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**TAXONOMIC STATUS OF ENOCHRUS VILIS (SHARP) AND
E. UNIFORMIS (SHARP) (COLEOPTERA, HYDROPHILIDAE)**

By YŪSUKI N. MINOSHIMA

Abstract

MINOSHIMA, Y. N. 2019. Taxonomic status of *Enochrus vilis* (Sharp) and *E. uniformis* (Sharp) (Coleoptera, Hydrophilidae). *Ins. matsum. n. s.* 75: 1–18, 5 figs.

The status of two taxonomically problematic species, *Enochrus* (*Methydus*) *uniformis* (Sharp, 1884) and *E. (M.) vilis* (Sharp, 1884), are studied. *Enochrus vilis* is affirmed as a distinct species and restored from synonymy of *E. (M.) affinis* (Thunberg, 1794). The lectotype of *E. uniformis* is designated. *Enochrus uniformis* and *E. vilis* are redescribed. *Enochrus vilis* exhibits geographical variation in body size and the shape of the median lobe of the aedeagus. Two morphologically differentiated populations of *E. vilis* (northern and southern populations) were detected in Japan. Genetic distance of the COI gene between the specimens collected from Hokkaido (northern population) and Yamaguchi Prefecture (southern population) is 1.67%. Occurrence of *E. affinis* in Japan is confirmed and diagnostic information of the species is provided.

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INTRODUCTION

The water scavenger beetle genus *Enochrus* Thomson, 1859 of the subfamily Enochrinae is one of the most species-rich genera of the family Hydrophilidae (Short & Fikáček, 2011, 2013). Although representatives of the genus are common in various aquatic habitats, the taxonomic study of *Enochrus* has been insufficient as previously mentioned by Schödl (1998). The genus *Enochrus* contains numerous groups of morphologically similar species and very widely distributed species (e.g., Hansen, 1999); these conditions create substantial challenges for taxonomic study of the group. Immature stages of approximately 10% of known *Enochrus* species have been described or illustrated so far (e.g., Archangelsky, 1997; Byttebier & Torres, 2009; Minoshima & Hayashi, 2011).

The aim of this study is to contribute to the knowledge of the genus *Enochrus* as a steppingstone better to understand its taxonomy. Here, I focus on the small-bodied Japanese species of *Enochrus*, *E. (Methydrus) vilis* (Sharp, 1884), *E. (M.) uniformis* (Sharp, 1884) and *E. (M.) affinis* (Thunberg, 1794). They are taxonomically problematic; *E. vilis* was considered as a junior synonym of *E. (M.) affinis* (Jia & Wang, 2010); however, Fikáček *et al.* (2015b) cast doubt on the synonymy. Moreover, identifications of these three species seem to often be incongruence in the literature (e.g., Satô, 1985; Nakane & Matsui, 1986; Lee *et al.*, 1988; Jia & Wang, 2010; Lee & Ahn, 2016).

In this paper, I determine the identity of *E. uniformis* and *E. vilis* based on the type specimens and restore *E. vilis* from synonymy with *E. affinis*. I redescribe *E. uniformis* and *E. vilis*, confirm the occurrence of *E. affinis* in Japan, and provide taxonomically important characters of *E. affinis*.

MATERIAL AND METHODS

Specimens. In this study, I redescribed *E. uniformis* and *E. vilis* based on the type specimens; reliable identified specimens were used for additional source. *Enochrus affinis* was briefly described its taxonomically important characters based on Japanese and European specimens. The following abbreviations are used for specimen depositories: AAIC: Atsushi Aimoto Collection, Hôfu, Japan; HOWP: Hoshizaki Institute for Wildlife Protection, Izumo, Japan (M. Hayashi); KMNH: Kitakyushu Museum of Natural History and Human History, Kitakyushu, Japan (Y. Minoshima); KWC: Kohei Watanabe Collection, Kanazawa, Japan; MMC: Masato Mori Collection, Osaka, Japan; NHM: Natural History Museum, London, United Kingdom (C. Taylor); NIC: Noriaki Inahata Collection, Kyoto, Japan; ROC: Ryôhei Okada Collection, Japan; NMPC: National Museum, Prague, Czech Republic (M. Fikáček); SSC: Shun'ichi Sakurai Collection, Sakata, Japan; SEHU: Systematic Entomology, Hokkaido University, Sapporo, Japan (M. Ôhara); SMNS: Stuttgart State Museum of Natural History, Stuttgart, Germany (A. Faille); TPM: Tochigi Prefectural Museum, Utsunomiya, Japan (T. Kurihara).

Morphological study. Specimens were examined using a Leica MZ16 stereomicroscope and an Olympus BX50 compound light microscope. The dissected parts were cleared by hot 10% KOH solution according the method described in Minoshima *et al.* (2015) or by proteinase K solution (Qiagen DNeasy Blood & Tissue Kit; 20 µl proteinase K and 180 µl Buffer ATL, ca. 48 hours at 55 °C). The parts were subsequently rinsed with 80% ethanol; after that, they were examined in Euparal after

Table 1. List of specimens of *Enochrus vilis* used for molecular analyses with GenBank accession numbers of the COI sequence.

Extraction ID	Locality data	Accession #
YNME#198	JAPAN: Hokkaido, Taiki-chō, Seika, Kimontō-numa, 42.62°N 143.48°E, 10 m; marsh/pond; 20.VIII.2018; YN. Minoshima leg.; Loc. #2018-76. KMNH IR 300,001	LC500139
YNME#203	JAPAN: Yamaguchi Pref., Yamaguchi-shi, Shimo-osaba, Kanōgi, 34.14°N 131.57°E, 370 m; 09.VII.2019; YN. Minoshima leg. Loc. #2019-16. KMNH IR 300,002	LC500140
YNME#205	Same locality as #2019-16. KMNH IR 300,003	LC500141

dehydration or in lactic acid. They were finally mounted in Euparal on small grass slide (Maruyama, 2004) or glued on a paper card with the specimen. A syntype of *E. uniformis* was previously dissected and its aedeagus was already mounted on a card with the specimen. I remounted only the aedeagus from the card by drops of hot water, transferred it into warm water, and then examined in lactic acid. After examination, the aedeagus was rinsed and mounted on the card with isinglass.

Body measurements were taken using a micrometric eyepiece. Body length means approximate length of the whole body, i.e., the length between apexes of the labrum and elytra of well-prepared specimens (e.g., Fig. 1B, D, E, J). Measurements of pronotum and elytra were done for northern and southern populations of *E. vilis*; the abbreviations of measurements used in this study are as follows: PL: length of pronotum in the middle; EL: maximum length of elytra; EW: maximum width of elytra. These measurements were given in text as follows: range (arithmetic mean $\pm$ standard deviation).

