct apical) serrulae; basal four annuli nearly straight or ventrally slightly curved basally and more apical annuli slightly arched toward apex of lancet; marginal sensillae long; dorsal membranous area broad, with groups of minute setae at intervals; narrow longitudinal rows of setae present between annular plates and before second annulus; first to third annular plates small, only in ventral part, fourth annular plate developed ventrally and usually also dorsally, and fifth and more posterior annular plates entire; middle annular plates with one to five sen-

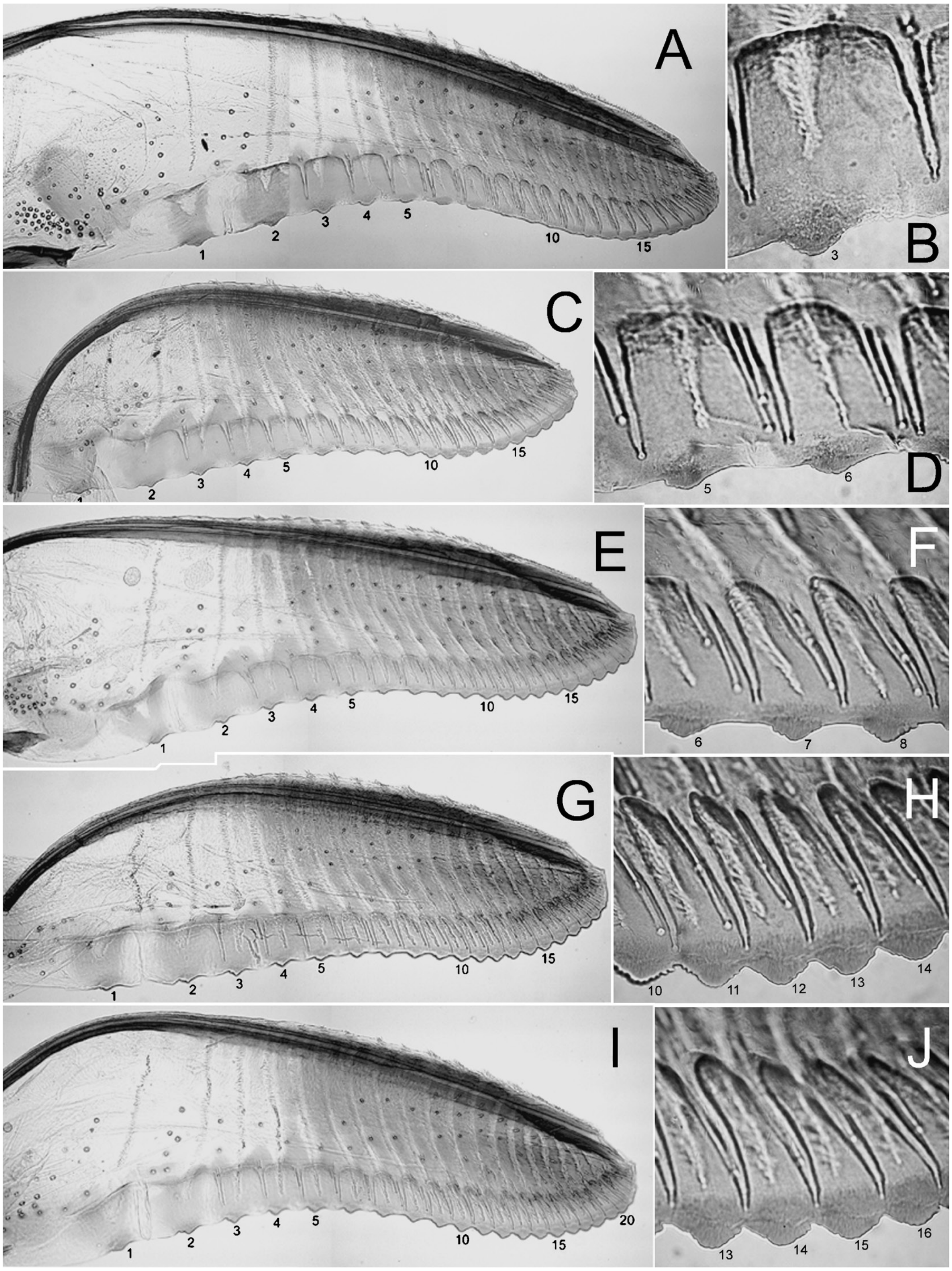


Fig. 4. Lancets, paratypes, Takedao, Hyogo Pref. — A, Collected as adult, June 4, 2002; B, same specimen, third serrula; C, reared, emerged July 15, 2012 (AS120618G); D, same specimen, fifth to sixth serrulae; E, reared, emerged August 25, 2012 (AS120725A); F, same specimen, sixth to eighth serrulae; G, reared, emerged August 27, 2012 (AS120725B); H, same specimen, tenth to 14th serrulae; I, reared, emerged September 2, 2012 (AS120725G); J, same specimen, 13th to 16th serrulae. Numerals refer to the serrula numbers from the base of lancet.

sory pores except for ventral ones; serrulae finely rather irregularly dentate, those in basal part of lancet small and low, those in middle and apical parts generally subtriangular (Figs. 3–4).

Male (Figs. 1D–F). Length 6.5–8.5 mm. Coloration as in female; forewing with band below stigma weak, becoming inconspicuous below vein M; genital capsule brown basally and black apically. Head in dorsal view with width across eyes slightly longer than width at genae (Fig. 2C). Distance between median fovea and front ocellus 2.0–2.5 × width of front ocellus. Interantennal carinae dorsally sharp, angularly curved inward, and fused into transverse carina above median fovea. Distance between eyes 1.0–1.1 × vertical diameter of eye; eye with vertical diameter 1.5–1.6 × horizontal diameter. Malar space 0.2–0.5 × width of front ocellus. Antennal length 1.5–1.8 × maximum width of head; flagellum distinctly compressed (Fig. 2K, L). In forewing, cell 2Rs with anterior length 1.1–1.4 × posterior length. Subgenital plate in ventral view with posterior margin rounded, slightly concave at apex (Fig. 5H).

