

First Record of the Family Dryopidae (Coleoptera) in Korea with Taxonomic Notes on *Elmomorphus brevicornis* and *Elmomorphus amamiensis*

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ABSTRACT

The Dryopidae (Coleoptera) is composed of approximately 300 species worldwide belonging to 33 genera; however, members of the family have not been recorded in Korea. We collected and recorded adult specimens of *Elmomorphus brevicornis* Sharp (= *E. brevicornis brevicornis* Sharp) on piles of submerged twigs and branches of a decayed tree (*Prunus* sp.) from a mountain stream in southwestern Korea with a comparison of the type specimens of *E. brevicornis amamiensis* Nomura from Japan. Both of the subspecies are raised to the species level herein. Redescription, photographs, line drawings of diagnostic characteristics, distribution map, habitat, and taxonomic notes for *Elmomorphus brevicornis* are provided.

Keywords: *Elmomorphus brevicornis*, long-toed water beetles, redescription, new Korean record

INTRODUCTION

The long-toed water beetle family Dryopidae is composed of approximately 300 described species worldwide that belong to 33 genera (Jäch and Balke, 2008). Dryopid diversity is the greatest in the tropics, but several species prefer temperate regions. Most adults are mainly found in aquatic or riparian habitats, while the larvae are usually terrestrial or semiaquatic and inhabit moist decaying wood, humid soil, and leaf litter (Ulrich, 1986; Hayashi and Kadowaki, 2008).

The genus *Elmomorphus* was established by Sharp (1888) on the basis of *Elmomorphus brevicornis* from Japan. This genus is widespread in the Oriental and Eastern Palearctic Regions (Kodada and Jäch, 2005, 2006; Kodada et al., 2009). However, there have been no records of *Elmomorphus* or any other dryopid beetles in the Korean Peninsula.

The adults of *Elmomorphus* are found on piles of submerged twigs and branches of a decayed tree in the lentic areas of a mountain stream. They may be xylophagous. They use plastron respiration, which is well characterized in the elmrid riffle beetles (Elmidae). The biology and taxonomy of dryopid larvae are poorly known.

In this study, we report the family Dryopidae for the first

time as part of the Korean fauna on the basis of the specimens of *Elmomorphus brevicornis* Sharp collected from Byeonsanbando National Park.

MATERIALS AND METHODS

Adult specimens of *Elmomorphus* were collected from piles of submerged twigs and branches of a decayed tree using a forceps. However, we could not find any larvae associated with them. They were preserved in 80% ethanol. One male and one female are deposited in the Chungnam National University Insect Collection (CNUIC); all other specimens are deposited in the Entomological Museum of Korea University (KU).

Morphological terminology for Dryopidae follows Kodada and Jäch (2005). The locality and dimensional abbreviations used in this study are as follows: JB, Jeollabuk-do; PL, pronotal length along midline in dorsal view; PW, maximum width of pronotum; EL, elytral length along the suture from the scutellum bases to the elytral apices; EW, maximum width of elytra; and TL, total length of PL and EL (Fig. 1).

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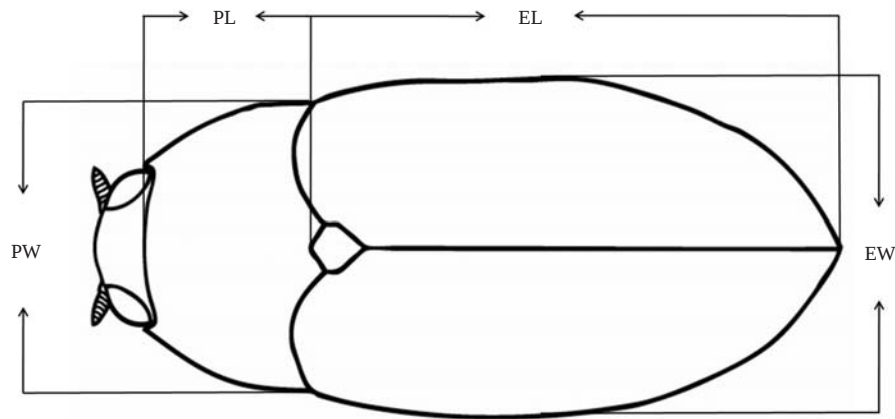


Fig. 1. Adult of the Dryopidae in dorsal aspect for biometric measurements. PL, pronotal length along midline in dorsal view; PW, maximum width of pronotum; EL, elytral length along the suture from the scutellum bases to the elytral apices; EW, maximum width of elytra.

