

RESEARCH PAPER

Taxonomy of the intertidal athetine genus *Eubadura* stat. nov. (Coleoptera: Staphylinidae: Aleocharinae) from Japan, with descriptions of two new species

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21st June 2022Published online:
12th July 2022

Abstract. The genus *Eubadura* Sawada, 1990 stat. nov. (Athetini: Athetina) which has formerly been regarded as a subgenus of the genus *Atheta* Thomson, 1858, from Japan is revised. The genus *Osakatheta* Maruyama, Klimaszewski & Gusarov, 2008 is synonymized with *Eubadura*. Four species are recognized in the genus: *Eubadura akiensis* (Sawada, 1990), comb. nov. (Japan: Hokkaidô, Honshû, Shikoku, Kyûshû), *E. yasukoae* (Maruyama, Klimaszewski & Gusarov, 2008), comb. nov. (Japan: Honshû; Korea), *E. onoi* sp. nov., (Japan: Honshû) and *E. hokkaidensis* sp. nov. (Japan: Hokkaidô). Key to the species is given, and a systematic position of *Eubadura* is discussed.

Key words. Coleoptera, Staphylinidae, Aleocharinae, Athetini, coastal species, intertidal zones, new combination, new species, Japan, Palaearctic Region

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Introduction

There have been a number of recent studies on the diversity of coastal aleocharines in Japan (e.g., MARUYAMA & HAYASHI 2009; MARUYAMA 2011a, b; YAMAMOTO & MARUYAMA 2012, 2013; ONO & MARUYAMA 2014; SONG et al. 2018; LIU et al. 2020, 2021). These studies were mostly of the tribes Aleocharini, Liparocephalini and Myllaenini. Despite its potential species richness, the diversity of coastal species of the tribe Athetini in Japan has not been studied in sufficient detail (SAWADA 1971, YOSII & SAWADA 1976, SAWADA 1990, LEE & AHN 2018). This is largely because Athetini is the most taxonomically difficult group in the Aleocharinae (ELVEN et al. 2010).

The athetine genus *Osakatheta* Maruyama, Klimaszewski & Gusarov, 2008, was established to include a single intertidal species, *Osakatheta yasukoae* Maruyama, Klimaszewski & Gusarov, 2008, from Japan (MARUYAMA et al. 2008). There has been no additional record of this species from Japan since its original description, although it has also been recorded in Korea (LEE et al. 2012). This species is found under stones on coastal mudflats (MARUYAMA et al. 2008, LEE et al. 2012).

The subgenus *Eubadura* Sawada, 1990, of the athetine genus *Atheta* Thomson, 1858 (Aleocharinae: Athetini,

Athetina), was established for a single species, *Atheta* (*Eubadura*) *akiensis* Sawada, 1990, which was also collected from an intertidal zone in western Honshu, Japan. A recent reanalysis revealed that *A. (E.) akiensis* and *O. yasukoae* are congeneric. Initially, *Osakatheta* was recognized phylogenetically and morphologically as a distinct genus within the Athetini (MARUYAMA et al. 2008, LEE et al. 2012, SONG et al. 2019). Therefore, *Osakatheta* should be regarded as a junior synonym of *Eubadura*, and *Eubadura* can be raised to the rank of genus. Our study also revealed the presence of two undescribed species of *Eubadura*, which are described in this paper. The systematic position of *Eubadura* is also discussed.

Materials and methods

Mr. Takeshi Hayama collected the beetles using flight interception traps (FIT) on coarse sand or gravel beaches with a grain diameter >1.0 mm in supratidal zones (Hayama, pers. comm.). Ms. Tomoko Taki collected the beetles by sifting using a plastic sieve with 1.5×20 mm mesh (Taki, pers. comm.). We used the technical procedures and methods used by MARUYAMA (2004, 2006). The holotype and paratypes are deposited in the Kyushu University Museum, Fukuoka, Japan (KUM), but several paratypes will