Genitalia as in Fig. 5; gonostipes in ventral view narrowing apically, with medial margin concave at middle and apical width narrower than basal width of harpe (Fig. 5B, F, H). Harpe very long, about as long as or slightly longer than ventral medial length of gonostipes, in dorsal view widest near base, pointed apically. Valviceps in dorsal view (Fig. 5A, D, G, I) narrow, with small dorsoapical lobe (dl) and large subtriangular posteromedian ventral lobe (vl) projecting laterally; in lateral view (Fig. 5C, F), main body subtriangular with large protruding ventral lobe and long dorsal apodemal projection (dap).

Larva. Early instar (Fig. 7E): Head black; trunk pale green, with minute spots on each segment, subspiracular lobes and spots on suranal and subanal lobes grayish; thoracic legs mostly blackish. Middle instar (Fig. 7F): Head black; trunk pale green, with minute spots on each segment and spots on suranal and subanal lobes black; subspiracular lobes and bases of prolegs grayish; thoracic legs yellowish green with coxae, trochanters, and part of femora black. Late instar (Figs. 7G–K, 8): Head blackish brown to black; trunk very pale olive green, partly tinted with creamy white particularly on anterior part of thorax and around ninth abdominal segment; prolegs and subspiracular lobe of ninth abdominal segment creamy white; large paired spots along middorsal line on each annulet of thoracic and abdominal segments, one or two spots on each side of first annulet, two spots on each side of second annulet and three spots on each side of third annulet of each segment, spiracles, large spot on each subspiracular lobe, spot at base of each proleg, and large spots on suranal and subanal lobes black; thoracic legs brown, base and often outer surface largely black. When mature, greenish area on trunk becoming reddish brown, partly mixed with light orange (particularly on prothorax and around subspiracular lobes), laterodorsal region becoming whitish with slight violet tinge, and thoracic legs becoming mostly black, while black patterns on trunk remaining unchanged (Fig. 7J, K).

Structure (last instar): Length 15 mm; antenna conical (Fig. 8E); clypeus with two pairs of setae; labrum with two pairs of setae; mandible with three to six setae on outer surface; maxillary palp with four palpomeres; palpifer with four to six setae; labial palp with three palpomeres; first to ninth abdominal segments each with three annulets (Fig. 8A–C); prolegs on second to sixth and tenth segments, those on second to sixth elongate; trunk largely setose; dorsal black spots each with several setae, small spots each with one to three setae; tenth tergum in dorsal view rounded apically; subanal lobe distinctly extending posteriorly beyond suranal lobe (Fig. 8J).

Cocoon (Fig. 1I). Creamy. Length 8.5–12 mm. Elongate oval, double walled; outer wall netted; inner wall parchment like.

Distribution Japan (Honshu, Shikoku).

Material examined. Holotype (Figs. 2A, B, E, F, I, J, M–O, 3): ♀, Takedao, Takarazuka, 110 m alt., larva coll. 25. VII. 2012, matured 12. VIII., em. 29. VIII. 2012 (AS120725E), Host: *Spiraea dasyantha*, A. and N. Shinohara. Depos-

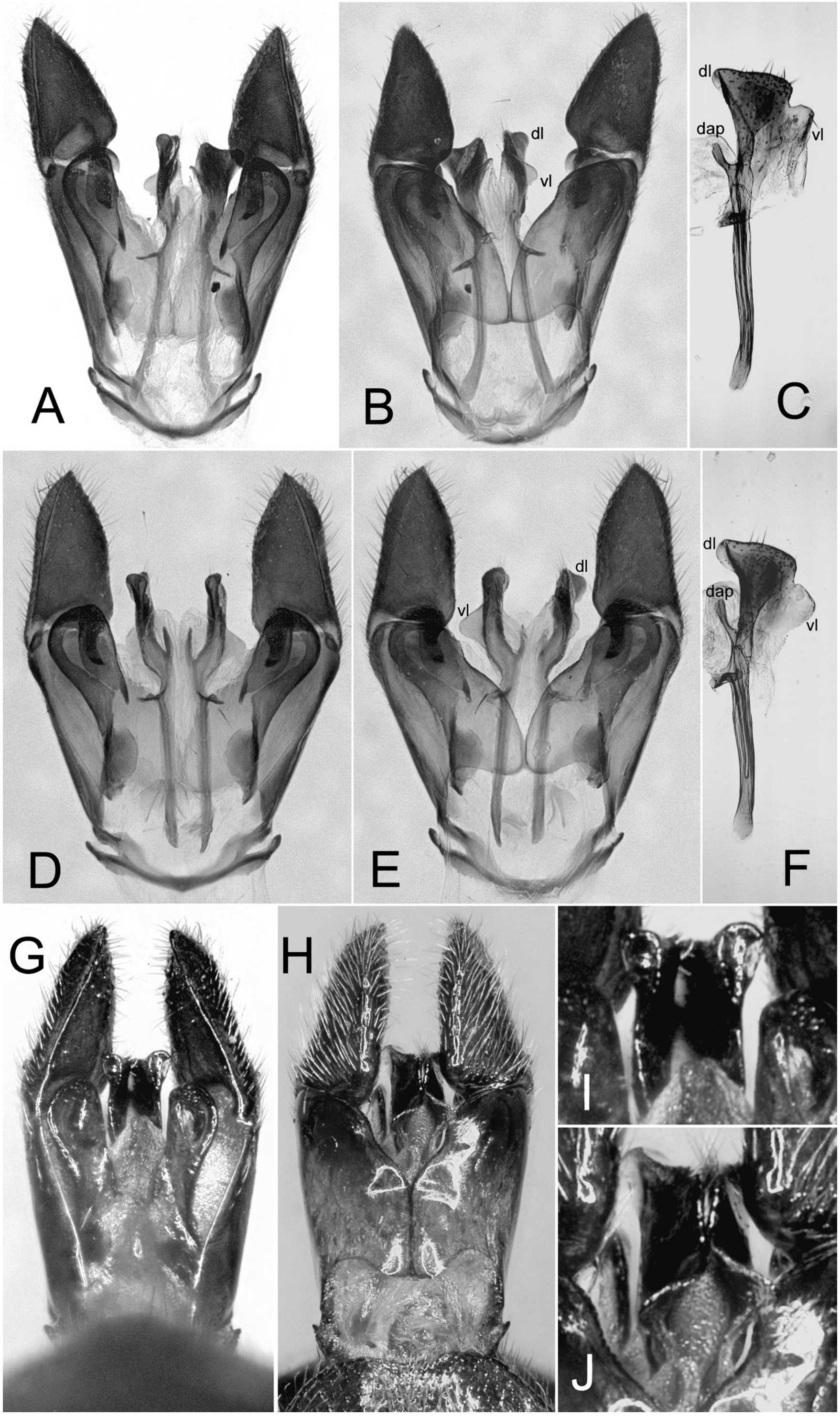


Fig. 5. Male genitalia, paratypes, Takedao, Hyogo Pref., AS120618Ga (A–C, G–J) and AS120725B (D–F). — A, D, G, Dorsal view; B, E, H, ventral view; C, F, penis valve, lateral view, left dorsal; I, valviceps, dorsal view; J, valviceps, ventral view. Abbreviations: dap, dorsal apodemal projection; dl, dorsal lobe; vl, ventral lobe.