Photographs were taken with digital cameras (Olympus OM-D E-M5 Mark II and E-M1 Mark II). Composite images of the specimens were created using the Image Stacking Software Helicon Focus 7 and composite images of the habitat (Fig. 5C) were created using Adobe Lightroom Classic CC. Photos were modified using the Adobe Lightroom and Photoshop CC as necessary. Illustrations were made with the aid of a drawing tube attached to the BX50; line drawings were prepared using the software Paint Tool SAI and the Photoshop.

Regarding the morphological terminology I generally follow Hansen (1991) and Archangelsky *et al.* (2016). Label data of the type series were cited verbatim, using a slash (/) for dividing separate rows and a double slash (//) for dividing separate labels.

Molecular study. A single gene fragment of cytochrome c oxidase I (COI; 658 bp) of *E. vilis* was sequenced. Vouchers are listed in Table 1. Total genomic DNA was extracted from an abdomen or a leg using a Qiagen DNeasy Blood & Tissue Kit following the method described by Cruickshank *et al.* (2001). The methods were generally identical to those described in Minoshima (2018). The COI genes were amplified using the primers LCO1490 and HCO2198 (Folmer *et al.*, 1994). The protocol of PCR was identical to that described in Minoshima *et al.* (2013). PCR products were purified using ExoSAP-IT (Affymetrix, Santa Clara). Each fragment was sequenced using the primers in both directions by Macrogen Japan Corporation, Kyoto. The sequences were assembled and edited manually in MEGA 7.0.26 (Kumar *et al.*, 2016). I used pairwise *p*-distance

analysis to test genetic distance using the MEGA.

RESULTS

Genus *Enochrus* Thomson, 1859

Enochrus is the only genus of the subfamily Enochrinae that occurs in Japan. However, Japanese species of the genus may be similar to those of Acidocerinae, but they are distinguishable by the following characters (see also keys in Minoshima & Fujiwara (2009) and Short & Fikáček (2013)). (1) Second segment of maxillary palpus is curved outwards (Fig. 3H–J), whereas curved inwards in *Helochaeres* Mulsant, 1844 and *Chasmogenus* Sharp, 1882 (e.g., Short, 2010; Clarkson & Ferreira, 2014; Devi *et al.*, 2016) or almost straight and widened towards the apex in *Agraphydrus* Régimbart, 1903 (e.g., Minoshima, 2016). (2) Sutural stria is present in *Enochrus* and *Chasmogenus*, whereas absent in *Agraphydrus* and *Helochaeres*. (3) Mesoventrite is with a longitudinal lamina of variable shape, exceptionally very low in *E. (Methydrus) esuriens* (Walker, 1858) (Short, 2010), whereas acidocerine species have very low to distinct carina (e.g., Minoshima *et al.*, 2015).

Enochrus (Methydrus) affinis (Thunberg, 1794) (Figs 1A, B, 3A, 5A)

Hydrophilus affinis Thunberg, 1794: 73. [Type locality: “Upfaliæ; Veftro-Gothia” (Thunberg, 1794) (Sweden, Västergötland, Uppsala)]

Enochrus (Methydrus) affinis (Thunberg); Orchymont, 1938: 430; Hansen, 1999: 177; Hansen, 2004: 51; Jia & Wang, 2010: 372 [part]; Fikáček *et al.*, 2015a: 59.

Enochrus (Methydrus) vilis (nec. sensu Sharp, 1884); Balfour-Browne, 1946: 458 [as “*Enochrus ? vilis*”]; ?Satô, 1985: 215 [judging from figure, figured specimen of *E. vilis* may be *E. affinis*]; Mitamura *et al.*, 2017: 151.

For detail synonymy, see Hansen (1999).

Material examined. JAPAN: Hokkaido: 1 female, 2 exs. (KMNH, ROC), Koshimizu-chô, Yambetsu, Nikuru-numa pond, 4.VII.2014, R. Okada leg.; 3 females (KMNH, ROC), Shibe-chô, Tôro, 20.IX.2015, R. Okada leg.; 2 males, 3 exs. (KMNH, ROC), Shibe-chô, Tôro, 18.IX.2015, R. Okada leg.; 3 exs. (KMNH), Toyokoro-chô, Horo-oka, pond, 0 m, 42.78°N, 143.56°E, 20.VIII.2018, YN. Minoshima leg., Loc. #2018-74; 2 exs. (TPM), Toyotomi-chô, Sarobetsu-gen'ya, 2.IX.1993, K. Satoh leg.; 1 male (HOWP), Toyotomi-chô, Wakasakanai, 1.VIII.1992, M. Hayashi leg.; 2 males, 4 exs. (KMNH, ROC), Urahoro-chô, Toyokita, 21.IX.2015, R. Okada leg.; 1 ex. (TPM), Wakkanai-shi, 7.XI.1992, S. Ohmomo leg. CZECH REPUBLIC: 1 male (KMNH), Bohemia, Horusice, pískovna, 16.VI.2000, M. Fikáček leg.; 1 ex. (KMNH), Moravia, Radostín, 618 m, peat bog, 7.VI.2001, M. Fikáček leg.; 1 ex. (NMPC), Moravia, M. Valtice - Alach, 8.V.1999, M. Fikáček leg. GERMANY: 1 male, 1 ex. (SMNS), Free State of Bavaria, Südbayern, Gut Königreich, 29.VI.1961, H. Schaefflein leg.; 4 males, 5 exs. (SMNS), Baden-Württemberg State, Beuren, Isny im Allgäu, Taufachmoos, 16.VI.1973, E. Ulbrich leg.; 2 males (SMNS), Baden-Württemberg State, Beuren, Allgäu, 17.VI.1973, G. Scheel leg.; 2 males, 3 exs. (SMNS), Baden-Württemberg State, Bad Wurzach, Württemberg, Wurzacher Ried, 18.IV.1985, Löderbusch leg. RUSSIA: 1 ex. (SMNS), Siberian Federal District, Novosibirsk, Umg.