SYSTEMATIC ACCOUNTS

Order Coleoptera

Family Dryopidae Billberg, 1820 (Korean name: Yeo-ul-beol-re-bu-chi-gwa)

Genus *Elmomorphus* Sharp, 1888 (Korean name: Yeo-ul-beol-re-bu-chi-sok)

Elmomorphus Sharp, 1888: 242; Satô, 1985: 255; Kodada et al., 2003: 455; Satô and Yoshitomi, 2005: 636.

Dryopidius Grouvelle, 1896: 33.

Elmomorphellus Chûjô and Satô, 1964: 193.

Type species: *Elmomorphus brevicornis* Sharp, 1888: 243.

Elmomorphus brevicornis Sharp (Fig. 2A–C) (Korean name: Yeo-ul-beol-re-bu-chi)

Elmomorphus brevicornis Sharp, 1888: 243 [type (gender unknown) (Natural History Museum, London): “South Japan, Kobé, May 1871, leg. Mr. G. Lewis”]; Nakane, 1963: 144; Kodada and Jäch, 2006: 442; Hayashi, 2011: 93.

Material examined. ♂, Korea: JB, Buan-gun, Byeonsan-myeon, Junggye-ri (35° 37'37.4"N, 126° 34'12.4"E, 137 m a.s.l.), downstream of Jikso Falls, 4 Jul 2009, Hwang JM (KU); 9♂, 7♀, ditto but 15 Jun 2011, Jung SW, Park HR (KU); ♂, ♀, ditto but deposited in CNUIC.

Redescription. Male adult: Body length (TL) 3.35–3.70 mm; width (EW) 1.60–1.80 mm. Body elongate, oval, convex dorsally, and black color. Femora, tibiae, prosternal process, middle parts of meso- and metaventricle reddish brown. Antennae reddish brown (live specimen) or brown (in alcohol); mouth parts and tarsi brown.

Head (Fig. 3A) retractable, hypognathous, with numerous punctures smaller than a facet, and with hair-like setae on

dorsal surface. Fronto-clypeal suture absent. Labrum wider than long, with dense setae anteriorly, round in frontal angles. Antennae short, with dense hydrofuge pubescence, 9-segmented; antennomere 1 slender posteriorly and stout anteriorly; antennomere 2 wider, $1/2 \times$ length of antennomere 1; antennomere 3 short and small; antennomeres 4–9 wider than long, gradually reducing in length and width. Mandibles symmetrical, longer than wide; dark brown and setigerous punctures in lateral parts; apex strongly curved, with four teeth; two long teeth anteriorly, two small teeth posteriorly; prostheca with numerous short stout spines anteriorly, dense thin setae in middle parts. Galea flattened, 2-segmented; basal galea short; apical galea expanded with dense hair-like setae anteriorly. Lacinia long, narrower than terminal palpomere, with long setae. Maxillary palp 4-segmented; palpomere 1 short; palpomere 2 longer than 3; palpomere 3 longer than 1; terminal palpomere relatively long with lateral sensory field, elongate, more or less wide, about half length of terminal palpomere. Labial palp 3-segmented; palpomere 1 shortest; palpomeres 2 and 3 short.

Pronotum (Fig. 3B) strongly convex, shiny at middle part, carinae absent, wider than long, widest posteriorly; punctures similar to head punctures on dorsal surface; anterior angle protruding, acute; posterior angle rectangular and acute. Scutellum shiny, longer and wide, with punctures, acute at apex. Prosternum punctate, with plastron; prosternal process (Fig. 3C) wider than long, without plastron, widest at middle part, shiny, round at apex. Hypomeron broadest posteriorly, narrowed anteriorly with plastron. Mesoventrite with plastron and punctate, deeply grooved for reception of prosternal process. Metaventricle (Fig. 3G) punctate, covered with plastron except narrow middle part, flat and shiny at middle part; median longitudinal suture; posterior part with transverse