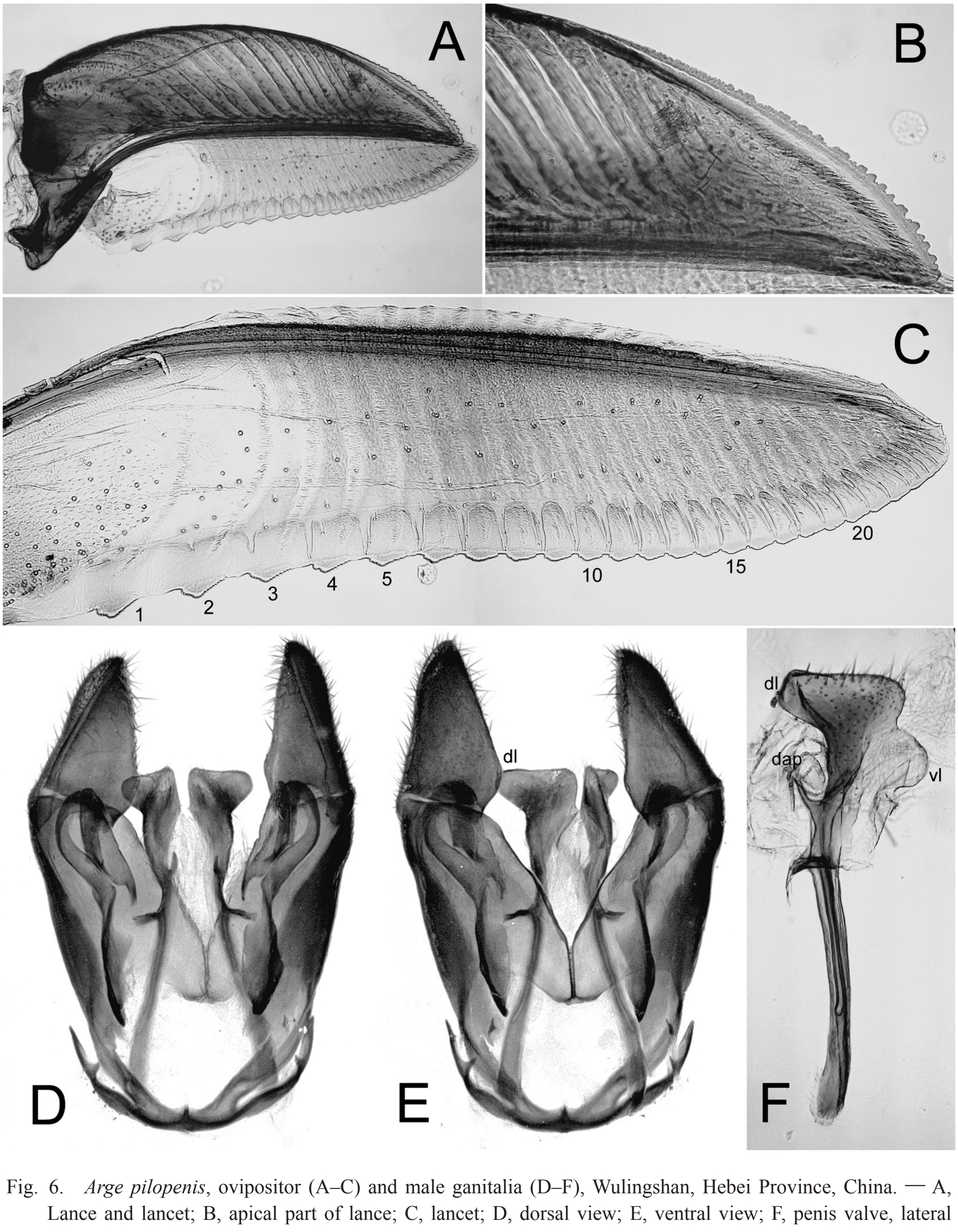
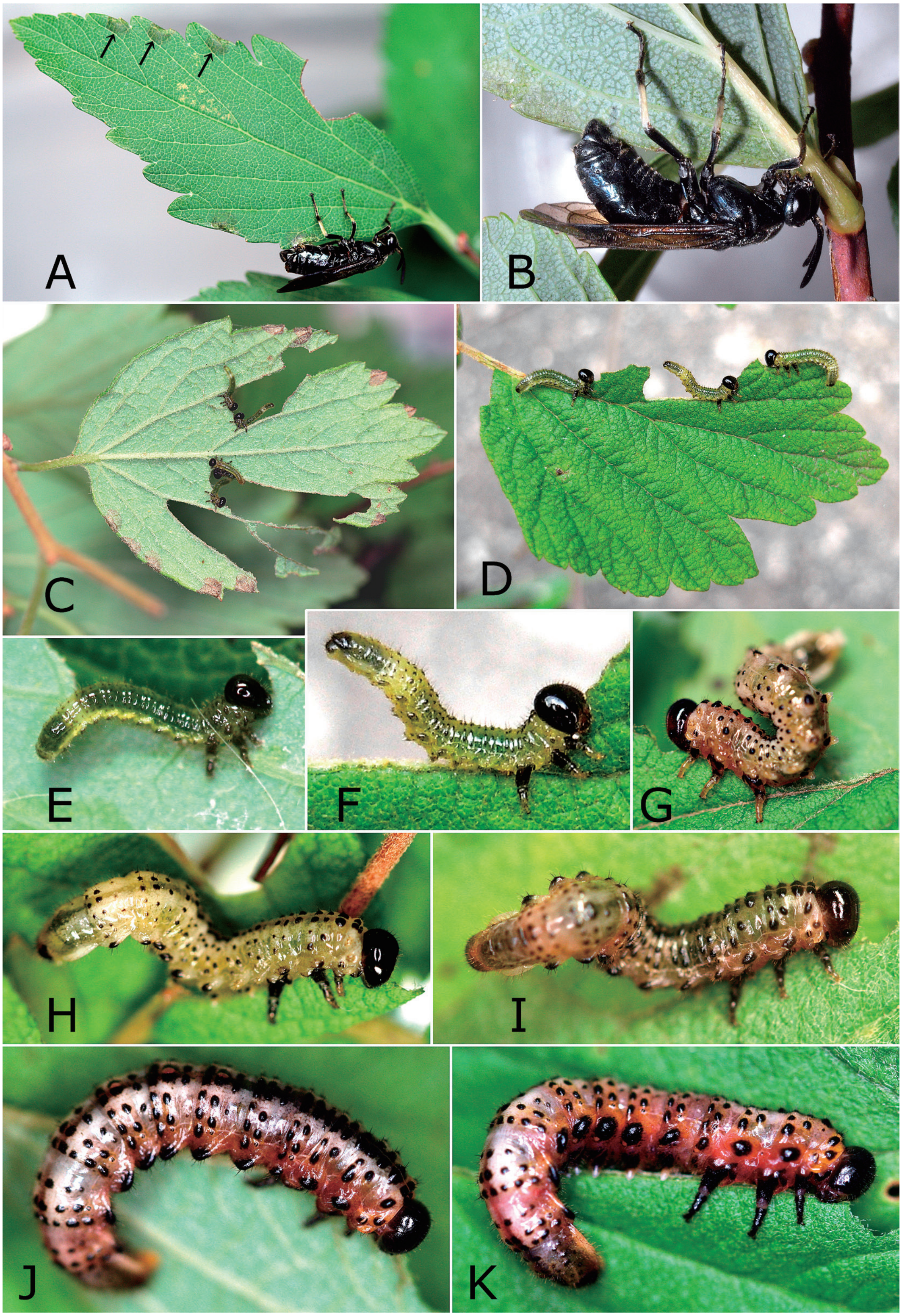