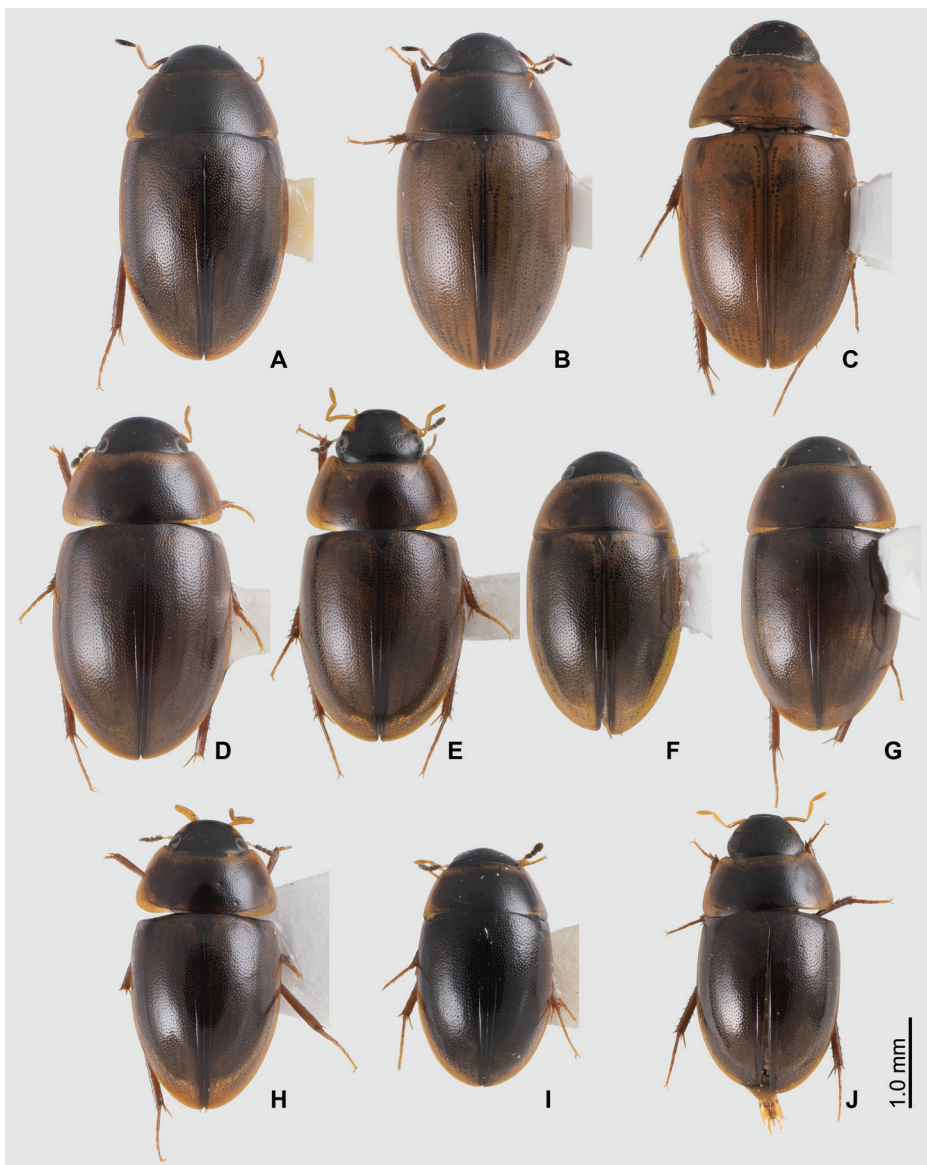


Fig. 1. Dorsal habitus. A, B, *Enochrus affinis*, Hokkaido; C, *E. uniformis*, Nagoya, Honshu; D–J, *E. vilis*; D, E, specimen from Hokkaido, Tomakomai-shi, Lake Utonai-ko; F, from Hokkaido, Taiki-chô, Seika, Kimontô-numa, 42.62°N 143.48°E, 10 m alt.; G, from Aomori Pref., Higashidôri-mura, Odanosawa, Aranuma; H, Fukushima Pref., Iwaki-shi, Kawamae-machi, Ojiroi, Seisai; I, Hyogo Pref., Sanda-shi, Saraike-shitsugen; J, Okayama Pref., Maniwa-shi, Hiruzen-shitao.

Akademgorodok, 23–31.V.1985, M. Schawaller leg.

Diagnosis. Rather small species (3.1–3.9 mm); elytra reddish brown to brown (Fig. 1A, B). Maxillary palpus bicoloured; apical segment of maxillary palpus black; basal half of palpomere 2 blackish to slightly infusate, often very indistinct; remaining parts brownish yellow (Fig. 1A, B). Ground punctures on pronotum and elytra coarse, densely arranged. Serial punctures on elytra almost indistinguishable from ground punctures. Mesoventrite with longitudinal lamina bearing apical small beak-like process. Aedeagus (Fig. 3A): Median lobe slender, as long as paramere, tapering apicad. Parameres ca. as long as phallobase, gradually narrowing apicad, suddenly curved outwards at apex.

Comparison. This species is easily distinguished from *E. uniformis* and *E. vilis* by a uniformly blackish apical maxillary palpomere, ground punctures on elytra, and the shape of aedeagus. The colouration of maxillary palpus resembles that of the European species *E. (M.) nigrinus* (Sharp, 1872); however, the apex of the paramere of *E. nigrinus* is straight.

Description of taxonomically important characters. Body length 3.1–3.9 mm, width 1.5–1.9 mm. Body (Fig. 1A, B) oblong-oval, moderately convex. Colour (Fig. 1A, B). Dorsal surface of head entirely black; lateral part of clypeus often yellowish. Pronotum reddish brown with pale lateral and anterior margins. Elytra paler than pronotum, variable in colour, reddish brown to yellowish brown. Four blackish spots on median part of pronotum usually very indistinct, undetectable. Maxillary palpus bicoloured; apical segment of maxillary palpus black to dark reddish brown; basal half of palpomere 2 blackish to slightly infusate, often very indistinct; remaining parts brownish yellow. Head. Labrum with rather fine, densely arranged ground punctures; systematic punctures on labrum composed of a few setiferous punctures. Clypeus and frons with coarse and densely arranged ground punctures. Frontoclypeal sulcus fine. Systematic punctures on clypeus indistinct, bearing fine setae. Systematic punctures of frons on anterior and lateral parts close to compound eye and frontoclypeal sulcus.

Thorax. Ground punctures on pronotum coarse, densely arranged. Ground punctures on elytra coarse, densely arranged. Elytra with very indistinct setiferous punctures which slightly larger than ground punctures; these punctures possibly systematic punctures or longitudinal serial punctures. Mesoventrite with longitudinal mesoventral lamina posteromesally; the lamina subtriangular shape with small beak-like process apically.

Abdomen. Aedeagus (Fig. 3A): Median lobe slender, as long as paramere, tapering apicad, almost parallel-sided in apical third; apex of median lobe rounded. Corona present in midlength of aedeagus. Parameres gradually narrowing apicad, with suddenly outcurved apex. Phallobase nearly parallel-sided with suddenly narrowing manubrium, ca. as long as paramere; manubrium oval, ca. as long as two-fifth of whole phallobase.

Ecology. Aquatic species. They were generally collected from standing water (Fig. 5A).

Distribution. Japan (Hokkaido). Widely distributed in Palaearctic region: from West Europe to East Asia (Hansen, 1999; Jia & Wang, 2010; Fikáček *et al.*, 2015a).