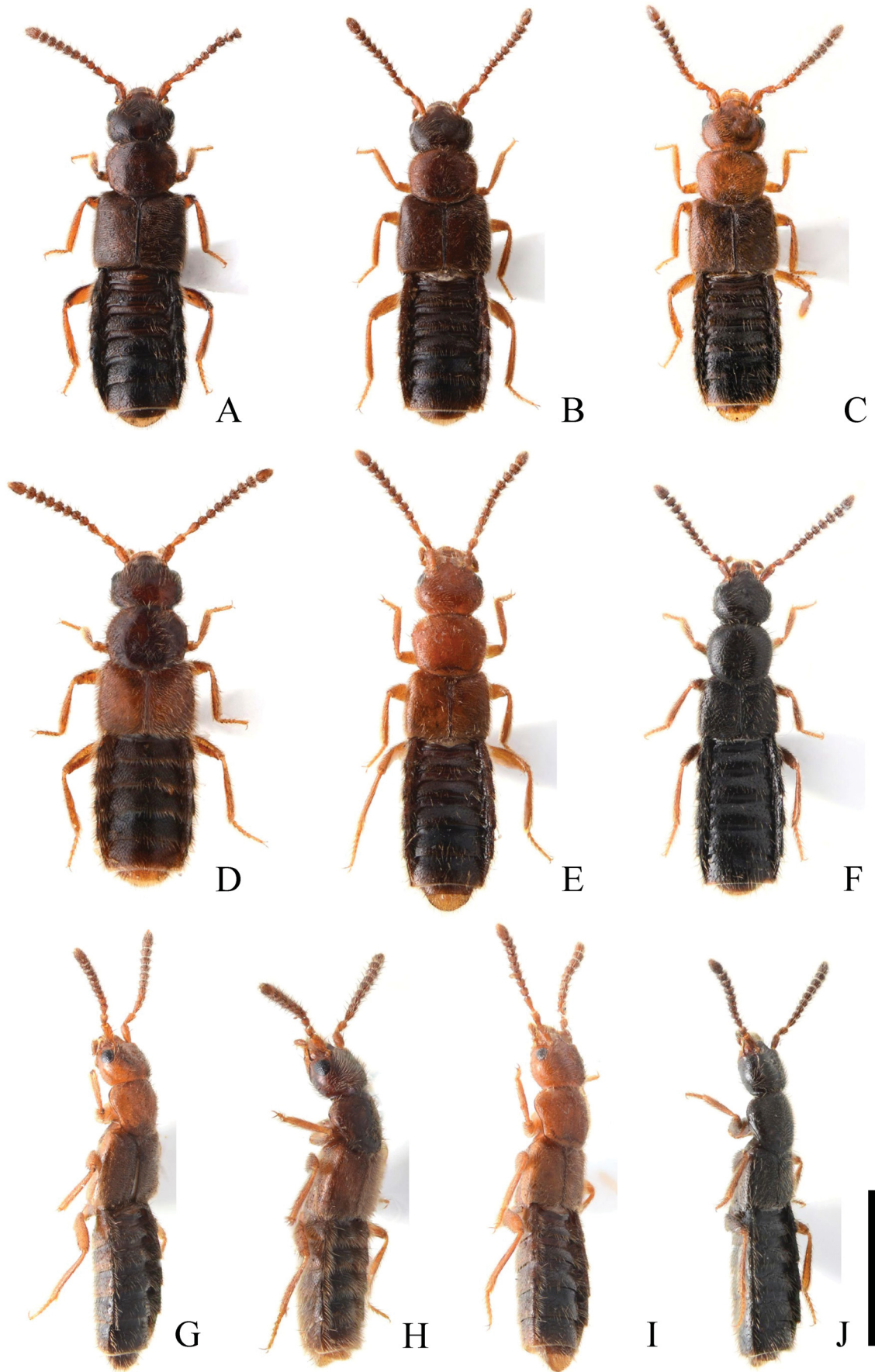


Fig. 1. Habitus of *Eubadura* spp. A–C, G – *E. akiensis* (Sawada, 1990); D, H – *E. yasukoae* (Maruyama, Klimaszewski & Gusarov, 2008); E, I – *E. onoi* sp. nov.; F, J – *E. hokkaidensis* sp. nov. Scale bars: 1.00 mm

be deposited in National Museum, Prague, Czech Republic (NMPC). All measurements are given in millimeters. The number of setae described refers to one side of the body.

Key to the species of the genus *Eubadura*

- 1 Hind wings fully developed.
..... *E. akiensis* (Sawada, 1990)
- Hind wings reduced. 2
- 2 Body almost black; pronotum as long as wide.
..... *E. hokkaidensis* sp. nov.
- Body reddish brown or blackish brown in ground colour; pronotum wider than long. 3
- 3 Pronotum widest around anterior 2/5; spermatheca 5 times as long as capsule.
..... *E. yasukoae* (Maruyama, Klimaszewski & Gusarov, 2008)
- Pronotum widest around anterior 1/3; spermatheca 3 times as long as capsule. *E. onoi* sp. nov.

Taxonomy

Genus *Eubadura* Sawada, 1990, stat. nov.

[Japanese name: Umihime-hanekakushi-zoku]

Eubadura Sawada, 1990: 543 (original description, as subgenus of *Atheta*); type species: *Atheta akiensis* Sawada, 1990.

Osakatheta Maruyama, Klimaszewski & Gusarov, 2008: 40 (original description); type species: *Osakatheta yasukoae* Maruyama, Klimaszewski & Gusarov, 2008. **New junior synonym.**

Diagnosis. *Eubadura* can be distinguished from other coastal athetine genera by a combination of the following character states: head large, slightly narrower than pronotum; body subparallel-sided and, more or less convex; whole body more or less covered with erect setae; apical lobe of median lobe elongated.

Remarks. See the other character states described in detail by SAWADA (1990) and MARUYAMA et al. (2008, as *Osakatheta*).

Eubadura akiensis (Sawada, 1990), comb. nov.

[Japanese name: Aki-umihime-hanekakushi]

(Figs 1A–C, G; 2; 5)

Atheta akiensis Sawada, 1990: 543 (original description).

Type locality. Japan, Honshū, Hiroshima Pref, Kami-Kamagari-shima, Hatsugami.

Type material. Not examined.