Fig. 6. *Arge pilopenis*, ovipositor (A–C) and male ganitalia (D–F), Wulingshan, Hebei Province, China. — A, Lance and lancet; B, apical part of lance; C, lancet; D, dorsal view; E, ventral view; F, penis valve, lateral view, left dorsal. Abbreviations: dap, dorsal apodemal projection; dl, dorsal lobe; vl, ventral lobe.

ited in the National Museum of Nature and Science, Tsukuba. Paratypes: Honshu: Hyogo Pref.: 1♀, "Hyogo-ken, Takarazuka-shi, Takedao, 2002 VI 4, Ikeda Takanao" "B1–592686" (MNHAH); 1♀, same locality, host and collectors as for holotype, larva coll. 18. VI. 2012, matured 20. VI., em. 11. VII. 2012 (AS120618A); 2♀, same locality, host and collectors, larva


A
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coll. 18. VI. 2012, matured 22. VI., em. 9. VII. 2012, oviposited 11. VII. (AS120618Bx, y); 2♀1♂, same locality, host and collectors, larva coll. 18. VI. 2012, matured 29–30. VI., em. 14–16. VII. 2012 (AS120618F); 2♂, same locality, host and collectors, larva coll. 18. VI. 2012, matured 25. VI., em. 11. VII. 2012 (AS120618G); 1♀, same locality, host and collectors, larva coll. 18. VI. 2012, matured 29. VI., em. 15. VII. 2012, oviposited 16. VII. (AS120618G); 1♀, same locality, host and collectors, larva coll. 18. VI. 2012, matured 27. VI., em. 12. VII. 2012, oviposited 14. VII. (AS120618J); 4♀, same locality, host and collectors, larva coll. 18. VI. 2012, matured 1–3. VII., em. 18–23. VII. 2012 (AS120618J); 1♀, same locality and host, larva coll. 25. VII. 2012, matured 1. VIII., em. 25. VIII. 2012 (AS120725A), A. Shinohara; 1♀1♂, same locality, host and collector, larva coll. 25. VII. 2012, matured 9–14. VIII., em. 27. VIII. 2012 (AS120725B); 2♀, same locality, host and collector, larva coll. 25. VII. 2012, matured 9–14. VIII., em. 28. VIII. 2012 (AS120725B); 2♀2♂, same locality, host and collector, larva coll. 25. VII. 2012, matured 6. VIII., em. 20–22. VIII. 2012 (AS120725C); 1♂, same locality, host and collector, larva coll. 25. VII. 2012, matured 6. VIII., em. 22. VIII. 2012 (AS120725E); 1♀, same locality, host and collector, egg coll. 25. VII. 2012, hatched 26. VII., matured 14–15. VIII., em. 2. IX. 2012 (AS120725G); 1♀, same locality, host and collector, larva coll. 8. X. 2012, matured 12. X., em. 1. XI. 2012 (AS121008A); 10♂, same locality, eggs deposited 16. VI. 2012, hatched 25. VII., matured 8–14. VIII., em. 24–28. VIII. 2012 (AS120618Ga, offspring of AS120618G), Host: *Spiraea cantoniensis*, A. and N. Shinohara. Shikoku: Kagawa Pref.: 4♀, Mt. Shippo-zan, 100–300 m alt., Mitoyo-shi, larva coll. 9. X. 2012, matured 11–17. X., em. 2–7. XI. 2012 (AS121009A), Host: *Spiraea dasyantha*, A. Shinohara; 2♂, same locality, host and collector, larva coll. 9. X. 2012, matured 14. X., em. 1. XI. 2012 (AS121009B); 1♀ (in ethanol), same locality, host and collector, larva coll. 9. X. 2012, matured 11. X., em. 2. XI. 2012 (AS121009C); 1♀, same locality, host and collector, larva coll. 9. X. 2012, matured 14. X., em. 3. XI. 2012 (AS121009C); 1♂, same locality, host and collector, larva coll. 9. X. 2012, matured 18. X., em. 6. XI. 2012 (AS121009D); 2♀, same locality, host and collector, larva coll. 9. X. 2012, matured 18. X., em. 9. XI. 2012 (AS121009D); 3♀, same locality, host and collector, larva coll. 10. X. 2012, matured 17. X., em. 4–7. XI. 2012 (AS121010A); 1♀, same locality, host and collector, larva coll. 10. X. 2012, matured 14. X., em. 3. XI. 2012 (AS121010B). Other material (larvae in ethanol): 3 early and 2 late instar larvae, same locality, host and collector as for holotype, coll. 18. VI. 2012, fixed 22–24. VI. (AS120618D); 4 late instar larvae, same data, fixed 5. VII. (AS120618K); 9 early (?first) instar larvae, same locality and collector, eggs deposited 11. VII. 2012, hatched 21. VII., fixed 22. VII. (AS120618Ba, offspring of AS120618Bx), Host: *Spiraea cantoniensis*, A. and N. Shinohara; 1 middle and 4 late instar larvae, same data as for holotype, fixed 28, 30. VII., 2, 6. VIII. (AS120725A, D).