Enochrus (Methydus) uniformis (Sharp, 1884)
(Figs 1C, 2A–C, H, I, 3B, C, H)

Philydrus uniformis Sharp, 1884: 453. [Type locality: Japan, Honshu Island, Kanagawa Prefecture, Yokohama.]



Fig. 2. Habitus and labels of type specimen of *Enochrus uniformis* and *E. vilis*. A–F, Type specimens; H–J, labels. A–C, *Enochrus uniformis*, lectotype; A, laterodorsal view; B, lateral view; C, ventral view. D–G, *Enochrus vilis*, holotype; D, dorsal view; E, lateral view; F, ventral view; G, detail of maxillary palpus, ventral view. H, *Enochrus uniformis*, lectotype; I, locality label of a syntype (see the section “Lectotype designation” in *E. uniformis*), J. *E. vilis*, holotype.

Enochrus (Lumetus) uniformis (Sharp); Zaitzev, 1908: 390; Knisch, 1924: 216; Nakane, 1963: 65 [diagnosis].

Enochrus (Methydrus) uniformis (Sharp); Nakane, 1963: 65 [figured specimen is not *E. uniformis*; description of the species indicates right identification]; Nakane & Matsui 1986: 81; Hansen, 1999: 188; Hansen, 2004: 51; Fikáček *et al.*, 2015a: 60.

Enochrus uniformis (nec. sensu Sharp, 1884); ?Satô, 1985: 215.

Enochrus (Methydrus) uniformis (nec. sensu Sharp, 1884); Lee *et al.*, 1988: 75; Lee & Ahn, 2016: 341.

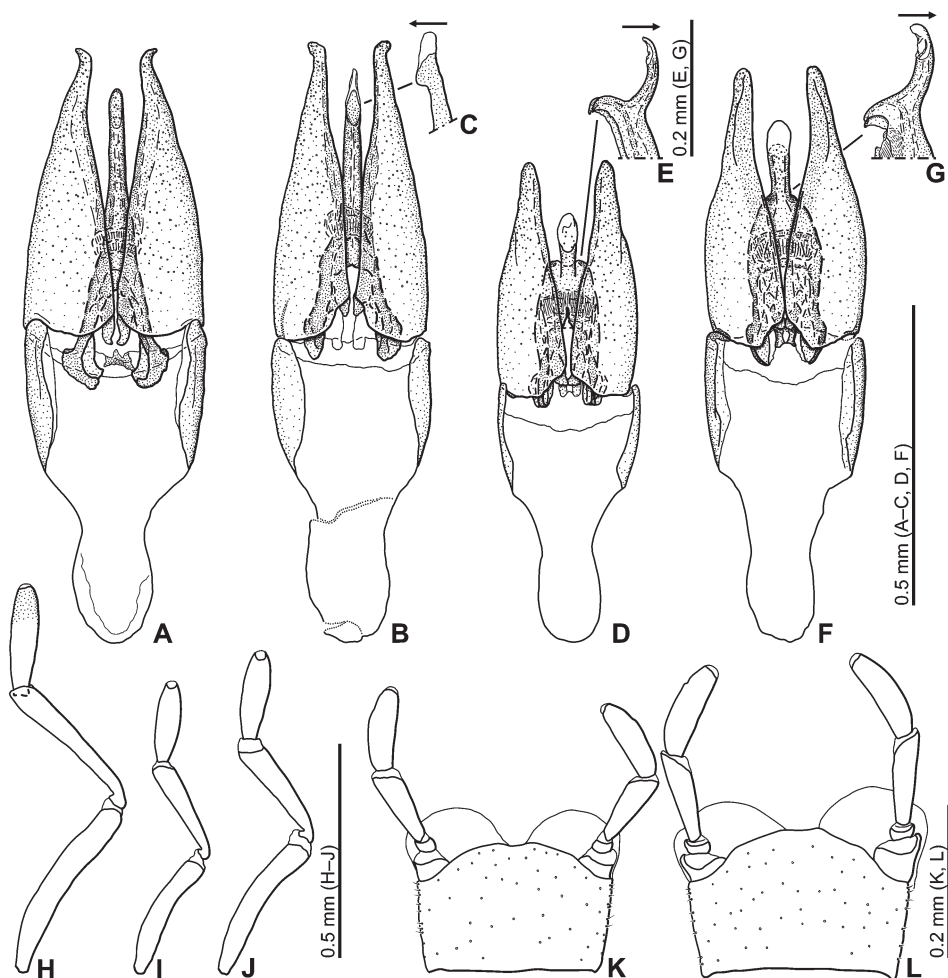


Fig. 3. Aedeagus, maxillary palpus and mentum. A–G, Aedeagus; A, B, D, F, whole aedeagus, dorsal view; C, E, G, apex of median lobe, lateral view, corona omitted in Fig. E, arrows indicate dorsal direction. A, *Enochrus affinis*; B, C, *E. uniformis*, lectotype; D–G, *E. vilis*, southern (D, E), northern (F, G) populations. H–J, Maxillary palpus; H, *E. uniformis*; I, J, *E. vilis*, southern (I), northern (J) populations. K, L, *Enochrus vilis*, mentum, ventral view, southern (K), northern (L) populations.

Type material examined. Lectotype (here designated). JAPAN: Honshu: Kanagawa Prefecture: male (NHM), "Co-" / "type" // "Japan." / "G.Lewis." / "1910–320." // "LECTOTYPUS" / "Philydrus" / "uniformis Shp." / "des. Schödl 1997" // "LECTOTYPE" / "PHILYDRUS" / "uniformis" / "Sharp, 1884" / "des. YN Minoshima 2018". Paralectotype: JAPAN: Honshu: Kanagawa Prefecture: 1 ex. (NHM), "Philydrus" / "uniformis" / "TypeD.S." / "Japan. Lewis" [written on card with specimen] // "Type" // "Japan" / "G. Lewis" // "Sharp Coll" / "1905-313" // "PARALECTOTYPUS" / "Philydrus" / "uniformis Shp." / "des. Schödl 1997"

// "PARALECTOTYPE" / "PHILYDRUS" / "uniformis" / "Sharp, 1884" / "des. YN Minoshima 2018"

Note on lectotype designation. On my request to loan the type series of *Philydrus uniformis* for NHM, I received two specimens; one specimen had a lectotype label attached (Fig. 2H), and the other had a paralectotype label. These labels were attached by Stefan Schödl (1957–2005), but the lectotype of the species has never been officially designated until now. As the morphology of aedeagus is crucial for reliable identification, I herein designate a male syntype as the lectotype to fix the identity of the species. When I received the syntypes from NHM, a label of a syntype “Yokohama” was already detached, and the label was in a capsule which was then pinned with a label written as “loose in tray” (Fig. 2I). According to Lee & Ahn (2016), this label may belong to the male syntype, which is the lectotype here designated, and was attached below the label “cotype” (Fig. 2H).

