



A new species *Agrypnus (Sabikikorius) uidoensis* sp. nov. (Coleoptera: Elateridae) from the Sand Dune Shore of Ui-do Island, Korea

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Abstract

A new species is described belonging to the subgenus *Sabikikorius* of *Agrypnus*, *Agrypnus (Sabikikorius) uidoensis* sp. nov., and isolated from the sand dunes of Ui-do Island, Korea. A key to the species is given with distributional information for each species of this subgenus. Sequencing data of the mitochondrial genes encoding COI (cytochrome c oxidase I) and 16S rDNA (16S ribosomal DNA) are also provided.

Key words: Taxonomy, Coleoptera, Elateridae, Agrypninae, *Agrypnus (Sabikikorius) uidoensis* sp. nov., new species, COI, 16S rDNA, Korea

Introduction

The subgenus *Sabikikorius* Nakane and Kishii (1955) belongs to the genus *Agrypnus* Eschscholtz, 1829 and was established with the type species *Lacon fuliginosus* Candèze, 1865, which is widespread in Japan. Regional congeners include eight species distributed in Laos, Vietnam, western South China, and Taiwan in Southeast Asia, Japan, and Korea in the Palearctic region (Ôhira 1970, 2003; Kishii 1999; Suzuki 1999).

Sabikikorius is a unique group within *Agrypnus* and is characterized by the presence of small sclerites with spines at the base of the bursa copulatrix, the lack of a nodule on the pronotal disk and a carina on the pronotal hind angle, an elongate and slender aedeagus, the presence of two setae bearing on the posterior lobe of the frontoclypeal region, the absence of seta between the posterior setae and dorso-lateral rowed setae on the abdominal mediotergite, and the distinct shape with nine abdominal segments in larva (Nakane and Kishii 1955; Ôhira 1962, 2003; Kishii 1987).

After its establishment, *Sabikikorius* was raised to genus status by Kishii (1957), but Chujô and Ôhira (1965) treated *Sabikikorius* as a subgenus of *Adelocera* Latreille 1829. Hayek (1973, 1979) treated *Sabikikorius* as a synonym under the genus *Agrypnus* along with other subgenera. However, Kishii (1987, 1999) adhered to maintaining the subgeneric system. Ôhira (2003) proposed that the systematic status of *Sabikikorius* should be corrected to place it as a subgenus under *Agrypnus* based on the several characters as above mentioned of adults and larvae. He also suggested that *Sabikikorius* could be treated as a valid genus based on the presence of small sclerite plates at the base of the bursa copulatrix. Most recently, Cate (2007) rearranged nine species of two subgenera (eight species of *Colaulon*, one species of *Sabikikorius*) under the genus *Agrypnus* in accordance with Hayek's (1973, 1979) integrated scheme. For the present, differences of opinion to accept the recognition of subgenera (including *Sabikikorius*) within the genus *Agrypnus* still exist

according to regional workers as above mention. However, in the process of our taxonomic study on the Korean click beetles, we consider the available homologous characteristics in *Sabkikorius* as mentioned by Ôhira (2003) make it distinguishable from other subgenera. Therefore, in this study we adopted the subgeneric system of Kishii (1987, 1999) and Ôhira (2003).

We found an unrecognized species assignable to *Sabikikorius* in coastal sand dunes on Ui-do Island within the Shinian Archipelago of Korea. We describe this species as new to science, *A. (S.) uidoensis* **sp. nov.**, and provide a key to all known species in the subgenus. Distributional information, illustrations, mitochondrial DNA (mtDNA) sequencing data, COI barcoding, and the 16S rDNA partial region, are also provided to facilitate further systematic study.

Materials and methods

Specimen collection and morphological examination. Type materials investigated in this study involved 23 adults of *A. (S.) uidoensis* **sp. nov.** (Ui-do Island, Shinan-gun, Jeollanam-do; Figs. 1, 2). All specimens were caught alive on sand dunes of the coastal area and were individually stored at -20 °C before morphological examination. For morphological study, specimens were observed under stereoscopic microscopes (MZ 16A and MZ 6; Leica, Solms, Germany) for general structures. All male and female genitalia were extracted from the ninth abdominal segment using forceps without removing the abdomen. During this step, small portions of the tissues such as reproductive glands, spiracle glands, and muscle were obtained for molecular analysis. Extracted genitalia were examined after warming in 10% KOH solution for 30 min, and genitalia were preserved in microvials of glycerin for further examination. A scanning electron microscope (SEM; 1420VP; LEO Electron Microscopy Ltd., Cambridge, UK) was used to observe minute structures in specimens of both sexes. The type specimens are preserved in the insect collection at the Applied Entomology Division, Department of Agricultural Biology, National Academy of Agricultural Science (NAAS), Suwon, Korea.