Etymology. This new species is named after Naoko Shinohara (Tokyo), who first noticed the existence of those inconspicuous hiding larvae of this sawfly in Takedao on June 18, 2012.

Host plant. Rosaceae: *Spiraea dasyantha* Bunge. In rearing, the adults oviposited on and the larvae fed on *Spiraea cantoniensis* Lour. (see

Fig. 7. Ovipositing females (A, B), larvae (C–K). — A, AS120618G, ovipositing on *S. cantoniensis*, July 16, 2012 (arrows indicate eggs); B, AS120618By, ovipositing on *S. dasyantha*, July 11, 2012; C, early or middle instar (AS120618Q) on *S. dasyantha*, June 21, 2012; D, middle instar (AS120618D) on *S. dasyantha*, June 18, 2012; E, first instar larva (AS120618Bb) on *S. dasyantha*, July 22, 2012; F, same as D; G, late instar (AS120618G), June 24, 2012; H, late instar larva (AS120618E), June 19, 2012; I, late instar larva (AS120618G), June 24, 2012; J, K, last instar larva (AS120618B), June 19, 2012. All photographed by A. Shinohara.

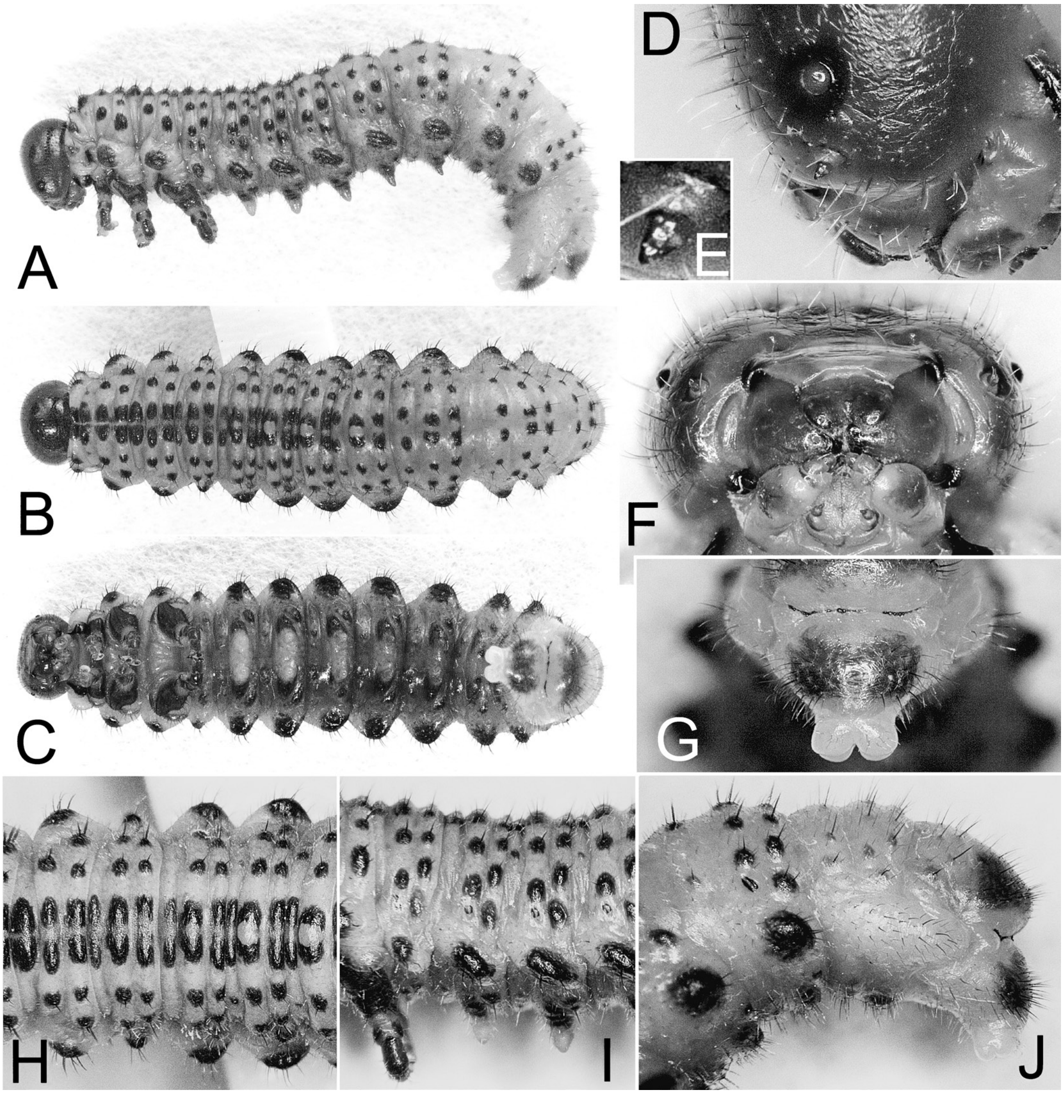

Fig. 8. Final instar larva, Takedao, Hyogo Pref. — A, Lateral view; B, dorsal view; C, ventral view; D, ventral part of head, lateral view; E, antenna, enlarged; F, head, ventral view; G, apex of abdomen, dorsocaudal view; H, third thoracic to third abdominal segments, dorsal view; I, third thoracic to fourth abdominal segments, lateral view; J, caudal abdominal segments, lateral view.

below).

