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Distribution and species identification in the crustacean isopod genus *Dynamene* Leach, 1814 along the North East Atlantic-Black Sea axis

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Abstract

Sphaeromatid isopods, such as *Dynamene*, are common and abundant members of the invertebrate fauna of littoral and shallow sublittoral substrates. Six species of *Dynamene* occur in the northern hemisphere. Only two species exist outside this range, in Australia. The distribution of the various species in the NE Atlantic-Black Sea axis has been controversial due to the difficulty in the identification of the different species. This has led to inaccurate records of their distribution, ultimately generating uncertain or faulty assessments on the biodiversity of these habitats. An update and a clarification about the distribution of this genus is therefore in order. In this study, we describe the distribution of *Dynamene* species in the light of new records from the NE Atlantic Ocean and its associated islands, and the Mediterranean, Black and Red Seas, and from re-examination of museum and several authors' personal collections. Based on these observations, we extend the northern and southern limits of *D. bidentata* (Adams); the western and southern limits of *D. magnitorata* Holdich; the northern, eastern and western limits of *D. edwardsi* (Lucas); and the eastern and western limits of *D. bifida* Torelli. The range of *Dynamene tubicauda* Holdich is extended, but is still only known from the eastern Mediterranean. We also clarify the synonymy of *D. torelliae* Holdich with *D. bicolor* (Rathke), and the occurrence of *D. bicolor* in the Black Sea. New distribution maps of the six *Dynamene* species are presented. Illustrated keys to the adult males and females of the northern hemisphere species are provided.

Keywords
Dynamene, Crustacea, Isopoda, Sphaeromatidae, identification, distribution

Introduction

Isopod crustaceans are common and sometimes abundant members of the invertebrate fauna of the littoral and shallow sublittoral habitats of the world's oceans (Poore and Bruce 2012). Species of the sphaeromatid isopod genus *Dynamene* Leach, 1814 are typical components of these habitats on coasts of the NE Atlantic Ocean and its islands, and the Mediterranean and Black Seas. Six species are endemic to these provinces (Holdich 1968a, 1970): *D. bidentata* (Adams, 1800); *D. bicolor* (Rathke, 1837); *D. edwardsi* (Lucas, 1849); *D. bifida* Torelli, 1930; *D. magnitorata* Holdich, 1968 and *D. tubicauda* Holdich, 1968. *Dynamene torelliae* Holdich, 1968 was considered to be synonymous with *D. bicolor* by Kussakin (1979) and this has been accepted by the current authors. Two additional species occur in, and are endemic to, Australia, but have rarely been recorded: *Dynamene ramuscula* (Baker, 1908) and *Dynamene curalii* Holdich and Harrison, 1980. A number of other *Dynamene* species are incorrectly listed in some databases, e.g., http:/isopods.nhm.org/, Brusca et al. (1995-2004), Myers et al. (2008). Species attributed to the genus *Dynamene* from the western USA, i.e., *D. angulata* Richardson, 1901; *D. benedicti* (Richardson, 1899); *D. dilatata* Richardson, 1899; *D. glabra* Richardson, 1899 and *D. sheari* Hatch, 1947 do not belong to this genus, as adult males do not possess a bidentate process arising from the sixth pereonite (see below), and are considered *incertae sedis* (http://www.marinespecies.org/). *Dynamene tuberculosa* Richardson, 1899 from the Aleutian Islands off Alaska is also still listed as such in some databases, but was considered as the female of *Paracerceis cordata* (Richardson, 1899) by Richardson (1905).

The distribution of the various *Dynamene* species associated with the NE Atlantic-Black Sea axis was previously examined by Holdich (1968a, 1970). Since then many general community studies have been published reporting the presence of *Dynamene* throughout its range (e.g., Pereira et al. 2006 in Portugal, Arrontes and Anadón 1990, Arrontes 1991, Viejo 1997, Castelló and Carballo 2001 in Spain, Castellanos et al. 2003 in northern Africa; and Kirkim et al. 2006 in Turkey). In addition, a large number of specimens have become available since Holdich's studies, which make the clarification and updating of distribution maps along the NE Atlantic-Black Sea axis necessary. This is particularly so because many of the records for the Mediterranean and Adriatic relate to *D. torelliae*, which has been synonymized with *D. bicolor*.

In order to be able to identify species of *Dynamene*, and distinguish them from some other sphaeromatid isopods, it is important to understand how the morphology changes during the life history. Adult males (stage 8) of the various *Dynamene* species can be distinguished from those of other sphaeromatid isopods, e.g., *Campecopea* Leach, 1814; *Cymodoce* Leach, 1814; *Ischyromene* Racovitza, 1908; *Lekanosphaera* Verhoeff, 1943 and *Sphaeroma* Bosc, 1802, that may be found in the same habitat, by a large two-pronged medial process (the bidentate process) arising from the dorsal

posterior margin of the sixth pereonite (Fig. 1). This characteristic is unique to the genus (Harrison and Ellis 1991). Some species of *Oxinasphaera* Bruce, 1997 have such a process, but this arises from the pleon (Bruce 1997, Schotte and Kensley 2005), and paired processes arise from the seventh pereonite in *Dynamenella dioxus* Barnard, 1914. Juveniles and females, and even sub-adult males (stages 6 and 7), are more difficult to distinguish between the species, and may also be confused with females of other genera. Vieira et al. (2015) have shown clear differences between *D. bidentata*, *D. magnitorata* and *D. edwardsi* at the genetic level using cytochrome oxidase I (COI-5P). Details of the changes occurring throughout the life history of the best-studied species, *D. bidentata*, are given below.

Dynamene species are present in a wide-range of habitats, but usually amongst algae and in cryptic habitats, e.g., under rocks, crevices, empty barnacle tests, amongst serpulid and tunicate colonies, mussel beds and encrusting sponges, from midlittoral to shallow sublittoral levels (Holdich 1970, 1976). *Dynamene bidentata*, at least, has a biphasic life cycle with a change of habitat, where the immature stages are present amongst the algal cover (which they eat), whilst the adults occupy cryptic habitats where they reproduce and where females can incubate their broods in relative safety (Holdich 1968b, 1970, 1976). Further details of the habitats occupied by *Dynamene* along the NE Atlantic-Black Sea axis are given for each species below.

Given that fully adult males may not be present in many collections, species identification is often difficult and leads to incorrect assignments, questioning the validity of the information about the actual distribution of the species. The literature is scattered with misidentifications, which have come to light when such authors' material and/or publications have been examined by us. In the present study we aim to update and correct the geographical distribution of the six described species of *Dynamene* from the NE Atlantic-Black Sea axis. To facilitate identification, keys to adult males and females of these six species are provided along with associated photographs. It is hoped that these will enable those involved in littoral and sublittoral surveys in the marine environment to identify species of *Dynamene* more easily.

Methods

The records of David Holdich (DMH) used in this study are derived from field work carried out in various localities in the British Isles, Atlantic islands, Atlantic coasts of mainland Europe, and the Mediterranean and Aegean Seas (Holdich 1968a, c, 1970, Holdich and Lincoln 1974, Holdich 1976). In addition, there have been donations from many colleagues between 1970 and 2014 (see Acknowledgments). Other samples deposited in several museum collections, particularly those in Leiden, Lisbon, London and Paris (see Acknowledgements), and dating back to the 1920s, have been examined. Also, the *Dynamene* specimens (deposited at the Universities of Aveiro and Minho) collected by Pedro Vieira, Henrique Queiroga and Filipe Costa with the help of other colleagues (see Acknowledgments) were used to supplement the collections. These sam-

ples were collected from the NE Atlantic coasts and the Macaronesian archipelagos of Madeira, Azores and Canary islands, between 2009 and 2015. Samples were taken from rocky shore habitats by scraping of the algal cover and hand picking during low tide.

All specimens of *Dynamene* from DMH's collections have been deposited in the Naturalis Biodiversity Centre, Leiden, The Netherlands under the catalogue numbers: RMNH.CRUS.1. 7517-7616 and 7642-7676. Specimens of *Dynamene* already present in the Leiden collections have the catalogue numbers: RMNH.CRUS.1. 7450-7514.

In most cases the only records considered were of specimens actually seen by the authors, confirmed by molecular tools (unpublished data), or where there were clear diagrams in the literature. Although Holdich (1968c) confirmed many specimens from England and Wales during his surveys, since that time most records of *D. bidentata* have mainly come about as part of the general fauna collected in marine surveys. So, although many records exist in various British databases, particularly those held in the National Biodiversity Network Gateway and ERICA (see Acknowledgements), the current authors have not tried to track down voucher specimens, but have relied on identifications being correct as only one species of *Dynamene* is indigenous to the British Isles, thus making records more reliable. Details of all the specimens examined in the current study are given in Suppl. material 1.

Using information in the databases, maps were constructed of the six *Dynamene* species occurring along the NE Atlantic-Black Sea axis using the software ARCGIS 10.3.

Keys and photographic montages based on the main characters of adult males (stage 8) and females are given at the end of the paper. To construct the montages, photographs of alcohol preserved specimens were taken with a Dino-Eye Microscope Camera attached to a Wild M5 binocular microscope via a phototube. Images were edited using appropriate software on a computer.

Results

In this section a generic description of *Dynamene* is given, followed by details of each of the six species present along the North East Atlantic-Black Sea axis. Keys to and photographs of males and females of each species are given at the end of the paper. Comparisons are made in the main discussion section and overall conclusions are dealt with in the final section. Details of the material examined and geographical coordinates of locations are given in Suppl. materials 1 and 2.

Dynamene Leach, 1814

Synonymy. *Nesaea*: Leach (1814).
Prochonaesea: Hesse (1873).
Sorrentosphaera: Verhoeff (1944).

Diagnosis. Eubranchiate sphaeromatid with body approximately elliptical. Anteriorly, cephalosome separating the bases of the antennules. Eyes set slightly into pereonal tergite 1. Coxal plates of pereonites 1–7 separated from tergites by sutures.The seventh somite is overlapped by the sixth in adult males (stage 8), with the pleura extended postero-laterally into two small processes, which vary in shape according to species. Pleotelson domed or keeled, and terminating in an obvious terminal foramen, which may be enclosed forming a tube. Antennular peduncle articles 1 and 2 dilated and juxtaposed to ventral margins of cephalosome. All pereopods ambulatory. Both rami of pleopods 1-3 bearing margin of plumose setae. Endopods of uropod fused with protopods and juxtaposed to pleotelsonic margin; exopods posteriorly directed. Sexual dimorphism pronounced. Adult male with pereonal tergite 6 longer than those preceding, posterior margin with an elongate, posteriorly directed process either side of the mid-line (the bidentate process). Posterior part of pleotelson with central boss. Penes small, separate. Endopod of pleopod 2 lacking appendix masculina. Female with pereonal tergite 7 similar to those preceding and lacking bidentate process; pleotelson smooth. Ovigerous female with ventral marsupium, formed from four pairs of lamellae, which arise from pereonites 1-4. Mouthparts strongly metamorphosed.

Type species. *Oniscus bidentatus* Adams, 1800

Dynamene bidentata (Adams, 1800)

Restricted synonymy. *Oniscus bidentatus*: Adams (1800).

Naesa bidentata: Leach (1815).

Dynamene bidentata: Holdich (1968a, b, c, 1969, 1970, 1971, 1976); Kussakin (1979); Harrison and Ellis (1991).

An extensive synonymy was given by Holdich (1968a, c) for citations prior to 1968.

Material examined. Specimens have been examined from 129 locations in the NE Atlantic, mainly from the British Isles, Channel Islands, France, Spain, Portugal and Morocco – see the Suppl. materials 1 and 2. A number of literature records have been included where the diagrams clearly indicate this species. In addition, there are 76 records from the NBN database.

Key morphological characters. Body convex; in stage 8 males the pleotelsonic boss is large and bilobed, the two halves are separated by a wide v-shaped groove; the arms of the bidentate process taper to a point, and are sparsely rugose dorsally (Fig. 2A–B). In stage 7 females the pleotelsonic dome is smoothly rounded in side view and the pleotelsonic foramen is open and flush with the edge of the pleotelson (Fig. 3A–B). In populations from Atlantic coasts the smooth outline of the pleotelsonic dome in females and juveniles is key to separating this species from *D. magnitorata* and *D. edwardsi*, where it is keeled in side view. Further details are provided by the scanning electron microscope pictures of the posterior body of a stage 8 male and a stage 7 female in Holdich (1976).

Size. Adult males (stage 8) typically 7.0 × 3.0 mm, although specimens 10 mm in length have been seen; pre-ovigerous females (stage 7) typically 6.0 × 2.9 mm.

Life-history. There are eight life-history stages in both males and females (Holdich 1968b). Sexual dimorphism becomes apparent in stage 6 males with the appearance of a very small bidentate process, this increases in size at the seventh, and is fully developed by the eighth and terminal stage (Figs 1D, 4–lower row 6–8). This process is absent from juveniles and females (Figs 1A-B, 4–upper row 6–8, 2A–M). Juveniles and females up to and including stage 7 are very similar to each other morphologically. At the moult to stage 8 females become ovigerous and are very similar morphologically between the species. Their mouthparts are strongly metamorphosed, and they die after releasing their broods (Hansen 1905, Holdich 1968b, 1971). Stage 8 males live for two breeding seasons, at least in the British Isles, and remain in their cryptic habitat for the entire period without apparently feeding (Holdich 1971). Those in their second year are recognizable from the growths of algae, and sometimes serpulids, on the pleotelson.

Habitat. All stages can be found on a wide variety of mid- to lower littoral algae, and also in rock pools in the upper littoral zone. Fenwick (pers. comm., July 2016) has found this species commonly amongst lower shore and sublittoral coralline algae in Cornwall, and he has also recorded adults from under large lower shore pebbles. Stage 7 females and stage 8 males move from the algae into cryptic habitats, such as crevices and empty barnacle tests, particularly *Balanus perforatus*, to breed (Holdich, 1970, 1976). Stage 7 females moult into stage 8 females within such a habitat and reach peak numbers in April/May each year (Holdich 1968b).

Colour. Some degree of camouflage in the algal habitat is given by green, yellow and brown 'uniformis' phenotypic varieties, and this is enhanced by the development in some individuals of patterns of white or red, dorsal, non-adaptable chromatophores (Tinturier-Hamelin 1962, 1967, Holdich 1969, Arrontes 2009). In the past some workers have given specific status to the red and green colour varieties, e.g. rubra and viridis (see Holdich 1968c). Adult males are particularly colourful when found amongst red algae on the lower shore, with the margins of the body segments and uropods bordered in orange.

Geographical distribution. The distribution of this species shown in Holdich (1970, 1974) has been extended by the present study. It occurs from the Shetland Islands to Tarfaya in western Morocco and Tenerife and Gran Canaria in the Canary Islands, which are the only two records of the species in Macaronesia (Fig. 5A). Within this range *D. bidentata* occurs in the north, northwest (including the outer islands), west and south coasts (as far as the Isle of Wight) of Great Britain, around Northern and Southern Ireland, the Channel Islands, northwest France, Atlantic Iberian Peninsula and in northwest Africa. Arrontes (1991) cites *D. bidentata* as being the most abundant isopod species on shores in northern Spain. It is the only species present in the British Isles (with the exception of a single record of *D. magnitorata* in southern England). It is particularly common in SW England and SW Wales, especially where the large barnacle, *Balanus perforatus* is present. There is one recent record for north-eastern England, which may be the result of a stranding, as are records for The Neth-

erlands, where it is not considered indigenous (Holthuis 1956). The closest record to the Mediterranean of *D. bidentata* is Tarifa, in southern Spain (Guerra-García et al. 2011, Izquierdo and Guerra-García 2011, Guerra-García et al. 2012, Torrecilla-Roca and Guerra-García 2012).

Remarks. Maggiore and Fresi (1984) described *D. bidentata* from the Gulf of Naples (publishing descriptions and figures), and several authors (e.g., Castelló and Carballo 2001, Castellanos et al. 2003, Junoy and Castelló 2003) have used Maggiore and Fresi's (1984) observations to justify their findings of *D. bidentata* in the Mediterranean. Yet, examination of the single specimen found by Maggiore and Fresi (1984) showed that it was in fact a *D. magnitorata*.

A lot of confusion regarding the identification of *D. bidentata* was caused by Torelli (1930) who figured what she called *D. bidentata* (a stage 8 male and a stage 8 ovigerous female), from the Bay of Naples, Italy. Omer-Cooper and Rawson (1934) used Torelli's figures to illustrate *D. bidentata* from Britain, which was then proliferated in some British identification guides, e.g., Barrett and Yonge (1964), although this has been corrected in more modern guides, e.g., Hayward and Ryland (1995). Pauli (1954) also used Torelli's figures to illustrate *D. bidentata* from the Black Sea. Holdich (1968a) collected material from Naples and decided that Torelli's figures were in fact of a new species, commonly found in the Bay of Naples, which he named *D. torelliae* Holdich, 1968. However, Kussakin (1979) decided that *D. torelliae* was in fact synonymous with *D. bicolor* (Rathke, 1837). This species was in fact unknown to Holdich at the time of his studies.

Databases we have consulted indicate that *D. bidentata* commonly occurs around Northern and Southern Ireland. However, we could only find one modern published record, i.e., de Grave and Holmes (1998) from Lough Hyne in County Cork.

Unlike most other isopods, stage 8 male *Dynamene bidentata* do not have appendix masculina on the endopods of the second pair of pleopods, this is also the case in the other *Dynamene* species. This phenomenon has also been noted by Messana (2004) in *Sphaeroma terebrans* Bate, 1866. It is very difficult to observe mating in *Dynamene* due to the cryptic habitat of the adults. It is probable that sperm are released directly into the marsupium as the eggs are laid.

Dynamene bicolor (Rathke, 1837)

Restricted synonymy. *Campecopea bicolor:* Rathke (1837).

Dynamene bidentata: Torelli (1930); Omer-Cooper and Rawson (1934); Pauli (1954); Holthuis (1956); Barrett and Yonge (1964); [not *D. bidentata* of Adams (1800)].

Dynamene torelliae: Holdich (1968, 1970).

Dynamene bicolor: Kussakin (1979); Maggiore and Fresi (1984).

Material examined. Specimens have been examined from 48 locations in 12 countries in the Mediterranean and Black Seas - see the Suppl. materials 1 and 2. A number of literature records have been included where the diagrams clearly indicate this species.

Key morphological characters. In stage 8 males the pleotelsonic boss is comprised of two right-angled triangular structures separated by a deep groove (however, the boss may be very low lying in some specimens, e.g., those from the Black Sea); the arms of bidentate process taper to a point and are rugose dorsally (Fig. 2J–K). In stage 7 females the pleotelsonic dome is keeled in side view and the pleotelsonic foramen is flush with the edge of the pleotelson (Fig. 3H, I). The females of this species are very difficult to separate from those of *D. magnitorata*. Maggiore and Fresi (1984) provide a complete description of *D. bicolor*.

Size. Adult males (stage 8) typically 3.5 × 1.5 mm, pre-ovigerous females (stage 7) typically 3.0 × 1.3 mm.

Life-history. Nothing is known of the life-history, other than the fact that sexual dimorphism occurs with males developing the bidentate process characteristic of the genus.

Habitat. Juveniles are usually found in shallow water on a variety of algae down to 3.0 m and adults in empty *Balanus* tests, in mussel beds, in rock crevices, within sponges, and under rocks throughout the Mediterranean. However, occasionally they have been found in deeper water, e.g., off the island of Chios (Greece) specimens were collected from *Cystoseira* at depths from 0.5 – 30 m (see Suppl. material 1).

Colour. As with *D. bidentata*, some degree of camouflage in the algal habitat is given by yellow or dull green 'uniformis' phenotypic varieties, and this is enhanced by the development in some individuals of patterns of white or red, dorsal, non-adaptable chromatophores (Holdich 1969).

Geographical distribution. The distribution of this species shown in Holdich (1970) has been extended by the present study. It is the most commonly recorded *Dynamene* species in the Mediterranean, occurring from the Balearic Islands in the west to the coast of Israel in the east, although there are only a few records for the North African coast (Fig. 5B). It has been frequently recorded around the Greek islands and mainland coast of both Greece and Turkey. The most northerly record is for Croatia in the Aegean Sea. It has also been recorded for a number of countries around the Black Sea (Bulgaria, Romania, Turkey and Georgia) (Fig. 5B). Most records in the literature refer to *D. torelliae*, which is now considered synonymous with *D. bicolor*.

Remarks. Many records exist, both published and unpublished, for *Dynamene bicolor* (usually as '*D. torelliae*') in the Mediterranean Sea, particularly from the coasts of Spain, France, Italy and Greece (Holdich 1970, Bakir et al. 2014). However, its presence in Egypt and Israel was unreported until now. Previous observations indicated its presence in the Black Sea (Kussakin 1979), where it was thought to be the only *Dynamene* species present (Gönlügür-Demirci and Katağan 2004). On comparing specimens from the Black and Mediterranean Seas the current authors have accepted the decision of Kussakin (1979) that *D. torelliae* and *D. bicolor* are synonymous. However, it is clear that some of the specimens from the Black Sea have a reduced pleotelsonic boss, and the two may eventually turn out to be separate species when more material is examined. Kirkim et al. (2006) commented on the form of the pleotelsonic boss, stating that this can vary from two small projections to a well-formed

boss in specimens of '*D. torelliae*' from the Aegean Sea. Rathke's (1837) drawings of *D. bicolor* show the posterior halves of a female and a stage 7 male. The male has two joined hemispherical pleotelsonic bosses, which are similar to those found in the same stage of '*D. torelliae*' and unlike that of *D. edwardsi* the other species in the region, which is single.

Dynamene bifida Torelli, 1930

Restricted synonymy. *Dynamene bifida*: Torelli (1930).

Dynamene bifida: Holdich (1968, 1970).

Material examined. Specimens were examined from seven locations in Spain, Greece, France, Italy and Turkey in the Mediterranean – see the Suppl. materials 1 and 2. A number of literature records have been included where the diagrams clearly indicate this species.

Key morphological characters. In stage 8 males each arm of the bidentate process is large, tapering and with a well-developed, downwardly-directed accessory process a quarter of the way from the apex; the pleotelsonic boss is very small with raised pointed corners (Fig. 2G–H). In stage 7 females the pleotelsonic dome is smoothly rounded in side view and the pleotelsonic foramen is at the end of short tube (Fig. 3L–M).

Size. Adult males (stage 8) typically 5.0 × 3.0 mm, although a specimen of 7.0 mm length has been seen; pre-ovigerous females (stage 7) typically 4.0 × 2.0 mm.

Life-history. Nothing is known of the life-history of this species, other than the fact that sexual dimorphism occurs with males developing the bidentate process characteristic of the genus.

Habitat. Adults, including stage 8 females, were found among *Hydroides unicata* colonies and other cryptic habitats in the Bay of Naples (Torelli 1930, Holdich 1970). Ledoyer (1962) recorded it from *Ulva lactuca* at Endoume, southern France, and Holthuis (unpublished records) from rocky shores amongst algae at 0.0–1.0 m at Banyuls-sur-Mer. The latter record included stage 8 females.

Colour. All specimens seen were a pale, sandy yellow. No polychromatism was observed.

Geographical distribution. The distribution of this species shown in Holdich (1970) has been extended by the present study. It has a widespread distribution in the Mediterranean stretching from southern Spain to Turkey (Fig. 5C).

Remarks. Originally described by Torelli (1930) from the Bay of Naples, males of this distinctive, and sometimes large, species has been infrequently recorded, and females even less so. The accessory process on each arm of the bidentate process is similar to that found in the Australian species, *D. ramuscula* (Holdich and Harrison 1980). The fact that ovigerous females were found amongst shallow-water algae raises questions about the life-history of this species, although in the Bay of Naples this stage has been recorded with males in more protective habitats.

Dynamene edwardsi (Lucas, 1849)

Restricted synonymy. *Naesa edwardsi*: Lucas (1849).

Dynamene hanseni: Monod (1923).

Dynamene edwardsi: Holdich (1968a, 1970); Harrison (1982).

Dynamene bidentata: Picker and Griffiths (2011).

An extensive synonymy was given by Holdich (1968a, c) for citations prior to 1968.

Material examined. Specimens were examined from 89 locations in NE Atlantic, Mediterranean, Adriatic, Aegean and Red Seas – see Suppl. materials 1 and 2. A number of literature records, e.g., the Suez Canal, have been included where the diagrams clearly indicate this species.

Life-history. Nothing is known of the life-history of this species, other than the fact that sexual dimorphism occurs with males developing the bidentate process characteristic of the genus.

Key morphological characters. Body convex; in stage 8 males the apices of arms of the bidentate process are swollen, each with a short, downwardly-directed spur; the pleotelsonic boss is plate-like with two forward-facing pegs; the body exhibits various degree of setation (Fig. 2E–F), e.g., specimens examined from the Balearic Islands (Spain) and the island of Chios (Greece) are somewhat different from other *D. edwardsi* seen by us in being very hirsute, with a pronounced developing boss and respiratory tube in the stage 7 males. In stage 7 females the pleotelsonic dome is keeled in side view, with a median protuberance; the pleotelsonic foramen is at the end of a short tube (Fig. 3E–G). Further details are provided by the scanning electron microscope pictures of the posterior body of a stage 8 male and a stage 7 female in Holdich (1976). See keys to stage 8 males and stage 7 females.

Size. Adult males (Stage 8) typically 5.5 × 2.25 mm; pre-ovigerous females (stage 7) typically 3.0 × 1.1 mm, specimens of 4.4 × 2.3 mm have been seen from the Venice Lagoon, Italy.

Habitat. Juveniles and adults have been found amongst a variety brown, green and red algae in the littoral and sublittoral zones, sometimes in conjunction with *D. bicolor* in the Mediterranean, and with *D. bidentata* and *D. magnitorata* on Atlantic coasts. Adults have also been recorded from amongst mussels and tube worm colonies and barnacle tests in the Bay of Naples (Torelli 1930, Holdich 1970), and elsewhere in the Mediterranean (e.g., Rivosecchi 1961, Bellan-Santini 1962). It has been found associated with encrusting matter on solid surfaces in some harbours and canals. On occasions it has been found amongst the 'trottoir' on steep-sided cliffs as deep as 10 m. Monod (1932) recorded it from coralline and fucoid algae on the coast of NW Africa. In the Azores, adults have been recorded from empty *Chthamalus stellatus* tests attached to lower shore cobbles, along with *Campecopea lusitanica*. In West Portugal (Buarcos) it is present with *D. bidentata* and *D. magnitorata*. However, while *D. bidentata* adults were present in barnacles, no *D. edwardsi* were found inside barnacles, only among intertidal algae and on a few 'small' algae in shaded crevices at 0-1 m. Also, they were not present among mussels. Unusually, adults, including stage 8 females, were found in upper shore sandstone crevices, along with *Campecopea hirsuta*, in southern Portugal.

Colour. The general body colour is a dull grey-green, individuals sometimes exhibit polychromatism caused by patterns of white, dorsal, non-adaptable chromatophores as seen in some of the other species (Holdich 1969).

Geographical distribution. The distribution of this species shown in Holdich (1970) has been extended by the present study. It is the most meridional of the Atlantic species, occurring from Galicia in north-western Spain to Nouadhibou in Mauritania (Fig. 5D). This is the currently known southern limit of *Dynamene* species of the NE Atlantic-Black Sea axis. It is widespread in the Macaronesian islands and in the eastern and western Mediterranean (Fig. 5D). The most northerly record comes from the Venice Lagoon in the Adriatic Sea. It is also the only *Dynamene* species recorded from the Red Sea, in the Gulf of Aqaba (Fig. 5D). Glynn (1972) recorded a species that is clearly *D. edwardsi* from the Suez Canal. Picker and Griffiths (2011) have recorded this species (as *D. bidentata*) from South Africa.

Remarks. *Dynamene edwardsi* occupies a wide vertical range in the littoral zone on NE Atlantic shores, and from the littoral zone down to 10 m in the Mediterranean. In recent field work, it was found to be very abundant in the Canary Islands and Madeira archipelago, whereas *D. magnitorata* was more common in the Azores and *D. edwardsi* rare. It is the most southerly of the *Dynamene* species extending down the West African coast to Mauritania and the only record for tropical waters. Glynn (1972) suggested that *D. edwardsi* has migrated from the Mediterranean throughout the whole length of the canal. Our study has shown that it has now reached the Gulf of Aqaba in the Red Sea

The records for the Suez Canal and Red Sea are interesting as they show movement from the Mediterranean Sea into the Red Sea, whilst many marine species are moving in the opposite direction (Galil et al. 2014). No *Dynamene* species have yet been recorded from the Indian Ocean (Schotte and Kensley 2005). However, a stage 8 male has been recorded from Port Elizabeth harbour in South Africa by Picker and Griffiths (2011). They suggest that it may have been introduced as a fouling organism or in ballast water. It is known that this species can be transported amongst fouling organisms on ships, as evidenced by the finding a stage 8 male on a ship in Tangiers harbour (Morocco) (see Suppl. material 1).

This species is variable in its morphology and particularly in the degree of hirsuteness. It may be that some of the specimens collected from the Balearic and Greek islands are in fact a new species, but more material is needed to prove this. Ideally, a molecular genetic analysis needs to be carried out on Mediterranean and Adriatic specimens. Such a technique applied to specimens from some NE Atlantic coasts and Macaronesian islands has shown that a number of cryptic species may be present (Vieira et al. 2015).

Dynamene magnitorata Holdich, 1968

Restricted synonymy. *Dynamene magnitorata*: Holdich (1968).

Dynamene bidentata: Monod (1932); Maggiore and Fresi (1984).

Dynamene magnitorata: Holdich (1968a, 1970, 1976).

Material examined. Specimens were examined from 52 locations in the NE Atlantic, and four countries in the Mediterranean – see the Suppl. materials 1 and 2. A number of literature records have been included where the diagrams clearly indicate this species.

Key morphological characters. Body convex; in stage 8 males the pleotelsonic boss is large, bilobed, with the two halves separated by a narrow groove; the arms of the bidentate process are of similar width along their lengths and are dorsally tuberculate (Holdich 1976, fig. 3A, B; Fig. 2C–D in this paper). In stage 7 females the pleotelsonic dome is keeled in side view and the pleotelsonic foramen is flush with the edge of the pleotelson (Fig. 3C–D). Further details are provided by the scanning electron microscope pictures of the posterior body of a stage 8 male and a stage 7 female in Holdich (1976). The females of this species are very difficult to separate from those of *D. bicolor*. See keys to stage 8 males and stage 7 females.

Size. Adult males (stage 8) typically 4.25 × 2.25 mm, pre-ovigerous females (stage 7) typically 4.0 × 2.0 mm.

Life-history. A comparison of the life-histories of *D. bidentata* and *D. magnitorata* from two Atlantic coast locations was made by Holdich (1976). Only a limited number of *D. magnitorata* specimens were available but it showed that this species has a similar sequence of seasonal events (see description for *D. bidentata*). However, whereas *D. bidentata* stage 8 males live for two breeding seasons, those of *D. magnitorata* may only live for one.

Habitat. A mid- to lower littoral and shallow sublittoral species, although sometimes recorded from deeper water. Its range occasionally overlaps that of *D. bidentata*. Juveniles are found associated with a wide range of littoral and shallow water algae, particularly *Corallina* sp., *Rhodomenia palmata*, *Chondrus cripspus* and *Gigartina stellata*. Adults have been found in empty tests of *Balanus crenatus*, amongst ascidians, and in channels within sponges (including those associated with eel grass beds). In the Roscoff region (northern France) adults were frequently found within the encrusting sponge, *Halichondria* sp. In the Azores (São Miguel island) adults have been found sublittorally in the empty tests of *Megabalanus azoricus*, as well as intertidally among algae on the islands of Terceira, São Miguel and Santa Maria. On Fuerteventura (Canary Islands) adult males were caught using a surface dip net. In the Chafarinas Islands off Mediterranean Morocco they have been recorded from 0.0m down to 20.0 m on a variety of algae. Like *Dynamene bidentata* (Harvey et al. 1973), *D. magnitorata* adults were found to have a tolerance to high air temperatures, i.e., 38° C (Holdich 1976). However, survival at 5° C was much lower for *D. magnitorata* compared to *D. bidentata* (Holdich 1976) and this may be the reason it has not colonized more northerly regions.

Colour. Individuals exhibit a wide variety of colours, often matching the colour of their background, the predominant colours being coralline-pink and brown, rather than the greens and yellows seen in *D. bidentata.* Individuals sometimes exhibit polychromatism caused by white, dorsal, non-adaptable chromatophores, as seen some other species (Holdich 1969, 1976).

Geographical distribution. The distribution of this species shown in Holdich (1970) has been extended by the present study. It has been recorded from southern

England (a single specimen only that may be the result of a stranding), the Channel Islands, around the coasts of Brittany, the Atlantic Iberian Peninsula and northwest Africa, the islands of the Azores, Canary Islands and Madeira in the Macaronesian archipelagos, and in the Mediterranean along the European and African coasts, and also Egypt (Fig. 5E).

Remarks. Almost all the *Dynamene* specimens found in the Azores during recent field work belonged to *D. magnitorata*. However, *Dynamene* was less prevalent in the benthic community when comparing with Canaries and Portugal (pers. obs., unpublished data). Maggiore and Fresi (1984) described *D. bidentata* from the Bay of Naples, but in fact examination of the specimen showed it to be a male *D. magnitorata*. If the author's had compared an actual *D. bidentata* with their specimen then they would have realized this, particular as it is so much smaller than any known *D. bidentata* specimen. *Dynamene magnitorata* has only rarely been recorded in the Mediterranean, i.e. twice in Spain, and once in each of Egypt, Italy, Monaco and Tunisia, although it was found to be common on the Chafarinas Islands off Morocco (Castellanos et al. 2003) (see Suppl. material 1).

Dynamene tubicauda Holdich, 1968

Restricted synonymy. *Dynamene tubicauda* Holdich (1968).

Dynamene tubicauda: Holdich (1968a, 1970); Lombardo (1984); Borg et al. (2006).

Material examined. Specimens were examined from six Italian locations in the Bay of Naples and off the island of Elba, and one location off Malta - see the Suppl. materials 1 and 2. A number of literature records from Sicily have been included as the diagrams clearly indicate this species (Lombardo 1984).

Key morphological characters. The morphology of this species is unique amongst the known *Dynamene* species - in stage 8 males the pereon length and width are similar; the epimera and front of the head form a shelf; the antennular peduncle is expanded; there are two widely separated, peg-like pleotelsonic bosses; and the pleotelsonic foramen is at the end of a ventrally-closed tube (Fig. 2I). In stage 7 females the body is also flattened with the epimera forming a shelf round the body; the pleotelsonic foramen is at the end of a well-developed tube (Figs 3J–K). See keys to stage 8 males and stage 7 females.

Size. Adult males (stage 8) typically 3.0 × 2.0 mm, pre-ovigerous females (stage 7) typically 2.5 × 2.0 mm.

Life-history. Nothing is known of the life-history of this species, other than the fact that sexual dimorphism occurs with males developing the bidentate process characteristic of the genus. Holdich (1968) only recorded males, but both sexes have been recorded in the present study. Lombardo (1984) was the first to describe the adult female.

Habitat. This species has been found between 2-30 m amongst algae in muddy/sandy and coralline habitats, rock scrapings, freely swimming at 30 m, and also in sea grass meadows (Lombardo 1984, Borg et al. 2006).

Colour. Pale yellow. No polychromatism was observed.

Geographical distribution. The distribution of this species shown in Holdich (1970) has been extended by the present study. However, it appears to be restricted to the eastern Mediterranean, having only been recorded off the west coast of Italy (Holdich 1968), Sicily (Lombardo 1984) and Malta (Borg et al. 2006) (Fig. 5F). The most northerly record is for the island of Elba and the most southerly is off Malta.

Remarks. The distribution of this species is the most restricted of all the *Dynamene* species along the NE Atlantic-Black Sea axis. Considering the large number of samples examined during this study this restricted distribution is most likely real. Its unusual flattened shape and the position of the pleotelsonic foramen at the end of a tube, even in adult males, may be an adaptation to inhabiting sediments.

***Dynamene* sp.**

Material examined. Two stage 8 males. See the Suppl. materials 1 and 2.

Key morphological characters. The bilobed pleotelsonic boss has a posteriorly-directed spine not seen in any other stage 8 males. The uropodal exopod is wide and the body markedly hirsute.

Habitat. Known only from the stomach contents of a black scorpionfish *Scorpaena porcus*.

Geographical distribution. Known only known from NW Aegean Sea.

Remarks. Only two specimens have been found, both stage 8 males, and both from the stomach contents of a black scorpionfish, *Scorpaena porcus*. This could well be a new species of *Dynamene*, but more material is needed to confirm this. It may even be related to the hirsute specimens found in the Balearic Islands and the Greek island of Chios. The fish is known to be a bottom feeder in the Black Sea, close to where the specimen came from, which was in the NW Aegean, where it occurs at 20–40 m depth (Başçïnar and Sağlam 2009). Rafrafi-Nouira et al. (2016) examined the diet of *S. porcus* from waters off the coast of Tunisia, but the only isopods they found were listed as unidentified.

Discussion

Three species of *Dynamene* occur on the shores of the continent and islands of the NE Atlantic Ocean (*D. bidentata*, *D. magnitorata* and *D. edwardsi*). In recent field work, no *Dynamene* specimens were collected in Scandinavia or Iceland (pers. obs., unpublished data). This is probably due to the fact that members of this genus may not be able to tolerate cold water and weather. For example, studies by Holdich (1968b, c, 1970) were meant to be carried out on the Gower Peninsula in South Wales, but the severe and long-lasting winter of 1962-1963 decimated the populations, as well as those of *Balanus perforatus*, and the study site was relocated to western Pembrokshire in 1964 (SW Wales), where the populations of both were unaffected. Moyse and Nelson-Smith (1964) showed that when sea and air temperatures were below 5°C for a long period, viable broods were not produced by females of *D. bidentata*. Moreover, with lower average air temperatures, populations of *Dynamene* must restrict their growth phases to fewer months of the year (Holdich

1976). The previously known northerly limit of *Dynamene* was Ardrossan in the west of Scotland (Holdich 1970). In this study, we extended the northern range of this genus to Clatholl in the north of Scotland, and recent surveys by British workers have shown that it also occurs in the Shetland Islands north of Scotland. There are a number of records for the Western Isles off Scotland (Fig. 5A) that are warmed by the Gulf Stream. However, one record is shown from north-eastern England (Fig. 5A), which tends to be colder than the west coast due to a lack of influence from the Gulf Stream, but it is not known if a permanent population exists there. It may represent a stranding from a population elsewhere. Holthuis (1956) recorded *D. bidentata* from the other side of the North Sea in The Netherlands. He was of the opinion that it was not indigenous there, but was occasionally stranded with flotsam and jetsam. There are old records in the literature of *D. bidentata* for eastern Scotland (Scott 1899) and also for south-east England (Butler 1878), but none (other than the record mentioned above) have come to light in the last few decades.

Dynamene bidentata is the only species present in the British Isles (Holdich 1969, 1970; Holdich and Lincoln 1974). Although in our databases there is a record of *Dynamene magnitorata* in southern England, we believe this probably does not represent an actual permanently established population. However, *D. magnitorata* is common on Guernsey (Channel Islands), which is not that far geographically from the south of England. According to Holdich (1970), and confirmed by the current study, *D. bidentata* is distributed along the Atlantic coasts of Europe from the northern British Isles to Portugal. Barrois (1888) recorded *D. bidentata* from the Azores, and it is listed as being present there by Ferraz et al. (2004) and Borges et al. (2010). Rodrigues (1990) recorded it as being common on the island of Flores. However, none of the specimens we have examined from the Azores have been of this species, and the records may well have been *D. magnitorata* or *D. edwardsi*. Pereira et al. (2006), Guerra-García et al. (2011), Izquierdo and Guerra-García (2011), Guerra-García et al. (2012) and Torrecilla-Roca and Guerra-García (2012) recorded it from southern Portugal and southwest Spain, and indicated that these regions as the most meridional locations where this species was collected. Our observations extend the distribution of *D. bidentata* further south, i.e., Akhfenir in Morocco and Tenerife and Gran Canaria in the Canary Islands. Because *D. bidentata* can survive at temperatures up to 38° C (Harvey et al. 1973), it is possible that this species occurs further south.

During the current study the authors examined many collections from the Mediterranean and we did not find any *D. bidentata*. It has been pointed out above that Torelli's (1930) '*D. bidentata*' from the Bay of Naples is in fact *D. bicolor*, as are a number of other references to *D. bidentata* in the literature. Also, Maggiore and Fresi's (1984) '*D. bidentata*' from the Bay of Naples is a *D. magnitorata*. From the examination of some other collections we also conclude that Castello's (1986) '*D. bidentata*' is an *Ischyromene* sp., that Kirkim's (1998) '*D. bidentata*' is *D. bicolor*, and that Castellanos' et al. (2003) '*D. bidentata*' is *D. magnitorata*. It is not impossible that *D. bidentata* occurs in the western Mediterranean as it has been recorded close to the Strait of Gibraltar (Torrecilla-Roca and Guerra-García 2012), but currently there is no evidence for this.

On Atlantic mainland coasts and islands, *D. bidentata*, *D. edwardsi* and *D. magnitorata* are usually present in the midlittoral to sublittoral zones, although occasionally they are found higher up the shore. Usually the juveniles are present among the fronds of

brown, red and sometimes green algae, whilst the adults inhabit cryptic habitats such as crevices, empty barnacle tests, mussel beds and encrusting organisms. Individuals often match the colour of the algae they are feeding on and additional camouflage is afforded by linear and globular patterns of white chromatophores on the dorsal surface (Tinturier-Hamelin 1962, Holdich 1969, 1976). In the Mediterranean and Black Seas, *D. magnitorata*, *D. bifida*, *D. bicolor* and *D. edwardsi* usually inhabit shallow water zones, although the last two species can also be present in deeper water off steep-sided islands. Juveniles of these species inhabit algae whilst adults are usually found in more cryptic habitats, but sometimes amongst algae. *Dynamene tubicauda* has been found between 2-30 metres amongst algae in muddy/sandy and coralline habitats, rock scrapings, freely swimming at 30 m, and also in sea grass meadows (Lombardo 1984, Borg et al. 2006, Holdich, pers. obs.). The vertical range of *D. bicolor* is the largest, extending from shallow-water algae and cryptic habitats such as barnacles down to 33 m off steep-sided islands. The vertical ranges of some *Dynamene* species may overlap, e.g., *D. bidentata* and *D. magnitorata* on Atlantic Ocean shores, although the latter usually occurs at a lower level on the shore (Holdich 1970, Arrontes and Anadón 1990a; Castelló and Carballo 2001, Guerra-García et al. 2011, Izquierdo and Guerra-García 2011). *Dynamene bicolor* and *D. edwardsi* frequently inhabit the same shallow-water algae in the Mediterranean.

Conclusions

Six species of *Dynamene* are present along the NE Atlantic-Black Sea axis, and one species extends into the Red Sea. It would appear that *D. bidentata* is restricted to coastal habitats of the NE Atlantic, no evidence was found to suggest it inhabits the Mediterranean. *Dynamene magnitorata* has a wider geographical range, occurring on coastal habitats of the NE Atlantic as well as those of the Mediterranean. *Dynamene edwardsi* has the widest geographical range of the six species under consideration, extending from the Macaronesian archipelagos in the NE Atlantic, down the north-western coast of Africa, through the Mediterranean into the Suez Canal and Red Sea. It is not known if a recent record from South Africa represents an introduction or an established population. *Dynamene bicolor*, *D. bifida* and *D. tubicauda* are restricted to the Mediterranean, although *D. bicolor* also extends into the Black Sea. *Dynamene bicolor* is the most commonly found and most wide-spread *Dyamene* species in the Mediterranean. *Dynamene bifida* has only been recorded at six locations, but its range extends from southern Spain to Turkey. *Dynamene tubicauda* has the smallest geographical range having only been recorded for Italy and Malta. Some species have large vertical ranges, having been found intertidally down to 30 m. It is highly probable that some of the records for the *Dynamene* species are the result of introductions via fouling organisms attached to ocean-going vessels, e.g., *D. magnitorata* and *D. bifida* with their sporadic distribution in the Mediterranean, and *D. edwardsi* in South Africa.

There are still a number of outstanding issues relating to *Dynamene* that can only be dealt with if more material becomes available. Firstly, the status of the hirsute spe-

cies from the Balearic Islands and the Greek island of Chios – are these a form of *D. edwardsi* or a new species? Secondly, the status of '*D. torelliae'* – is it really synonymous with *D. bicolor* from the Black Sea? Thirdly, the status of the specimens found in the *Scorpaena porcus* stomach, which appears different from the other species, but cannot be confirmed until more stage 8 males are found. Fourthly, a genetic analysis of all the species needs to be carried out to ascertain the taxonomic status and species boundaries, and the phylogenetic relationships between species, especially those in the Mediterranean and Black Seas. Currently, only *D. bidentata*, *D. magnitorata* and *D. edwardsi* from NE Atlantic coasts have been analyzed, and have been found to be distinct.

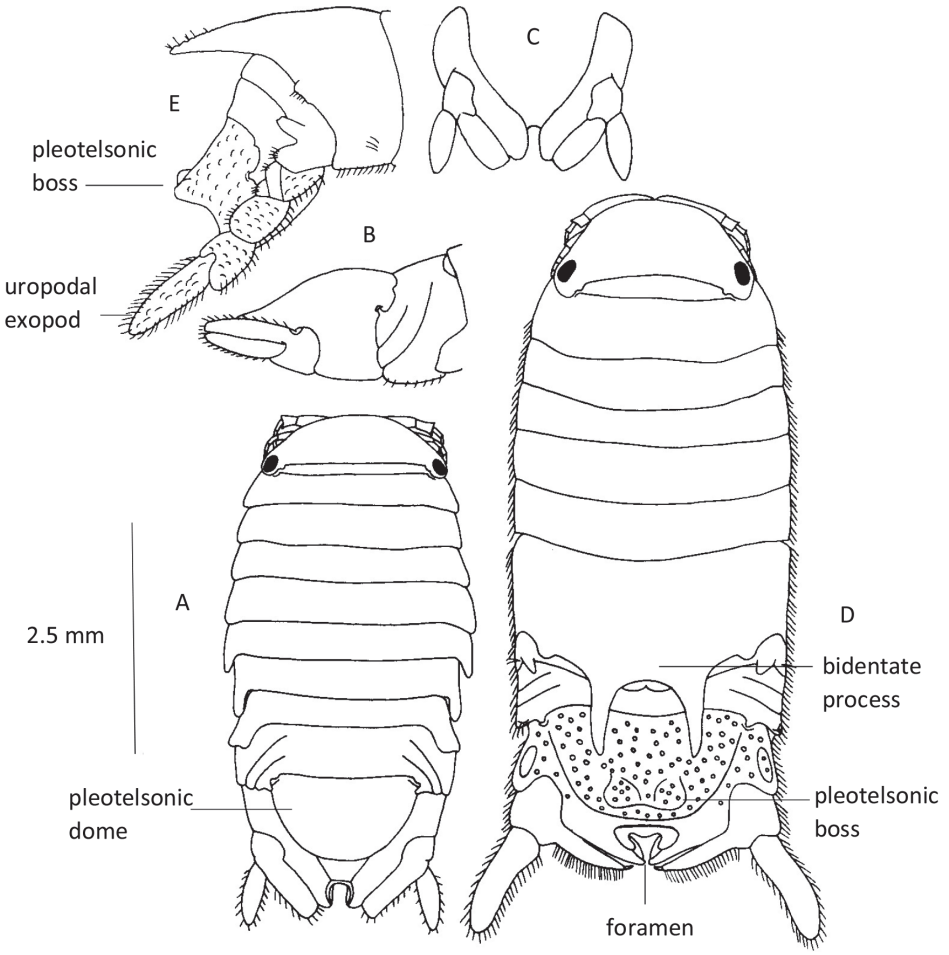

Figure 1. Adult male (stage 8) and pre-ovigerous female (stage 7) *Dynamene bidentata*. **A** Dorsal view of stage 7 female **B** Lateral view of pleon (with posterior border of pereonite 7), pleotelson and right uropod of stage 7 female **C** Ventral view of pleotelson and uropods of stage 7 female **D** Dorsal view of stage 8 male **E** Lateral view of pereonal segment 6, pleon, and pleotelson and exopod of right uropod of stage 8 male. Adapted from Holdich (1968b).

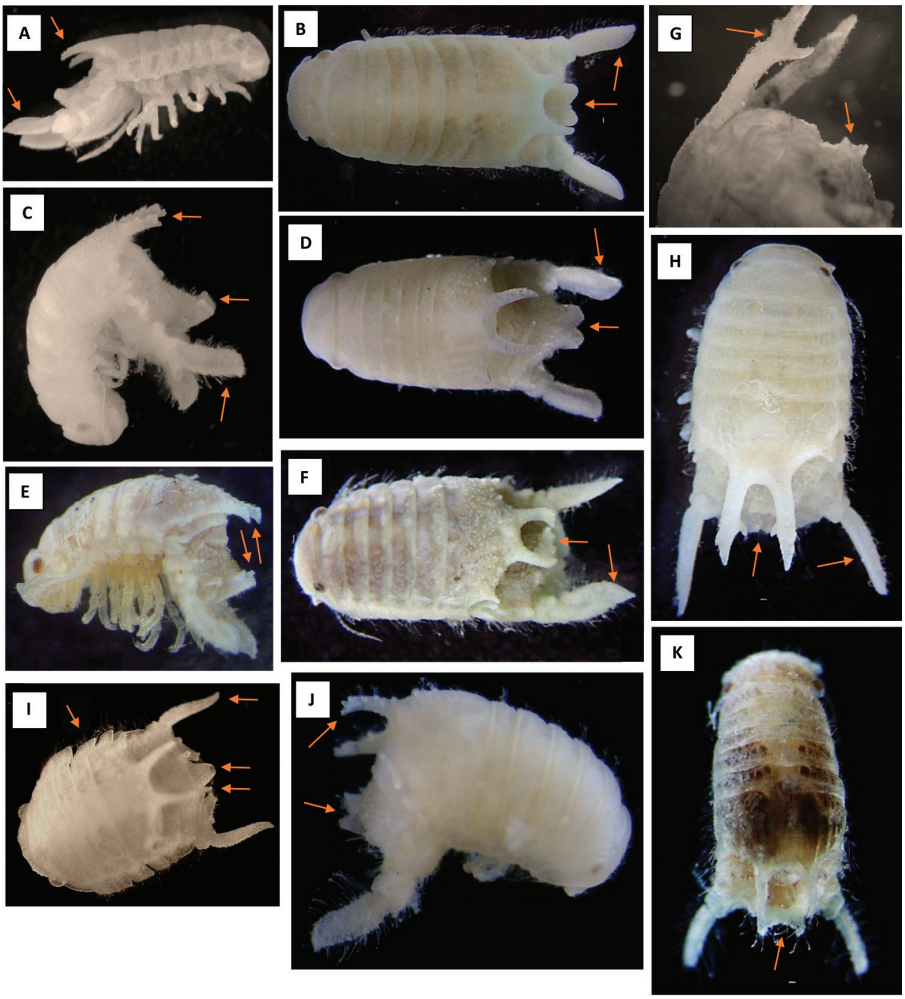

Figure 2. Main features of adult males (stage 8) of the NE Atlantic-Black Sea axis *Dynamene* spp. **A, B** *D. bidentata* (S. Wales). Arrows indicate shape of the bidentate process (**A**), uropods (**A, B**) and pleotelsonic boss (**B**) **C, D** *D. magnitorata* (Roscoff, France). Arrows indicate shape of the bidentate process (**C**), the uropods (**C, D**) and the pleotelsonic boss (**C**, **D**). Note the difference in the shape of the boss and the ends of the arms of the bidentate process to those of *D. bidentata* **E, F** *D. edwardsi* (**E** Canaries **F** Azores). Arrows indicate shape of the bidentate process (**E, F**), uropods (**F**) and pleotelsonic boss (**E, F**). Specimen in E shows relatively little dorso-lateral setation, whilst that in **F** is hirsute. Note the differences in the shape of the boss and the tips of the arms of the bidentate process compared to those of *D. bidentata* and *D. magnitorata* **G, H** *D. bifida* (France, Mediterranean). Arrows indicate shape of the bidentate process (**G, H**), uropodal exopod (H) and pleotelsonic boss (**G**). Note the large accessory process on each arm of the bidentate process, the small sessile pleotelsonic boss and the long narrow uropodal exopods **I** *D. tubicauda* (Bay of Naples, Italy). Arrows indicate the unique body shape, tubular respiratory channel, peg-like pleotelsonic bosses, and the curved uropodal exopods **J, K** *D. bicolor* (Bay of Naples, Italy). Arrows indicate shape of the bidentate process (**J**), and pleotelsonic boss (**J, K**). Note in particular the rugose nature of the dorsal surface of the bidentate arms, and the triangular shape of each half of the boss – in specimens from the Black Sea the boss is of a similar shape but much less prominent.

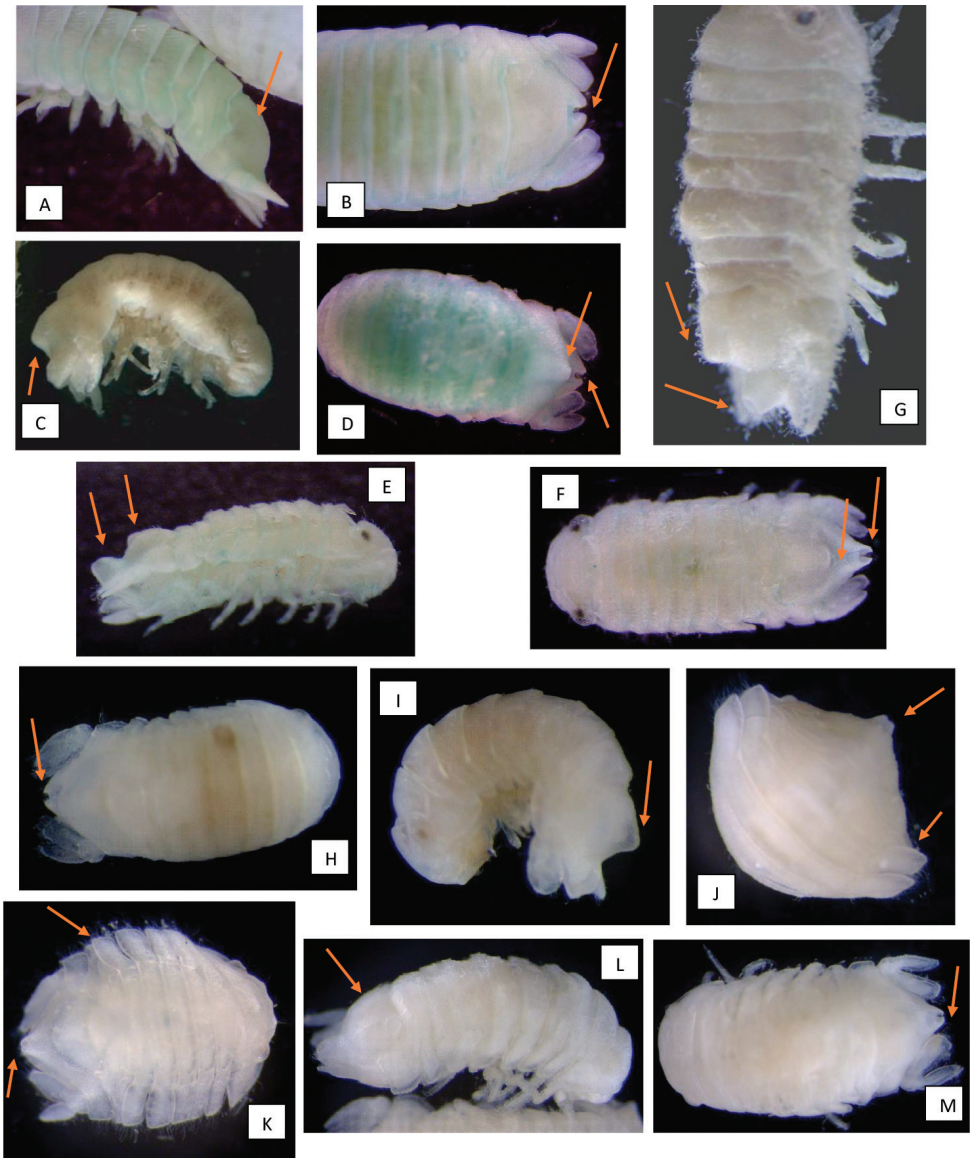

Figure 3. Main features of females and juveniles of the NE Atlantic-Black Sea axis *Dynamene* spp. **A, B** *Dynamene bidentata* (S. Wales). Arrows indicate smooth outline of pleotelsonic dome (**A**) and non-tubular pleotelsonic foramen (**B**) **C, D** *Dynamene magnitorata* (Roscoff, France). Arrows indicate angular outline of pleotelsonic dome (**C**), posterior extension of pleotelsonic keel and non-tubular pleotelsonic foramen (**D**) **E, F, G** *Dynamene edwardsi* (Italy). Arrows indicate angular outline of pleotelsonic dome (**E**) with central bulge (**E, F, G**) and tubular pleotelsonic foramen. (**E** and **F** from Naples, Italy **G** hirsute female from the Venice Lagoon, Italy) **H, I** *Dynamene bicolor* (Naples, Italy). Arrows indicate angular outline of pleotelsonic dome (**I**) and non-tubular pleotelsonic foramen (**H**) **J**, **K** *Dynamene tubicauda* (Ischia, Italy). Arrows indicate flattened epimera surrounding body that give this species a unique body shape (**J, K**) and the tubular pleotelsonic foramen (**J, K**) **L, M**. *Dynamene bifida* (Ischia, Italy). Arrows indicate smooth outline to pleotelsonic dome (**L**) and pleotelsonic foramen at end of short tube (**M**).