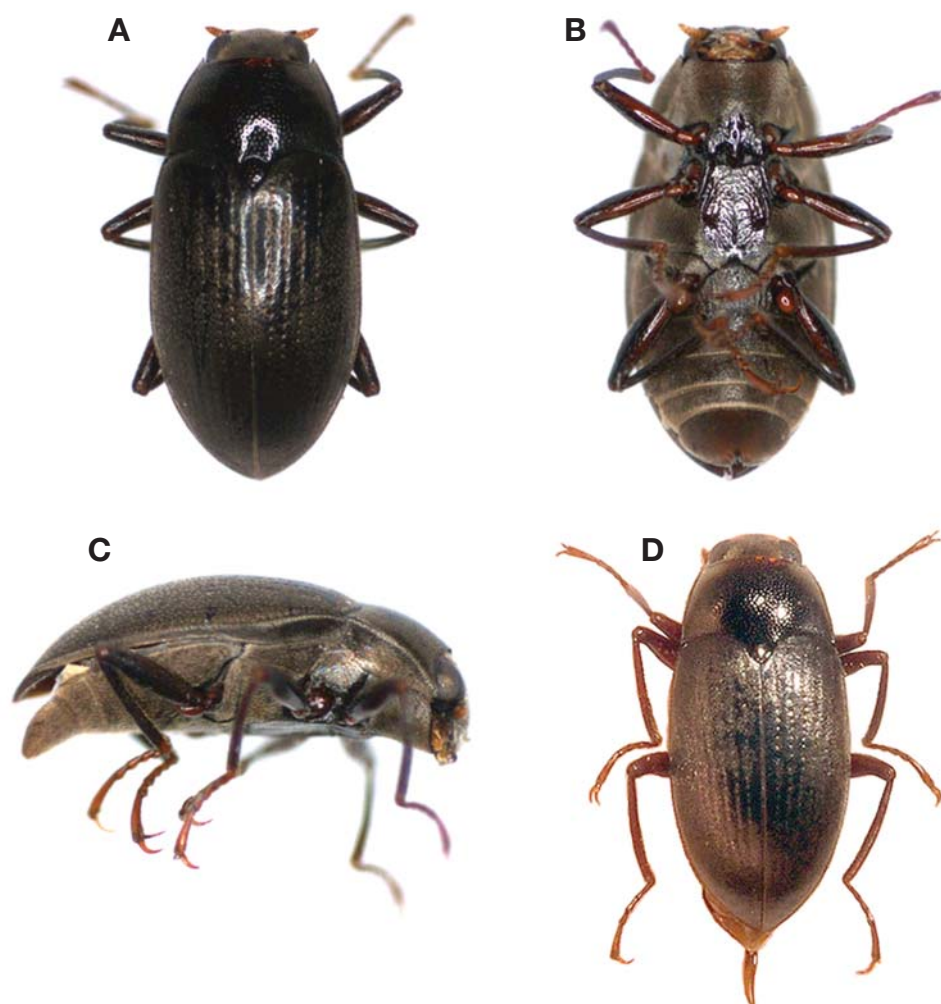


Fig. 2. *Elmomorphus brevicornis* Sharp, male, body length 3.42 mm. A, Habitus, dorsal view; B, Habitus, ventral view; C, Habitus, lateral view. *Elmomorphus amamiensis* Nomura, male, body length 3.20 mm. D, Habitus, dorsal view.

suture. Legs (Fig. 3I–K) long and slender; procoxae and mesocoxae globular; metacoxae transverse; trochanters of hind legs flat, largest and round; femora clavate, with small punctures; middle femora with row of long strong setae on inner surface; tibiae slender, toment on inner surface, $1.11 \times$ as long as tarsi; tarsi 5-segmented, light brown; tarsomeres 1–4 short; tarsomere 5 longest, as long as tarsomeres 1–4 combined; two claws with one basal tooth, slender, sharp, and shiny.

Elytra (Fig. 3H) elongate oval, convex dorsally, widest near middle part, sparsely short setae laterally and posteriorly; lateral margin crenulate; pointed at apex. Each elytron with nine punctate striae; stria punctures moderately large and deep anteriorly, becoming gradually finer posteriorly; striae 6 and 7 obscure at posterior 1/4; 8th stria combined with 5th at posterior 1/6; 9th stria obscure at posterior 1/5;

intervals 1–5 wide; intervals 6–8 narrow. Hind wings fully developed. Abdomen (Fig. 3F) with five ventrites, longer than wide, with plastron; ventrite 5 strongly granulate laterally, widely emarginate at apex; apical margin feebly crenulate. Sternite 9 (Fig. 3D) long, with anterior medial process narrow.

Aedeagus (Fig. 3L, M); penis shorter than parameres, gradually narrowed anteriorly, apex narrow and round, ventrally curved in lateral view; anterolateral apophyses short and acute; membranous ventral sac with fine longitudinal furrows; fibula absent; phallobase moderately long, $2.08 \times$ as long as parameres.