Field observations and rearing records. In Takedao, Hyogo Pref., we collected 40 larvae on June 18, 21 larvae and several eggs on July 25 and 13 larvae on October 8, 2012 (Table 1). The young larvae were gregarious but the late instar larvae were usually solitary. The number of the individuals in one larval group (the larvae apparently in the same instar found on one leaf or a few adjacent leaves) varied from one to ten. Of the 40 larvae of various instars collected on June 18, 23 matured on June 20 to July 3, and 15 adults (11 females and four males) emerged on July 7 to 21, 2012 (Fig. 9A). Others did not survive. Four newly emerged females (AS120618Bx, AS120618By, AS120618G, AS120618J, Table 1) were used for oviposition experiments on four species of *Spiraea* (Table 2).

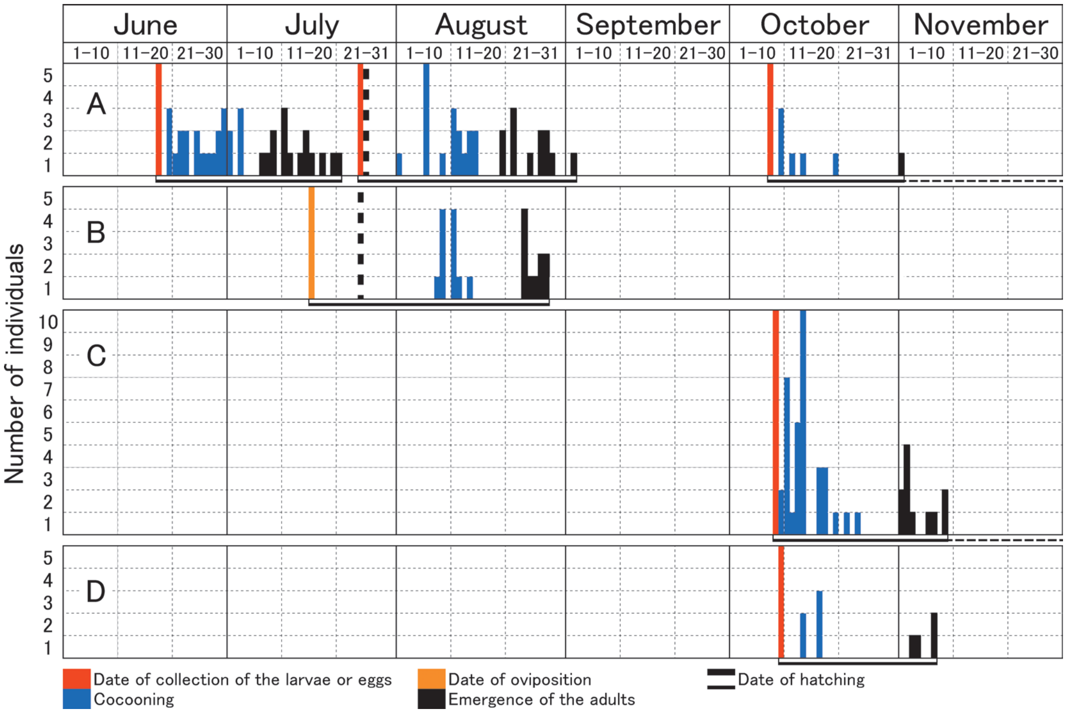

Fig. 9. Records of collection of the larvae and rearings in 2012. — A, Takedao, Hyogo Pref., larvae were collected on June 18, July 25 and October 8, eggs were collected on July 25, and they hatched on July 26; B, a female that emerged on July 15 from a larva collected in Takedao on June 18 oviposited on July 16 and the eggs hatched on July 25; C, Mt. Shippo-zan, Kagawa Pref., larvae were collected on October 9; D, same locality, larvae were collected on October 10. Solid underlines show period from the collection of larvae or eggs (A, C, D) or the oviposition (B) to the adult emergence; broken underlines in A and C show existence of hibernating individuals. See text for more explanation.

The females deposited one to 16 eggs into the leaf margin of a leaf (Fig. 7A, B; Table 2). One female (AS120618G) deposited a total of 20 eggs on six leaves of *S. cantoniensis* on July 16 (Tables 1, 2), the eggs hatched on July 25, the larvae fed on this plant, 11 larvae matured on August 8 to 14, and 10 adult males emerged on August 24 to 28 (Fig. 9B). The other three females oviposited on *S. dasyantha*, *S. cantoniensis*, or *S. japonica* L. f., but all the larvae died before reaching maturity (Table 1). The 21 larvae collected on July 25 were mainly in early instars and 14 of these matured on August 1 to 14 (13 on August 6 to 14). Eleven adults (six females and five males) emerged from these larvae on August 22 to 29 (Fig. 9A). On July 25, several eggs were also collected and they hatched on July 26. Three larvae matured and cocooned on August 14 and 15 and one female adult emerged on September 2, 2012. Of the 13 larvae collected on October 8, only six cocooned on October 10 to 20, one female emerged on November 1 (Fig. 9A), one was still alive on November 21, 2012, while the others were dead. In Mt. Shippo-zan area, Kagawa Prefecture, we collected 43 larvae of various instars on October 9 and 10, 2012 (Table 3), of which 39 matured on October 10 to 24. Fifteen adults (12 females and three males) emerged on November 1 to 9 of the same year (Fig. 9C, D). Of the remaining 24 larvae, six were alive and 18 were dead when examined on November 21, 2012. Under experimental conditions, the egg period was nine or ten days (AS120618Bb, AS120618Ba, AS120618Ja, AS120618Ga, Table

Table 1. Summary of rearings in 2012, specimens from Takedao, Hyogo Prefecture, Honshu.