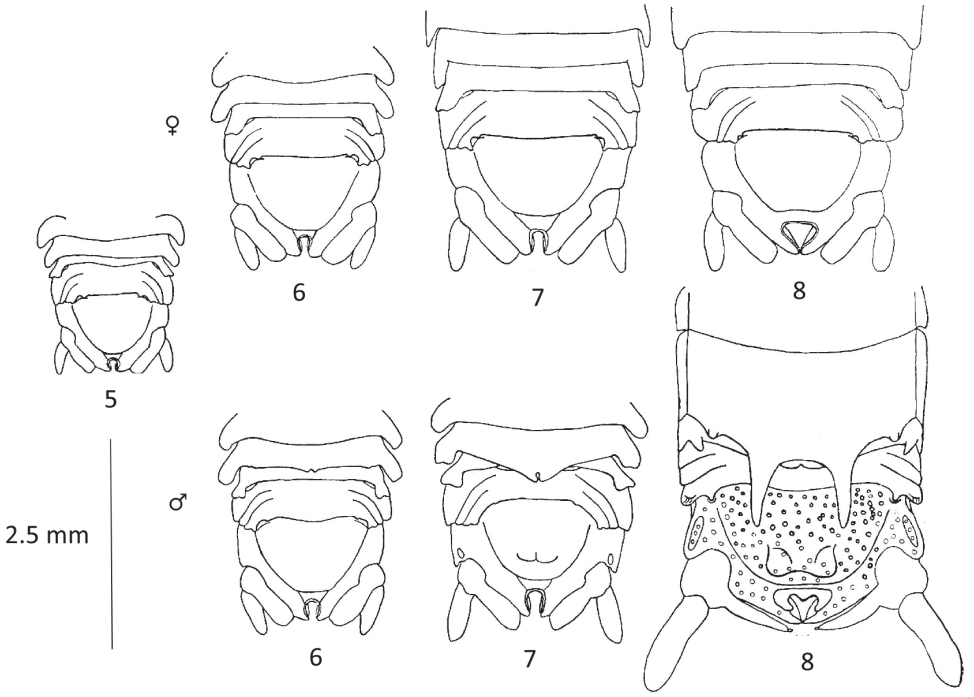

Figure 4. Dorsal views of the posterior halves of the bodies of various life history stages (**5–8**) of *Dynamene bidentata*. **5** juvenile **Upper row** female stages **6, 7, 8** (ovigerous) **Lower row** male stages **6, 7, 8**. Adapted from Holdich 1968b.

Key to the adult males (stage 8) of *Dynamene spp.* along the NE Atlantic-Black Sea axis

1 With a bidentate process arising from posterior margin of pereonite 6 - sub-adult and adult ♂ *Dynamene* (Figs 1, 2, 3)..... **2**

– Without bidentate arising from posterior margin of pereonite 6 ....**juvenile and ♀ *Dynamene*** (see key to females)

2 With large bidentate process arising from posterior margin of pereonite 6: adult ♂ *Dynamene* (Figs 1D, 2A–K)..... **3**

– With small or medium bidentate process arising from posterior margin of pereonite 6.....**sub-adult ♂ *Dynamene*** (Fig. 4–lower row 6-7)

3 Pereon length and width similar; epimera and front of head forming a shelf; antennular peduncle expanded; two widely separated, peg-like pleotelsonic bosses; pleotelsonic foramen at end of a ventrally-closed tube (Fig. 2I)..... .....***D. tubicauda***

– Pereon length greater than width, pleura and front of head not forming a shelf; antennular peduncle not expanded; pleotelsonic boss single..... **4**

4 Bidentate processes large, tapering and with a well-developed, downwardly-directed accessory process a quarter of the way from the apex; pleotelsonic

boss very small with raised pointed corners (Fig. 2G–H) .... ***D. bifida***

– Bidentate processes without well-developed accessory process; pleotelsonic boss well-developed, without raised pointed corners **5**

5 Apices of bidentate processes swollen, each with short, downwardly-directed spur; pleotelsonic boss plate-like with two forward-facing pegs; body exhibiting various degree of setation, sometimes hirsute (Fig. 2E–F) ... ***D. edwardsi***

– Bidentate processes without swollen apices or spurs, pleotelsonic boss not plate-like.....**6**

6 Pleotelsonic boss comprised of two right-angled triangular structures separated by a deep groove (however, the boss may be very low lying in some specimens, e.g. those from the Black Sea); arms of bidentate process tapering to point, rugose dorsally (Fig. 2J–K) .....***D. bicolor***

– Pleotelsonic boss comprising two hemispherical structures separated by a wide or a narrow groove, joined at the base.....**7**

7 Pleotelsonic boss large, bilobed, two halves separated by a narrow groove; arms of bidentate process of similar width with along length, dorsally tuberculate (Fig. 2C–D).....***D. magnitorata***

– Pleotelsonic boss large, bilobed, two halves separated by a wide v-shaped groove; arms of bidentate process tapering to point, sparsely rugose dorsally (Fig. 2A–B).....***D. bidentata***

Key to pre-ovigerous females (stage 7) and juveniles of *Dynamene* spp. along the NE Atlantic-Black Sea axis

1 Sphaeromatid without process arising from the posterior margin of the pereonite 6, and with simple pleotelsonic foramen; with or without dorsal tuberculation ..... **juvenile and ♀♀ *Campecopea*, *Dynamene* and *Ischyromene***

– Without tuberculation on surface of posterior pereonites, pleonites and/or pleotelsonic dome (Figs 1A, B; Figs 4-upper row 6-8, 3A–M) .... juvenile and ♀♀ *Dynamene*...**2**

2 Body flattened, epimera flattened to form a shelf round the body; pleotelsonic foramen at end of a well-developed tube (Fig. 3J-K) ..... ***D. tubicauda***

– Body convex, pleura not flattened to form shelf round body; pleotelsonic foramen either flush with edge of pleotelson or at end of a short tube.....**3**

3 Pleotelsonic dome smoothly rounded in side view, pleotelsonic foramen open and flush with edge of pleotelson or at end of short tube **4**

– Pleotelsonic dome keeled in side view, with or without a median protuberance **5**

4 Pleotelsonic foramen open and flush with edge of pleotelson (Fig. 3A–B) ....***D. bidentata***

– Pleotelsonic foramen at end of short tube (Fig. 3L–M)..... ***D. bifida***

5 Pleotelsonic dome keeled in side view, pleotelsonic foramen flush with edge of pleotelson ..... Fig. 3C–D – ***D. magnitorata*** and Fig. 3H, I – ***D. bicolor***

– Pleotelsonic dome keeled in side view, with median protuberance; pleotelsonic foramen at end of short tube (Fig. 3E, F, G)..... ***D. edwardsi***

Notes: When identifying *Dynamene* juveniles and ♀♀ care must be taken not to confuse them with those of *Ischyromene lacazei* Racovitza, 1908 and *Campecopea lusitanica* (Nolting, Reboreda and Wägele, 2008). If in doubt, then consult Schüller and Wägele (2005) and Bruce and Holdich (2002) respectively.

Except for size, juveniles are very similar to stage 7 females. *Dynamene magnitorata* and *D. bicolor* females are very similar and cannot be keyed out, except on size – on average *D. magnitorata* tends to be larger (see main text). Ovigerous females are very similar between species and it is not possible to create a key for them. They are characterized by metamorphosed mouthparts, ventral marsupium, wide body and a pleotelsonic foramen that is more upturned and which gradually becomes closed posteriorly (Fig. 4–upper row 8).

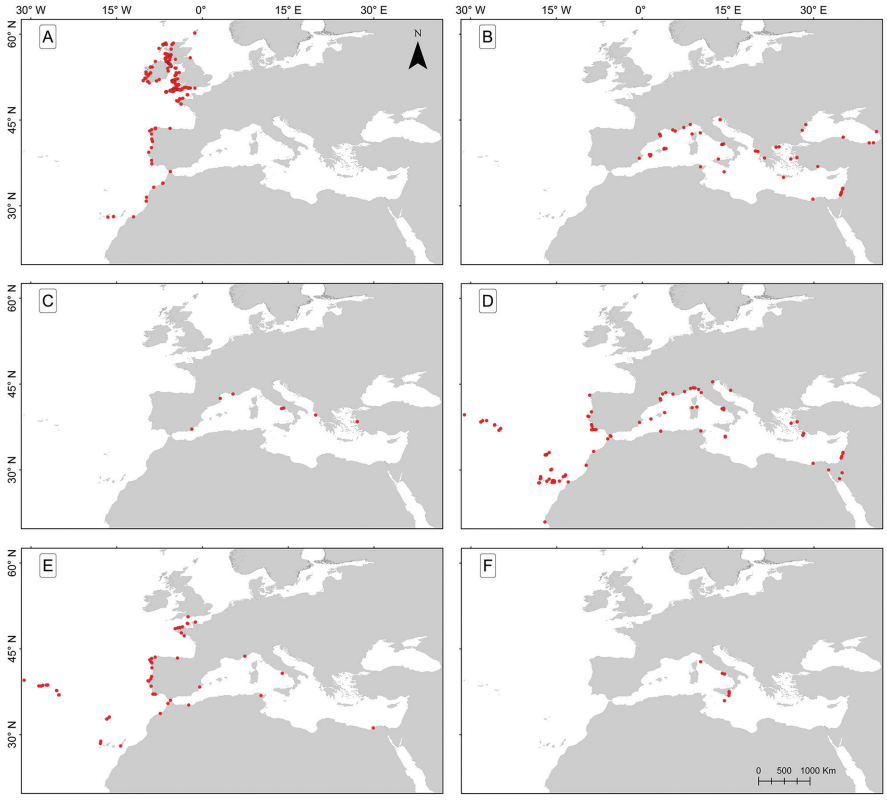

Figure 5. Distribution of *Dynamene* species along the NE Atlantic-Black Sea axis based on material validated during the present study. **A** *Dynamene bidentata* **B** *Dynamene bicolor* **C** *Dynamene bifida* **D** *Dynamene edwardsi* **E** *Dynamene magnitorata* **F** *Dynamene tubicauda*.

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References

Adams J (1800) Description of some marine animals found on the coast of Wales. Transactions of the Linnean Society of London 5: 7–13. doi: 10.1111/j.1096-3642.1800.tb00574.x

Arrontes J, Anadón R (1990a) Distribution of intertidal isopods in relation to geographical changes in macroalgal cover in the Bay of Biscay. Journal of Marine Biological Association of the United Kingdom 70: 283–293. doi: 10.1017/S0025315400035402

Arrontes J, Anadón R (1990b) Seasonal variation and population dynamics of isopods inhabiting intertidal macroalgae. Scientia Marina 54: 231–240. http://scimar.icm.csic.es/scimar/index.php/secId/6/IdArt/2445/

Arrontes J (1991) Colour polymorphism in relation to spatial distribution in some intertidal isopods in Northern Spain. Journal of Marine Biological Association of the United Kingdom 71: 749–758. doi: 10.1017/S002531540005342X

Bakir AK, Katağan T, Aker HV, Özcan T, Sezgin M, Ateş AS, Koçak C, Kirkim F (2014) The marine arthropods of Turkey. Turkish Journal of Zoology 38: 765–831. doi: 10.3906/zoo-1405-48

Barrett J, Yonge C (1964) Collins Pocket Guide to the Sea Shore. Collins, Ammanford, 272 pp.

Barrois T (1888) Catalogue des crustacés marins recueillis aux Açores durant les mois d'Août et Septembre 1887. LeBigot frères, Lille, 110 pp.

Başçïnar NS, Sağlam H (2009) Feeding habits of black scorpion fish *Scorpaena porcus*, in the South-Eastern Black Sea. Turkish Journal of Fisheries and Aquatic Sciences 9: 99–103. http://www.trjfas.org/uploads/pdf_735.pdf

Bellan-Santini D (1962) Étude floristique et faunistique de quelques peuplements infralittoral de substrat rocheux. Recueil des Travaux de la Station Marine d'Endoume 50: 249–262.

Borg JA, Rowden AA, Attrill MJ, Schembri PJ, Jones MB (2006) Wanted dead or alive: high diversity of macroinvertebrates associated with living and "dead" *Posidonia oceanica* matte. Marine Biology 149: 667–677. doi: 10.1007/s00227-006-0250-3

Borges PAV, Costa A, Cunha R, Gabriel R, Gonçalves V, Martins AF, Melo I, Parente M, Raposeiro P, Rodrigues P, Santos RS, Silva L, Vieira P, Vieira V (Eds) (2010) A List of the Terrestrial and Marine Biota from the Azores. Princípia, Cascais, 430 pp.

Bruce NL (1997) A new genus of marine isopod (Crustacea: Flabellifera: Sphaeromatidae) from Australia and the Indo-Pacific region. Memoirs of Museum Victoria 56: 145–234. http://biostor.org/reference/103898

Bruce NL, Holdich DM (2002) Revision of the isopod crustacean genus *Campecopea* (Flabellifera: Sphaeromatidae), with discussion of the phylogenetic significance of dorsal processes.

Journal of Marine Biological Association of the United Kingdom 82: 51–58. doi: 10.1017/S0025315402005179

Brusca R, Coelho VR, Taiti S (2015) Guide to the Coastal Marine Isopods of California. Tree of Life Web Project. http://tolweb.org/notes/?note_id=3004/ [cited 2015 July 11]

Butler E (1878) The natural history of Hastings and St. Leonards and the vicinity. 1st Suppl. United Kingdom.

Castellanos C, Hernández-Vega S, Junoy J (2003) Isópodos marinos (Crustacea: Isopoda) de las islas Chafarinas (Mediterráneo occidental). Boletin Instituto Español de Oceanografía 19: 219–233. http://www.revistas.ieo.es/index.php/boletin_ieo/article/view/133/126

Castelló J (1986) Sobre la fauna de crustáceos isópodos litorales de Cataluña y Baleares. (III). Flabeliifera. Publicaciones del Departamento de Zoología, Universidad de Barcelona 12: 59–69.

Castelló J, Carballo JL (2001) Isopod fauna , excluding Epicaridea , from the Strait of Gibraltar and nearby areas (Southern Iberian Peninsula). Scientia Marina 65: 221–241. doi: 10.3989/scimar.2001.65n3221

De Grave S, Holmes JMC (1998). The distribution of marine isopods (Crustacea) in Lough Hyne. Biology & Environment, Proceedings of the Royal Irish Academy 98B: 23–30. http://www.jstor.org/stable/20500015

Ferraz RR, Santos V, Visión S, Guerreiro G, Carditos F, Frade P, Tempera F, Santos RS (2004) Caracterização ecológica e sócio-económica do sítio de importância comunitária Costa Nordeste e Ponta do Topo (PTJOR0013) e medidas de gestão propostas. Arquivos do DOP (Série Estudos) 20/2004. University of Azores, Department of Oceanography and Fisheries. Azores (Portugal), IV, 57 pp.

Glynn, PW (1972) Isopoda of the Suez Canal. Israel Journal of Zoology 21: 275–300. doi: 10.1080/00212210.1972.10688366

Galil BS, Marchini A, Occhipinti-Ambrogi A, Minchin D, Narščius A, Ojaveer H, Olenin S (2014) International arrivals: widespread bioinvasions in European Seas. Ethology Ecology & Evolution 26: 2–3, 152–171. doi: 10.1080/03949370.2014.897651

Gönlügür-Demirci G, Katağan T (2004) Qualitative and quantitative investigations on *Ulva rigida* facies from the upper infralittoral zone along Sinop coast, middle Black Sea. In: Ozturk B, Mokievsky VO, Topaloğlu B (Eds) International Workshop on Black Sea Benthos, İstanbul (Turkey), April 2004. Turkish Marine Research Foundation, Istambul, 161–170.

Guerra-García JM, Baeza-Rojano E, Cabezas MP, García-Gómez JC (2011) Vertical distribution and seasonality of peracarid crustaceans associated with intertidal macroalgae. Journal of Sea Research 65: 256–264. doi: 10.1016/j.seares.2010.12.001

Guerra-García JM, Ros M, Izquierdo D, Soler-Hurtado MM (2012) The invasive *Asparagopsis armata* versus the native *Corallina elongata*: differences in associated peracarid assemblages. Journal of Experimental Marine Biology and Ecology 416/417: 121–128. doi: 10.1016/j.jembe.2012.02.018

Hansen HJ (1905) On the propagation, structure, and classification of the Family Sphseromidae. Quartely Journal of Microscopical Science 49: 69–135. http://biostor.org/reference/60090

Harrison K (1982) Taxonomy of some Australian serolid and sphaeromatid isopods (Crustacea). PhD Thesis, Nottingham, University of Nottingham.

Harrison K, Ellis JP (1991) The genera of the Sphaeromatidae (Crustacea: Isopoda): a key and distribution list. Invertebrate Taxonomy 5: 915–952. doi: 10.1071/IT9910915

Harvey CE, Jones MB, Naylor E (1973) Some factors affecting the distribution of estuarine isopods (Crustacea). Estuarine and Coastal Marine Science 1: 113–124. doi: 10.1016/0302-3524(73)90064-9

Hayward PJ, Ryland JS (1995) Handbook of the Marine Fauna of North-west Europe. Oxford University press, Oxford, 816 pp.

Hesse M (1873) Mémoire sur des Crustacés rare et nouveaux des côtes de France. Annales des sciences naturelles, Zoologie 5/17: 1–35.

Holdich DM (1968a) A systematic revision of the genus *Dynamene* (Crustacea: Isopoda) with description of three new species. Pubblicazioni Della Stazione Zoologica di Napoli 36: 401–426.

Holdich DM (1968b) Reproduction growth and bionomics of *Dynamene bidentata* (Crustacea - Isopoda). Journal of Zoology 156: 137–153. doi: 10.1111/j.1469-7998.1968.tb05925.x

Holdich DM (1968c) The biology of *Dynamene bidentata* (Adams) and some related sphaeromatid Isopoda. PhD Thesis, University of Wales, Swansea.

Holdich DM (1969) Polychromatism in the genus *Dynamene* (Crustacea: Isopoda). Pubblicazioni Della Stazione Zoologica di Napoli 37: 18–27.

Holdich DM (1970) The distribution and habitat preferences of the Afro-European species of *Dynamene* (Crustacea: Isopoda). Journal of Natural History 4: 419–438. doi: 10.1080/00222937000770401

Holdich DM (1971) Changes in physiology, structure and histochemistry occurring during the life-history of the sexually dimorphic isopod *Dynamene bidentata* (Crustacea: Peracarida). Marine Biology 8: 35–47. doi: 10.1007/BF00349343

Holdich DM, Lincoln RJ (1974) The distribution and habitat preferences of marine isopods: A survey Scheme. Field Studies 4: 97–104. http://www.nmbl.org/cgi-bin/koha/opac-detail.pl?biblionumber=189674

Holdich DM (1976) A comparison of the ecology and life cycles of two species of littoral isopod. Journal of Experimental Marine Biology and Ecology 24: 133–149. doi: 10.1016/0022-0981(76)90099-X

Holdich DM, Harrison K (1980) The isopod genus *Dynamene* from Australian waters, with description of a new species from coral reefs. Memoirs of Museum Victoria 20: 163–170. http://biostor.org/reference/151868

Holthuis LB (1956) Isopoda en Tanaidacea. Fauna van Nederland 16: 1–280.

Izquierdo D, Guerra-García JM (2011) Distribution patterns of the peracarid crustaceans associated with the alga *Corallina elongata* along the intertidal rocky shores of the Iberian Peninsula. Helgoland Marine Research 65: 233–243. doi: 10.1007/s10152-010-0219-y

Junoy J, Castelló J (2003) Catálogo de las especies ibéricas y baleares de isópodos marinos (Crustacea: Isopoda). Boletin Instituto Español de Oceanografía 19: 293–325. http://www.revistas.ieo.es/index.php/boletin_ieo/article/view/139/132

Kirkim F (1998) Ege denizi Isopoda (Crustacea) faunasinin sistematiği ve ekolojisis üzerine araştirmalar. PhD Thesis, Ege Üniversitesi fen Bilimleri Enstitüsü, Izmir.

Kirkim F, Kocataş A, Katagan T, Sezgin M (2006) Contribution to the Knowledge of the Free-Living Isopods of the Aegean Sea Coast of Turkey. Turkish Journal of Zoology 30: 361–372. http://journals.tubitak.gov.tr/zoology/issues/zoo-06-30-4/zoo-30-4-4-0507-15.pdf

Kussakin OG (1979) [Marine and brackish water isopods of cold and temperate regions of the Northern Hemisphere (including the Black Sea but not the Mediterranean). Part I. Suborder Flabellifera]. Opred Faune SSSR Akad Nauk 122: 1–470.

Leach WA (1814) Crustaceology. In 'Edinburgh Encyclopedia' 7: 383–347.

Ledoyer M (1962) Étude de la faune vagile des herbiers superficiels de Zostéracees et de quelque biotopes d'algues littorales. Recueil des Travaux de la Station Marine d'Endoume (Bull. 25): 117–235.

Lombardo CA (1984) Descrizione della femmina di *Dynamene tubicauda* Holdich 1968 Isopoda, Sphaeromatidae. Animalia 11: 41–44. http://isopods.nhm.org/pdfs/2476/2476.pdf

Lucas H (1849) Histoire naturelle des animaux articulés. Exploration scientifiques de l'Algérie pendant les annes 1840, 1841, 1842. Sciences physiques Zoologie I: 1-403. Paris.

Maggiore F, Fresi E (1984) Presence of *Dynamene bidentata* (Adams, 1800) in the Mediterranean (Isopoda). Crustaceana 46: 309–313. doi: 10.1163/156854084X00234

Messana G (2004) How can I mate without an appendix masculina? The case of *Sphaeroma terebrans* Bate, 1866 (Crustacea, Isopoda, Sphaeromatidae). Crustaceana 77: 499–515. doi: 10.1163/1568540041643346

Monod T (1923) Fauna de l'appontement de l'administration à Port-Etienne. Bulletin de la Société Zoologique de France 48: 313–316.

Monod T (1932) Tanaidaces et Isopodes aquatic de l'Afrique occidentale et septentrionale. Pt3. Sphaeromatidae. Mémoire Société des Sciences Naturelles du Maroc 29: 1–91.

Myers P, Espinosa R, Parr CS, Jones T, Hammond GS, Dewey TA (2008) The Animal Diversity. Michigan. http://animaldiversity.org/ [cited 2010 April 29]

Moyse J, Nelson-Smith A (1964) Effects of the severe cold of 1962-63 upon shore animals in South Wales. Journal of Animal Ecology 33: 183–190.

Omer-Cooper J, Rawson J (1934) Notes on the British Sphaeromatidae (Crustacea, Isopoda). Reports of the Dove Marine Laboratory 3: 22–58.

Pauli VL (1954) Free living isopods of the Black Sea. Travaux of the Sevastopol Biological Station 8: 100–135.

Pereira SG, Lima FP, Queiroz NC, Ribeiro P, Santos AM (2006) Biogeographic patterns of intertidal macroinvertebrates and their association with macroalgae distribution along the Portuguese coast. Hydrobiologia 555: 185–192. doi: 10.1007/s10750-005-1115-3

Picker MD, Griffiths CL (2011) Alien and Invasive Animals – A South African Perspective. Struik-Random House Publishers, Cape Town, 240 pp.

Poore GCB, Bruce NL (2012) Global diversity of marine isopods (except asellota and crustacean symbionts). PLoS One 7: e43529. doi: 10.1371/journal.pone.0043529

Rafrafi-Nouira S, Kamel-Moutalibi O El, Boumaïza M, Reynaud C, Capapé C (2016) Food and feeding habits of black scorpionfish, *Scorpaena porcus* (Osteichthyes: Scorpaenidae) from the northern coast of Tunisia (Central Mediterranean). Journal of Ichthyology 56: 107–123. doi: 10.1134/S0032945216010112

Rathke H (1837) Zur Fauna der Krym. Mémoires of the Academy of Imperial Science, St Petersburg 3: 291–454.

Richardson H (1905) Monographs on the Isopods of North America. Govt print off, Washington, 800 pp. doi: 10.5962/bhl.title.1031

Rivosecchi ET (1961) Osservazione a Sabellaria di Lavinio. Rendiconti Accademia Nazionale dei XL 12: 147–157.

Rodrigues LSB (1990) Estudo dos isópodes (Crustacea: Isopoda) do litoral da ilha das Flores (Açores). Relatórios e Comunicações do Departamento de Biologia 18: 113–115.

Schotte M, Kensley B (2005) New species and records of Flabellifera from the Indian Ocean (Crustacea: Peracarida: Isopoda). Journal of Natural History 39(16): 1211–1282. doi: 10.1080/00222930400005757

Scott T (1899) Notes on some Crustacea from Granton, Firth of Forth. The Annals of Scottish Natural History 30: 115–116.

Schüller M, Wägele JW (2005) Redescription of *Ischyromene lacazei* Racovitza, 1908 (Isopoda: Sphaeromatidae) from the Mediterranean coast of southern France. Organisms Diversity and Evolution 5[Electr Suppl. 8]: 1–14. doi: 10.1016/j.ode.2004.10.012

Tinturier-Hamelin E (1962) Sur le polychromatism de l'Isopode Flabellifère *Dynamene bidentata* (Adams). I. Premiers resultats d'une étude génétique. Comptes rendus hebdomadaires des séances de l'Académie des Sciences 254: 3906–3908.

Tinturier-Hamelin E (1967) Sur le polychromatism de l'Isopode Flabellifère *Dynamene bidentata* (Adams). II. Étude génétique due mutant *bimaculata* partiellement lie au sexe. Archives de zoologie expérimentale et générale 108: 511–520.

Torelli B (1930) Sferomidi del Golfo di Napoli: revisione degli sferomoidi mediterranei. Pubblicazioni Della Stazione Zoologica di Napoli 10: 297–343.

Torrecilla-Roca I, Guerra-García JM (2012) Feeding habits of the peracarid crustaceans associated to the alga *Fucus spiralis* in Tarifa Island, Cádiz (Southern Spain). Zoologica Baetica 23: 39–47. https://idus.us.es/xmlui/handle/11441/28212

Verhoeff E (1944) *Sorrentosphaera* n.g. (Sphaeromidae) und zur vergleichenden Morphologie der Uropoden. Zoologischer Anzeiger Leipzig 144: 156–162.

Viejo RM (1997) The effects of colonization by *Sargassum muticum* on tidepool macrofauna assemblages. Journal of Marine Biological Association of the United Kingdom 77: 325–340. doi: 10.1017/S0025315400071708

Vieira P, Gomes N, Holdich DM, Queiroga H, Costa FO (2015) Phylogeographic structure of *Dynamene edwardsi* (Crustacea: Isopoda) matches remarkably the sequential genesis of the Macaronesian islands. In: (2015) Scientific abstracts from the 6th International Barcode of Life Conference / Résumés scientifiques du 6e congrès international « Barcode of Life ». Genome 58(5): 163–303. doi: 10.1139/gen-2015-0087

Supplementary material 1

Material examined in this study

Authors: Pedro E. Vieira, Henrique Queiroga, Filipe O. Costa, David M. Holdich

Data type: occurence

Explanation note: Each entry shows the number of specimens observed for each life history stage, habitat, person who provided the specimen(s), location and country, co-ordinates and other information.

Supplementary material 2

List of locations where *Dynamene* specimens were recorded in this study

Authors: Pedro E. Vieira, Henrique Queiroga, Filipe O. Costa, David M. Holdich

Data type: occurence

Explanation note: Complete list of locations and respective regions and co-ordinates where *Dynamene* specimens were recorded in this study, organized by species.

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RESEARCH ARTICLE

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Two new species of *Floresorchestia* (Crustacea, Amphipoda, Talitridae) in Thailand

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Abstract

The beach-hopper and land-hopper genus *Floresorchestia* Bousfield, 1984 is most widespread in terrestrial and marine littoral habitats and has been recorded from the South African coasts through to tropical Indo-Pacific and Caribbean Sea. In Thailand, there is only *Floresorchestia samroiyodensis* Azman, Wongkamhaeng & Dumrongrojwattana, 2014 reported from the swamp of Prachuab Kiri Khan, southern Thailand. In this work, two new species of *Floresorchestia* from Phutsa Reservoir in Nakhon Ratchasima and the man-made swamp in Burapha University are described. The new species are characterised by the mandible left lacinia mobilis 4-dentate; the posterior margin of merus, carpus and propodus covered in palmate setae; the uropod 3 peduncle with two robust setae and the telson longer than broad. The characters of the specimens are described and illustrated in this paper. All specimens are deposited in the Princess Maha Chakri Sirindhorn Natural History Museum, Prince of Songkla University, Thailand.

Keywords

Amphipoda, Crustacean, *Floresorchestia*, new species, Talitridae, Thailand

Introduction

The talitrid amphipod genus *Floresorchestia* Bousfield, 1984 is most widespread in littoral and terrestrial habitats. They have been recorded from the South African coast through to tropical Indo Pacific and Caribbean Sea. The amphipod can be recognised from the number of stridulating organs above the ventral margin (epimera 1–3, 2 or 2–3). Members of this genus occupy a variety of habitat such as beach (beach-hoppers) or land (land-hoppers) or stream (stream-hoppers) (Lowry and Springthorpe 2015). The genus *Floresorchestia* has established by Bousfield (1984) for a group of amphipod species with epimeral slit. After that, Serejo (2004) proposed the classification for superfamily Talitroidea and *Floresorchestia* is placed into the family Talitridae, the lineage of amphipods that invaded the terrestrial habitat. The *Floresorchestia* has recently been revised by Lowry and Springthorpe (2015). From that, four species are redescribed based on neotypes and lectotypes newly established from this work with the description of nine new species.

In Southeast Asia, thirteen species of *Floresorchestia* have been recorded. There are both supralittoral (seven species) and terrestrial groups (six species). The supralittoral species have been reported from the Gulf of Thailand (*Floresorchestia* sp. 3), (Bussarawich 1985); South China Sea (*Floresorchestia* sp. 1); Malaysian Peninsula (*F. seringat* Lowry & Springthorpe, 2015); Indonesian Waters (*F. floresiana* (Weber, 1892) and *F. laurenae* Lowry & Springthorpe, 2015) and Taiwan Waters (*F. anpingensis* Miyamoto & Morino , 2008 and *F. oluanpi* Lowry & Springthorpe, 2015). The terrestrial species have also been recorded from different areas including *F. samroiyodenesis* Azman, Wongkamhaeng & Dumrongrojwattana, 2014 from Thailand; *F. malayensis* (Tattersall,1922) from Singapore and Malaysia; *F. thienemanni* (Schellenberg, 1931) from Indonesia; *F. vugiaensis* (Dang & Le, 2011) and *F. hanoiensis* Hou & Li, 2003 in Vietnam and *F. yehyuensis* Miyamoto & Morino, 2008 from Taiwan. In this study, two new 4-dentate cuspidactylate amphipods from terrestrial swamps and supralittoral have been discovered from north-eastern and eastern Thailand.

Material and methods

This study is based upon material collected from leaf litter of Phutsa Reservoir in Nakhon Ratchasima, north-eastern Thailand and a man-made swamp in Burapha University, eastern Thailand in March and April 2016 respectively. Samples were collected using hand-nets and were then carefully transferred into plastic containers and fixed in 10% buffered formalin. In the laboratory, amphipod specimens were sorted out and stored in 70% alcohol. The animals were then examined under a compound microscope and later selected for dissection. The appendages of the dissected specimens were examined and figures were produced using camera lucida attached to an Olympus CH30 light microscope. The pencil drawings were scanned and digitally inked using a WACOM bamboo CTH-970 graphics board following the method described in Coleman (2003). Setal and mouthpart classifications were made following Watling (1989).

Abbreviations for the figures

A	antenna;	**T**	telson;
G	gnathopod;	**U**	uropod;
HD	head;	**UR**	urosome;
LL	lower lip;	**UL**	upper lip;
MD	mandible;	**R**	right;
MX	maxilla;	**L**	eft;
MP	maxilliped;	♂	male;
P	pereopod;	♀	female.
Pl	pleopod;		

Type material has been deposited at Prince of Songkla University Zoological Collection (PSUZC).

Systematic Results

Suborder Senticauda Lowry & Myers, 2013a
Infraorder Talitrida Rafinesque, 1815, Serejo 2004
Superfamily Talitroidea Bulycheva, 1957
Family Talitridae Rafinesque, 1815

***Floresorchestia* Bousfield, 1984**

Type species. *Orchestia floresiana* Weber 1892, original designation.

Species composition. *Floresorchestia ancheidos* (K.H. Barnard, 1916); *Floresorchestia andrevo* Lowry & Springthorpe, 2015; *Floresorchestia anomala* (Chevreux, 1901); *Floresorchestia anoquesana* (Bousfield, 1971); *Floresorchestia anpingensis* Miyamoto & Morino, 2008; *Floresorchestia australis* Lowry & Springthorpe, 2009b; *Floresorchestia floresiana* (Weber, 1892); *Floresorchestia guadalupensis* Ciavatti, 1989; *Floresorchestia hanoiensis* Hou & Li, 2003; *Floresorchestia kalili* Lowry & Springthorpe, 2015; *Floresorchestia laurenae* Lowry & Springthorpe, 2015; *Floresorchestia malayensis* (Tattersall,1922); *Floresorchestia monospina* (Stephensen, 1935); *Floresorchestia oluanpi* Lowry & Springthorpe, 2015; *Floresorchestia palau* Lowry & Myers, 2013b; *Floresorchestia papeari* Lowry & Springthorpe, 2015; *Floresorchestia pectenispina* (Bousfield, 1970); *Floresorchestia pohnpei* Lowry & Myers, 2013b; *Floresorchestia poorei* Lowry & Springthorpe, 2009a; *Floresorchestia samoana* (Bousfield, 1971); *Floresorchestia samroiyodensis* Azman, Wongkamhaeng & Dumrongrojwattana, 2014; *Floresorchestia seringat* Lowry & Springthorpe, 2015*; Floresorchestia thienemanni* (Schellenberg, 1931); *Floresorchestia vitilevana* (J.L. Barnard, 1960); *Floresorchestia vugiaensis* (Dang & Le, 2011); *Floresorchestia yap* Lowry & Springthorpe, 2015; *Floresorchestia yehyuensis* Miyamoto & Morino, 2008.

Key to known Thai Species of *Floresorchestia*

1 Male gnathopod 1: posterior margin of carpus and propodus each with a lobe covered in palmate seta; uropod 3 peduncle with three robust setae..... ..... ***F. samroiyodensis***

– Male gnathopod 1 posterior margin of merus, carpus and propodus each with a lobe covered in palmate seta; uropod 3 peduncle with two robust setae....**2**

2 Gnathopod 2 extending between 31–35% along the posterior margin; uropod 1 peduncle with 4-6 robust setae; uropod 3 ramus without marginal robust setae; telson apically incised with four robust setae per lobe ....***F. boonyanusithii* sp. n.**

– Gnathopod 2 reaching between 36–40% along posterior margin; uropod 1 peduncle with more than six robust setae; uropod 3 ramus with a marginal robust seta; telson apically incised with five robust setae per lobe..... .....***F. buraphana* sp. n.**

***Floresorchestia boonyanusithii* sp. n.**
http://zoobank.org/6DD48CE1-F8DE-41CE-BA9E-3D2A758971FA
Figures 1–5, Table 1

Type material. Holotype. ♂, THAILAND, North-eastern Thailand, Phutsa Reservoir, Nakhon Ratchasima (15°2'59"N, 102°2'18"E), 21 Febuary 2016, Boonyanusith, C. PSUZC-CR-0310. Allotypes, ♀ collected with holotype; PSUZC-CR-0311; Paratype, collected with holotype (PSUZC-CR-0312 (5♂; 5♀))

Etymology. Named after Chaichat Boonyanusith in appreciation of his contribution to the terrestrial amphipod study in Thailand.

Ecological type. Land-hoppers (truly terrestrial). Size 5.5 mm. Sexual dimorphism present.

Description. Based on male, holotype, 5.5 mm, PSUZC-CR 0310.

Head. *Eye* large (1/2 head length). *Antenna 1* short, having four short articles of flagellum, extending one quarter (¼) of peduncle article 5. *Antenna 2* peduncular articles slender; article 5 longer than article 4; flagellum of 13 articles, longer than peduncle, final article minute, without apical cluster of serrate setae. *Upper lip* broad, deep, apex rounded. *Lower lip* without inner plates. *Left mandible* incisor 4-dentate, lacinia mobilis 4-dentate, molar strong. *Maxilla 1* inner plate slender with two terminal setae; outer plate with nine terminal serrate setae with small palp, 1-articulate. *Maxilliped* inner plate with apical and subapical plumose setae and three large conical robust setae; outer plate with two rows of subapical setae; palp article 2 distomedial lobe well developed; article 4 reduced, button-shaped.

Pereon. *Gnathopod 1* sexually dimorphic; subchelate; coxa 1 smaller than coxa 2, ventral margin with six setae; posterior margin of merus, carpus and propodus each with a lobe covered in palmate setae, palmate lobes in male only; carpus 1.4 times as long as propodus, 2.6 times as long as broad; propodus subtriangular with well-de-

veloped posterodistal lobe, anterior margin with two groups of robust setae, posterior margin with four robust setae, palm with seven robust setae; dactylus cuspidactylate, subequal in length to palm.

Gnathopod 2 sexually dimorphic; subchelate; basis anterior margin smooth, widened distally; ischium with rounded lobe on mid-anterior margin; carpus triangular, reduced (enclosed by merus and propodus) without posterior lobe; propodus subovate, 1.5 times as long as wide; palm acute, extending 33% along posterior margin, lined with robust setae; dactylus longer than palm, attenuated distally, posterior margin smooth.

Pereopods 3–7 cuspidactylate. *Pereopod 3* coxa subquadrate with posterior process, merus longer than carpus, distally expanded; propodus slender, longer than carpus. *Pereopod 4* slightly shorter than pereopod 3; coxa wider than long with posterior process; carpus significantly shorter than carpus of pereopod 3; dactylus thickened proximally with a notch midway along the posterior margin. *Pereopod 5* coxa bilobed, anterior lobe slightly larger than the posterior lobe; propodus distinctly longer than the carpus. *Pereopods 6–7; pereopod 6* subequal in length to pereopod 7; coxa posterior lobe inner view posteroventral corner rounded, posterior margin perpendicular to ventral margin; coxal gill convoluted; propodus slender, longest; dactylus narrow. *Pereopod 7;* basis lateral sulcus absent, posterior margin with distinct minute serrations, each with a small seta, posterodistal lobe present, shallow, broadly rounded; merus and carpus distally expanded; carpus subrectangular propodus slender, longest; dactylus short.

Pleon. *Pleopods* all well developed. *Pleopod 1* peduncle without marginal setae; biramous, inner ramus not longer than outer ramus, shorter than peduncle; inner ramus with seven articles; outer ramus with seven articles. *Pleopod 2* peduncle without marginal setae; biramous, inner ramus subequal to outer, shorter than peduncle; inner ramus with eight articles; outer ramus with eight articles. *Pleopod 3* peduncle without marginal setae; biramous, outer ramus shorter than peduncle; inner ramus with ten articles; outer ramus with eight articles.

Epimera 1–3 vertical slits present on plate 2 and 3. *Epimera 2* with 27 slits. *Epimera 3* with 20 slits. *Epimeron 2* subequal in length to *epimeron 3*. *Epimeron 3* posterior margin smooth, without setae, posteroventral corner with small subacute tooth, ventral margin without robust setae.

Uropod 1 peduncle with four robust setae, distolateral robust seta absent; inner ramus subequal in length to outer ramus, inner ramus with marginal robust setae (one row), with four marginal robust setae; outer ramus without marginal robust setae. *Uropod 2* not sexually dimorphic; peduncle with three robust setae; inner ramus subequal in length to outer ramus, with marginal robust setae; outer ramus with marginal robust setae in one row, outer ramus with two marginal robust setae. *Uropod 3* peduncle with two robust setae; ramus not fused to peduncle; ramus shorter than peduncle, 1.75 times as long as broad, ramus linear with three apical setae.

Telson longer than broad, apically cleft, dorsal midline half of the telson, with marginal and apical robust setae, four setae per lobe.

Female (sexually dimorphic characters). *Gnathopod 1* coxa anterior margin straight; merus lacking tumescent lobe, posterior margin with five robust setae; propo-

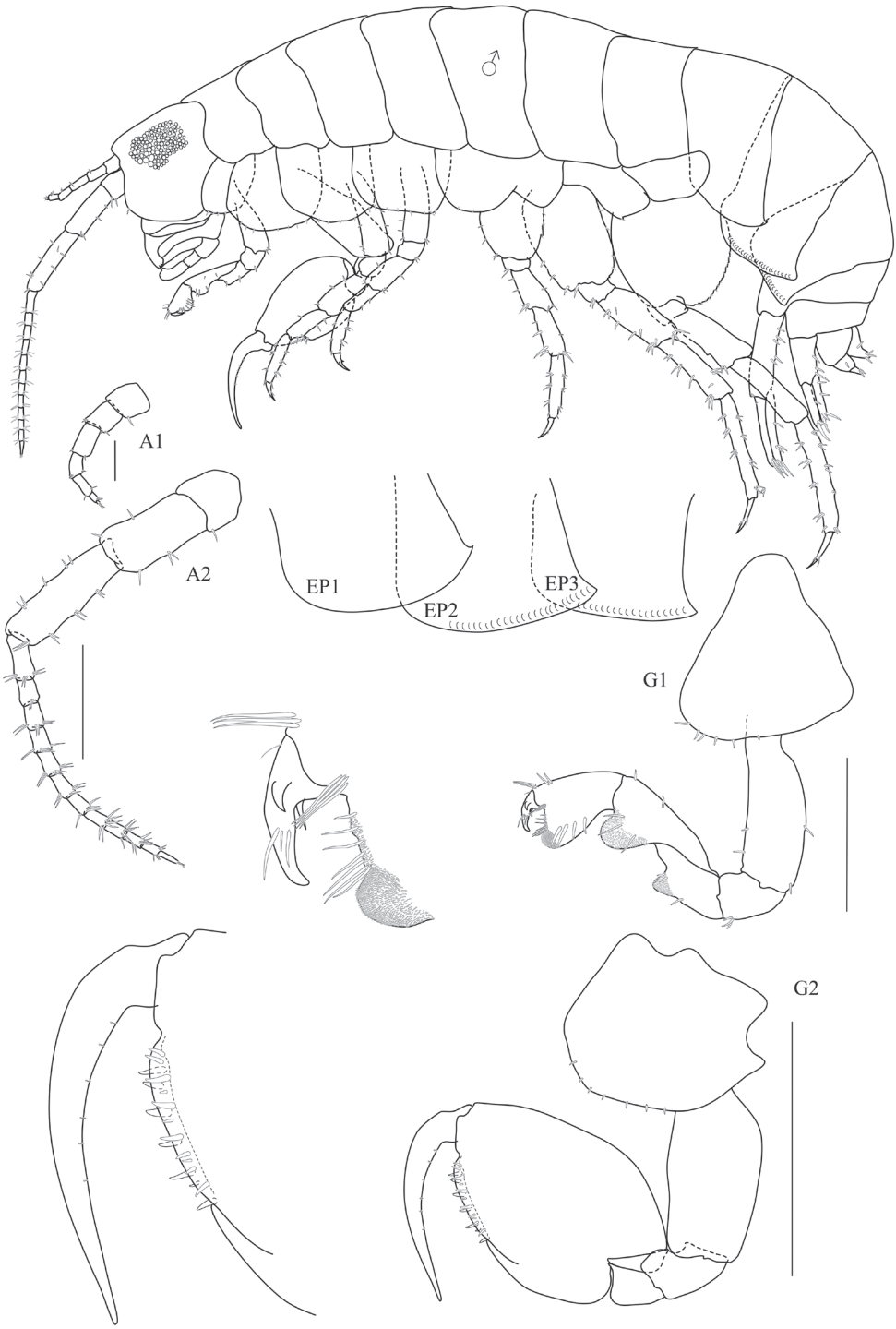

Figure 1. *Floresorchestia boonyanusithii* sp. n. holotype, male, 5.5 mm (PSUZC-CR-0310), Phutsa Reservoir in Nakhon Ratchasima. Scale bars for A2, G1 and G2 represent 0.5 mm and for A1 represents 0.2 mm.

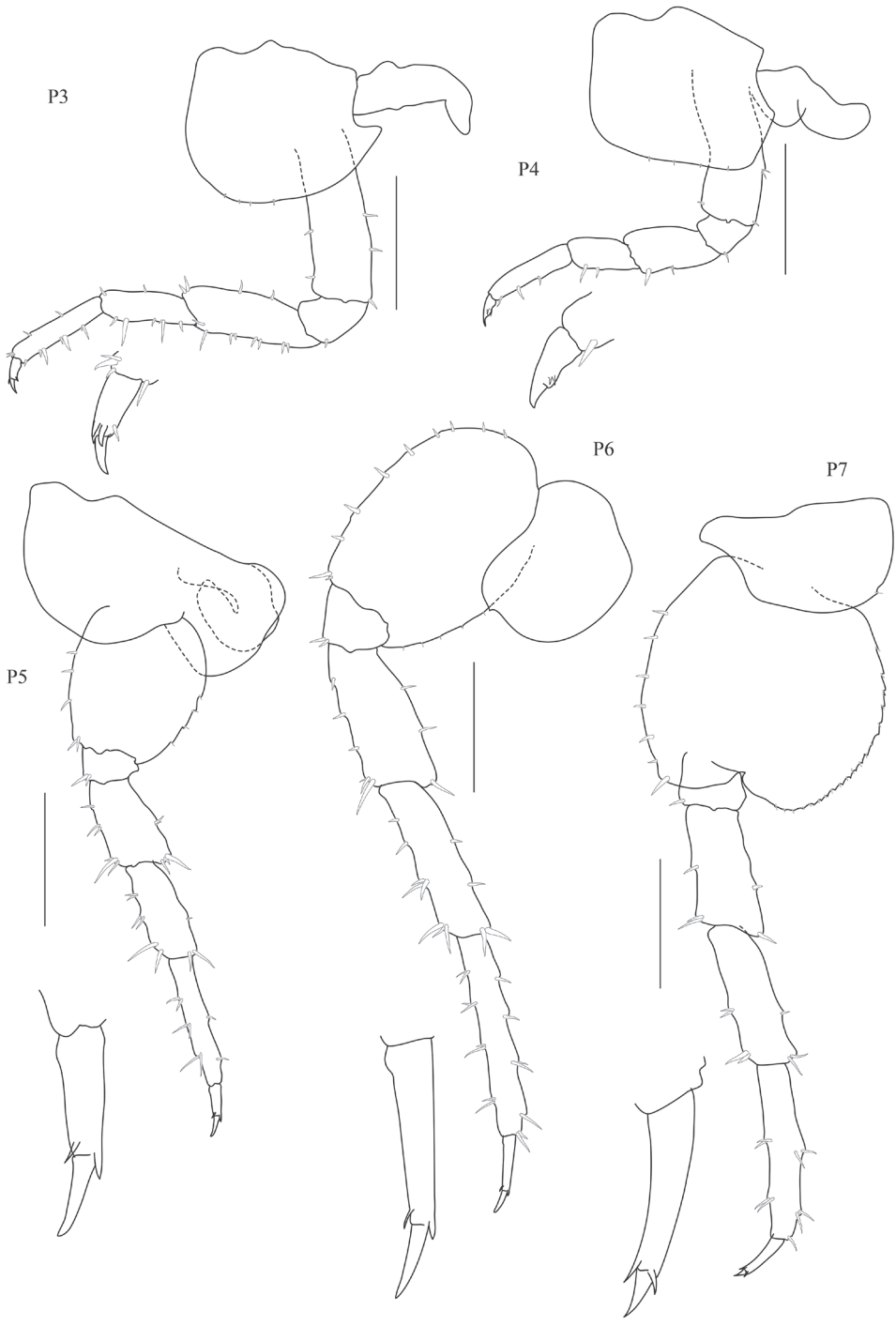

Figure 2. *Floresorchestia boonyanusithii* sp. n. holotype, male, 5.5 mm (PSUZC-CR-0310), Phutsa Reservoir in Nakhon Ratchasima. Scale bars represent 0.5 mm.

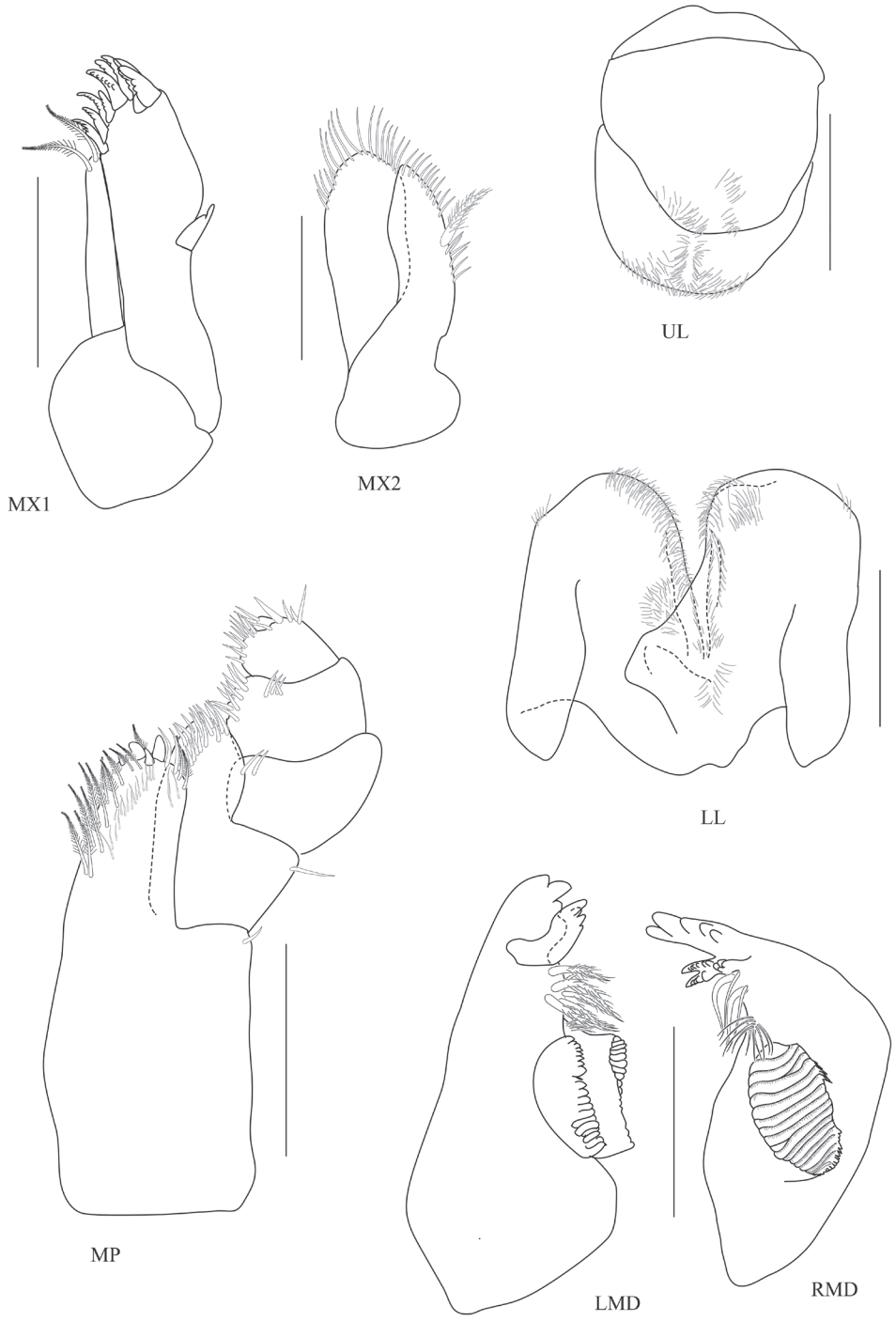

Figure 3. *Floresorchestia boonyanusithii* sp. n. holotype, male, 5.5 mm (PSUZC-CR-0310), Phutsa Reservoir in Nakhon Ratchasima. Scale bars for MX1, MX2, MP, LMD and RMD represent 0.2 mm and for UL and LL represent 0.1 mm.

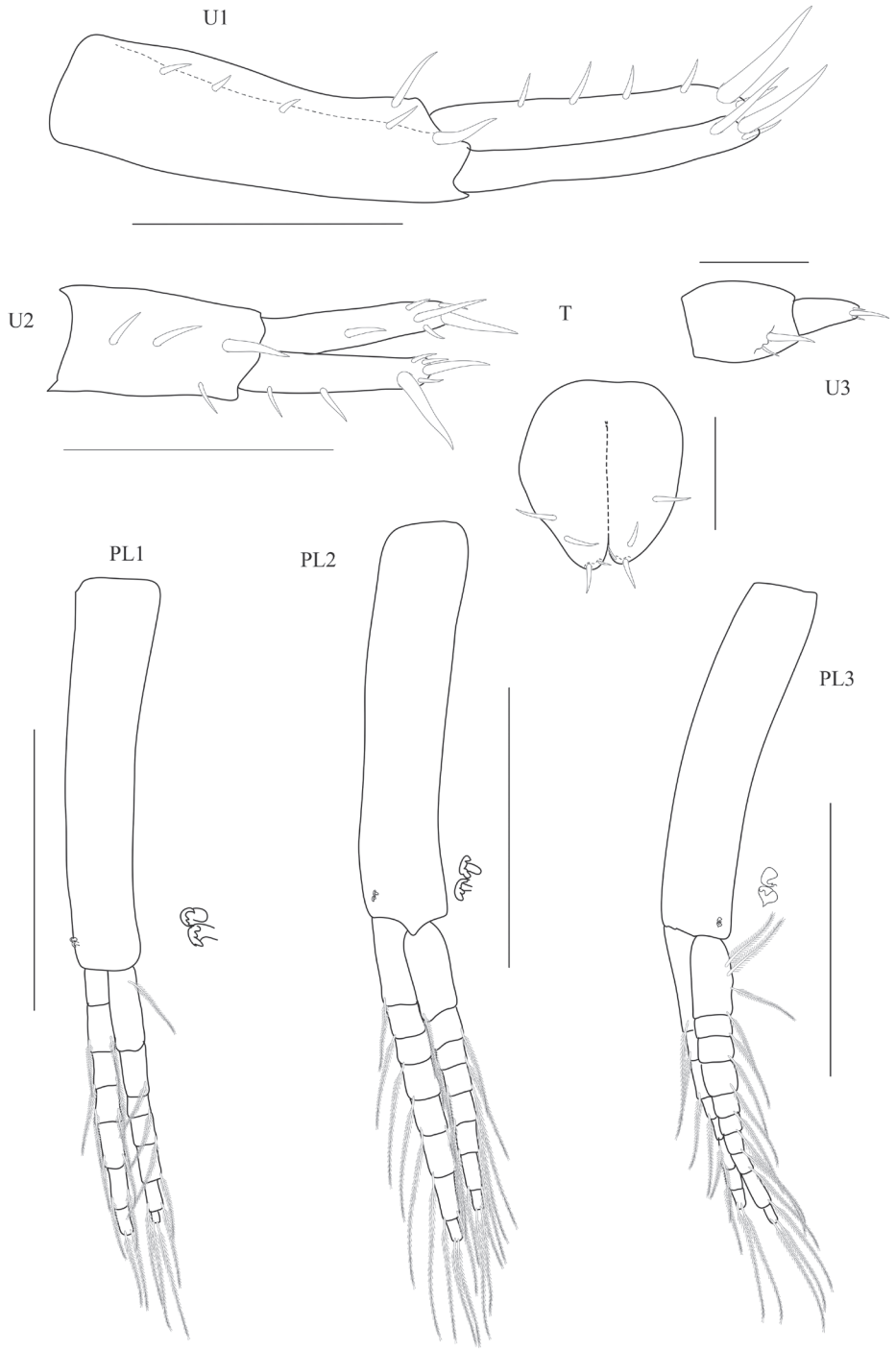

Figure 4. *Floresorchestia boonyanusithii* sp. n. holotype, male, 5.5 mm (PSUZC-CR-0310), Phutsa Reservoir in Nakhon Ratchasima. Scale bars for PL1-3 represent 0.5 mm, for U1-2 represent 0.2 mm, and U3 and T represent 0.1 mm.