Material examined. **JAPAN:** HOKKAIDŌ: 1 ex., Otaru-shi, Takashima 3chōme, 6 VI 2017, H. Ono; 2 ex., Ishikari-shi, Atsuta-ku, Betsukari, mouth of Atsuta riv., 13 VI 2020, Y. Tasaku; 1 ex., same data, but 26 IV 2020; 2 ex., same data, but 5 VI 2021; 3 exs, Shimamaki-mura, Enoshima, 20 II 2021, D. Sumikawa; 1 ex. same data, but 3 VII 2021. **HONSHŪ:** 2 exs, Hyōgo-ken, Tatsuno-shi, Murotsu, 2 II 2020, R. Wakimura; 1 ex., same data, but 24 II 2021; 2 exs, same data but, 23 III 2021; 22 exs, Shimane-ken, Izumo-shi, Taisya-chō, Hinomisaki, Akaishihana, Hirogenohama, 6–12 VI 2009, T. Hayama. (FIT); 17 exs, same data, but 12–19 VI 2009; 5 exs, same data but, 8–15 VIII 2009; 13 exs, Shimane-ken, Izumo-shi, Taisya-chō, Hinomisaki, Akaishihana, 6–15 V 2009, T. Hayama. (FIT); 57 exs, same data, but 2–8 V 2009. **SHIKOKU:** 2 exs, Kagawa-ken, Higashikagawa-shi, Koiso, Kitayama kaigan, 25 V 2013, T. Taki; 1 ex., same data, but 14 IX 2013; 1 ex., same data but, 23 IX 2013; 3 exs, same data but, 18 V 2014; 2 exs, same data, but 7 II 2015; 42 exs, Kagawa-ken, Higashikagawa-shi, Matsubara, Komatusbara kaigan, 5 V 2014, T. Taki; 14 exs, same data but,

6 VI 2015; 42 exs, same data, but 29 I 2016; 2 exs, Kagawa-ken, Higashikagawa-shi, Kaburagoshi-kaigan, 5 II 2017, T. Taki; 6 exs, Kagawa-ken, Higashikagawa-shi, Koiso, Koura kaigan, 15 IV 2015; 4 exs, same data, but 19 IV 2015; 1 ex., same data but, 25 IV 2015; 22 exs, same data, but 4 V 2015; 3 exs, same data, but 7 VI 2015; 6 exs, same data, but 18 VII 2015; 3 exs, same data, but 8 IX 2015; 1 ex., same data, but 23 XI 2015; 3 exs, same data but, 19 XII 2015. **KYŪSHŪ:** 1 ♂, Ōita-ken, Ōita-shi, Seki, Kurogahama, 22 III 2013, T. Miyake (teneral).

Redescription. Head, pronotum, elytra and abdomen blackish brown or reddish brown; antennae, mouthparts and legs paler. Head (Figs 1A–C) wider than long (head width/head length ratio ca. 1.2). Pronotum slightly transverse, about 1.3 times as wide as long, widest around anterior 1/4, narrowed posteriorly; postero-lateral corner rounded; surface finely punctate, densely covered with setae, with 6 macrosetae along lateral margin. Scutellum with integument smooth and sparsely covered with setae. Elytra (Figs 1A–C) 1.3 times as wide as pronotum; surface finely punctured, densely covered with setae, with 4 or 5 small macrosetae laterally. Hind wings fully developed. Abdomen oblong, widest around segments VI and VII; surface smooth; tergites II–VII densely covered with setae. Antennae (Figs 1A–C) almost as long as head and pronotum combined; antennomere I long, almost as long as II; antennomere III slightly shorter than II; antennomeres IV–X moniliform, each almost as long as wide; antennomere XI long, almost twice as long as X.

Male. Male tergite VIII (Fig. 2A) densely covered with setae, with 4 pairs of macrosetae. Male sternite VIII (Fig. 2B) rounded on posterior margin, with 7 pairs of macrosetae. Median lobe of aedeagus as in Figs 2F–G; in lateral view (Fig. 2G) apical lobe bent paramerally, much narrowed subapically, sinuate abparamerally and rounded at apex. Paramere (Fig. 2H) with apical lobe of paramerite narrowed apically.

Female. Female tergite VIII (Fig. 2C) densely covered with setae, with 4 pairs of macrosetae. Female sternite VIII (Fig. 2D) rounded on posterior margin, with 5 pairs of macrosetae. Spermatheca (Fig. 2E) with basal part of stem twice curved around base; capsule dilated apically, about 1/5 as long as stem, densely covered with wrinkles on internal side of apical 2/5–1/2.

Measurements (mm). Body length ca. 2.00–2.50; fore body length ca. 1.1–1.3; head width 0.40–0.46; pronotal length 0.34–0.40; pronotal width 0.46–0.50.

Variation. The body color (1A–C) tends to vary by region: reddish brown in Hokkaido; blackish brown or reddish brown in Honshu and Shikoku. We also examined a single specimen from Kyūshū, but it was a teneral specimen.

Differential diagnosis. This species can be distinguished from other *Eubadura* species by its fully developed hind wings.

Biology. The beetles were found among gravel in the intertidal zone. In Kagawa Prefecture the adult beetles were observed throughout the year among gravel and the highest number of the beetles are collected in May (Taki, pers. comm.). This annual observation results similar to those of *Bryothinus algarum* Sawada, 1971, another Japanese intertidal rove beetle, shown in KAWAKAMI (2008). The beginning of May to the middle of June and the beginning of August, many adult beetles were collec-

ted by FIT in Shimane Prefecture, and some were teneral (Hayama, pers. comm.). It is possible that the beetles fly around just after becoming adult. In Hokkaidô, Northern Japan, the beetles were collected among landside gravel (few meters distant from seashore) in February. The beetles probably overwinter among gravel. Immature stages have not been found.

