First record of the predatory stink bug species *Picromerus griseus* (Dallas) (Hemiptera, Heteroptera, Pentatomidae, Asopinae) in Japan, with an illustrated key to the Japanese species of the genus *Picromerus* Amyot & Serville

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Abstract

Background

The predatory stink bug genus *Picromerus* Amyot & Serville, 1843 (Hemiptera, Heteroptera, Pentatomidae, Asopinae) comprises 11 species found in the Northern Hemisphere. In Japan, two species have been recorded to date. However, an easy-to-understand identification method, such as an illustrated key, is lacking. Currently, *Picromerus griseus* (Dallas, 1851) has been recorded in Bangladesh, Bhutan, China, Indonesia, Myanmar, Pakistan and Taiwan, but not in Japan.

New information

Picromerus griseus was recorded in Japan for the first time, based on a single individual collected from grasslands around the fields of Ishigaki Island of the Ryukyu Islands, which belong to the Oriental Region. This discovery represents the easternmost record of the species. An illustrated key to the species of *Picromerus* occurring in Japan is also provided.

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Keywords

Heteroptera, Pentatomidae, Asopinae, *Picromerus griseus*, stink bug, new record, illustrated key, Japan, Ryukyu Islands, Ishigaki Island, Oriental Region

Introduction

The stink bug subfamily Asopinae Spinola, 1850 comprises 303 species in 63 genera worldwide and all species for which their biology is known are predacious (Schuh and Weirauch 2020). The following twelve species in eight genera are known in Japan: *Andrallus spinidens* (Fabricius, 1787); *Arma custos* (Fabricius, 1794); *Dinorhynchus dybowski* Jakovlev, 1876; *Eocanthecona furcellata* (Wolff, 1811); *E. japonica* (Esaki & Ishihara, 1950); *E. kyushuensis* (Esaki & Ishihara, 1950); *E. shikokuensis* (Esaki & Ishihara, 1950); *Picromerus bidens* (Linnaeus, 1758); *P. lewisi* Scott, 1874; *Pinthaeus sanguinipes* (Fabricius, 1781); *Rhacognathus corniger* Hsiao & Cheng, 1977; and *Zicrona caerulea* (Linnaeus, 1758) (Ishikawa 2016). Two Japanese species, *A. spinidens* and *E. furcellata*, are expected to have some success in effectively utilising indigenous natural enemies through conservation (Rural Culture Association 2016).

The genus *Picromerus* Amyot & Serville, 1843 (Asopinae) comprises 11 species from the Northern Hemisphere: *P. bidens*; *P. brachypterus* Ahmad & Önder, 1990; *P. conformis* Herrich-Schäffer, 1841; *P. elevatus* Zhao, Liu & Bu, 2013; *P. fasciaticeps* Zheng & Liu, 1987; *P. griseus* (Dallas, 1851); *P. lewisi*; *P. nigridens* (Fabricius, 1803); *P. orientalis* Rishi & Abbasi, 1973; *P. pseudobidens* Ahmad & Önder, 1990; and *P. viridipunctatus* Yang, 1934 (Thomas 1994, Rider 2006, Zhao et al. 2013). In Japan, two species, *P. bidens* and *P. lewisi*, were only recorded from Japan proper and its surrounding islands, which belong to the Palearctic Region (Ishikawa 2016), while no species have been recorded from the Ryukyu Islands, whose central and southern parts belong to the Oriental Region. These two species are so similar that it is difficult to distinguish them at first glance. Although some field guides and pictorial books dealing with Japanese Asopinae have been published (e.g. Yasunaga et al. (1993), Takai and Ishikawa (2012)), no identification key illustrating the diagnostic characteristics of the two species, based on the Japanese populations, has been provided for easier and more accurate identification. Therefore, field surveys on the Ryukyu Islands and publication of an illustrated key for Japanese *Picromerus* are needed to elucidate Asopinae in Japan and make this genus known to the public.