FIGURE 1. Site map of Ui-do Island within the Shinian archipelago, Korea (right), and its a satellite image (left) obtained with Google Earth 4.3

DNA extraction, PCR, and DNA sequencing. Genomic samples were isolated from the genital tissues of both sexes using a QIAamp DNA Mini Kit (Qiagen, Hilden, Germany) in accordance with the manufacturer's instructions. Polymerase Chain Reaction (PCR) (20 µl) was performed using AccuPower PCR PreMix (Bioneer, Daejeon, Korea) under the following conditions: initial denaturation at 94°C for 5 min, then 35 cycles at 94°C for 30s, 50°C for 20s, and 72°C for 40s, followed by a final extension at 72°C for 5 min. The primers for the COI gene were LCO1490 and HCO2198 (Folmer *et al.* 1994) and the 16S rDNA gene was amplified using 16SB and 16SC as reported previously (Hosoya *et al.* 2001). The amplicons were purified using a QIAquick PCR Purification Kit (Qiagen, Korea) after the product yield was monitored by use of 0.7% agarose gel electrophoresis. Sequencing was performed using an automated DNA sequencer (ABI 3730xl 96-capillary DNA analyzer; Applied Biosystems, Foster City, CA) with the same primers used for PCR. All sequences are available from GenBank under the accession numbers as follows: COI: FJ217993–7, 16S rRAN: FJ217998–9, FJ472596–8.



FIGURES 2–4. The type locality of *A. (S.) uidoensis* sp. nov., Donmok Beach, Ui-do Island, Shinan-gun, Korea. 2: Landscape of Donmok beach's seashore; 3: Boundary between the tidal zone and the sand dune covered with rubbish deposited from the shore; 4: A male stalking on the sand.

Taxonomy

Genus *Agrypnus* Eschscholtz, 1829

Subgenus *Sabikikorius* Nakane *et* Kishii, 1955

Type species: *Lacon fuliginosus* Candèze, 1865: 10 (Japan), by original designation.

Subgenus diagnosis. Body generally elongate robust, situated rather parallel, 13–18 mm long in males, about 20 mm long in females. Color generally rust, dusky brown to reddish-brown, but basal antennal segments, legs, and ventral region more or less paler than the dorsal aspect. Surface with scale-like hair densely covered wholly. Antenna short, reaching to one-half or two-thirds length of pronotum, distinctly serrate from fourth antennomere; second antennomere larger than the third one; combined length of second and third antennomeres clearly longer or almost equal with the fourth. Pronotum convex, with weakly impressed longitudinal median depression posteriorly; anterior angles strongly produced to cover more than half of the eye; lateral margin completely carinate. Pronotal hind angle broad at base, truncated at apex, without carina. Prosternum generally convex, with roundly margined anterior lobe. Hypomeron with deep groove for reception of the foretarsi or without such a groove; basal region strongly and broadly grooved for reception of the forefemur. Pronotosternal suture deeply grooved anteriorly for reception of antenna; antennal groove extending to posterior two-thirds of pronotosternal suture. Scutellum pentagonal, simple, flattened.

Mesocoxal cavity closed to mesepimeron and mesepisternum. Seventh sternite with a smooth area without vestiture in female. Male genitalia elongate, paramere slender, straight, gradually narrowed at apex, with distinct triangular expansion of apex. Females with a pair of small sclerotized plates bearing short spines in the bursa copulatrix.

Distribution. Korea, Japan, Taiwan, South China, Vietnam, Laos.

Notes. This diagnosis was modified from Kishii (1987) and Ôhira (2003) based on traditional morphological characteristics.