Distribution. Japan: Honshû (SAWADA 1990), Hokkaidô, Shikoku, and Kyûshû (new records).

***Eubadura yasukoae* (Maruyama, Klimaszewski & Gusarov, 2008), comb. nov.**

[Japanese name: Kebuka-umihime-hanekakushi]
(Figs 1D, H; 5)

Osakatheta yasukoae Maruyama, Klimaszewski & Gusarov, 2008: 41
(original description).

Type locality. Japan, Ôsaka-fu, Ôsaka-shi, Suminoe-ku, Nankô-yachôen.

Material examined. JAPAN: HONSHÛ: 1 ex., Ôsaka-fu, Ôsaka-shi, Suminoe-ku, Nankô-yachôen, 14 IV 2004, Y. Kawakami; 1 ex., same data, but 16 IV 2003.

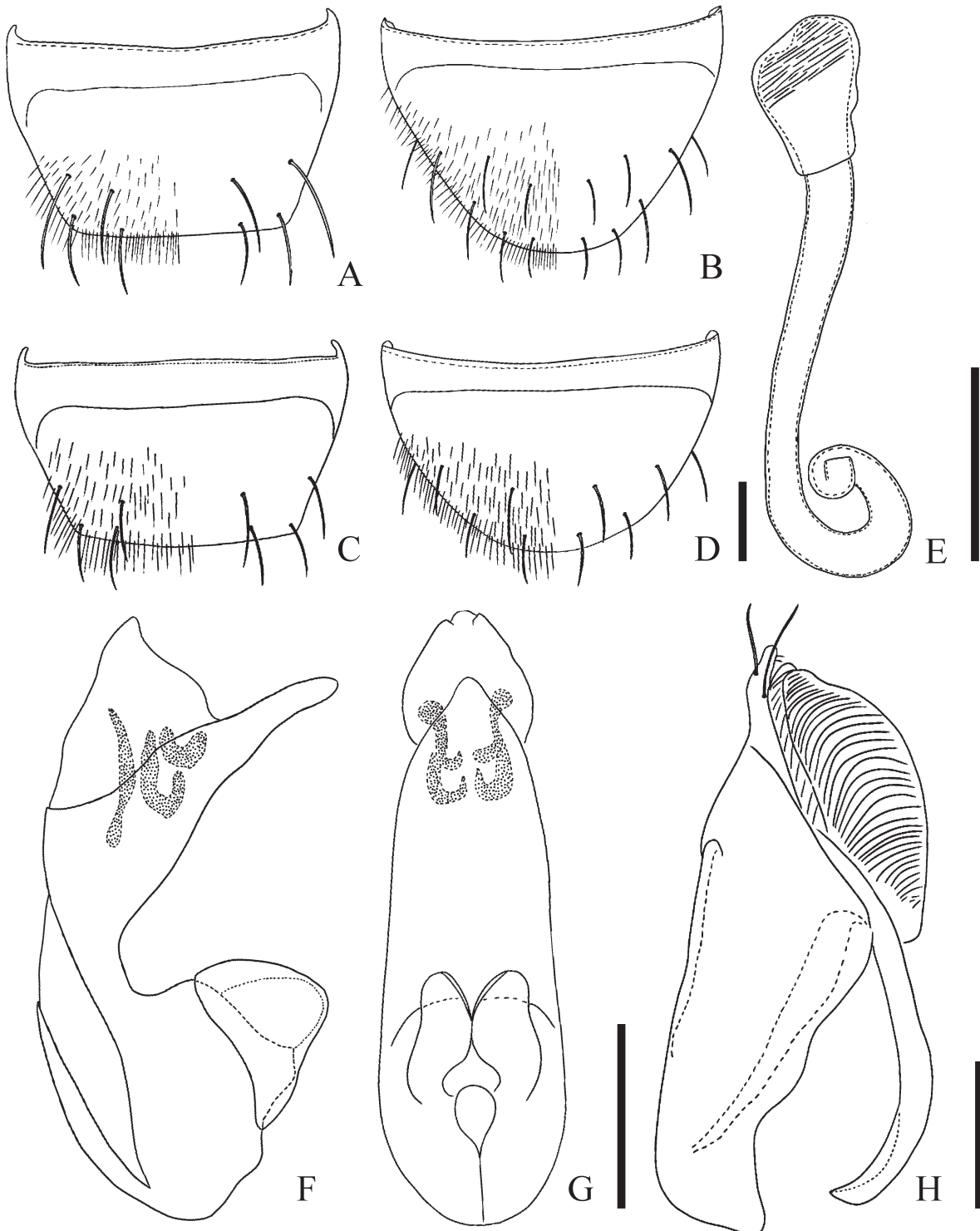


Fig. 2. *Eubadura akiensis* (Sawada, 1990). A – male tergite VIII; B – male sternite VIII; C – female tergite VIII; D – female sternite VIII; E – spermatheca; F – median lobe, ventral view; G – median lobe, lateral view; H – paramere. Scale bars: 0.1 mm.

Differential diagnosis. This species can be distinguished from other *Eubadura* species by the long erect setae covering the whole body (Figs 1G–J).