Additional material examined. JAPAN: Honshu: Aichi Prefecture: 1 male (SEHU), Nagoya-shi, Chikusa-ku, Kakuôsan, 10–20.VIII.1947, T. Nakane leg.; 1 male (SEHU), Nagoya-shi, Higashiyama, 18–20.IV.1948, No collector data; 1 ex. (SEHU), Nagoya-shi, Higashiyama, 7.V.1948, S. Osawa [?] leg. Gifu Prefecture: 1 male, 1 ex. (SEHU), “Gifu”, 28.VIII.1945, K. Ohbayashi leg., *Enochrus uniformis*, T. Nakane det.

Diagnosis. Rather small species. Maxillary palpus bicoloured (Figs 2A–C, 3H), as long as width of head; apex of apical palpomere darkened. Ground punctures on pronotum and elytra coarse, densely arranged. Serial punctures on elytra almost indistinguishable from ground punctures. Mesoventrite with longitudinal mesoventral lamina bearing apical small beak-like process. Aedeagus (Fig. 3B, C): Median lobe slender, as long as paramere, tapering apicad from dorsal view; apex with securiform-like projection from lateral view. Corona on median part. Parameres gradually narrowing apicad, suddenly curved outwards at apex. Phallobase as long as paramere.

Comparison. This species is distinguished from *E. affinis* and *E. vilis* by infusate apex of maxillary palpus and characters of aedeagus. Within the Japanese species, the darkened apex of maxillary palpus resembles that of *E. esuriens* (Walker, 1858), which is distinguishable by body size (*E. esuriens* smaller than *E. uniformis*), mesoventral lamina (the lamina is very low in *E. esuriens*), and characters of aedeagus.

Redescription. Body length 3.5–4.0 mm, width 2.0–2.1 mm. Body (Figs 1C, 2A–C) oblong-oval, moderately convex. Colour (Figs 1C, 2A–C): Colouration of dorsal surface yellowish brown, head black with yellowish lateral margin of clypeus. Median part of pronotum with four blackish spots forming rectangle. Antenna and labial palpus uniformly light brownish yellow with infusate antennal club. Maxillary palpus bicoloured (Fig. 3H); palpus brownish yellow and apex of apical palpomere darkened. Ventral surface dark reddish brown. Tibia and tarsus light in colour.

Head: Labrum with rather fine, densely arranged ground punctures; systematic punctures on labrum composed of a few setiferous punctures. Clypeus and frons with coarse and densely arranged ground punctures. Frontoclypeal sulcus fine. Systematic punctures on clypeus indistinct, bearing fine setae. Systematic punctures of frons on anterior and lateral parts close to compound eye and frontoclypeal sulcus. Antenna with nine antennomeres. Pedicel conical, as long as antennomere 3–5 combined; antennomere 6 as wide as antennomere 7; antennal club distinctly longer than antennomere 2–6 combined. Maxillary palpus (Fig. 3H) rather long, as long as width of head. Palpomere 2 shorter than palpomeres 3 and 4 combined. Length of palpomere 3 four-fifths of

palpomere 2; palpomere 4 two-thirds of palpomere 3. Labial palpus as long as width of mentum. Mentum ca. 1.6 times as wide as long; punctures on mentum fine, moderately densely arranged.

Thorax: Ground punctures on pronotum coarse, densely arranged. Systematic punctures on pronotum very indistinct, on antero- and posterolateral parts, composed of an irregular transverse row of setiferous punctures. Prosternum weakly tectiform medially. Ground punctures on elytra coarse, densely arranged. Elytra with very indistinct setiferous punctures which slightly larger than ground punctures; these punctures possibly systematic punctures or longitudinal serial punctures. Mesoventrite with longitudinal mesoventral lamina posteromesally; the lamina slightly rounded subtriangular shape with small beak-like process apically from lateral view. Metaventrite with mesal elevated portion having oblong oval glabrous area medially. Profemoral pubescence in basal three-fourths, meso- and metafemoral pubescence in basal four-fifths.

Abdomen: Abdominal ventrites densely covered with fine pubescence. Ventrite 5 with small apical incision. Aedeagus (Fig. 3B, C): Median lobe slender, as long as paramere, tapering apicad from dorsal view, membranous at apex, with moderately short basal apophysis which ca 0.3 times as long as whole median lobe. Apex of median lobe securiform-like from lateral view (Fig. 3C). Corona moderate in size, on median part. Parameres gradually narrowing apicad, suddenly curved outwards at apex. Phallobase parallel-sided with suddenly narrowing manubrium, as long as paramere; manubrium ca. as long as half of whole phallobase, ca. half of width of anterior part of phallobase.

Distribution. Japan (Honshu; ?Nansei-shotô Islands); ?Far East Russia, ?South Korea (Fikáček *et al.*, 2015a). At least, the occurrence in the Nansei-shotô Islands (Japan) and South Korea need to be reconfirmed (see Remarks).

Enochrus uniformis have been recorded from Honshu to the Nansei-shotô Islands in Japan (Satô, 1985; Nakane & Matsui, 1986). Although I cannot exclude the possibility that this species occurs in the Nansei-shotô Islands, specimens from these islands bear finer ground punctures on the elytra than *E. uniformis* and *E. vilis* in the specimens I have examined (e.g., Kamite & Aoyagi, 2018; Minoshima, pers. obs.); hence, I consider that they are a different species from *E. uniformis*.

Ecology. Unknown. Presumably aquatic species.

Remarks. This species was described based on specimens collected from Yokohama, Kanagawa Prefecture, Honshu Island (Sharp, 1884). Nakane (1963) mentioned dark apex of maxillary palpomere 4 (this character delimits *E. uniformis* from *E. vilis* and *E. affinis*) in the diagnosis but the figured specimen preserved in SEHU is not *E. uniformis*. On the other hand, judging from the figure, the aedeagus illustrated in Nakane & Matsui (1986) is correctly identified. This species was also recorded from South Korea (Hansen, 1999). Judging from the papers on Korean *E. uniformis* (Lee *et al.*, 1988; Lee & Ahn, 2016), figured specimens are similar to *E. vilis* rather than *E. uniformis*.

Enochrus (Methydrus) vilis (Sharp, 1884) stat. restit.
(Figs 1D–J, 2D–F, J, 3D–G, I–L, 4, 5B, C)

Philydrus vilis Sharp, 1884: 453. [Type locality: Japan, Hokkaido Island, Sapporo.]

