

Description of one new species of *Agriotypus* Curtis, 1832 (Hymenoptera, Ichneumonidae, Agriotypinae) from South Korea

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Abstract

Two species of the genus *Agriotypus* Curtis, 1832, *A. jilinensis* Chao, 1981 and *A. wangpiensis* **sp. nov.**, are added to the South Korean fauna. In total, four species, *A. gracilis*, *A. jilinensis*, *A. silvestris*, and *A. wangpiensis* **sp. nov.**, have now been found in South Korea. The female of *A. jilinensis* is described for the first time and the species is redescribed based on the first fully eclosed specimens. Photographs of collecting sites, the larva and the adult of *A. wangpiensis* **sp. nov.**, and a key to the South Korean species of *Agriotypus* are provided.

Keywords

Agriotypus wangpiensis sp. nov., *A. jilinensis*, aquatic wasp, DNA barcode, taxonomy, Trichoptera

Introduction

The subfamily Agriotypinae (Hymenoptera: Ichneumonidae) is a small group of aquatic parasitoid wasps which are known to parasitize trichopteran pupae and prepupae in fast-running water but, some species (*A. armatus*) can attack hosts in lakes and

slow-moving rivers (Townes 1969; Bennett 2001). The subfamily is monotypic with *Agriotypus* Curtis as the only recognized genus. Until recently, the genus was comprised of 16 species from the Palearctic and Oriental Regions (Bennett 2001) however, five species were just reported from China (Tang et al. 2022), thus, a total of 21 species of *Agriotypus* are currently known. In South Korea, two species, *A. gracilis* Waterston and *A. silvestris* Konishi and Aoyagi, were previously recorded and *A. armatus* Curtis was excluded from the South Korean fauna (Kim et al. 2018).

This genus can be easily identified by the following characteristics: a strongly distinct spine on the scutellum; all metasomal sternites fully sclerotized; fused 2nd and 3rd metasomal tergites and sternites. Because of the latter two characteristics, Mason (1971) proposed *Agriotypus* should be given family status in the superfamily Proctotrupoidea. However, all other taxonomists preferred to recognize *Agriotypus* within Ichneumonidae (Short 1952; Townes 1969; Sharkey and Wahl 1992; Bennett 2001). Also, Chao (1992) described the genus *Atopotypus* Chao as a new monotypic Agriotypinae genus, but Bennett (2001) synonymized *Atopotypus* with *Agriotypus* forming *Agriotypus succinctus* (Chao), based on the results of a cladistic analysis of morphological characters of adults and larvae. Bennett (2001) also defined two species groups within *Agriotypus*, the Palearctic *armatus* species group and the Oriental *himalensis* species group (based on the absence or presence, respectively of longitudinal carinae at the base of the second metasomal tergite). Prior to this study, the *armatus* group included *A. armatus* Curtis, *A. changbaishanus* Chao, *A. gracilis* Waterston, *A. jilinensis* Chao, *A. silvestris* Konishi & Aoyagi and *A. succinctus* (Chao).

In this study, a new species, *A. wangpiensis* sp. nov., and the female of *A. jilinensis* are described, including the larva of *A. wangpiensis* sp. nov. We also provide DNA barcodes and an illustrated identification key to the South Korean species.

Materials and methods

Type specimens of the new species are preserved in the Insect Inquiry Education Institute in Daegu National University of Education (**DNUE-IIIEI**, Daegu, Korea), Nakhongang National Institute of Biological Resources (**NNIBR**, Sangju, Korea), and Ehime University of Matsuyama (**EUM**, Japan). Other examined material is deposited in the Canadian National Collection of Insects, Arachnids and Nematodes (**CNC**, Ottawa, Canada). Specimens used in this study were collected by rearing from trichopteran pupae and prepupae (Figs 2, 3) and Malaise trapping. Most of the images of specimens of the new species were taken using an AxioCam MRC5 camera attached to a stereo microscope (Zeiss SteREO Discovery. V20; Carl Zeiss, Göttingen, Germany), processed using AxioVision SE64 software (Carl Zeiss), and optimized with a Delta imaging system (i-solution, IMT i-Solution Inc. Vancouver, Canada). Some images of the new species were taken using a Leica MC190 HD Camera attached to a Leica M125 Microscope (Leica Microsystems, Germany) and processed using LEICA LAS X software (Leica). The epomia is not visible in Figs 5E, 8D, but we verified that it

extends dorsal to pronotal furrow. This character is very hard to photograph because of two factors: first, the region is highly setose which obscures the epomia and second the area is often in shadow because of the head and mesoscutum. The morphological terminology follows Broad et al (2018), except for the terms for the male genitalia that follow Konishi (2005).

The examined *Agriotypus wangpiensis* sp. nov. specimens for DNA barcoding are deposited in DNUE-III. Genomic DNA from two adult females and five adult males, one pupa, and one larva were extracted using a DNeasy Blood & Tissue Kit (Qiagen, Valencia, California). Each PCR was performed in a 30 µl volume consisting of 15 µl of premix (*Solg*TM 2× *Taq* PCR Pre-Mix: 0.5× Band DoctorTM with dye, *Taq* DNA polymerase (5U/µl), 10× *Taq* Reaction Buffer (25 mM MgCl₂ included), 10 mM each dNTP Mix), 2 µl of DNA template, 1 µl of each primer as 10 pmol, and 11 µl of DNase free water. An approximately 650–700 bp piece of the mitochondrial cytochrome oxidase I(COI) gene was amplified using the primers LCO1490 (5'-GGT CAA CAA ATC ATA AAG ATA TTG G-3') and HCO2198 (5'-TAA ACT TCA GGG TGA CCA AAA AAT CA-3') (Folmer et al. 1994). Polymerase chain reactions were run with an initial predenaturation step at 94 °C for 5 min, followed by 35 cycles of denaturation for 1 min at 94 °C, 1 min of annealing at 50 °C, and 1 min of extension at 72 °C; the last cycle was followed by a final 5 min extension step. The amplified fragments were cleaned and sequenced by BIONEER (Daejeon, South Korea), after which the sequences were edited and aligned. Sequences have been deposited in GenBank under accession numbers [OQ981233.1–OQ981241.1](#). *Agriotypus silvestris* and *A. gracilis* were barcoded with the following modifications to the above protocol. The amplification components were 2 µl 2.5 mM dNTPs. 0.2 µl TaKaRa Ex Taq[®] Hot Start, 2.5 µl 10× Ex Taq buffer, 2 µl 25 mM MgCl₂, 1 µl of 10 µM primers LCO1490 and HCO2198, 1–4 µl genomic DNA and water to 25 µl. The amplification protocol was as follows: 95 °C for 1 minute, 35 cycles of 95 °C for 15 s, 49 °C for 15 s, and 72 °C for 45 s, and 72 °C for 4 minutes. The amplified product was viewed on a 2% agarose gel with GelRed, then cleaned with ExoSAP-IT (PE Applied Biosystems, Foster City, CA, USA). Cycle sequencing was completed with the BigDye Terminator v3.1 kit (PE Applied Biosystems, Foster City, CA, USA) in 10 µl reactions. Sequencing was completed at the Agriculture & Agri-Food Canada Ottawa Research and Development Centre Core Sequencing Facility (Ottawa, ON, Canada) on a 3500 xl DNA Genetic Analyzer (PE Applied Biosystems, Foster City, CA, USA). All sequences obtained were assembled and manually edited using Bioedit 7.2.5 (Hall 1999) and finally aligned using ClustalW implemented in MEGA 11 (Tamura et al. 2021). COI sequences were aligned using MEGA 5.2 (Tamura et al. 2011) and Clustal W. A dataset consisting of 25 COI sequences was finally trimmed to 537 bp in length.