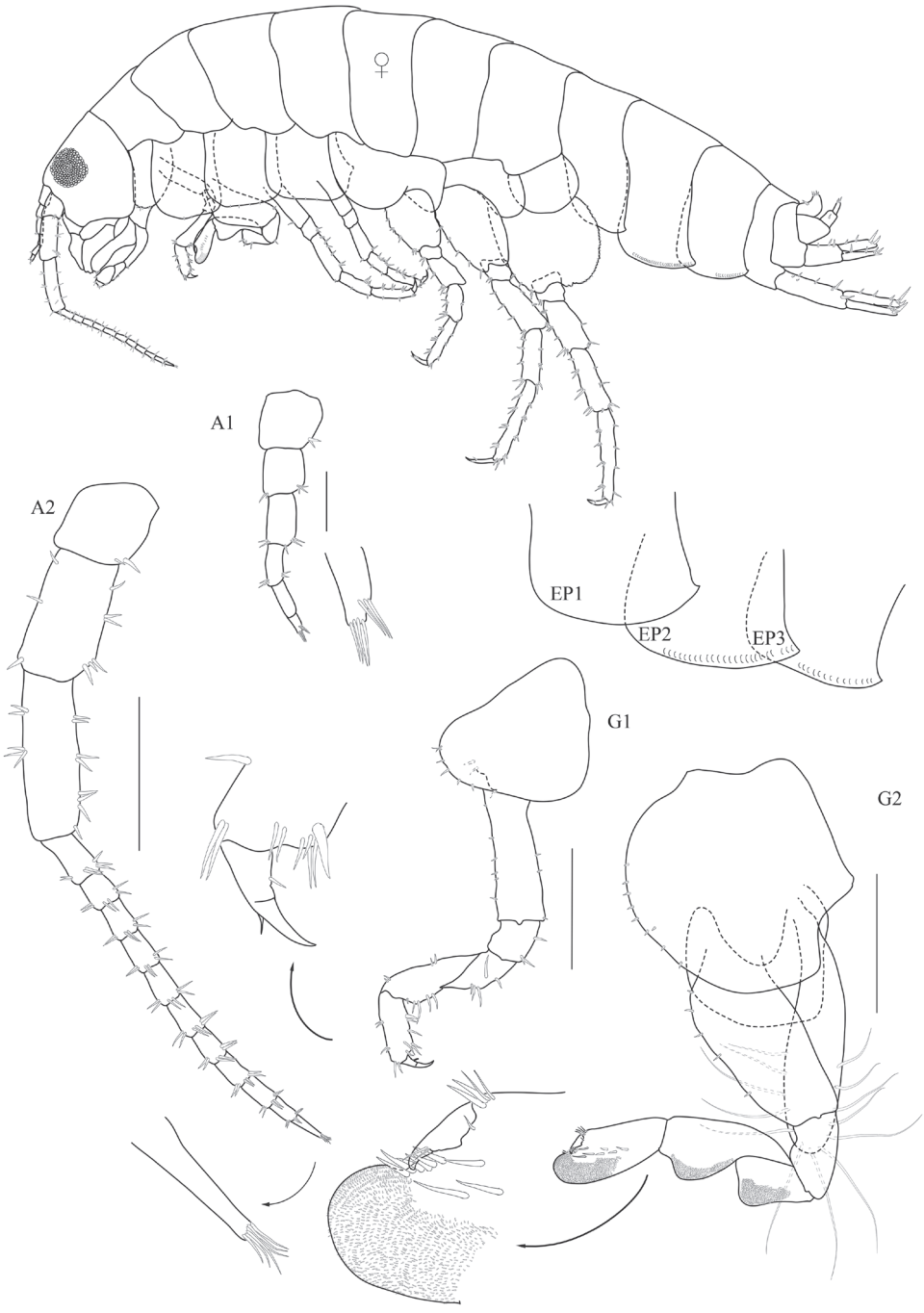

Figure 5. *Floresorchestia boonyanusithii* sp. n. allotype, female 8.8 mm (PSUZC-CR-0311), Phutsa Reservoir in Nakhon Ratchasima. Scale bars for A2, G1 and G2 represent 0.5 mm and for A1 represents 0.2 mm.

dus without tumescent protuberance, anterior margin with two groups of robust setae; palm slightly acute, dactylus inner lateral posterior margin with one robust seta.

Gnathopod 2 mitten-shaped; posterior margin of carpus and propodus each with lobe covered in palmate setae; carpus well developed, posterior lobe projecting between merus and propodus; nearly twice as long as wide; palm obtuse, not lined with robust setae, posterodistal corner without spine; dactylus subequal in length to palm, not modified distally, blunt.

Habitat. Terrestrial, most prefer living in *Typha angustifolia* root near reservoir.

Distribution. North-eastern Thailand.

Remarks. *Floresorchestia boonyanusithii* sp. n. is the second land-hopper reported in Thailand. It can be distinguished from *F. samroiyodensis* by the characters in the above key. Additionally, this species shows the following differences: 1) the left mandible lacinia mobilis has four cusps in both male and female (vs. male 4-dentate and female 6-dentate); 2) male gnathopod 1 carpus is 2.6 times longer than broad, 1.4 as long as propodus (vs. 2 times longer than broad, 1.8 times as long as propodus); 3) male gnathopod 2 propodus 1.4 times longer than broad, palm extending 39% along posterior margin (propodus 1.8 times longer than broad, palm extending 27% along posterior margin); 4) pereopod 7 is shallow, broadly rounded (vs. rounded, produced downwards almost to merus).

Floresorchestia boonyanusithii is characterised by a mandible left lacinia mobilis 4-dentate and uropod 3 peduncle with two robust setae. The only similar species are *F. buraphana* sp. n. and *F. hanoiensis* Hou & Li, 2003. The new species differs from *F. hanoiensis* Hou & Li, 2003 in its pereopod 4 is thickened proximally with a notch midway along its posterior margin (vs. pereopod 4 similar to pereopod 3 dactylus) pereopod 7 basis shallow, broadly rounded (vs. produced downwards almost to merus); pleopod 1-3 peduncle without marginal robust setae; epimera 3 posterior margin without setae with 20 slits (vs epimera 3 posterior margin with five slits) and telson apically incised with four robust setae per lobe (vs. three robust setae per lobe).

Floresorchestia boonyanusithii shared several characters with *F. buraphana* in having a mandible left lacinia mobilis 4-dentate; posterior margin of merus, carpus and propodus covered in palmate setae; uropod 3 peduncle with two robust setae and telson is longer than broad. *F. boonyanusithii* differs from *F. buraphana* in having uropod 3 rami without marginal setae (vs rami with one marginal seta) and telson with four robust setae per lobe (vs. five robust setae per lobe).

***Floresorchestia buraphana* sp. n.**

http://zoobank.org/ED87B33E-9CB9-4F84-B23D-E325114C9976
Figures 6–10, Table 1

Type material. Holotype. ♂, THAILAND, Eastern Thailand, Man-made swamp in Burapha University, Chonburi (13°16'37"N, 100°55'21"E), 21 April 2016, Damrongrojwattana, P. PSUZC-CR-0312. Allotypes, ♀ collected with holotype; PSUZC-CR-0313; Paratype, collected with holotype (PSUZC-CR-0314 (5♂; 5♀))

Etymology. Named for Burapha University where the man-made swamp is the type locality of the species.

Ecological type. Supralittoral (325 m from the Bang San Beach). Size 6.3 mm. Sexual dimorphism present.

Description. Based on male, holotype, 6.3 mm, PSUZC-CR 0312.

Head. *Eye* large (one third of head length). *Antenna 1* short, having five articles of flagellum, extending one quarter (¼) of antenna 2 peduncle article 5. *Antenna 2* peduncular articles slender; article 5 longer than article 4; flagellum of 13 articles, longer than peduncle, final article minute, without apical cluster of serrate setae. *Upper lip* broad, deep, apex rounded. *Lower lip* without inner plates. *Left mandible* incisor 5-dentate, lacinia mobilis 5-dentate, molar strong. *Maxilla 1* inner plate slender with two terminal setae; outer plate with nine serrate robust setae and with small palp, 1-articulate. *Maxilliped* inner plate with apical and subapical plumose setae and three large conical robust setae; outer plate with two rows of subapical setae; palp article 2 distomedial lobe well developed; article 4 reduced, button-shaped.

Pereon. *Gnathopod 1* sexually dimorphic; subchelate; coxa 1 smaller than coxa 2, ventral margin with five setae; posterior margin of merus, carpus and propodus each with lobe covered in palmate setae, palmate lobes in male only; carpus 1.5 times as long as propodus, twice as long as broad; propodus sub-triangular with well-developed posterodistal lobe, anterior margin with two groups of robust setae, posterior margin with five robust setae, palm with five robust setae; dactylus cuspidactylate, subequal in length to palm. *Gnathopod 2* sexually dimorphic; subchelate; basis anterior margin smooth, widened distally; ischium with rounded lobe on mid-anterior margin; carpus triangular, reduced (enclosed by merus and propodus) without posterior lobe; propodus subovate, 1.5 times as long as wide; palm acute, extending 37% along posterior margin, lined with robust setae; dactylus longer than palm, attenuated distally, posterior margin smooth.

Pereopods 3–7 cuspidactylate. *Pereopod 3* coxa subquadrat with posterior process, merus longer than carpus, distally expanded; propodus slender, longer than carpus. *Pereopod 4* slightly shorter than pereopod 3; coxa wider than long with posterior process; carpus significantly shorter than carpus of pereopod 3; dactylus thickened proximally with a notch midway along posterior margin. *Pereopod 5* coxa bilobed, anterior lobe larger than posterior lobe; propodus distinctly longer than carpus. *Pereopod 6* subequal in length to pereopod 7; coxa posterior lobe inner view - posteroventral corner rounded, posterior margin perpendicular to ventral margin; coxal gill simple; propodus slender, longest; dactylus narrow. *Pereopod 7* basis lateral sulcus absent, posterior margin with distinct minute serrations, each with a small seta, posterodistal lobe present, shallow, broadly rounded; merus and carpus distally expanded; carpus subrectangular, propodus slender, longest; dactylus short.

Pleon. *Pleopods* all well developed. *Pleopod 1* peduncle without marginal setae; biramous, inner ramus subequal to outer ramus, shorter than peduncle; inner ramus with nine articles; outer ramus with nine articles. *Pleopod 2* peduncle without marginal setae; biramous, inner ramus subequal to outer, shorter than peduncle; inner

ramus with eight articles; outer ramus with eight articles. *Pleopod 3* peduncle without marginal setae; biramous, outer ramus shorter than peduncle; inner ramus with eight articles; outer ramus with eleven articles.

Epimera 1–3 vertical slits present on plates 2 and 3. *Epimera 2* with 27 slits. *Epimera 3* with 20 slits. *Epimeron 2* subequal in length to *epimeron 3*. *Epimeron 3* posterior margin smooth, without setae, posteroventral corner with small subacute tooth, ventral margin without robust setae.

Uropod 1 peduncle with nine robust setae, distolateral robust seta absent; inner ramus subequal in length to outer ramus, inner ramus with marginal robust setae (one row), with three marginal robust setae; outer ramus without marginal robust setae. *Uropod 2* not sexually dimorphic; peduncle with four robust setae; inner ramus subequal in length to outer ramus, with marginal robust setae; outer ramus with marginal robust setae in one row, outer ramus with two marginal robust setae. *Uropod 3* peduncle with two robust setae; ramus not fused to peduncle; ramus shorter than peduncle, 2.2 times as long as broad, ramus linear with a marginal seta and three apical setae.

Telson longer than broad, apically cleft, dorsal midline half of the telson, with marginal and apical robust setae, five setae per lobe.

Female (sexually dimorphic characters). *Gnathopod 1* coxa anterior margin straight; merus lacking tumescent lobe, posterior margin with five robust setae; propodus without tumescent protuberance, anterior margin with two groups of robust setae; palm slightly acute, dactylus inner lateral posterior margin with one robust seta.

Gnathopod 2 mitten-shaped; posterior margin of carpus and propodus each with a lobe covered in palmate setae; carpus well developed, posterior lobe projecting between merus and propodus; nearly twice as long as its width; palm obtuse, not lined with robust setae, posterodistal corner without spine; dactylus subequal in length to palm, not modified distally, blunt.

Habitat. Fresh water swamps in Burapha University.

Distribution. Eastern Thailand.

Remarks. The characters of *Floresorchestia buraphana* sp. n. that separate it from *F. samroiyodensis* Azman et al. 2014 and *F. boonyanusithii* sp. n. have been given in the above key. Additionally, this species shows the following features: 1) uropod 1 peduncle with nine robust setae; 2) uropod 3 peduncle with two robust setae and rami with three apical setae and telson longer than broad, dorsal midline at least halfway, apically incised with five robust setae per lobe.

F. buraphana sp. n. appears to be closely related to *F. yehyuensis*, sand-hopper from Taiwan in having; 1) a mandible left lacinia mobilis 4-dentate; 2) gnathopod 1 merus, carpus and propodus each with palmate lobe and 3) uropod 3 ramus with one marginal setae. It differs however in the pereopod 4 dactylus which is thickened proximally with a notch midway along the posterior margin (similar to pereopod 3 dactylus in *F. yehyensis*), uropod 3 peduncle with three robust setae (with two robust setae in *F. yehyensis*), epimera 2 with 25 slits (33 slits in *F. yehyensis*) and telson longer than broad with dorsal midline half way (telson is broader than its length without dorsal midline in *F. yehyensis*).

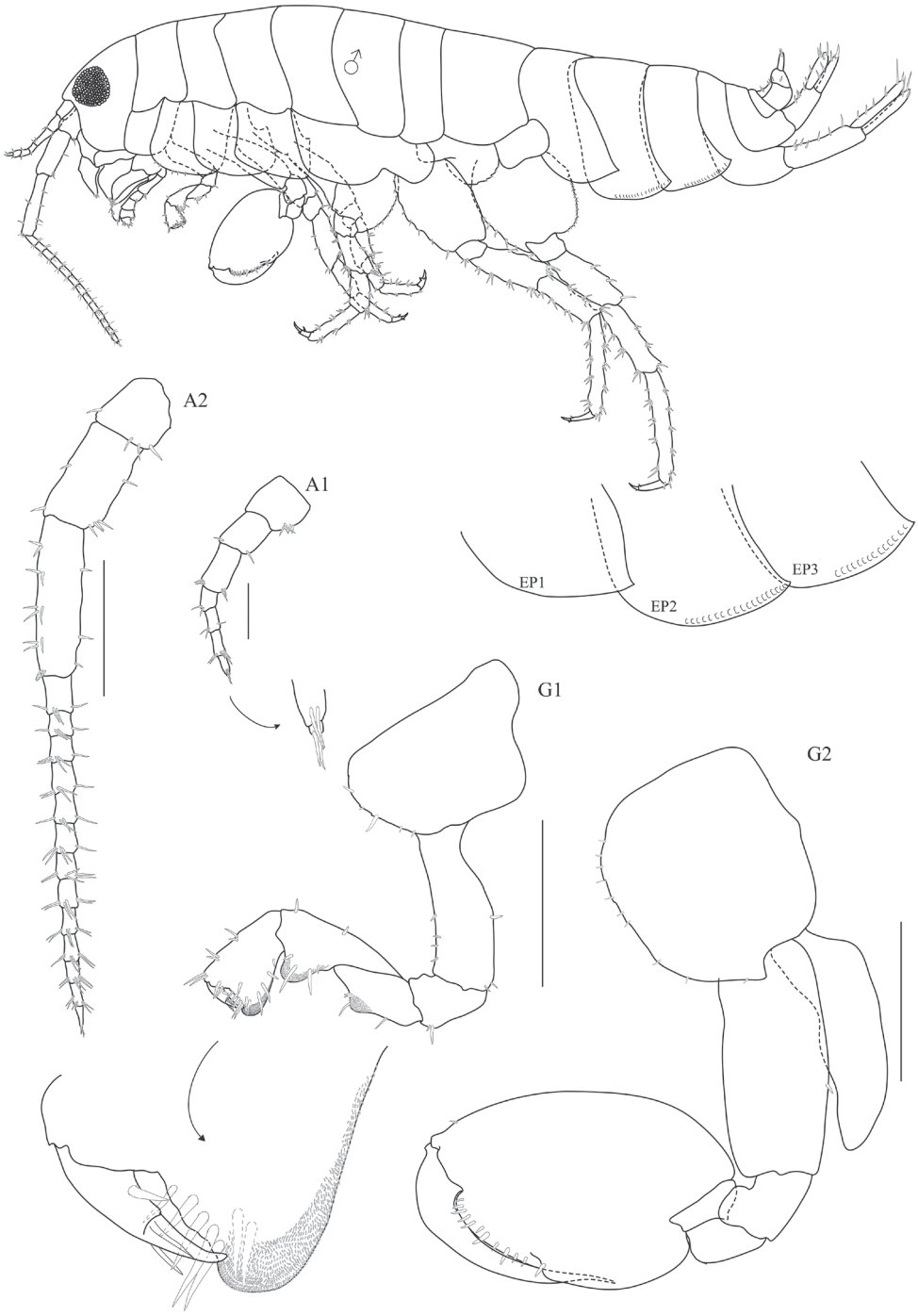

Figure 6. *Floresorchestia buraphana* sp. n. holotype, male, 6.3 mm (PSUZC-CR-0312), Burapha University, Chonburi. Scale bars for A2, G1 and G2 represent 0.5 mm and for A1 represents 0.2 mm.

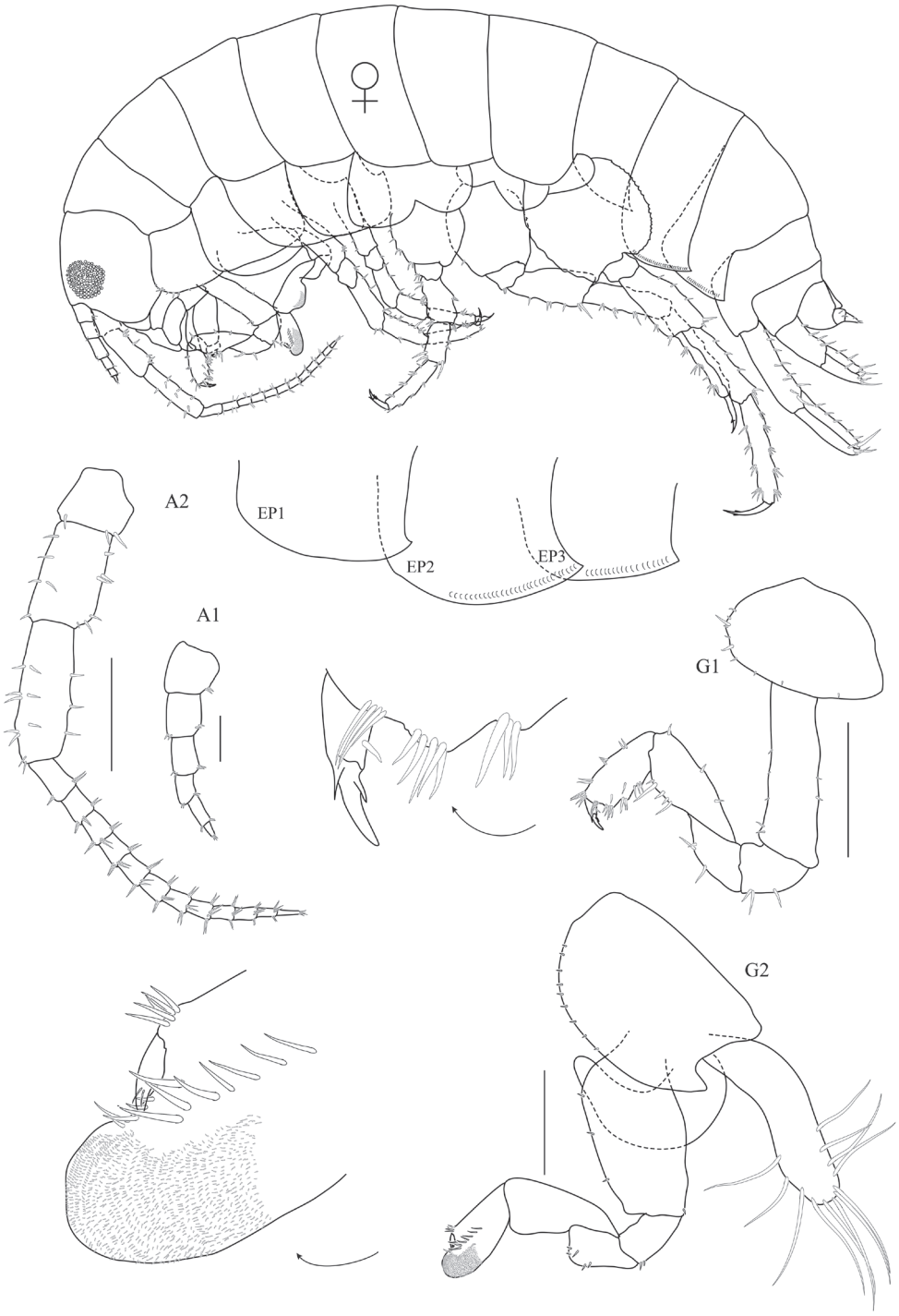

Figure 7. *Floresorchestia buraphana* sp. n. holotype, male, 6.3 mm (PSUZC-CR-0312), Burapha University, Chonburi. Scale bars 0.5 mm.

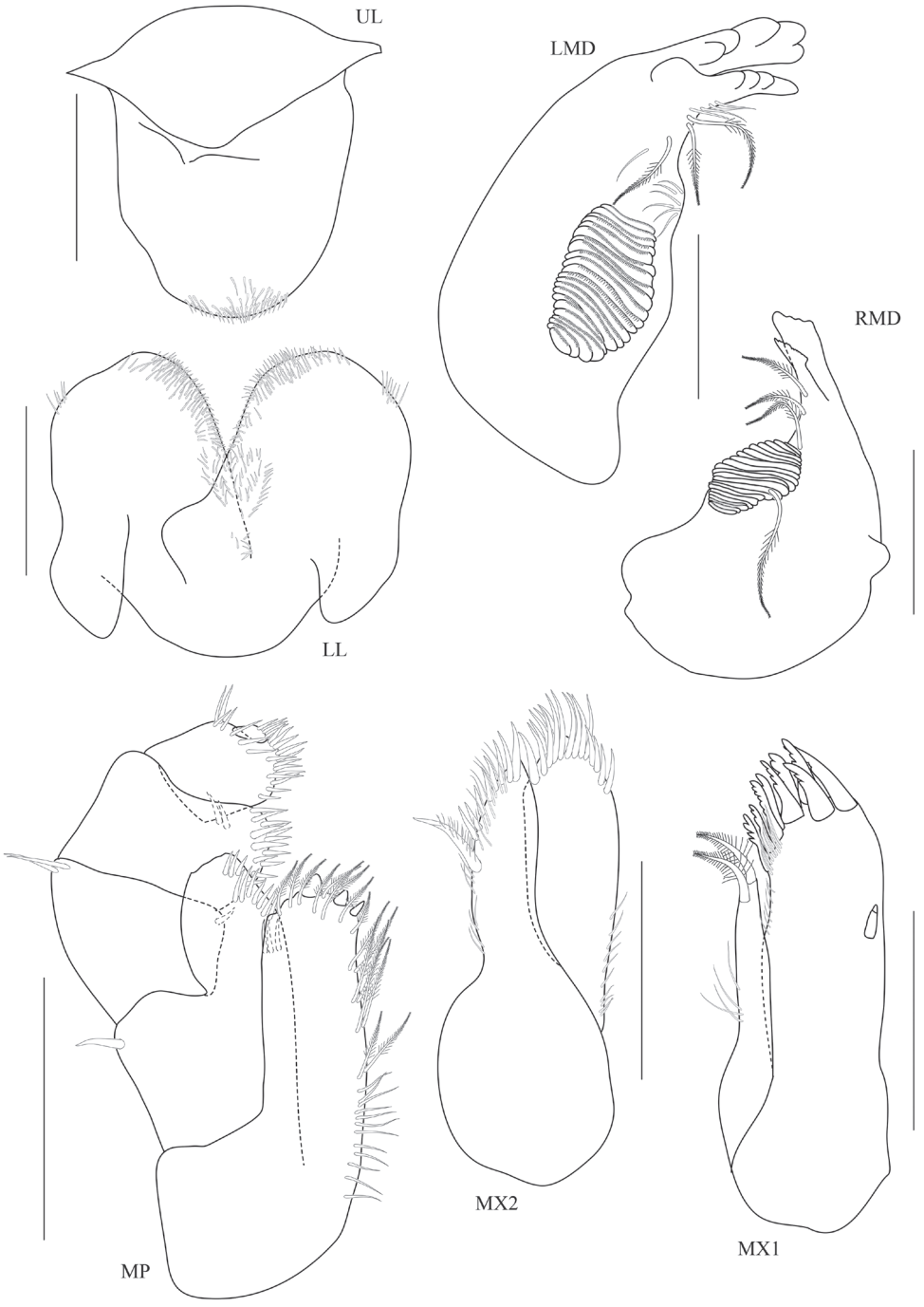

Figure 8. *Floresorchestia buraphana* sp. n. holotype, male, 6.3 mm (PSUZC-CR-0312), Burapha University, Chonburi. Scale bars for MX1, MX2, MP, LMD and RMD represent 0.2 mm and for UL and LL represent 0.1 mm.

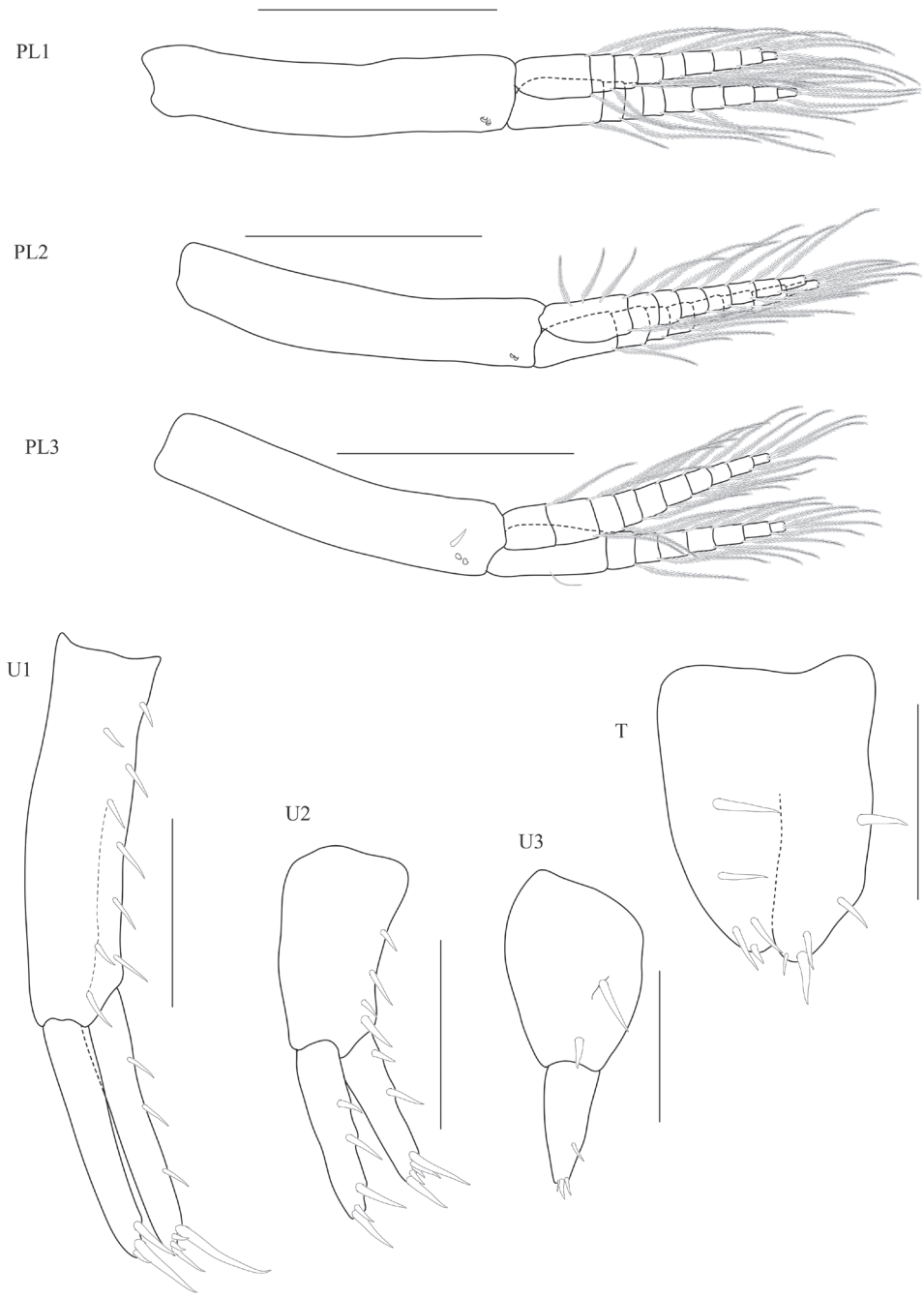

Figure 9. *Floresorchestia buraphana* sp. n. holotype, male, 6.3 mm (PSUZC-CR-0312), Burapha University, Chonburi. Scale bars for PL1-3 represent 0.5 mm, for U1-2 represent 0.2 mm, and for U3 and T represent 0.1 mm.

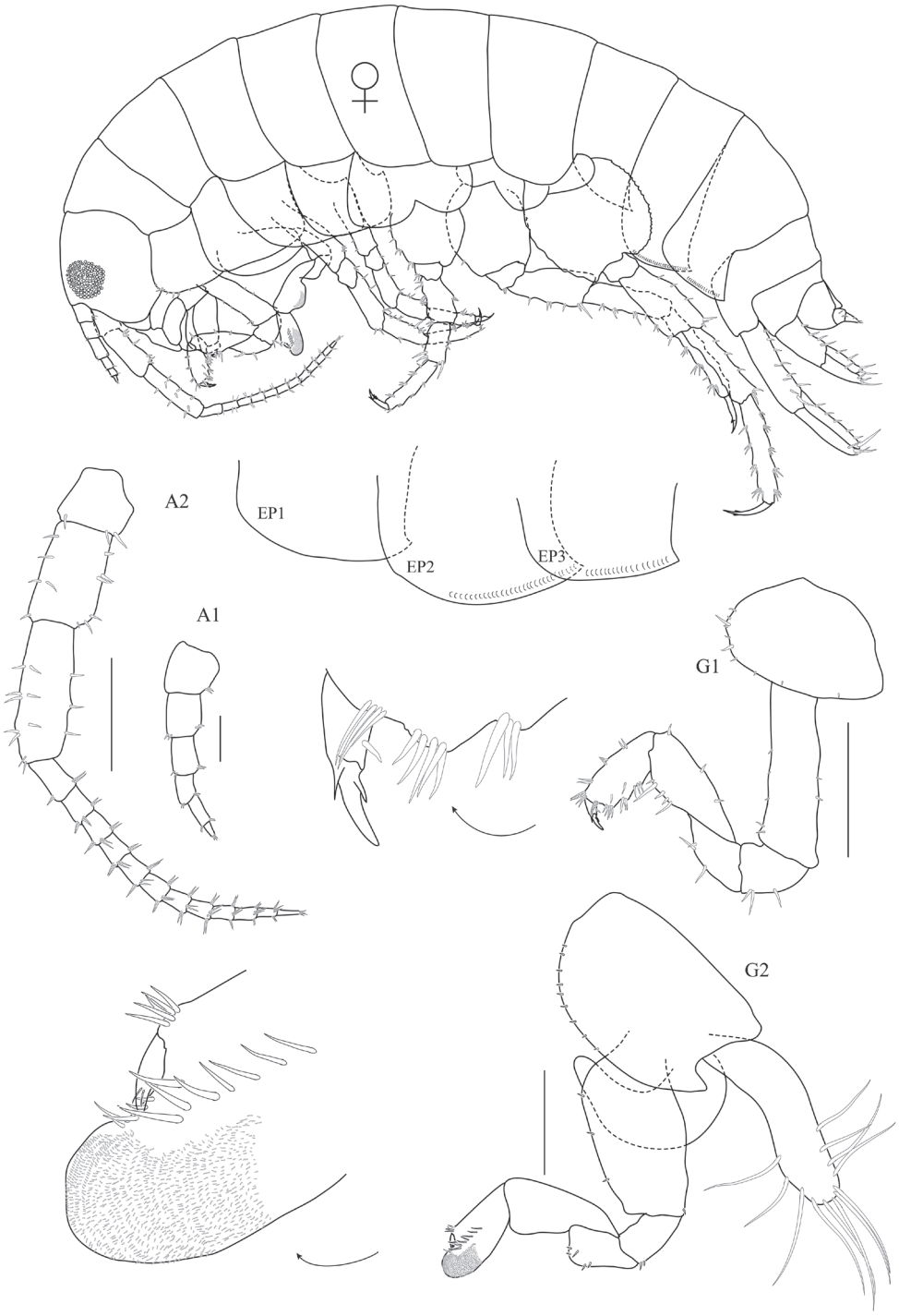

Figure 10. *Floresorchestia buraphana* sp. n. allotype, female 8.8 mm (PSUZC-CR-0313), Burapha University, Chonburi. Scale bars 0.5 mm.

Table 1. A summary of the diagnostic characteristics that serve to distinguish closely related *Floresorchestia* species.

Species	Body length (mm)	Left mandible lacinia mobilis	Gnathopod 1	Gnathopod 1 carpus	Pleopod 1–3 peduncle	Slit on epimera 2 and 3	Uropod 1 peduncle	Uropod 3 peduncle	Telson
F. boonyanusithii sp. n.	5.5	4-dentate	Posterior margin of merus, carpus and propodus each with lobe covered in palmate setae	2.6 × as long as broad, palm extending 33% along posterior margin	Without marginal setae	27 and 20 slits	With 6 robust setae	Peduncle with 2 robust setae, rami 1.8 as long as broad without marginal setae	Dorsal midline at least halfway with 4 setae per lobe
F. buraphana sp. n.	6.3	4-dentate	Posterior margin of merus, carpus and propodus each with lobe covered in palmate setae	2 × as long as broad, palm extending 37% along posterior margin	Without marginal setae	25 and 15 slits	With 9 robust setae	Peduncle with 2 robust setae, rami 2.2 x as long as broad with a marginal seta	Dorsal midline at least halfway with 5 setae per lobe
F. hanoiensis Hou & Li, 2003	6.5	4-dentate	Posterior margin of merus, carpus and propodus each with lobe covered in palmate setae	1.9 × as long as broad, palm extending between 46-50% along posterior margin	With marginal robust setae	22 and 5 slits	With 8 robust setae	Peduncle with 2 robust setae, rami 1.8 as long as broad without marginal setae	Dorsal midline entire with 3 setae per lobe
F. samroiyodensis Azman, Wongkamhaeng & Dumrongrojwattana, 2014	10.5	Male 4-dentate, female 6-dentate	Posterior margin of carpus and propodus each with lobe covered in palmate setae	2 × as long as broad, palm extending 27% along posterior margin	Without marginal setae	21 and 13 slits	With 6 robust setae	Peduncle with 2 robust setae, rami 1.9 as long as broad with a marginal seta	Dorsal midline vestigial or absent with 5 setae per lobe

Acknowledgements

The authors would like to thank Dr. Chaichat Boonyanusith for providing specimens for study and being a source of inspiration for this work. We gratefully acknowledge Dr. Charles Oliver Coleman from the Museum of für Naturkunde in Berlin, Germany and Dr. Jim Lowry from the Australian Museum in Sydney for their assistance with the literature. This work was partially financial supported by Research Grant of Burapha University through National Research Council of Thailand (Grant no. 6/2559).

References

Azman BAR, Wongkamhaeng K, Dumrongrojwattana P (2014) Description of *Floresorchestia samroiyodensis*, a new species of landhopper (Crustacea, Amphipoda, Talitridae) from Thailand. Zoosystematics and Evolution 90: 7–19. doi: 10.3897/zse.90.7085

Barnard JL (1960) Insects of Micronesia. Crustaceana 4: 13–30.

Barnard KH (1916) Contributions to the crustacean fauna of South Africa. 5. The Amphipoda. Annals of the South African Museum 15: 105–302. doi: 10.5962/bhl.part.22196

Bousfield EL (1970) Terrestrial and Aquatic Amphipod Crustacea from Rennell Island 6: 154–168.

Bousfield EL (1971) Amphipoda of the Bismarck Archipelago and adjacent Indo-Pacific islands (Crustacea). Steenstrupia 1: 255–293.

Bousfield EL (1984) Recent advances in the systematics and biogeography of landhoppers (Amphipoda: Talitridae) of the Indo-Pacific region. In: Radovsky FJ, Reven PH, Sohmer SH (Eds) Biogeography of the tropical Pacific, proceedings of a symposium. Bishop Museum Special Publication 72: 171–210.

Bulycheva AI (1957) Sea fleas of the seas of the USSR and adjacent waters Amphipoda-Talitroidea. Opredeliteli po faune SSSR 65: 1–186.

Bussarawich S (1985) Gammaridean amphipoda from mangroves in Thailand. In: NRCT (Ed.) Fifth Seminar on Mangrove Ecosystems, Phuket (Thailand), 26–29 July 1985, 1–17.

Chevreux E (1901) Amphipodes des eaux souterraines de France et d'Algérie. Bulletin de la Société zoologique de France 1901: 211–221.

Ciavatti G (1989) Les talitres (Curstacea: Amphipoda) des plages de la Guadeloupe. Description de deux espèces nouvelles. Annales de l'Institut Océanographique 65: 127–146.

Coleman CO (2003) "Digital inking": how to make perfect line drawings on computers. Organisms, Diversity and Evolution 3: 303–304. doi: 10.1078/1439-6092-00081

Dang NT, Le HA (2011) Ho Talitridae (Amphipoda - Gammaridea) Biên Viêt Nam. Tap chí Sinh hoc 33(4): 1–7.

Hou Z-E, Li S-Q (2003) Terrestrial talitrid amphipods (Crustacea: Amphipoda) from China and Vietnam: studies on the collection of IZCAS. Journal of Natural History 37: 2441–2460. doi: 10.1080/00222930210144343

Lowry JK, Myers AA (2013a) A Phylogeny and Classification of the Senticaudata subord. n. (Crustacea: Amphipoda). Zootaxa 3610(1): 1–80. doi: 10.11646/zootaxa.3610.1.1

Lowry JK, Myers AA (2013b) New species of *Floresorchestia* from Micronesia living in unusual habitats (Crustacea, Amphipoda, Talitridae). Zootaxa 3737: 576–584. doi: 10.11646/zootaxa.3737.5.4

Lowry JK, Springthorpe RT (2009a) The genus *Floresorchestia* (Amphipoda: Talitridae) on Cocos (Keeling) and Christmas Islands. Memoirs of Museum Victoria 66: 117–127.

Lowry JK, Springthorpe RT (2009b) The genus *Floresorchestia* (Amphipoda: Talitridae) in tropical Australia. The Beagle, Records of the Museums and Art Galleries of the Northern Territory 25: 65–70.

Lowry JK, Springthorpe R (2015) The tropical talitrid genus *Floresorchestia* (Crustacea, Amphipoda, Talitridae). Zootaxa 3935: 1–68. doi: 10.11646/zootaxa.3935.1.1

Miyamoto H, Morino H (2008) Taxonomic Studies on the Talitridae from Taiwan, III. The Genus *Floresorchestia* Bousfield, 1984. Crustaceana 81: 837–860. doi: 10.1163/156854-008784771667

Rafinesque CS (1815) Analyse de la nature, ou Tableau de l'Université et des corps organises. Palerme, 224 pp. doi: 10.5962/bhl.title.106607

Schellenberg A (1931) Amphipoden der Sunda-Expeditionen Thienemann und Rensch. Sonder-Abdruck aus dem Archiv für Hydrobiologie Supplement 8. Tropische Brinnengewässer 1: 493–511.

Serejo CS (2004) Cladistic revision of talitroidean amphipods (Crustacea, Gammaridea), with a proposal for a new classification. Zoologica Scripta 33: 551–586. doi: 10.1111/j.0300-3256.2004.00163.x

Stephensen K (1935) Terrestrial Talitridae from the Marquesas. Bernice P Bishop Museum 142: 19–32.

Tattersall WM (1922) Zoological Results of a Tour in the Far East: Amphipoda with Notes on an Additional Species of Isopoda. Memoirs of the Asiatic Society of Bengal 6: 437–459.

Watling L (1989) A classification system for crustacean setae based on the homology concept. In: Felgenhauer BE, Watling L, Thistle AB (Eds) Functional Morphology of Feeding and Grooming in Crustacea. Crustacean Issues 6: 15–27.

Weber M (1892) Der Susswasser-Crustaceen des Indischen Archipels, nebst bemerkungen uber die Susswasser-Fauna im Allgemeinen. Zoologisclze Ergebnisse einer Reise nach niederlaizdischen Ost-indien 2: 528–571.

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Two new species of pontogeneiid amphipods (Crustacea, Senticaudata, Calliopioidea) from Korean waters

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Abstract

Two new pontogeneiid amphipods, *Eusiroides pilopalpus* **sp. n.** and *Paramoera dentipleurae* **sp. n.**, from Korean waters are described and illustrated. *Eusiroides pilopalpus* **sp. n.** can be distinguished from congeners by the following characters: mandibular palp article 3 has brush-like setation, maxilla 2 has an inner plate that is not enlarged, and gnathopods 1 and 2 ischium has a well-developed anterior lobe. *Paramoera dentipleurae* **sp. n.** can be discriminated from congeners by the following characters: head anterior cephalic lobe is sinusoid, pereopods 5–7 are homopodous and slender, pereopods 6 and 7 basis are proximally lobed but distally diminished on posterior margins, and epimeron 3 is prominently expanded posterodistally.

Keywords

Amphipoda, *Eusiroides pilopalpus*, *Paramoera dentipleurae*, Korea, new species, taxonomy

Introduction

The family Pontogeneiidae Stebbing, 1906, one of the largest taxa of Calliopioidea Sars, 1895, consists of 31 genera readily distinguishable from its closely related families Cheirocratidae d'Udekem d'Acoz, 2010 and Hornelliidae d'Udekem d'Acoz, 2010 by the presence of calceoli on antennae 1 and 2 (absent in the former), and from the family Calliopiidae Sars, 1895 by a deeply to weakly cleft telson (notched, emarginated or entire in Calliopiidae) (Lowry and Myers 2013).

Members of the genus *Eusiroides* Stebbing, 1888 share some plesiomorphic characters with littoral marine pontogeneiids such as setose palmar margins of gnathopods, stout homopodous pereopods, and linear, apically setose rami of the uropods (Bousfield and Hendrycks 1995). To date, this genus accommodates 16 nominal species widely distributed in coastal marine regions of warm-temperate and tropical areas of the Atlantic Ocean, the Indian Ocean, and the Pacific Ocean (Haswell 1879; Stebbing 1888; Giles 1890; Chevreux 1900; Walker 1904, 1909; Barnard KH 1932; Ledoyer 1978; 1982; McKinney et al. 1980; Hirayama 1985; Bellan-Santini and Ledoyer 1986; Bousfield and Hendrycks 1995). Near Korean waters, the following two *Eusiroides* species have been recorded: *E. japonica* Hirayama, 1985 originally described from Japan and *E. diplonyx* Walker, 1909 originally described from the Seychelles in the Indian Ocean and subsequently reported from China (Walker 1909; Hirayama 1985; Ren 2012).

The genus *Paramoera* was established by Miers (1875) as monotypic based on *P. australis*. It is one of the largest groups of Pontogeneiidae including more than 50 species (Miers 1875; Staude 1995; Sidorov 2010). *Paramoera* members are mostly confined to marine and brackish water habitats; however, some of them live in fresh water or subterranean environments from temperate latitudes around the Pacific Ocean (Staude 1995; Kuribayashi and Kyono 1995; Sidorov 2010). In the Far East region, seven species of *Paramoera* have been recorded from marine habitats: *Paramoera udehe* (Derzhavin, 1930), *P. koreana* Stephensen, 1944, *P. brevirostrata* (Bulycheva, 1952), *P. mokyevskii* (Gurjanova, 1952), *P. tridentata* Bulycheva, 1952, *P. hanamurai* Hirayama, 1990, and *P. koysama* Kuribayashi & Kyono, 1995 (Stephensen 1944; Bulycheva 1952; Gurjanova 1952; Hirayama 1990; Kuribayashi and Kyono 1995; Labay 2012).

In Korean waters, three pontogeniids, *Eusiroides japonica*, *Paramoera koreana*, and *Pontogeneia rostrata* Gurjanova, 1938 have been recorded from marine habitats (Kim and Kim 1987, 1991). Here, further two new species are reported, *Eusiroides pilopalpus* sp. n. and *Paramoera dentipleurae* sp. n., from Korean waters with detailed descriptions and illustrations.

Materials and methods

Samples were collected from the benthic zones using a sledge net (mesh size 300 μm, mouth size 120 × 45 cm). Specimens were initially fixed with 5% formaldehyde-seawater solution. They were preserved with 85% ethyl alcohol after sorting in the laboratory. Samples were stained with lignin pink dyes. Specimen appendages were dissected in a Petri dish filled with glycerol using dissection forceps and a needle under a stereomicroscope (SZH10; Olympus, Tokyo, Japan). They were mounted onto temporary slides using glycerol-ethanol solution or permanent slides using polyvinyl lactophenol solution. Drawings were performed under a light microscope (LABOPHOT-2; Nikon, Tokyo) with aid of a drawing tube. Definition of the term for 'seta' and its types follows those of Watling (1989). Type material was deposited in the National Institute of Biological Resources (NIBR), Incheon, Korea.

Systematic accounts

Order Amphipoda Latreille, 1816
Suborder Senticaudata Lowry & Myers, 2013
Superfamily Calliopioidea Sars, 1895
Family Pontogeneiidae Stebbing, 1906
Genus *Eusiroides* Stebbing, 1888

***Eusiroides pilopalpus* sp. n.**
http://zoobank.org/5B037355-73B0-4F5A-94A3-CD907324FAD9
Figs 1–6

Type locality. Jeju Island, South Korea, 33°14'23"N 126°34'59"E, sublittoral (average depth 24 m).

Material examined. Holotype: NIBRIV0000328601, adult female, 8.4 mm, collected from the type locality on 30 Nov 2012 by Prof. H.-Y. Soh.

Etymology. The composite epithet of the specific name of *pilopalpus* is a combination of Latin *pilosus* and *palpus* meaning 'hairy palp'. This name refers to the character of the mandibular palp article 3: the surface is covered with several rows of minute setae along the distal two-thirds length and with a group of brush-like fine setae at the center of the outer margin. Noun in apposition.

Diagnosis. Head with short rostrum; eyes reniform, well-developed. Antennae with stout peduncular articles, with calceoli on flagellum; accessory flagellum of antenna 1 uni-articulate, as long as 1st proximal article of flagellum. Upper lip slightly angulate distally. Lower lip outer lobe with 7 bifid setae on surface. Mandibles both with bi-dentate (1 small and 1 enlarged) incisors, with trifid and 6-dentate lacinia mobilis on right and left mandibles, respectively; palp article 3 covered with numerous fine setae laterodistally. Maxilla 1 outer plate with 10 dentate robust setae apically. Maxilla 2 inner plate broader than outer plate. Maxilliped with short inner plate; outer plate elongate; palp articles 1–3 expanded, article 4 falcate. Gnathopods moderately subchelate, similar to each other, with developed anterior lobe on basis and ischium; dactylus falcate, elongate. Pereopods 3–4 ordinary; basis lined with short setae posteriorly; ischium anterior lobe acute distally; merus anterodistal corner produced bearing 1 robust seta. Pereopods 5–7 basis expanded posteriorly; ischium posterior lobe developed; merus produced posterodistally. Pleonal epimera each with submarginal setae ventrally; epimera 2 and 3 with oblique redge on surface; epimeron 3 with serrations posteriorly. Uropod 1 peduncle with largest seta mediodistally; outer ramus with lateral setae only. Uropod 2 shorter than uropod 1, peduncle with 1 distal seta laterally. Uropod 3 rami lancerolate. Telson shallowly cleft (approximately 1/4 on its length).

Description of holotype female. ***Head*** (Fig. 1A): rostrum short; lateral cephalic lobes weakly produced and slightly oblique; antennal sinus not deep; eyes reniform, well-developed, enlarged.

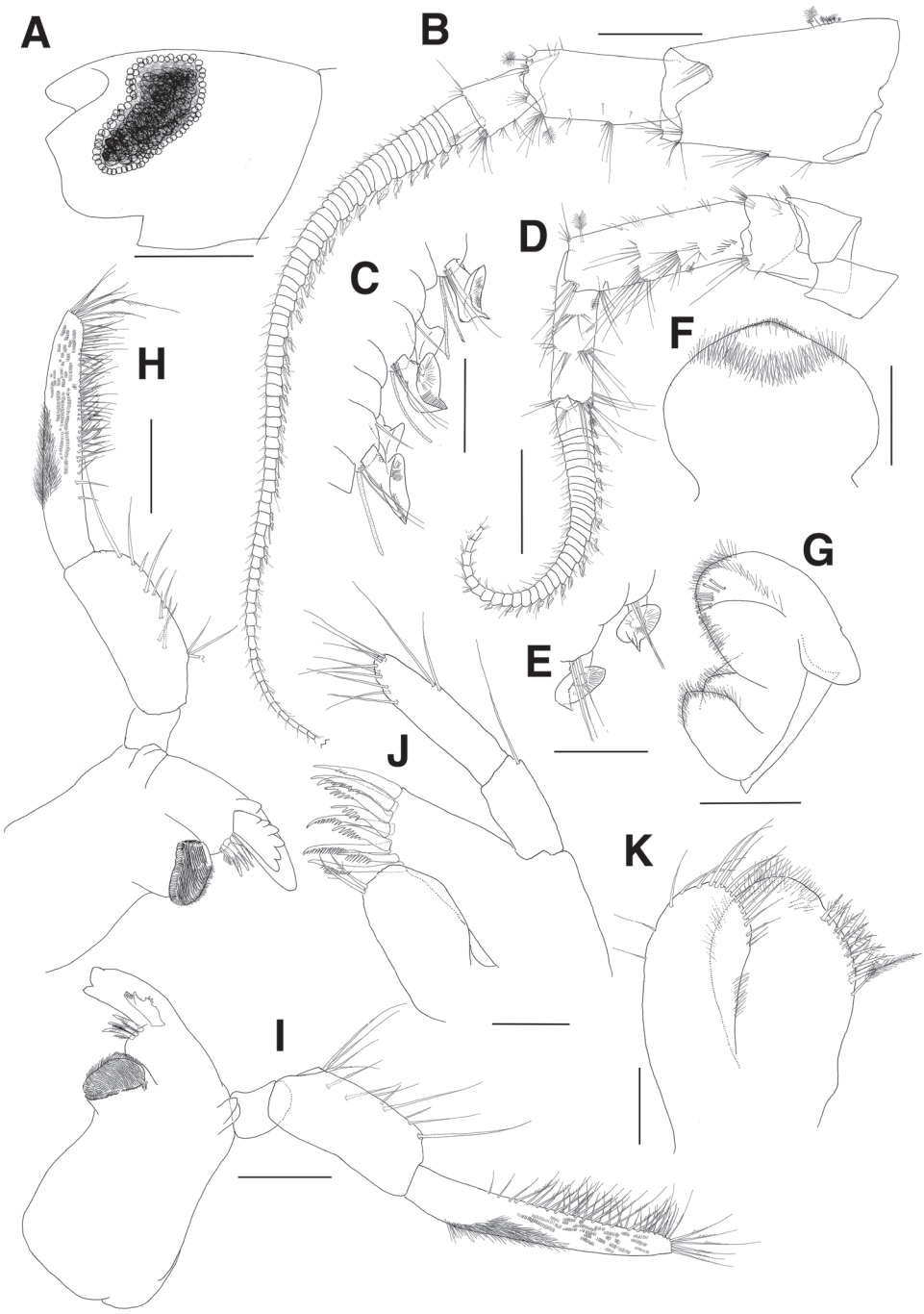

Figure 1. *Eusiroides pilopalpus* sp. n., holotype. **A** Head **B** Antenna 1 **C** Calceoli of flagellum on antenna 1 **D** Antenna 2 **E** Calceoli of flagellum on antenna 2 **F** Upper lip **G** Lower lip **H** Left mandible **I** Right mandible **J** Maxilla 1 **K** Maxilla 2. Scale bars 0.1 mm (**C, E, J, K**), 0.2 mm (**F–I**), 0.5 mm (**A, B, D**).

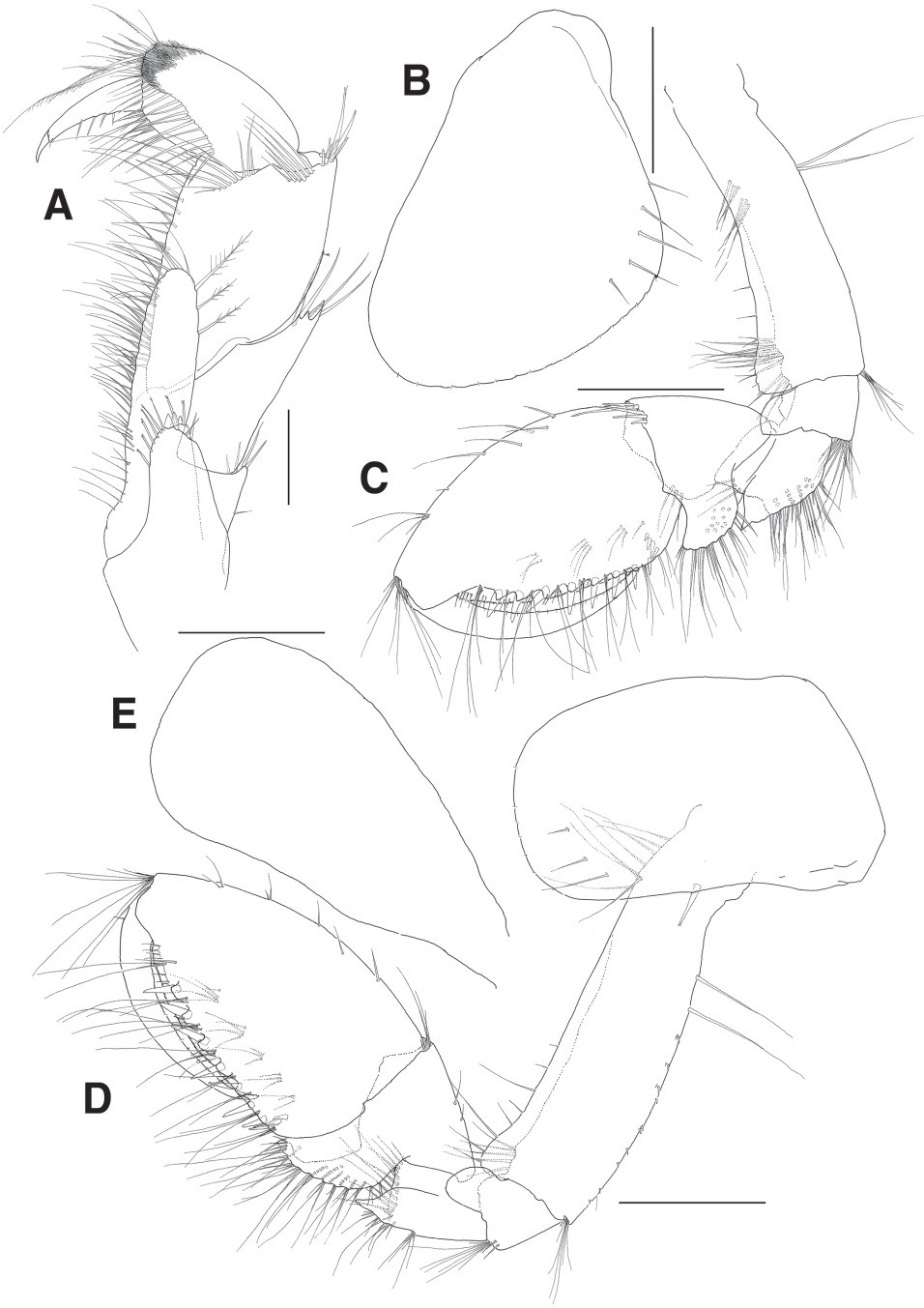

Figure 2. *Eusiroides pilopalpus* sp. n., holotype. **A** Maxilliped **B** Coxa 1 **C** Gnathopod 1 **D** Gnathopod 2 **E** Coxal gill of gnathopod 2. Scale bars 0.2 mm (**A**), 0.5 mm (**B–D**).