In autumn, 2022, the second author collected a single individual of an indeterminate species of *Picromerus* from the grasslands around the fields of Ishigaki Island of the Ryukyu Islands (Oriental Region). After the first author examined its morphological characteristics, we concluded that it belonged to *P. griseus*, which is currently known to occur in Bangladesh, Bhutan, China, Indonesia, Myanmar, Pakistan and Taiwan (Thomas 1994, Rider 2006, Zhao et al. 2013, Zheng and Lin 2013). Herein, we report *P. griseus* in

Japan for the first time, representing the easternmost occurrence of this species. In addition, we provide an illustrated key for all three Japanese species of *Picromerus*.

Materials and methods

Morphological characteristics of dried specimens were observed using a stereoscopic microscope (SZ60; Olympus, Tokyo, Japan). To examine the genital characteristics, the male terminalia were removed from the body after softening the specimens in hot water. The removed genital capsule was immersed in hot 15% potassium hydroxide (KOH) solution for 5 min. For further observations, parameres were removed from the genital capsule soaked in 99% ethanol. Male genitalia were preserved in small polyethylene vials containing a 50% glycerine and 50% water solution. A polyethylene vial was mounted on the pin with the specimens. The specimens were photographed using a digital microscope (Dino-Lite Premier M; Opto Science, Tokyo, Japan) and a compact digital camera (Tough TG-6; Olympus) and image stacks were processed using Adobe Photoshop 2021 ver. 22.5.1 (Adobe Inc., CA, USA) when using the digital microscope. Measurements were obtained using a stereoscopic microscope equipped with an ocular grid and a digital microscope. Morphological terms were assigned as described by Tsai et al. (2011).

The single specimen of *Picromerus griseus* examined in the present study was deposited at the Laboratory of Entomology, Faculty of Agriculture, Tokyo University of Agriculture, Kanagawa, Japan (TUA). Specimens of the Japanese species of *Picromerus* that were used for creating the identification key and for comparison with *P. griseus* were deposited in the Entomological Laboratory, Faculty of Agriculture, Kyushu University, Fukuoka, Japan (ELKU) and TUA.

Taxon treatment

Picromerus griseus (Dallas, 1851)

Nomenclature

Canthecona grisea Dallas, 1851 - Dallas (1851): 92, new species and description.

Picromerus obtusus Walker, 1867 - Walker (1867): 133, new species and description; Schouteden (1907): 25, synonymised with *Picromerus griseus*.

Picromerus nigrivitta Walker, 1867 - Walker (1867): 133, new species and description; Distant (1900): 58, synonymised with *Picromerus obtusus*.

Picromerus sundanus Breddin, 1902 - Breddin (1902): 96, new species and description; Thomas (1994): 192, synonymised with *Picromerus griseus*. Gaedike (1971): 100, designation of lectotype.

Picromerus griseus Schouteden, 1907 - Schouteden (1907): 25, new combination; Thomas (1994): 192, catalogue and distribution; Rider (2006): 243, catalogue and distribution; Zhao et al. (2013): 73, diagnosis, figure, and distribution; Zheng and Lin (2013): 145, figure and distribution.

Material

a. scientificName: *Picromerus griseus* (Dallas, 1851); namePublishedIn: 1851; kingdom: Animalia; phylum: Arthropoda; class: Insecta; order: Hemiptera; family: Pentatomidae; genus: *Picromerus*; specificEpithet: *griseus*; scientificNameAuthorship: Dallas; islandGroup: Ryukyu Islands; island: Ishigaki Island; country: Japan; countryCode: Okinawa; municipality: Ishigaki-shi; locality: Sakieda; decimalLatitude: 24.438250; decimalLongitude: 124.102167; geodeticDatum: WGS84; samplingProtocol: none specified; eventDate: 08-11-2022; individualCount: 1; sex: male; lifeStage: adult; recordedBy: Akihiro Utagawa; identifiedBy: Jun Souma; dateIdentified: 2023; institutionCode: TUA; basisOfRecord: PreservedSpecimen; occurrenceID: B9C40A18-594B-59E7-BCA1-4AB46599AC3E

Diagnosis

Picromerus griseus can be distinguished from other species of the genus using a combination of the following characteristics: head, pronotum, scutellum and femora uniformly brown (Fig. 1a, b); humeral angle of pronotum strongly protruding laterad, acute at apex, posteriorly with a distinct subapical prominence (Fig. 2a); posterior margin of genital capsule weakly curved inwards in middle part (Fig. 4a); and paramere weakly curved inwards in apical part in dorsal and caudal views, distinctly concave along inner margin in dorsolateral view (Figs 3a, 5a, 6a).