We employed two phylogenetic methods: distance-based Neighbor-Joining (NJ) and optimality criterion-based Maximum Likelihood (ML) (Han et al. 2019). A NJ analysis (Saitou and Nei 1987) was performed using MEGA 5.2. Genetic distances were calculated using the Kimura 2-parameter model (Kimura 1980) in MEGA

5.2. The support values for each node were estimated with 1,000 bootstrap replicates (Fig. 9) (Felsenstein 1985).

A ML analysis was performed using the IQ-TREE web server (Trifinopoulos et al. 2016). The best-fit model for the molecular evolution of the COI sequence data was TIM2+F+I (−lnL = 1739.8817) based on the Bayesian information criterion, as determined using ModelFinder (Kalyaanamoorthy et al. 2017). Branch support was evaluated by 1,000 ultrafast bootstrap (UFBoot) replicates (Mihn et al. 2013; Hoang et al. 2017). Also, two species, *Echthrus reluctator* (Linnaeus 1758) (Cryptinae) and *Endasys patulus* (Viereck 1911) (Phygadeuontinae), were included as outgroup taxa for the Maximum Likelihood (ML) analysis (Fig. 10) (Geiger et al. 2016; Hebert et al. 2016; Bennett et al. 2019).

The final tree was visualized using FigTree v1.4.4 (<http://tree.bio.ed.ac.uk/software/figtree>). The tree is drawn to scale, with branch lengths in the same units as those of the evolutionary distances used to infer the phylogenetic tree. The evolutionary distances were computed using the Kimura 2-parameter method. The evolutionary distance is omitted in the Fig. 10 and shows only bootstrap values above 75%.

Taxonomy

Family Ichneumonidae Latreille, 1802

Subfamily Agriotypinae Haliday, 1838

Genus *Agriotypus* Curtis, 1832

Agriotypus Curtis, 1832: 389. Type species: *Agriotypus armatus* Curtis, by original designation.

Crotopus Holmgren, 1858: 353. Type species: *Crotopus abnormis* Holmgren = *armatus* Curtis, by monotypy. Synonymized by Dalla Torre, 1902.

Atopotypus Chao, 1992: 325. Type species: *Atopotypus succintus* Chao, by monotypy. Synonymized by Bennett, 2001.

Key to the species of South Korean *Agriotypus*

- 1 Females.....2
- Males.....5
- 2 Face with median vertical ridge. Body color almost entirely reddish brown (Fig. 1A). Propodeum with medial longitudinal carinae nearly parallel (weakly converging posteriorly) (Fig. 1F)*A. jilimensis*
- Face without median vertical ridge. Body color generally blackish (Fig. 5A). Propodeum with medial longitudinal carinae strongly converging posteriorly (Fig. 5F)3

- 3 Clypeus in anterior view with summit pointed medially (see Fig. 4E in Bennett 2001). Fore wing with hyaline longitudinal bands complete proximal and distal to pterostigma (Fig. 6A).....*A. gracilis*
- Clypeus in anterior view with summit rounded medially (not pointed), (Fig. 5C and see Fig. 1B of Konishi and Aoyagi 1994). Fore wing with hyaline longitudinal bands complete (Fig. 6B) or absent (Fig. 6F, G) proximal and distal to pterostigma.....4
- 4 Basal 1/4 of fourth submarginal cell and third discal cell of fore wing hyaline (arrows in Fig. 6B). Clypeus in lateral view with summit of convexity rounded (see Fig. 1C of Konishi and Aoyagi 1994).....*A. silvestris*
- Basal 1/4 of fourth submarginal cell and third discal cell of fore wing infusate, without hyaline spot (arrows in Fig. 6F, G). Clypeus in lateral view with summit of convexity angulate (Fig. 5B).....*A. wangpiensis* Choi and Lee, sp. nov.
- 5 Face with median vertical ridge. Fore wing with abscissa of vein M between 2rs-m and 2m-cu 0.3–0.9 times as long as 2rs-m. Digitus elongated, but shorter than lamina volsellaris (Fig. 7C).....*A. jilinensis*
- Face without median vertical ridge. Fore wing with abscissa of vein M between 2rs-m and 2m-cu 2.0 times as long as 2rs-m. Digitus strongly elongated, longer than lamina volsellaris (Fig. 7D)6
- 6 Clypeus in anterior view with summit pointed medially (see Fig. 4E, F in Bennett 2001).....*A. gracilis*
- Clypeus in anterior view with summit rounded medially (see Fig. 1E, F of Konishi and Aoyagi 1994)7
- 7 Hypopygium concave in median dorsal margin (see Fig. 5D of Konishi and Aoyagi 1994). Clypeus in lateral view with summit of convexity evenly rounded (not angulate) (see Fig. 1F of Konishi and Aoyagi 1994).....*A. silvestris*
- Hypopygium evenly round in median dorsal margin (Fig. 7B). Clypeus in lateral view with summit of convexity rounded dorsally and angulate ventrally (Fig. 8C).....*A. wangpiensis* Choi and Lee, sp. nov.

Agriotypus jilinensis Chao, 1981

Figs 1, 6C–D, 7A, C, 8A, B

Agriotypus jilinensis Chao, 1981: 79. Chao & Zhang, 1981, by original description.

Specimens examined. Holotype: ♂, CHINA: Changbaishan Nature Reserve, Jilin Province, 25. vi. 1980 (Y. Zhang) (Fujian Agriculture and Forestry University). **Other material:** SOUTH KOREA: 1 ♀, 2.iv.2015, Toegokgyo, Toegok-ri, Yeongok-myeon, Gangneung-si, Gangwon-do (S.W. Jeong) (NNIBR); 1 ♀, 27.iv–10.v.2003, Jirisan, Hamyang-gun, Samjeong-li, 700 m asl, Malaise trap in a big clearing, 35°20'55"N, 127°38'21"E,

(*P. Tripotin*) (EUM); 1♀, 11.iv–8.v.2004, Jirisan, Macheon-myeon, Samjeong-li, 700 m asl, Malaise trap on small stream in forest clearing, 36°20.930'N, 127°38.503'E, (*P. Tripotin*) (EUM); 1♀18♂♂, 8.v–5.vi.2004, Jirisan, Macheon-myeon, Samjeong-li, 700 m asl, Malaise trap on small stream in forest clearing, 36°20.930'N, 127°38.503'E, (*P. Tripotin*) (EUM); 1♀, 11–18.v.2003, Jirisan, Samcheon-ri, Macheon-myeon, Hamyang-gun, Gyeongsangnam-do, Alt. 700 m, in cleared resinuous forest, (*P. Tripotin*) (DNUE_IIIEI); 2♂♂, 24.iv.1997, Mt. Odae, Pyungchang, Kangwon, yellow pan trap (J.Y. Choi) (EUM); 1♀, 2–26.v.2006, above small stream, Dunjeon-ri, Sangchon-myeon, Yeongdong-gun, Chungcheongbuk-do, Alt. 750 m, 36°04'36"N, 127°50'17"E, (*P. Tripotin*) (DNUE_IIIEI).

Description. Female. Body length 5.6–6.7 mm; fore wing length 4.5–5.2 mm.

Head. Face width (minimum length of inner orbits) 1.1 times as wide as its median height (length between antennal socket and clypeal margin), with a median vertical ridge (see Fig. 4G in Bennett 2001), with dense punctures and hairs except area between lateral ocellus and eye impunctate (Fig. 1B). Antenna with 20–22 flagellomeres, 0.5 times as long as fore wing. Temple behind eyes slightly roundly narrowed in dorsal view. Antennal scrobe deep. POL: OOL = 1:1–1:2. Face with median longitudinal ridge, coarse rugosity and dense pubescence. Area between antennal sockets with a glabrous short longitudinal tubercle. Clypeus in anterior view with apical margin truncate, not pointed; anterior edge in profile moderately convex; summit of convexity in lateral view angulate; shape of angular summit of clypeus in anterior view rounded medially (Fig. 1B). Distance between anterior tentorial pits 1.2–1.3 times as long as length between a tentorial pit and eye. Occipital carina weak, but complete. Malar space 1.4 times as long as basal width of mandible; mandible twisted, lower tooth longer than upper one.