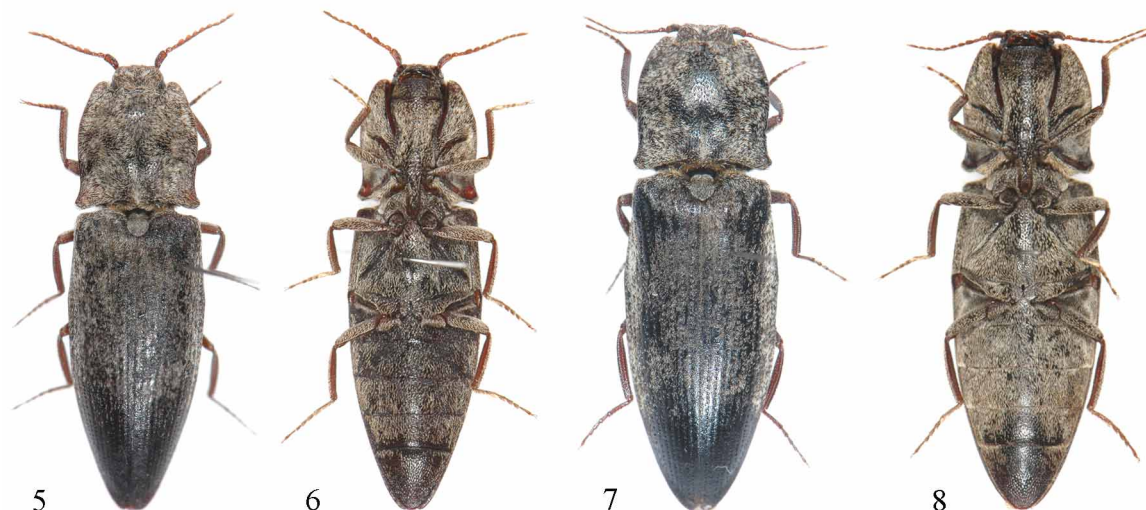
A key to the species of the subgenus *Sabikikorius*

1. Hypomerion and metasternum without grooves for reception of tarsi, or with only indistinct or shallow impressions 2
 - Hypomerion and metasternum with distinct grooves for reception of tarsi..... 5
2. Body blackish-brown; antenna reaching just before apex of pronotal hind angle; combined length of second and third antennomeres sub-equal to fourth antennomere; Hypomerion and metasternum with indistinct or shallow tarsal impressions (Japan: Ryukyu Islands)..... subspecies of *A. (S.) amamiensis*...3
 - Body dusky reddish brown; antenna reaching to two-thirds of pronotal length; combined length of second and third antennomeres longer than fourth antennomere; Hypomerion and metasternum without tarsal grooves (Japan: Hokkaido, Shikoku, Honshu, Kyushu) *fuliginosus* (Candèze)
3. Pronotal disk smooth and regularly punctuate..... 4
 - Pronotal disk densely and coarsely punctuate with various sized punctures (Japan: Takara-jima Island of the Ryukyu Islands)..... *amamiensis arenicola* Nakane *et* Kishii
4. Body size larger than 17 mm; tarsal impression of hypomerion and metasternum indistinct (Japan: Amaio-jima Island, Tokuno-jima Island, and Kikaiga-jima Island of the Ryukyu Islands) *amamiensis amamiensis* (Miwa)
 - Body size smaller than 17 mm; tarsal impression of hypomerion and metasternum shallow (Japan: Okinawa-honto Island of the Ryukyu Islands) *amamiensis okinawanus* (Ôhira)
5. Anterior margin of tarsal groove of hypomerion smoothly impressed, not carinate; prosternal process inwardly bent beyond procoxal cavity (Japan: Ishigaki-jima Island and Iriomot-jima Island of the Ryukyu Islands).....
 - *ryukyuensis* Kishii
 - Anterior margin of tarsal groove of hypomerion clearly carinate; prosternal process extended straight to procoxal cavities 6
6. Pronotum and elytra covered only with recumbent scale-like hairs 7
 - Pronotum and/or elytra covered with dense recumbent scale-like hairs and sparse erect setae..... 9
7. Body blackish-brown; lateral subapical barb of paramere in male genitalia obtuse at apex, its base almost parallel-sided in lateral margin (Korea: Ui-do Island)..... *uidoensis* **sp. nov.**
 - Body reddish-brown or dusky reddish-brown; lateral subapical barb of paramere in male genitalia sharply pointed at posterior apex, its base clearly concave inwardly in lateral margin 8
8. Body reddish-brown; fourth antennomere wider than long (Laos, Vietnam)..... *taciturnus* (Candèze)
 - Body dusky brown; fourth antennomere longer than wide (Taiwan) *sauteri* (Ôhira)
9. Pronotal hind angle broadly truncated at apex (Laos, Vietnam, South China, Taiwan, Japan (?), Korea (?))
 - *setiger* (Bates)
 - Pronotal hind angle somewhat narrowly truncated at apex (Korea)..... *herzi* (König)