Enochrus (Lumetus) vilis (Sharp); Zaitzev, 1908: 390; Knisch, 1924: 216.

Enochrus (Methydrus) vilis (nec. sensu Sharp, 1884); Balfour-Browne, 1946: 458 [*E. affinis* as

"*Enochrus (Methydus) ? vilis*".
Enochrus vilis (nec. sensu Sharp); Satô, 1985: 215 [figured specimen may be *E. affinis*]; Mitamura *et al.*, 2017: 151 [*E. affinis*].
Enochrus (Methydus) vilis (Sharp, 1884); Nakane & Matsui 1986: 80; Hansen, 1999: 188; Hansen, 2004: 51.
?*Enochrus (Methydus) uniformis* (nec. sensu Sharp, 1884); Lee *et al.*, 1988: 75; Lee & Ahn, 2016: 341.
Enochrus (Methydus) affinis (Sharp); Jia & Wang, 2010: 372 [synonymized with *E. affinis*]; Fikáček *et al.*, 2015a: 59.

Type material examined. Holotype. Japan: Hokkaido: female (NHM), "♀" // "Type" // "Sapporo." / 5.VIII.-16.VIII.80." // "Japan." / "G.Lewis." / "1910—320." // "Philydrusvilis" / "TypeD.S" // "Holotype" / "Philydrus" / "vilisShp. 1884" / "Schödl des. 1996" [Sharp (1884) mentioned that he examined a single specimen to describe this species. Therefore, the type specimen is considered as the holotype]

Additional material examined. JAPAN: Hokkaido: 1 male, 1 ex. (SEHU), Hamanaka-chô, Wakayama-numa, 26.VI.1981, K. Ijima leg.; 1 ex. (SEHU), Kushiro-chô, Hosooka, 14.VI.1992, Yamakawa leg.; 2 exs. (KMNH), Kushiro-shi, Hokuto, shallow puddle, 20 m, 43.06°N, 144.32°E, 19.VIII.2018, YN. Minoshima leg., Loc. #2018-72; 1 male, 3 exs. (KMNH, ROC), Nemuro-shi, Ochiishi, 19.IX.2015, R. Okada leg.; 1 female (KMNH), Shibechea-chô, Lake Tôro-ko, 30.VIII.2002, T. Ito leg.; 2 males, 10 exs. (KMNH), Taiki-chô, Seika, Kimontô-numa, marsh/pond, 10 m, 42.620°N, 143.480°E, 20.VIII.2018, YN. Minoshima leg., Loc. #2018-76; 1 male, 1 female, 3 exs. (KMNH), Tomakomai-shi, Lake Utonai-ko, 18.V.2006, K. Watanabe leg.; 1 ex. (KMNH), Wakkanai-shi, Kabaoka, 13.VIII.1997, S. Sakurai leg.; 1 ex. (TPM), Wakkanai-shi, Meguma-numa marsh, 3.IX.1993, K. Satoh leg. Honshu: Aomori Prefecture: 1 male, 1 female (HOWP), Higashidôri-mura, Odanosawa, Aranuma, 13.VIII.1996, M. Hayashi leg.; 1 male (HOWP), Higashidôri-mura, Oori, Hayakakedaira, 14.VIII.1996, M. Hayashi leg.; 2 males (SEHU), Tsugaru-shi, Kokeyachi, 23.VIII.1991, A. Abe leg. Fukushima Prefecture: 1 male (HOWP), Iwaki-shi, Kawamae-machi, Ojiroi, Seisai, 6.VI.2009, T. Mitamura leg. Hiroshima Prefecture: 1 male (HOWP), Geihoku-chô, Shimokobara, 24.V.1992, M. Hayashi leg.; 1 male (HOWP), Kure-shi, Kawajiri-chô, Mt. Norosan, 27.IX.1998, Y. Akiyama leg. Hyogo Prefecture: 2 males, 3 exs. (KMNH, NIC), Kasai-shi, Abiki-chô, Abiki-shitsugen, Dai'ni-shitchi, marsh, 3.V.2017, N. Inahata leg.; 1 female (HOWP), Kasai-shi, Aonogarah, Sakaetani-ike, 34°53'N, 134°54'E, 4.VII.1994, M. Hayashi leg.; 1 male, 1 female, 1 ex. (KMNH, MMC), Ono-shi, Aonogahara, 13.X.2013, M. Mori leg.; 8 males, 3 females (KMNH, NIC), Sanda-shi, Shimoaino, Saraike-shitsugen, marsh, 16.IX.2016, N. Inahata leg.; 2 males (KMNH, NIC), Sanda-shi, Saraike-shitsugen, B-shitchi, marsh, 2.V.2016, N. Inahata leg. Iwate Prefecture: 1 female (KMNH), "Iwate-ken", 15.V.2009. Nagano Prefecture: 1 ex. (HOWP), Shinano-machi, Ookubo-ike, 25.V.1995, M. Hayashi leg. Okayama Prefecture: 8 males, 4 females (KMNH, KWC), Maniwa-shi, Hiruzen-shitao, 19.V.2016, K. Watanabe leg.; 1 male, 1 ex. (KWC), same locality, 19.V.2013, K. Watanabe leg.; 1 female (KWC), Setouchi-shi, Ushimado-chô, Ushimado, 7.VI.2017, K. Watanabe leg.. Shiga Prefecture: 3 males, 1 female, 1 ex. (HOWP, KMNH), Kôka-shi, Shigaraki-chô, Kinose, 3.X.2005, N. Kawase leg. Tochigi Prefecture: 1 female (TPM), Nasu-karasuyama-shi, Umayakubo, 27.IV.1991, H. Ohkawa leg.; 1 ex. (TPM), Nikkô-shi, Kiwadashima, Benten-numa, pond, 18.V.1991, H. Ohkawa leg.; 1 female, 1 ex. (TPM), Utsunomiya-shi, Nagaoka-chô, 7.VII.1995, K. Satoh leg.; 1 male, 2 exs. (TPM), Utsunomiya-shi, Tsuruta-machi, Shagekijô-atochi, 15.VII.1993, K. Satoh leg.; 3 males, 3 exs. (TPM), same locality, marsh, 19.V.1994, K. Satoh leg.; 1 ex. (TPM), Utsunomiya-shi, Tsuruta-numa, 24.VI.1998, K. Sato leg. Yamagata Prefecture: 1 female (SSC), Sakegawa-