Mesosoma. Pronotum with long and strong epomia extending dorsal of furrow and almost straight. Mesoscutum shiny, anterior 1/2–2/3 of median lobe moderately punctate and setose, the rest of medial lobe and all lateral lobes completely impunctate and lacking setae; notaulus distinct, meeting at around middle (Fig. 1D). Scutellum in dorsal view, long triangle-shaped, 1.6 times as long as its basal width including spine, 0.9–1.1 times as long as propodeum; scutellum with lateral carinae at base, convex medially, tapering toward apex, spine-like apical half, smooth (Fig. 1E); spine 0.5–0.6 times as long as propodeum (distance as long as lateral longitudinal carinae from base to apex); in lateral view roundly curved medially, weakly up-curved (Fig. 8D). Mesopleuron finely punctate and pubescent, with longitudinal groove complete, without longitudinal carina on anterior edge at mid-height; epicnemial carina curving sharply anteriorly to meet anterior edge of mesopleuron and with a vertical extension dorsally; sternaulus present as a weak and wide groove. Metapleuron finely punctate and pubescent Propodeum with lateromedian longitudinal carinae almost parallel; lateral longitudinal carinae straight, complete and parallel to lateromedian longitudinal carinae (Fig. 1F, G).

Wings. Fore wing with 1cu-a distad M&Rs; abscissa of vein M between 2rs-m and 2m-cu 1.0–2.0 times as long as 2rs-m. Hind wing with 6–8 distal hamuli; vein 1/Cu & 1cu-a intercepted by 1/Cu in lower 0.44 Cu (Fig. 1I).

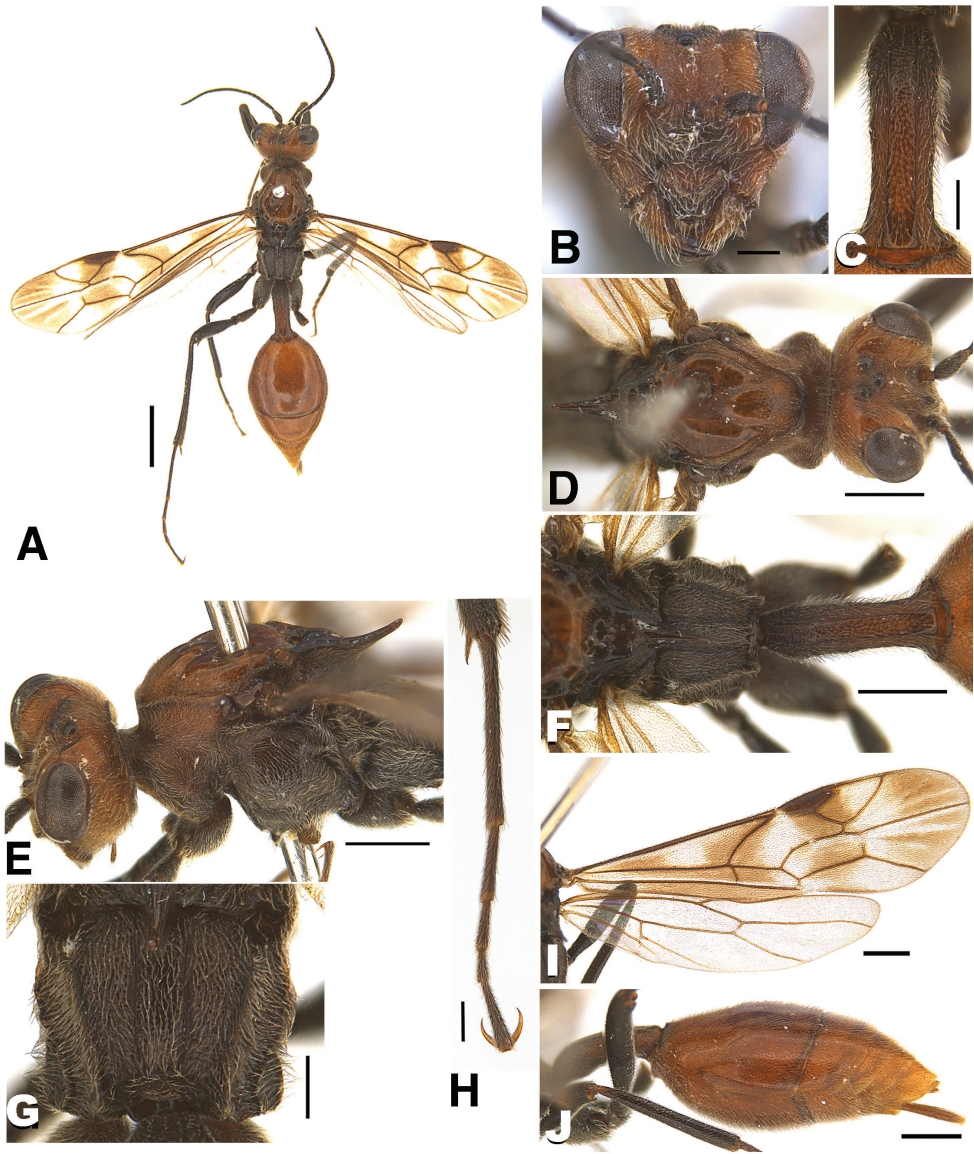


Figure 1. Adult of *A. jilinus* (female) (non-type) **A** habitus in dorsal view **B** head in frontal view **C** metasomal tergite I in dorsal view **D** head and mesoscutum in dorsal view **E** head and mesosoma in lateral view **F** propodeum and metasomal tergite I in dorsal view **G** propodeum in dorsal view **H** hind tarsomeres and tarsal claw **I** wings **J** metasomal tergites in lateral view. Scale bars: 1 mm (**A**); 0.5 mm (**D, E, F, I, J**); 0.2 mm (**B, C, G, H**).

Metasoma. Metasomal tergite I 3.0–4.2 times as long as its posterior width (Fig. 1C), 1.6 times as long as length of propodeum; metasomal tergite I finely punctulate-reticulate, spiracles situated at anterior 0.20–0.25; lateromedian carinae and dorsolateral carinae complete and strong, reaching to apex. Metasomal tergite II and following

tergites densely punctulate and shiny (Fig. 1J). Metasomal tergite II without dorsal and dorsolateral carinae. Ovipositor sheath 0.6 times as long as length of hind basitarsus.

Colour. Generally reddish brown. Head, pronotum, mesoscutum and metasoma reddish brown. Scutellum and metasomal tergite I dark reddish brown. All legs, mesopleuron and propodeum almost black. Fore wing with fuscous longitudinal bands and with wide hyaline spots occupying middle of basal cell, discosubmarginal cell and distal half of marginal and basal of fourth submarginal cells (Fig. 6C); hind wing hyaline (Fig. 1I).

Male. Agrees with the above-mentioned description of the female, except for the following character states: Body length 5.5–7.4 mm (holotype: 7 mm); fore wing length 4.7–6.0 mm; antenna with 29–34 flagellomeres (holotype: 32 flagellomeres); mesoscutum entirely punctate with setae; spine of scutellum laterally compressed and slightly up-curved or straight (Fig. 8B); abscissa of vein M between 2rs-m and 2cu-m 0.3–0.9 times as long as 2rs-m (Fig. 6D); metasomal tergite I 5.4 times as long as apical width, lateromedian carina incomplete posterior to 0.2 length of segment; body, antenna and legs black; wings hyaline except apical marginal area of fore wing weakly tinged with brown. Male genitalia and hypopygium shown in Fig. 7A, C, with digitus relatively weakly elongated but shorter than half of paramere, somewhat broadened toward apex (Fig. 7C). Apex of paramere almost truncate with corners rounded. Penis valve slightly curved ventrally; basal apodeme of aedeagus striate dorsally.

Variation. The scutellar spine of the male holotype is straight and relatively stout apically compared to some South Korean *A. jilinensis* specimens that are more up-curved and tapered (although some are straight and non-tapered as in Fig. 8B).

Larva. Unknown.

Host. Unidentified Trichoptera.

Distribution. China (Jilin), South Korea (new record).