Agrypnus (Sabikikorius) uidoensis Han and Park, sp. nov.

(Figs. 4–35)

Specimens examined. Holotype: male, sand dune of Donmok beach on Ui-do Island, Dochoi-myeon, Jeollanam-do, Korea. 21. V. 2008. Hae Chul Park (**Paratypes:** 8 males and 14 females, same data as for holotype. Holotype and all paratypes deposited in NAAS.



FIGURES 5–8. Adults of *A. (S.) uidoensis* sp. nov., 5: Male holotype in a dorsal view; 6: Same as 5 in a ventral view; 7: Female in a dorsal view; 8: Same as 7 in a ventral view (scale bar, 10mm)

Description. Holotype (Figs. 5–6; male) 15.5mm long, 4.5 mm wide; body elongate-oval, parallel-sided, rather convex; color blackish brown, but antennae, maxillary palpi, and legs dusky reddish brown (Figs. 5, 6); two kind of scale liked-hair densely covered, of which reddish brown hairs (rbh) bearing from large punctures and white gray hairs (wgh) bearing from small punctures (Fig. 17). Head (Fig. 9) shallowly impressed at longitudinal median region; carina above antennal socket well ridged, not reaching to frontal margin (Fig. 13); with ‘v’ shaped marking of white gray hairs (wgh) at vertex; eyes almost parallel sided (Fig. 10). Maxillary palpi axed shape (Fig. 14); Antennae short, reaching two-thirds length of pronotum; first antennomere large, stout, 2.46 times longer than wide; second antennomere cylindrical, 1.28 times longer than wide and 1.35 times longer than third one; third antennomere subobconic, 1.32 times longer than wide; fourth antennomere serrated (Fig. 11); 11th antennomere fusiform, slender, elongated, 1.90 times longer than wide (Fig. 15). Pronotum (Fig. 16) convex, dorsal-lateral portions slightly declivous; 1.07 times longer than wide, widest just before mid-length, but not wider than width of hind angles; longitudinal median furrow distinct beyond middle to posterior; lateral margin slightly arched, gradually narrow to anterior; base of hind angles weakly sinuate; hind angle broad at base, slightly divergent laterally, without carina, truncated at apex (Fig. 18). Prosternum (Fig. 19) convex, sinuate to base of antennal groove; anterior lobe rounded, more long than apex of hypomeron; prosternal process (Fig. 20) horizontal, gradually narrowing to apex, with long pubescence at apex; pronotosternal sutures forming deep groove to keep antennae; hypomeron broad, with distinct and deep groove for reception of fore tarsus, groove not reaching lateral margin, posterior margin almost straight. Scutellum (Fig. 21) subtrapezoidal, flattened, scale-like hairs densely covered, 1.17 times as long as wide; anterior margin parallel, narrower than lateral margins at middle; lateral margins strongly sinuate inwardly at one thirds of anterior; posterior margin rounded. Mesocoxal cavity surrounded by mesosternum and metasternum. Metasternum (Fig. 23) moderately convex at middle, with distinct tarsal grooves reaching to

postero-lateral margins. Elytra convex, 2.26 times longer than wide, widest at one third and then gradually convergent to posterior; surface with punctuate striae, striae vestigial and indistinct (Fig. 22); intervals feebly convex. Sternite 7 (Fig. 24) semi-oval, 1.27 times as wide as long. Legs; hind femur as long as hind tibia; posterior half of 1st to 4th tarsal segments densely clothed with golden pubescence ventrally; claws simple, with two setae at base. Male genitalia (Fig. 27–29) elongate, rather slender, weakly bent downward at midlength (Fig. 28); median lobe slender, gradually narrow to apex, a little longer than parameres; paramere slender, gradually narrow to apex, slightly sinuate inwardly at middle, with lateral subapical barb expanded triangularly; lateral subapical barb rather short, 1.36 times longer than wide (Fig. 30), with several long setae on median region ventral, almost parallel-sided at base (Fig. 31).