Female adult: Body length (TL) 3.70–3.95 mm; width (EW) 1.80–1.90 mm. Metaventricle with plastron except wide middle part. Abdominal ventrite 5 narrowly emarginate at apex; ovipositor (Fig. 3E) strongly sclerotized, elongate; coxite

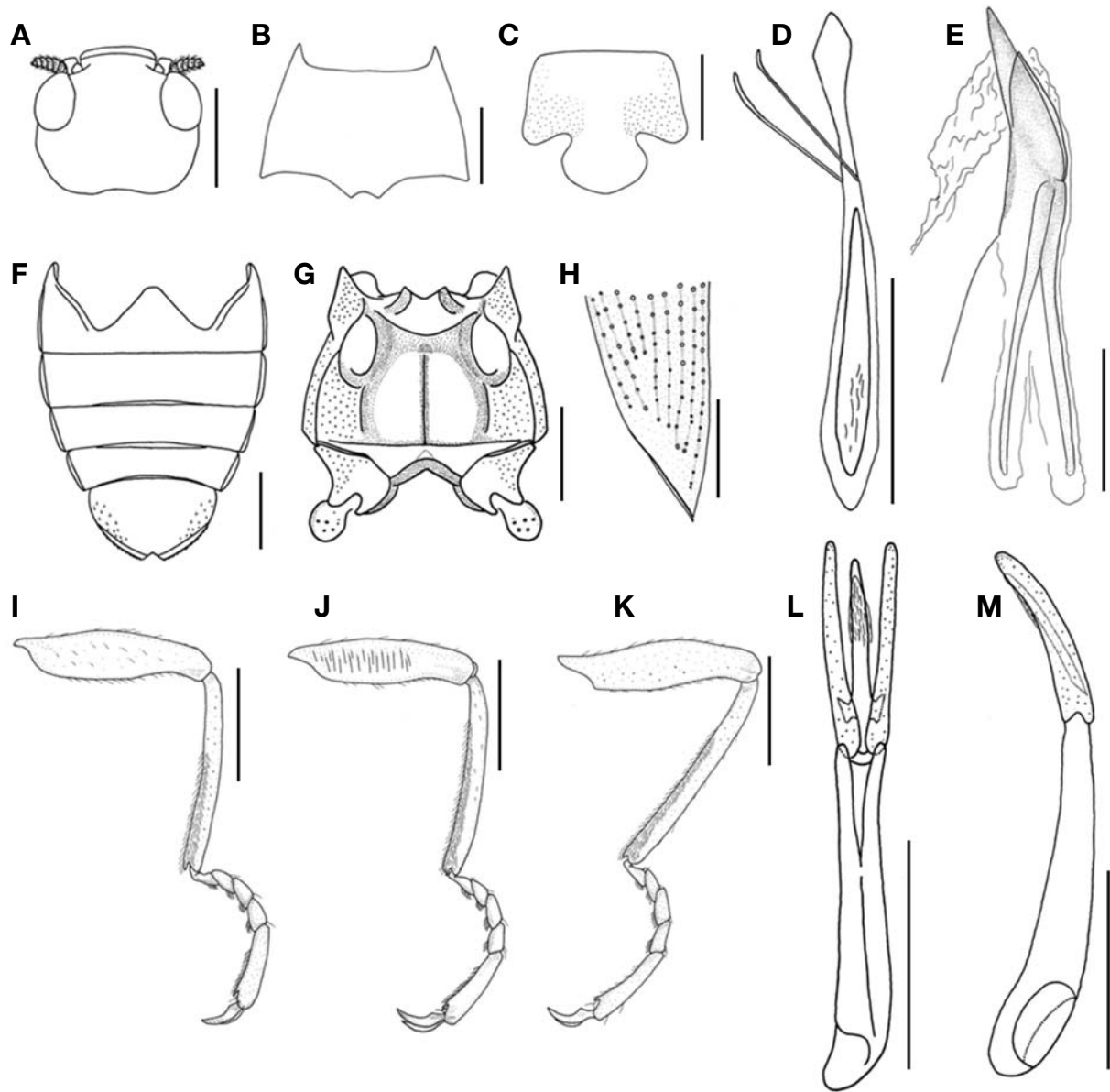


Fig. 3. *Elmomorphus brevicornis* Sharp. A, Head, dorsal view; B, Pronotum, dorsal view; C, Prosternal process, ventral view; D, Male sternite 9, ventral view; E, Ovipositor, ventral view; F, Abdomen, ventral view; G, Metaventricle, ventral view; H, Elytra, left, dorsal view; I, Fore leg, left, lateral view; J, Middle leg, left, lateral view; K, Hind leg, left, lateral view; L, Genitalia, ventral view; M, Genitalia, lateral view. Scale bars: A–M=0.5 mm.

curved, pointed at apex; valvifer about twice as long as coxite.

Measurements. Males (n=5): TL 3.35–3.70 (3.51) mm, PL 0.75–0.80 (0.79) mm, PW 1.35–1.45 (1.40) mm, EL 2.60–2.90 (2.72) mm, EW 1.60–1.80 (1.71) mm. Females (n=5): TL 3.70–3.95 (3.83) mm, PL 0.85–0.90 (0.88) mm, PW 1.50–1.60 (1.56) mm, EL 2.85–3.05 (2.95) mm, EW 1.80–1.90 (1.83) mm.