Distribution

Japan (Ryukyu Islands: Ishigaki Island), Bangladesh, Bhutan, China, Indonesia, Myanmar, Pakistan, Taiwan (Thomas 1994, Rider 2006, Zhao et al. 2013, Zheng and Lin 2013, present study).

The discovery of *Picromerus griseus* from Japan represents the easternmost record of the species.

Biology

Picromerus griseus was collected from grasslands surrounding fields in Japan. In Japan, adults are collected in November; however, the nymphs are unknown.

Taxon discussion

The specimen recorded above (Figs 1a, b, 2a, 3a, 4a, 5a, 6a) matched the photographs and descriptions (Dallas 1851, Zhao et al. 2013) of *Picromerus griseus* in terms of morphological characteristics, including the humeral angle and male genitalia. The Japanese specimen was identified as *P. griseus* using a key for the East Asian

species of *Picromerus* (Zhao et al. 2013), based on its morphological characteristics. However, the colouration of the connexivum of the Japanese specimen (yellow and black) did not match the above-mentioned key (entirely black). To the best of our knowledge, Japanese populations of *P. bidens* and *P. lewisi* show a high degree of intraspecific variation in the colouration of the connexivum (yellow and black to entirely black) (Figs 1c, d, 7). In conclusion, we did not use the colouration of the connexivum as a diagnostic characteristic of *Picromerus* and identified the Japanese specimen as *P . griseus,* based on the shape of the humeral angle and male genitalia.

Checklist of the species of *Picromerus* occurring in Japan

Picromerus bidens (Linnaeus, 1758)

Distribution: Afghanistan, Albania, Algeria, Armenia, Austria, Azerbaijan, Belgium, Bosnia Herzegovina, Bulgaria, Byelorussia, Canada, China, Croatia, Czech Republic, Denmark, Estonia, Finland, France, Georgia, Germany, Greece, Hungary, Iran, Ireland, Italy, Japan (Kunashiri Island, Hokkaido, Rishiri Island, Honshu), Kazakhstan, Kirgizia, Korea, Latvia, Liechtenstein, Lithuania, Luxemburg, Macedonia, Moldavia, Mongolia, Montenegro, Netherlands, Norway, Poland, Portugal, Romania, Russia, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Tajikistan, Turkey, Ukraine, United Kingdom, USA, Uzbekistan (Thomas 1994, Kanyukova and Marusik 2006, Rider 2006, Takai and Ishikawa 2012, Aukema et al. 2013, Zhao et al. 2013, Ishikawa 2016, Roca-Cusachs et al. 2020).

Picromerus griseus (Dallas, 1851)

- http://en.wikipedia.org/wiki/Atypus_affinis

Distribution: Bangladesh, Bhutan, China, Indonesia, Japan (Ishigaki Island), Myanmar, Pakistan, Taiwan (Thomas 1994, Rider 2006, Zhao et al. 2013, Zheng and Lin 2013, present study).

Picromerus lewisi Scott, 1874

Distribution: China, Japan (Hokkaido, Honshu, Sado Island, Awa Island, Shikoku, Kyushu, Tsushima Island, Shimokoshiki Island, Shimoshima Island), Kazakhstan, Korea, Russia, Taiwan (Yasunaga et al. 1993, Thomas 1994, Rider 2006, Takai and Ishikawa 2012, Aukema et al. 2013, Zhao et al. 2013, Zheng and Lin 2013, Ishikawa 2016, Nozaki et al. 2016, Roca-Cusachs et al. 2020).

Identification keys

Key to the species of *Picromerus* occurring in Japan

The key below is based on morphological characteristics and colouration that are stable in the Japanese populations and the distribution of three species in Japan.