Female (Figs. 7, 8). Length 17.52–19.10 mm, width 5.50–5.65 mm, generally larger than male; Antenna shorter than male, approximately reaching half-length of pronotum, fourth antennomere more weakly serrated than male, 1.13–1.16 times as long as wide (Fig. 12); pronotum more convex than male and lateral margin more strongly arched; from posterior half of sternite 6 and sternite 7 with smooth elliptic region on median with small punctures without pubescence (Figs. 25, 26); ovipositor stout, lacking stylus (Fig. 32), weakly bent downwardly near apex in profile (Fig. 33); vagina (Fig. 34) rather short; uterus greatly enlarged, with two colleterial glands; bursa copulatrix (Fig. 35) stout, cylindrical, elongated, spiraled right, including two spiniferous rows, with a pair of small sclerotized plates at base.

Larva. Unknown

COI profile. We obtained a region data set of 686 nucleotides for five paratypes. No sequence divergence was detected at the infraspecific level. Base frequencies were: A = 27.1%, C = 25.4%, G = 18.5%, and T = 29.0%.

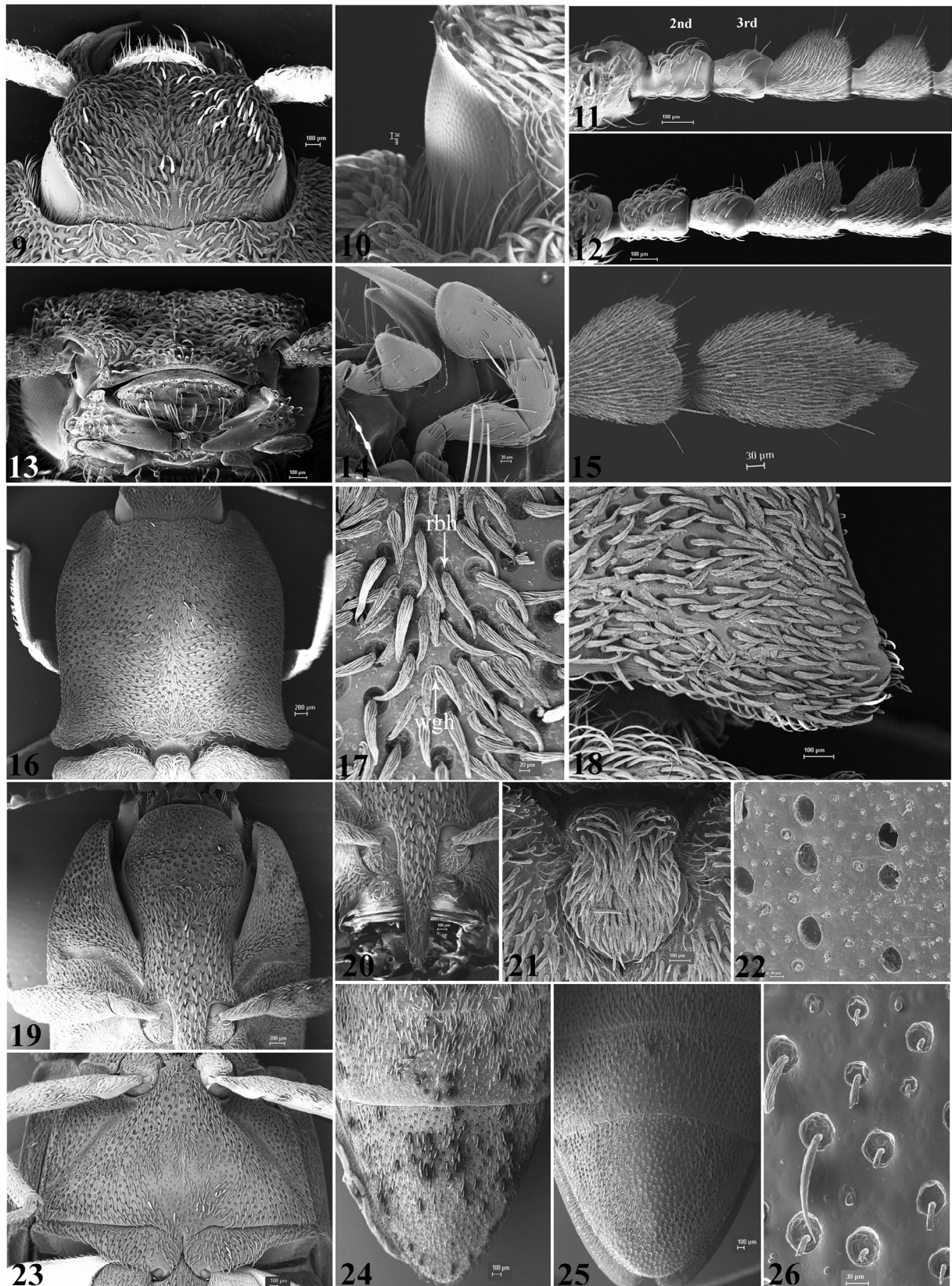
16S rDNA. We obtained a partial region data set of 965 bases for five paratypes of this novel species. Mean base frequencies were as follows: A = 42.4%, C = 19.7%, G = 9.7%, and T = 28.2%. Kimura 2-pairwise divergences within the new species ranged from 0.1% to 0.5%.