Antenna 1 (Fig. 1B, C): stout, with length ratio of 1.0:0.7:0.3 in peduncular articles 1–3; peduncular article 1 with 1 group of 7 plumose setae on anterior margin proximally and with smooth groove bearing setae on lateral margin subdistally; peduncular article 2 with 1 subdistal and 2 distal setae laterally and 1 pair of distal setae medially on anterior margin, also with small groove bearing setae on distal margin; accessory flagellum uni-articulate, as long as 1st proximal article of flagellum, with 5 setae on apex; flagellum more than 72-articulate and slightly longer than twice as long as peduncular articles 1–3 combined, proximal article longest, with single or paired aesthetascs and calceoli present from 1st to 54th articles discontinuously.

Antenna 2 (Fig. 1D, E): stout, shorter than antenna 1; with length ratio of 1.0:0.7 in peduncular articles 4–5; flagellum more than 36-articulate, slightly shorter than peduncular articles 3–5 combined, proximal article longest, with calceoli present from 1st to 24th articles discontinuously.

Upper lip (Fig. 1F): apex convex, slightly angulate distally, covered with apical and subapical fine setae.

Lower lip (Fig.1G): inner lobe weak; outer lobe apically round with 7 bifid setae on surface; mandibular processes developed bearing round apices.

Right mandible (Fig. 1I): incisor bi-dentate (1 small and 1 enlarged); lacinia mobilis trifid, each multidentate; accessory setal row with 3 serrate and 3 plumose setae alternatively; molar triturative, columnar; palp 3-articulate; palp article 1 shortest; palp article 2 rectilinear, with 12 setae on expanded medial margin; palp article 3 weakly falcate, with marginal and submarginal serrate setae on distal 3/4 of medial margin, covered with several rows of fine setae on distal 2/3 of surface, densely covered with group of brush-like setae at centre on lateral margin and surface, apex bluntly truncate with 6 serrate setae.

Left mandible (Fig. 1H): incisor bi-dentate (1 small and 1 enlarged); lacinia mobilis 6-dentate; accessory setal row with 1 simple, 3 serrate, and 1 plumose setae; palp similar to that of right mandible.

Maxilla 1 (Fig. 1J): inner plate enlarged, with 2 plumose setae at mediodistal corner; outer plate with 10 dentate robust setae apically; palp long, beyond apical setae of outer plate, palp article 1 with 1 long seta laterodistally, article 2 with 1 row of 9 setae along apical and mediodistal margins, with 1 pair of long setae laterally.

Maxilla 2 (Fig. 1K): inner plate ovoid, broader than outer plate, with 1 row of 8 weakly plumose and 1 long plumose setae on medial margin subdistally, covered with fine setae on apical and subapical margins; outer plate with 16 setae on apical margin, with 2 setae on lateral margin distally.

Maxilliped (Fig. 2A): inner plate short, tongue-shaped, with 3 robust setae apically, with 8 bifid and 2 simple setae arranged from apex to mediodistal margin; outer plate elongate, 2.0 times as long as inner plate, lined with numerous long setae arranged from apex to medial margin, with 3 long weakly plumose setae on lateral margin; palp with expanded articles 1–3; article 1 with 1 group of 4 elongate setae laterodistally; article 2 lined with numerous simple long setae on medial margin, with 2 rows of setae subdistally, with 1 group of 6 unequal setae at laterodistal corner; article 3 0.3 times as long as article 2, with ledge bearing 1 row of long setae on surface, with 7 serrate and

4 simple setae at laterodistal corner, covered with numerous fine setae laterodistally; article 4 falcate, slightly shorter than article 3, with 4 setae along inner margin.

Gnathopod 1 (Fig. 2B, C): moderately subchelate; coxa expanded anterodistally, with 16 minute setae on round ventral margin, with 1 small notch bearing 1 minute seta posteroventrally, with 1 oblique row of 5 long setae on surface posteroventrally; basis lined with short setae and shallowly lobed anterodistally, with 2 groups of 3 submarginal setae proximally and with 2 groups of 9 subdistal and 3 distal setae medially on anterior margin, with 1 pair of elongate setae on posterior margin proximally and with 1 group of 6 setae at posterodistal corner; ischium largely lobed anteriorly, without setae on posterior margin and with 1 group of 11 setae posterodistally; merus forming groove anterodistally, with 1 row of 4 setae medially, with acute protrusion posterodistally, lined with numerous setae on posterior margin; carpus longer than merus, without setae on anterior margin and with 1 row of 5 setae at anterodistal corner, posterior margin broadly lobed laterally, weakly crenulate and with groups of serrate and simple setae and with 3 setae mediodistally; propodus ovoid, shorter than basis, with 1 group of 3 setae and 6 single setae on anterior margin and with 1 group of 9 setae at anterodistal corner, with 1 vertical row of 4 robust defining setae on medial surface near posterior margin, palm approximately 3.0 times as long as posterior margin and minutely pectinate, with 7 robust setae along toothed submargin; dactylus falcate, stout, long, fitting palm.

Gnathopod 2 (Fig. 2E, D): moderately subchelate, similar to gnathopod 1; coxa rectangular, not expanded anterodistally, with 1 oblique row of 4 elongate setae on surface posteroventrally, with 1 robust seta on posterior margin, ventral margin subrounded with 7 minute setae, coxal gill longer than coxa and expanded distally; basis shallowly lobed and lined with 8 setae anterodistally, with 1 group of 5 setae mediodistally on anterior margin, with 2 elongate setae proximally and lined with single or paired minute setae on posterior margin, with 1 group of 7 setae at posterodistal corner; ischium largely lobed and slightly dilated anterodistally, without setae on posterior margin and with 1 pair of subdistal and 1 group of 7 distal setae at posterodistal corner; merus forming groove anterodistally, with 1 row of 13 setae medially, with acute protrusion posterodistally; carpus longer than merus, with 2 setae on anterior margin and 1 group of 4 setae at anterodistal corner, posterior margin broadly lobed, weakly crenulate and with groups of simple setae; propodus triangular, shorter than basis, with 3 single and 2 pairs of setae on anterior margin and with 1 group of 8 setae at anterodistal corner, with 1 vertical row of 3 robust defining setae on medial surface near posterior margin, palm poorly defined, about 3.0 times as long as posterior margin and minutely pectinate, with 7 robust setae along toothed submargin; dactylus falcate, stout, long, fitting palm.

Pereopod 3 (Fig. 3A, B): coxa rectangular, similar to that of gnathopod 2, facial setae absent, with 7 minute setae on ventral margin, with 1 robust seta on posterior margin, coxal gill as long as coxa and expanded distally; basis slightly curved proximally, anterior margin lined with setae, anterodistal lobe weak with several setae, with more than 10 groups of minute setae on posterior margin; ischium short, anterodistally lobed, with 1 group of 3 setae at posterodistal corner; merus 0.7 times as long as basis, expanded anterodistally, with 3 proximal and 2 distal setae on anterior margin,

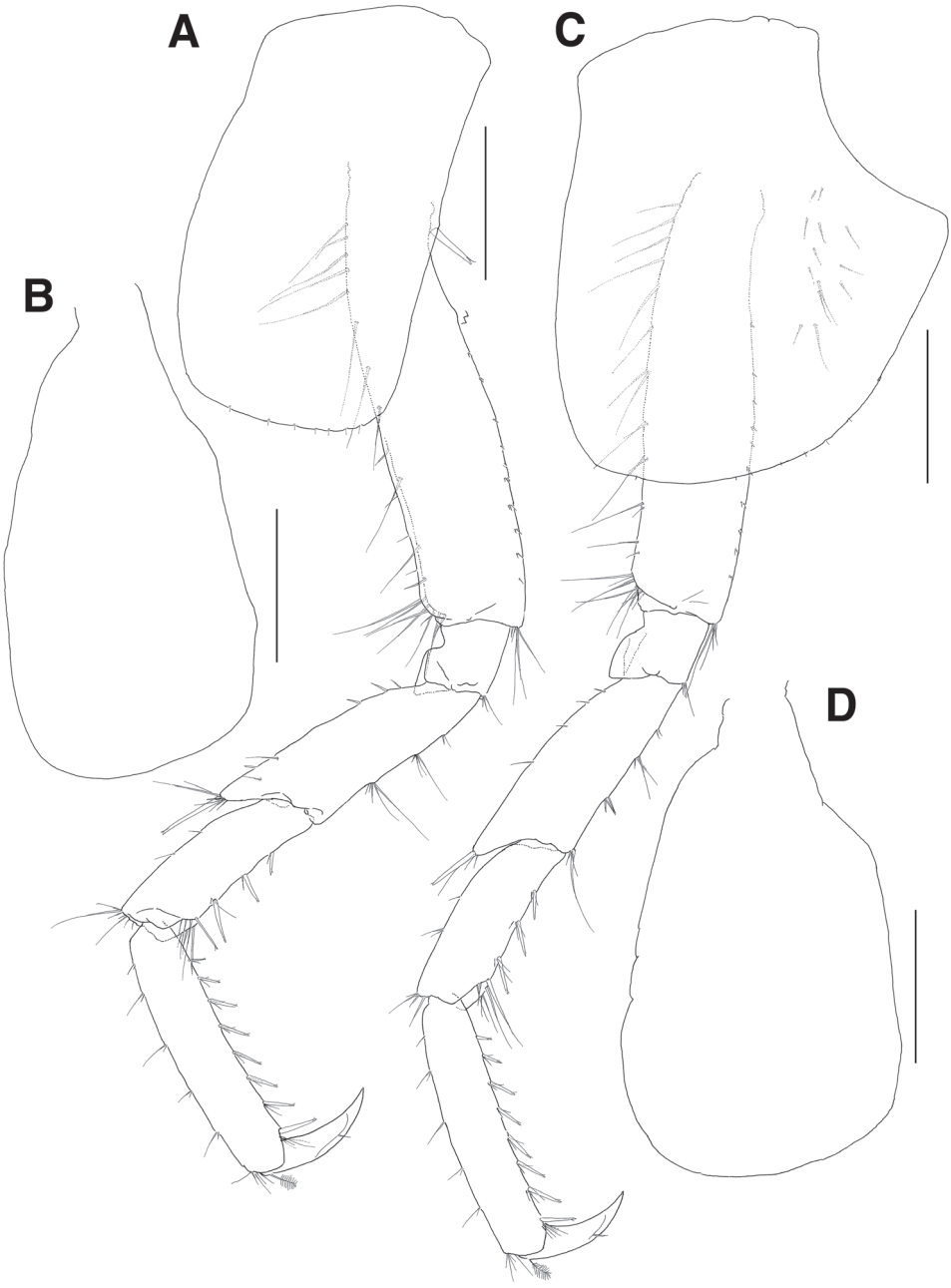

Figure 3. *Eusiroides pilopalpus* sp. n., holotype. **A** Pereopod 3 **B** Coxal gill on pereopod 3 **C** Pereopod 4 **D** Coxal gill of pereopod 4. Scale bars 0.5 mm.

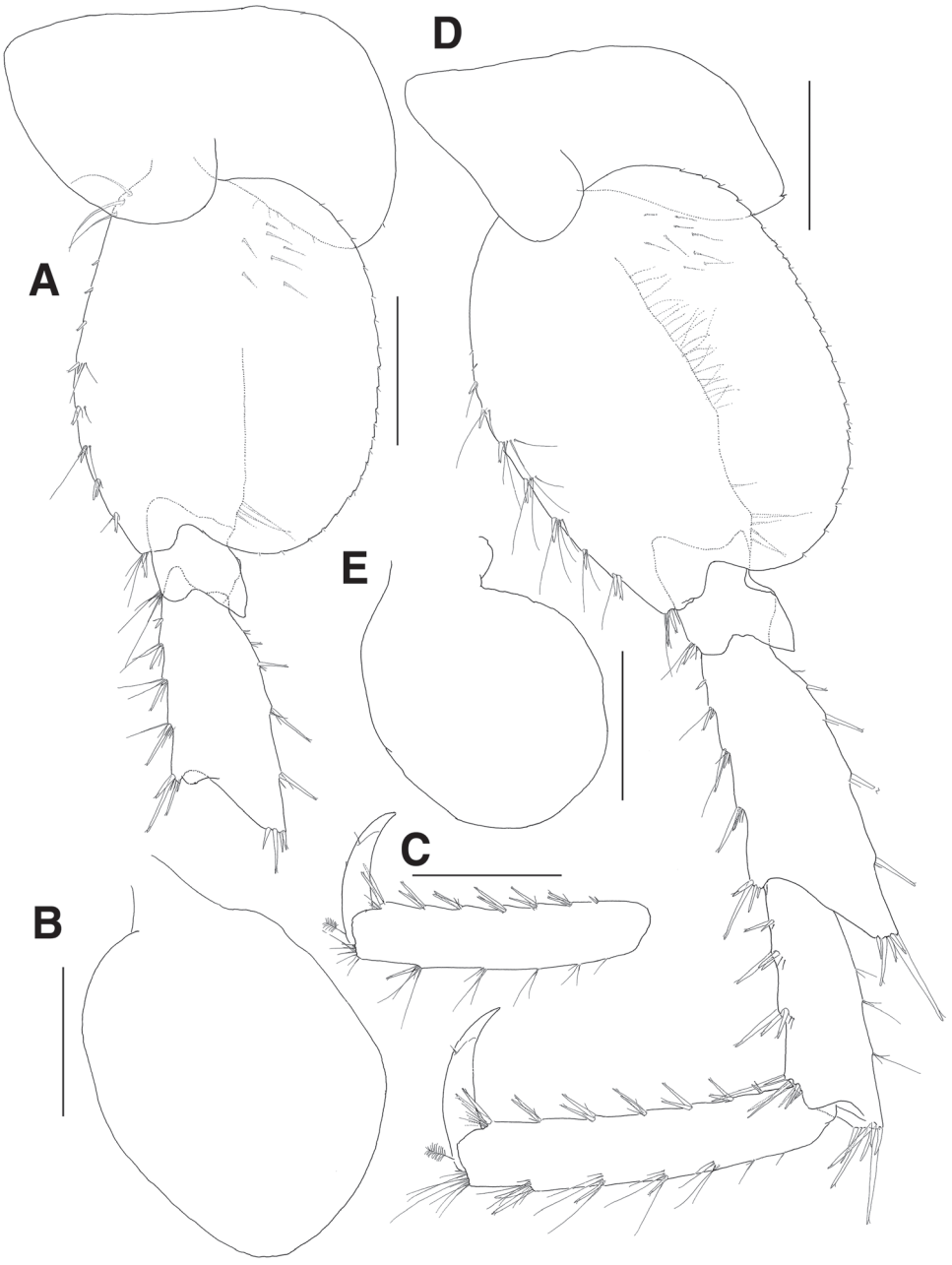

Figure 4. *Eusiroides pilopalpus* sp. n., holotype. **A** Pereopod 5 **B** Coxal gill of pereopod 5 **C** Propodus and dactylus on pereopod 5 **D** Pereopod 6. Scale bars 0.5 mm.

anterodistal corner produced with 1 group of 1 robust and 6 simple setae, with 3 groups of simple setae on posterior margin; carpus not expanded, 0.9 times as long as merus, with 2 setae on anterior margin and with 7 setae on anterodistal corner, with 3 pairs of 1 robust and 1 simple setae on posterior margin, posterodistal corner oblique with 4 lateral and 3 medial setae; propodus 1.1 times as long as carpus, with 5 pairs of setae on anterior margin and with 1 group of 5 setae at anterodistal corner, with 7 groups of robust and simple setae on posterior margin and with 1 group of 1 locking seta and 4 simple setae at posterodistal corner; dactylus falcate, as long as half of propodus.

Pereopod 4 (Fig. 3C, D): coxa acutely produced backwards posteriorly; other articles similar to those of pereopod 3.

Pereopod 5 (Fig. 4A–C): coxa bilobed, posterior lobe narrower and more ventrally produced than anterior lobe, with 5 minute setae on ventral margin, coxal gill subovoid, smaller than that of pereopod 4; basis ovoid, with 3 elongate setae proximally and lined with 3 single setae and 5 groups of setae on anterior margin, anterodistal corner bluntly lobed with 1 group of 5 setae, posterior margin expanded and with 22 weak serrations bearing 1 minute seta, with 3 setae mediodistally, with 7 setae on medial surface proximally; ischium short, anterodistal corner weakly lobed downwards with 1 group of 6 setae, posterior margin largely expanded and slightly lurched posterodistally on lateral border; merus shorter than basis, with 4 groups of robust and simple setae on anterior margin and with 1 group of 5 robust setae at anterodistal corner, posterior margin expanded with 5 groups of robust and simple setae, posterodistal corner produced with 4 robust setae; propodus 1.4 times as long as merus, with 6 groups of paired setae on anterior margin, with paired locking setae and 3 simple setae at anterodistal corner, posterior margin irregularly setose with robust and simple setae, with 6 short setae at posterodistal corner; dactylus falcate, 0.3 times as long as propodus.

Pereopod 6 (Fig. 4D, E): coxa bilobed, smaller than that of pereopod 5, anterior lobe small, posterior lobe expanded backwards and with 1 notch bearing 1 minute seta posteroventrally, coxal gill circular and slightly smaller than that of pereopod 5; basis ovoid, larger than that of pereopod 5, with 2 minute setae proximally and 7 groups of robust and simple setae on anterior margin, anterodistal corner bluntly lobed with 1 group of paired robust setae and 3 simple setae, posterior margin expanded with 25 weak serrations bearing 1 minute seta, with 23 setae proximally and 5 setae distally on medial border, with 8 setae on medial surface proximally; ischium short, anterodistal corner weakly lobed downwards with 1 group of 1 robust and 5 simple setae, posterior margin largely expanded and slightly lurched posterodistally on lateral border; merus shorter than basis, with 1 robust seta and 3 groups of robust and simple setae on anterior margin, with 1 group of 4 robust setae at anterodistal corner, posterior margin expanded with 2 setae and 3 pairs of robust and simple setae, posterodistal corner produced with 5 robust setae; carpus not linear, slightly shorter than merus, with 3 groups of robust and simple setae on anterior margin and with 1 group of 8 robust setae at anterodistal corner, posterior margin broadly expanded with 3 groups of simple setae, posterodistal corner weakly produced with 1 group of 7 robust setae; propodus 1.3 times as long as merus, with 6 groups of paired robust and simple setae on anterior

margin, with paired locking setae and 7 simple setae at anterodistal corner, posterior margin setose irregularly with robust and simple setae, with 8 setae at posterodistal corner; dactylus falcate, 0.5 times as long as propodus.

Pereopod 7 (Fig. 5A, B): as long as pereopod 6; coxa unilobed, ventrally convex, coxal gill present, longish subovoid, smaller than that of pereopod 6; other articles similar to those of pereopod 6 except for flattened posterior margin of basis.

Pleonal epimera (Fig. 6E): epimeron 1 with 1 oblique ledge on surface, with 1 group of 2 robust and 2 simple setae on ventral margin anteriorly, with 3 pairs of robust and simple setae and 1 robust seta submarginally, weakly produced at posteroventral corner; epimeron 2 larger than epimeron 1, also with 1 oblique ledge on surface, convex ventrally and with 4 pairs of robust and simple setae and 1 robust seta submarginally on anterior half of ventral margin, weakly produced at posteroventral corner; epimeron 3 largest, flattened ventrally, with 3 single setae and 1 pair of robust and simple setae on anterior half of ventral margin, posterior margin expanded backwards and with 11 serrations bearing 1 minute seta on distal half.

Uropod 1 (Fig. 5C, D): peduncle with 7 marginal and 1 distal robust setae dorsomedially and 7 marginal robust setae dorsolaterally; inner ramus linear, as long as peduncle, with 4 medial and 5 lateral robust setae dorsally, apex blunt with 1 pair of robust setae subapically and 3 robust setae (1 large and 2 small) apically; outer ramus shorter than inner ramus, with 5 lateral robust setae dorsally; apex blunt with 1 robust seta subapically and 2 robust setae (1 large and 1 small) apically.

Uropod 2 (Fig. 5E, F): peduncle 0.7 times as long as that of uropod 1, with 2 marginal and 1 subdistal robust setae dorsomedially, with 1 distal robust seta dorsolaterally; inner ramus 1.6 times as long as peduncle, with 7 medial and 7 lateral robust setae dorsally; apex blunt with 1 pair of robust setae subapically and 3 robust setae (1 large and 2 small) apically; outer ramus much shorter than inner ramus, with 3 medial and 3 lateral robust setae dorsally; apex blunt with 1 robust seta subapically and 2 robust setae (1 large and 1 small) apically.

Uropod 3 (Fig. 5G): shortest; peduncle 0.8 times as long as that of uropod 2, with 1 medial seta dorsally; rami lancerolate; inner ramus 1.6 times as long as peduncle, with 7 robust and 8 plumose setae medially and 7 robust setae laterally; outer ramus slightly shorter than inner ramus, with 6 robust and 5 plumose setae medially and 5 robust setae laterally.

Telson (Fig. 5H): shallowly cleft (about 1/4 length), with 1 pair of robust setae proximally, with single or paired simple setae on surface; each apex with 1 notch and 1 simple seta subapically.

Oostegites (Fig. 6A–D): present on gnathopod 2 to pereopod 5, with numerous long setae marginally; that of gnathopod 2 largest; that of pereopod 3 larger than that of pereopod 4, both dilated distally; that of pereopod 5 sublinear, smallest.

Male. Unknown.

Remarks. *Eusiroides pilopalpus* sp. n. is very similar to *E. japonica* Hirayama, 1985. It can be readily distinguished from *E. japonica* by the following characteristic features: (1) degree of setation of peduncular articles 4 and 5 on antenna 2 is weaker than that of *E. japonica*; (2) anterior and posterior margins of peduncular article 5 on antenna 2 are parallel in *E. pilopalpus* sp. n. (vs. margins are gradually diminish distally, and

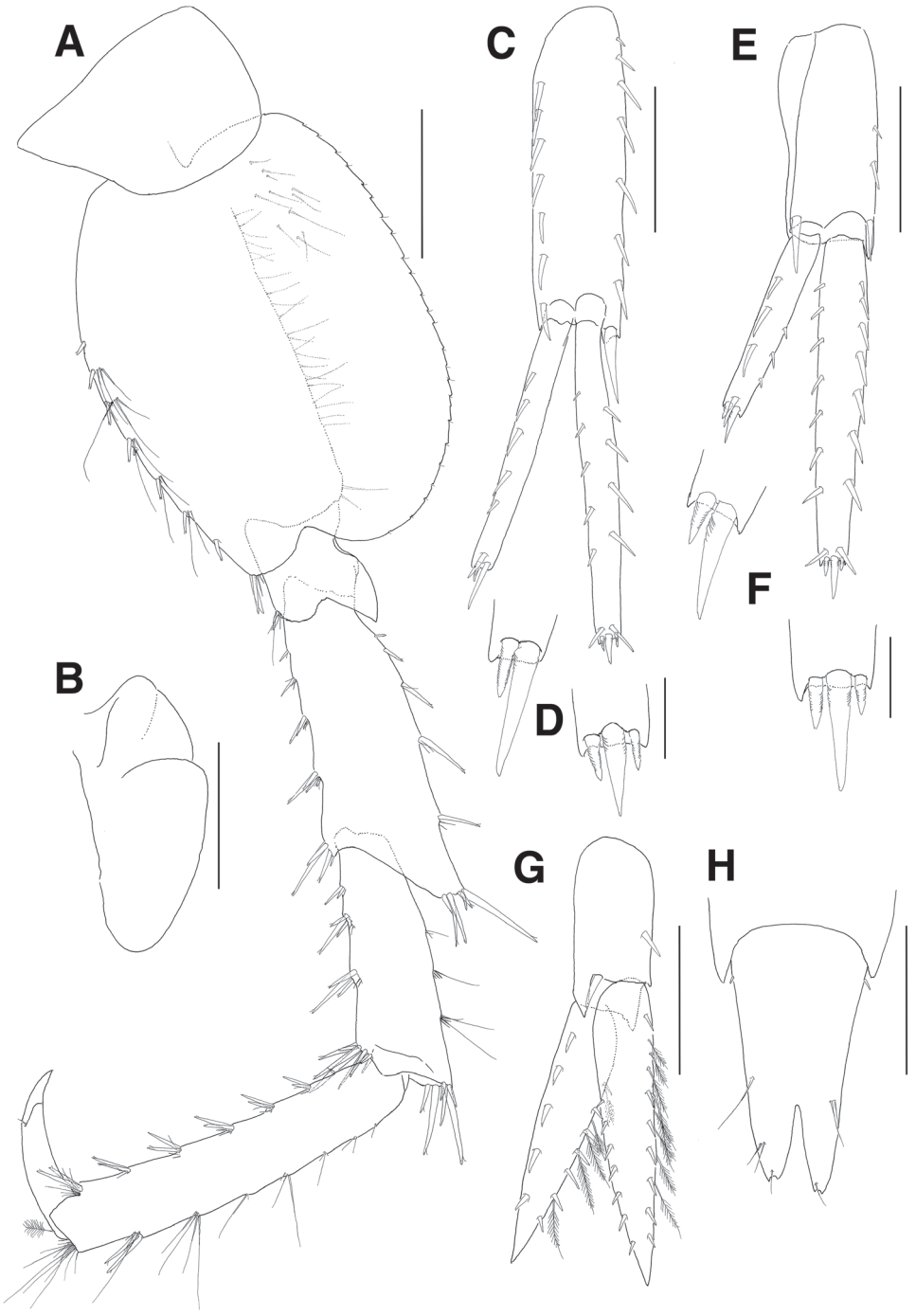

Figure 5. *Eusiroides pilopalpus* sp. n., holotype. **A** Pereopod 7 **B** Coxal gill of pereopod 7 **C** Uropod 1 **D** Apices of rami on uropod 1 **E** Uropod 2 **F** Apices of rami on uropod 2 **G** Uropod 3 **H** Telson. Scale bars 0.1 mm (**D, F**), 0.5 mm (**A–C, E, G, H**).

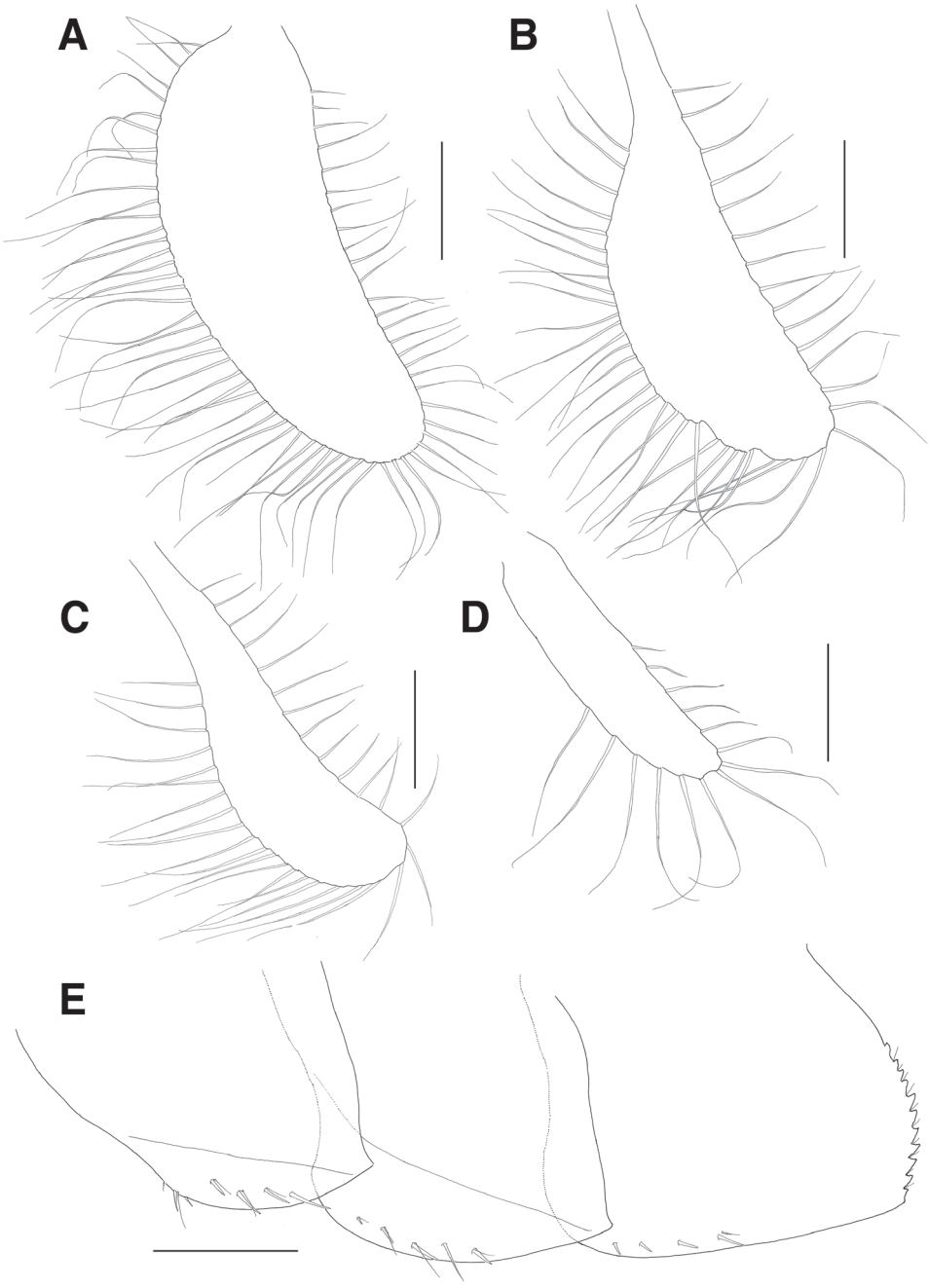

Figure 6. *Eusiroides pilopalpus* sp. n., holotype. **A–D** Oostegites of gnathopod 2–pereopod 5 **E** Pleonal epimera. Scale bars 0.5 mm.

anterodistal and posterodistal corners are produced in *E. japonica*); (3) mandibular palp article 3 has a group of brush-like setae on the lateral surface (vs. several rows of minute setae in *E. japonica*); (4) expanded medial lobe of mandibular palp article 2 is not swollen in *E. pilopalpus* sp. n. (vs. swollen medially in *E. japonica*); (5) inner plate on maxilla 2 is not enlarged in *E. pilopalpus* sp. n. (vs. distinctly enlarged in *E. japonica*); (6) maxillipedal palp article 3 is covered with fine setae on its distal surface (vs. transverse rows in *E. japonica*); (7) anterior lobe of ischium on gnathopods 1 and 2 is well-developed in *E. pilopalpus* sp. n. (vs. moderately developed in *E. japonica*), (8) acute protrusion at the posterodistal corner of merus on gnathopods 1 and 2 is larger than that of *E. japonica*; (9) length of the dactylus on gnathopods 1 and 2 is longer than that of *E. japonica*; (10) posterior lobe of ischium on pereopods 5–7 is acutely produced distally; (11) merus, carpus, and propodus on pereopods 5–7 are more slender than those of *E. japonica*; (12) both pleonal epimera 1 and 2 have oblique ridges on their lateral surfaces (vs. the ridges are not present in *E. japonica*) and posterior margin of pleonal epimeron 3 has 11 serrations (vs. seven in *E. japonica*); (13) the outer ramus on uropod 2 has three dorsal setae medially (vs. dorsal setae are absent in *E. japonica*); and (14) the distal fourth of the telson is cleft in *E. pilopalpus* sp. n., (vs. cleft beyond the distal half in *E. japonica*) (Hirayama 1985).

Eusiroides pilopalpus sp. n. shares several characters with *Eusiroides diplonyx* Walker, 1909. However, *E. diplonyx* can be easily discriminated from its congeners because it has stout and round-ended locking setae on pereopods 3 and 4 (Walker 1909; Pirlot 1936; Barnard JL 1970; Myers 1985). These are not observed at *E. pilopalpus* sp. n. in this study. Furthermore, *E. pilopalpus* sp. n. is different from *E. diplonyx* in the following ways: (1) inner plate on maxilla 2 is not enlarged in *E. pilopalpus* sp. n. (vs. the inner plate of maxilla 2 is larger than the outer plate in *E. diplonyx*); (2) one group of fine setae on the surface of mandibular palp article 3 is present in *E. pilopalpus* sp. n. (vs. absent in *E. diplonyx*); (3) posterior lobe of the ischium on pereopods 5–7 of *E. pilopalpus* is more acute than that of *E. diplonyx*; and (4) the telson of *E. pilopalpus* sp. n. is cleft to one fourth of the length (vs. more than half the length in *E. diplonyx*) (Walker 1909; Pirlot 1936; Barnard JL 1970; Myers 1985; Ren 2012).

Genus *Paramoera* Miers, 1875

Paramoera dentipleurae sp. n.

http://zoobank.org/D0556EA9-F25D-458F-9FDD-EEAFACAEA53F
Figs 7–11

Type locality. Jeju Island, South Korea, 33°14'23"N 126°34'59"E, sublittoral (average depth 24 m).

Material examined. Holotype: NIBRIV0000328602, adult female, 7.6 mm, collected from the type locality on 30 Nov 2012 by Prof. H.-Y. Soh.

Etymology. The composite epithet of the species name of *dentipleurae* is a combination of Latin *dens*, Gen. *dentis* (meaning 'teeth' or 'serration') and *pleurae* (indicating 'pleonal epimera'). Noun in apposition.

Diagnosis. Head with short rostrum; lateral cephalic lobes not mammilliform, with sinusoid upper part; inferior antennal sinus forming deep notch, lower margin produced forward; eyes large, reniform. Antenna 1 with stout peduncular articles; accessory flagellum uni-articulate, short, scale-like. Antenna 2 slightly shorter than antenna 1. Lower lip outer lobe with 5 bifid setae mediodistally. Right mandible with 6-dentate incisor and bifid lacinia mobilis. Left mandible with 6-dentate incisor and 5-dentate lacinia mobilis. Maxilla 1 outer plate with 10 dentate robust setae apically; palp bi-articulate, apex beyond apical setae of outer plate. Maxilla 2 inner plate shorter than outer plate. Maxilliped outer plate as long as inner plate, with long serrate setae along apex and medial margins submarginally; palp articles 2 and 3 slender. Gnathopods 1 and 2 moderately subchelate. Gnathopod 1 palm oblique, with robust defining setae of 1, 1, 3 laterally and 2, 3, 1 medially in formulae. Gnathopod 2 palm more oblique than in gnathopod 1, with robust defining setae laterally in formula 1, 2, 1. Pereopods 3–7 dactylus short, with blunt protrusion bearing 1 seta on inner margin, apex curved and claw-like. Pereopods 5–7 elongate and slender. Pereopod 7 basis expanded posteriorly, angulate proximally and diminished distally. Pereonite 7 and pleonites 1–3 carinate dorsally. Pleonal epimeron 1 with 2 naked serrations and 1 weak notch posteriorly; epimeron 2 with 2 serrations bearing 1 minute seta and 1 naked notch posteriorly; epimeron 3 largest, weakly upturned posterodistally, with 5 serrations and 1 distal small notch bearing 1 minute seta posteriorly. Uropod 1 slender; peduncle longer than rami. Uropod 2 shortest. Uropod 3 rami lanceolate, longer than peduncle. Telson deeply cleft (approximately 3/4 length).

Description of holotype male. ***Head*** (Fig. 7A): rostrum short; lateral cephalic lobes not mammilliform, with sinusoid upper part; inferior antennal sinus forming deep notch, lower margin produced forward; eyes large, reniform.

Antenna 1 (Fig. 7B–F): peduncular articles stout, with length ratio of 1.0:0.8:0.5 in peduncular articles 1–3, each article with 4–6 groups of elongate setae along posterior margin; peduncular article 1 with 1 robust seta posterodistally and with small triangular lobe on surface posterodistally; peduncular article 2 also with 1 robust seta posterodistally; peduncular article 3 without posterodistal setae; accessory flagellum uni-articulate, short, scale-like, with 5 simple setae on apex and 1 simple seta anteroproximally; flagellum 33-articulate, 2.0 times as long as peduncular articles 1–3 combined, proximal article longest, with aesthetasc present on every alternate article and calceoli present from 3rd to 24th articles posterodistally.

Antenna 2 (Fig. 7G, H): slightly shorter than antenna 1; gland cone produced with 2 simple setae; peduncular articles stout, with length ratio of 1.0:1.7:1.8 in peduncular articles 3–5; flagellum 29-articulate, 1.6 times as long as peduncular articles 3–5 combined, proximal article longest, with calceoli present from 1st to 20th articles.

Upper lip (Fig. 7I): triangular, apical margin convex, covered with fine setae distally.

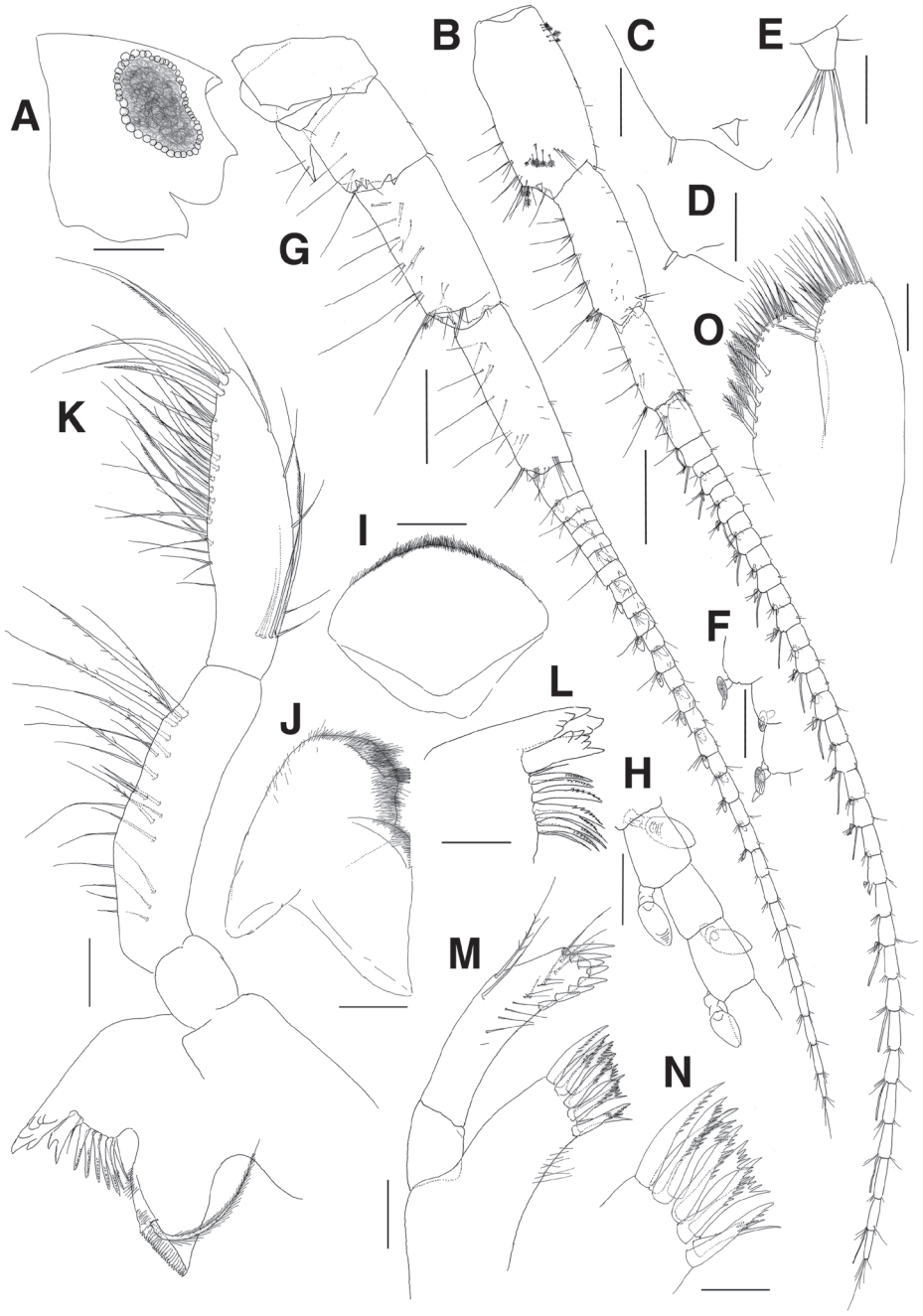

Figure 7. *Paramoera dentipleurae* sp. n., holotype. **A** Head **B** Antenna 1 **C** Posterodistal part of peduncular article 1 on antenna 1 **D** Posterodistal part of peduncular article 2 on antenna 1 **E** Accessory flagellum **F** Calceoli of flagellum on antenna 1 **G** Antenna 2 **H** Calceoli of flagellum on antenna 2 **I** Upper lip **J** Lower lip **K** Right mandible **L** Left mandible **M** Maxilla 1 **N** Dentate apical setae of outer plate on maxilla 1 **O** Maxilla 2. Scale bars 0.05 mm (**C–F, H–M, O**), 0.1 mm (**N**), 0.2 mm (**A, B, G**).

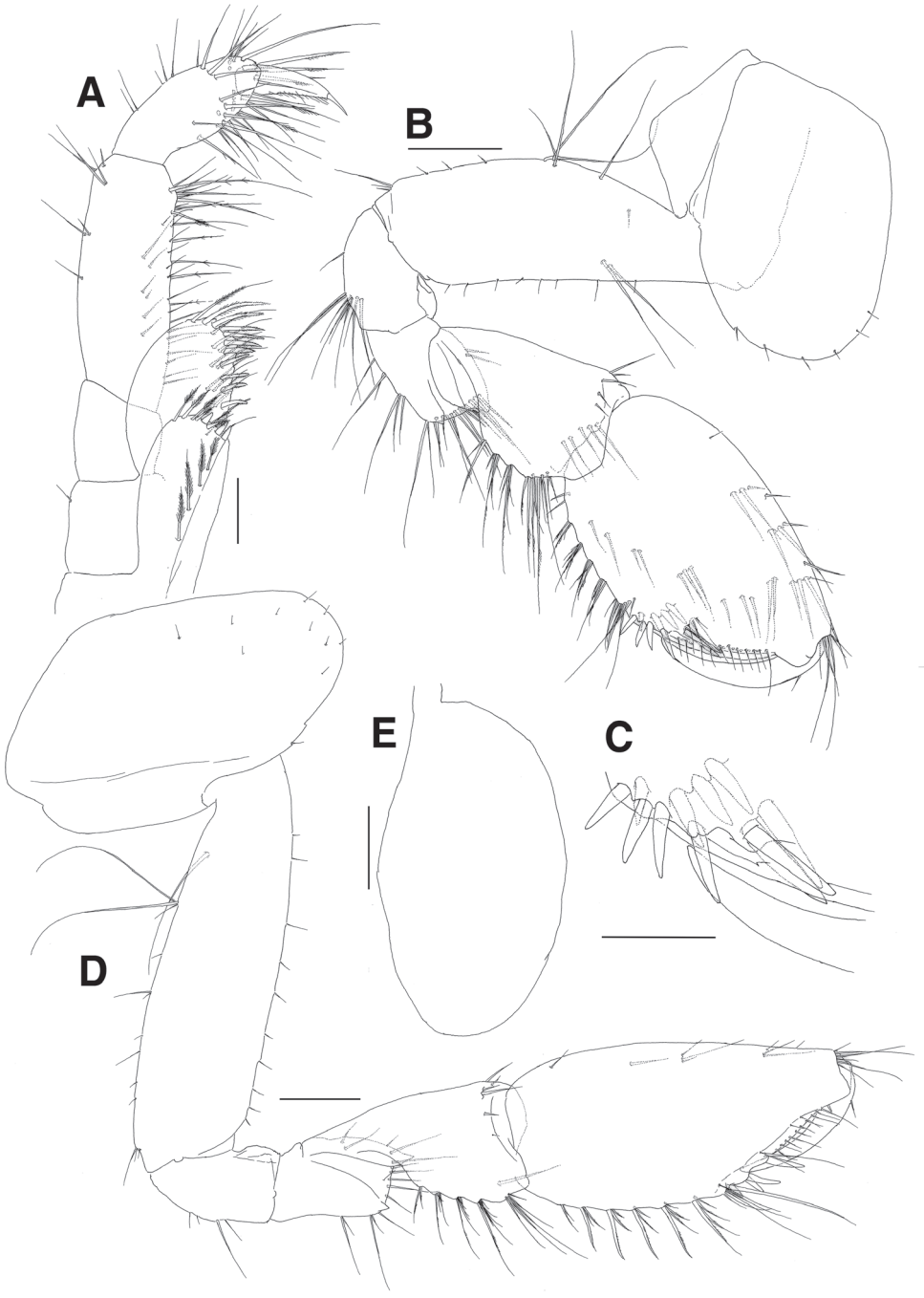

Figure 8. *Paramoera dentipleurae* sp. n., holotype. **A** Maxilliped **B** Gnathopod 1 **C** Setae of posterodistal margin of propodus on gnathopod 1 **D** Gnathopod 2 **E** Coxal gill of gnathopod 2. Scale bars 0.05 mm (**A, C**), 0.1 mm (**B, D, E**).

Lower lip (Fig. 7J): with well-developed mandibular processes bearing round apices; outer lobe apically round with 5 bifid setae mediodistally; inner lobe weak.

Right mandible (Fig. 7K): with 6-dentate incisor and bifid lacinia mobilis; accessory setal row lined with 1 simple, 5 serrate and 2 simple setae in turn; molar triturative, columnar, with 1 long plumose seta; palp enlarged, 3-articulate; palp article 1 shortest; palp article 2 lined with plumose setae on surface and medial margin; palp article 3 brush-like, with many simple, plumose and serrate setae along apex and medial margin.

Left mandible (Fig. 7L): with 6-dentate incisor and 5-dentate lacinia mobilis; accessory setal row with 1 simple, 7 serrate setae and 1 simple seta in turn.

Maxilla 1 (Fig. 7M, N): outer plate with 10 dentate setae apically; palp long, beyond apical setae of outer plate, article 2 with 1 row of 9 setae on surface and 8 robust setae along apical and mediodistal margins, with 1 plumose and 1 simple seta at centre of lateral margin.

Maxilla 2 (Fig. 7O): inner plate with 1 oblique row of 5 plumose setae on medial margin, with apical and subapical setae; outer plate with 2 serrate and 2 forked setae on mediodistal margin, with apical and subapical setae.

Maxilliped (Fig. 8A): inner plate subrectangular, swollen laterodistally, with 3 robust setae apically, with plumose setae on apex and mediodistal margin; outer plate as long as inner plate, convex laterally and wider than inner plate, with elongate plumose setae along apex and medial margin submarginally; palp elongate, slender, 4-articulate; article 2 subrectangular, longest, lined with long forked and simple setae on medial margin; article 3 thumb-shaped, with forked, serrate and simple setae on distal surface and margin; article 4 falcate, 0.8 times as long as article 3, lined with setae on medial margin, with 1 elongate seta apically.

Gnathopod 1 (Fig. 8B, C): subchelate; coxa subrectangular, ventral margin round with 5 minute setae and with 1 small notch bearing 1 minute seta posteroventrally; basis anterior margin straight with 8 minute setae, with 1 pair of elongate setae on medial surface anteroproximally, posterior margin with 1 elongate seta proximally, lined with 1 group of 4 elongate setae and with 3 minute setae, with 1 group of 3 simple setae subdistally; ischium with moderate anterior lobe, posterior margin convex with 1 simple seta and 1 group of 9 elongate setae; merus rectangular, as long as ischium, forming groove anterodistally, with medial and lateral protrusions distally, with 1 pair of short setae medially, with elongate setae in formula 1, 2, 3, 2 on posterior margin, lined with 14 long setae on distal margin; carpus longer than merus, with 1 lateral row of 5 setae anterodistally and 1 medial row of 5 setae on distal margin, posterior margin broadly lobed and weakly crenulate, with 4 groups of serrate and simple setae; propodus ovoid, as long as basis, with 4 setae on anterior margin, with 1 group of 6 simple setae at anterodistal corner, with 5 groups of serrate setae on weakly crenulate posterior margin, with setae of various combinations on medial surface, palm oblique with medial and lateral rows of simple setae, with robust defining setae of in formulae 1, 1, 3 laterally and 2, 3, 1 medially; dactylus falcate, stout, slightly shorter than palm.

Gnathopod 2 (Fig. 8D, E): also moderately subchelate, similar to gnathopod 1 in size; coxa subrectangular, with 3 minute setae on round ventral margin anteriorly, with

2 small notches posteroventrally, with 7 minute setae on anterodistal surface, coxal gill ovoid and large, slightly shorter than basis; basis anterior margin slightly convex lined with 10 minute setae, posterior margin with 1 elongate setae proximally and 1 group of 3 simple setae (2 elongate and 1 short) at proximal 1/3, lined with 7 simple setae and 1 group of 3 simple setae subdistally at distal half; ischium with moderate anterior lobe, posterior margin convex with 4 setae; merus as long as ischium, forming groove anterodistally, with medial and lateral protrusions distally, with 2 pairs of simple setae on anterior margin medially, with 1 seta and 2 pairs of setae on posterior margin distally, with 6 elongate setae on distal margin; carpus longer than merus, with 1 lateral row of 6 setae anterodistally, posterior margin broadly lobed and weakly crenulate with 5 groups of serrate and simple setae; propodus ovoid, as long as basis, with 4 simple setae on anterior margin, with 1 group of 6 simple setae at anterodistal corner, weakly crenulate posteriorly with 7 groups of serrate setae, palm more oblique than in gnathopod 1, with medial and lateral rows of simple setae, with robust defining setae laterally in formula 1, 2, 1; dactylus falcate, stout, slightly shorter than palm.

Pereopod 3 (Fig. 9A, B): coxa subrectangular, convex anteriorly, with 4 minute setae on anterior surface, ventral margin round with 3 marginal and 5 submarginal setae, with 2 small notches bearing 1 minute seta at posteroventral corner, posterior margin short, coxal gill ovoid and large, as long as coxa; basis anterior margin straight with 4 pairs and 6 minute setae, posterior margin setose; ischium short, with moderate anterior lobe, with 1 minute seta on posterior margin and 1 pair of simple setae at posterodistal corner; merus 0.7 times as long as basis, anterior margin weakly spinose and slightly expanded distally, with 1 group of 3 simple setae at anterodistal corner, posterior margin weakly setose; carpus not expanded and slightly curved, with 2 groups of simple setae on anterior margin and 1 pair of simple setae at anterodistal corner, with 1 minute and 3 pairs of simple setae on posterior margin, with several minute setae at posterodistal corner, distal margin round; propodus slender, 1.1 times as long as carpus, with 3 groups of simple setae on anterior margin and 1 row of 4 setae at anterodistal corner, with 1 small seta and 2 pair of setae on posterior margin, with 1 elongate, 1 robust and 2 moderate setae at posterodistal corner; dactylus short, with blunt protrusion bearing 1 seta on inner margin, apex curved and claw-like.

Pereopod 4 (Fig. 9C, D): coxa subquadrate, with acutely produced posterior margin; dactylus with blunt protrusion on inner margin but weaker than that of pereopod 3; other articles similar to those of pereopod 3 except for additional 1 robust seta at posterodistal corner of basis.