1	Humeral angle of pronotum posteriorly with a distinct subapical prominence (Figs 1a, 2a, b); lateral sides of abdomen without black spots on ventral surface; known from Ryukyu Islands	*Picromerus griseus* (Dallas, 1851)
–	Humeral angle of pronotum without distinct subapical prominence (Figs 1c, d, 2b, c); lateral sides of abdomen with black spots on ventral surface; known from Japan proper and its surrounding islands	2
2	Humeral angle of pronotum strongly protruding laterad, acute at apex (Fig. 2 b); posterior margin of genital capsule weakly curved inwards in middle part (Fig. 4b); paramere weakly curved inwards in apical part in dorsal and caudal views, distinctly concave in inner margin in dorsolateral view (Figs 3b , 5b, 6b)	*Picromerus bidens* (Linnaeus, 1758)
–	Humeral angle of pronotum weakly protruding laterad, obtuse at apex (Fig. 2 c); posterior margin of genital capsule strongly curved inwards in middle part (Fig. 4c); paramere strongly curved inwards in apical part in dorsal and caudal views, slightly concave in inner margin in dorsolateral view (Figs 3c, 5c, 6c)	*Picromerus lewisi* Scott, 1874

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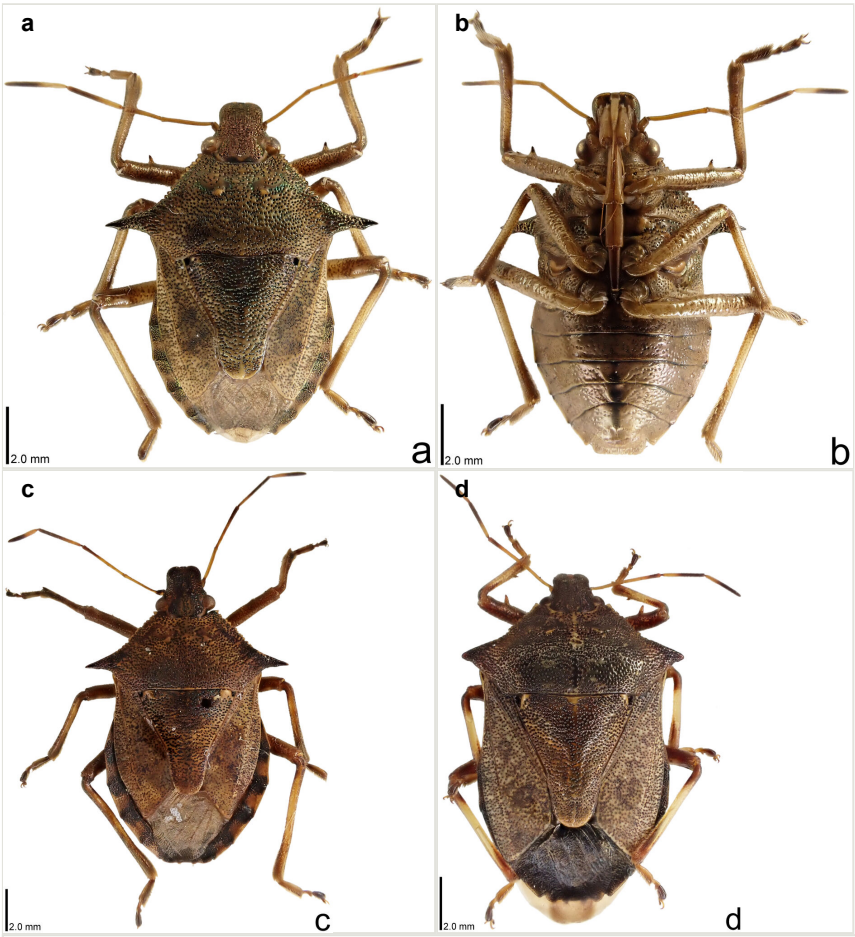


Figure 1.

Habitus of three species of *Picromerus* from Japan.

a: *Picromerus griseus*, dorsal view.
b: *Picromerus griseus*, ventral view.
c: *Picromerus bidens*, dorsal view.
d: *Picromerus lewisi*, dorsal view.