Distribution. Korea (Ui-do Island).

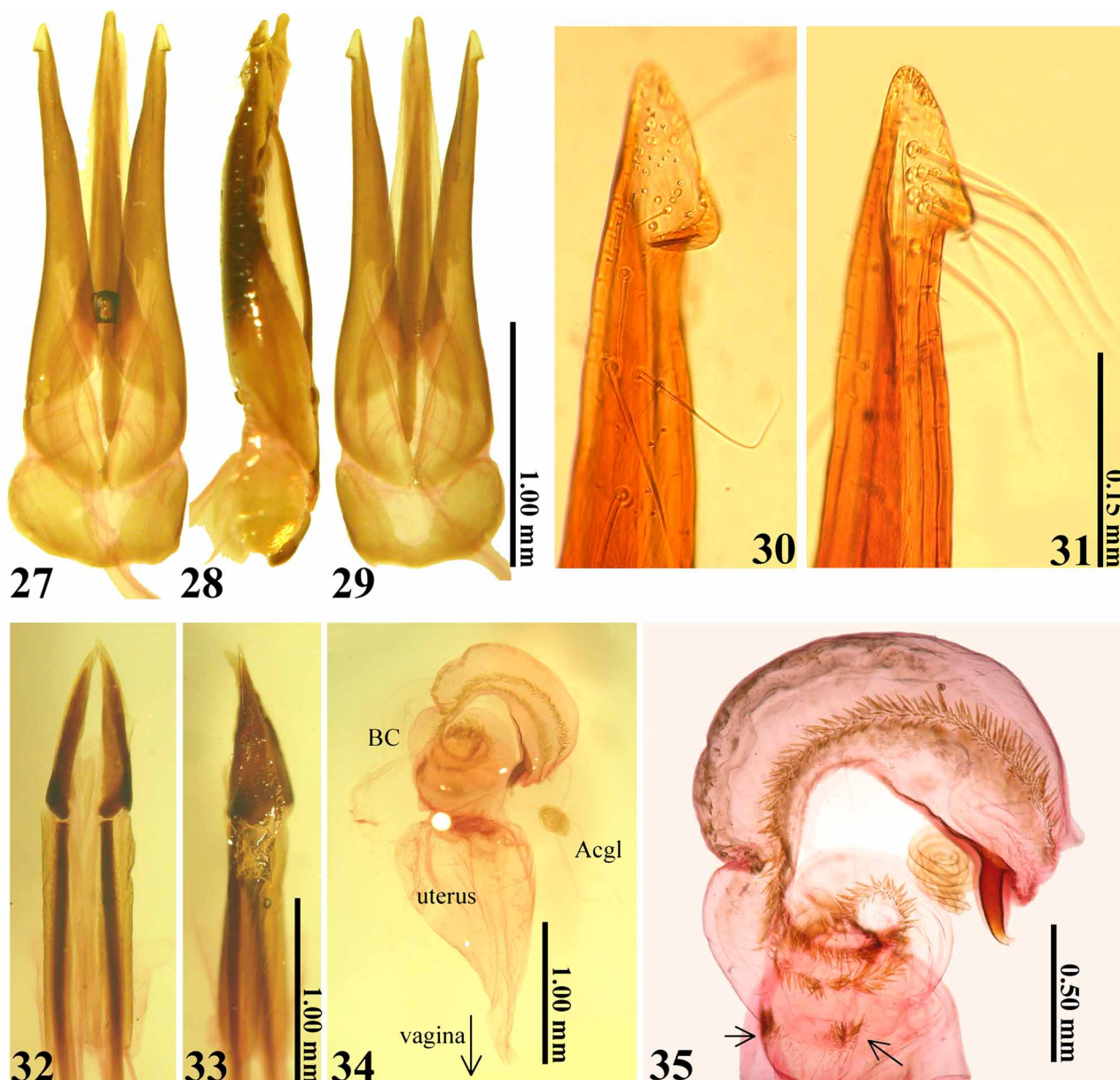
Biology. This species remains unknown for detailed biological information. We can only provide brief collecting information that they were caught during the day under some logs and driftage deposited on the beach (Figs. 3, 4). Some individuals were collected by pitfall traps, with each trap containing a small amount of a mixture of 10 volumes of 100% ethyl alcohol and one volume of pupal broth extracted from *Bombyx mori* (L.); the traps were left overnight.