Distribution. Japan: Honshû (Ôsaka-wan, Ise-wan) (MARUYAMA et al. 2008), Korea (LEE et al. 2012).

Eubadura onoi sp. nov.

[Japanese name: Nisekebuka-umihime-hanekakushi]

(Figs 1E, I; 3; 5)

Type material. HOLOTYPE: ♂, JAPAN: HONSHÛ: Chiba-ken, Kisarazu-shi, Kuzuma, mouth of Obitsu-gawa riv., 13 III 2007, H. Ono (KUM).

PARATYPES: 7 exs, same data as holotype (KUM, NMPC); 1 ex., same data as holotype, but 2 III 2007 (KUM); 2 exs, same data as holotype, but 12 III 2009 (KUM); 7 exs, Chiba-ken, Tateyama-shi, Sunosaki-kai-gan, 22 IV 2009, H. Ono (KUM); 3 exs, Chiba-ken, Minamibôsô-shi, Shirahama-machi, Nemoto, 26 III 2007, H. Ono (KUM).

Description. Head, pronotum and elytra reddish yellow; abdomen almost black and reddish yellow; antenna, mouthparts and legs paler. Head (Fig. 1E) wider than long (head width/head length ratio ca. 1.2). Pronotum slightly transverse, about 1.2 times as wide as long, widest around anterior 1/3, narrowed posteriorly; pos-

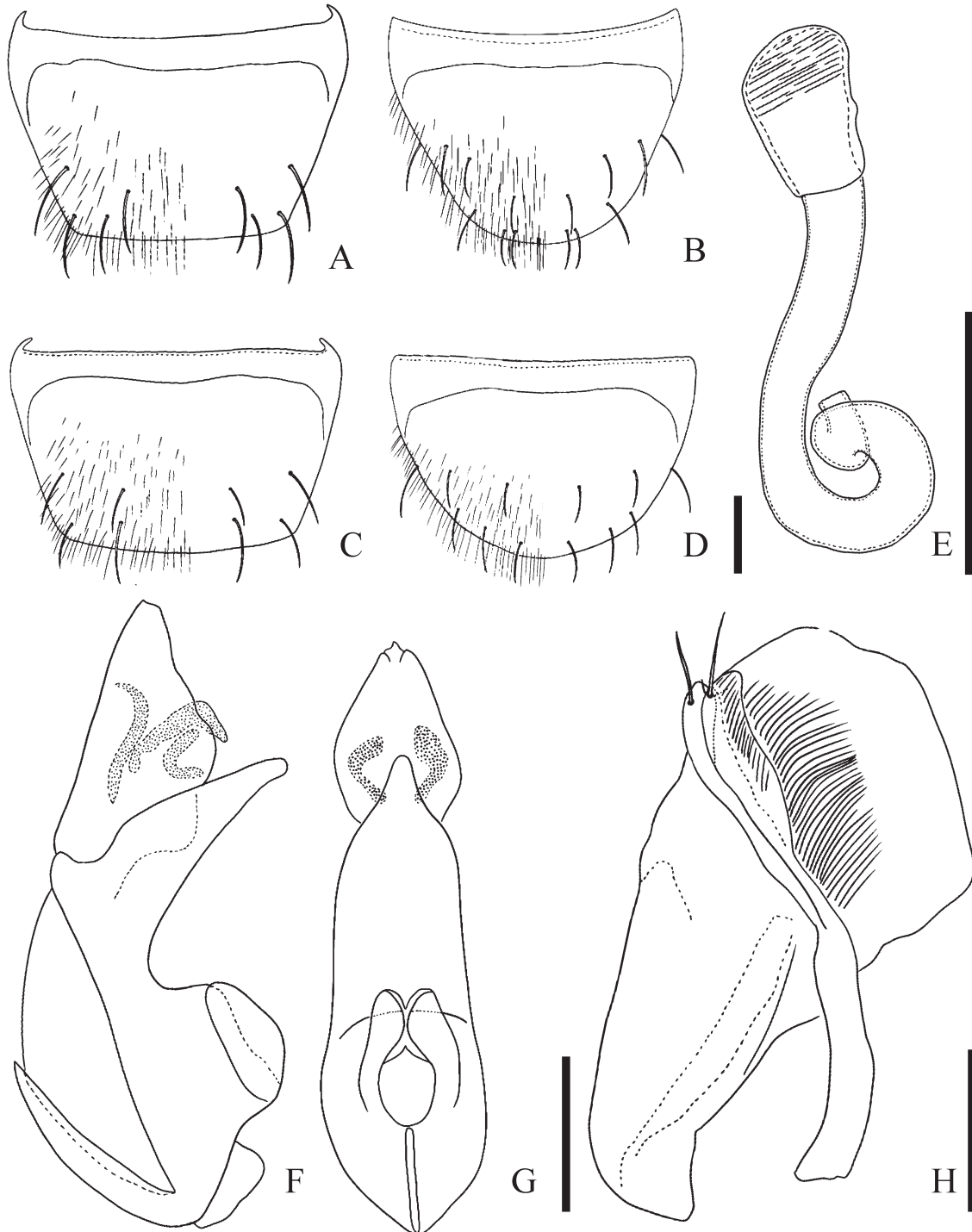


Fig. 3. *Eubadura onoi* sp. nov. A – male tergite VIII; B – male sternite VIII; C – female tergite VIII; D – female sternite VIII; E – spermatheca; F – median lobe, ventral view; G – median lobe, lateral view; H – paramere. Scale bars: 0.1 mm.