Host plants	Found	Larval group codes	Number of larvae/eggs	Cocooned*	Emerged**	Remarks
Spiraea dasyantha	18. VI.	AS120618A	3	20. VI. (3)	11. VII. (1 ♀)	
		AS120618B	3	21 VI. (1) 22. VI. (2)	7. VII. (1 ♀) 9. VII. (2 ♀)	2 ♀ emerged 9. VII. (AS120618Bx, AS120618By) oviposited 11. VII.
		AS120618C	1	23. VI.	dead in cocoon	
		AS120618D	5	all dead before maturity		dead and fixed 22-24. VI. (5)
		AS120618E	1	23. VI.	8. VII. (1 ♂)	
		AS120618F	4	29. VI. (1) 30. VI. (3)	14. VII. (1 ♂) 15. VII. (1 ♀) 16. VII. (1 ♀)	
		AS120618G	3	25. VI. (2) 29. VI. (1)	11. VII. (2 ♂) 15. VII. (1 ♀)	oviposited 16. VII.
		AS120618I	2	26. VI. (1) 28. VI. (1)	dead in cocoons	
		AS120618J	6	27. VI. (1) 1. VII. (2) 3. VII (3)	12. VII. (1 ♀) 18. VII. (1 ♀) 20. VII. (1 ♀) 21. VII. (1 ♀)	♀ emerged 12. VII. oviposited 14. VII.
		AS120618K	9	all dead before maturity		dead 30. VI. - 1, VII. (5); fixed 5. VII. (4)
		AS120618Q	5	all dead before maturity		dead 24. VI. (3)
	eggs deposited 11. VII.	AS120618Bb (hatched 21.VII.)	39	all dead before maturity		offspring of AS120618By; dead 25. VII.
	25. VII.	AS120725A	3	1. VIII. (1)	25. VIII. (1 ♀)	
		AS120725B	6	9. VIII. (1) 11. VIII. (2) 12. VIII. (1) 14. VIII. (1)	27. VIII. (1 ♀ 1 ♂) 28. VIII. (2 ♀)	
		AS120725C	5	6. VIII. (4)	20. VIII. (1 ♀ 1 ♂) 22. VIII. (1 ♀ 1 ♂)	
		AS120725D	4	11. VIII. (1)	dead in cocoon	
		AS120725E	2	6. VIII. (1) 12. VIII. (1)	22. VIII. (1 ♂) 29. VIII. (1 ♀) [holotype])	
		AS120725F	1	13. VIII.		
		AS120725G (found as eggs; hatched 26. VII.)	several	14. VIII. (1) 15. VIII. (2)	2. IX. (1 ♀)	
	8. X.	AS121008A	7	10. X.(3) 12. X.(1) 14. X.(1) 20. X.(1)	1. XI. (1 ♀) 9. XI. (1 parasitoid)	1 still alive in cocoon 21. XI.
		AS121008B	2	all dead before maturity		all dead by 7.XI.
		AS121008C	4	all dead before maturity		all dead by 30.X.
Spiraea cantoniensis	eggs deposited 11. VII.	AS120618Ba (hatched 21.VII.)	9	all dead before maturity		offspring of AS120618Bx; fixed 22. VII.
	eggs deposited 14. VII.	AS120618Ja (hatched 23.VII.)	12	all dead before maturity		offspring of AS120618J; dead 25. VII.
	eggs deposited 16. VII.	AS120618Ga (hatched 25.VII.)	20	8. VIII. (1) 9. VIII. (4) 11. VIII. (4) 12. VIII. (1) 14. VIII. (1)	24 VIII. (4 ♂) 25 VIII. (1 ♂) 26 VIII. (1 ♂) 27 VIII. (2 ♂) 28 VIII. (2 ♂)	offspring of AS120618G

* Number of individuals given in parentheses when such data are available.
** Number and sex of specimens given in parantheses; other specimens died or were fixed in larval stage.

Table 2. Summary of oviposition experiments.

Plants oviposited	Mother females			
	AS120618Bx*	AS120618By**	AS120618G***	AS120618J****
Spiraea dasyantha	no oviposition	4 eggs per leaf (4/0)***** 8 eggs per leaf (6/2) 11 eggs per leaf (8/3) 16 eggs per leaf (1/15)	no trial	no trial
Spiraea cantoniensis	2 eggs per leaf (2/0) 7 eggs per leaf (7/0)	no oviposition	1 egg per leaf (1/0) 1 egg per leaf (1/0) 2 eggs per leaf (2/0) 5 eggs per leaf (5/0) 5 eggs per leaf (3/2) 6 eggs per leaf (6/0)	5 eggs per leaf (3/2) 7 eggs per leaf (5/2)
Spiraea japonica	no trial	5 eggs per leaf (3/2)	no trial	no trial
Spiraea thunbergii	no oviposition	no trial	no trial	no trial

* Emerged July 9, oviposited July 11
** Emerged July 9, oviposited July 11
*** Emerged July 15, oviposited July 16
**** Emerged July 12, oviposited July 14
***** Number of eggs laid on each margin of leaf

Table 3. Summary of rearings in 2012, specimens from Mt. Shippo-zan, Kagawa Prefecture, Shikoku.

Host plants	Found	Larval group codes	Number of larvae/eggs	Cocooned*	Emerged**	Remarks
Spiraea dasyantha	9. X.	AS121009A	10	10. X. (2) 11. X. (2) 12. X. (1) 13. X. (1) 14. X. (2) 17. X. (2)	2. XI. (3 ♀) 7. XI. (1 ♀)	3 still alive 21. XI.
		AS121009B	6	13. X. (2) 14. X. (2) 17. X. (1) 20. X. (1)	1. XI. (2 ♂)	2 still alive 21. XI.
		AS121009C	7	11. X. (5) 14. X. (2)	2. XI. (1 ♀) 3. XI. (1 ♀)	1 still alive 21. XI.
		AS121009D	6	18. X. (3) 22. X. (1) 24. X. (1)	6. XI. (1 ♂) 9. XI. (2 ♀)	
		AS121009E	3	all dead before maturity		all dead by 20. X.
		AS121009F	6	13. X. (2) 14. X. (4)		
	10. X.	AS121010A	3	17. X. (3)	4. XI. (1 ♀) 7. XI. (2 ♀)	
		AS121010B	2	14. X. (2)	3. XI. (1 ♀)	

* Number of individuals given in parentheses when such data are available.
** Number and sex of specimens given in parantheses; other specimens died or were fixed in larval stage.

1), the larval period was 14 to 20 days (AS120725G, AS12018Ga, Table 1), and the cocoon period was 14 to 24 days without prolonged diapause (Tables 1, 3).