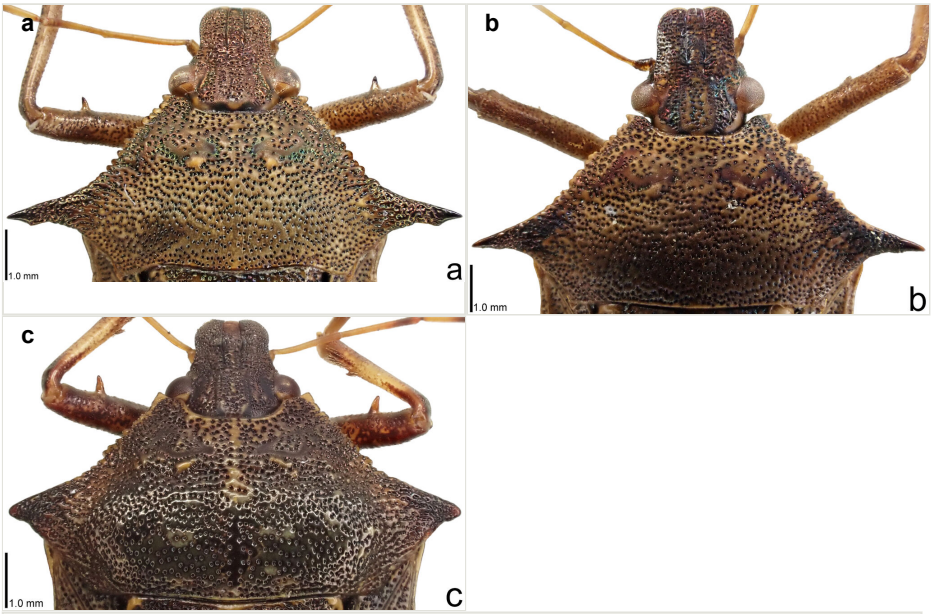


Figure 2.

Heads and pronota of three species of *Picromerus* from Japan, dorsal view.

a: *Picromerus griseus*.
b: *Picromerus bidens*.
c: *Picromerus lewisi*.

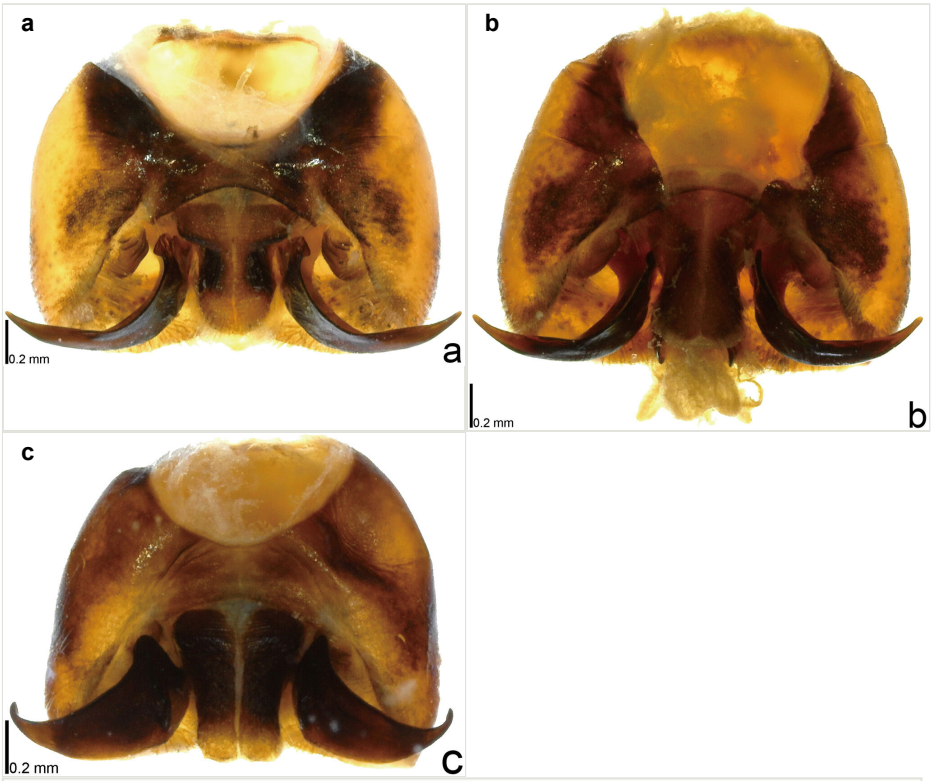


Figure 3.

Genital capsules of three species of *Picromerus* from Japan, dorsal view.

a: *Picromerus griseus*.

b: *Picromerus bidens*.

c: *Picromerus lewisi*.