tero-lateral corners rounded; surface finely punctured, densely covered with setae, with 7 macrosetae along lateral margin. Scutellum with integument smooth and sparsely covered with setae. Elytra (Fig. 1E) 1.3 times as wide as pronotum; surface finely punctured, densely covered with setae, with 3 small macrosetae laterally. Hind wings reduced, as long as elytra. Abdomen oblong, tergites III–VII almost subparallel, surface smooth; tergites II–VII densely covered with setae. Antennae (Fig. 1E) almost as long as head and pronotum combined; antennomere I long; antennomere II shorter than I; antennomere III slightly shorter than II; antennomeres IV–X

moniliform, each almost as long as wide; antennomere XI long, almost twice as long as X.

Male. Male tergite VIII (Fig. 3A) densely covered with setae, with 4 pairs of macrosetae. Male sternite VIII (Fig. 3B) rounded on posterior margin, with 7 pairs of macrosetae. Median lobe of aedeagus as in Figs 3F–G; in lateral view (Fig. 3G) apical lobe much narrowed subapically, sinuate abparamerally and rounded at apex. Paramere (Fig. 3H) with apical lobe of paramerite dilated apically.

Female. Female tergite VIII (Fig. 3C) densely covered with setae, with 4 pairs of macrosetae. Female sternite VIII (Fig. 3D) rounded on posterior margin, with 6 pairs

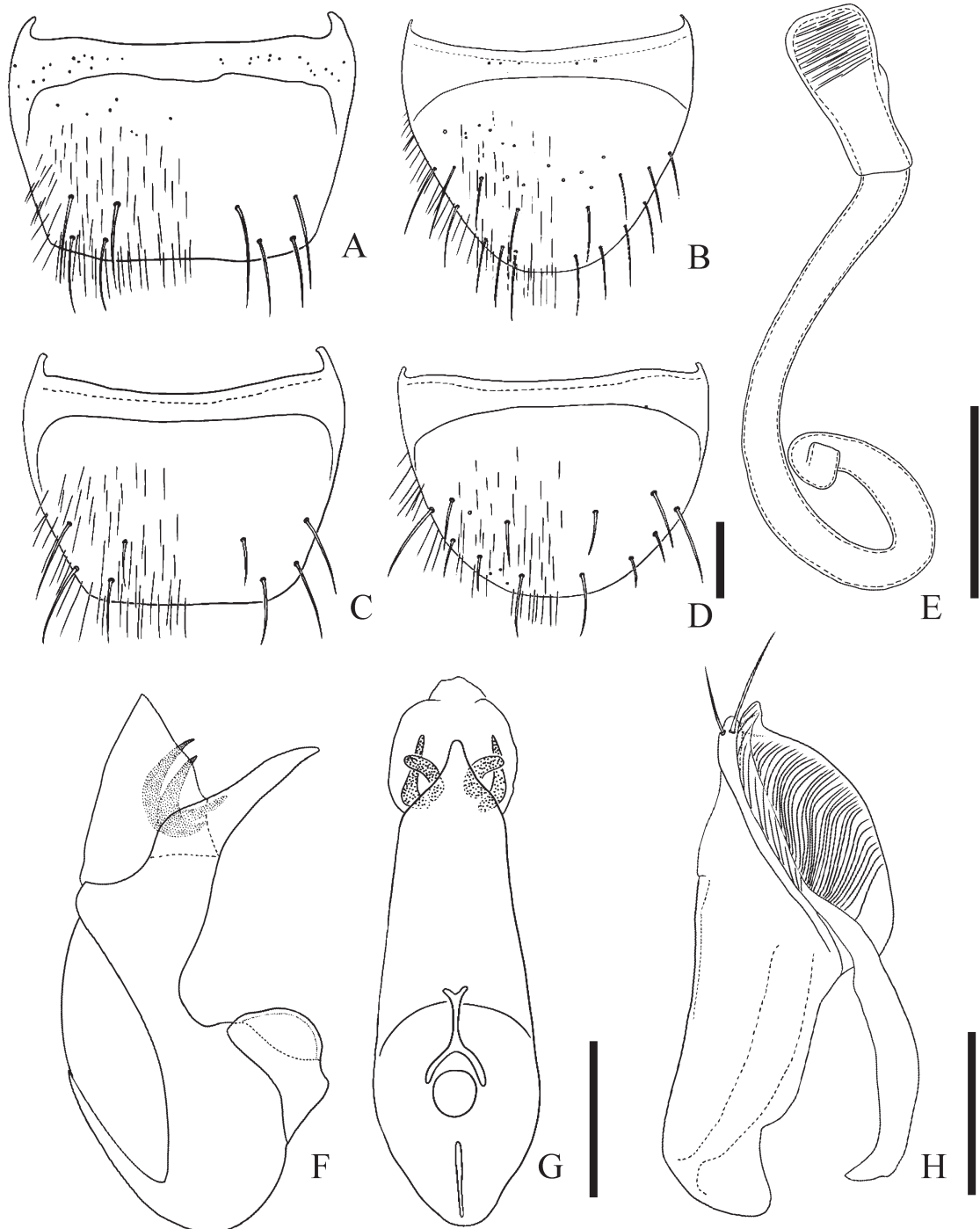


Fig. 4. *Eubadura hokkaidensis* sp. nov. A – male tergite VIII; B – male sternite VIII; C – female tergite VIII; D – female sternite VIII; E – spermatheca; F – median lobe, ventral view; G – median lobe, lateral view; H – paramere. Scale bars: 0.1 mm.

of macrosetae. Spermatheca (Fig. 3E) with basal part of stem twice curved around base; capsule dilated apically, about 1/3 as long as stem, densely covered with wrinkles on internal side of apical 2/5.