Pereopod 5 (Fig. 10A–D): elongate and slender; coxa bilobed, anterior lobe expanded downwards with 4 minute setae on ventral margin, posterior lobe not expanded with 1 small notch bearing 1 minute seta at posteroventral corner, coxal gill ovoid and small; basis subovoid, anterior margin convex with 1 group of 5 elongate setae proximally and lined with 7 robust setae, anterodistal corner weakly lobed downwards with 1 pair of robust setae, posterior margin moderately expanded with 13 weak serrations bearing 1 minute seta; ischium short, anterodistal corner weakly lobed downwards with 1 pair of setae, posterior lobe moderate; merus as long as

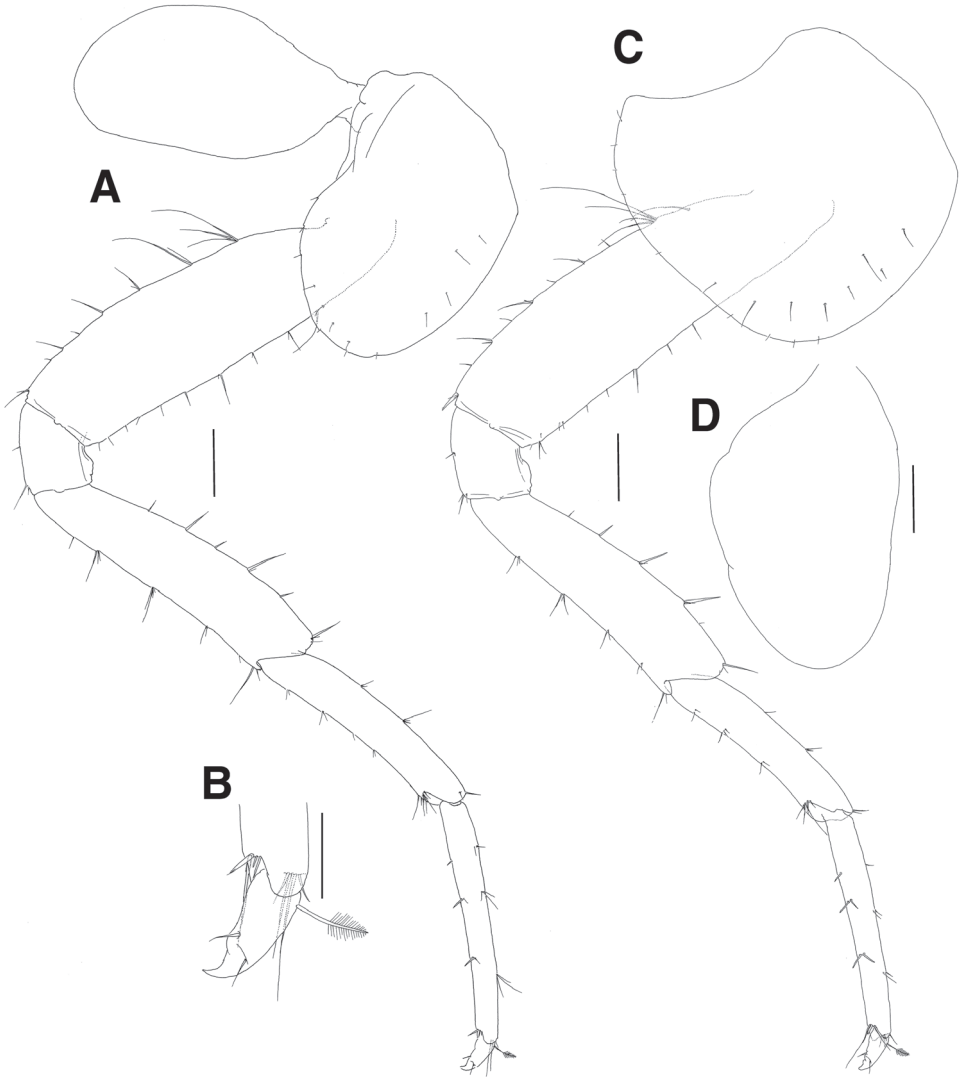

Figure 9. *Paramoera dentipleurae* sp. n., holotype. **A** Pereopod 3 **B** Dactylus of pereopod 3 **C** Pereopod 4 **D** Coxal gill of pereopod 4. Scale bars 0.05 mm (**B**), 0.2 mm (**A, C, D**).

basis, with short robust setae on anterior margin and with 1 pair of robust and simple setae at anterodistal corner, posterior margin weakly expanded and setose with robust setae, posterodistal corner slightly produced with 1 pair of unequal setae; carpus linear and slender, as long as merus, margins weakly setose, anterodistal and posterodistal corners with robust and simple setae; propodus also linear, 0.9 times as long as carpus, with 4 pairs of robust setae on anterior margin and with 1 group of 4 setae (1 simple elongate and 3 robust) at anterodistal corner, with 4 groups of robust and simple setae on posterior margin and with 10 setae (1 robust and 9 simple) at

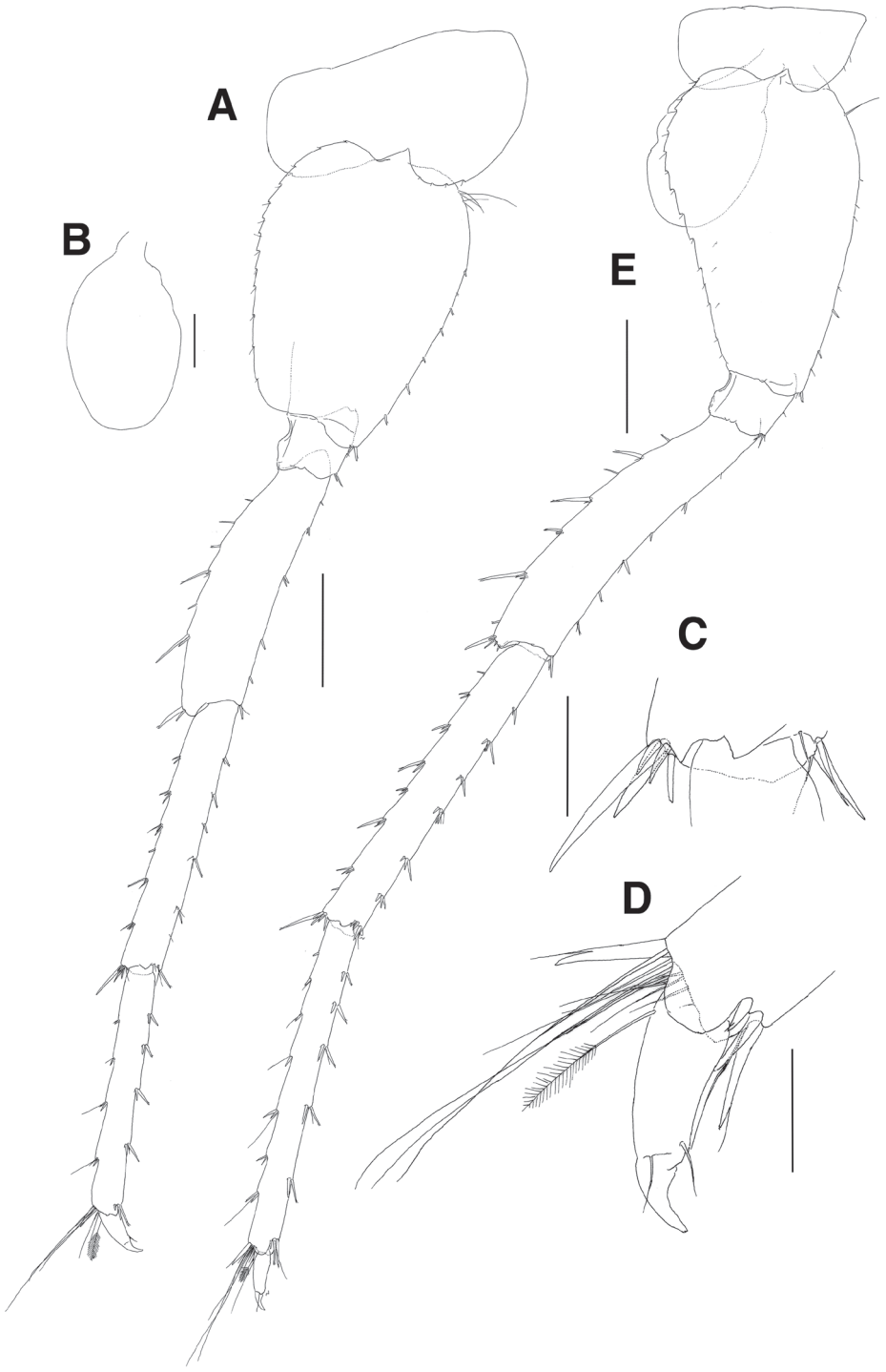

Figure 10. *Paramoera dentipleurae* sp. n., holotype. **A** Pereopod 5 **B** Coxal gill on pereopod 5 **C** Distal part of carpus on pereopod 5 **D** Dactylus on pereopod 5 **E** Pereopod 6. Scale bars 0.1 mm (**B**), 0.05 mm (**C, D**), 0.2 mm (**A, E**).

posterodistal corner; dactylus short, with blunt protrusion bearing 1 seta on inner margin, with curved and claw-like apex.

Pereopod 6 (Fig. 10E): elongate and slender, longer than pereopod 5; coxa bilobed, smaller than that of pereopod 5, anterior lobe expanded downwards with 2 minute setae anteriorly, posterior lobe not expanded with notch bearing 1 minute seta at posteroventral corner, coxal gill ovoid and slightly smaller than that of pereopod 5; basis as long as that of pereopod 5, anterior margin convex with 1 elongate seta proximally and irregular spaced 7 robust and simple setae, anterodistal corner weakly lobed downwards with 1 robust seta, posterior margin expanded proximally and diminished distally, with 13 weak serrations bearing 1 minute seta and 2 minute setae distally; ischium short, anterodistal corner weakly lobed downwards with 1 group of 3 setae, posterior lobe moderate; merus as long as basis, setose with robust and simple setae on anterior margin, with 1 pair of setae at anterodistal corner, posterior margin weakly expanded and setose with elongate and short robust setae irregularly, posterodistal corner slightly produced with 1 group of 5 setae; carpus linear and slender, 1.1 times as long as merus, margins weakly setose, anterodistal and posterodistal corners with robust and simple setae; propodus also linear, as long as carpus, with 5 groups of robust and simple setae on anterior margin, and with 1 group of 4 setae (1 simple elongate and 3 robust) at anterodistal corner, posterior margin armed with setae of various combinations, with 9 setae (8 simple elongate and 1 robust) at posterodistal corner; dactylus short, with blunt protrusion bearing 1 seta on inner margin, with curved and claw-like apex.

Pereopod 7 (Fig. 11A, B): shorter but stouter than pereopod 6; coxa unilobed, with 1 simple seta at anterior corner, with 2 notches bearing 1 minute seta and 2 small naked notches on posterior margin; basis larger than that of pereopod 6, anterior margin widened with irregular spaced 8 minute setae, anterodistal corner a little lobed distally with 1 group of 3 robust setae, posterior margin expanded, angulate proximally and diminished distally, with 12 weak serrations bearing 1 minute seta and 2 naked serrations distally; ischium short, anterodistal corner weakly lobed downwards with 1 group of 5 robust setae, posterior lobe moderate; merus short, 0.7 times as long as basis, anterior margin straight and setose with single or paired setae, anterodistal corner weakly produced with 1 subapical simple seta and 1 pair of robust apical setae, posterior margin slightly expanded and setose with irregular elongate and short robust setae, posterodistal corner slightly produced with 1 group of 6 robust setae (1 elongate and 5 moderate); carpus linear, as long as basis, with 5 groups of robust setae on anterior margin and with 1 group of 7 robust setae at anterodistal corner, with 1 single and 5 groups of robust setae on posterior margin and with 1 group of 6 robust setae at posterodistal corner; propodus also linear, as long as carpus, with 5 groups of 3 robust setae on anterior margin and 1 group of 4 setae (1 simple elongate and 3 robust) at anterodistal corner, posterior margin armed with setae of various combinations, with 13 setae (2 robust and 11 simple) at posterodistal corner; dactylus short, with blunt protrusion bearing 1 seta on inner margin, with curved and claw-like apex.

Pereonite 7 and pleonites 1–3 (Fig. 11C): each carinate dorsally.

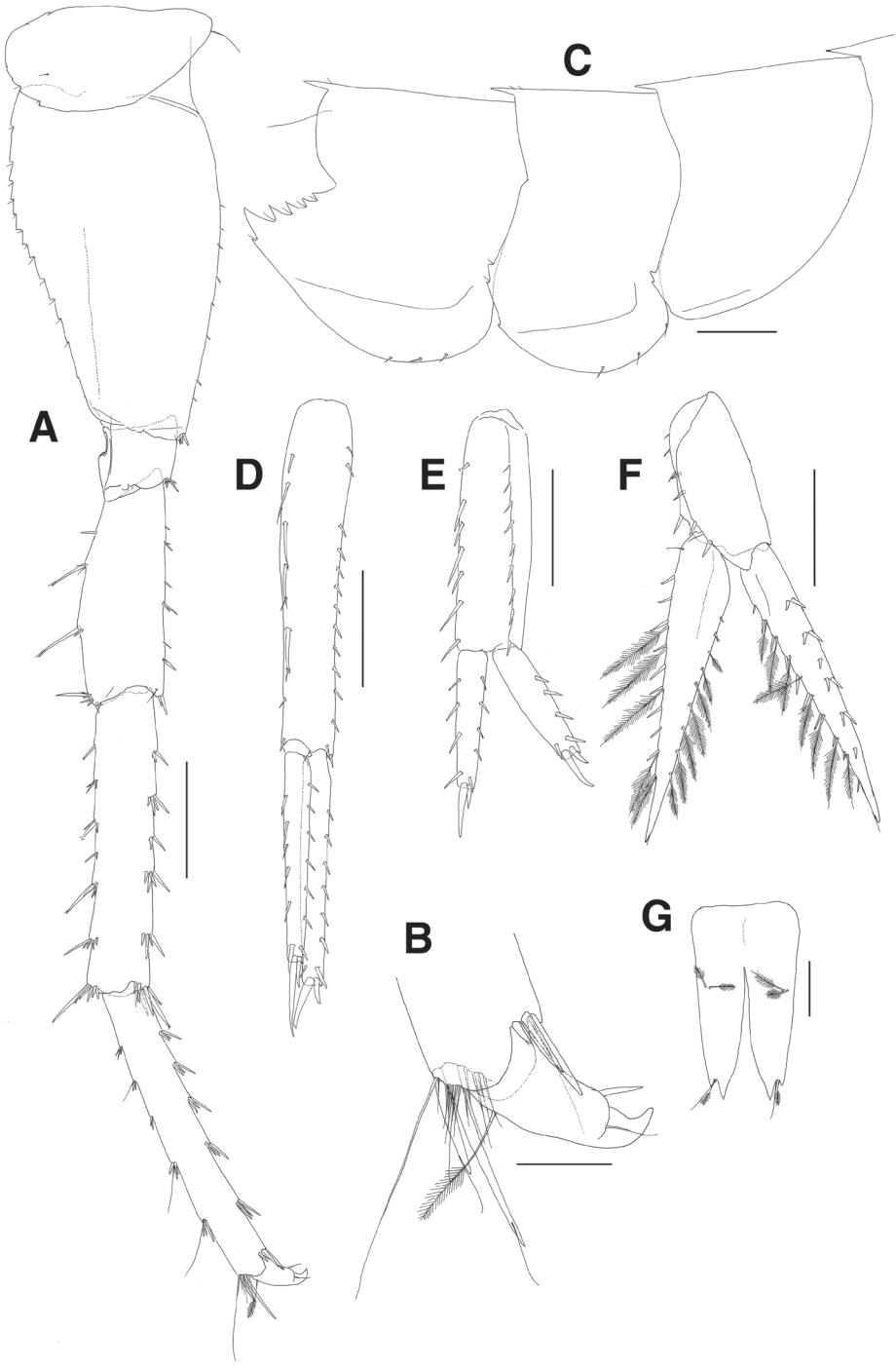

Figure 11. *Paramoera dentipleurae* sp. n., holotype. **A** Pereopod 7 **B** Dactylus on pereopod 7 **C** Pleonal epimera **D** Uropod 1 **E** Uropod 2 **F** Uropod 3 **G** Telson. Scale bars 0.05 mm (**B**), 0.1 mm (**G**), 0.2 mm (**A, C–F**).

Pleonal epimera (Fig. 11C): epimeron 1 with 2 naked serrations and 1 weak notch on posterior margin; epimeron 2 round ventrally, with 3 setae on anterior half of ventral margin, with 2 serrations bearing 1 minute seta and 1 naked notch on posterior margin; epimeron 3 largest, weakly upturned posterodistally, with 3 setae on ventral margin, with 5 serrations and 1 distal small notch bearing 1 minute seta on posterior margin.

Uropod 1 (Fig. 11D): slender; peduncle longer than rami, with 14 lateral and 9 medial robust setae dorsally; outer ramus with 6 lateral robust setae dorsally, apex blunt with 2 subapical and 2 apical robust setae; inner ramus shorter than outer ramus, with 6 lateral and 5 medial robust setae dorsally, apex blunt with 2 subapical and 2 apical robust setae.

Uropod 2 (Fig. 11E): shortest; peduncle 0.7 times as long as that of uropod 1, with 9 lateral and 7 medial robust setae dorsally; outer ramus shorter than peduncle, with 4 lateral robust setae dorsally, apex blunt with 2 subapical and 2 apical robust setae; inner ramus subequal to outer ramus, with 4 lateral and 3 medial robust setae dorsally, apex blunt with 2 subapical and 2 apical robust setae.

Uropod 3 (Fig. 11F): peduncle 0.7 times as long as that of uropod 2, with 4 medial and 4 lateral robust setae dorsally; rami lanceolate; outer ramus 2.0 times as long as peduncle, with 4 pairs and 2 single robust setae along lateral margin, with 2 single robust setae, 7 pairs of robust and plumose setae, and 1 minute subapical seta along medial margin; inner ramus slightly longer than outer ramus, with 2 proximal single setae, 7 plumose setae and 1 minute subapical seta on lateral margin, with 1 proximal simple seta, 10 robust and 5 plumose setae on medial margin.

Telson (Fig. 11G): deeply cleft (about 3/4 length), each lobe with notch bearing 1 pair of 1 plumose and 1 long simple seta on apex, with 1 pair of plumose setae on dorsal surface.

Female. Unknown.

Remarks. *Paramoera dentipleurae* sp. n. is very similar to *P. tridentata* Bulycheva, 1952 and *P. hanamurai* Hirayama, 1990 in the following characteristics: (1) the anterior cephalic lobe is sinusoid; (2) pereopods 5–7 are more slender than those of other congeners; (3) the posterior lobe of basis on pereopods 6–7 is largely expanded proximally and diminished distally; (4) epimera 1–3 are carinate dorsally; and (5) epimeron 3 is prominently expanded backward with very similar serration pattern on the posterior margin (Bulycheva 1952; Hirayama 1990). However, *P. dentipleurae* sp. n. can be readily distinguished from *P. tridentata* by the following features: (1) the inferior antennal sinus is deeply cleft and its lower part is produced forward in *P. dentipleurae* sp. n., whereas it is concaved quadrately in *P. tridentata*; (2) the formulae of robust defining setae at the palmar corners on gnathopods 1 and 2 are complex in *P. dentipleurae* sp. n. (1, 1, 3 for lateral and 2, 3, 1 for medial setae on gnathopod 1 and 1, 2, 1 for lateral setae on gnathopod 2), whereas *P. tridentata* has only two lateral setae on gnathopods 1 and 2, respectively; (3) the serrations of each posterior margin of the basis on pereopods 5–7 are weaker in *P. tridentata*; and (4) the dorsal carina on pereon 7 is absent in *P. tridentata* (Bulycheva 1952; Labay 2012).

Paramoera dentipleurae sp. n. can be discriminated from *P. hanamurai* by the following features: (1) upper and lower parts of the inferior antennal sinus do not overlap in *P. dentipleurae* sp. n.; (2) antenna 1 is longer than antenna 2 in *P. dentipleurae* sp. n., but antenna 2 is longer than antenna 1 in *P. hanamurai*; (3) setations of the peduncular articles on antennae 1 and 2 of *P. dentipleurae* sp. n. are weaker; (4) accessory flagellum has five apical setae in *P. dentipleurae* sp. n., but it has only two apical setae in *P. hanamurai*; (5) formulae of the robust defining setae at the palmar corners on gnathopods 1 and 2 are different from each other (1, 1, 3 for lateral setae and 2, 3, 1 for medial setae on gnathopod 1, and 1, 2, 1 for lateral setae in gnathopod 2 in *P. dentipleurae* sp. n., whereas there are three rows of three setae on the medial surface of gnathopod 1 and without setae on gnathopod 2 in *P. hanamurai*); (6) posterior margin of basis on pereopod 5 is more expanded distally and the length of the merus is shorter in *P. hanamurai*; (7) serration patterns are weaker and the posterodistal lobes are indistinct for basis on pereopods 5–7 in *P. dentipleurae* sp. n. compared to *P. hanamurai*; (8) each dorsal margin from pereon 7 to pleon 3 has a distal carina in *P. dentipleurae* sp. n., whereas the distal carina is absent in *P. hanamurai*; and (9) serration patterns of the posterior margins on the pleonal epimera are simpler in *P. hanamurai* compared to those in *P. dentipleurae* sp. n. (Hirayama 1990).

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References

Barnard JL (1970) Sublittoral Gammaridea (Amphipoda) of the Hawaiian Islands. Smithsonian Contributions to Zoology 34: 1–286. doi: 10.5479/si.00810282.34

Barnard KH (1932) Amphipoda. Discovery Reports 5: 1–326. doi: 10.5962/bhl.part.27664

Bellan-Santini D, Ledoyer M (1986) Gammariens (Crustacea, Amphipoda) des Iles Marion et Prince Edward. Bolletino Museo Civico Storia Naturale Verona 13: 349–435.

Bousfield EL, Hendrycks EA (1995) The amphipod superfamily Eusiroidea in the North American Pacific regions. I. family Eusiridae: systematics and distributional ecology. Amphipacifica 1: 3–59.

Bulycheva AI (1952) A new species of side-swimmers (Amphipoda, Gammaridea) from the Japan Sea. Trudy Zoologicheskogo Instituta AN SSSR 12: 195–250. [In Russian]

Chevreux E (1900) Amphipodes provenant des campagnes de l'Hirondelle (1885-1888). Resultats des Campagnes Scientifiques Accomplies par le Prince Albert I. Monaco 16: 1–195.

Derzhavin AN (1930) The freshwater Malacostraca of the Russian Far East. Hydrobiologische Zeitschrift 9: 1–8.

Giles GM (1890) Descriptions of seven additional new Indian amphipods. Natural history notes from H.M.'s Indian marine survey steamer 'Investigator', commander Alfred Carpenter RN, DSO, commanding No. 15. Journal of the Asiatic Society of Bengal 59: 63–74.

Gurjanova EF (1938) Amphipoda, Gammaroidea of Siaukhu Bay and Sudzukhe Bay (Japan Sea). Reports of the Japan Sea Hydrobiological Expedition 1: 241–404. [In Russian]

Gurjanova EF (1952) A new species of side-swimmers (Amphipoda, Gammaridea) from the Far Eastern seas. Trudy Zoologicheskogo Instituta AN SSSR 12: 171–194. [In Russian]

Haswell WA (1879) On some additional new genera and species of amphipodous crustaceans. Proceedings of the Linnean Society of New South Wales 4: 319–350. doi: 10.5962/bhl.part.22854

Hirayama A (1985) Taxonomic studies on the shallow water gammaridean Amphipoda of West Kyushu, Japan. IV. Dexaminidae (Guernea), Eophiliantidae, Eusiridae, Haustoriidae, Hyalidae, Ischyroceridae. Publications of the Seto Marine Biological Laboratory 30: 1–53.

Hirayama A (1990) A new species of the genus *Paramoera* (Crustacea: Amphipoda) from the intertidal zone of Hokkaido, northern Japan. Zoological Science 7: 955–959.

Kim HS, Kim CB (1987) Marine gammaridean Amphipoda (Crustacea) of Cheju Island and its adjacent waters, Korea. The Korean Journal of Systematic Zoology 3: 1–23.

Kim W, Kim CB (1991) The marine amphipod crustaceans of Ulreung Island, Korea: part II. The Korean Journal of Systematic Zoology 7: 13–38.

Kuribayashi K, Kyono M (1995) Two new species of the genus *Paramoera* (Amphipoda, Gammaridea) from Hokkaido, northern Japan, with special reference to the strangely transformed second pleopod. Crustaceana 68: 759–778. doi: 10.1163/156854095X01970

Labay VS (2012) *Paramoera anivae* a new species of Eusiridae Stebbing, 1888 (Crustacea: Amphipoda: Gammaridea) from the Okhotsk Sea. Zootaxa 3475: 69–85.

Ledoyer M (1978) Contribution à l'étude des amphipodes gammariens profonds de Madagascar (Crustacea). Tethys 8: 365–382.

Ledoyer M (1982) Family Eusiridae. In: Ruffo S (Ed.) The Amphipoda of the Mediterranean, Part 1, Gammaridea (Acanthonotozomatidae to Gammaridae). Mémoires de L'Institut Océanographique 13: 233–244.

Lowry JK, Myers AA (2013) A phylogeny and classification of the Senticaudata subord. nov. (Crustacea: Amphipoda). Zootaxa 3610: 1–80. doi: 10.11646/zootaxa.3610.1.1

McKinney LD (1980) Four new and unusual amphipods from the Gulf of Mexico and Caribbean Sea. Proceedings of the Biological Society of Washington 93: 83–103.

Miers EJ (1875) Descriptions of new species of Crustacea collected at Kerguelen's Island by the Rev. A. E. Eaton. The Annals and Magazine of Natural History Series 4 16: 73–76. doi: 10.1080/00222937508681124

Myers AA (1985) Shallow-water, coral reef and mangrove Amphipoda (Gammaridea) of Fiji. Records of the Australian Museum, Supplement 5: 1–143. doi: 10.3853/j.0812-7387.5.1985.99

Pirlot JM (1936) Les amphipodes de l'expédition du Siboga. Deuxiéme partie. II. Les amphipodes de la mer profonde. III. Les amphipodes littoraux. I. Lysianassidae, Ampeliscidae, Leucothoidae, Stenothoidae, Phliantidae, Colomastigidae, Ochlesidae, Liljeborgiidae, Oedicerotidae, Synopiidae, Eusiridae, Gammaridae. Siboga-Expeditie 33e: 237–328.

Ren X (2012) Fauna Sinica, Invertebrata vol. 43, Gammaridea (II). Science Press, Beijing, 651 pp.

Sars GO (1895) Amphipoda. An account of the Crustacea of Norway with short descriptions and figures of all the species 1, 711 pp.

Staude CP (1995) The amphipod genus *Paramoera* Miers (Gammaridea: Eusiroidea: Pontogeneiidae) in the Eastern North Pacific. Amphipacifica 1: 61–102.

Stebbing TRR (1888) Report on the Amphipoda collected by HMS Challenger during the years 1873–76. Zoology 29: 1–1737.

Stebbing TRR (1906) Amphipoda I – Gammaridea. Das Tierreich 21, 806 pp.

Stephensen K (1944) Some Japanese amphipods. Videnskabelige Meddelser fra Dansk naturhistorisk Forening i Kobenhavn 1: 25–88.

Sidorov DA (2010) A new subgenus of eusirid amphipod (Crustacea: Amphipoda: Eusiridae) from subterranean waters and springs of the Eastern Sikhote-Alin Mountain Ridge, with comments on the morphology of sternal humps, genital papillae and pleopods. Zootaxa 2518: 1–31.

Walker AO (1904) Report on the Amphipoda collected by Professor Herdman, at Ceylon, in 1902. Report to the Government of Ceylon on the Pearl Oyster Fisheries of the Gulf of Manaar, Supplementary Report 17: 229–300.

Walker AO (1909) Amphipoda Gammaridea from the Indian Ocean. British East Africa, and the Red Sea. Transactions of the Linnean Society of London, series 2. Zoology 12: 323–344.

Watling L (1989) A classification system for crustacean setae based on the homology concept. In: Felgenhauer B, Watling L, Thistle AB (Eds) Functional morphology of feeding and grooming in Crustacea. Rotterdam, 15–26.

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RESEARCH ARTICLE

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A new species of the genus *Calliaxina* Ngoc-Ho, 2003 from the South China Sea (Crustacea, Decapoda, Axiidea, Callianassidae)

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Abstract

A new species of the genus *Calliaxina* Ngoc-Ho, 2003, *C. xishaensis* **sp. n.**, collected from the South China Sea is described and illustrated. It is distinguishable from *C. thomassini* Ngoc-Ho, 2014 by having the rostrum broadly triangular with pointed tip and is distinguishable from *C. novaebritanniae* (Borradaile, 1900) and *C. punica* (de Saint Laurent & Manning, 1982) by the posterior margin of telson being convex. It is also the first record of this genus from the China seas. A key to the species of *Calliaxina* is given.

Keywords

Callianassidae, *Calliaxina*, new species, South China Sea

Introduction

While working on the taxonomic study of the axiidean fauna (Crustacea, Decapoda) of the China Sea, an undescribed species assignable to the genus *Calliaxina* Ngoc-Ho, 2003 was found from Xisha islands, South China Sea. Ngoc-Ho (2003) established the genus *Calliaxina* mainly differing from *Calliax* de Saint Laurent, 1973 and *Eucalliax* Manning & Felder, 1991 by having an exopod on maxilliped 3. Sakai (2005)

considered *Calliaxina* as a synonym of *Calliax*, but later Sakai (2011) recognised *Calliaxina* as valid: he argued that the presence of a sulcus was considered significant in the classification of the genera, and the presence of an exopod on the maxilliped 3 was not "of vital importance", but he never-the-less expanded the genus to include eight species.

In this work, the classification of *Calliaxina* as defined by Ngoc-Ho (2003) is adopted, since the cardiac sulcus as an uncalcified suture running across the carapace between the cervical groove and the posterior border is regarded as significant, while the presence of an exopod on maxilliped 3 is a diagnostic character (Ngoc-Ho, 2014). Two species *Eucalliax kensleyi* Dworschak, 2005 and *Callianassa bulimba* Poore & Griffin, 1979 with rudimentary exopod on maxilliped 3 also should be belong to this genus.

Six species of the genus are known: *C. punica* (de Saint Laurent & Manning, 1982) is known from the eastern Atlantic and Mediterranean, and *C. bulimba* (Poore & Griffin, 1979), *C. kensleyi* (Dworschak, 2005), *C. novaebritanniae* (Borradaile, 1900), *C. sakaii* (de Saint Laurent & LeLoeuff, 1979), and *C. thomassini* Ngoc-Ho, 2014 are known from the Indo-West Pacific.

Key to the species of the genus *Calliaxina*

1	Maxilliped 3 exopod rudimentary	**2**
–	Maxilliped 3 exopod distinct	**3**
2	Telson widest distally	***C. kensleyi***
–	Telson widest proximally	***C. bulimba***
3	Maxilliped 3 exopod short	***C. sakaii***
–	Maxilliped 3 exopod long, over-reaching ischium	**4**
4	Rostrum minute or nearly absent	***C. thomassini***
–	Rostrum broadly triangular with pointed tip	**5**
5	Posterior margin of telson convex	***C. xishaensis* sp. n.**
–	Posterior margin of telson almost straight	**6**
6	Telson 1.2 times as wide as long	***C. punica***
–	Telson 2.0 times as wide as long	***C. novaebritanniae***

Methods

All specimens examined have been deposited in the Institute of Oceanology, Chinese Academy of Sciences, Qingdao, China (IOCAS). The drawings were made with the aid of drawing tube mounted on a Zeiss Stemi Sv11 compound microscope. The following abbreviation is used throughout the text: **MBM:** Marine Biology Museum; **CL:** carapace length.

Taxonomy

Family Callianassidae Dana, 1852
Genus *Calliaxina* Ngoc-Ho, 2003

***Calliaxina xishaensis* sp. n.**
http://zoobank.org/DC3F4E82-68C9-47EA-A894-B538F2FFEB3A
Figs 1–2

Material examined. Holotype, ♀(cl, 7.0 mm), MBM136806/58C-639, Dengqin island of Xisha islands, South China Sea, coll. Zhengang Fan & Jieshan Xu, 11 May 1958. Paratype, ♀(cl, 5.8 mm), collected with holotype.

Diagnosis. Rostrum broadly triangular with pointed tip, not reaching middle of eyestalks. Antennular peduncle over-reaching distal end of antennal peduncle penultimate segment. Maxilliped 3 exopod as long as ischium. Pereopods 1 subequal, slightly dissimilar. Left pereopod 1 cutting edge of fixed finger unarmed, with longitudinal depression scattered with small tubercles; right pereopod 1 cutting edge of fixed finger bearing large triangular tooth in basal 1/3 and with 14-17 small teeth from basal to subdistal. Telson 1.8 times as broad as long, poster margin convex.

Description. Carapace scattered with small shallow depressions, lacking the dorsal oval. The frontal margin bears a broadly triangular rostrum, acute terminally, not reaching middle of eyestalks in dorsal view (Fig. 1A). Lateral projections produced, nearly reaching tip of rostrum. Cervical groove distinct, conjunct with linea thalassinica. Distinct suture (linea anomurica) ventral to hepatic boss extending posteroventrally to ventral margin of carapace. Cardiac suture in middle posterior half of carapace well defined, incomplete across midline of carapace, extending anterioventrally to linea anomurica.

Eyestalks dorsally flattened, approximately 1.5 times as long as broad at base, corneas rounded, pigmented subterminally, 0.7 width of eyestalks.

Antennular peduncle shorter but observably heavier than antennal peduncle (Fig. 1A); article 1 laterally and ventrally inflated; article 2 slightly longer than basal article, article 3 nearly 2/3 length of article 2; articles 2-3 with ventrolateral row of long, ventrally directed setae, continued onto ventral ramus of flagellum; rami of flagellum about equal length, nearly six times length of third article of peduncle; dorsal ramus with sparse short setae. Antennular peduncle (Fig. 1A) distinctly longer than antennal peduncle; article 1 with dorsolateral carina bearing regular line of fine setae above laterally produced excretory pore; article 3 shorter than article 2, with rudimentary scale on dorsal surface; article 4 elongate, longer than article 5 or combined length of first three.

Maxilliped 3 (Fig. 1C, D) exopod articulated, overreaching ischium of endopod. Ischium of endopod subtriangular, slightly longer than broad, medial longitudinally crista dentata on inner surface, holding 20-23 teeth; merus subquadrate about 0.8 time as long as broad; carpus strongly flexed in proximal third with setose lobe on lower

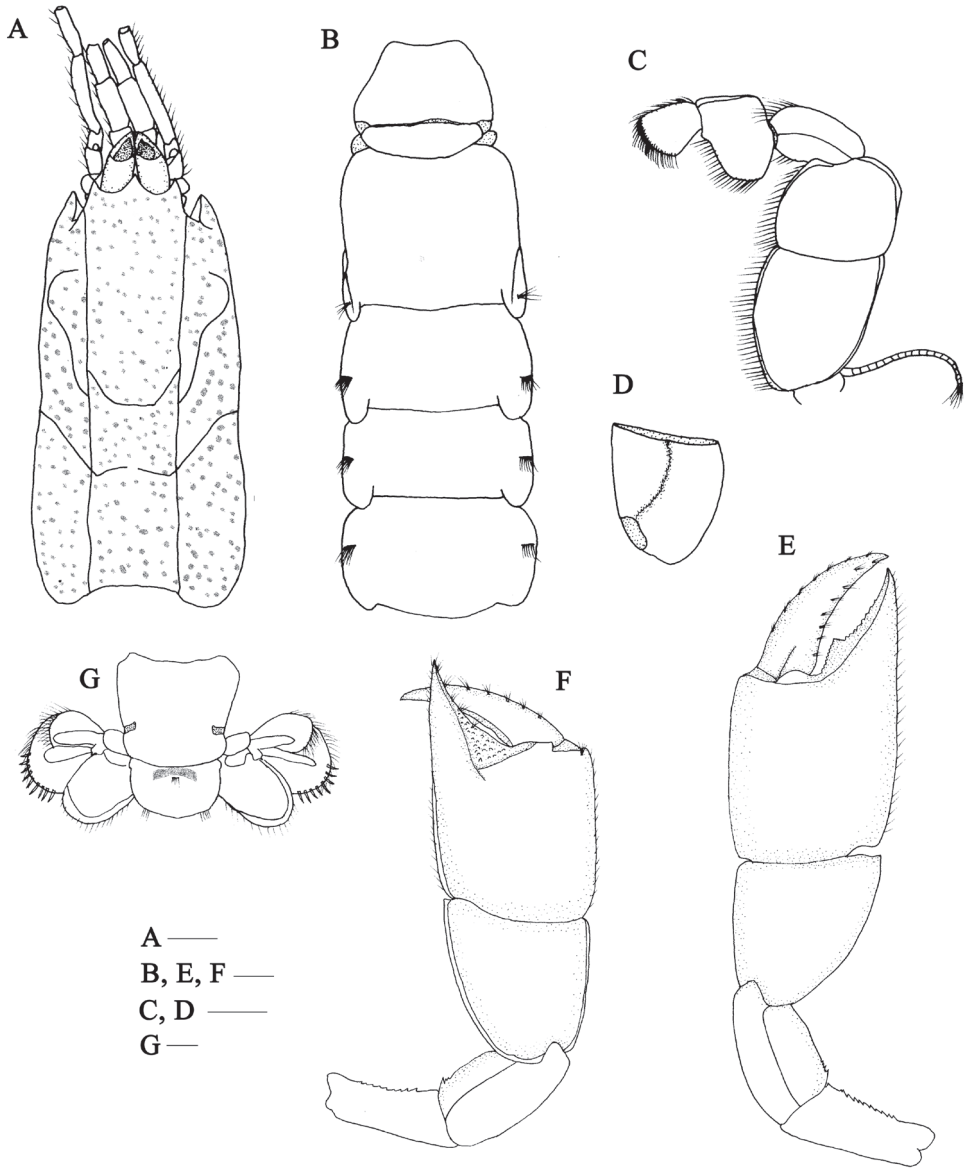

Figure 1. *Calliaxina xishaensis* sp. n. **A–F** Holotype female, MBM136806/58C-639 **A** carapace, dorsal and lateral view **B** pleomere, dorsal view **C** maxilliped 3, outer view **D** maxilliped 3, ischium, inner view **E** right cheliped, lateral view **F** left cheliped, lateral view **G** pleomere 6, telson and uropods. Scale bars: 1 mm.

margin; propodus subquadrate, 1.4 times broader than long; dactylus with rounded terminal border bearing dense closely set stiff setae.

Left and right pereopod 1 subequal, dissimilar in dentition of fixed fingers. Right cheliped (Fig. 1E) ischium slender, approximately 2.1 times as long as broad, upper margin almost straight, lower margin with 11-13 small denticles in middle. Merus

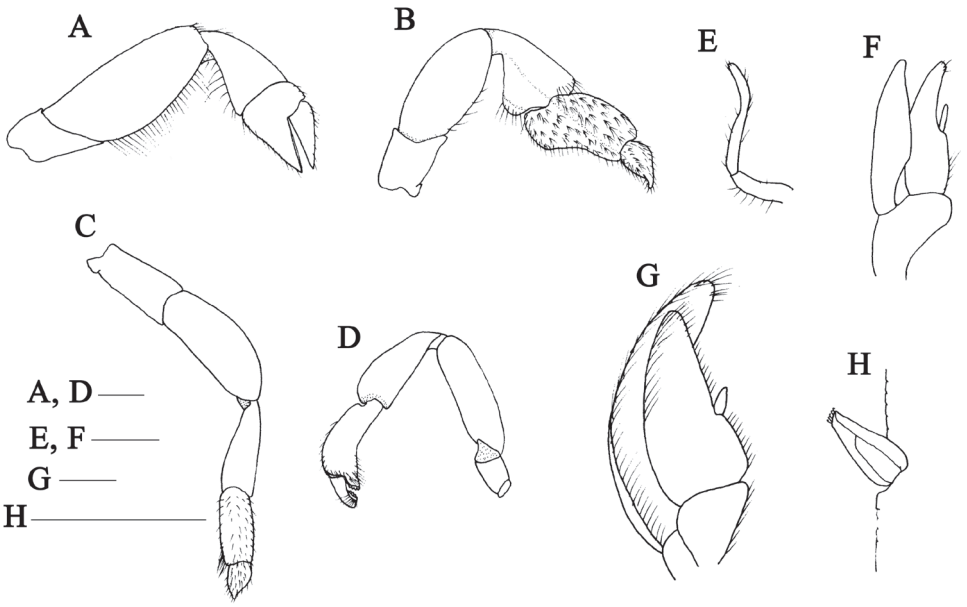

Figure 2. *Calliaxina xishaensis* sp. n. **A–H** Holotype female, MBM136806/58C-639 **A–D** pereopods 2-5, lateral views **E** pleopod 1, posterior view **F** pleopod 2, posterior view **G** pleopod 3, posterior view **H** appendix interna of pleopod 3, posterior view. Scale bars: 1 mm.

about 1.8 times as long as broad, upper margin slightly convex, lower margin with 5-6 small denticles proximally. Carpus broad, increasing in breadth distally, lower margin arcuate, upper and lower margins keeled, terminating distally in triangular corners. Propodus heavy, 1.1 times as long as broad, inner surface of palm smooth; upper and lower propodal margins keeled, keel of lower becoming ill-defined beyond mid-length and absent on fixed finger, tufts of setae on inner face above lower margin; fixed finger thick, prehensile margin armed with one well-separated triangular tooth in mid-length, micro-serrations on upper margin of tooth and distally of it, distal 1/4 of finger unarmed, terminating in acute tip. Dactylus heavy, slightly longer than fixed finger, with pointed curved tip, unarmed.

Left cheliped (Fig. 1F) slightly smaller, similar in shape, cutting edge of fixed finger unarmed, but with a longitudinal triangular depression field of small tubercles on outer face; dactylus more slender than in major cheliped.

Pereopod 2 (Fig. 2A) ischium 0.7 times as long as high; merus 2.4 times as long as high, upper margin smooth, lower margin protruding and with row of dense long setae; carpus subtriangular, shorter than merus; chela shorter than carpus, with dense setae on lower and upper margins; palm with upper margin slightly convex; dactylus 2.8 times as long as upper margin of palm; carpus and chela fringed with short to long setae along margins.

Pereopod 3 (Fig. 2B) simple, moderately slender. Ischium slender, approximately as long as high; merus approximately 2.0 times as long as high, upper and lower mar-

gin slightly convex; carpus subtriangular, shorter than merus, broadest subdistally, approximately 1.4 times as long as high; propodus subrectangular, broadly flared distally to produce strong lower lobe, upper margin slightly convex and 0.7 length of carpus, with numerous tufts of setae on lateral surface and row of thick setae along upper and lower margins; dactylus subtriangular, upper and lower margins convex, outer surface densely setose, terminating in corneous tip.

Pereopod 4 (Fig. 2C) slender, all articles unarmed. Ischium rectangular; merus 1.6 times as long as ischium, upper margin convex; carpus 0.7 length of merus; propodus 0.7 length of carpus, lower margin densely setose; dactylus tapering distally, setose on lateral margin.

Pereopod 5 (Fig. 2D) minutely chelate, all articles unarmed. Ischium rectangular; merus nearly 4.3 times as long as ischium; carpus approximately 0.8 length of merus, upper margin swollen; propodus 0.6 length of carpus, lower distal corner projecting to form a chela with dactylus, lateral surface beset distally with dense setae; dactylus hooked excavate, spooned, toward external side of fixed finger, tips of dactylus and fixed finger obtuse.

Pleon long (Fig. 1B); dorsal length ratio (along midline) of first to sixth pleomere 1.0: 1.8: 1.2: 1.1: 1.0: 1.0. First pleomere narrowing anteriorly in dorsal view; dorsal tergite fused with the lateral pleurites; pleuron weakly developed but with clearly defined ventral margin. Second pleomere with concave anterior margin, posterior margin expanded posterolaterally, with two plumose setal rows near the posterior margin. Third to fifth pleomere each distinctly shorter than second somite; pleura each with tuft of moderately long plumose setae midlaterally and on posteroventral margin. Sixth pleomere subquadrate in dorsal view, very slightly narrowed posteriorly; lateral margin smooth, with a transparent, subrectangular punctae on posterior 1/4.

Female pleopod 1 (Fig. 2E) uniramous, of 2 articles, proximal article c. 0.5 length of distal article, long setae distally, distal article slender with a few setae. Female pleopod 2 (Fig. 2F) biramous, with appendix interna on endopod; exopod more slender than endopod. Pleopod 3–5 (Fig. 2G) biramous, foliaceous endopod bearing finger-like appendix internae (Fig. 2H).

Telson (Fig. 1G) c. 1.9 times as broad as long, broadest at midlength, posterolateral margin rounded, with one tuft of setae each near lateral margin, posterior margin convex; dorsal surface with row of long setae at anterior 1/4 and a transparent, banded punctae near anterior margin.

Uropodal endopod (Fig. 1G) subovate, longer than telson, 1.6 times as long as wide; margins unarmed; with distinct submedian carina on dorsal surface. Uropodal exopod (Fig. 1G) broad, fan-shaped, almost as long as wide, posterodistal margin with thick spiniform setae and dense fringe of setae; with distinct submedian carina and dorsal plate on dorsal surface, distal edge of carina lined with short spiniform setae.

Variation. Maxilliped 3 exopod rudimentary in small specimen (paratype).

Etymology. The species name is based on the type locality, Xisha islands, South China Sea.

Distribution and habitat. Presently only known from the type locality.

Remarks. The genus may be divided into three groups: maxilliped 3 with rudimentary exopod (*C. bulimba* and *C. kensleyi*) and maxilliped 3 with distinct exopod (*C. novaebritanniae*, *C. punica*, *C. sakaii*, *C. thomassini*).

Calliaxina xishaensis sp. n. is the seventh species assigned to the genus. It is remarkably distinguished from the other species of the genus in the sixth pleomere somite with two lateral transparent, subrectangular punctae, and the dorsal surface of the telson with transparent, banded punctae.

The new species is closely related to *C. novaebritanniae* and *C. punica* in having the rostrum broadly triangular with a pointed tip, whereas *C. thomassini* has a minute or nearly absent rostrum. It can also be distinguished from *C. novaebritanniae* and *C. punica* by the convex posterior margin of the telson (versus straight). It is also similar to *C. bulimba* in the fixed finger of left cheliped bearing a longitudinal triangular depression field of small tubercles on its outer face, but It can be distinguished from latter by the distinct exopod on maxilliped 3 (versus rudimentary).

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References

Borradaile LA (1900) On the Stomatopoda and Macrura brought by Dr. Willey from the South Seas. In: Willey A (Ed.) Zoological results based on the material from New Britain, New Guinea, Loyalty Islands and elsewhere collected during the years 1895, 1896, and 1897. Cambridge, 395–428.

Dworschak PC (2005) A new species of *Eucalliax* Manning & Felder, 1991 (Decapoda: Callianassidae) from the Red Sea. Proceedings of the Biological Society of Washington 118: 209–217. doi: 10.2988/0006-324X(2005)118[209:ANSOEM]2.0.CO;2

Manning RB, Felder DL (1991) Revision of the American Callianassidae (Crustacea: Decapoda: Thalassinidea). Proceedings of the Biological Society of Washington 104: 764–792.

Ngoc-Ho N (2003) European and Mediterranean Thalassinidea (Crustacea, Decapoda). Zoosystema 25: 439–555.

Ngoc-Ho N (2014) Six species of Axiidea and Gebiidea from the Indo-West Pacific (Crustacea, Decapoda). Zoosystema 36: 545–561. doi: 10.5252/z2014n3a1

Poore GCB, Griffin DJG (1979) The Thalassinidea (Crustacea: Decapoda) of Australia. Records of the Australian Museum 32: 217–321. doi: 10.3853/j.0067-1975.32.1979.457

de Saint Laurent M (1973) Sur la systématique et la phylogénie des Thalassinidea: définition des familles des Callianassidae et des Upogebiidae et diagnose de cinq genres nouveaux. Comptes Rendus Hebdomadaires de Séances de l'Académie des Sciences (Paris) 277: 513–516.

de Saint Laurent M, Le Loeuff P (1979) Campagnes de la Calypso au large des côtes Atlantiques Africaines (1956 et 1959) (suite). 22. Crustacés Décapodes Thalassinidea. I. Upogebiidae et Callianassidae. In: Forest J (Ed.) Résultats Scientifiques des Campagnes de la Calypso. Fasc. 11 (22). Annales de l'Institut Océanographique, Monaco et Paris 55 suppl., 29–101.

de Saint Laurent M, Manning RB (1982) *Calliax punica*, espéce nouvelle de Callianassidae (Crustacea, Decapoda) des eaux méditerranéennes. Quaderni della Laboratorio di Tecnologia della Pesca 3: 211–224.

Sakai K (2005) Callianassoidea of the world (Decapoda: Thalassinidea). Crustaceana Monographs 4: 1–285.

Sakai K (2011) Axioidea of the world and a reconsideration of the Callianassoidea (Decapoda, Thalassinidea, Callianassida). Crustaceana Monographs 13: 1–616.

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RESEARCH ARTICLE

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A survey of *Pireneitega* from Tajikistan (Agelenidae, Coelotinae)

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Abstract

Five new species of *Pireneitega* species from Tajikistan are described: *P. zonsteini* **sp. n.** (♂♀), *P. muratovi* **sp. n.** (♀), *P. tyurai* **sp. n.** (♀), *P. ramitensis* **sp. n.** (♀) and *P. kovblyuki* **sp. n.** (♂). *Pireneitega major* (Kroneberg, 1875) is redescribed for the first time based on the lectotype designated here. DNA barcodes for the five new species are documented for future use and as proof of molecular differences between these species.

Keywords

Aranei, central Asia, description, new species, *Paracoelotes,* redescription, spider, taxonomy

Introduction

Coelotinae is the largest subfamily of Agelenidae with more than 650 species distributed in the Holarctic and southeast Asia (World Spider Catalog 2016). *Pireneitega* Kishida, 1955 with 30 species distributed across the Palaearctic (World Spider Catalog 2016, Zhang et al. 2016) is one of the most species-rich genera of the subfamily. It is relatively well studied in comparison to other species-rich (and non-monophyletic) genera *Coelotes* Blackwall, 1841 and *Draconarius* Ovtchinnikov, 1999. The species

of *Pireneitega* found in Caucasus and Xinjiang were recently revised (Kovblyuk et al. 2013; Zhang et al. 2016) but the genus remains poorly studied in Central Asia. Of three species known from central Asia (Mikhailov 2013: *P. birulai* (Ermolajev, 1927) (currently considered a junior synonym of *P. luctuosa* (L. Koch, 1878)), *P. fedotovi* (Charitonov, 1946) and *P. major* (Kroneberg, 1875)), *P. fedotovi* is known only from the original description and *P. major* only from two very short descriptions supplied with sketchy figures. A short trip by the junior author to Tajikistan revealed five new morphospecies of *Pireneitega*, each separated by distinct genetic gaps. The goal of this paper is to provide descriptions of the new species (including records of their molecular markers) and a redescription of *P. major* whose type locality lies in northern Tajikistan.

Material and methods

Specimens were examined and measured with a Leica M205C stereomicroscope. Images were captured with an Olympus C7070 wide zoom digital camera (7.1 megapixels) mounted on an Olympus SZX12 dissecting microscope. Epigynes and male palps were examined after dissection. Epigynes were cleared by boiling it in 10% KOH solution before taking photos of the dorsal view. All measurements are given in millimeters. *Pireneitega major* was photographed and drawn using an MBS-9 stereomicroscope with Pro-MicroScancamera. Leg measurements are given as: total length (femur, patella + tibia, metatarsus, tarsus).

Terminology used for copulatory organ characters in the text and figure legends follows Wang (2002) with some modifications.

Abbreviations used in the text and figure legends are:

A epigynal atrium;
ALE anterior lateral eye;
AME anterior median eye;
AME-ALE distance between AME and ALE;
AME-AME distance between AME and AME;
ALE-PLE distance between ALE and PLE;
CD copulatory ducts;
CF cymbial furrow;
CO conductor;
d dorsal;
E embolus;
EB embolic base;
ET epigynal teeth;
FD fertilization ducts;
Fe femur;

H epigynal hood;
MA median apophysis;
Mt metatarsus;
p prolateral;
PA patellar apophysis;
Pa patella;
PLE posterior lateral eye;
PME posterior median eye;
PME-PLE distance between PME and PLE;
PME-PME distance between PME and PME;
R receptacle;
r retrolateral;
RTA retrolateral tibial apophysis;
ST subtegulum;
T tegulum;
Ta tarsus;
Ti tibia;
v ventral;
VTA ventral tibial apophysis.

DNA barcodes were obtained for future use: a partial fragment of the mitochondrial gene cytochrome oxidase subunit I (COI) was amplified and sequenced for five new species using Primers LCO1490-oono (5'-CWACAAAYCATARRGATATTGG-3') (Folmer et al. 1994; Miller et al. 2010) and HCO2198-zz (5'-TAAACTTCCAGGTGACCAAAAAATCA-3') (Folmer et al. 1994; Zhao & Li 2016). For additional information on extraction, amplification, and sequencing procedures, see Zhao et al. (2013). All sequences were blasted in GenBank; accession numbers are provided in Table 1.

Holotypes and some paratypes will be deposited in the Zoological Museum of the Moscow State University (ZMMU). Most paratypes are deposited in the Institute of Zoology, Chinese Academy of Sciences (IZCAS) in Beijing, China.

Table 1. Voucher specimen information.

Species	GenBank accession number	Sequence length	Collection localities
P. zonsteini sp. n.	KY024475	642bp	Env. of Dushanbe, Hissar Mt. Ridge 48th km of Varzob Hwy
P. muratovi sp. n.	KY024477	642bp	Env. of Dushanbe Hissar, Mt. Ridge 20th km of Varzob Hwy Gusgarf Vill.
P. tyurai sp. n.	KY024478	642bp	Khatlon Area Khovaling Distr., Obimazar River
P. ramitensis sp. n.	KY024476	642bp	Khatlon Area Hissar Mt. Range Ramit Reserve
P. kovblyuki sp. n.	KY024474	642bp	Tajikstan: Khatlon Area Dangara Distr Sanglogh

Taxonomy

Genus *Pireneitega* Kishida, 1955

Pireneitega Kishida, 1955: 11. Type species *Amaurobius roscidus* L. Koch, 1868 (= *P. segestriformis* (Dufour, 1820)) from Germany.

Paracoelotes Brignoli, 1982: 347. Type species *Coelotes armeniacus* Brignoli, 1978 from Turkey.

Note. *Pireneitega* was long considered a *nomen nudum* (Yaginuma, in Brignoli 1983: p. 468). Kishida (1955), in a general survey of Agelenidae, considered *Pireneitega* to have been described by himself in 1928, although he had no publications that year. The genus "*Pireneitega* Kishida, 1928 [Genotype: *roscida* (Koch, 1868)]" was considered among the tribe Tegenariini Kishida, 1928 (Kishida 1955: p. 11). Although eye pattern was mentioned in the key to the genera of "Tegenariini", Kishida (1955) did not provide a formal description of the genus. Brignoli (1982) described *Paracoelotes* (type species *Coelotes armeniacus* Brignoli, 1978) from Turkey. Subsequently, Wang and Jäger (2007) revalidated *Pireneitega* with *Paracoelotes* as a junior synonym.

Diagnosis. The chelicerae in most species of *Pireneitega* (including the type species) have 3 promarginal and 3 retromarginal teeth; other coelotines have either 2 or 4 retromarginal teeth (Zhang et al. 2016). The females can be distinguished by the widely separated epigynal teeth, the large atrium with subparallel margins, and the broad copulatory ducts (Fig. 2A–B); other coelotines usually have a small atrium and copulatory ducts. The males can be distinguished by the absence of a dorsal "apophysis" on the conductor, the small RTA, and the distinct median apophysis (Fig. 1A–C); other coelotines usually have a broad dorsal apophysis on the conductor and a reduced or indistinct median apophysis.

Composition. Thirty species of *Pireneitega* are known from Spain to Sakhalin (World Spider Catalog 2016; Mikhailov 2013). One species, *P. major*, was known from Tajikistan before the current study.

Pireneitega zonsteini sp. n.

http://zoobank.org/1AF265B6-AAB0-4974-A8A7-94A906F8FBBF

Figs 1–2, 8

Type material. Holotype ♂ (ZMMU): Tajikstan, environs of Dushanbe, Hissar Mt. Range, 48th km of Varzob Hwy, S exposed slope with *Juglans* litter & under stones, 38°55'31"N, 68°48'18"E, 1530 m, 7.05.2015 (Y.M. Marusik, M. Saidov). Paratypes: 1♂1♀ (IZCAS), same data as holotype.

Etymology. The species is named after Sergei Zonstein (University of Tel-Aviv, Israel) a partner of the junior author in the expedition to Tajikistan; noun (name) in genitive case.

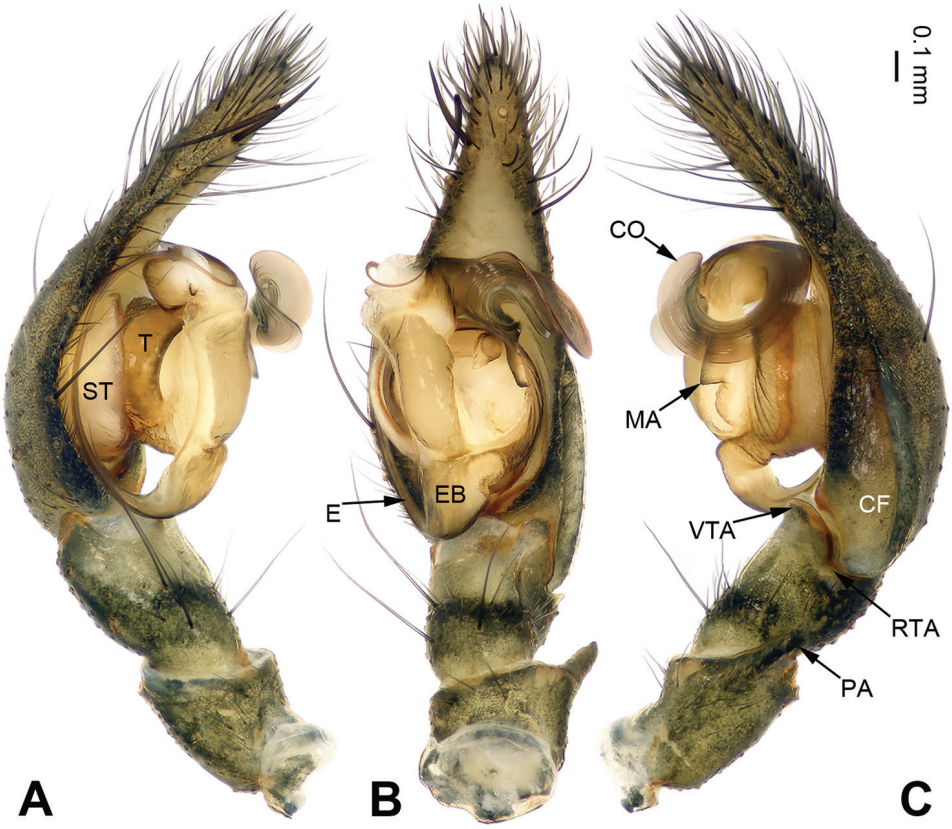

Figure 1. Male palp of *Pireneitega zonsteini* sp. n., holotype. **A** Prolateral **B** Ventral **C** Retrolateral. Scale bar 0.1 mm.