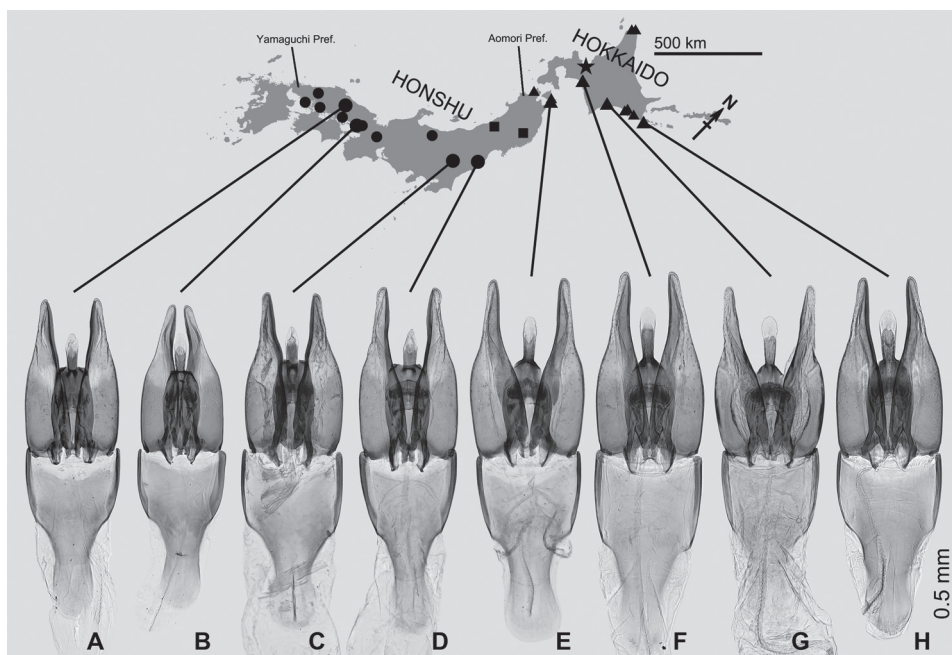


Fig. 4. Distributional map and aedeagus of *E. vilis* in Japan, based on examined specimens. A–H, Aedeagus, dorsal view. A, specimen from Okayama Pref., Maniwa-shi, Hiruzen-shitao; B, Hyogo Pref., Kasai-shi, Abiki-shitsugen; C, Tochigi Pref., Utsunomiya-shi, Tsuruta-machi; D, Fukushima Pref., Iwaki-shi, Kawamae-machi, Ojiroi; E, Aomori Pref., Higashidôri-mura, Odanosawa, Aranuma; F, Hokkaido, Tomakomai-shi, Lake Utonai-ko; G, Hokkaido, Taiki-chô, Seika, Kimontô-numa; H, Hokkaido, Nemuro-shi, Ochiishi. Symbols: star: type locality; triangle: northern population; circle: southern population; square: population uncertain (male specimen not available).

mura, 27.VII.2000, S. Sakurai leg.; 1 female (SSC), Mamurogawa-machi, 9.V.2006, S. Sakurai leg. Yamaguchi Prefecture: 1 ex. (HOWP), Ube-shi, Tsumazakikaisaku, Kojima, 13.V.2002, K. Kawano leg.; 4 males, 2 females (KMNH, AAIC), Yamaguchi-shi, Shimo-osaba, Kanôgi, 34.14°N, 131.57°E, 2.X.2018, A. Aimoto leg.; 1 male, 1 female, 3 exs. (KMNH), same locality, 9.VII.2019, YN. Minoshima leg., Loc. #2019-16.

Diagnosis. Rather small species. Maxillary palpus uniformly light brownish yellow, three-fourths of width of head (Figs 2G, 3H, J). Ground punctures on pronotum and elytra coarse, densely arranged (Fig. 2D, E). Setiferous punctures on elytra (systematic or serial punctures) almost indistinguishable from ground punctures. Mesoventrite with longitudinal mesoventral lamina bearing apical small beak-like process. Aedeagus (Figs 3D–G, 4): Median lobe stout, shorter than paramere, bottle shaped with long and narrow basal apophysis; apex of median stout part with a pair of ventral hooks. Corona present on median part. Parameres nearly straight to very weakly incurved, stout in basal half, distinctly narrowing apicad in apical half. Phallobase as long as or slightly longer than paramere.

Comparison. *Enochrus vilis* is distinguishable from *E. affinis* and *E. uniformis* by



Fig. 5 Habitat of *Enochrus* species. A, Collecting locality of *E. affinis* in Hokkaido, Toyokoro-chô, Horo-oka. B, C, Collecting locality of *E. vilis* in Hokkaido (northern population); B, Kushiro-shi, Hokuto; C, Taiki-chô, Seika, Kimontô-numa.

the uniformly yellowish maxillary palpus and the morphology of aedeagus.

Redescription. Body length 3.1–4.0 mm in northern population (Hokkaido and Aomori Prefecture), 2.8–3.4 mm in southern population (Fukushima to Yamaguchi Prefectures). Measurements: Northern population: Male ($n = 10$): PL: 0.75–0.81 (0.78 ± 0.02) mm; EL: 2.05–2.30 (2.16 ± 0.08) mm; EW: 1.76–2.03 (1.88 ± 0.09) mm. Female ($n = 7$): PL: 0.76–0.88 (0.82 ± 0.04) mm; EL: 2.18–2.45 (2.31 ± 0.11) mm; EW: 1.85–2.02 (1.95 ± 0.07) mm. Southern population: Male ($n = 12$): PL: 0.62–0.75 (0.67 ± 0.04) mm; EL: 1.79–2.10 (1.90 ± 0.10) mm; EW: 1.37–1.7 (1.6 ± 0.10) mm. Female ($n = 8$): PL: 0.68–0.81 (0.75 ± 0.04) mm; EL: 1.92–2.24 (2.10 ± 0.11) mm; EW: 1.63–1.95 (1.77 ± 0.10) mm.

Body (Figs 1D–J, 2D–F) oblong-oval, moderately convex (Fig. 2D, E). Colour: Dorsal surface of head black, lateral part of clypeus yellowish; colouration of pronotum and elytra variable, dark reddish brown to yellowish brown; margins of pronotum, and lateral margin of elytra yellowish (Figs 1D–J, 2D, E). Median part of pronotum with indistinct four blackish spots forming rectangle, often very indistinct or undetectable. Antenna, maxillary and labial palpi uniformly light brownish yellow with infuscate antennal club (Fig. 2F, G). Ventral surface (Fig. 2F) dark reddish brown to brown. Tibia and tarsus light in colour.

Head: Labrum with rather fine, densely arranged ground punctures; systematic

punctures on labrum composed of a few setiferous punctures. Clypeus and frons with coarse and densely arranged ground punctures. Frontoclypeal sulcus fine. Systematic punctures on clypeus indistinct, bearing fine setae. Systematic punctures of frons on anterior and lateral parts close to compound eye and frontoclypeal sulcus. Antenna with nine antennomeres. Pedicel conical, as long as antennomere 3–6 combined; antennomere 6 as wide as antennomere 7; antennal club distinctly longer than antennomere 2–6 combined. Maxillary palpus (Fig. 3I, J) as long as ca. 0.8 times of width of head. Approximate ratio of palpomeres 2:3:4 = 1:0.8:0.6. Mentum ca. 1.6 times as wide as long; punctures on mentum fine, rather densely arranged. Labial palpus slightly shorter than width of mentum.