Region. Eastern Palearctic.

Remarks. This species has been known previously from only two pharate males (holotype and paratype). Thus, this is the first description of the female and of the wings of the male. (Korean name: Am-bul-eun-bae-mul-beol).

Agriotypus wangpiensis Choi & Lee, sp. nov.

<https://zoobank.org/2A235DB3-F5E4-484D-861E-3938B06EC3C6>

Figs 2–5, 6E–G, 7B, D, 8C, D

Type materials. *Holotype* ♀, SOUTH KOREA: 31.v.2022, Wangpicheon, Uljin-gun, Gyeongsangbuk-do, South Korea (S.J. Kwon), rearing date: 12.vi.2022. Type depository: DNUE-IIIEI.

Paratypes. 8 ♀♀, 31.v.2022, Wangpicheon, Uljin-gun, Gyeongsangbuk-do, South Korea (S.J. Kwon), rearing date: 7–17.vi.2022 (DNUE-IIIEI, EUM); 2 ♀♀, ditto, (NNIBR-NNIBRIN166268, NIER); 16 ♂♂, Wangpicheon, Uljin-gun, Gyeongsangbuk-do, South Korea (S.J. Kwon), rearing date: 6–15.vi.2022 (DNUE-IIIEI, EUM); 2 ♂♂, ditto, (NNIBR-NNIBRIN166269, NIER).

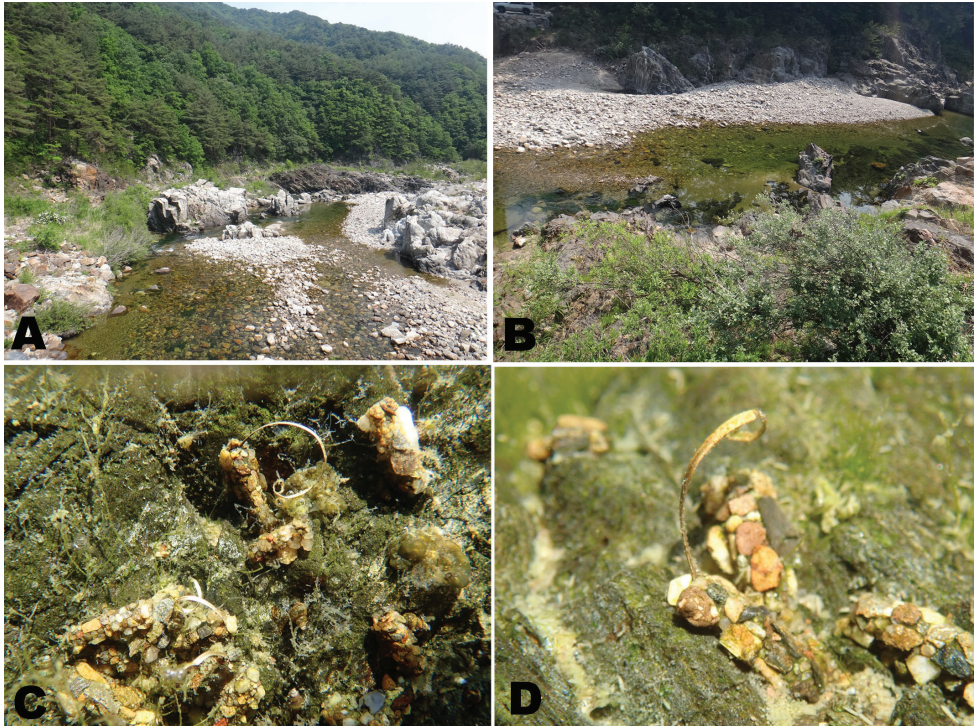


Figure 2. Habitat and collecting sites of *A. wangpiensis* sp. nov. **A** distant view of Wangpicheon stream **B** close range view of Wangpicheon stream **C** parasitized hosts **D** parasitized trichopteran pupae.

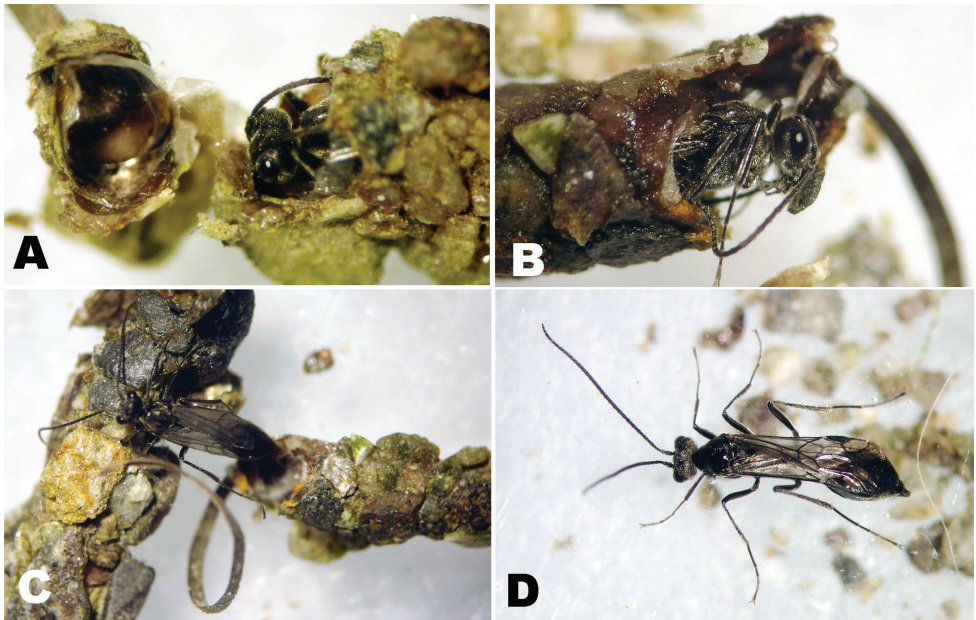


Figure 3. Reared *A. wangpiensis* sp. nov. **A–B** breaking case of trichopteran species **C** exiting trichopteran case **D** male adult following exit from trichopteran case.