Larva. Hayashi and Kadowaki (2008) firstly described the larva of *E. brevicornis* presenting color photographs of speci-

mens reared from adults in the laboratory: body yellowish brown, elongate; mesothorax and abdominal segments I–VII with spiracles laterally, abdominal segment VIII with spiracle dorsally (except first instar); operculum present in terminal abdominal segment.

Distribution. Korea (new record) (Fig. 4), Japan.

Habitat. We found all the Korean specimens under piles of submerged twigs and branches of a tree belonging to *Prunus* sp. (family Rosaceae) in Byeonsanbando National Park, which

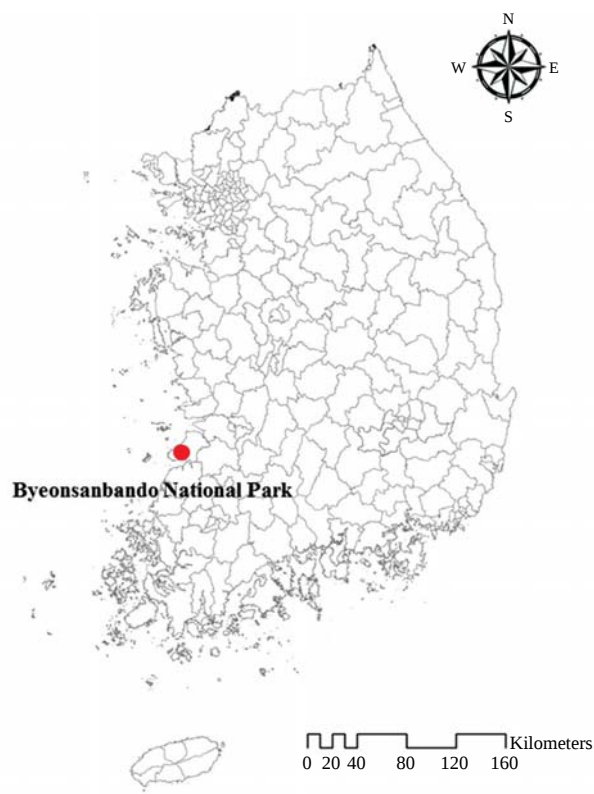


Fig. 4. Distribution of *Elmomorphus brevicornis* Sharp in Korea.

is located in the southwestern coastal area of the Korean Peninsula (Fig. 5). They were collected from a stream located below Jikso Falls (height, 30 m), which is about 15–20 m in width and about 15 cm in depth, with boulders (10%), cobbles (20%), pebbles (40%), and gravel (30%).

Taxonomic remarks. According to Sharp (1888), G. Lewis found two specimens of this species from Kobe, South Japan. Jan Kodada (Comenius University, Slovakia) confirmed deposition of the type specimen (1 dry specimen) in the British Museum of Natural History (Fedor Ciampor, personal communication).

This is the first record of the family Dryopidae in Korea. Two subspecies belonging to the genus *Elmomorphus* were previously recorded in Japan.

***Elmomorphus amamiensis* Nomura (Fig. 2D)**

Elmomorphus brevicornis amamiensis Nomura, 1959: 33 [holotype ♀ (National Science Museum, Tokyo): “Japan, Amami-Ōshima, 20 Jul 1955, leg. T. Shirozu”; Satō, 1960: 252; 1965: 90; 1977: 1; Kodada and Jäch, 2006: 442.

Material examined. ♀, Japan: Amami, Kawakami, Kasari-cho, 16 Jul 2006, Kamite Y leg (KU); 2♂, 2♀, Okinawa, Genka-ōkawa, Nago-shi, 16 May 2007, Kamite Y leg (KU);

♀, Kumejima, Suhara-gawa, Kumejima-chō, 19 May 2007, Kamite Y leg (KU).

Description. Male adult: Body length (TL) 3.15–3.20 mm, width (EW) 1.55 mm. Body elongate, oval, and convex dorsally. Legs, prosternal process, and middle part of mesoventrite reddish brown. Antennae and mouth parts brown.

Head retractable, with numerous punctures smaller than a facet, and with hair-like setae on dorsal surface. Fronto-clypeal suture absent. Labrum wider than long, with dense setae anteriorly, round in frontal angles. Antennae short, with dense hydrofuge pubescence, 9-segmented; antennomere 1 slender posteriorly and stout anteriorly; antennomere 2 wider; antennomere 3 short and small; antennomeres 4–9 wider than long, gradually reducing in length and width. Mandibles dark brown, longer than wide; apex strongly curved, with four teeth; two long teeth anteriorly, two small teeth posteriorly. Maxillary palp 4-segmented; palpomere 1 short; palpomere 2 longer than 3; palpomere 3 longer than 1; terminal palpomere relatively long with lateral sensory field. Labial palp 3-segmented; palpomere 1 shortest; palpomeres 2, 3 short and stout.