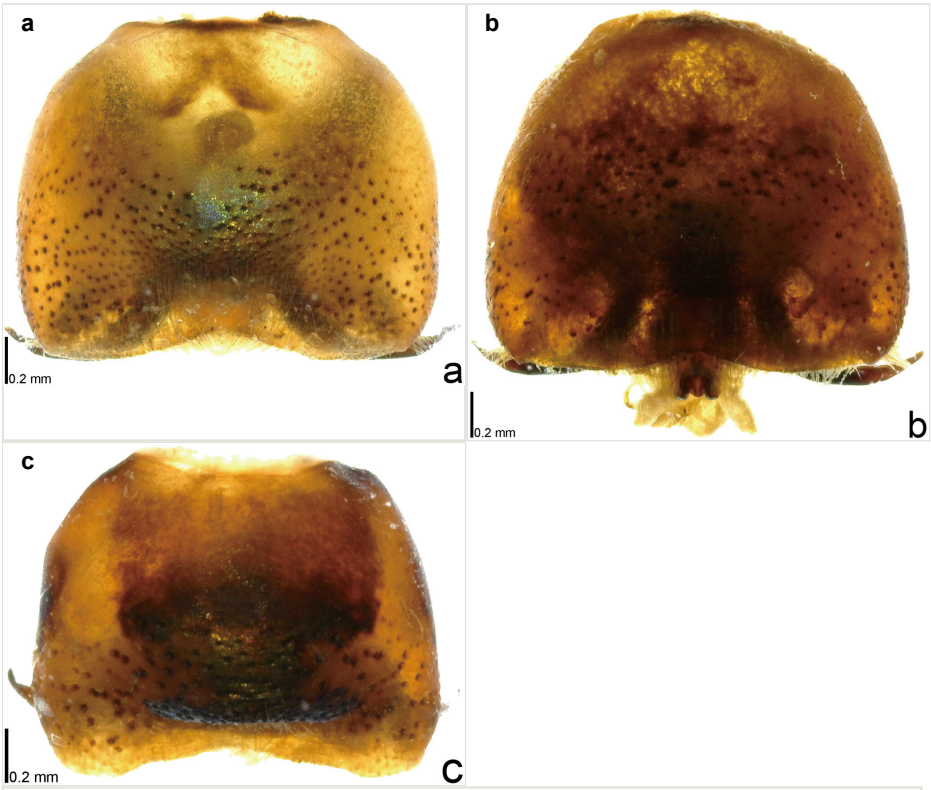


Figure 4.

Genital capsules of three species of *Picromerus* from Japan, ventral view.

a: *Picromerus griseus*.
b: *Picromerus bidens*.
c: *Picromerus lewisi*.

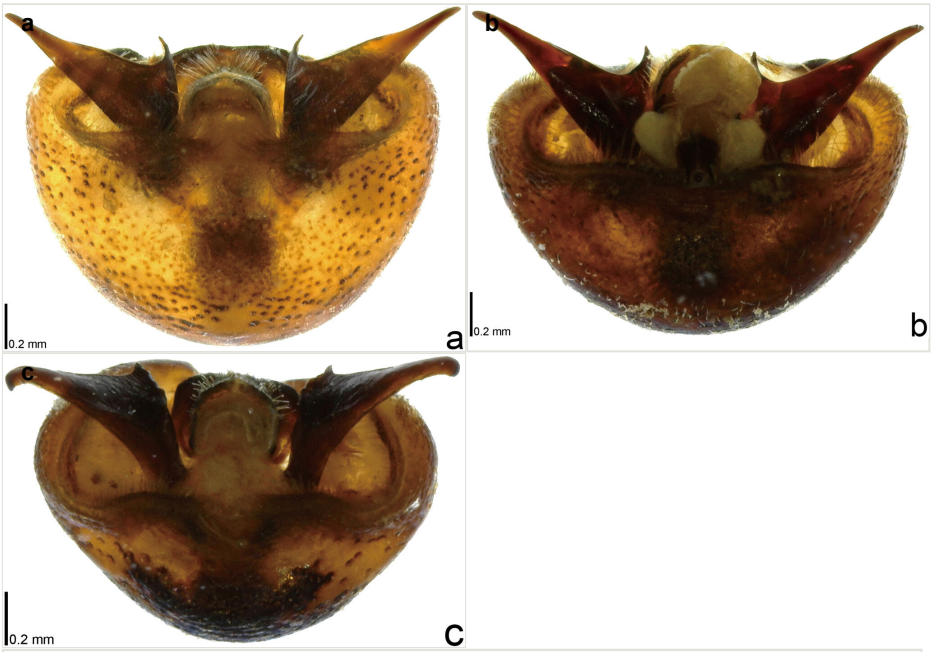


Figure 5.