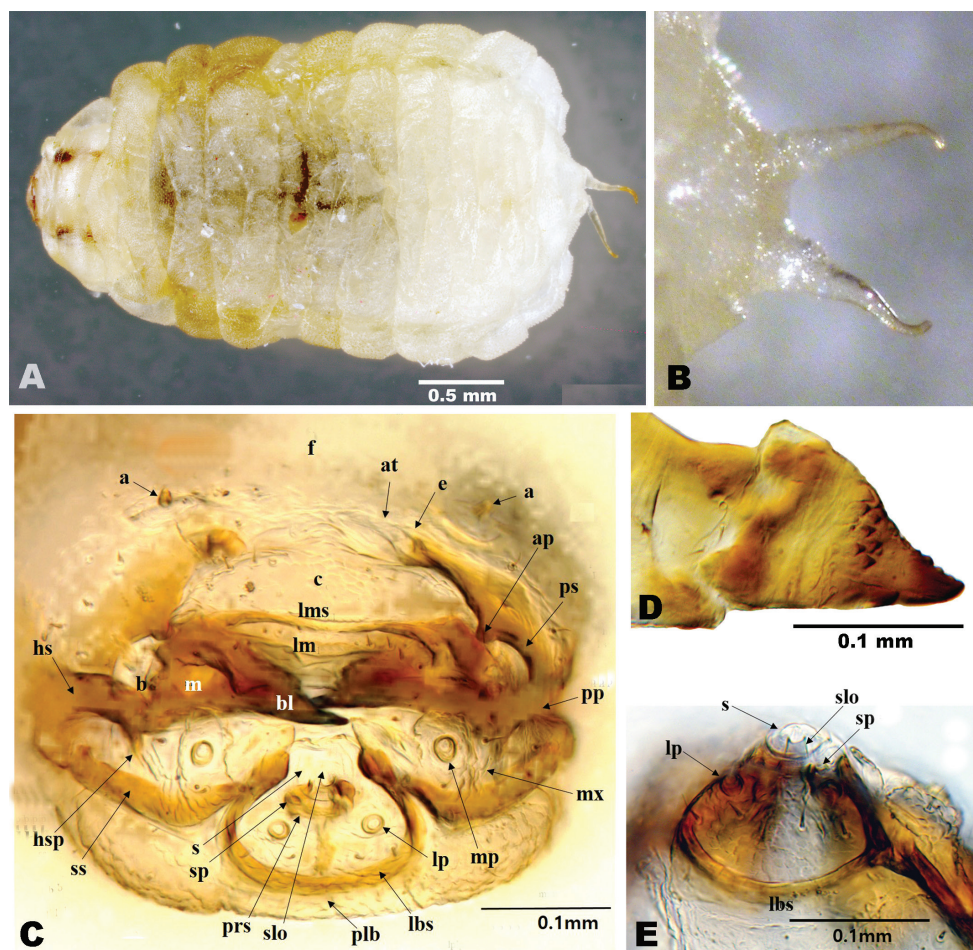


Figure 4. Final larva instar of *A. wangpiensis* sp. nov. **A** whole body of larva in dorsal view **B** caudal filaments **C** head of larva in frontal view **D** mandible of larva **E** salivary orifice (s) and orifice of silk press (slo) in ventral view. [a: antenna, ap: anterior pleurostomal process, at: anterior tentorial pit, b: base of mandible, bl: blade of mandible, c: clypeus, e: epistoma, f: frons, hs: hypostoma, hsp: spur of hypostoma, lb: labium, lbs: labial sclerite, lm: labrum, lms: labral sclerite, lp: labial palp, m: mandible, mp: maxillary palp, mx: maxilla, plb: postlabium, pp: posterior pleurostomal process, prlb: prelabium, prs: prelabial sclerite, ps: pleurostoma, s: salivary orifice, slo: orifice of silk press, sp: silk press, ss: stipital sclerite].

Diagnosis. Females of *Agriotypus wangpiensis* sp. nov. can be distinguished from all other species for which the female is known by the combination of the following characters: 1) metasomal tergite II lacking dorsal and dorsolateral carinae anteriorly (Fig. 5F) (present in all species of the *A. himalensis* species group); 2) clypeus in lateral view with summit of convexity angulate (Fig. 5B) (rounded in *A. armatus* and *A. silvestris*); 3) clypeus in anterior view with summit of convexity rounded medially (Fig. 5C) (acutely pointed medially in *A. gracilis*); 4) pronotum with a long and strong epomia

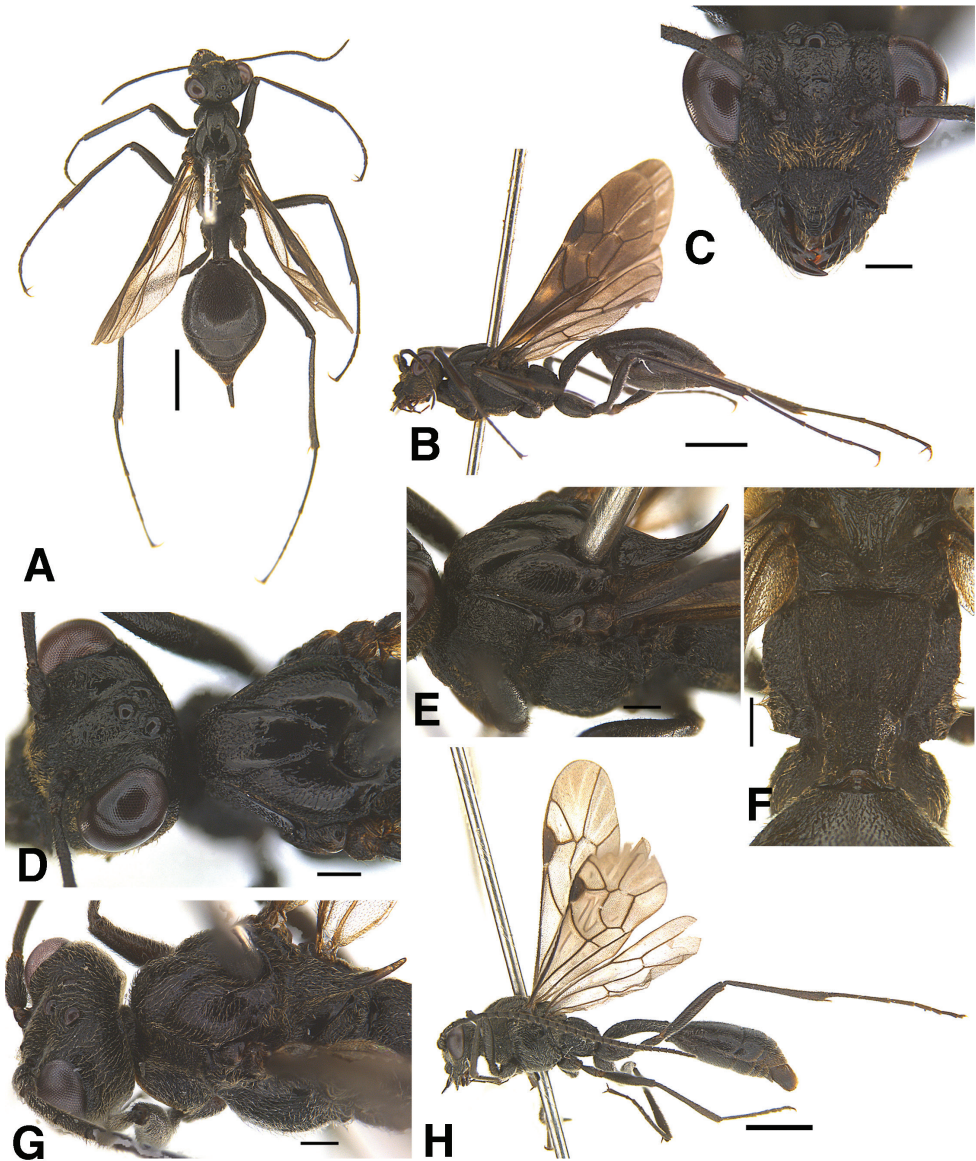


Figure 5. *A. wangpiensis* sp. nov. (Holotype, female **A–F** Paratype, male **G, H**) **A** habitus, dorsal view **B** habitus, lateral view **C** head, frontal view **D** head and mesoscutum, dorsal view **E** mesosoma, lateral view **F** propodeum, dorsal view **G** head and mesoscutum, dorsolateral view **H** habitus, lateral view. Scale bars: 1 mm (**A, B, H**); 0.2 mm (**C–G**).

extending dorsal of pronotal furrow (epomia short in *A. changbaishanus*, not extending dorsal of furrow as in Fig. 5B in Bennett 2001); 5) fore wing lacking complete longitudinal bands proximal and distal to pterostigma, the wing predominantly dark with at most hyaline fascia in basal, discosubmarginal and marginal cells (Fig. 6F, G) (fore

wing with complete longitudinal, hyaline bands proximal and distal to pterostigma in *A. jilinensis* as in Fig. 6C). Note that the female of *A. succinctus* (*A. armatus* group) is not known. In addition, females of several species of the *A. himalensis* species group are unknown, but it is likely they could be distinguished from the new species by character 1 (above). Males of *Agriotypus wangpiensis* sp. nov. can be distinguished from all other species for which the male is known by the combination of characters 1–4 in the female diagnosis as well as the face lacking a medial, vertical ridge (ridge present in *A. jilinensis*). All males of the *A. armatus* group are known.

Description. Female (Adult). Body length 5.0–6.8 mm; fore wing length 4.0–4.9 mm.