Measurements (mm). Body length ca. 2.20–2.80; fore body length ca. 1.1–1.3; head width 0.41–0.44; pronotal length 0.38–0.44; pronotal width 0.44–0.48.

Differential diagnosis. This species is similar to *E. akiensis* in body shape but distinguished from it by hind wings reduced and the spermathecal shape. This species is also similar to *E. yasukoae* but distinguished from it by the spermathecal shape.

Etymology. Named after the collector of the holotype, Mr. Hiroki Ono for his contribution to the knowledge of the coastal rove beetle fauna in Japan.

Biology. Adult beetles were found under stones on mud-flats.

Distribution. Japan: central Honshû.

***Eubadura hokkaidensis* sp. nov.**

[Japanese name: Kuro-umihime-hanekakushi]
(Figs 1F, J; 4; 5)

Type material. HOLOTYPE: ♂, [JAPAN]: Hokkaidô, Abashiri-shi, Komaba, 20 VI 2021, Y. Tasaku. (KUM). PARATYPES: 23 exs, same data as holotype (KUM, NMPC); 5 exs, same data as holotype, but 16. IX. 2020, Y. Tasaku (KUM); 3 exs, Ishikari-shi, Atsuta-ku, Betsukari, mouth of Atsuta-gawa riv., 5. VI. 2021, Y. Tasaku (KUM); 3 exs, Sôya, Esashi-tyô, 23 VII 2009, M. Ôhara (KUM); 2 exs, Nemuro, Rausu-tyô, Azabu, 19 IX 2009, M. Ôhara, H. Yamamoto & M. Furuta (KUM).

Description. Head, pronotum, elytra and abdomen almost black; antennae, mouthparts and legs blackish brown and yellowish brown. Head (Fig. 1F) as long as wide. Pronotum slightly transverse, about 1.1 times as wide as long, narrowed posteriorly; postero-lateral corner rounded; surface finely punctured, densely covered with setae, with 7 macrosetae along lateral margin. Scutellum with integument smooth and sparsely covered with setae. Elytra (Fig. 1F) as wide as pronotum; surface finely punctured, densely covered with setae, with 2–3 small macrosetae laterally. Hind wings reduced, about 1/3 as long as elytra. Abdomen oblong, widest around segments VI and VII; surface smooth; tergites II–VII densely covered with setae. Antennae (Fig. 1F) almost as long as head and pronotum combined; antennomere I long; antennomere II shorter than I; antennomere III slightly shorter than II; antennomeres IV–X moniliform, each almost as long as wide; antennomere XI long, almost twice as long as X.

Male. Male tergite VIII (Fig. 4A) densely covered with setae, with 4 pairs of macrosetae. Male sternite VIII (Fig. 4B) rounded on posterior margin, with 8 pairs of macrosetae. Median lobe of aedeagus as in Figs 4F–G; in lateral view (Fig. 4G) apical lobe bent paramerally, much narrowed subapically, sinuate abparamerally and acutely narrowed apically. Paramere (Fig. 4H) with apical lobe of paramerite narrowed slightly.

Female. Female tergite VIII (Fig. 4C) densely covered with setae, with 4 macrosetae on each side; female sternite