Pronotum convex, shiny at middle part, carinae absent, wider than long, widest posteriorly; punctures similar to head punctures on dorsal surface; anterior angle protruding, acute; posterior angle acute. Scutellum shiny, longer and wide, with punctures. Prosternum punctate, with plastron; prosternal process (Fig. 6C) wider than long, without plastron, widest posteriorly, shiny. Hypomeron broadest posteriorly, narrowed anteriorly with plastron. Mesoventrite with plastron and punctate, deeply grooved for reception of prosternal process. Metaventricle punctate, covered with plastron except middle part, flat and shiny at middle part; median longitudinal suture; posterior part with transverse suture. Legs (Fig. 6A, B, D) long and slender; procoxae and mesocoxae globular; metacoxae transverse; trochanters of hind legs flat, largest and round; femora clavate, with small punctures; middle femora with row of long strong setae on inner surface; tibiae slender, tomentous on inner surface, $1.32\times$ as long as tarsi; tarsi 5-segmented, slender and small, light brown; tarsomeres 1–4 short; tarsomere 5 longest, as long as tarsomeres 1–4 combined; two claws with one basal tooth, slender, sharp, and shiny.

Elytra elongate oval, convex dorsally, widest near middle part, sparsely short setae laterally and posteriorly; lateral margin slightly crenulate; pointed at apex. Each elytron with nine punctate striae; stria punctures moderately large anteriorly, becoming gradually finer posteriorly; intervals 1–5 wide; intervals 6–8 narrow. Hind wings fully developed. Abdomen with five ventrites, longer than wide, with plastron; ventrite 5 widely emarginate at apex.

Aedeagus (Fig. 6F, G); penis slightly curved, shorter than



Fig. 5. Habitat of *Elmomorphus brevicornis* Sharp in Byeonsanbando National Park. A, Jikso falls (30 m high); B, Jikso stream of lower area in mountain stream; C, *Prunus* sp. (family Rosaceae); D, Pile of decayed twigs of *Prunus* sp.; E, F, Crawling on decayed wood under water.

parameres, gradually narrowed anteriorly; membranous ventral sac with fine longitudinal furrows; fibula absent; parameres strongly curved apically in lateral view; phallobase moderately long, $2.62 \times$ as long as parameres

Female adult: Body length (TL) 3.40–3.50 mm; width (EW) 1.60–1.65 mm. Metaventricle with plastron. Abdominal ventricle 5 narrowly emarginate at apex; ovipositor as in Fig. 6E.

Measurements. Males ($n=2$): TL 3.15–3.20 (3.17) mm; PL 0.80 mm; PW 1.30–1.35 (1.32) mm; EL 2.35–2.40 (2.37) mm; EW 1.55 mm. Females ($n=4$): TL 3.40–3.50 (3.46) mm; PL 0.80 mm; PW 1.35–1.40 (1.36) mm; EL 2.60–2.70 (2.65) mm; EW 1.60–1.65 (1.61) mm.

Larva. Unknown.

Distribution. Japan (Amami-ôshima, Kumejima, Okinawa, Tokuno-shima).

Habitat. All specimens were collected from the Ryukyu Islands, volcanic islands with subtropical climate.

Taxonomic remarks. This species is endemic to Japan. Male adult of *Elmomorphus brevicornis amamiensis* Nomura can be distinguished from that of *Elmomorphus brevicornis brevicornis* Sharp by the following characters: *Elmomorphus brevicornis amamiensis* is smaller in body length (mean, 3.30 mm); prosternal process (Fig. 6C) is broadly rounded at apex; mesofemora are long; tarsi and claws are smaller (Fig. 6B); parameres are strongly curved at apex; and phallobase is long, $2.5 \times$ as long as parameres (Fig. 6F, G).

Elmomorphus brevicornis amamiensis was originally described on the basis of single female specimen and found only on Amami-ôshima Island, southern Japan. Although they are geographically isolated from each other, they are clearly distinguished by the morphological characters of the male genitalia. We therefore raise both of the subspecies to the species level, *E. brevicornis* Sharp and *E. amamiensis* Nomura.