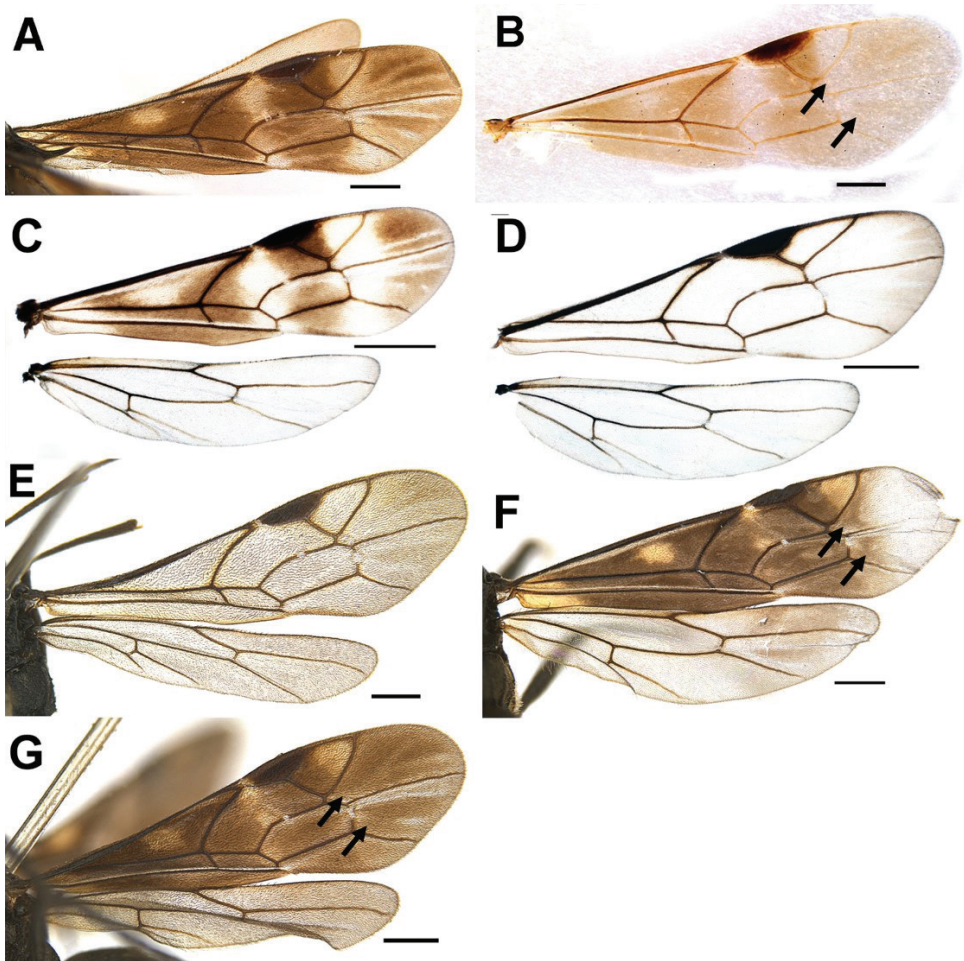


Figure 6. Wings of South Korean *Agriotypus* species (**A–C, F, G** female; **D–E** male) **A** *Agriotypus gracilis* **B** *A. silvestris* **C–D** *A. jilinensis* **E–G** *A. wangpiensis* sp. nov. (**F** = variation in paratype, **G** = holotype). Scale bars: 1 mm (**C, D**); 0.5 mm (**A, B, E–G**).

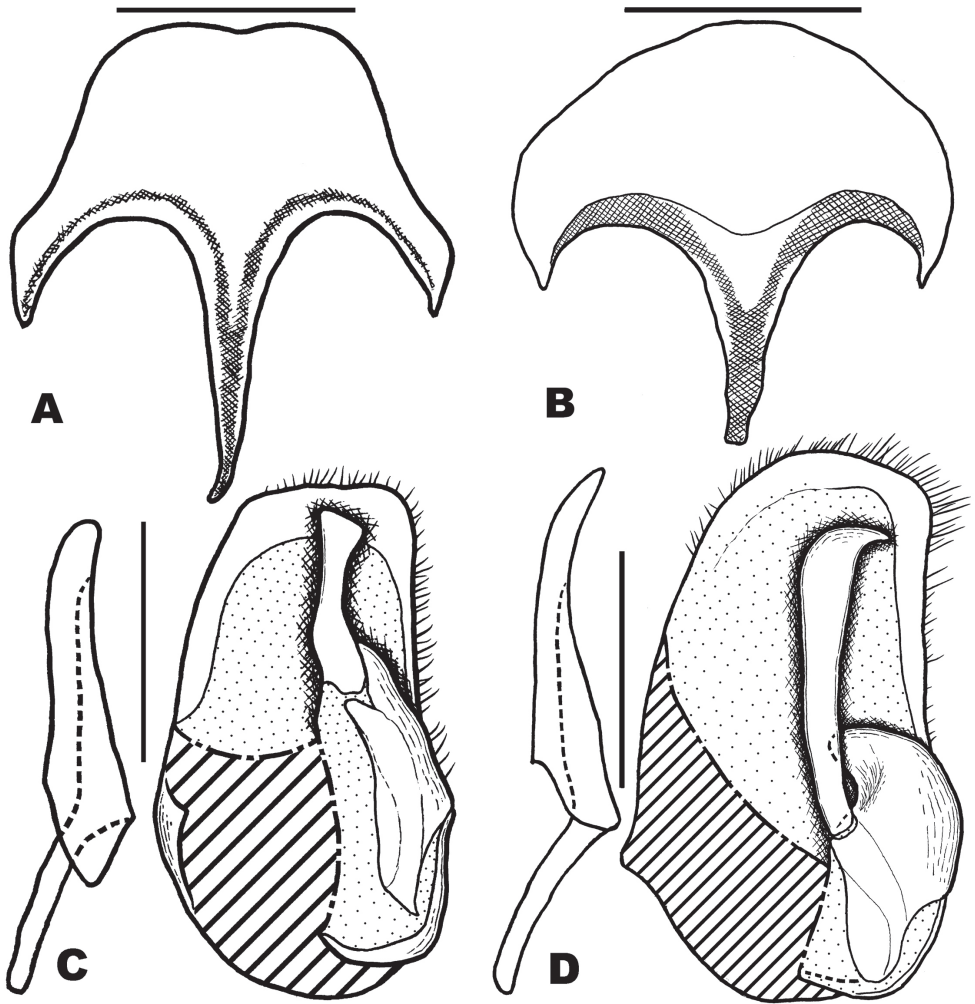


Figure 7. Male genitalia and hypopygium of *Agriotypus jilinenis* (**A, C** non-type) and *A. wangpiensis* sp. nov. (**B, D** paratype) **A** hypopygium, ventral view of *A. jilinenis* **B** hypopygium, ventral view of *A. wangpiensis* sp. nov. **C** genitalia of *A. jilinenis* **D** genitalia of *A. wangpiensis* sp. nov. Scale bar: 0.3 mm.

Head. Head width 1.0 times as wide as its median height (Fig. 5C). Face width (minimum length of inner orbit) 1.57 times as wide as its median height (length between antennal socket and clypeal margin), convex medially, without a median vertical ridge, with coarse rugosity and dense pubescence (Fig. 5C). Antenna with 20 flagellomeres, 0.6 times as long as fore wing. Temple behind eyes roundly narrowed in dorsal view. Transverse diameter of eye 0.9 times as wide as temple in dorsal view. Frons finely densely punctulate-reticulate. Area between antennal sockets lacking a glabrous short longitudinal tubercle. Antennal scrobe deep. POL: OOL = 1: 2. Clypeus in anterior view with apical margin round; anterior edge in profile moderately convex; summit of convexity in lateral view angulate; shape of angular summit of clypeus in anterior view

rounded medially (Fig. 5C). Distance between anterior tentorial pits shorter than length between a tentorial pit and eye; malar space 1.3 times as long as basal width of mandible; mandible twisted, lower tooth longer than upper one. Occipital carina strong.