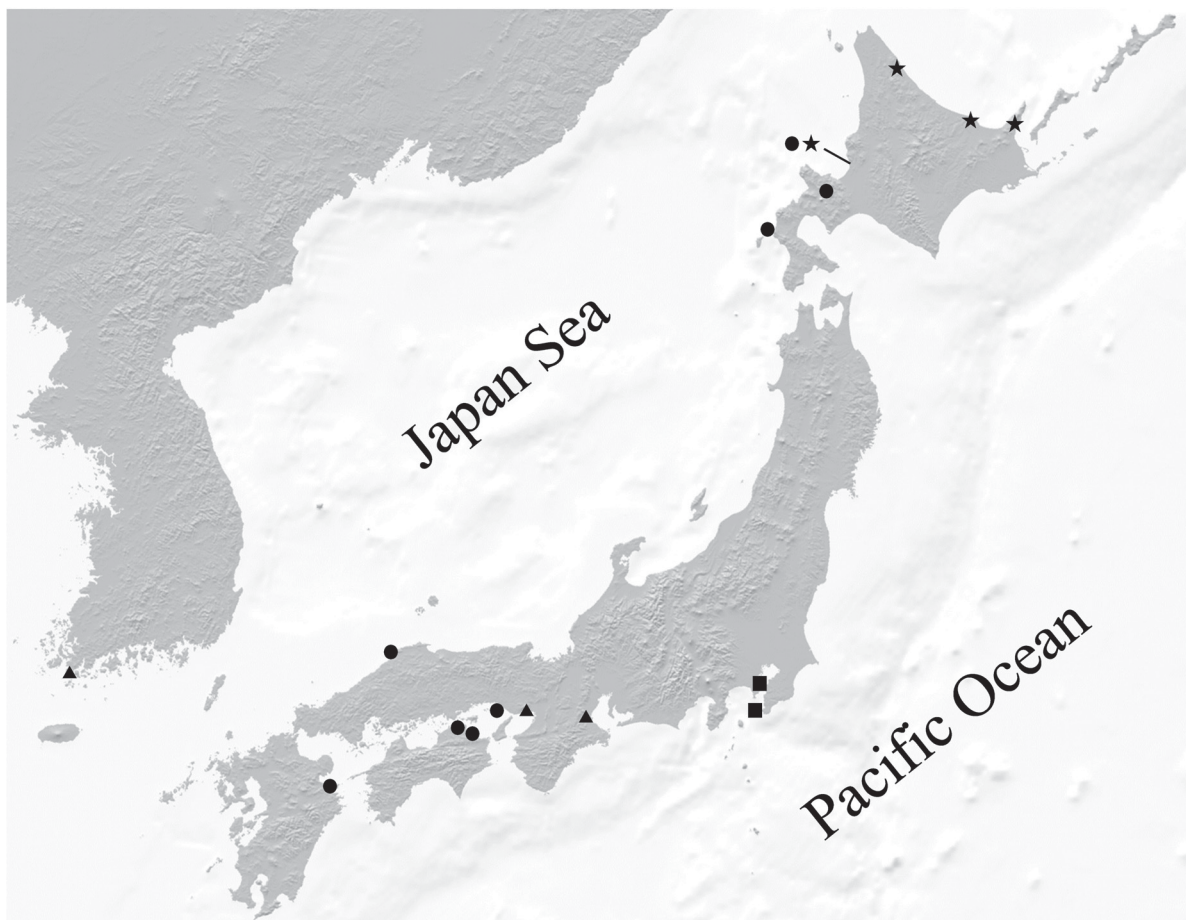


Fig. 5. Known localities of *Eubadura* spp. Black circle – *E. akiensis* (Sawada, 1990); black triangle – *E. yasukoae* (Maruyama, Klimaszewski & Gusarov, 2008); black square – *E. onoi* sp. nov.; black star – *E. hokkaidensis* sp. nov.

VIII (Fig. 4D) rounded on posterior margin, with 6 macrosetae on each side. Spermatheca (Fig. 4E) with basal part of stem once curved at apical and twice curved around base; capsule dilated apically, about 1/4 as long as stem, densely covered with wrinkles on internal side of apical 1/3.

Measurements (mm). Body length ca. 1.90–2.20; fore body length ca. 1.0–1.1; head width 0.36–0.38; pronotal length 0.32–0.38; pronotal width 0.38–0.40.

Differential diagnosis. This species can be distinguished from other *Eubadura* species by its black body color.

Etymology. Named after the type locality. Adjective.

Biology. The beetles were found under supratidal driftwood or seaweeds on sandy and gravel beaches.

Distribution. Japan: Hokkaidô.

Discussion

MARUYAMA et al. (2008) showed that *Osakatheta* can be readily distinguished from other coastal athetine genera by the erect setae covering the whole body. In our morphological study of *Osakatheta* and *Eubadura* species, we found numerous morphological congruences in these genera, and *Eubadura* is also covered with erect setae, although to a lesser extent than *Osakatheta*. The denser erect setae of *Osakatheta* may have evolved from those originally possessed by *Eubadura* to inhabit the mudflats. Therefore, we regard *Osakatheta* as a junior synonym of *Eubadura*. In their molecular phylogenetic study, SONG et al. (2019) showed that *Osakatheta* is distantly related to other intertidal athetine genera. Therefore, *Eubadura* is raised here to the rank of a genus.

Previously, *Eubadura* was only known from the intertidal zone. *Eubadura hokkaidensis* sp. nov. is the first *Eubadura* species to be found under supratidal seaweed and driftwood on sandy beaches and gravel beaches, as also reported for *Atheta (Badura)* (SONG et al. 2019).

SONG et al. (2019) also showed that *Osakatheta* is more closely related to coastal species of the subgenus *Badura* Mulsant & Rey, 1873 of the genus *Atheta*, than other coastal athetine genera. *Eubadura yasukoae* may be unique among *Eubadura* species in that it inhabits coastal mudflats and its whole body is covered with long erect setae. Therefore, it will be necessary to conduct phylogenetic and morphological studies, including *Eubadura* species, which has a similar habitat to *Badura*, to clarify the relationships between *Eubadura* and other coastal athetine species.

Acknowledgements

We wish to express our cordial thanks to Mr. Daisuke Sumikawa, Dr. Masahiro Ôhara, Mr. Takeshi Hayama, Dr. Yasuko Kawakami, Mr. Hiroki Ono, Ms. Tomoko Taki, Mr. Ryôtarô Wakimura for kindly offering the specimens, and Dr. Taro K. Eldredge for critically reviewing the manuscript. This paper is supported by KAKENHI (19H03285) funded to MM.

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