Etymology. This new species was named *A. (S.) uidoensis* based on its collection locality, Ui-do Island, Korea.

Notes. Within the region including Korea and Japan, this novel species closely resembles *A. (S.) ryukyensis* Kishii 1985 from the Ryukyu Islands, Japan, in general appearance and body color. *Agrypnus (S.) uidoensis* **sp. nov.** has a distinctly carinate anterior margin of the hypomeral groove for reception of the fore tarsi, the prosternal process extends straight in the posterior direction, the scutellum is more weakly inwardly concave, especially in male genitalia, the median lobe is slightly longer than the paramere, and the lateral margin of the subapical barb of the paramere is slightly inclined and almost parallel-sided at the base. In contrast, *A. (S.) ryukyensis* has indistinct anterior margins of the hypomeral groove, the prosternal process is bent slightly inwardly behind the procoxal cavities, the scutellum is strongly concave inwardly, the median lobe of the male genitalia is equal in length to the paramere apex, and the lateral margin of the subapical barb of the paramere is more strongly inclined and clearly concave at the base. *Agrypnus (S.) uidoensis* is also separated from *A. (S.) taciturnus* and *A. (S.) sauteri* by general body color, the ratio of the length and width of the fourth antennomeres, and the differences in male genital shape as given above in the key. The molecular sequence data set of COI and 16S rDNA of mtDNA will be useful to search for the unknown larva, which is expected to have same genetic information with adult of this novel species, as well as in determining the relationship between congeners of *Sabikikorius* and status for further systematic study.



FIGURES 9–26. SEM images of *A. (S.) uidoensis*. 9: Head; 10: Eye in a dorsal view; 11: 2nd to 4th antennomeres, male; 12: Ditto, female; 13: Frontal view of the head; 14: Ventral view of the maxillary palpi; 15: 10th and 11th antennomeres, male; 16: Pronotum; 17: Hairlike scales on the disk of the pronotum; 18: Hind angle of the pronotum; 19: Ventral view of the prosteronum; 20: Prosternal process in a ventral view; 21: Scutellum; 22: Elytral punctures; 23: Metasternum; 24: 6th and 7th sternites, male; 25: Ditto, female; 26: The different puncture shape on the smooth elliptic region, female.



FIGURES 27–35. Male genitalia and female reproductive organs of *A. (S.) uidoensis* sp. nov. 27: Aedeagus in a dorsal view; 28: Ditto in a profile view; 29: Ditto in a ventral view; 30: Apex region of the paramere in a dorsal view; 31: Ditto in a ventral view; 32: Ovipositor in a dorsal view; 33: Ditto in a profile view; 34: Female reproductive organs in a ventral view (BC: bursa copulatrix; Acgl: Accessory gland); 35: Bursa copulatrix in a ventral view.

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