Mesosoma. Pronotum with long and strong epomia, upper area of pronotum with more than 10 fine carinae dorso-posteriorly. Mesoscutum shiny, anterior half of median lobe and outer side of lateral lobes punctate and setose; notauli distinct, meeting in posterior 0.3 (Fig. 5D, E). Scutellum in dorsal view triangular, 1.8 times as long as its anterior width including spine, 1.25 times as long as length of propodeum; scutellum with lateral carina at base, and spine smooth in lateral view, distinctly upcurved (Figs 5E, 8D). Mesopleuron and metapleuron densely punctate, reticulate and pubescent, with longitudinal groove deep and wide, without longitudinal carina on anterior edge at mid-height; epicnemial carina curving sharply anteriorly to meet anterior edge of mesopleuron and with a vertical extension dorsally. Sternaulus present. Dorsal area of mesopleuron with transverse carinae. Propodeum finely coriaceous-punctate; lateromedian longitudinal and lateral longitudinal carinae weakly convergent posteriorly (Fig. 5F).

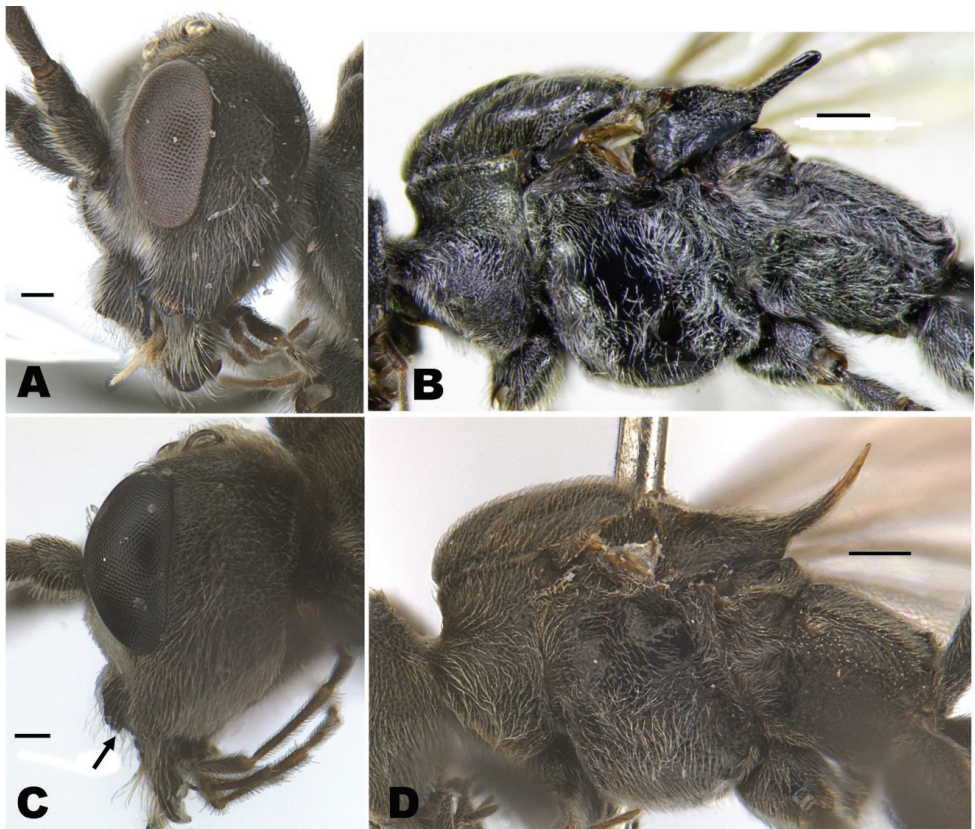


Figure 8. Head and mesosoma of *Agriotypus jilinensis* (non-type) (A, B) and *A. wangpiensis* sp. nov. para-type (C, D) A male head, lateral view B male mesosoma C male head, lateral view (arrow point to ventral angulation of clypeus) D male mesosoma. Scale bars: 0.1 mm (A, C); 0.2 mm (B, D).

Wings. Fore wing with 1cu-a distad of M&Rs; abscissa of vein M between 2rs-m and 2cu-m 2.5–2.7 times as long as 2rs-m. Hind wing with 8 distal hamuli; vein 1/Cu & 1cu-a intercepted by 2/Cu in lower 0.25–0.35 (Fig. 6G).

Metasoma. Metasomal tergite I 3.8 times as long as its apical width, 1.7 times as long as length of propodeum; metasomal tergite I finely punctulate-reticulate, spiracles situated in anterior 0.45, lateromedian and dorsolateral carinae complete and strong, reaching to apex. Metasomal tergite II lacks dorsal and dorsolateral carinae. Ovipositor sheath 0.7 times as long as length of hind basitarsus.

Colour. Almost black. Apical spine of scutellum, posterior metasomal tergites slightly reddish brown. Fore wing generally infusate, with small hyaline spots occupying middle of basal cell, discosubmarginal cell and marginal cell: hyaline spot of basal cell at basal 0.6 on the basal cell of fore wing, hyaline spots of discosubmarginal cell narrow, distal half of marginal cell with hyaline spot, fourth submarginal cell without hyaline spot (Fig. 6G).

Variation. In some specimens, apical area of fore wing hyaline (Fig. 6F).

Male. Body length 5.0–6.0 mm; fore wing length 4.1–5.1 mm. Antenna with 27–29 flagellomeres. Fore wing with abscissa of vein M between 2rs-m and 2m-cu 2.0 times as long as 2rs-m. Hind wing vein 1/Cu & 1cu-a intercepted by 2/Cu at lower 0.43 (Fig. 6E). Metasomal tergite I 4.1–5.0 times as long as apical width, with incomplete dorsolateral carinae, extending only to 0.35 length of segment; lateromedian carinae of metasomal tergite I incomplete, but extending past spiracles. Fore wing hyaline (Figs 2, 5H, 6E); hind wing hyaline. Otherwise, similar to female. Male genitalia and hypopygium shown in Fig. 7B, D, with digitus relatively strongly elongated, longer than half of paramere, somewhat broadened toward apex, dorso-apical corner rounded and ventro-apical corner produced (Fig. 7D). Apex of paramere slightly convex. Penis valve curved ventrally, apex of penis valve produced, dorso-apical portion with a tooth; basal apodeme of aedeagus striate dorsally.

Last instar larva (Fig. 4). Body length 3.5 mm; body maximum width: 2.0 mm. Cephalic sclerites (Fig. 4D). Hypostoma (hs) wide; stipital sclerite (ss) moderately curved and sclerotized; labial sclerite (lbs) roundly triangular, narrowing dorsally, dorsal part almost 0.5 times as wide as ventral part, moderately sclerotized, except dorsally, with salivary orifice (s) circular (Fig. 4C). Apical part of larva with caudal filaments, paired and curved, apical part of caudal filaments darker (Fig. 4B). Mandible triangular, strongly sclerotized with 6–8 small toothlike projections medially on dorsal edge (Fig. 4D). Body color ivory (Fig. 4A).

Host. *Goera japonica* Banks, 1906 (Trichoptera: Goeridae). (Det. Dr. Kwon). The Wangpicheon River originates from Mt. Geumjangsan (849 m), which straddles Subi-myeon, Yeongyang-gun and Onjeong-myeon, Uljin-gun, GB, and flows into the East Sea through Uljin-gun.

Distribution. South Korea.

Region. Eastern Palaearctic.

Etymology. The species is named after ‘Wangpicheon’, from the location where the type specimens was collected. (Korean name: Wang-pi-mul-beol).

Molecular data. *COI* barcode sequences (GenBank accession nos. [OQ981233.1](#)–[OQ981241.1](#)), *Echthrus reluctator* (BOLD [GMGMH1512-14](#)) and *Endasys patulus* (BOLD [HYCNL036-19](#); NCBI [MK959419](#)) (Figs 9, 10).