Diagnosis. The male can be distinguished from all other *Pireneitega* species except *P. involuta* (Wang et al., 1990) by having a broad conductor and thick patellar apophysis. From *P. involuta* it is distinguished by the blunt tip of the patellar apophysis (*vs* a tapering tip in *P. involuta*) (Fig. 1; Wang et al. 1990: figs 13–15). The female can be distinguished from all other *Pireneitega* species except *P. fedotovi* by having a nearly trapezoidal atrium, long copulatory ducts, and short receptacles. From *P. fedotovi* it can be distinguished by its short epigynal teeth, about 0.5 times as long as length of the atrium (*vs* long epigynal teeth in *P. fedotovi*, about as long as the length of the atrium) (Fig. 2; Charitonov 1946: fig. 4).

Description. Male (holotype): Total length 8.90. Carapace 4.40 long, 3.50 wide. Abdomen 4.50 long, 2.80 wide. Eye sizes and interdistances: AME 0.15, ALE 0.20, PME 0.15, PLE 0.20; AME-AME 0.07, AME-ALE 0.06, PME-PME 0.15, PME-PLE 0.18. Leg measurements: I: 12.95 (3.50, 4.30, 3.15, 2.00); II: 12.25 (3.25, 4.00, 3.00, 2.00); III: 10.40 (3.15, 3.00, 3.25, 1.00); IV: 16.00 (4.50, 5.00, 4.25, 2.25). Carapace greenish, the radial grooves indistinct, with black lateral margins. Abdomen blackish, with yellow herringbone pattern.

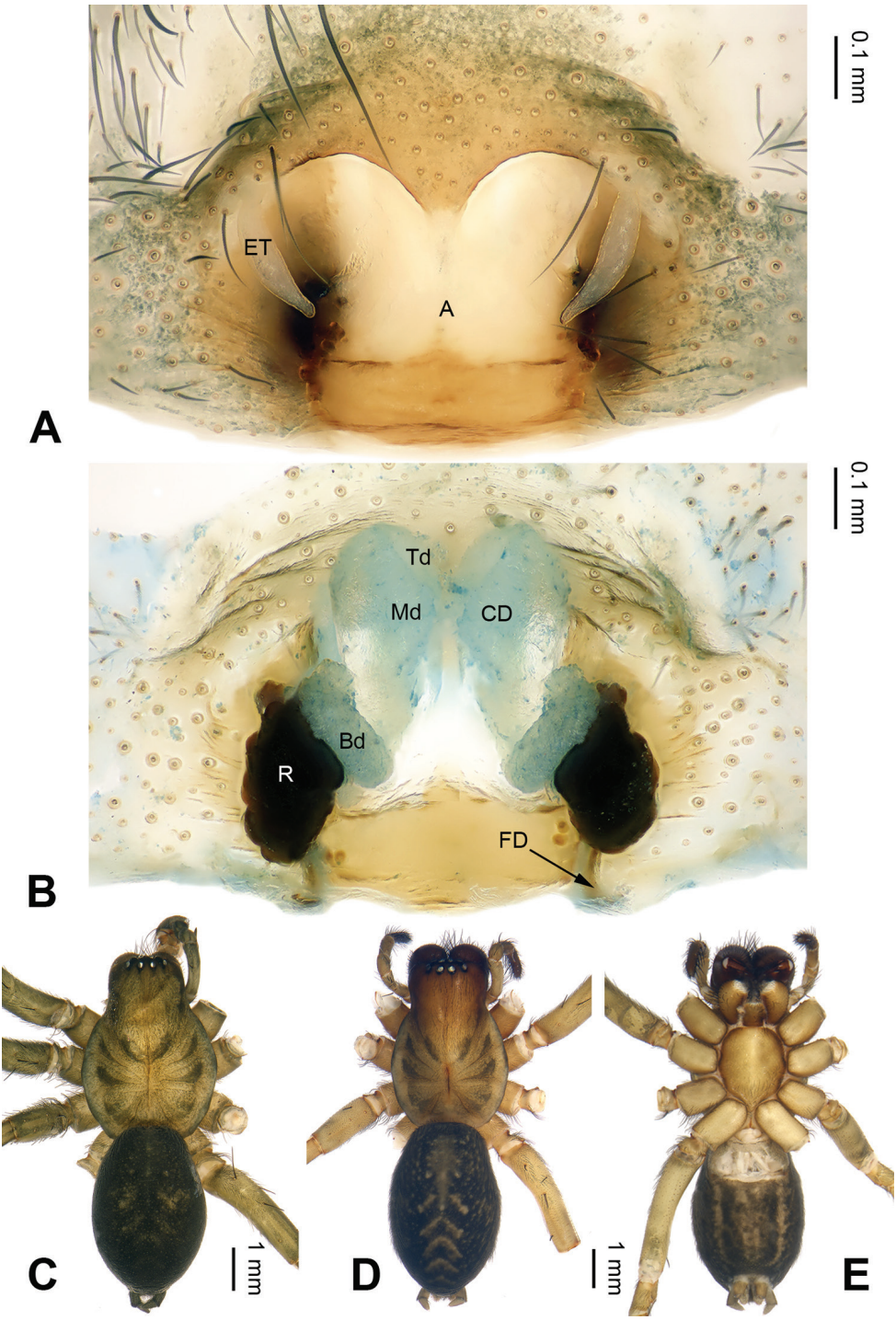

Figure 2. *Pireneitega zonsteini* sp. n., female paratype and male holotype. **A** Epigyne, ventral **B** Vulva, dorsal **C** Male habitus, dorsal **D** Female habitus, dorsal **E** Female habitus, ventral. Scale bars equal for **D, E**.

Spination in male

	Fe	Pt	Ti	Mt	Ta
I	3d 2p 1r	–	3-3v	3-3v	–
II	3d 1p 1r	–	2p 3-3v	2p 3-3v	–
III	3d 2p 2r	1p 1r	1d 2p 2r 3-3v	2p 2r 3-3v	–
IV	3d 2p 1r	1p 1r	2p 2r 3-3v	2p 2r 3-3v	–

Palp as in Fig. 1: patellar apophysis long, more than half length of tibia; tibia short, about 1/4 length of tarsus; VTA subequal to the tibial length, without pointed tip, extending beyond the tibia; RTA short, about 1/6 length of VTA; cymbial furrow long, more than half length of cymbium; conductor broad and with two spiraling loops; median apophysis broad and nearly triangular; embolus with broad base originating proximally on base of tegulum.

Female (paratype): Total length 10.0. Carapace 4.75 long, 3.65 wide. Abdomen 5.25 long, 3.45 wide. Eye sizes and interdistances: AME 0.20, ALE 0.25, PME 0.21, PLE 0.26; AME-AME 0.08, AME-ALE 0.05, PME-PME 0.17, PME-PLE 0.20. Leg measurements: I: 12.50 (3.75, 4.25, 2.75, 1.75); II: 11.75 (3.50, 4.00, 2.75, 1.50); III: 10.60 (3.00, 3.50, 2.60, 1.50); IV: 15.00 (4.25, 4.75, 4.00, 2.00). Carapace yellow. Abdomen black, with yellow spots and herringbone pattern.

Epigyne as in Fig. 2A–B: epigynal teeth narrow and relatively short (shorter than width of atrium); septum short with weakly sclerotized tip, about 0.3 times as long as wide; atrium with well delimited posterior margin, about 1.3 times longer than wide, about 4 times longer than septum, subequal to width of septum; copulatory opening hidden by anterior margin of atrium; receptacles long, about 2 times longer than wide, separated by 2.5 times their diameters; copulatory ducts with 3 parts, the basal part running from receptacle posteriorly (*Bd*), median part running anteriorly (*Md*), and terminal part (*Td*) running posteriorly and leading to copulatory opening; median part as wide as terminal and 2 times longer than basal part; median part 1.5 times longer than receptacle; median parts touching each other; hoods indistinct.

Spination in female

	Fe	Pt	Ti	Mt	Ta
I	3d 2p 1r	–	3-3v	3-3v	–
II	3d 1p 1r	–	1p 3-3v	1p 3-3v	–
III	3d 1p 2r	1p 1r	2p 2r 3-3v	2p 2r 3-3v	–
IV	3d 1p 1r	1p 1r	2p 2r 3-3v	1p 2r 3-3v	–

Distribution. Known only from the type locality (Fig. 8).

***Pireneitega muratovi* sp. n.**
http://zoobank.org/A01FC654-273B-4E50-A278-052B957FBA4B
Figs 3, 8

Type material. Holotype ♀ (ZMMU): Tajikstan: env of Dushanbe, Hissar Mt. Ridge, 20th km of Varzob Hwy, Gusgarf [Gushharf] Vill., N exposed slope with *Acer* litter & cliffs, 38°44'22"N, 68°47'33"E, 1750 m, 8.05.2015, Y. M. Marusik. Paratype: 1♀ (IZCAS), same data as holotype.

Etymology. The species is named after Tajikistan zoologist Rustam Muratov (Dushanbe, Tajikistan) who was very helpful in organizing the expedition to Tajikistan; noun (name) in genitive case.

Diagnosis. The female can be distinguished from all other *Pireneitega* species except *P. fedotovi*, *P. luniformis* (Zhu & Wang, 1994), and *P. major* by having narrow epigynal teeth and an elongate oval atrium. It can be distinguished from *P. fedotovi* by the pointed tip of septum (*vs* blunt tip in *P. fedotovi*), from *P. luniformis* by the elongate oval receptacles (*vs* spiralled in *P. luniformis*), and from *P. major* by its short epigynal teeth, *ca.* 0.8 times as long as length of the atrium (*vs* long epigynal teeth in *P. major*, about as long as the length of the atrium) (Figs 3, 7; Charitonov 1946: fig. 4; Zhu and Wang 1994: figs 5–6).

Description. Male: unknown.

Female (holotype): Total length 9.94. Carapace 4.49 long, 3.05 wide. Abdomen 5.45 long, 2.90 wide. Eye sizes and interdistances: AME 0.18, ALE 0.23, PME 0.24, PLE 0.30; AME-AME 0.10, AME-ALE 0.05, PME-PME 0.15, PME-PLE 0.10. Leg measurements: I: 11.25 (3.25, 4.00, 2.50, 1.50); II: 10.30 (3.00, 3.50, 2.50, 1.30); III: 9.70 (2.75, 3.00, 2.65, 1.30); IV: 13.75 (3.75, 4.25, 4.00, 1.75). Carapace yellow, the radial grooves indistinct. Abdomen whitish-yellow, with green herringbone pattern.

Epigyne as in Fig. 3A–B: epigynal teeth narrow, their length equal to width of the narrowest part of the atrium; septum with well delimited tip, *ca.* 0.5 times as long as wide; copulatory opening distinct; atrium with well delimited posterior margin, about 1.4 times longer than wide, *ca.* 2 times longer than and 0.7 times as wide as septum; receptacles long, about 2.5 times as long as wide, bases of receptacles separated by 2 diameters; copulatory ducts with 3 parts, median part as long as receptacles, and anterior part slightly wider than receptacles; hoods indistinct.

Spination

	Fe	Pt	Ti	Mt	Ta
I	3d 2p 1r	–	3-3v	1p 3-3v	–
II	3d 3p 2r	–	2p 3-3v	3-3v	–
III	3d 3p 2r	1p 1r	2p 2r 3-3v	5p 4r 3-3v	1p 1r
IV	3d 1p 1r	1d 1p 1r	1d 2p 2r 3-3v	5p 5r 3-3v	2p 1r

Distribution. Known only from the type locality (Fig. 8).

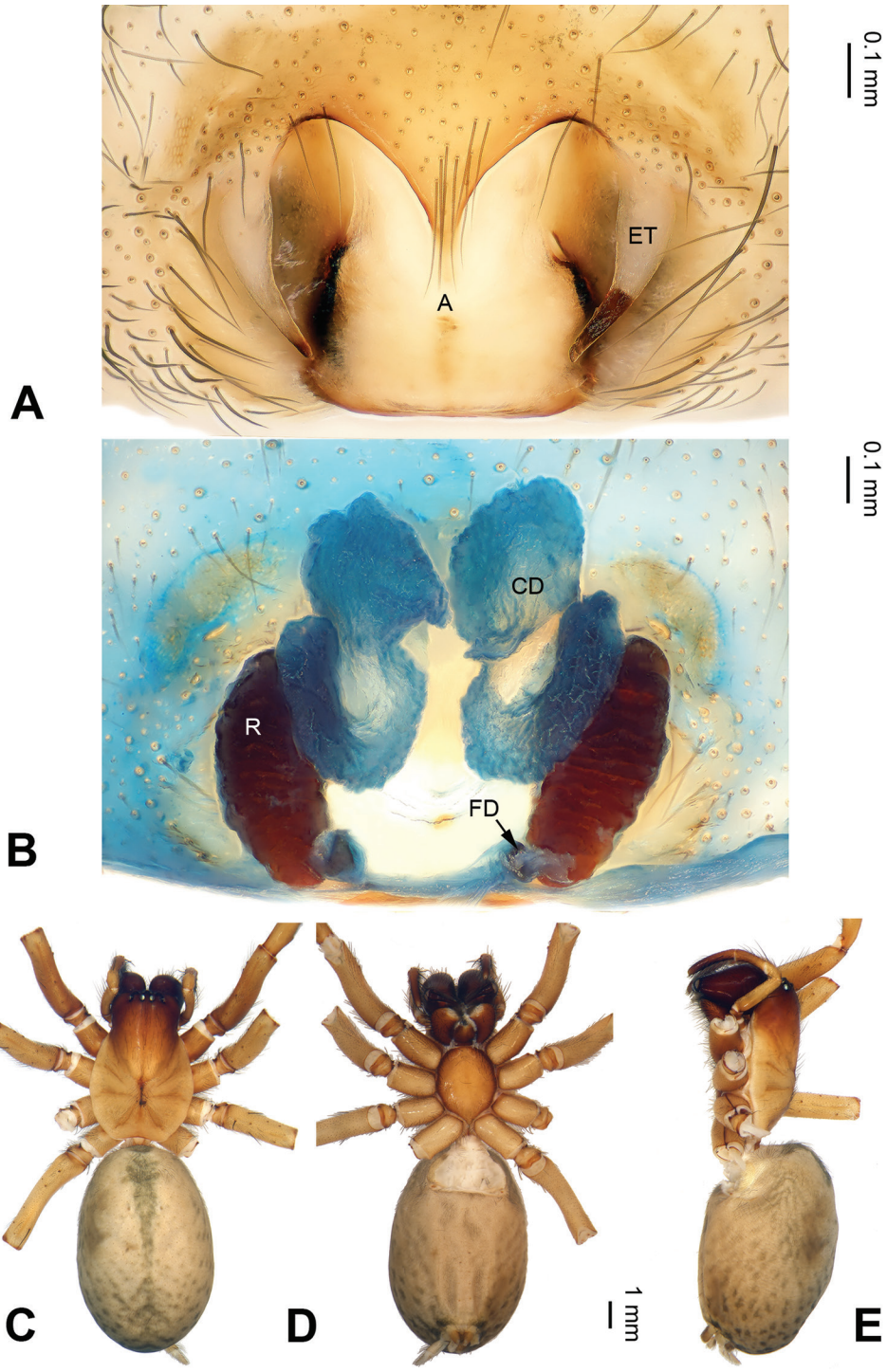

Figure 3. *Pireneitega muratovi* sp. n., female holotype. **A** Epigyne, ventral **B** Vulva, dorsal **C** Habitus, dorsal **D** Habitus, dorsal **E** Habitus, ventral view. Scale bars equal for **C, D, E**.

***Pireneitega tyurai* sp. n.**
http://zoobank.org/B14F37A9-6A33-446F-80AF-2C65472362D3
Figs 4, 8

Type material. Holotype ♀ (ZMMU): Tajikstan: Khatlon Area, Khovaling Distr., Obimazar River, Sultan-Mazar, clay cliffs, 38°28'19"N, 70°04'01"E, 1854 m, 27.04.2015 (Y.M. Marusik). Paratypes: 4♀ (IZCAS), same data as holotype.

Etymology. The species is named after Sergei V. Tyura (Magadan, Russia) a friend of the junior author; noun (name) in genitive case.

Diagnosis. The female can be distinguished from all other *Pireneitega* species except *P. tianchiensis* (Wang et al., 1990) by having short receptacles and copulatory ducts. It can be distinguished from *P. tianchiensis* by the broad and long epigynal teeth, about 0.85 times as long as atrium (*vs* short and narrow epigynal teeth in *P. tianchiensis*, about 0.5 times as long as atrium) (Fig. 4A–B; Wang et al. 1990: figs 84–85).

Description. Male: unknown.

Female (holotype): Total length 5.15. Carapace 2.15 long, 1.75 wide. Abdomen 3.00 long, 2.00 wide. Eye sizes and interdistances: AME 0.10, ALE 0.13, PME 0.15, PLE 0.15; AME-AME 0.05, AME-ALE 0.10, PME-PME 0.02, PME-PLE 0.04. Leg measurements: I: 6.20 (1.90, 2.25, 1.25, 0.80); II: 5.10 (1.60, 1.75, 1.00, 0.75); III: 4.80 (1.50, 1.60, 1.00, 0.70); IV: 7.05 (2.05, 2.50, 1.50, 1.00). Carapace yellow, with black lateral margins. Abdomen blackish, with yellow herringbone pattern.

Epigyne as in Fig. 4A–B: epigynal teeth long (nearly as long as atrium); septum with weakly sclerotized tip, about 0.5 times as long as wide; atrium with weakly sclerotized posterior margin, about 0.7 times as long as wide, about 1.8 times longer than and 0.7 times as wide as septum; copulatory opening hidden; receptacles large, *ca.* 2 times longer than wide; copulatory ducts with two parts, terminal parts (Tp) not touching each other, about 0.5 length of receptacles, basal parts (Bp) shorter than width of receptacle; hoods indistinct.

Spination

	Fe	Pt	Ti	Mt	Ta
I	3d 2p	–	3-3v	3-3v	–
II	3d 1p 1r	1p	2p 3-3v	1p 3-3v	–
III	3d 1p 1r	1p 1r	2p 2r 3-3v	5p 4r 3-3v	2p 1r
IV	2d 1p 1r	1p 1r	2p 2r 3-3v	5p 4r 3-3v	2p 1r

Distribution. Known only from the type locality (Fig. 8).

***Pireneitega ramitensis* sp. n.**
http://zoobank.org/C74C6BAE-DE7C-4A95-A4A2-5E5BFC45C341
Figs 5, 8

Type material. Holotype ♀ (ZMMU): Tajikstan: Khatlon Area, Hissar Mt. Range, Ramit Reserve, 38°44'36"N, 69°18'30"E, 1324 m, 1.05.2015 (Y.M. Marusik). Paratypes: 4♀ (IZCAS), 2♀ (ZMMU), same data as holotype.

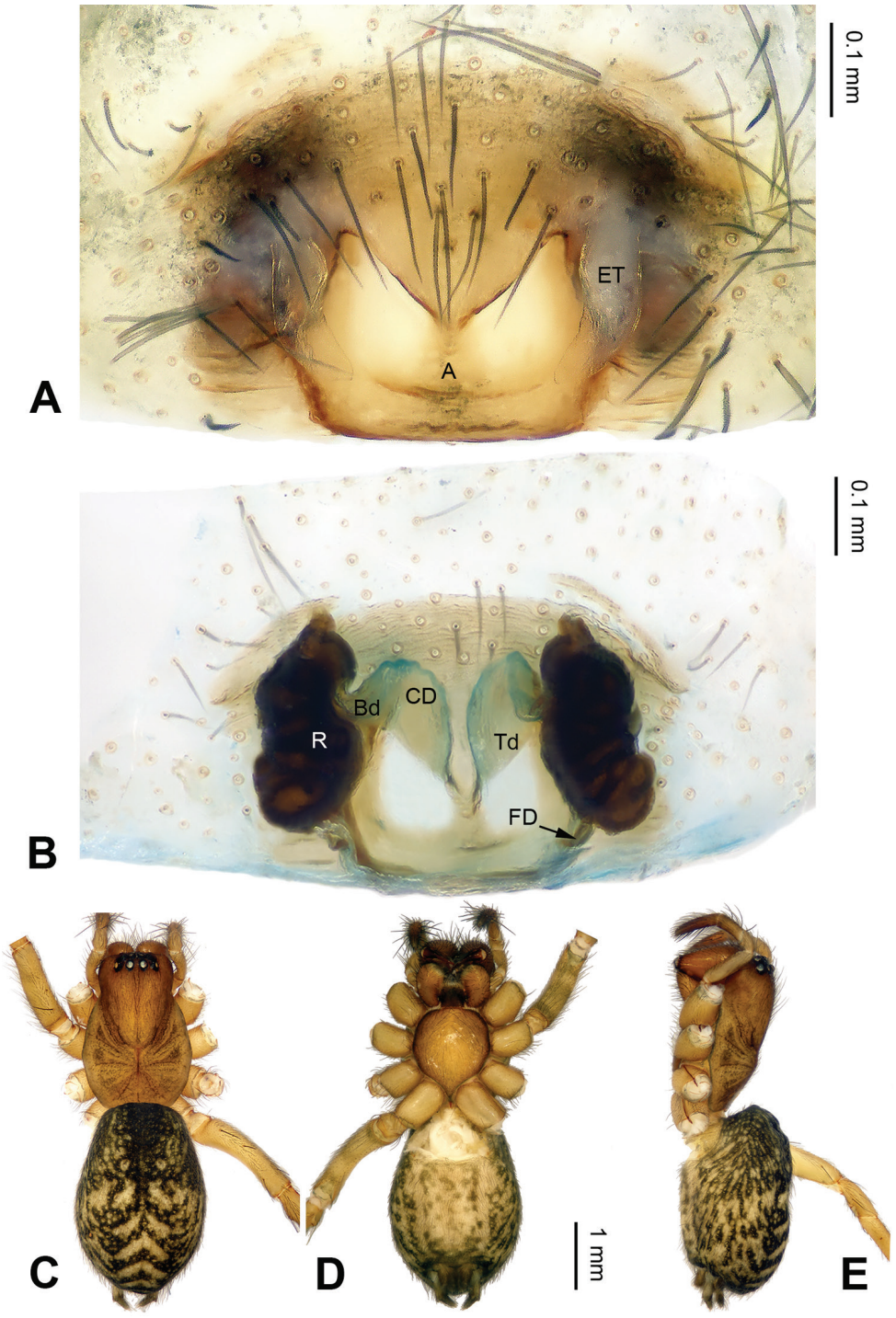

Figure 4. *Pireneitega tyurai* sp. n., female holotype. **A** Epigyne, ventral **B** Vulva, dorsal **C** Habitus, dorsal **D** Habitus, dorsal **E** Habitus, ventral. Scale bars equal for **C, D, E**.

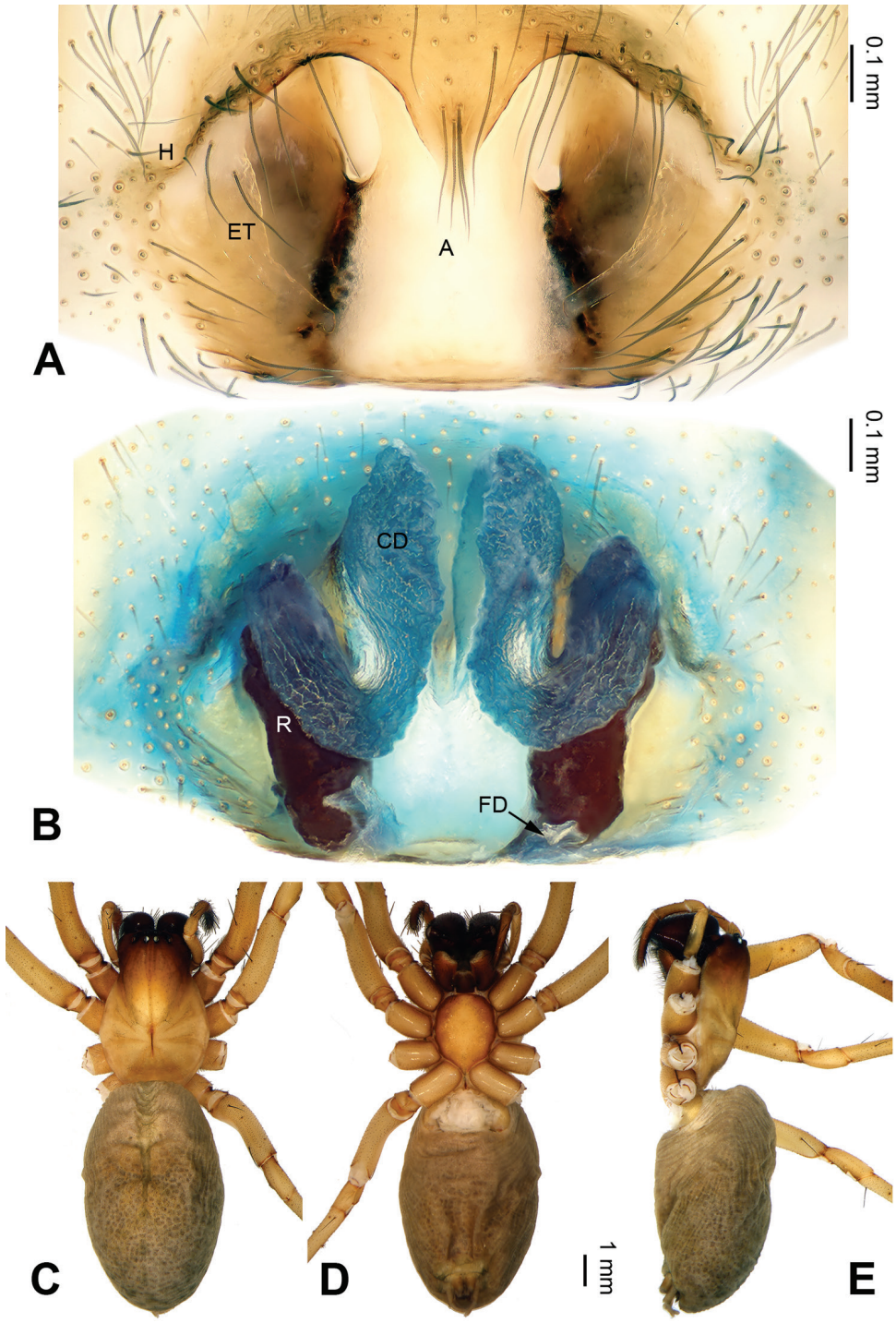

Figure 5. *Pireneitega ramitensis* sp. n., female holotype. **A** Epigyne, ventral **B** Vulva, dorsal **C** Habitus, dorsal **D** Habitus, ventral **E** Habitus, ventral. Scale bars equal for **C, D, E**.

Etymology. The specific name is an adjective and refers to the type locality; adjective.

Diagnosis. The female can be distinguished from all other *Pireneitega* species except *P. muratovi* sp. n., *P. fedotovi*, *P. luniformis* and *P. major*, by having an elongate oval atrium, narrow epigynal teeth, and long copulatory ducts. It can be distinguished from *P. muratovi* sp. n. and *P. luniformis* by the narrow tip of the copulatory ducts (*vs* round tip in *P. muratovi* sp. n. and *P. luniformis*) and from *P. fedotovi* and *P. major* by the bent epigynal teeth (*vs* straight epigynal teeth in *P. fedotovi* and *P. major*) (Figs 3, 5, 7; Charitonov 1946: fig. 4; Zhu & Wang 1994: figs 5–6).

Description. Male: unknown.

Female (holotype): Total length 12.00. Carapace 4.50 long, 3.55 wide. Abdomen 7.50 long, 4.75 wide. Eye sizes and interdistances: AME 0.20, ALE 0.23, PME 0.25, PLE 0.20; AME-AME 0.10, AME-ALE 0.20, PME-PME 0.10, PME-PLE 0.23. Leg measurements: I: 14.05 (4.00, 4.75, 3.45, 1.85); II: 13.40 (3.90, 4.50, 3.25, 1.75); III: 13.00 (3.75, 4.25, 3.25, 1.75); IV: 16.55 (4.75, 5.40, 4.40, 2.00). Carapace yellowish, with brown lateral margins. Abdomen pale-yellow, with brown spots.

Epigyne as in Fig. 5A–B: epigynal teeth pale, hyaline, long and thin, about 0.9 times as long as receptacles; septum with weakly sclerotized tip, *ca.* 0.5 times as long as wide, nearly triangular; copulatory ducts distinct; atrium about 1.4 times longer than wide, with well delimited posterior margin, *ca.* 2.8 times longer than and about as wide as septum; receptacles large, about. 3 times longer than wide; receptacle bases separated by about 2 diameters; copulatory ducts with 3 parts, basal part about 2/3 of receptacle length, median part as long as receptacle, terminal part somewhat shorter than median part; hoods distinct.

Spination

	Fe	Pt	Ti	Mt	Ta
I	3d 2p 1r	–	1p 3-3v	1p 3-3v	–
II	3d 2p 2r	–	2p 3-3v	2p 3-3v	–
III	3d 3p 2r	1p 1r	2p 2r 3-3v	5p 4r 3-3v	2p 2r
IV	3d 2p 1r	1p 1r	2p 2r 3-3v	5p 4r 3-3v	2p 2r

Distribution. Known only from the type locality (Fig. 8).

***Pireneitega kovblyuki* sp. n.**

http://zoobank.org/25787234-B768-4EB3-B6B2-781E025AB5D4

Figs 6, 8

Type material. Holotype ♂ (ZMMU): Tajikistan, Khatlon Area, Dangara Distr., Sanglogh (=Sanglok) Mt. Range above Shar-Shar Pass, 38°17'56"N, 69°13'36"E, 1700–2060 m, 29.04.2015, (Y.M. Marusik). Paratypes: 3♂ (IZCAS), 2♂ (ZMMU), same data as holotype.

Etymology. The specific name is a patronym in honour of the well known arachnologist and friend of the junior author Mykola M. Kovblyuk (Simferopol, Ukraine); noun (name) in genitive case.

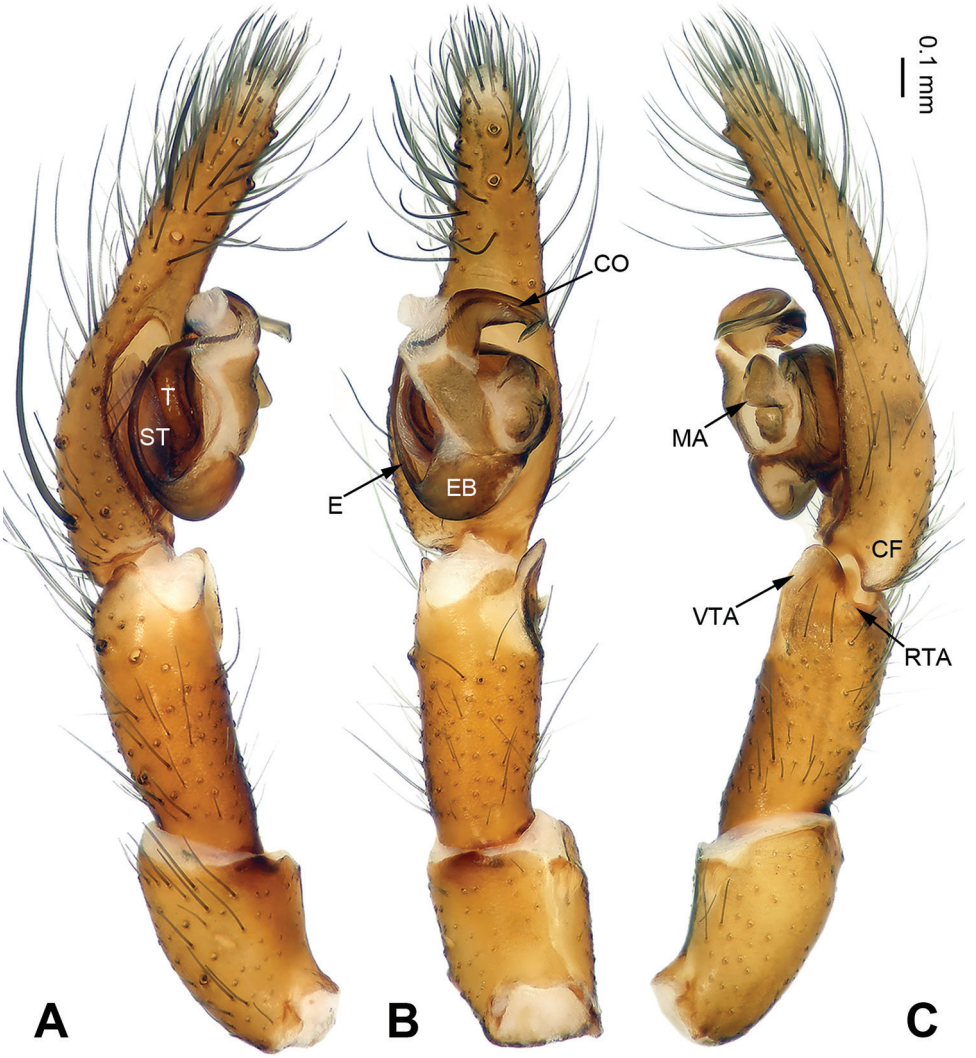

Figure 6. Male palp of *Pireneitega kovblyuki* sp. n., holotype. **A** Prolateral **B** Ventral **C** Retrolateral. Scale bar 0.1 mm.

Diagnosis. The male can be distinguished from all other *Pireneitega* species except *P. tianchiensis* by having a hook-shaped conductor, and narrow cymbium. It can be distinguished from *P. tianchiensis* by the short cymbial furrow, *ca.* 1/10 length of cymbium (*vs* long cymbial furrow in *P. tianchiensis*, about 0.5 length of cymbium) (Fig. 6; Wang et al. 1990: figs 81–83).

Description. Male (holotype): Total length 7.90. Carapace 4.00 long, 3.00 wide. Abdomen 3.90 long, 2.65 wide. Eye sizes and interdistances: AME 0.15, ALE 0.20, PME 0.18, PLE 0.19; AME-AME 0.08, AME-ALE 0.07, PME-PME 0.13, PME-PLE 0.15. Leg measurements: I: 10.90 (3.25, 4.05, 2.00, 1.60); II: 9.85 (3.00, 3.50, 2.00,

1.35); III: 8.60 (2.75, 2.50, 2.10, 1.25); IV: 12.55 (3.70, 3.75, 3.50, 1.60). Carapace yellow, the radial grooves indistinct. Abdomen pale, with yellow herringbone pattern.

Palp as in Fig. 6A–C: patellar apophysis absent; tibia long, *ca*. 0.5 length of cymbium; VTA short and wide, about 1/3 length of tibia, without pointed tip; RTA short, about 1/5 length of VTA, poorly visible; cymbium long, its tip as long as or longer than genital bulb; conductor short, with hook-shaped, partially looped tip, tip located distally from tegulum; median apophysis broad and nearly triangular; embolus with broad, nearly tongue-shaped base, beginning at 6:30 o'clock position.

Spination

	Fe	Pt	Ti	Mt	Ta
I	3d 2p 1r	–	3-3v	3-3v	–
II	3d 3p 1r	1p	2p 3-3v	3p 3-3v	–
III	3d 2p 2r	1d1p 1r	1d 2p 2r 3-3v	5p 5r 3-3v	1p 1r
IV	3d 1p 1r	1p 1r	2p 2r 3-3v	5p 5r 3-3v	2p 1r

Female: Unknown.

Distribution. Known only from the type locality (Fig. 8).

***Pireneitega major* (Kroneberg, 1875)**
Figs 7–8

Coelotes major Kroneberg, 1875: 15, pl. 1, fig. 6 (♀); Charitonov, 1946: 20, fig. 5 (♀).

Paracoelotes major: Ovtchinnikov, 1988: 142 (transferred from *Coelotes*).
Misidentifications:
Coelotes major: Schenkel 1936: 284, fig. 97 (♀); Hu & Wu 1989: 180, fig. 150.1–2 (♀).
Paracoelotes major: Song et al. 1999: 389, fig. 229Q–R (♀).

Material examined. Lectotype ♀ (ZMMU) with label «Та 3845 1♀ ZMMU [Зоомузей МГУ]» «Lectotypus» 2/VI; Аучи дагана [Auchi dagana] *Coelotes major* Kroneberg, 1875», ca 39°35'N, 69°05'E. Paralectotype: 1♀ (ZMMU) with 2 labels «Та1059, 1, *Coelotes major*» «Туркестанская Учёная Экспедиция Имераторскаго Общества Любителей Естествознанія. Федченко [Turkestan Scientific Expedition of the Emperor's Society of Devotees of Natural Sciences. Fedchenko]» and «*Coelotes major* n. sp. Та, No.1059, Кокандское ханство, Федченко [Kokand Khanate, Fedchenko]».

Comments. The figures of *P. major* presented by Schenkel (1936), Hu and Wu (1989), and Song et al. (1999; copied from Hu and Wu 1989) are of a species other than *P. major*, the identity of which is currently unknown. All records of this unknown species are from Xinjiang, China.

Diagnosis. This species is easily distinguished from other species of *Pireneitega* found in Tajikistan by its larger size (carapace length >6 mm *vs* <4.75) and having 5 spines on tarsus IV (*vs* other species with 0–4). The epigyne of *P. major* is most similar

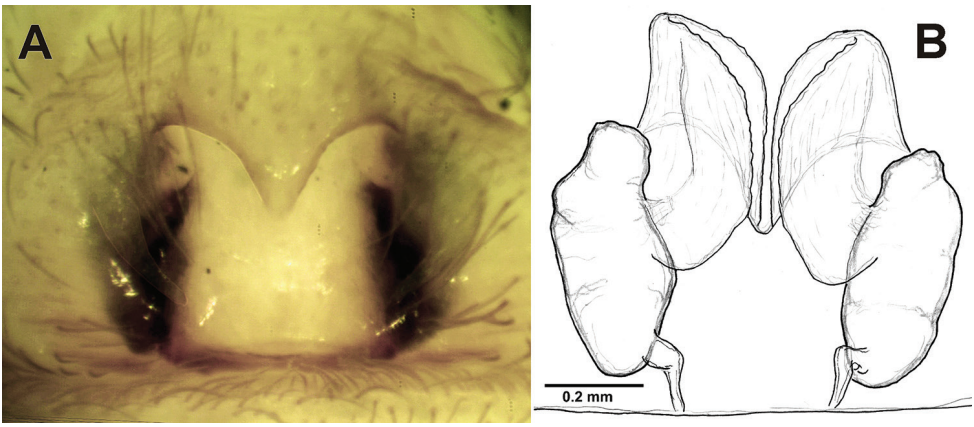

Figure 7. Epigyne of *Pireneitega major*, lectotype. **A** Ventral **B** Dorsal.

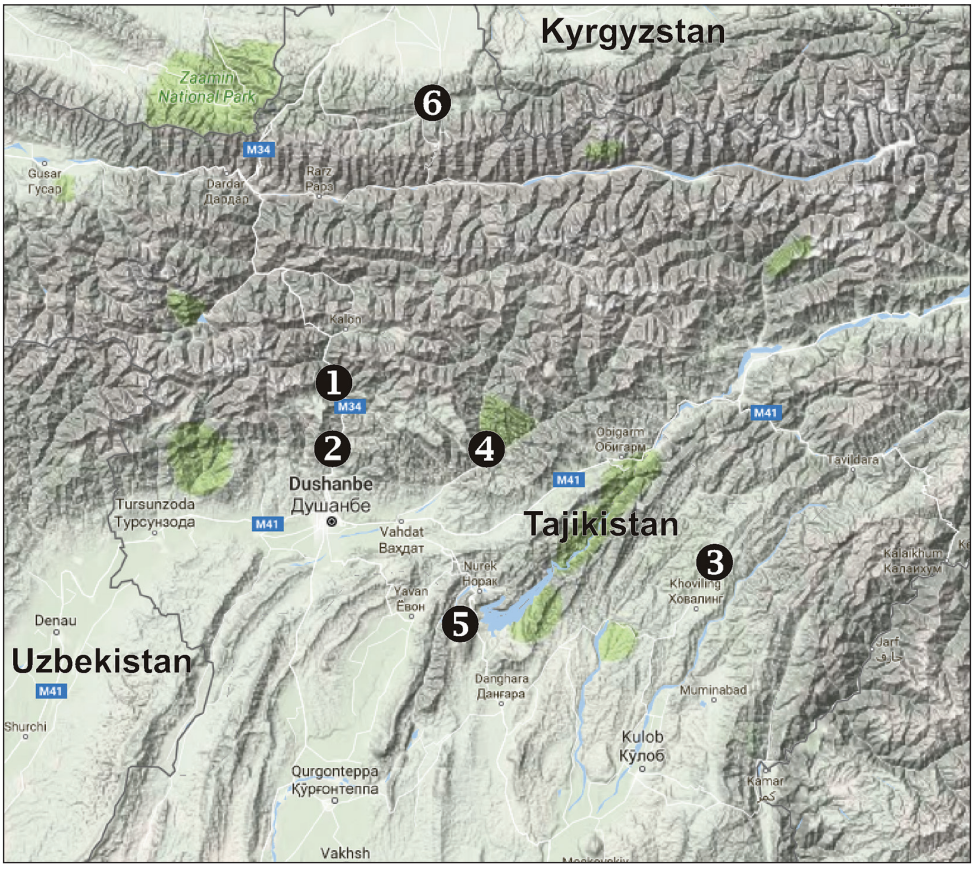

Figure 8. Localities of *Pireneitega* species from Tajikistan. **1** *P. zonsteini* sp. n. **2** *P. muratovi* sp. n. **3** *P. tyurai* sp. n. **4** *P. ramitensis* sp. n. **5** *P. kovblyuki* sp. n. **6** *P. major*.

to that of *P. muratovi* sp. n. and *P. ramitensis* sp. n. It can be distinguished from *P. muratovi* sp. n. by its shorter receptacles with length/width ratio of 2.3 (*vs* 2.6 in *P. muratovi*), shape of copulatory ducts, and shorter teeth (cf. Figs 3A–B and 7A–B). *Pireneitega major* can be separated from *P. ramitensis* sp. n by its wider epigynal atrium and shorter, wider receptacles as well as by its shorter and wider copulatory ducts (cf. Figs 5A–B and 7A–B).

Description. Male: unknown.

Female: Lectotype. Total length 16.7. Carapace 7.0 long, 5.0 wide, fovea 1.25 long. Leg measurements: I:19.75 (5.5, 2.5, 4.6, 4.65, 2.5); II: 18.6 (5.1, 2.5, 4.0, 4.5, 2.5); III: 17.2 (4.75, 2.2, 3.55, 4.6, 2.1); IV: 21.85 (5.75, 2.3, 5.0, 6.25, 2.55).

Spination

	Fe	Pt	Ti	Mt	Ta
I	3d 2p 2r	–	3-3v	3-3v 1vm	–
II	3d 3p 2r	–	2p 3-3v	1p 3-3v	–
III	3d 3p 2r	1p 1(0)r	2p 2r 3-3v	5p 4r 3-3v	2p 1-1v
IV	3d 2p 1r	1p 1r	2p 2r 3-3v	5p 4r 3-3v	2p 3r

Paralectotype ♀. Total length: 11.0. Carapace 6.0 long, 4.0 wide. Epigyne 0.51 wide.

Epigyne as in Fig. 7: epigynal teeth pale, hyaline, long and thin; septum with weakly sclerotized tip, about 0.4 times as long as wide, subtriangular; atrium as long as wide; receptacles large, about 2.5 times longer than wide; receptacle bases separated by *ca.* 2 diameters; copulatory ducts with 2 parts, basal part as long as receptacle, terminal part somewhat shorter receptacle.

Comments. Known from the type series females only. Exact locality is known for the lectotype only: Auchi lies on the northern macroslope of the Turkestan Mt Range (Fig. 8).

Acknowledgements

We thank Sergei Zonstein (Tel-Aviv, Israel; a partner of the junior author in the expedition to Tajikistan), Rustam Muratov and Murod Saidov (Dushanbe, Tajikistan) for field assistance and helping to organize the expedition; Kirill G. Mikhailov (Moscow, Russia) for allowing us to study the type material of *P. major*; Seppo Koponen (Turku, Finland) for providing museum facilities in Turku; and Zhe Zhao (Beijing, China) for helping to provide the molecular data. English of the final draft was kindly checked by Robert Bennett (Victoria, British Columbia, Canada). This study was supported by the National Natural Sciences Foundation of China to Guo Zheng (NSFC-31172121,31372224,31672315).

References

Brignoli PM (1982) On a few spiders from China (Araneae). Bulletin of the British Arachnological Society 5: 344–351.

Brignoli PM (1983) A catalogue of the Araneae described between 1940 and 1981. Manchester University Press 468: 1–755.

Charitonov DE (1946) New forms of spiders of the USSR. Izvestiya Yestestvenno-Nauchnogo Instituta pri Molotovskom Gosudarstvennom Universitete imeni M. Gor'kogo 12: 19–32. [In Russian]

Folmer O, Black M, Hoeh W, Lutz R, Vrijenhoek R (1994) DNA primers for amplification of mitochondrial cytochrome c oxidase subunit I from diverse metazoan invertebrates. Molecular Marine Bilogy and Biotechnology 3(5): 294–299.

Hu JL, Wu WG (1989) Spider from agricultural regions of Xinjiang Uygur Autonomous Region, China. Shandong University Publishing House, Jinan, 435 pp.

Kishida K (1955) A synopsis of spider family Agelenidae. Acta Arachnologica (Tokyo) 14: 1–13. doi: 10.2476/asjaa.14.1

Kovbyluk MM, Kastrygina ZA, Marusik YM, Ponomarev AV (2013) The spider genus *Pireneitega* Kishida, 1955 in the Caucasus (Aranei: Agelenidae: Coelotinae). Arthropoda Selecta 22: 59–73.

Kroneberg A (1875) Araneae. In: Fedtschenko AP (Ed.) Puteshestvie v Tourkestan. Izvestiya Imperatorskogo Obshchestva Lyubitelei Yestestvoznaniya 19: 1–58. [In Russian]

Mikhailov KG (2013) The spiders (Arachnida: Aranei) of Russia and adjacent countries: a non-annotated checklist. Arthropoda Selecta, Supplement 3: 1–262.

Miller JA, Carmichael A, Ramirez MJ, Spagna JC, Haddad CR, Řezáč M, Johannesen J, Král J, Wang XP, Griswold CE (2010) Phylogeny of entelegyne spiders: affinities of the family Penestomidae (new rank), generic phylogeny of Eresidae, and asymmetric rates of change in spinning organ evolution (Araneae, Araneoidea, Entelegynae). Molecular Phylogenetics and Evolution 55: 786–804. doi: 10.1016/j.ympev.2010.02.021

Ovtchinnikov SV (1988) [Materials on spider fauna of the superfamily Amaurobioidea of Kirghizia]. Entomologiceskie issledovanija v Kirgizii 19: 139–152. [In Russian]

Schenkel E (1936) Schwedisch-chinesische wissenschaftliche Expedition nach den norwestlichen Province Chinas. Arkiv för Zoologi 29(A1): 1–314.

Song DX, Zhu MS, Chen J (1999) The Spiders of China. Hebei University of Science and Techology Publishing House, Shijiazhuang, 640 pp.

Wang JF, Yin CM, Peng XJ, Xie LP (1990) New species of the spiders of the genus *Coelotes* from China (Araneae: Agelenidae). Spiders in China: One Hundred New and Newly Recorded Species of the Families Araneidae and Agelenidae. Hunan Normal University Press, 172–253.

Wang XP (2002) A generic-level revision of the spider subfamily Coelotinae (Araneae, Amaurobiidae). Bulletin of the American Museum of Natural History 269: 1–150. doi: 10.1206/0003-0090(2002)269<0001:AGLROT>2.0.CO;2

Wang XP, Jäger P (2007) A revision of some spiders of the subfamily Coelotinae F. O. Pickard-Cambridge 1898 from China: transfers, synonymies, and new species (Arachnida, Araneae, Amaurobiidae). Senckenbergiana Biologica 87: 23–49.

World Spider Catalog (2016) World Spider Catalog. Natural History Museum Bern. http://wsc.nmbe.ch [accessed on October 10, 2016]

Zhang XQ, Zhao Z, Zheng G, Li S (2016) Nine new species of the spider genus *Pireneitega* Kishida, 1955 (Agelenidae, Coelotinae) from Xinjiang, China. ZooKeys 601: 49–74. doi: 10.3897/zookeys.601.7893

Zhao Z, Li S (2016) *Papiliocoelotes* gen. n., a new genus of Coelotinae (Araneae, Agelenidae) spiders from the Wuling Mountains, China. ZooKeys 585: 33–50. doi: 10.3897/zookeys.585.8007

Zhao Z, Su TJ, Chesters D, Wang SD, Ho SYW, Zhu CD, Chen XL, Zhang CT (2013) The mitochondrial genome of *Elodia flavipalpis* Aldrich (Diptera: Tachinidae) and the evolutionary timescale of tachinid flies. PLoS ONE 8: e61814.

Zhu CD, Wang JF (1994) Seven new species of the genus *Coelotes* from China (Araneae: Agelenidae). Acta Zootaxonomica Sinica 19: 37–45.

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RESEARCH ARTICLE

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Antarctotrechus balli sp. n. (Carabidae, Trechini): the first ground beetle from Antarctica

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Abstract

Fossil elytra of a small trechine carabid are reported from the Oliver Bluffs on the Beardmore Glacier at lat. 85°S. They were compared with counterparts from the extant genera *Trechisibus*, *Tasmanorites*, *Oxytrechus* and *Pseudocnides*. The fossils share some characters but are sufficiently different to be described as a new genus and species. We named the new species *Antarctotrechus balli* in honour of George E. Ball who made major contributions to the study of carabids through his own research and the training of students while at the University of Alberta, Edmonton, Alberta, Canada. The closest extant relatives to the extinct *A. balli* are species of *Trechisibus,* which inhabit South America, the Falkland Islands and South Georgia, and *Tasmanorites*, which inhabit Tasmania, Australia. Plant fossils associated with *A. balli* included *Nothofagus* (southern beech), *Ranunculus* (buttercup), moss mats and cushion plants that were part of a tundra biome. Collectively, the stratigraphic relationships and the growth characteristics of the fossil plants indicate that *A. balli* inhabited the sparsely-vegetated banks of a stream that was part of an outwash plain at the head of a fjord in the Transantarctic Mountains. Other insects represented by fossils in the tundra biome include a listroderine weevil and a cyclorrhaphan fly. The age of the fossils, based on comparison of associated pollen with $^{40}Ar/^{39}Ar$ dated pollen assemblages from the McMurdo Dry Valleys, is probably Early to Mid-Miocene in the range 14–20 Ma. The tundra biome, including *A. balli*, became extinct in the interior of Antarctica about 14 Ma and on the margins of the continent by 10–13 Ma. *A. balli* confirms that trechines were once widely distributed in Gondwana. For *A. balli* and other elements of the tundra biome it appears they continued to inhabit a warmer Antarctica for many millions of years after rifting of Tasmania (45 Ma) and southern South America (31 Ma).

Keywords
Trechini, Carabidae, Antarctica, Miocene

Introduction

Insects are least well-represented in Antarctica than anywhere else on Earth. The living fauna consists of three species of flightless chironomid midges. Two of these are considered native and one is adventive. Molecular analysis confirms that *B. antarctica* and *Eretmoptera murphyi* Schaeffer are closely related in the subfamily Orthocladiinae and represent an ancient Antarctic lineage. *Parochlus steinenii* (Gerke), the third species, is in the subfamily Podonominae and more closely related to an older lineage from Tierra del Fuego and South Georgia (Allegruchi et al. 2006). Both of the native species occur on the west side of the Antarctic Peninsula and offshore islands, and also South Shetland, South Orkney and the South Sandwich Islands (Convey and Block 1996). Only one of them, *Belgica antarctica* Jacobs, 1900, is truly restricted to the Antarctica Peninsula and subantarctic islands. The lack of available moisture, low temperatures and vegetation are considered limiting factors. The furthest south *B. antarctica* is known from is 68°S (Convey and Block 1996).

The fossil record for insects in Antarctica is equally poor. Older records are reviewed by Carpenter (1969). Impressions of wings and distorted bodies in late Paleozoic to middle Mesozoic-aged carbonaceous shales have proved difficult to assign to anything other than the broadest categories e.g. Odonata, Homoptera and Coleoptera. Newer records for insects are from Neogene-aged deposits in the Transantarctic Mountains. They differ from the older insects in that they are pieces of exoskeletal elements, not impressions. A fragment of an elytron, possibly a curculionid, was reported from 14 million year old deposits in the Olympus Range in the McMurdo Dry Valleys (Lewis et al. 2008). Exceptionally well-preserved beetle fragments, including a pronotum covered in fine setae, were reported from a soil profile in the New Mountain area, also in the McMurdo Dry Valleys (Mahaney et al. 2012). The specimens were said to be of Miocene age but because of the preservation of the fine setae we do not accept that the specimens are fossil. Most probably they represent parts of a modern beetle that had contaminated the sample in storage in North America before analysis.

The fossil trechine we report is from the same stratigraphic horizon as a head and a leg of a listroderine weevil (Ashworth and Kuschel 2003) and the posterior segments of a puparium of a cyclorraphan fly (Ashworth and Thompson 2003)

Location and stratigraphy of the Meyer Desert Formation

The fossils come from the Oliver Bluffs on the Beardmore Glacier which is a major outlet glacier of the East Antarctic Ice Sheet. The site is within the Transantarctic

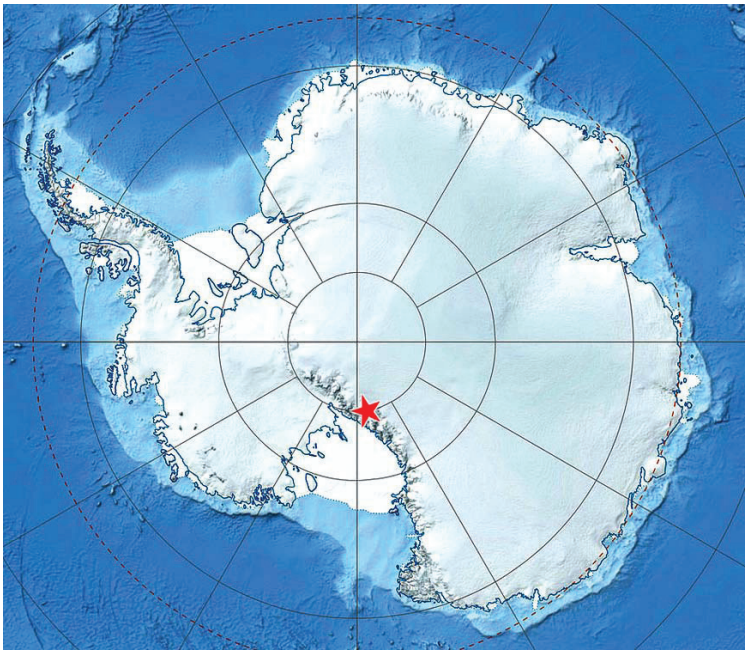

Figure 1. The type locality for *Antarctotrechus balli* sp. n. is shown by the red star. Image map is a modified MODIS Mosaic of Antarctica from National Snow and Ice Data Center, http://nsidc.org/data/moa/

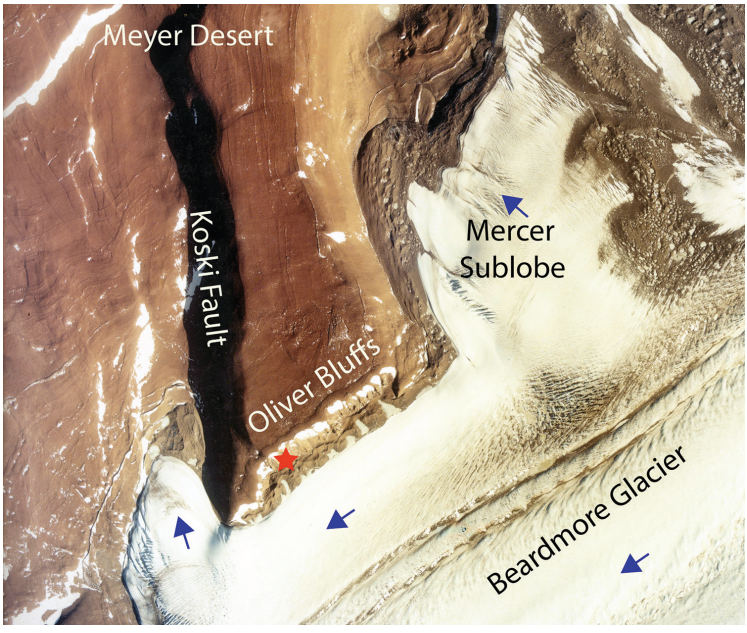

Figure 2. An aerial view of the Oliver Bluffs on the Beardmore Glacier. Ice flow directions are shown by the blue arrows. The Meyer Desert Formation is downthrown to the north along the Koski Fault. The type locality for *A.balli* sp. n. is shown by a red star. The aerial image # TMA-2738-4 is from the collections of the The United States Antarctic Resource Center (USARC), USGS, Reston, VA.