Thorax: Ground punctures on pronotum coarse, densely arranged. Systematic punctures on pronotum indistinct, on antero- and posterolateral parts, composed of an irregular transverse row of setiferous punctures. Prosternum weakly tectiform medially. Ground punctures on elytra coarse, densely arranged. Elytra with very indistinct setiferous punctures which slightly larger than ground punctures; these punctures possibly systematic punctures or longitudinal serial punctures. Mesoventrite with longitudinal mesoventral lamina posteromesally; the lamina subtriangular shape with small beak-like process apically from lateral view (holotype not bearing beak-like process, maybe broken or worn down). Metaventrte with mesal elevated portion having oblong oval glabrous area medially. Pro-, meso-, and metafemoral pubescence in ca. basal four-fifths.

Abdomen: Abdominal ventrites densely covered with fine pubescence. Ventrite 5 with small apical incision. Aedeagus (Figs 3D–G, 4): Median lobe bottle shaped with rather long basal apophysis; apex of median lobe membranous, rounded. Apex of median stout part of median lobe with a pair of ventral hook-like projection projecting ventrally and slightly posteriorly, oblique from dorsal/ventral views in northern population (Figs 3F, G, 4E–H), truncate and often with slight median incision in southern population (Figs 3D, E, 4A–D). Corona large, situated medially. Parameres nearly straight to very weakly incurved towards apex, weakly curved dorsad, stout in basal half, distinctly narrowing apicad in apical half. Phallobase parallel-sided to slightly narrowing, with suddenly narrowing manubrium, as long as or slightly longer than paramere; manubrium oblong oval, slightly narrower than half of width of anterior part of phallobase.

Ecology. Aquatic species. They were generally collected from standing water (Fig. 3B, C).

Genetic variation. Genetic distance (*p*-distance) of the COI gene between specimens from Hokkaido and Yamaguchi Prefecture is 1.67 % (Table 2; see also Fig. 4 for the position of the prefectures). The two specimens collected from the same locality in Yamaguchi Prefecture are identical.

Distribution. Japan (Hokkaido, Honshu). The Chinese record should be reconfirmed (see below).

The first Chinese record of the species is by Balfour-Browne (1946) (Gentili *et al.*, 1995; Hansen, 1999), who recorded a single male specimen from Zalantun, Inner Mongolia. He mentioned as “*Enochrus (Methydrus) ? vilis*” and “the apical segment of the maxillary palpi distinctly infusate, that of the type being quite testaceous” (after Balfour-Browne, 1946). As a black apical segment of the maxillary palpus is characteristic of *E. affinis* and *E. nigrinus* (Hansen, 1987) and only *E. affinis* was recorded from China and its adjacent areas, I consider the specimen to be *E. affinis*.

Table 2. Pairwise between sequence in analysis expressed as a percentage of nucleotide differences (*p*-distance).

	1	2
1 <i>Enochrus vilis</i> YNME#198 (Hokkaido)		
2 <i>E. vilis</i> YNME#203 (Yamaguchi Pref.)	1.67%	
3 <i>E. vilis</i> YNME#205 (Yamaguchi Pref.)	1.67%	0.00%

This species has not been recorded from South Korea. The figured specimens in the previous research (Lee *et al.*, 1988; Lee & Ahn, 2016) are very similar to *E. vilis* (see also Remarks of *E. uniformis*). There are similar species to *E. vilis* in continental East Asia (e.g., *E. (M.) amurensis* Hebauer, 1995 and *E. (M.) fretus* Orchymont, 1932; Jia & Wang, 2010), I retain identification only based on the figured specimens.

Remarks. *Enochrus vilis* was described based on a single female specimen “in very bad condition” collected in Sapporo, Hokkaido Island (Sharp, 1884) (Fig. 4, star) and have been confused with *E. uniformis* and *E. affinis*. In the key to the species of Japanese *Enochrus* by Nakane & Matsui (1986), *E. vilis* and *E. uniformis* were distinguished by the presence or absence of a “regular row of punctures” on the pronotum (i.e., systematic punctures on pronotum). Although the systematic punctures are extremely indistinct especially on the type specimens, the setiferous punctures were observed in both species; this character therefore does not work to separate these species. Satô (1985) followed this diagnostic character; however, the figured specimen seems to have a black apical segment of the maxillary palpus. Thus, the specimen in Satô (1985) may be *E. affinis*. Later, *E. vilis* was synonymized with *E. affinis* by Jia & Wang (2010). Re-examination of the holotype of *E. vilis* revealed that its maxillary palpus is uniformly pale in colour as Balfour-Browne (1946) mentioned; the holotype of *E. vilis* therefore does not fit with *E. affinis*. Based on that fact, I herein restore *E. vilis* from the synonymy of *E. affinis*.

Enochrus vilis is morphologically variable and contains two populations, which are tentatively referred to as northern (Hokkaido and Aomori Prefecture) and southern (Fukushima to Yamaguchi Prefecture) populations (Fig. 4) in this paper. The borderline between these populations is expected to be in Tohoku region in northern Honshu, but more specimens from the region are required to confirm this hypothesis. Currently, these two populations do not seem to be sympatric.

Body size of the northern population is generally larger than southern population. Most significantly, shape of apex of stout part of median lobe (i.e., ventral hooks) clearly separates this species into northern (Figs 3F, G, 4E–H) and southern (Figs 3D, E, 4A–D) populations. The character is constant within each population, whereas no other qualitative differences were found between populations. The hooks are situated in front of the ejaculatory duct and may have a functional importance for copulation. As the difference between “little” and “big” differences of the aedeagus are often subjective, I cannot rule out that the difference of the hooks strongly affect copulation even though there is a little difference.

The genetic distance is an additional source to consider taxonomic status of the population. The *p*-distance of a fragment of COI gene between specimens from

Hokkaido and Yamaguchi Prefecture (the direct distance is ca. 1,400 km; see map in Fig. 4) was 1.67%. This value does not positively support separation of these populations into two species. In this study, I sequenced only three specimens, from two localities. To fully evaluate these populations based on molecular evidence, it is essential to sequence specimens from extensive regions.

Consequently, there is not strong evidence to separate population as species so far, I conservatively conclude that local populations will be better rather than species or subspecies rank. Extensive studies on the populations of *E. vilis* are essential to further illuminate the taxonomy of the species.

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