Discussion

Comparison with the Related Species

Arge naokoae is most closely related to *A. pilopenis* Wei, 2002 (Fig. 6), from Inner Mongolia, Beijing, Hebei and Henan provinces, China (Wen and Wei, 2002). These two species are peculiar in that their valviceps is setose and of characteristic shape (Figs. 5, 6D–F), their lancet has no non-annulated areas, and their annuli are oblique and directed toward the apex ventrally, except at the base of the lancet (Figs. 3C, 4A, C, E, G, I, 6C). In *A. pilopenis*, the general color is black without any bluish reflection and the supraclypeal carina is short, just as long as the distance between the interantennal carinae, in both sexes, the lance has several linear membranous areas, the lancet has 24 or more serrulae, and the basal serrulae are subtriangular and large in the female (Fig. 6A–C), and the apex of the subgenital plate is not concave and the dorsal lobe at the apex of the valviceps is larger (Fig. 6D, E) in the male. In *A. naokoae*, the ground color has distinct bluish reflection and the supraclypeal carina is longer than the distance between the interantennal carinae in both sexes, the lance has no linear membranous areas, the lancet has only 20 distinct serrulae, and the basal serrulae are very small in the female (Figs. 3C, 4A, C, E, G, I), and the apex of the subgenital plate is concave (Fig. 5H) and the dorsal lobe at the apex of the valviceps is small (Fig. 5B, E, dl) in the male.

Among the Japanese congeners, *A. naokoae* resembles *A. aruncus* Hara and Shinohara, 2012, from Hokkaido and Honshu, but differs from it in the black flagellum (Fig. 1A–F) (usually orange to dark brown in *A. aruncus*), the apically obtusely pointed sawsheath (in posterodorsal view) (Fig. 2N, P) (broadly rounded in *A. aruncus*, fig. 3A in Hara and Shinohara, 2012), short malar space in the female (0.4–0.7 × width of front ocellus, 0.8–1.0 × in *A. aruncus*), absence of distinct linear membranous areas in the lance (Fig. 3A, B) and absence of non-annulated area and very different shape of serrulae in the lancet in the female (compare Figs. 3C, 4A, C, E, G, I with fig. 3F–K in Hara and Shinohara, 2012), and very different shape of the valviceps in the male (compare Fig. 5 with fig. 4 in Hara and Shinohara, 2012).

In Takeuchi's (1939) key, *A. naokoae* may go close to *A. jonasi* (Kirby, 1882) described from Japan. In Gussakovskij's (1935) key, this new species runs to the couplets 145/162 but it does not precisely agree with either of them. *Arge jonasi* and its close relatives, *A. kobayashii* Takeuchi, 1931 and *A. solowiyofka* (Matsumura, 1911), both from Japan and Sakhalin (Hara *et al.*, 2007), are comparatively large species, usually more than 10 mm long in females and more than 8 mm long in males, and have a weakly carinate or rounded median supraclypeal ridge, and nonciliate apical wing margins.

The larvae of *A. naokoae* are somewhat similar to those of *A. aruncus* in their general color pattern and particularly in the more or less reddish coloration of the mature larvae. The larvae of *A. aruncus* feed gregariously on *Aruncus dioicus* (Walter) Fernald var. *kamtschaticus* (Maxim.) H. Hara. Besides the definite difference in the host plant, the late instar larvae of *A. naokoae* are distinguished from those of *A. aruncus* by the relatively small black dorsolateral spots on the trunk, especially on the apical abdominal segments (compare Figs. 7K, 8A with figs. 1H, J, 8B in Hara and Shinohara, 2012). When mature, the larvae of *A. naokoae* differ from those of *A. aruncus* in having the trunk whitish and reddish brown (compare Fig. 7J, K with fig. 1J in Hara and Shinohara, 2012).

Host Plant

Larvae of some Argidae are associated with the plants of the family Rosaceae. Known host genera are numerous (see *e.g.* Smith, 1989; Liston, 1995), including *Sanguisorba*, *Potentilla*, *Rosa*, *Rubus*, *Aria*, *Crataegus*, *Malus*, *Cotoneas-*

ter, *Pourthiaea*, *Sorbus*, *Aruncus*, *Cerasus* and *Amygdalus* in East Asia (Okutani, 1967; Wei and Nie, 2003; Shinohara and Hara, 2009, 2010, 2012; Hara, 2010; Hara and Shinohara, 2012), but no species are known to feed on the genus *Spiraea*. This is the first record of *Spiraea* as a host plant for Argidae. *Spiraea* is phylogenetically close to *Aruncus* in the tribe Spiraeeae of the subfamily Spiraeoideae (Potter *et al*., 2007). The argid species feeding on *Aruncus* is *A. aruncus*, which resembles the new species, as discussed above. It is interesting that apparently closely related *Arge* species are associated with different but closely related genera of the Rosaceae.

In the field, larvae of *A. naokoae* were found only on *Spiraea dasyantha*, but the emerged females oviposited also on *Spiraea cantoniensis* Lour. and *Spiraea japonica* L. f. and the larvae grew without problems at least on the former plant (Tables 1, 2). The host range of the species is probably wider than the present knowledge, and, if so, the actual distribution of this species may be extensive because *Spiraea* is a speciose genus widely distributed in temperate northern Hemisphere.

Life History

In Takedao, Hyogo Prefecture, the adult of *A. naokoae* was collected in early June and the larvae were found in mid June, late July and early October (see *Material examined* and Table 1, Fig. 9). The emergence of the adults in rearing experiments was mainly in early to mid July, late August and early November. These observations clearly suggest that *A. naokoae* is a multivoltine species, probably having up to five generations a year in Takedao. Our rearing experiments showed that one life cycle of this species (from deposition of the egg to emergence of the adult) may last 37–54 days (egg 9–10 days, larva 14–20 days, cocoon 14–24 days, see above) without prolonged diapause. A hypothetical scheme is that the adult emergence in Takedao is 1) late April to early May, 2) early June, 3) mid July, 4) late August and 5) late September. The occurrence of the larvae in Mt. Shippo-zan area, Kagawa Prefecture, in early October strongly indicates a similar life cycle pattern also in this area. Some adults emerged in early November in the laboratory, but this may not occur in the field. The polymodal emergence of the adult, quite common in *Arge* species (Shinohara and Hara, 2008, 2009; Shinohara *et al*., 2009), has not been clearly recognized in this species. The larvae collected in the field in June and July all became the adults without long diapause.

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