Figure 3. Ancient glacial deposits of the Meyer Desert Formation exposed in the Oliver Bluffs on the flanks of the Beardmore Glacier. The deposits are downthrown along the Koski fault which is marked by the prominent escarpment towards the north end of the bluffs (left on image). The type locality for *A. balli* sp. n. is at the north end of the bluffs marked by a red star.

Figure 4. The type locality for *A. balli* sp. n. is a siltstone lens within a sequence of lodgement tills exposed in the gulley wall to the left of the person highest in the gully.

Mountains about 550 km from the South Pole (Figure1). As uplift occurred on the flanks of the Ross Sea rift, the Beardmore Glacier became progressively entrenched leaving older glacial deposits on the flanks (Figures 2–4). The present elevation of the Oliver Bluffs is 1731m above msl. However, based on a report of agglutinated foraminifera from the basal deposits at the Oliver Bluffs (Webb et al. 1994), it is probable that the deposits in which *Antarctotrechus balli* and other fossils were preserved accumulated near sea-level on the margins of a fjord. The older glaciogene deposits of the Beardmore Glacier region are referred to as the Mt. Mills, Meyer Desert and Cloudmaker Formations of the Sirius Group, formerly Sirius Formation (McKelvey et al. 1991; Webb et al. 1996). The Meyer Desert Formation is the youngest of these and the only one known to contain *in situ* fossils from terrestrial and freshwater habitats. The trechine fossils come from a siltstone lens located about 20 m above the base of a bluff located at 85.117222°S, 166.657500°E (Figures 2–4).

The lens is interbedded within large boulder diamictites and is part of a horizon containing outwash sandstones and conglomerates, laminated proglacial lake deposits, debris flows, peat beds and shallow lacustrine mudstones. The siltstone lens formed from the infilling of a stream channel. Insect and plant parts were washed or blown into the stream channel which eventually became sediment-choked and finally buried by lodgement till during the next glacial advance down the valley. The Oliver Bluffs stratigraphy supports the interpretation that the stream was part of a broad outwash plain that extended between the glacier margin and the fjord (Ashworth and Cantrill 2004).

Paleoecology

The Oliver Bluffs on the Beardmore Glacier is one of the most important Neogene terrestrial paleontological sites in Antarctica. The possibility that fossils might be found there was first noted by John Mercer. He recognized that the wet-based glacial sediments exposed in the bluffs could only have been deposited at the time when the climate was warmer and wetter than it is now (Mercer 1972). On a later expedition, fossil wood was discovered (Webb and Harwood 1987) and assigned to *Nothofagus* (Carlquist, 1987). This was followed by the discovery of a mat of *Nothofagus* leaves, one-leaf thick. The leaves have similar size and shape to the extant sub-alpine *N. gunnii* from Tasmania. They have a different veination pattern, however, which led to them being described as an extinct species, *N. beardmoreensis* (Hill et al., 1996). An analysis of tree rings of the abundant twig-sized *Nothofagus* wood indicated prostate shrubs rather than trees (Francis and Hill 1996). Pollen from the site is represented by a single species of *Nothofagus*, *N. lachlaniae* (Askin and Markgraf 1986). Other plant fossils from the site, notably abundant achenes of *Ranunculus* and cushion plants of both moss and an angiosperm species, indicate a patchy shrub tundra (Ashworth and Cantrill 2004). The habitat for the new species of trechine was the sparsely vegetated sand and gravel banks of a meltwater-fed stream.

Age of the deposits

Based on the occurrence of marine diatoms within the Sirius Group deposits, their age was reported as Pliocene c. 3 Ma (Webb et al. 1994). This age estimate, however, is controversial and likely too young. Several studies suggest that the diatoms were deposited onto older glacial deposits by wind from Pliocene marine deposits located on the margins of the continent (Scherer et al. 2015). Two lines of evidence from the Oliver Bluffs, one geomorphological and the other palynological, also support an older age for the deposits.

The Meyer Desert Formation at the northern end of the Oliver Bluffs is off-set by splay faults associated with the Koski Fault (Figure 2). Surface exposure ages of Beardmore moraine boulders overlying the Meyer Desert Formation, and offset by faults, are between 1.9-5.8 Ma (Ackert and Kurz 2004). The estimate assumed no erosion and constant elevation leading the authors of the study to conclude that the Meyer Desert Formation had to be much older than c.3 Ma.

Pollen from the Meyer Desert Formation most closely matches an assemblage from near Mount Boreas in the McMurdo Dry Valleys dated by $^{39}Ar/^{40}Ar$ from a volcanic ash to be of mid-Miocene age (14.07 ± 0.05 Ma., Lewis et al. 2008). Also, fossiliferous Neogene deposits in the region of the Friis Hills in the McMurdo Dry Valleys are early to mid-Miocene based on $^{39}Ar/^{40}Ar$ dating (Lewis and Ashworth 2016). We conclude that the best age estimate for the trechine fossils is mid-Miocene. Certainly it is possible that the retreat of glaciers and colonization by a tundra biota correlates with the mid-Miocene climatic optimum, a well-known globally warm climatic event (Flower and Kennett 1995, Warny et al. 2009, Feakins et al. 2012).

Fossil preparation

The fossiliferous siltstone is calcite-cemented which disaggregated after soaking in water. The grains were further separated by washing in a jet of water and those that remained on a 300μ mesh were then examined under a binocular microscope (20×). Fossils picked from the sediment matrix in addition to the trechine elytra included twigs of *Nothofagus* (southern beech) wood, moss stems, seeds of *Ranunculus* (buttercups) (Ashworth and Cantrill 2004).

Description

***Antarctotrechus* Ashworth & Erwin, gen. n.**
http://zoobank.org/698F1D95-6514-4AED-8E6A-F29EBD6C6014

Type species. *Antarctotrechus balli* Ashworth & Erwin, sp. n.

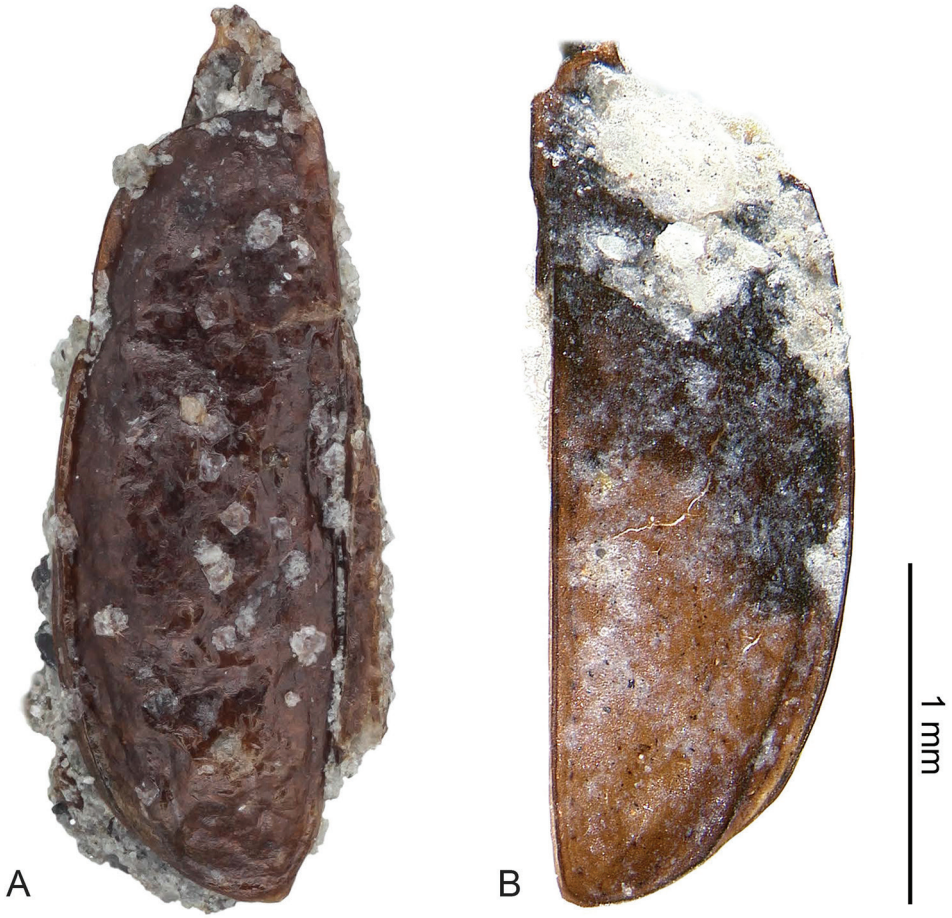

Figure 5. Fossils of the left and right elytra of *A. balli* sp. n. **A** The left elytron, 2.36 mm in length, is designated as the paratype (USNM: ADP147732). A small part of the right elytron of the same individual is attached along the suture near the apex. The siltstone matrix is visible along the outer margin near the apex. The small rhomb-shaped crystals on the surface are authigenic calcite **B** The right elytron is designated as the holotype. (NMNH: ADP147741). The elytron is 2.40 mm in length. The base is deformed by a crack and concealed by sediment grains. A small part of the left elytron of the same individual is still attached along the suture near the base.

***Antarctotrechus balli* Ashworth & Erwin, sp. n.**
http://zoobank.org/B5A220C2-B707-489D-ACCD-03980BD2A231

Holotype (sex unknown), a right elytron. **Antarctica**, Oliver Bluffs, Beardmore Glacier region, Meyer Desert Formation, 85.117222°S, 166.657500°E, (Allan Ashworth 2003) (NMNH: ADP147741).

Derivation of genus name. *Antarctotrechus* refers to its relationship with the Trechini and the place where the specimens were found.

Figure 6. Fossil of right elytron of *A. balli* sp. n. and elytra of three species of Neaustral *Trechisibus* spp. with line drawings of each showing 3rd interval setigerous pores and recurrent grooves of the latter.

Derivation of specific epithet. The epithet, *balli*, is a Latinized eponym based on the family name of George E. Ball, Carabidologist, and academic leader of a host of younger carabidologists, in celebration of his 90th birthday, September 26, 2016.

Proposed english vernacular name. Ball's Antarctic Tundra Beetle.

Diagnosis. Only the left and right elytra known (Figure 5). They are from two individuals. Form as in alate Neaustral trechines in the genus *Trechisibus* Motschulsky 1862. Lack of recurrent groove as in Andean and Pampas trechines in the genera *Oxytrechus* Jeannel, 1927 and *Pseudocnides* Jeannel 1927, respectively. Placement of mid-discal elytral setiferous pore as in *Trechisibus* and other trechines, Placement of preapical in third interneur unique (Figures 6–7). Absence of apical elytral setiferous pore in third interneur unique.

Description. (Figures 5–7). *Size*: Elytron length and width within range of *Trechisibus* species, Length 2.36mm, W = 0.85 mm.

Color: Typically trechine brown.

Luster: Unknown due to deposition and lithification processes over ~ 20 -14 Ma.

Microsculpture: Apparently isodiametric.

Head: Unknown.

Prothorax: Unknown.

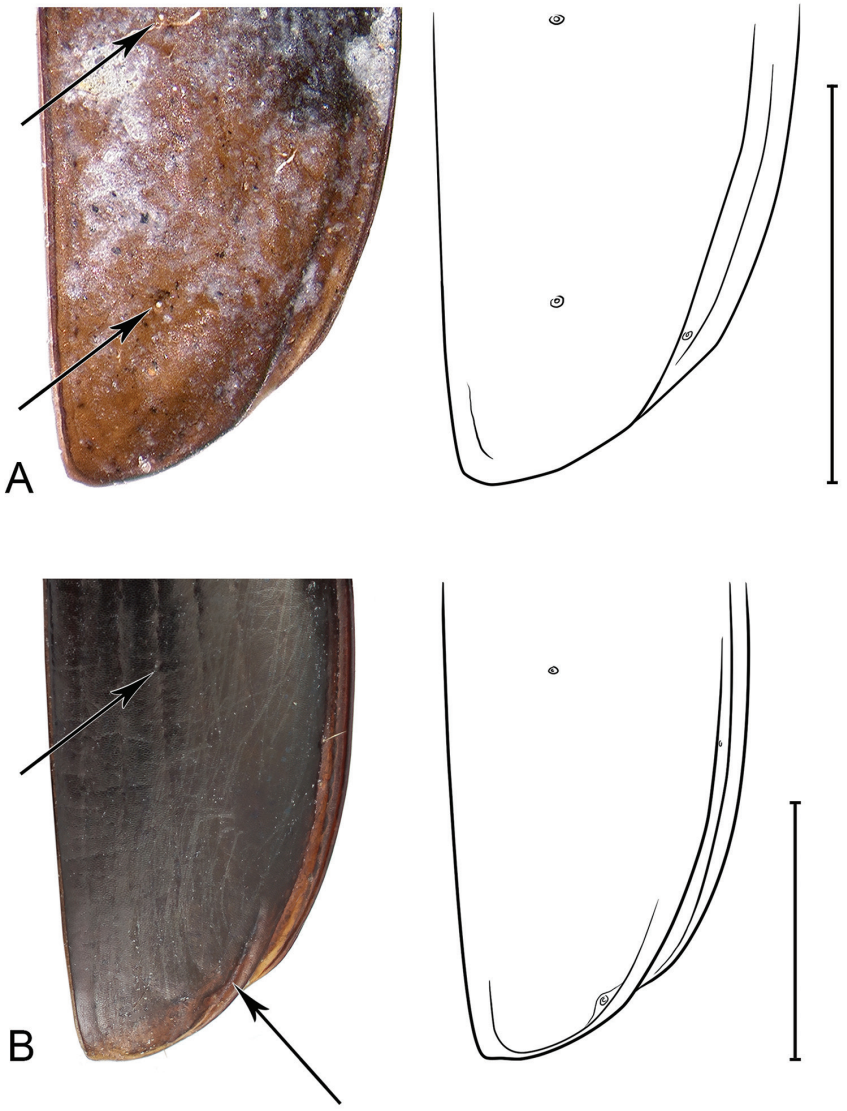

Figure 7. Comparison of the apices of the fossil right elytron *A. balli* sp. n. and a modern *Trechisibus* sp. with line drawings of each showing 3rd interval setigerous pores and recurrent grooves of the latter. An isodiametric microornament is partially visible on the fossil.

Pterothorax: Shape of humerus (compare Figure 5) not sloped, indicating the adult was possibly fully winged.

Legs: Unknown.

Abdomen: Unknown.

Male genitalia: Unknown.

Female genitalia: Unknown.

Dispersal potential. If these beetles were macropterous (see above), they were likely capable of flight. *Trechisibus* adults are moderately swift and agile runners, so likely were adults of *A. balli*. All known species of *Tasmanorites* are brachypterous.

Other specimens examined. A left elytron also from the type locality is designated as the paratype. This specimen is reposited in the collections of the Smithsonian Institution National Museum of Natural History (NMNH:ADP147732).

Systematics and biogeographic significance

Our search for relationships of the fossil species focused on four genera of southern trechines: *Trechisibus* Motschulsky 1862, *Tasmanorites* Jeannel 1927, *Oxytrechus* Jean-

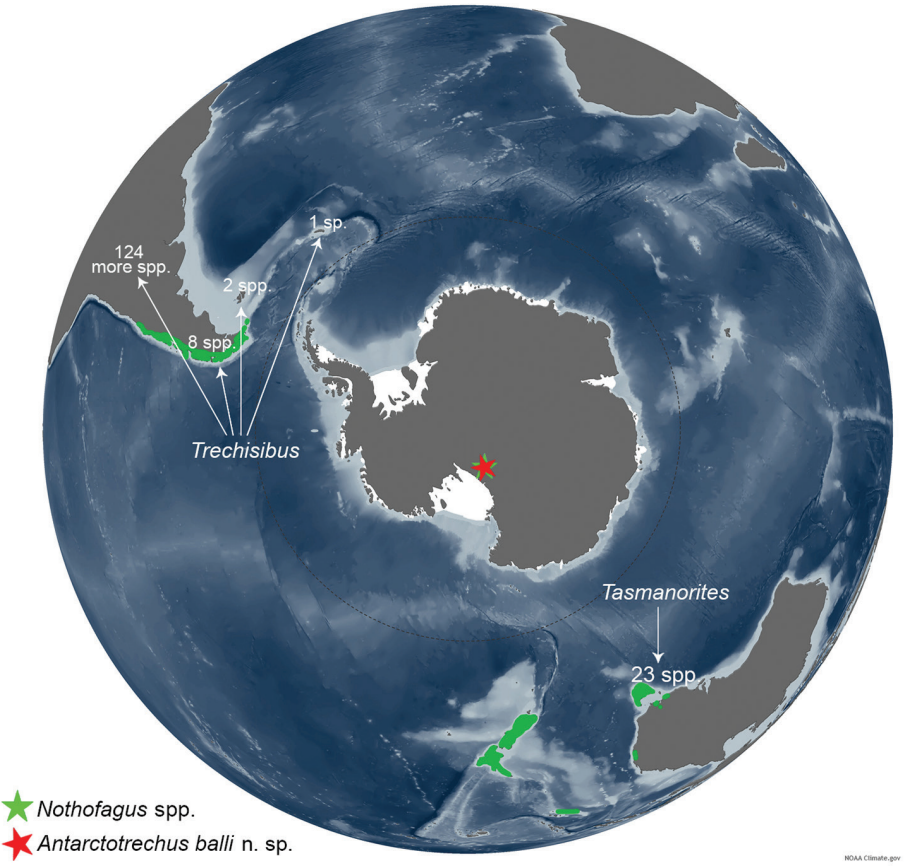

Figure 8. The distribution of extant species of *Trechisibus, Tasmanorites and Nothofagus* and the fossil occurrence of *A. balli* sp. n. and *Nothofagus beardmorensis* on the Beardmore Glacier shown by red and green stars: information for *Trechisibus* species (Allegro et al., 2008) and *Tasmanorites* (Eberhard S, Giachino, PM, 2011). Base image: NOAA Climate.gov https://www.climate.gov/news-features/understanding-climate/polar-opposites-arctic-and-antarctic

nel, 1927, and *Pseudocnides* Jeannel, 1927. *Oxytrechus* and *Pseudocnides* share with the fossil a unique feature in trechines, i.e., lack of a recurrent groove, however, neither is associated with *Nothofagus* (southern beech) forests, rather they are for the most part montane and lowland grassland species (La Puna and La Pampa). In addition, the latter two genera are not truly Neaustral, rather Andean or Pampean.

With the exception of the lack of a recurrent groove, the fossils are similar in size and shape and in the placement of mid-discal elytral setiferous pore to *Trechisibus* and *Tasmanorites*. These genera are very closely related (David Maddison, Oregon State University, pers. comm., based on molecular studies). *Trechisibus* is abundant in the fauna of southernmost South America extending northward to the Andes in Peru and Ecuador. *Tasmanorites* occurs in Tasmania but not on the mainland of Australia or New Zealand. *Trechisibus* and *Tasmanorites* have a circum-Antarctic relationship and both are associated with *Nothofagus* forests, as was the new genus and species *Antarctotrechus balli* (Figure 8).

The conflicting signals both in anatomical attributes and biogeography, and in ecological setting as well, leave open the question of relationships, thus giving us no alternative but to flag the species represented by fossil evidence through erection of new genus status, hence drawing attention to it and the need for further paleontological studies in Antarctica.

The type locality of *A. balli* is midway between Tasmania and southernmost Patagonia (4600 vs 4300 km) suggesting that *Trechisibus-Tasmanorites*-like clades occupied a vast area of the southern land masses prior to ~14 Ma ago (Figure 8). There is no known *Trechisibus-Tasmanorites*- like clade in New Zealand where the southernmost part is only 3 degrees further north than the southernmost part of Tasmania. The absence of the clade in New Zealand adds fuel to the controversial hypothesis that the original Gondwana biota of New Zealand was drowned during marine transgression in the Oligocene and/or the early Miocene (Mildenhall et al. 2014).

Populations of *Antarctotrechus balli* had probably become extinct in the Beardmore Glacier region (lat. 85°S) by ~14 Ma ago, or earlier. Further north in the Olympus Range (lat. 77°S), in the McMurdo Dry Valleys, major climate change at ~14 Ma ago resulted in the extinction of the tundra biota (Lewis et al. 2008). The warmth and moisture needed to support patches of tundra with *Nothofagus*, and populations of *A. balli*, may have persisted on the margins of the continent (lat. 65°S) until 10-13 Ma ago (Anderson et al. 2011, Wei et al. 2013). Eventually, however, the climate became too cold and too dry to support anything but extremophiles.

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References

Ackert RP, Kurz MD (2004) Age and uplift rates of Sirius Group sediments in the Dominion range, Antarctica, from surface exposure dating and geomorphology. Global and Planetary Change 42(1–4): 207–225. doi: 10.1016/j.gloplacha.2004.02.001

Allegro G, Giachino PM, Sciaky R (2008) Notes on some Trechini (Coleoptera Carabidae) of South America with description of new species from Chile, Ecuador and Peru. Biodiversity of South America, I. Memoirs on Biodiversity 1: 131–171.

Allegrucci G, Carchini G, Todisco V, Convey P, Sbordoni V (2006) A molecular phylogeny of Antarctic chironomidae and its implications for biogeographical history. Polar Biology 29: 320–326. doi: 10.1007/s00300-005-0056-7

Anderson JB, Warny S, Askin RA, Wellner JS, Bohaty SM, Kirshner AE, Livsey DN, Simms AR, Smith TR, Ehrmanng W, Lawver LA, Barbeau D, Wise SW, Kulhanek DK, Weaver FM, Majewski W (2011) Progressive Cenozoic cooling and the demise of Antarctica's last refugium. PNAS 108(28): 11356–11360. doi: 10.1073/pnas.1014885108

Ashworth AC, Cantrill DJ (2004) Neogene vegetation of the Meyer desert formation (Sirius Group) Transantarctic Mountains, Antarctica. Palaeogeography Palaeoclimatology Palaeoecology 213(1–2): 65–82. doi: 10.1016/S0031-0182(04)00359-1

Ashworth AC, Kuschel G (2003) Fossil weevils (Coleoptera : Curculionidae) from latitude 85 degrees S Antarctica. Palaeogeography Palaeoclimatology Palaeoecology 191(2): 191–202. doi: 10.1016/S0031-0182(02)00712-5

Ashworth AC, Thompson FC (2003) A fly in the biogeographic ointment. Nature 423: 135–136. doi: 10.1038/423135a

Askin RA, Markgraf V (1986) Palynomorphs from the Sirius Formation, Dominion Range, Antarctica. Antarctic Journal of Science 21(5): 34–35.

Carlquist S (1987) Pliocene *Nothofagus* wood from the Transantarctic Mountains. Aliso 11: 571–583.

Carpenter F (1969) Fossil insects from Antarctica. Psyche 76: 418–425. doi: 10.1155/1969/17070

Convey P, Block W (1996) Antarctic Diptera: Ecology, physiology and distribution. European Journal of Entomology 93(1): 1–13.

Eberhard S, Giachino PM (2011) Tasmanian Trechinae and Psydrinae (Coleoptera, Carabidae): a taxonomic and biogeographic synthesis, with description of new species and evaluation of the impact of Quaternary climate changes on evolution of the subterranean fauna. Subterranean Biology 9: 1–72. doi: 10.3897/subtbiol.9.2516

Feakins SJ, Warny S, Lee J-E (2012) Hydrologic cycling over Antarctica during the middle Miocene warming. Nature Geoscience 5: 557–560. doi: 10.1038/ngeo1498

Flower BP, Kennett JP (1995) Middle Miocene deepwater paleoceanography in the southwest Pacific: relations with East Antarctic ice sheet development. Paleooceanography 10(6): 1095–1112.

Francis JE, Hill RS (1996) Fossil plants from the Pliocene Sirius Group, Transantarctic Mountains: evidence for climate from growth rings and fossil leaves. Palaios 11(4): 389–396. doi: 10.2307/3515248

Hill RS, Harwood DM, Webb P-N (1996) *Nothofagus beardmorensis* (Nothofagaceae), a new species based on leaves from the Pliocene Sirius Group, Transantarctic Mountains, Antarctica. Review of Palaeobotany and Palynology 94(1–2): 11–24. doi: 10.1016/S0034-6667(96)00003-6

Jeannel R (1927) Monographie des Trechinae. Morphologie comparée et distribution géographique d'un groupe de Coléoptères (2em livr). L'Abeille Journal d'Entomologie 33: 1–592.

Jeannel R (1962) Les Trechides de la paléantarctide occidentale. Biologie de L'Amerique Australe 1: 527–655. [Debouteville CD, Rapaport E]

Lewis AR, Ashworth AC (2016) An early to middle Miocene record of ice-sheet and landscape evolution from the Friis Hills, Antarctica. Geological Society of America Bulletin 128(5–6): 719–738. doi: 10.1130/B31319.1

Lewis AR, Marchant DR, Ashworth AC, Hedenäs L, Hemming SR, Johnson JV, Leng ML, Machlus ML, Newton AE, Raine JI, Willenbring JK, Williams M, Wolfe AP (2008) Mid-Miocene cooling and the extinction of tundra in continental Antarctica. PNAS 105(31): 10676–10680. doi: 10.1073/pnas.0802501105

Lorenz W (2005) Systematic list of extant ground beetles of the world (Insecta, Coleoptera "Geadephaga": Trachypachidae and Carabidae incl. Paussinae, Cicinidelinae, Rhysodinae). Privately published, W. Lorenz, Tutzing, 530 pp.

Mercer JH (1972) Some observations on the glacial geology of the Beardmore Glacier area. In: Adie RJ (Ed.) Antarctic Geology and Geophysics, International Union of Geological Sciences Series B –Number 1. Universitetsforlaget, Oslo, 427–433.

Mahaney WC, Hart KM, O'Reilly SS, Allen CCR, Dohm JM, Hancock RGV, Kelleher BP, Milne MW (2012) Coleoptera and microbe biomass in Antarctic Dry Valley paleosols adjacent to the Inland Ice: Implications for Mars. Planetary and Space Science 60(1): 386–389. doi: 10.1016/j.pss.2011.11.008

McKelvey BC, Webb P-N, Harwood DM, Mabin MCG (1991) The Dominion Range Sirius Group: A record of the late Pliocene-early Pleistocene Beardmore Glacier. In: Thomson MRA, Crame JA, Thomson JW (Eds) Geological evolution of Antarctica. Cambridge University Press, Cambridge, 675–682.

Mildenhall DC, Mortimer N, Bassett KN, Kennedy EM (2014) Oligocene paleogeography of New Zealand: maximum marine transgression. New Zealand Journal of Geology and Geophysics 57(2): 107–109. doi: 10.1080/00288306.2014.904587

Moore BP (1972) A revision of the Australian Trechinae (Coleoptera: Carabidae). Australian Journal of Zoology, Supplement No. 18: 1–61.

Motschulsky V de (1862a) Entomologie speciale. Remarques sur al collection d'insectes de V. de Motschulsky. Coléoptères. Études Entomologiques 11: 15–55.

Scherer RP, DeConto RM, Pollard D, Alley RB (2016) Windblown Pliocene diatoms and East Antarctic Ice Sheet retreat. Nature Communications 12957. doi: 10.1038/ncomms12957

Warny S, Askin RA, Hannah MJ, Moh BAR, Raine JI, Harwood DM, Florindo F, SMS Science Team (2009) Palynomorphs from a sediment core reveal a sudden remarkably warm Antarctica during the middle Miocene. Geology 37(10): 955–958. doi: 10.1130/G30139A

Webb P-N, Harwood DM (1987) Late Neogene terrestrial flora of Antarctica. Its significance in interpreting Late Cenozoic glacial history. Antarctic Journal of the United States 22: 7–11.

Webb P-N, Harwood DM, Mabin MGC, McKelvey BC (1994) Late Neogene uplift of the Transantarctic Mountains in the Beardmore Glacier region. Terra Antarctica 1(2): 463–467.

Webb P-N, Harwood DM, Mabin MGC, McKelvey BC (1996) A marine and terrestrial Sirius group succession, middle Beardmore glacier Queen Alexandra range, Transantarctic mountains, Antarctica. Marine Micropaleontology 27(1–4): 273–297. doi: 10.1016/0377-8398(95)00066-6

Wei LJ, Raine JI, Liu XH (2013) Terrestrial palynomorphs of the Cenozoic Pagodroma Group, northern Prince Charles Mountains, East Antarctica. Antarctic Science 26(1): 69–70. doi: 10.1017/S0954102013000278

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RESEARCH ARTICLE

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A taxonomic revision of *Neoserica* (*sensu lato*): the species groups *N. lubrica*, *N. obscura*, and *N. silvestris* (Coleoptera, Scarabaeidae, Sericini)

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Abstract

The species of the *Neoserica lubrica* Brenske, 1898, *N. obscura* (Blanchard, 1850) and *N. silvestris* Brenske, 1902 species groups are revised. The study resulted in the following new synonymies and combinations: *Neoserica obscura* (Blanchard, 1850) = *Microserica roeri* Frey, 1972, **syn. n.**, = *Maladera chinensis* (Arrow, 1946), **syn. n.**; *Neoserica hainana* (Brenske, 1898), **comb. n.**, and *Neoserica minor* (Arrow, 1946), **comb. n.** The known species are redescribed. The following nine new species are described from China: *N. allobscura* Ahrens, Fabrizi & Liu, **sp. n.**, *N. dongjiafenensis* Ahrens, Fabrizi & Liu, **sp. n.**, *N. fugongensis* Ahrens, Fabrizi & Liu, **sp. n.**, *N. mantillerii* Ahrens, Fabrizi & Liu, **sp. n.**, *N. menglunensis* Ahrens, Fabrizi & Liu, **sp. n.**, *N. pseudosilvestris* Ahrens, Fabrizi & Liu, **sp. n.**, *N. sakoliana* Ahrens, Fabrizi & Liu, **sp. n.**, *N. shuyongi* Ahrens, Fabrizi & Liu, **sp. n.**, and *N. tahianensis* Ahrens, Fabrizi & Liu, **sp. n.** A key to the Sericini genera with multilamellate antenna, species groups of *Neoserica* of mainland Asia, and species of the species groups examined here are provided. Maps of the species distribution are provided, habitus and male genitalia are illustrated.

Keywords

Beetles, chafers, *Neoserica*, China, new species, new records

Introduction

In the course of the revision of the species-rich genus *Neoserica* Brenske, 1894, of China a series of papers was published recently (Ahrens et al. 2014a–c, Liu et al. 2014a–c, 2015). In continuation of this work, here we present the results of the revision of the *Neoserica lubrica*, *N. obscura* and *N. silvestris* species groups.

As shown earlier (Ahrens 2003, 2004), *Neoserica* (*sensu lato*) comprises a polyphyletic mix of the larger species with multi-lamellate antenna (Liu et al. 2015) which require a revision of their nomenclature once their taxonomy, morphology, and phylogeny are better known. Apart from a number of new and interesting locality records, examined material also contained a number of new species which are described herein.

Material and methods

The terminology and methods used for measurements, specimen dissection and genital preparation follow Ahrens (2004). Data from specimens examined are cited in the text with original label contents given in quotation marks, multiple labels are separated by a "/". Descriptions and illustrations of the new taxa are based on the holotype if not otherwise stated, while the variation of specimens is given separately under "variation". Remarks of the authors and comments are indicated in square brackets. Male genitalia were glued to a small pointed card and photographed in both lateral and dorsal view using a stereomicroscope Leica M125 with a Leica DC420C digital camera or a Zeiss AxioCam HRc digital camera mounted on a Zeiss Stereo Discovery.V20 stereomicroscope. With the Automontage software, a number of serial images were combined in order to obtain an entirely focused image. The resulting images were subsequently digitally edited in Artweaver (www.artweaver.de).

Abbreviations used in the text for the collection depositories are as follows:

BMNH Natural History Museum, London, UK;
BPBM Bernice P. Bishop Museum, Honolulu, USA;
CN collection M. Nikodým, Prague, Czech Republic;
CP collection P. Pacholátko, Brno, Czech Republic;
CS collection G. Sabatinelli, Prevessin, France;
HBUM Museum of Hebei University, Baoding, Hebei Province, China;
IZAS Institute of Zoology, Chinese Academy of Sciences, Beijing, China;
MHNG Muséum d'Histoire Naturelle, Genève, Switzerland;
MNHN Museum national d'Histoire naturelle, Paris, France;
NHMW Naturhistorisches Museum Wien; Austria;
NHRS Naturhistoriska Riksmuseet Stockholm, Sweden;
NMPC National Museum Prague (Natural History), Prague, Czech Republic;
NWAFU Northwest A & F University, Yangling, Shaanxi Province, China;
SMFD Senckenbergmuseum, Frankfurt Main, Germany;

SNUC Shanghai Normal University, Department of Biology, China;
SYUG Sun Yat-Sen University, Guangzhou, China;
USNM National Museum of Natural History, Washington D.C., U.S.A.;
ZFMK Zoologisches Forschungsmuseum A. Koenig, Bonn, Germany;
ZMHB Museum für Naturkunde, Berlin, Germany.

Results

Key to the Sericini genera and *Neoserica* species groups with multi-lamellate antennal club (the key is so far suitable only for species known with both sexes):

1 Hypomeron not carinate..... ***Tetraserica* Ahrens, 2004**
– Hypomeron carinate..... **2**
2 Antennal club in female composed of 3 antennomeres..... **3**
– Antennal club in female composed of more than 3 antennomeres..... **16**
3 Posterior margin of metafemur serrate ventrally and dorsally..... **4**
– Posterior margin of metafemur smooth ventrally..... **7**
4 Anterior angles of pronotum obsolete..... **5**
– Anterior angles of pronotum acute and moderately produced..... ***Neoserica* (s.l.) *calva* group**
5 Dorsal surface nearly glabrous..... ***Gastroserica* Brenske, 1897**
– Dorsal surface densely setose..... **6**
6 Metatibia beside dorsal margin with a serrated longitudinal line or carina..... ***Neoserica* (s.str.) Brenske, 1894**
– Metatibia beside dorsal margin without a serrated longitudinal line or carina..... ***Calloserica* Brenske, 1894**
7 Metatibia beside dorsal margin with a serrated longitudinal line or carina..... **8**
– Metatibia beside dorsal margin without a serrated longitudinal line or carina... **9**
8 Metatibia with one group of robust spines..... ***Lasioserica* Brenske, 1896**
– Metatibia with two groups of robust spines..***Neoserica* (s.l.) *silvestris* group**
9 Antennal club in males long and reflexed.....***Anomalophylla* Reitter, 1887**
– Antennal club in males short or moderately long and straight..... **10**
10 Protibia bidentate..... **11**
– Protibia tridentate..... ***Trioserica* Moser, 1922**
11 Elytra bicolored, yellowish or reddish brown and black..... **12**
– Elytra unicolored..... **13**
12 Parameres symmetrical..... ***Oxyserica* Brenske, 1900**
– Parameres asymmetrical..... ***Microserica* Brenske, 1894**
13 Apex of metatibia shallowly truncate at interior apex near tarsal articulation... **14**
– Apex of metatibia sharply truncate at interior apex near tarsal articulation... **15**
14 Dorsal surface yellowish brown to reddish brown, strongly and simply shiny..... ***Neoserica* (s.l.) *lubrica* group**

– Dorsal surface dull or iridescent shiny..... ***Neoserica* (s.l.) *vulpes* group, other *Neoserica* (s.l.)**
15 Pronotum and elytra always nearly glabrous ..... ***Sericania* Motschulsky, 1860** (see also couplet 21)
– Pronotum and elytra always distinctly setose... ***Gynaecoserica* Brenske, 1896**
16 Labrum without a transverse rim of very dense, short and robust setae **17**
– Labrum short, with a transverse rim of very dense, short and robust setae. Dorsal surface densely setose..... ***Neoserica* (s.l.) *pilosula* group**
17 Metatibia slender and long..... **19**
– Metatibia short and wide **18**
18 Body smaller 8.5 mm..... ***Neoserica* (s.l.) *obscura* group**
– Body larger 9 mm ..... ***Neoserica* (s.l.) *uniformis* group** & ***N.* (s.l.) *multifoliata* group** (from Indochina)
19 Antennal club of males with 7 antennomeres..... **20**
– Antennal club of males with 6 or less antennomeres **21**
20 Metafemur with a continuously serrated line adjacent to the anterior margin of metafemur. Protibia more or less distinctly tridentate..... ***Neoserica* (s.l.) *septemlamellata* group**
– Metafemur without a continuously serrated line adjacent to the anterior margin of metafemur. Protibia always distinctly bidentate ..... ***Nepaloserica* Frey, 1965**
21 Basis of labroclypeus dull. Antennal club of males with 6 antennomeres... **22**
– Antennal club of males with 5 or 4 antennomeres..... **23**
22 Angle between basis of hypomeron and that of pronotum strongly rounded, angle between surfaces of hypomeron and pronotum basally blunt. Hypomeron basally strongly produced ventrally and transversely sulcate ..... ***Lepidoserica* Nikolaev, 1979**
– Angle between basis of hypomeron and that of pronotum sharp, angle between surfaces of hypomeron and pronotum sharp. Hypomeron basally not produced ventrally and not sulcate..... ***Neoserica* (s.l.) *abnormis* group**
23 Apex of metatibia shallowly truncate at interior apex near tarsal articulation..... **24**
– Apex of metatibia deeply truncate at interior apex near tarsal articulation..... ***Sericania* Motschulsky, 1860** (see 14)
24 Body surface strongly shiny. Body smaller (5.7–6.6 mm)..... ***Neoserica* (s.l.) *speciosa* group**
– Body surface dull. Body larger (8 mm) ..... ***Chrysoserica* Brenske, 1897**

Neoserica lubrica group

Diagnosis. Body small (6–8 mm), oval, moderately convex; often unicoloured yellowish to reddish brown, entire dorsal surface strongly shiny and glabrous. Antenna with 10 antennomeres, yellow; antennal club of ♂ composed of 4–5 antennomeres, in ♀

of 3 antennomeres. Base of hypomeron carinate. Protibia bidentate. Metatibia at apex moderately sinuate near tarsal articulation. Metafemur without serrated line adjacent to anterior margin. Metatibia moderately wide, without serrated longitudinal line.

Remarks. The species group was based on *Neoserica lubrica* Brenske, 1898 (Ahrens 2004) to accommodate the species closely related to *N. lubrica* (from Myanmar).

Distribution. Eastern Himalaya and northeastern India, southern China and Indochina.

Key to the Chinese species of the *Neoserica lubrica* group:

1 Labrum without densely setose carina **2**
– Labrum with densely setose carina ....***N. menglunensis*** **Ahrens, Fabrizi & Liu, sp. n.**
2 Distal hook of left paramere nearly half as long as paramere itself **3**
– Distal hook of left paramere shorter than one quarter of length of paramere itself..... ***N. dongjiafenensis*** **Ahrens, Fabrizi & Liu, sp. n.**
3 Distal hook of left paramere strongly curved and at apex bent backwards ....***N. mantillerii*** **Ahrens, Fabrizi & Liu, sp. n.**
– Distal hook of left paramere moderately curved and at apex bent externally only .....***N. fugongensis*** **Ahrens, Fabrizi & Liu, sp. n.**

Neoserica **(s.l.)** ***fugongensis*** **Ahrens, Fabrizi & Liu, sp. n.**
http://zoobank.org/9E36767D-BF22-422D-AC35-0AC1E88ECF75
Figs 1A–D, 6

Type material examined. Holotype: ♂ "China (Yunnan) Nujiang Lisu Aut. Pref., Salween side valley, 5 km S Fugong, road SS228, km 223 (creek bank, litter sifted) 8.VI.2007 leg. D. Wrase/ X-DA1554" (ZFMK).

Diagnosis. The new species has the genitalia similar in shape to *N. incompta* Ahrens & Fabrizi, 2009, but *N. fugongensis* differs by the lens-shaped labrum and lacking the anterior fringe of dense setae on the labrum.

Description. Body length: 6.7 mm, length of elytra: 4.5 mm, body width: 3.7 mm. Body oval, yellowish brown, dorsal surface strongly shiny and glabrous.

Labroclypeus subtrapezoidal, distinctly wider than long, widest at base, lateral margins nearly straight, convergent anteriorly, anterior angles strongly rounded, anterior margin very shallowly sinuate medially, margins moderately reflexed; surface convexly elevated at centre, shiny, finely and sparsely punctate, with a few single setae anteriorly; frontoclypeal suture distinctly incised, slightly elevated and weakly curved; smooth area anterior to eye weakly convex, approximately 1.5 times as wide as long; ocular canthus short and narrow (1/3 of ocular diameter), impunc-

tate, with one terminal seta. Frons with fine and sparse punctures, with a few long erect setae beside eyes and on posterior half of frons. Eyes large, ratio diameter/ interocular width: 0.69. Antenna with ten antennomeres, club with five antennomeres and straight, slightly longer than remaining antennomeres combined. Mentum elevated and convex anteriorly. Labrum short, lens-shaped in anterior view, not produced medially, with shallow median sinuation and without densely setose anterior margin.

Pronotum moderately transverse, widest shortly behind middle, lateral margins evenly convex and weakly convergent towards base, more strongly convergent anteriorly; anterior angles distinctly produced and sharp, posterior angles blunt and weakly rounded at tip; anterior margin straight, with a fine complete marginal line; surface moderately densely and finely punctate, glabrous; lateral and anterior border sparsely setose; hypomeron distinctly carinate basally, not produced ventrally. Scutellum narrow, triangular, with fine, dense punctures, impunctate on basal midline, glabrous.

Elytra oval, widest at posterior third, striae finely impressed, finely and densely punctate, intervals nearly flat, with sparse, fine punctures concentrated along striae, glabrous; epipleural edge fine, ending at widely rounded external apical angle of elytra, epipleura densely setose, apical border with a fine fringe of microtrichomes (visible at 100× magnification).

Ventral surface shiny, finely and densely punctate, metasternum glabrous; metacoxa glabrous, with a few single setae laterally; abdominal sternites finely and densely punctate, with a transverse row of coarse punctures, each bearing a short robust seta. Mesosternum between mesocoxae as wide as the mesofemur. Ratio of length of metepisternum/ metacoxa: 1/ 1.55. Pygidium moderately convex and shiny, finely and sparsely punctate, without smooth midline, with a few long setae along apical margin.

Legs short; femora shiny, with two rudimentary longitudinal rows of setae, superficially and sparsely punctate, glabrous; metafemur with anterior margin acute, without serrated line behind anterior edge, posterior margin smooth ventrally in apical half only weakly widened, posterior margin smooth dorsally. Metatibia moderately wide and short, widest at middle, ratio of width/ length: 1/ 2.8; dorsal margin sharply carinate, with two groups of spines, basal group at one third, apical group at two thirds of metatibial length, basally with a few short single setae; lateral face weakly convex, finely and very sparsely punctate, smooth along the middle; ventral edge finely serrated, with three robust nearly equidistant setae; medial face smooth, apex interiorly near tarsal articulation bluntly truncate. Tarsomeres ventrally with sparse, short setae, smooth, neither laterally nor dorsally carinate; metatarsomeres with a strongly serrated ridge ventrally, smooth; first metatarsomere slightly shorter than following two tarsomeres combined and distinctly longer than dorsal tibial spur. Protibia moderately long, bidentate, distal tooth sharply pointed at apex; anterior claws symmetrical, basal tooth of inner claw sharply truncate at apex.

Aedeagus: Fig. 1A–C. Habitus: Fig. 1D. Female unknown.

Etymology. This new species is named with reference to its type locality, Fugong.

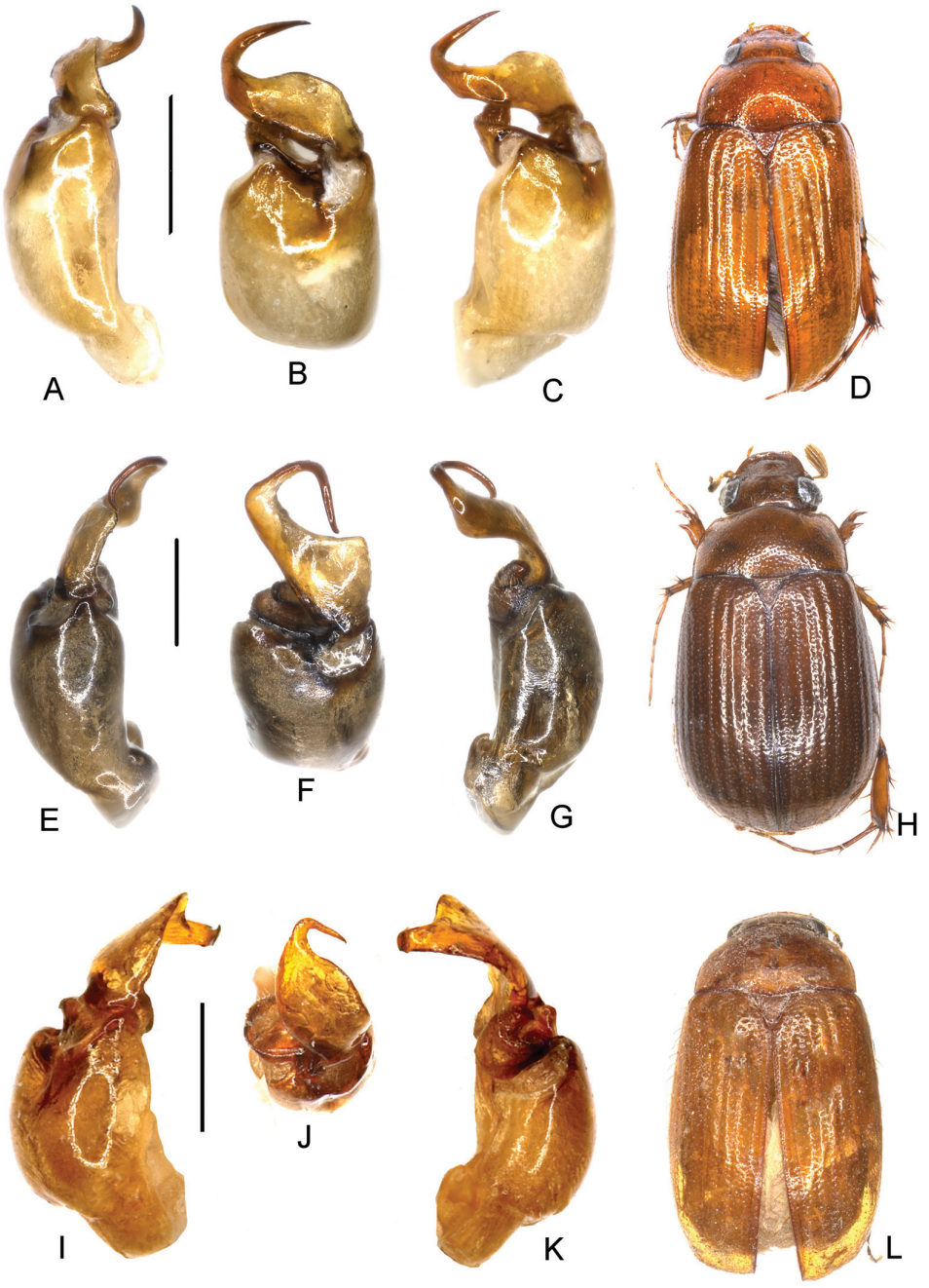

Figure 1. A–D *Neoserica fugongensis* Ahrens, Fabrizi & Liu, sp. n. (holotype) **E–H** *N. mantillieri* Ahrens, Fabrizi & Liu, sp. n. (holotype) **I–L** *N. dongjiafenensis* Ahrens, Fabrizi & Liu, sp. n. (holotype) **A, E** aedeagus, left side lateral view **C, G** aedeagus, right side lateral view **B, F** parameres, dorsal view **D, H** habitus. Scale bars: 0.5 mm. Habitus not to scale.

***Neoserica* (s.l.) *mantillerii* Ahrens, Fabrizi & Liu, sp. n.**
http://zoobank.org/83803BBD-4FB9-4691-B8A7-9DA3267CBCF9
Figs 1E–H, 6

Type material examined. Holotype: ♂ "CHINE - Yunnan Tongbinguan 24°36'N, 97°35'E alt. 1180m/ Museum Paris 13.VI.2001 Deuve, Mantilleri, Rougerie & Tian leg." (MNHN).

Diagnosis. The new species is very similar to *Neoserica fugongensis* in the shape of the genitalia and in external appearance, but *N. mantillierii* differs by the shape of the left paramere: it is longer and its external margin has a blunt angle in the middle, its apex is hook-like and strongly bent backwards.

Description. Body length: 6.8 mm, length of elytra: 4.5 mm, body width: 3.7 mm. Body oval, yellowish brown, dorsal surface strongly shiny and glabrous.

Labroclypeus subtrapezoidal, distinctly wider than long, widest at base, lateral margins nearly straight, convergent anteriorly, anterior angles strongly rounded, anterior margin very shallowly sinuate medially, margins moderately reflexed; surface convexly elevated at centre, shiny, finely and sparsely punctate, with a few single setae anteriorly; frontoclypeal suture distinctly incised, slightly elevated and weakly curved; smooth area anterior to eye weakly convex, approximately 1.5 times as wide as long; ocular canthus short and narrow (1/3 of ocular diameter), impunctate, with one terminal seta. Frons with fine and sparse punctures, with a few long erect setae beside eyes and on posterior half of frons. Eyes large, ratio diameter/ interocular width: 0.69. Antenna with ten antennomeres, club with five antennomeres and straight, slightly longer than remaining antennomeres combined. Mentum elevated and convex anteriorly. Labrum short, lens-shaped in anterior view, not produced medially, with shallow median sinuation and without densely setose anterior margin.

Pronotum moderately transverse, widest shortly behind middle, lateral margins evenly convex and weakly convergent towards base, more strongly convergent anteriorly; anterior angles distinctly produced and sharp, posterior angles blunt and weakly rounded at tip; anterior margin weakly convex, with a fine complete marginal line; surface moderately densely and finely punctate, glabrous; lateral and anterior border sparsely setose; hypomeron distinctly carinate basally, not produced ventrally. Scutellum narrow, triangular, with fine, dense punctures, impunctate on basal midline, glabrous.

Elytra oval, widest at posterior third, striae finely impressed, finely and densely punctate, intervals nearly flat, with sparse, fine punctures concentrated along striae, glabrous; epipleural edge fine, ending at widely rounded external apical angle of elytra, epipleura densely setose, apical border with a fine fringe of microtrichomes (visible at 100× magnification).

Ventral surface shiny, finely and densely punctate, metasternum glabrous; metacoxa glabrous, with a few single setae laterally; abdominal sternites finely and densely punctate, with a transverse row of coarse punctures, each bearing a short robust seta. Mesosternum between mesocoxae as wide as the mesofemur. Ratio of length of me-

tepisternum/ metacoxa: 1/ 1.42. Pygidium moderately convex and shiny, finely and sparsely punctate, without smooth midline, with a few long setae along apical margin.

Legs short; femora shiny, with two rudimentary longitudinal rows of setae, superficially and sparsely punctate, glabrous; metafemur with anterior margin acute, without serrated line behind anterior edge, posterior margin smooth ventrally in apical half only weakly widened, posterior margin smooth dorsally. Metatibia moderately wide and short, widest at middle, ratio of width/ length: 1/ 2.8, dorsal margin sharply carinate, with two groups of spines, basal group at one third, apical group at three quarters of metatibial length, basally with a few short single setae; lateral face weakly convex, finely and sparsely punctate, smooth along the middle; ventral edge finely serrated, with three robust nearly equidistant setae; medial face smooth, apex interiorly near tarsal articulation bluntly truncate. Tarsomeres ventrally with sparse, short setae, smooth, neither laterally nor dorsally carinate; metatarsomeres with a strongly serrated ridge ventrally, smooth; first metatarsomere slightly shorter than following two tarsomeres combined and distinctly longer than dorsal tibial spur. Protibia moderately long, bidentate, distal tooth sharply pointed at apex; anterior claws symmetrical, basal tooth of inner claw sharply truncate at apex.

Aedeagus: Fig. 1E–G. Habitus: Fig. 1H. Female unknown.

Etymology. This new species is named after one of its collectors, Mr. Mantilleri, who provided us with a series of unidentified specimens from his expedition to China.

***Neoserica* (s.l.) *dongjiafenensis* Ahrens, Fabrizi & Liu, sp. n.**
http://zoobank.org/355E6236-4249-4A86-8915-462111D2939F
Figs 1I–L, 6

Type material examined. Holotype: ♂ "Dongjiafen, Jingdong, Yunnan, 16.VI.1956, leg. Zaguljaev" (IZAS). Paratype: 1 ♂ "Jingdong, Yunnan, 23.VI.1956, light trap, leg. Krshzhanovsknja" (ZFMK).

Diagnosis. The new species is in shape of genitalia and in external appearance very similar to *Neoserica fugongensis* and *N. mantillierii* but differs distinctly in the shape of the left paramere: the distal hook in *N. dongjiafenensis* is much shorter compared to the total length of the paramere whose basal portion is nearly as wide as long and nearly lobiform.

Description. Body length: 6.4 mm, length of elytra: 4.5 mm, body width: 3.5 mm. Body oval, yellowish brown, dorsal surface strongly shiny and glabrous.

Labroclypeus subtrapezoidal, distinctly wider than long, widest at base, lateral margins nearly straight, convergent anteriorly, anterior angles strongly rounded, anterior margin very shallowly sinuate medially, margins moderately reflexed; surface convexly elevated at centre, shiny, finely and sparsely punctate, with a few single setae anteriorly; frontoclypeal suture distinctly incised, slightly elevated and weakly curved; smooth area anterior to eye weakly convex, approximately 1.5 times as wide as long; ocular canthus short and narrow (1/3 of ocular diameter), impunctate, with one terminal seta.

Frons with fine and sparse punctures, with a few long erect setae beside eyes and on posterior half of frons. Eyes moderately large, ratio diameter/ interocular width: 0.6. Antenna with ten antennomeres, club with five antennomeres and straight, as long as remaining antennomeres combined. Mentum elevated and convex anteriorly. Labrum short, lens-shaped in anterior view, not produced medially, with shallow median sinuation and without densely setose anterior margin.

Pronotum moderately transverse, widest at base, lateral margins evenly convex and weakly convergent anteriorly; anterior angles distinctly produced and sharp, posterior angles blunt and weakly rounded at tip; anterior margin weakly convex, with a fine complete marginal line; surface moderately densely and finely punctate, glabrous; lateral and anterior border sparsely setose; hypomeron distinctly carinate basally, not produced ventrally. Scutellum narrow, triangular, with fine, moderately dense punctures, impunctate on basal midline, glabrous.

Elytra oval, widest at posterior third, striae finely impressed, finely and densely punctate, intervals nearly flat, with sparse, fine punctures concentrated along striae, glabrous except a few long setae on penultimate lateral interval; epipleural edge fine, ending at widely rounded external apical angle of elytra, epipleura densely setose, apical border with a fine fringe of microtrichomes (visible at 100× magnification).

Ventral surface shiny, finely and densely punctate, metasternum glabrous; metacoxa glabrous, with a few single setae laterally; abdominal sternites finely and densely punctate, with a transverse row of coarse punctures, each bearing a short robust seta. Mesosternum between mesocoxae as wide as the mesofemur. Ratio of length of metepisternum/ metacoxa: 1/ 1.64. Pygidium moderately convex and shiny, finely and sparsely punctate, without smooth midline, with a few long setae along apical margin.

Legs short; femora shiny, with two rudimentary longitudinal rows of setae, superficially and sparsely punctate, glabrous; metafemur with anterior margin acute, without serrated line behind anterior edge, posterior margin smooth ventrally in apical half only weakly widened, posterior margin smooth dorsally. Metatibia moderately wide and short, widest at middle, ratio of width/ length: 1/ 2.8, dorsal margin sharply carinate, with two groups of spines, basal group at one third, apical group at three quarters of metatibial length, basally with a few short single setae; lateral face weakly convex, finely and sparsely punctate, smooth along the middle; ventral edge finely serrated, with three robust nearly equidistant setae; medial face smooth, apex interiorly near tarsal articulation bluntly truncate. Tarsomeres ventrally with sparse, short setae, smooth, neither laterally nor dorsally carinate; metatarsomeres with a strongly serrated ridge ventrally, smooth; first metatarsomere distinctly shorter than following two tarsomeres combined and slightly longer than dorsal tibial spur. Protibia moderately long, bidentate, distal tooth sharply pointed at apex; anterior claws symmetrical, basal tooth of inner claw sharply truncate at apex.