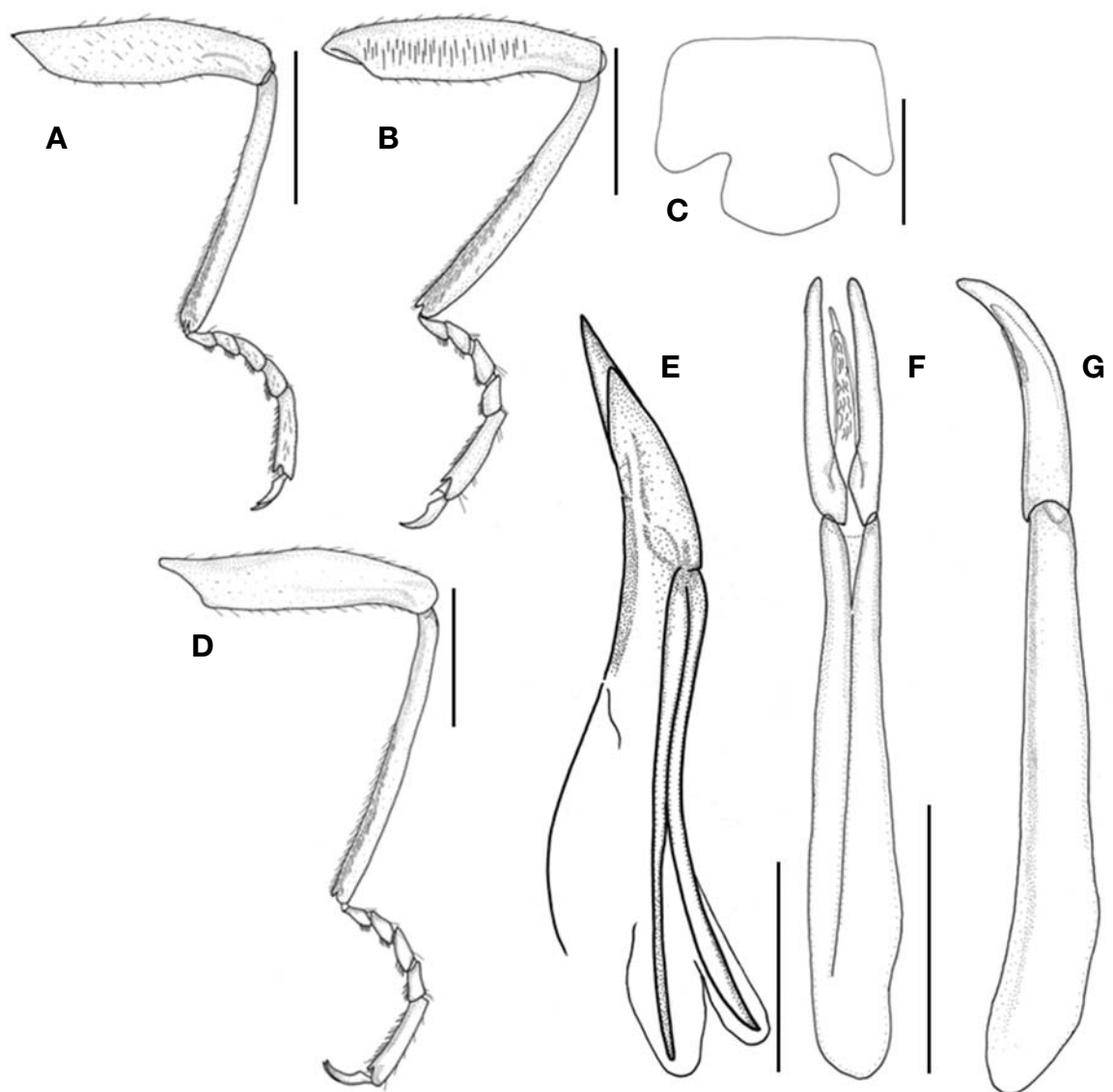


Fig. 6. *Elmomorphus amamiensis* Nomura. A, Fore leg, left, lateral view; B, Middle leg, left, lateral view; C, Prosternal process, ventral view; D, Hind leg, left; E, Ovipositor, ventral view; F, Genitalia, ventral view; G, Genitalia, lateral view. Scale bars: A–G=0.5 mm.