Remarks. This new species is similar to *A. silvestris* Konishi & Aoyagi, 1994, but the female can be distinguished from the latter by the profile of the clypeus (convex with angulation but, roundly convex without angulation in *A. silvestris*); the ratio of the lengths of the scutellar spine and the propodeum (scutellar spine length 1.25 times as long as propodeum but only 0.75 times as long as in *A. silvestris*); the colour of the female fore wing (basal areas of fourth submarginal cell and third discal cells of fore wing almost completely dark without hyaline spot (arrows in Fig. 6G) compared to *A. silvestris* that has the basal 1/4 of these cells hyaline (arrows in Fig. 6B)); length of metasomal tergite I of female (3.8 times as long as length of posterior width but 4.6 times as long as posterior width in *A. silvestris*); hypopygium (evenly round median dorsal margin but, emarginate in median dorsal margin in *A. silvestris*).

Agriotypus gracilis Waterston, 1930

Material examined. JAPAN: 1 ♂, 21.iii.2002, Honshu, Aichi, Horai, Shiose (N. Kawase) (DNUE_IIIEI); 1 ♀, 21.vi–7.vii.2002, Honshu, Shizuoka, Shimizu (T. Nozaki) (DNUE_IIIEI); 1 ♀, 16.xi.2013, Tokyo: Hamura City, Tamagawa River, 35.4507 139.1837, 116 m, reared (S. Shimizu) [CNC5245937](#) (CNC).

Molecular data. *COI* barcode sequences BOLD [CNC5245937](#) (=AIB453 AB2 in Figs 9 and 10).

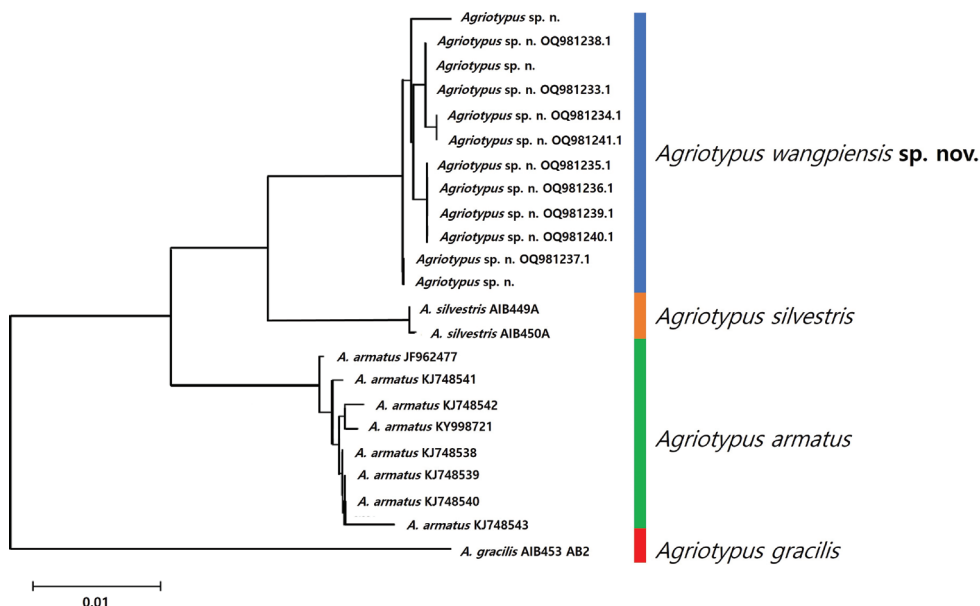


Figure 9. Neighbour-joining tree (NJ) of the successfully DNA barcoded specimens of *Agriotypus*.

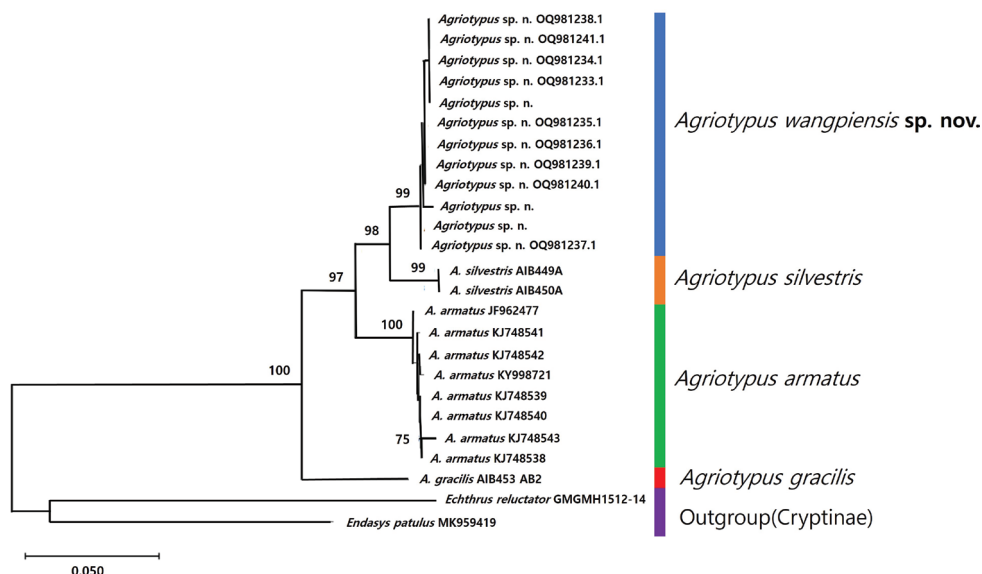


Figure 10. Maximum Likelihood tree (ML) of the successfully DNA barcoded specimens of *Agriotypus*. The bootstrap support for nodes is displayed if higher than 75%.

Agriotypus silvestris Konishi & Aoyagi, 1994

Material examined. JAPAN: 1 ♀, 11.ix.2006, Hokkaido Oshima, Mori-machi Torisaki river (T. Ito) (DNUE_IIIEI); 1 ♂, 1–2.ix.1996, Honshu, Gunma, Matsuida env., 1100 m, yellow pan trap, (L. Masner) [CNC5245940](#) (CNC); 1 ♂, 1 ♀, 25.viii.1996, Honshu, Iwate, Mt. Hayachine, 750 m, yellow pan trap, (L. Masner & K. Yamagishi) ([CNC5245938](#), [CNC5245939](#)) (CNC).

Molecular data. *COI* barcode sequences BOLD [CNC5245938](#) (= AIB449A in Figs 9 and 10), BOLD [CNC5245939](#) (= AIB450A in Figs 9 and 10).

Discussion

The first study on South Korean Agriotypinae by Kim (1963) reported *Agriotypus armatus* from South Korea. However, Konishi and Aoyagi (1994) and Bennett (2001) mentioned that *A. armatus* is very similar to *A. gracilis* but clearly distinguished by the clypeus, mesonotum, metasomal tergite I, host records, and geographical distribution. Kim et al. (2018) excluded the record of *A. armatus* from the South Korean insect fauna based on the literature review and specimen examination. Therefore four species, *A. gracilis*, *A. jilinensis*, *A. silvestris*, and *A. wangpiensis* sp. nov., are now known to be found in South Korea. All of these species belong to the *A. armatus* species group of Bennett (2001) on the basis of the lack of the longitudinal carina at the anterior of metasomal tergite II. Among them, *A. wangpiensis* sp. nov. is a parasitoid of *Goera japonica* Banks, 1906 in Wangpicheon in the northeast of Gyeongsangbuk-do Province.

In the DNA barcode analysis, *Agriotypus gracilis* is highly divergent from the other species (8.5–10% different DNA barcode) and *Agriotypus wangpiensis* sp. nov. is most closely related to *A. silvestris* (Fig. 9). The species status of *A. wangpiensis* sp. nov. is confirmed by both the unique combination of morphological characters (see the species diagnosis) and the molecular analysis that found that the DNA barcode region of the new species is 3.4–3.6% different from *A. silvestris* (Fig. 9). In a ML analysis (Fig. 10), the four species in the genus *Agriotypus* [*Agriotypus wangpiensis* sp. nov., *A. silvestris*, *A. gracilis* and *A. armatus*] clustered as a monophyletic group with strong support (100%). Also, the clustering of all specimens of *A. wangpiensis* sp. nov. together (monophyly of the new species) is supported by the 99% bootstrap score, while the sister relationship of the new species and *A. silvestris* is supported with 98% bootstrap score.

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