Genital capsules of three species of *Picromerus* from Japan, caudal view.

a: *Picromerus griseus*.
b: *Picromerus bidens*.
c: *Picromerus lewisi*.

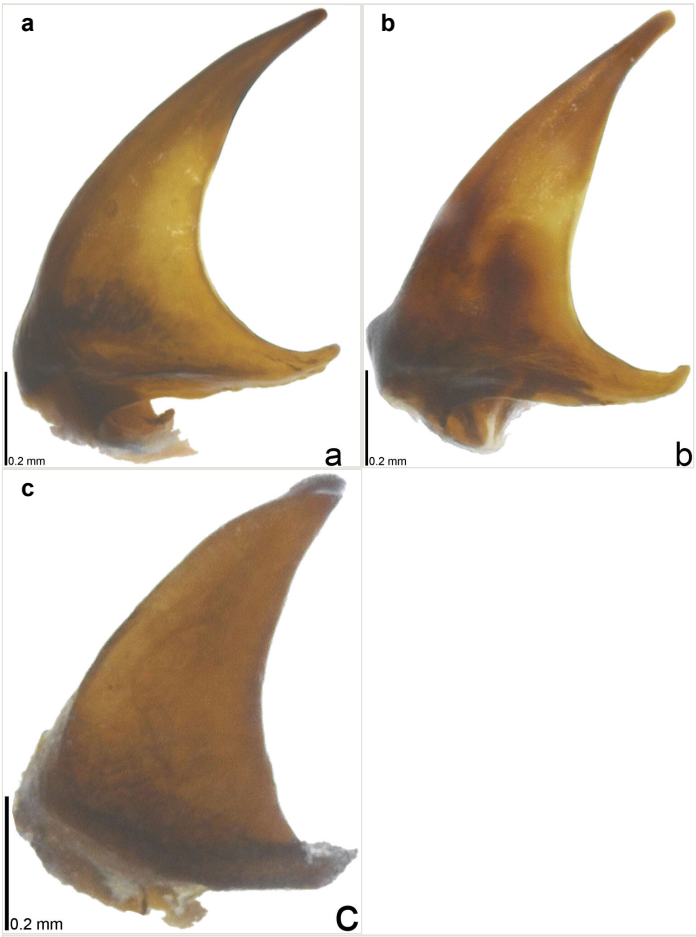


Figure 6.

Parameres of three species of *Picromerus* from Japan, dorsolateral view.

a: *Picromerus griseus*.
b: *Picromerus bidens*.
c: *Picromerus lewisi*.

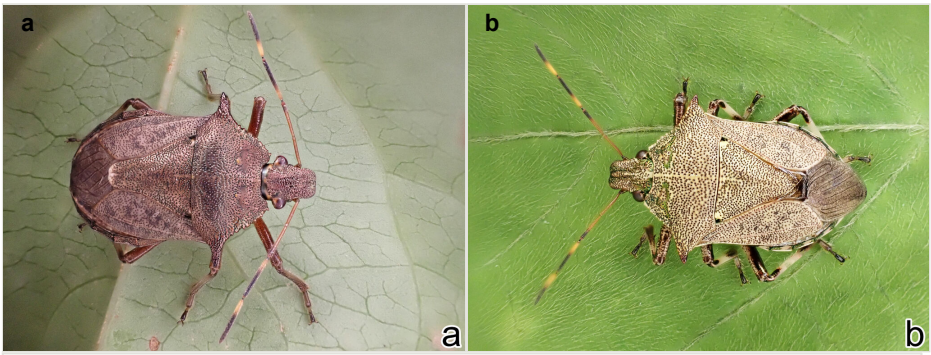


Figure 7.

Living individuals of two species of *Picromerus* from Japan.

a: *Picromerus bidens*.
b: *Picromerus lewisi*.