Key to the Korean and Japanese species of *Elmomorphus*

- 1. Mesofemur long; tarsi and claws small; parameres strongly curved apically in lateral view *E. amamiensis* (Japan)
- Mesofemur shorter; tarsi and claws large; parameres not strongly curved apically in lateral view *E. brevicornis* (Korea, Japan)

ACKNOWLEDGMENTS

We thank Dr. Yuuki Kamite (Nagoya City Public Health Re-

search Institute, Japan) for the loan of voucher specimens; Dr. William D. Shepard (Essig Museum of Entomology, USA) for providing valuable literature; Mr. Min-Seop Son (Byeonsanbando National Park, Korea) for guidance to the collecting site; Dr. Fedor Ciampor (Institute of Zoology SAV, Slovakia) and Dr. Jan Kodada (Comenius University, Slovakia) for the type information of *Elmomorphus brevicornis* Sharp. We are also indebted to Dr. Manfred A. Jäch (Naturhistorisches Museum Wien, Austria) for useful comments and reading the manuscript. This work was supported by a grant from the National Institute of Biological Resources (NIBR), funded by the Ministry of Environment (MOE) of

the Republic of Korea (NIBR No. 2013-02-001).

REFERENCES

- Chûjô M, Satô M, 1964. 11. Family Dryopidae. In: Nature and life in southeast Asia. Vol. III (Eds., Kira T, Umesao T). Fauna and Flora Research Society, Kyoto, pp. 193-194.
- Grouvelle A, 1896. Potamophilides, Dryopides, Helmides et Heterocerides des Indes Orientales. Annali del Museo Civico di Storia Naturale de Genova, 37:32-56.
- Hayashi M, 2011. Aquatic Coleoptera of Shimane Prefecture. Bulletin of the Hoshizaki Green Foundation, (1):1-117.
- Hayashi M, Kadowaki H, 2008. Records on aquatic Coleoptera from rivers in and around Mt. Daisen, Tottori Prefecture, Japan, Part II. Bulletin of the Hoshizaki Green Foundation, 11:269-286.
- Jäch MA, Balke M, 2008. Global diversity of water beetles (Coleoptera) in freshwater. Hydrobiologia, 595:419-442.
- Kodada J, Jäch MA, 2005. Chapter 18.3. Dryopidae Bilberg, 1820. In: Handbook of zoology, Vol. IV, Arthropoda: insecta, Part 38, Coleoptera, beetles, Vol. 1. Morphology and systematics (Achoestemata, Adephaga, Myxophaga, Polyphaga partim) (Eds., Beutel RG, Leschen RAB). Walter de Gruyter, Berlin, New York, pp. 496-508.
- Kodada J, Jäch MA, 2006. Family Dryopidae. In: Catalogue of Palaearctic Coleoptera, Vol. 3, Scarabaeoidea, Scirtoidea, Dascilloidea, Buprestoidea, Byrrhoidea (Eds., Löbl I, Smetana A). Apollo Books, Stenstrup, pp. 441-442.
- Kodada J, Jäch MA, Čiampor F, 2003. Dryopidae: I. *Stenomy-stax*, a new aquatic genus (Coleoptera). In: Water beetles of China, Vol. III (Eds., Jäch MA, Ji L). Zoologisch-Botanische Gesellschaft in Österreich and Wiener Coleopterologenverein, Vienna, pp. 431-472.
- Kodada J, Jäch MA, Fedor C Jr, 2009. Review of the genus *Drylichus* Heller (Insecta: Coleoptera: Dryopidae). Zootaxa, 2157:43-58.
- Nakane T, 1963. Dryopidae. Iconographia Insectorum Japonicorum Colore naturali edita. Vol. II. Coleoptera. Hokuryukan, Tokyo, p. 144.
- Nomura S, 1959. Notes on the Japanese Dryopoidea (Coleoptera). II. Tôhō-Gakuhô, 9:33-38.
- Satô M, 1960. Aquatic Coleoptera from Amami-Ôshima of the Ryukyu Island (I). Kontyû, 28:251-254.
- Satô M, 1965. Dryopoidea of the Ryukyu Archipelago, I (Coleoptera). Journal of the Nagoya Women's College, 11:76-94.
- Satô M, 1977. Family Dryopidae. Check-List of Coleoptera of Japan, 8:1.
- Satô M, 1985. Chapter 9 Coleoptera. Dryopidae. In: An illustrated book of aquatic insects of Japan (Ed., Kawai T). Tokai University Press, Tokyo, pp. 255-259.
- Satô M, Yoshitomi H, 2005. Chapter Coleoptera. Dryopidae. In: Aquatic insects of Japan: manual with keys and illustrations (Eds., Kawai T, Tanida K). Tokai University Press, Kanagawa, pp. 636-641.
- Sharp D, 1888. XXXI. Descriptions of some new Coleoptera from Japan. The Annals and Magazine of Natural History, 2:242-245.
- Ulrich GW, 1986. The larvae and pupae of *Helichus suturalis* LeConte and *Helichus productus* LeConte (Coleoptera: Dryopidae). The Coleopterists Bulletin, 40:325-334.

Received October 1, 2013
Revised December 16, 2013
Accepted December 20, 2013