Aedeagus: Fig. 1I–K. Habitus: Fig. 1L. Female unknown.

Etymology. The name of the new species is derived from the type locality, Dongjiafen.

Variation. Body length: 5.3–6.4 mm, length of elytra: 4.2–4.5 mm, body width: 3.4–3.5 mm.

***Neoserica* (s.l.) *menglunensis* Ahrens, Fabrizi & Liu, sp. n.**
http://zoobank.org/7F36A5E3-BACF-45F0-90B4-09671F612ACC
Figs 2A–D, 6

Type material examined. Holotype: ♂ "[China] Menglun, Yunnan, 19.V.1991, leg. Wang Yinglun, Tian Binggang" (NWAFU). Paratype: 1 ♂ "[China] Guangxi, Shangsi Shiwandashan 2011-VII-7, 263m" (IZAS).

Diagnosis. *Neoserica menglunensis* Ahrens, Fabrizi & Liu sp. n. differs from all other Chinese species of the *N. lubrica* group by the presence of a transverse rim of dense setae on the anterior margin of labrum, and also by the shape of parameres: the left paramere is narrow and long (5 times as long as wide), and sharply pointed at its apex.

Description. Body length: 5.5 mm, length of elytra: 4.0 mm, body width: 3.7 mm. Body oval, yellowish brown, dorsal surface strongly shiny and glabrous.

Labroclypeus short and subtrapezoidal, distinctly wider than long, widest at base, lateral margins nearly straight, convergent anteriorly, anterior angles moderately rounded, anterior margin broadly sinuate medially, margins moderately reflexed; surface nearly flat, shiny, finely and sparsely punctate, with a few single setae anteriorly; frontoclypeal suture distinctly incised, slightly elevated and weakly curved; smooth area anterior to eye weakly convex, approximately 1.5 times as wide as long; ocular canthus short and narrow (1/3 of ocular diameter), impunctate, with one terminal seta. Frons with fine and moderately dense punctures, with a few long erect setae beside eyes and behind frontoclypeal suture. Eyes moderately large, ratio diameter/interocular width: 0.64. Antenna with ten antennomeres, club with five antennomeres and straight, slightly shorter than remaining antennomeres combined. Mentum elevated and convex anteriorly. Labrum short, nearly lens-shaped in anterior view, not produced medially, with shallow median sinuation and with a rim of dense setae near anterior margin.

Pronotum moderately transverse, widest at base, lateral margins in basal half nearly straight and moderately convergent to middle, evenly convex and weakly convergent anteriorly; anterior angles distinctly produced and sharp, posterior angles blunt and weakly rounded at tip; anterior margin weakly convex, with a fine complete marginal line; surface moderately densely and finely punctate, glabrous; lateral and anterior border sparsely setose; hypomeron distinctly carinate basally, not produced ventrally. Scutellum narrow, triangular, with fine, moderately dense punctures, impunctate on basal midline, glabrous.

Elytra oval, widest at posterior third, striae finely impressed, finely and densely punctate, intervals nearly flat, with sparse, fine punctures concentrated along striae, glabrous except a few long setae on penultimate lateral interval; epipleural edge fine, ending at widely rounded external apical angle of elytra, epipleura densely setose, apical border without a fine fringe of microtrichomes (visible at 100× magnification).

Ventral surface shiny, finely and densely punctate, metasternum glabrous; metacoxa glabrous, with a few single setae laterally; abdominal sternites finely and densely punctate, with a transverse row of coarse punctures, each bearing a short robust seta. Mes-

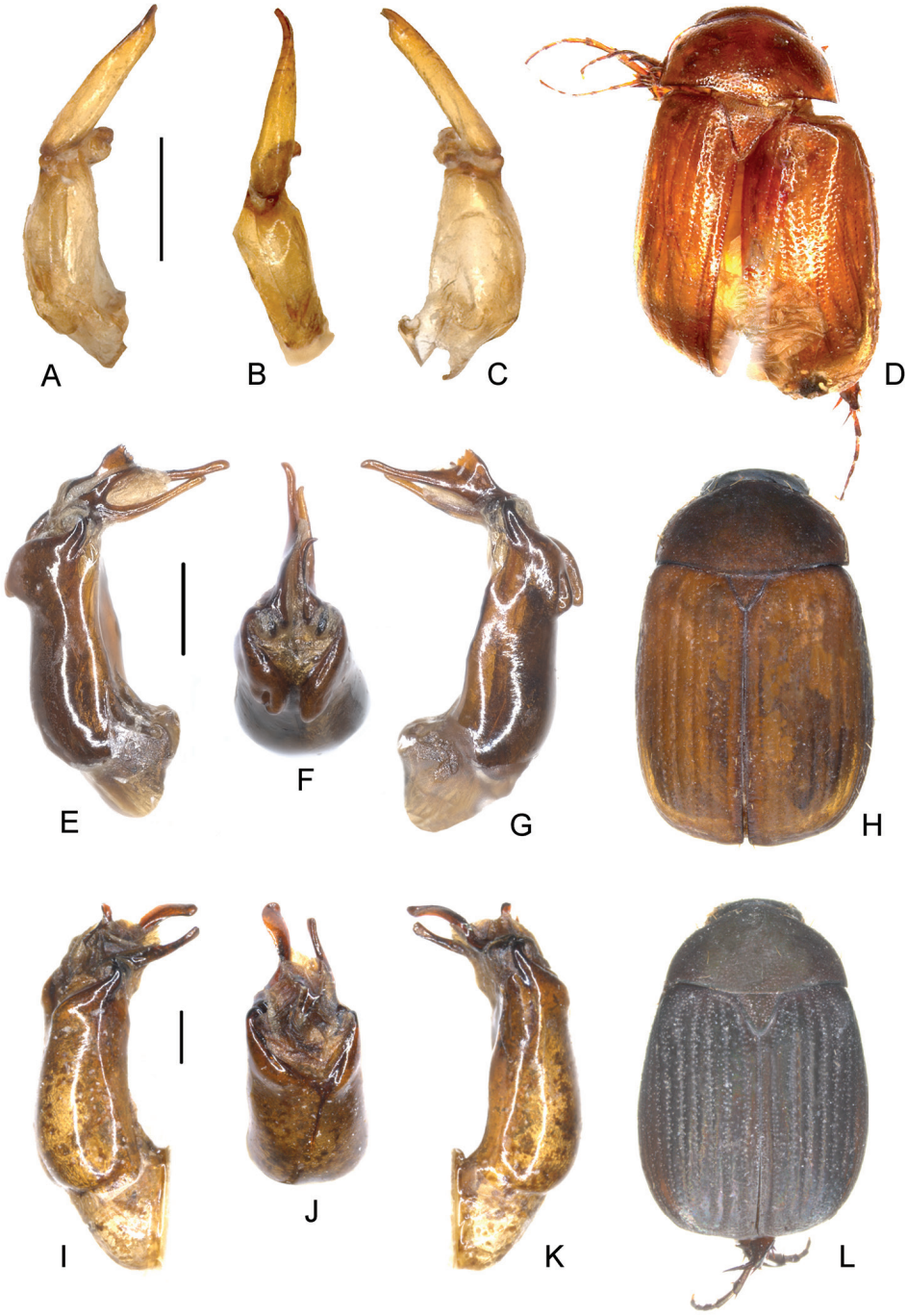

Figure 2. A–D *Neoserica menglungensis* Ahrens, Fabrizi & Liu, sp. n. (holotype) **E–H** *N. obscura* (Blanchard) (holotype, *M. roeri* Frey) **I–L** *N. allobscura* Ahrens, Fabrizi & Liu, sp. n. (holotype) **A, E** aedeagus, left side lateral view **C, G** aedeagus, right side lateral view **B, F** parameres, dorsal view **D, H** habitus. Scale bars: 0.5 mm. Habitus not to scale.

osternum between mesocoxae as wide as the mesofemur. Ratio of length of metepisternum/ metacoxa: 1/ 1.61. Pygidium moderately convex and moderately shiny, finely and densely punctate, without smooth midline, with a few long setae along apical margin.

Legs short; femora shiny, with two rudimentary longitudinal rows of setae, superficially and sparsely punctate, glabrous; metafemur with anterior margin acute, without serrated line behind anterior edge, posterior margin smooth ventrally in apical half only weakly widened, posterior margin smooth dorsally. Metatibia wide and short, widest at middle, ratio of width/ length: 1/ 2.4, dorsal margin sharply carinate, with two groups of spines, basal group at one third, apical group at three quarters of metatibial length, basally with a few short single setae; lateral face weakly convex, finely and sparsely punctate, smooth along the middle; ventral edge finely serrated, with three robust nearly equidistant setae; medial face smooth, apex interiorly near tarsal articulation bluntly truncate. Tarsomeres ventrally with sparse, short setae, smooth, neither laterally nor dorsally carinate; metatarsomeres with a strongly serrated ridge ventrally, smooth; first metatarsomere distinctly shorter than following two tarsomeres combined and only slightly longer than dorsal tibial spur. Protibia moderately long, bidentate, distal tooth sharply pointed at apex; anterior claws symmetrical, basal tooth of inner claw sharply truncate at apex.

Aedeagus: Fig. 2A–C. Habitus: Fig. 2D. Female unknown.

Variation. Body length: 5.4–5.5 mm, length of elytra: 3.9–4.0 mm, body width: 3.3–3.7 mm.

Etymology. The new species is named after the type locality, Menglun.

Neoserica obscura group

Diagnosis. Body small (6–8 mm), oval, strongly convex; often bicoloured black and reddish-brown, entire dorsal surface dull and nearly glabrous. Antenna with 10 antennomeres, dark; antennal club of ♂ composed of 4 antennomeres, in ♀ of 4 antennomeres, but club shorter than remaining antennomeres combined. Hypomeron basally carinate. Protibia bidentate. Metatibia at apex moderately sinuate close to tarsal articulation. Metafemur without serrated line adjacent to anterior margin. Metatibia moderately wide, without serrated longitudinal line.

Remarks. The species group was based on *Neoserica obscura* (Blanchard, 1850) proposed here to accommodate species closely related to *N. obscura.*

Distribution. Eastern China and northern Indochina.

Key to the Chinese species of the *Neoserica obscura* group:

1 Phallobase with a strong ventral lamina on the right side. **2**
– Phallobase without a ventral lamina. **3**
2 Phallobase at apex with a pair of distinct dorsal protuberances... ***N. hainana***

– Phallobase at apex without a pair of distinct dorsal protuberances..... ..... ***N. tahianensis*** **Ahrens, Fabrizi & Liu, sp. n.**
3 Phallobase at apex with a pair of distinct dorsal protuberances.....***N. obscura***
– Phallobase at apex without a pair of distinct dorsal protuberances.....**4**
4 Parameres distinctly less than half as long as phallobase ....***N. allobscura*** **Ahrens, Fabrizi & Liu, sp. n.**
– Parameres half as long as phallobase.....**5**
5 Right paramere nearly straight ..***N. sakoliana*** **Ahrens, Fabrizi & Liu, sp. n.**
– Right paramere strongly bent ventrally behind middle..... ..... ***N. shuyongi*** **Ahrens, Fabrizi & Liu, sp. n.**

Neoserica **(s.l.)** ***obscura*** **(Blanchard, 1850)**
Figs 2E–H, 6

Omaloplia obscura Blanchard, 1850: 79.
Neoserica obscura: Frey 1972a: 212, Ahrens 2006: 239, 2007: 26.
Microserica roeri Frey, 1972b: 171; Ahrens 2006: 239, 2007: 26; **syn. n.**
Aserica chinensis Arrow, 1946b: 268; *Maladera* (*Aserica*) *chinensis*: Ahrens 2006: 234, 2007: 19; **syn. n.**

Type material examined. Lectotype (*O. obscura*, here designated): ♂ "Museum Paris Chine Gallery 5-46/ O. obscura Cat. Mus. China" (MNHN). Paralectotypes (*obscura*): 1 ♂ "Museum Paris Gallery 5-46/ Omaloplia obscura Blanch. ex Typis/ Brsk. I 98 vid" (MNHN), 1 ♂ "Museum Paris Chine Gallery 5-46" (MNHN). Syntype (*A. chinenesis*): 2 ♂♂ "China Kuliang 1923 S. F. Light" (BMNH), 1 ♂ "Foochow" (BMNH). Holotype (*M. roeri*): ♂ "Kuatun (2300 m) 27,40 n.Br. 117,49 ö.L. J. Klapperich 17.6.1938 (Fukien) /Type Microserica roeri n.sp. G. Frey 1971" (ZFMK). Paratypes (*M. roeri* FREY): 1 ♂ "Kuatun (2300 m) 27,40 n.Br. 117,49 ö.L. J. Klapperich 16.6.1938 (Fukien)/Paratype Microserica roeri n.sp. G. Frey 1971" (ZMHB), 3 ♂♂, 1 ♀ "Kuatun (2300 m) 27,40 n.Br. 117,49 ö.L. J. Klapperich 17.6.1938 (Fukien) / Paratype Microserica roeri n.sp. G. Frey 1971" (ZFMK), 1 ♀ "Kuatun (2300 m) 27,40 n.Br. 117,49 ö.L. J. Klapperich 15.6.1938 (Fukien) /Paratype Microserica roeri n. sp. G. Frey 1971" (ZFMK), 1 ex. (not sexed) "Kuatun (2300 m) 27,40 n.Br. 117,49 ö.L. J. Klapperich 25.5.1938 (Fukien)/ M. roeri m. G. Frey 1971/ Paratype Microserica roeri Frey, 1972 det. Ahrens 2016" (ZFMK), 4 ex. (not sexed) "Kuatun (2300 m) 27,40 n.Br. 117,49 ö.L. J. Klapperich 4.6.1938 (Fukien)/ M. roeri m. G. Frey 1971/ Paratype Microserica roeri Frey, 1972 det. Ahrens 2016" (ZFMK), 2 ex. (not sexed) "Kuatun (2300 m) 27,40 n.Br. 117,49 ö.L. J. Klapperich 12.6.1938 (Fukien)/ M. roeri m. G. Frey 1971/ Paratype Microserica roeri Frey, 1972 det. Ahrens 2016" (ZFMK), 15 ex. (not sexed) "Kuatun (2300 m) 27,40 n.Br. 117,49 ö.L. J.Klapperich 14.6.1938 (Fukien)/ M. roeri m. G. Frey 1971/ Paratype Microserica roeri Frey, 1972 det. Ahrens 2016" (ZFMK), 25 ex. (not sexed) "Kuatun (2300 m) 27,40 n.Br. 117,49

ö.L. J.Klapperich 15.6.1938 (Fukien)/ M. roeri m. G. Frey 1971/ Paratype Microserica roeri Frey, 1972 det. Ahrens 2016" (ZFMK), 27 ex. (not sexed) "Kuatun (2300 m) 27,40 n.Br. 117,49 ö.L. J.Klapperich 16.6.1938 (Fukien)/ M. roeri m. G. Frey 1971/ Paratype Microserica roeri Frey, 1972 det. Ahrens 2016" (ZFMK), 58 ex. (not sexed) "Kuatun (2300 m) 27,40 n.Br. 117,49 ö.L. J.Klapperich 17.6.1938 (Fukien)/ M. roeri m. G. Frey 1971/ Paratype Microserica roeri Frey, 1972 det. Ahrens 2016" (ZFMK), 9 ex. (not sexed) "Kuatun (2300 m) 27,40 n.Br. 117,49 ö.L. J.Klapperich 18.6.1938 (Fukien)/ M. roeri m. G. Frey 1971/ Paratype Microserica roeri Frey, 1972 det. Ahrens 2016" (ZFMK), 1 ex. (not sexed) "Kuatun (2300 m) 27,40 n.Br. 117,49 ö.L. J.Klapperich 20.6.1938 (Fukien)/ M. roeri m. G. Frey 1971/ Paratype Microserica roeri Frey, 1972 det. Ahrens 2016" (ZFMK), 1 ex. (not sexed) "Kuatun (2300 m) 27,40 n.Br. 117,49 ö.L. J.Klapperich 21.6.1938 (Fukien)/ M. roeri m. G. Frey 1971/ Paratype Microserica roeri Frey, 1972 det. Ahrens 2016" (ZFMK), 1 ex. (not sexed) "Kuatun (2300 m) 27,40 n.Br. 117,49 ö.L. J.Klapperich 9.7.1938 (Fukien)/ M. roeri m. G. Frey 1971/ Paratype Microserica roeri Frey, 1972 det. Ahrens 2016" (ZFMK), 1 ex. (not sexed) "Kuatun (2300 m) 27,40 n.Br. 117,49 ö.L. J.Klapperich 27.7.1938 (Fukien)/ M. roeri m. G. Frey 1971/ Paratype Microserica roeri Frey, 1972 det. Ahrens 2016" (ZFMK), 1 ex. (not sexed) "Kuatun (2300 m) 27,40 n.Br. 117,49 ö.L. J.Klapperich 8.8.1938 (Fukien)/ M. roeri m. G. Frey 1971/ Paratype Microserica roeri Frey, 1972 det. Ahrens 2016" (ZFMK), 4 ex. (not sexed) "Kuatun (2300 m) 27,40 n.Br. 117,49 ö.L. J.Klapperich 9.8.1938 (Fukien)/ M. roeri m. G. Frey 1971/ Paratype Microserica roeri Frey, 1972 det. Ahrens 2016" (ZFMK), 1 ex. (not sexed) "Kuatun (2300 m) 27,40 n.Br. 117,49 ö.L. J.Klapperich 22.8.1938 (Fukien)/ M. roeri m. G. Frey 1971/ Paratype Microserica roeri Frey, 1972 det. Ahrens 2016" (ZFMK).

Additional material examined. 8 ex. "China Fujian prov. Sangang env. 3.-5./.1991 M. Nikodým leg." (ZFMK), 4 ex. "Chine 18.V.46 Kuatun, Fukien leg. Tschung-Sen" (MHNG), 18 ex. "Chine 1.VI.46 Kuatun, Fukien leg. Tschung-Sen" (MHNG), 4 ex. "Chine 4.VI.46 Kuatun, Fukien leg. Tschung-Sen" (MHNG), 3 ex. "Chine 8.VI.46 Kuatun, Fukien leg. Tschung-Sen" (MHNG), 12 ex. "Chine 10.VI.46 Kuatun, Fukien leg. Tschung-Sen" (MHNG), 6 ex. "Chine 12.VI.46 Kuatun, Fukien leg. Tschung-Sen" (MHNG), 57 ex. "Chine 15.VI.46 Kuatun, Fukien leg. Tschung-Sen" (MHNG), 78 ex. "Chine 20.VI.46 Kuatun, Fukien leg. Tschung-Sen" (MHNG), 14 ex. "Chine 29.VI.46 Kuatun, Fukien leg. Tschung-Sen" (MHNG), 37 ex. "Chine 28.VII.46 Kuatun, Fukien leg. Tschung-Sen" (MHNG), 6 ex. "Chine 4.VII.46 Kuatun, Fukien leg. Tschung-Sen" (MHNG), 24 ex. "Chine 6.VII.46 Kuatun, Fukien leg. Tschung-Sen" (MHNG), 24 ex. "Chine 7.VII.46 Kuatun, Fukien leg. Tschung-Sen" (MHNG), 36 ex. "Chine 14.VII.46 Kuatun, Fukien leg. Tschung-Sen" (MHNG), 18 ex. "Chine 22.VII.46 Kuatun, Fukien leg. Tschung-Sen" (MHNG), 3 ex. "Chine 14.VIII.46 Kuatun, Fukien leg. Tschung-Sen" (MHNG), 2 ex. "Reg. de Luc-Nam (Tonkin) L. Blaise/ Museum Paris (Coll. Ph. Francois) Coll. L. Bedel 1922" (MNHN), 4 ex. "Museum Paris Kouy-Tcheou P. Cavalerie 1910" (MNHN), 2 ex. "Museum Paris Kouy-Tcheou Reg. de Pin-Fa, P. Cavalerie 1908" (MNHN), 2 ex. "Museum Paris Kouy-Tcheou Kouy-Yang, P.P. Cavalerie et Fortunat 1906" (MNHN), 6 ex. "Hangchow 6-5-24/ J.

F. Illingworth" (BPBM), 2 ex. "Kwangtung, S.C. Chukiang Lungtaushan 17.VI.1947/ J.L. Gressitt Collector" (BPBM), 1 ex. "S. China Kwangtung Loh-chang Dist. 1947/ J.L. Gressitt Colletor Bishop Museum" (BPBM), 3 ex. "S. China: Kwangtung Tsin-leong Shan 5.VI.1936/ L. &. M. Gressitt Collectors Bishop Museum" (BPBM), 1 ex. "S. China NE Kwangtung Yim-na Shan 10-15.VI.36/ J. L. Gressitt Collector Bishop Museum" (BPBM), 1 ex. "Fukien, S. China Kienyang: Nwangkeng 6.VI.42 T. C. Maa" (BPBM), 1 ex. "China: Taipe‘ v.1925/ D. T. Fullaway, Coll. Bishop Museum Acc. +1986.189" (BPBM), 2 ex. "Hong Kong: Hong Kong Island IV.1958/ N.L.H. Krauss Collector Bishop" (BPBM), 1 ex. "Fukien, S. China Shaowu: Tachulan 1000 m. 22.VII.42/ T. C. Maa Collector Bishop Mus." (BPBM), 2 ex. "Fukien, S. China Kienyang City 1941-23. VI. Maa" (BPBM), 1 ex. "Fukien, S. China Kienyang: Kwang-keng to Tachulan 1943. Maa" (BPBM), 1 ex. "Fukien, S. China Shaowu: Tachulan 1000 m. T. Maa/ 1.VII.42" (BPBM), 1 ex. "Fukien, S. China Shaowu: Tachulan 1000 m. T. Maa/ 7.V.42" (BPBM), 2 ex. "Fukien, S. China Changting City 1940 3.VI. Maa" (BPBM), 1 ex. "Fukien, S. China Changting: Hotien 24.VII.1940/ T.C. Maa Collector Bishop" (BPBM), 1 ex. "Fukien, S. China Shahsien 15.VII.1940 T. Maa" (BPBM), 2 ex. "Kuatun (2300 m) 27,40 n.Br. 117,49 ö.L. J.Klapperich 17.6.1938 (Fukien)/ Neoserica obscura Bl. det G. Frey 1967/68" (CF), 3 ex. "Kiangsi, S. China Taiauhong, S. of Sungwu, 540 m VII-5-36 Gressitt" (BPBM), 1 ex. "Fukien, S. China Chungan Bohea Hills 12.VI.1941 T.C. Maa" (BPBM), 1 ex. "Foochow July‘24/ J.F. Illingworth" (BPBM), 2 ex. "Kiangsi, SE China Hong Shan 1000 m VI-25-36, Gressitt" (BPBM), 1 ex. "China, W Jiangxi Jinggang Shan-Ciping 2-14.VI.1994 E. Jendek & O. Sausa leg./ CS 18" (CP), 7 ex. "China, W Jiangxi Jinggang Shan Ciping env. 2-14.VI.1994" (NHMW), 46 ex. "China Hunan SE Ling Xian env. 26.31N 113.44E 15-18.VI.1994" (NHMW), 2 ex. "China Hunan S Chenzhou env. 25.49N 112.59E 19-21.VI.1994" (NHMW), 1 ex. "China Hunan SE Guidong env. 26.04N 113.56E 26-31.V.1994" (NHMW), 3 ex. "China Schf." (ZMHB), 5 ex. " China Canton" (ZMHB), 1 ex. " Kiautschou China" (ZMHB), 1 ex. "China Canton V.-VII.11 Mell S.V." (ZMHB), 3 ex. "China Tsha-jiu-san VII-IX.10 Mell S.V." (ZMHB), 1 ex. "Prov.Fo-Kien (China)" (ZMHB), 1 ex. "Fockien Donckier" (ZMHB), 5 ex. "Museum Paris Chekiang Hang Tcheou A. Pichon 1925" (MNHN), 1 ex. "China, N Fujian, 8.-25,V. Wuyi Shan mts. ~10km W Xingcun pitfall traps, 27.65N 117.85E Jaroslav Turna leg., 2005" (ZFMK), 8 ex. "Kuatun (2300m) 27,40n.Br. 117,40o.L. J. Klapperich 17.6. 1938 (Fukien)/ ex. Coll. V. Balthasar National Museum Prague, Czech Republic" (NMPC), 2 ex. "Kuatun (2300m) 27,40n.Br. 117,40o.L. J. Klapperich 14.6. 1938 (Fukien)/ ex. Coll. V. Balthasar National Museum Prague, Czech Republic" (NMPC), 2 ex. "Kuatun (2300m) 27,40n.Br. 117,40o.L. J. Klapperich 16.6. 1938 (Fukien)/ ex. Coll. V. Balthasar National Museum Prague, Czech Republic" (NMPC), 1 ex. "Kuatun (2300m) 27,40n.Br. 117,40o.L. J. Klapperich 18.8. 1938 (Fukien)/ ex. Coll. V. Balthasar National Museum Prague, Czech Republic" (NMPC), 2 ex. "Kuatun (2300m) 27,40n.Br. 117,40o.L. J. Klapperich 25.5. 1938 (Fukien)/ ex. Coll. V. Balthasar National Museum Prague, Czech Republic" (NMPC), 5 ex. "Kuatun Fukien China 18.6.46 (Tschung Sen.)/ ex. Coll. V. Balthasar National Museum Prague, Czech Republic" (NMPC), 1 ex. "Kuatun Fukien China 15.6.46 (Tschung

Sen.)/ ex. Coll. V. Balthasar National Museum Prague, Czech Republic" (NMPC), 1 ♂ "China: E Guizhou prov.; Fodingshan; Ganshi; 25km of Shiguian; 1300m; BOLM lgt.; 5.-9.vi.1997" (CP), 3 ex. "Datchulau China '39 TH Cheng/ July 39" (USNM), 2 ex. "Hangchow VI-22 1927 Coll. C.Y. Wong" (USNM), 3 ex. "Hangchow VI-23 1927 Coll. C.Y. Wong" (USNM), 1 ex. "Hangchow VI-24 1927 Coll. C.Y. Wong" (USNM), 1 ex. "Foochow China VII- 18 2519 Coll. C.C. Wee" (USNM), 1 ex. "Hangchow China./ VII-6 to VIII-17-1926 Coll. H.A. Jaynes" (USNM), 1 ex. "Hangchow China./ V-10-1926 Coll. H.A. Jaynes" (USNM), 1 ex. "Hangchow IX-20-1924/ J.F. Illingwerth Ex flower" (USNM), 1 ex. "Zakow China VII-16-1924" (USNM), 1 ex. "Zakow China./ III-24 to IV-15-1926 Coll. H.A. Jaynes" (USNM), 1 ex. "Foochow China CI-1928/ F.C. Hadden Collector" (USNM), 2 ex. "Chekiang China/ OL Cartwright collection 1959" (USNM), 1 ♂ "Guangdong, 9,10.VII.1965" (IZAS), 1 ♂ "Xiadao, Nanping, Fujian, 27.V.1963, leg. Zhang Youwei" (IZAS), 2 ♂♂, 1 ♀ "Hujiang, Lianxian County, Guangdong, 18.VI.1965, leg. Zhang Youwei" (IZAS), 1 ♂ "Guangdong, 7.VII.1965" (IZAS), 1 ♂ "Jiuniutang, Mao'ershan, Guangxi, 13.VII.1985, 1100m, leg. Liao Subai" (IZAS), 1 ♂ "Chong'an Xingcun, Fujian, 10.VII.1960, 200m, leg. Jiang Shengqiao" (IZAS), 1 ♂ "Xiangshui, Boluo, Guangdong, 31.V.1965, leg. Zhang Youwei" (IZAS), 1 ♂ "Guanping, Tongmuguan, Chong'an, Fujian, 13.VIII.1960, 900-1000m, leg. Jiang Shengqiao" (IZAS), 4 ex. "China: Zhejiang, Longquan City, 30.VI.1979" (SNUC).

Redescription. Body length: 5.6 mm, length of elytra: 3.9 mm, body width: 3.6 mm. Body short-oval, black, elytra reddish brown, dorsal surface except anterior labroclypeus dull, pronotum and elytra glabrous.

Labroclypeus subtrapezoidal, distinctly wider than long, widest at base, lateral margins weakly convex, convergent anteriorly; anterior angles strongly rounded; anterior margin shallowly sinuate medially, margins moderately reflexed; surface weakly convex, shiny, base dull, coarsely and densely punctate, with numerous erect setae; frontoclypeal suture indistinctly incised, vanishing under dull toment; smooth area in front of eye convex, nearly as long as wide; ocular canthus short and triangular (1/3 of ocular diameter), sparsely punctate, with one or more terminal setae. Frons with fine and moderately dense punctures, with a few long erect setae beside eyes and behind frontoclypeal suture. Eyes small, ratio diameter/ interocular width: 0.41. Antenna with ten antennomeres, club (♂) with four antennomeres and straight, as long as remaining antennomeres combined. Mentum convexly elevated and flattened anteriorly.

Pronotum transverse, widest at base, lateral margins in basal half nearly straight and moderately convergent to middle, evenly convex and weakly convergent anteriorly; anterior angles distinctly produced and sharp, posterior angles blunt and weakly rounded at tip; anterior margin straight, with a fine complete marginal line; surface densely and finely punctate, glabrous, with minute setae in punctures (100× magnification); lateral border densely setose; hypomeron distinctly carinate basally, not produced ventrally. Scutellum triangular, with fine, dense punctures, glabrous.

Elytra short-oval, widest shortly behind middle, striae finely impressed, finely and densely punctate, intervals weakly convex, with sparse, fine punctures concentrated along striae, glabrous except a few single, short setae on odd intervals; epipleural edge

robust, ending at nearly blunt external apical angle of elytra, epipleura densely setose; apical border without a fine fringe of microtrichomes (visible at 100× magnification).

Ventral surface dull, finely and densely punctate; metasternum nearly glabrous except a few long robust setae on disc, punctures with minute setae (100× magnification); metacoxa glabrous, with a few single setae laterally; abdominal sternites finely and densely punctate, with a transverse row of coarse punctures, each bearing a short robust seta, last sternite half as long as penultimate one. Mesosternum between mesocoxae as wide as the mesofemur, with a semi-circular ridge bearing long setae. Ratio of length of metepisternum/ metacoxa: 1/ 1.9. Pygidium dull, moderately convex, finely and densely punctate, without smooth midline, with a few long setae along apical margin.

Legs short; femora moderately shiny, with two rudimentary longitudinal rows of setae, finely and sparsely punctate, glabrous; metafemur with anterior margin acute, without serrated line behind anterior edge, posterior margin smooth ventrally, in apical half only weakly widened, posterior margin smooth dorsally. Metatibia wide and short, widest at middle, ratio of width/ length: 1/ 2.7; dorsal margin sharply carinate, with two groups of spines, basal group at one third, apical group at three quarters of metatibial length, basally with a few short single setae; lateral face weakly convex, finely and sparsely punctate, smooth along middle; ventral edge finely serrated, with three robust nearly equidistant setae; medial face smooth, apex interiorly near tarsal articulation bluntly truncate and slightly concavely sinuate. Tarsomeres ventrally with sparse, short setae, smooth, neither laterally nor dorsally carinate; metatarsomeres with a strongly serrated ridge ventrally, glabrous; first metatarsomere as long as following two tarsomeres combined and slightly longer than dorsal tibial spur. Protibia short, bidentate, distal tooth sharply pointed at apex; anterior claws symmetrical, basal tooth of inner claw sharply truncate at apex.

Aedeagus: Fig. 2E–G. Habitus: Fig. 2H.

Variation. The colour may vary from being totally black to reddish brown. Female: antennal club also composed of 4 antennomeres, however, the club is slightly shorter than in males and the first joint of the club is slightly shorter than the club; pygidium moderately convex, at middle strongly shiny and finely punctate.

Remarks. The parameres of the lectotype of *Neoserica obscura* (Blanchard) are virtually identical in the shape with those of *Microserica roeri* Frey and *Aserica chinensis* Arrow. The latter two names are consequently proposed here as junior synonyms of *Neoserica obscura*.

Neoserica (s.l.) *allobscura* Ahrens, Fabrizi & Liu, sp. n.

http://zoobank.org/04D24B11-EEC3-496B-AFCB-2E9311F9DD97
Fig. 2I–L

Type material examined. Holotype: ♂ "China coll. Chev./ obscura Bl. Mit cotype vergl 4.I.98./ obscura Bl./coll. Brenske" (ZMHB).

Diagnosis. *Neoserica allobscura* Ahrens, Fabrizi & Liu sp. n. is in external appearance and genital morphology very similar to *N. obscura*. *Neoserica allobscura* differs by the less distinct pair of protuberances on the dorsoapical phallobase and the shape of the parameres: the right paramere is strongly curved in the middle and its basal lobe is longer than the rudimentary one of *N. obscura*; the dorsal lobe of the left paramere is displaced more basally and bent interiorly, while in *N. obscura* it is directly above the ventral lobe of the left paramere.

Description. Body length: 6.9 mm, length of elytra: 3.9 mm, body width: 3.6 mm. Body short-oval, dark brown, elytra black, dorsal surface except anterior labroclypeus dull, pronotum and elytra glabrous.

Labroclypeus subtrapezoidal, distinctly wider than long, widest at base, lateral margins weakly convex, convergent anteriorly; anterior angles strongly rounded; anterior margin shallowly sinuate medially, margins moderately reflexed; surface weakly convex, shiny, base dull, densely punctate, coarse punctures mixed with minute ones, with numerous erect setae; frontoclypeal suture indistinctly incised, weakly curved medially; smooth area in front of eye convex, nearly as long as wide; ocular canthus short and triangular (1/3 of ocular diameter), sparsely punctate, with one or more terminal setae. Frons with fine and moderately dense punctures, with a few long erect setae beside eyes and behind frontoclypeal suture. Eyes small, ratio diameter/ interocular width: 0.42. Antenna with ten antennomeres, club (♂) with four antennomeres and straight, as long as remaining antennomeres combined. Mentum convexly elevated and flattened anteriorly.

Pronotum transverse, widest at base, lateral margins evenly convex and moderately convergent anteriorly; anterior angles distinctly produced and sharp, posterior angles blunt and weakly rounded at tip; anterior margin straight, with a fine complete marginal line; surface densely and finely punctate, glabrous, with minute setae in punctures (100× magnification); lateral border densely setose; hypomeron distinctly carinate basally, not produced ventrally. Scutellum triangular, with fine, dense punctures, glabrous.

Elytra short-oval, widest shortly behind middle, striae finely impressed, finely and densely punctate, intervals weakly convex, with sparse, fine punctures concentrated along striae, glabrous; epipleural edge robust, ending at nearly blunt external apical angle of elytra, epipleura densely setose; apical border without a fine fringe of microtrichomes (visible at 100× magnification).

Ventral surface dull, finely and densely punctate; metasternum nearly glabrous except a few long robust setae on disc, punctures with minute setae (100× magnification); metacoxa glabrous, with a few single setae laterally; abdominal sternites finely and densely punctate, with a transverse row of coarse punctures, each bearing a short robust seta, last sternite half as long as penultimate one. Mesosternum between mesocoxae as wide as the mesofemur, with a semi-circular ridge bearing long setae. Ratio of length of metepisternum/ metacoxa: 1/ 2.2. Pygidium dull, moderately convex, coarsely and densely punctate, without smooth midline, with a few long setae along apical margin.

Legs short; femora moderately shiny, with two rudimentary longitudinal rows of setae, finely and sparsely punctate, glabrous; metafemur with anterior margin acute, without serrated line behind anterior edge, posterior margin smooth ventrally, in apical half only weakly widened, posterior margin smooth dorsally. Metatibia wide and short, widest at middle, ratio of width/ length: 1/ 2.7; dorsal margin sharply carinate, with two groups of spines, basal group at one third, apical group at three quarters of metatibial length, basally with a few short single setae; lateral face weakly convex, finely and sparsely punctate, smooth along middle; ventral edge finely serrated, with three robust nearly equidistant setae; medial face smooth, apex interiorly near tarsal articulation bluntly truncate and slightly concavely sinuate. Tarsomeres ventrally with sparse, short setae, smooth, neither laterally nor dorsally carinate; metatarsomeres with a strongly serrated ridge ventrally, glabrous; first metatarsomere as long as following two tarsomeres combined and as long as dorsal tibial spur. Protibia short, bidentate, distal tooth sharply pointed at apex; anterior claws symmetrical, basal tooth of inner claw sharply truncate at apex.

Aedeagus: Fig. 2I–K. Habitus: Fig. 2L. Female unknown.

Etymology. The name of the new species is derived from the Greek prefix "allo-" (other) and the Latin adjective "obscurus" (dark) with reference to the name and the similarity to *N. obscura*.

Neoserica (s.l.) *hainana* (Brenske, 1898), comb. n.

Figs 3A–D, 6

Microserica hainana Brenske, 1898: 216.

Type material examined. Lectotype (here designated): ♂ "Hainan Schmack/ Serica hainana var. type Brsk./ Coll. v. Schönfeldt" (SMFD). Paralectotypes: 4 ♂♂, 3 ♀♀ "Hainan Schmack/ Coll. v. Schönfeldt" (SMFD), 1 ♂ "hainana var. type/ Coll. v. Schönfeldt" (SMFD), 1 ♂ "Hainan Schmack/ Serica hainana type Brsk./ Coll. v. Schönfeldt/ hainana Brske" (SMFD), 1 ♀ "Hainan v.Schönfeldt/ Serica hainana type Brsk." (ZMHB), 1 ♂ "19./ Hainan Schmack/ Serica hainana var. type Brsk./ Coll. v. Schönfeldt" (SMFD).

Additional material examined. 1 ♂ "Qiongzhong, Hainan, Guangdong, 17.VII.1960, 400m, leg. Zhang Xuezhong" (IZAS), 1 ♂, 1 ♀ "Bawangzhen, Changjiang, Hainan, 5-7.VI.2008, leg. Ba Yibin, Lang Juntong" (HBUM), 3 ♂♂ "Bawangzhen, Changjiang, Hainan, 5-7.VI.2008, leg. Ba Yibin, Lang Juntong" (HBUM).

Redescription. Body length: 6.8 mm, length of elytra: 4.8 mm, body width: 4.2 mm. Body short-oval, black, elytra reddish brown, dorsal surface except anterior labroclypeus dull, pronotum and elytra glabrous.

Labroclypeus subtrapezoidal, distinctly wider than long, widest at base, lateral margins weakly convex, convergent anteriorly; anterior angles strongly rounded; anterior

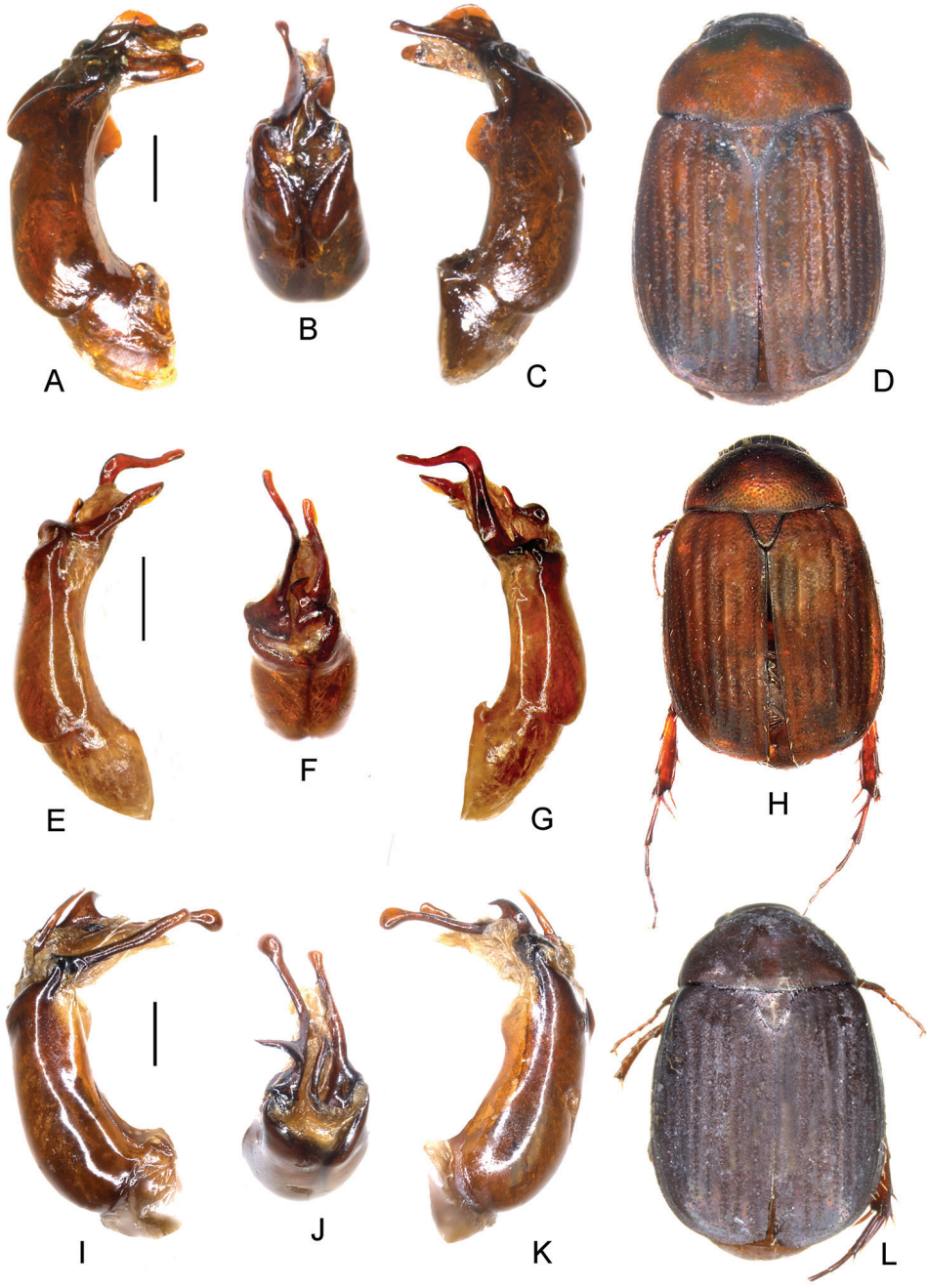

Figure 3. A–D *Neoserica hainana* (Brenske) (lectotype) **E–H** *N. shoyungi* Ahrens, Fabrizi & Liu, sp. n. (holotype) **I–L** *N. sakoliana* Ahrens, Fabrizi & Liu, sp. n. (holotype) **A, E** aedeagus, left side lateral view **C, G** aedeagus, right side lateral view **B, F** parameres, dorsal view **D, H** habitus. Scale bars: 0.5 mm. Habitus not to scale.

margin shallowly sinuate medially, margins moderately reflexed; surface weakly convex, shiny, base dull, coarsely and densely punctate, with numerous erect setae; frontoclypeal suture indistinctly incised, nearly vanishing under dull toment; smooth area in front of eye convex, nearly as long as wide; ocular canthus short and triangular (1/3 of ocular diameter), sparsely punctate, terminal setae in lectotype lacking. Frons with fine and moderately dense punctures, without erect setae. Eyes small, ratio diameter/ interocular width: 0.4. Antenna with ten antennomeres, yellowish, club (♂) with four antennomeres and straight, as long as remaining antennomeres combined. Mentum convexly elevated and flattened anteriorly.

Pronotum transverse, widest shortly before base, lateral margins in basal half nearly straight and moderately convergent to middle, evenly convex and weakly convergent anteriorly; anterior angles distinctly produced and sharp, posterior angles blunt and weakly rounded at tip; anterior margin straight, with a fine complete marginal line; surface densely and finely punctate, glabrous, with minute setae in punctures (100× magnification); lateral border densely setose; hypomeron distinctly carinate basally, not produced ventrally. Scutellum triangular, with fine, dense punctures, glabrous.

Elytra short-oval, widest shortly behind middle, striae finely impressed, finely and densely punctate, intervals weakly convex, with sparse, fine punctures concentrated along striae, glabrous except a few single, short setae on odd intervals; epipleural edge robust, ending at nearly blunt external apical angle of elytra, epipleura densely setose; apical border without a fine fringe of microtrichomes (visible at 100× magnification).

Ventral surface dull, finely and densely punctate; metasternum nearly glabrous except a few long robust setae on disc, punctures with minute setae (100× magnification); metacoxa glabrous, with a few single setae laterally; abdominal sternites finely and densely punctate, with a transverse row of coarse punctures, each bearing a short robust seta, last sternite half as long as penultimate one. Mesosternum between mesocoxae as wide as the mesofemur, with a semi-circular ridge bearing long setae. Ratio of length of metepisternum/ metacoxa: 1/ 2.0. Pygidium dull, moderately convex, finely and densely punctate, without smooth midline, with a few long setae along apical margin.

Legs short; femora moderately shiny, with two rudimentary longitudinal rows of setae, finely and sparsely punctate, glabrous; metafemur with anterior margin acute, without serrated line behind anterior edge, posterior margin smooth ventrally, in apical half only weakly widened, posterior margin smooth dorsally. Metatibia wide and short, widest at middle, ratio of width/ length: 1/ 2.8; dorsal margin sharply carinate, with two groups of spines, basal group at one third, apical group at three quarters of metatibial length, basally with a few short single setae; lateral face weakly convex, finely and sparsely punctate, smooth along middle; ventral edge finely serrated, with three robust nearly equidistant setae; medial face smooth, apex interiorly near tarsal articulation bluntly truncate and slightly concavely sinuate. Tarsomeres ventrally with sparse, short setae, smooth, neither laterally nor dorsally carinate; metatarsomeres with a strongly serrated ridge ventrally, glabrous; first metatarsomere slightly shorter than following two tarsomeres combined and slightly longer than dorsal tibial spur. Protibia short, bidentate, distal tooth sharply pointed at apex; anterior claws symmetrical, basal tooth of inner claw sharply truncate at apex.

Aedeagus: Fig. 3A–C. Habitus: Fig. 3D.

Variation. The colour varies from an entirely black body, or a blackish anterior body (head and pronotum) with reddish elytra, to a nearly entirely reddish body with dark head and anterior pronotum, dorsal surface sometimes with greenish shine. Female: pygidium moderately convex, at middle strongly shiny and finely punctate; antennal club slightly shorter than the remaining antennomeres combined, composed of 4 antennomeres.

***Neoserica* (s.l.) *shuyongi* Ahrens, Fabrizi & Liu, sp. n.**

http://zoobank.org/B0DCDC55-D503-4263-9013-D51163B33251

Figs 3E–H, 6

Type material examined. Holotype: ♂ "Tianchi, Mt. Jianfengling, Hainan, 25.IV.1980, 750m, leg. Wang Shuyong" (IZAS). Paratypes: 1 ♂ "Mts. Jianfengling, Hainan, 1.IV.1984, leg. Lin Youdong" (IZAS), 1 ♀ "Mts. Jianfengling, Hainan, 10.IV.1980, 800m, leg. Wang Shuyong" (IZAS), 1 ♂ "Tianchi, Mt. Jianfengling, Hainan, 18.IV.1980, 700m, leg. Pu Fuji" (ZFMK).

Description. Body length: 5.9 mm, length of elytra: 3.9 mm, body width: 3.6 mm. Body short-oval, dark brown partly reddish, dorsal surface except anterior labroclypeus moderately dull, pronotum and elytra glabrous.

Labroclypeus subtrapezoidal, distinctly wider than long, widest at base, lateral margins weakly convex, convergent anteriorly; anterior angles strongly rounded; anterior margin shallowly sinuate medially, margins distinctly reflexed; surface nearly flat, shiny including base, coarsely and densely punctate, behind anterior margin with a few even coarser punctures each bearing an erect seta; frontoclypeal suture distinctly incised, weakly curved medially; smooth area in front of eye convex, nearly as long as wide; ocular canthus moderately short and triangular (1/3 of ocular diameter), sparsely punctate, with one terminal seta. Frons with moderately coarse and dense punctures, with a few long erect setae beside eyes and behind frontoclypeal suture. Eyes small, ratio diameter/ interocular width: 0.47. Antenna with nine antennomeres, club (♂) with four antennomeres and straight, 1.2 times as long as remaining antennomeres combined. Mentum convexly elevated and flattened anteriorly.

Pronotum transverse, widest at base, lateral margins evenly convex and moderately convergent anteriorly; anterior angles distinctly produced and sharp, posterior angles blunt and weakly rounded at tip; anterior margin straight, with a fine complete marginal line; surface densely and moderately coarsely punctate, glabrous, with minute setae in punctures (100× magnification); lateral border densely setose; hypomeron distinctly carinate basally, not produced ventrally. Scutellum triangular, with moderately coarse and dense punctures, glabrous.

Elytra short-oval, widest shortly behind middle, striae finely impressed, finely and densely punctate, intervals moderately convex, with sparse, fine punctures concentrated along striae, glabrous except a few short setae on odd intervals; epipleural edge

robust, ending at rounded external apical angle of elytra, epipleura densely setose; apical border without a fine fringe of microtrichomes (visible at 100× magnification).

Ventral surface dull, finely and densely punctate; metasternum with a few short setae and long robust setae on metasternal disc; metacoxa glabrous, with a few single setae laterally; abdominal sternites finely and densely punctate, with a transverse row of coarse punctures, each bearing a short robust seta, last sternite half as long as penultimate one. Mesosternum between mesocoxae as wide as the mesofemur, with a semi-circular ridge bearing long setae. Ratio of length of metepisternum/ metacoxa: 1/ 1.72. Pygidium dull, moderately convex, coarsely and densely punctate, without smooth midline, with a few long setae along apical margin.

Legs short; femora dull, with two rudimentary longitudinal rows of setae, finely and sparsely punctate, glabrous; metafemur shiny, with anterior margin acute, without serrated line behind anterior edge, posterior margin apically serrate ventrally, in apical half only weakly widened, posterior margin distinctly serrate dorsally. Metatibia wide and short, widest at middle, ratio of width/ length: 1/ 3.1; dorsal margin only in posterior quarter carinate, otherwise longitudinally convex, with two groups of spines, basal group at one third, apical group at three quarters of metatibial length, basally with a few short single setae; lateral face convex, finely and sparsely punctate, smooth along middle in posterior half; ventral edge finely serrated, with three robust nearly equidistant setae; medial face smooth, apex interiorly near tarsal articulation bluntly truncate and slightly concavely sinuate. Tarsomeres ventrally with sparse, short setae, smooth, neither laterally nor dorsally carinate; metatarsomeres with a strongly serrated ridge ventrally, glabrous; first metatarsomere slightly longer than following two tarsomeres combined and distinctly longer than dorsal tibial spur. Protibia short, bidentate, distal tooth sharply pointed at apex; anterior claws symmetrical, basal tooth of inner claw sharply truncate at apex.

Aedeagus: Fig. 3E–G. Habitus: Fig. 3H.

Diagnosis. *Neoserica shuyongi* Ahrens, Fabrizi & Liu, sp. n. differs from all other species of the *N. obscura* group by the serrate posterior margin of metafemur, antenna composed of 9 antennomeres, shiny base of the clypeus and the shape of the aedeagus (Fig. 3E–G).

Etymology. The new species is named after its collector, Wang Shuyong.

Variation. Among the paratypes no apparent size variation was found; colour varied from entirely reddish brown to dark brown. Female: pygidium less convex, antennal club in the paratype missing.

Neoserica (s.l.) *sakoliana* Ahrens, Fabrizi & Liu, sp. n.

http://zoobank.org/D21DD61A-7938-4F0A-9682-E3B101763B2B
Figs 3I–L, 6

Type material examined. Holotype: ♂ "China: Hainan I., No-dong nr. Sa ko lia 12.VII.1935/ L. & M. Gressitt Collectors BISHOP Mus." (BPBM). Paratypes: 2

♂♂, 1 ♀ "Mts. Limushan, Qiongzhong, Hainan, 22-23.VII.2006, leg. Wang Jiliang, Gao Chao" (HBUM), 1 ♂ "Xiangshui, Boluo, Guangdong, 30.V.1965, leg. Zhang Youwei" (IZAS), 1 ♂ "Kwangtung, S. China, Tsung Hau, Mei-hsien (District), 19-21.VII.1933, leg. F. K. To" (SYUG), 1 ♂ "Liuwan Forestry Farm, Yulin Insects 0354, 25.V.1981, leg. Huang Xiaoming" (IZAS), 1 ♂ "Mt. Paiyangshan, Guangxi, 27.V.1984, leg. Lu Xiaoshan" (NWAFU), 1 ♂ "Hongchagou, Xishan Forestry Farm, Rong'an, Guangxi, 26.VII.2007, leg. Yang Ganyan" (IZAS), 1 ♂ "Xiangshui, Boluo, Guangdong, 30.V.1965, leg, Zhang Youwei" (IZAS), 1 ♂ "Xinzuochang, Boluo, Guangdong, 3.VI.1965, leg. Zhang Youwei" (IZAS), 1 ♂ "Mt. Diaoluoshan, Hainan, 22.IV.1980, 1000m, leg. Wang Shuyong" (IZAS), 1 v "Wanning, Hainan, Guangdong, 16.IV.1960, 10m, leg. Li Suofu"(ZFMK), 1 ♂ "Sean No.19, Yaosam (Kwangsi), 16.VII.1934, leg. H.C. Tao" (IZAS).

Diagnosis. *Neoserica sakoliana* Ahrens, Fabrizi & Liu sp. n. is in external appearance and genital morphology similar to *N. allobscura*. *Neoserica sakoliana* differs by the distinctly longer parameres.

Description. Body length: 6.4 mm, length of elytra: 4.4 mm, body width: 4.2 mm. Body short-oval, dark brown, ventral face reddish brown, entire surface except anterior labroclypeus dull, head with some greenish shine, pronotum and elytra glabrous.

Labroclypeus subtrapezoidal, distinctly wider than long, widest at base, lateral margins weakly convex, convergent anteriorly; anterior angles strongly rounded; anterior margin shallowly sinuate medially, margins moderately reflexed; surface weakly convex, shiny, base dull, finely and densely punctate, mixed with a few larger punctures bearing each an erect seta; frontoclypeal suture distinctly incised, weakly curved medially; smooth area in front of eye convex, nearly as long as wide; ocular canthus short and triangular (1/3 of ocular diameter), sparsely punctate, with a terminal seta. Frons with fine and moderately dense punctures, with a few long erect setae beside eyes and behind lateral frontoclypeal suture. Eyes small, ratio diameter/ interocular width: 0.4. Antenna with ten antennomeres, club (♂) with four antennomeres and straight, slightly longer than remaining antennomeres combined. Mentum convexly elevated and flattened anteriorly.

Pronotum transverse, widest at base, lateral margins evenly convex and moderately convergent anteriorly; anterior angles distinctly produced and sharp, posterior angles blunt and weakly rounded at tip; anterior margin straight, with a fine complete marginal line; surface densely and finely punctate, glabrous, with minute setae in punctures (100× magnification); lateral border densely setose; hypomeron distinctly carinate basally, not produced ventrally. Scutellum triangular, with fine, dense punctures, on midline impunctate, glabrous.

Elytra short-oval, widest shortly behind middle, striae finely impressed, finely and densely punctate, intervals weakly convex, with sparse, fine punctures concentrated along striae, except a few robust setae on penultimate external intervals glabrous; epipleural edge robust, ending at nearly blunt external apical angle of elytra, epipleura densely setose; apical border without a fine fringe of microtrichomes (visible at 100× magnification).

Ventral surface dull, finely and densely punctate; metasternum nearly glabrous except a few long robust setae on disc, punctures with minute setae (100× magnification); metacoxa glabrous, with a few single setae laterally; abdominal sternites finely and densely punctate, with a transverse row of coarse punctures, each bearing a short robust seta, last sternite half as long as penultimate one. Mesosternum between mesocoxae as wide as mesofemur, with a semi-circular ridge bearing long setae. Ratio of length of metepisternum/ metacoxa: 1/ 2.2. Pygidium dull, moderately convex, coarsely and densely punctate, without smooth midline, with a few long setae along apical margin.

Legs short; femora moderately shiny, with two rudimentary longitudinal rows of setae, finely and sparsely punctate, glabrous; metafemur with anterior margin acute, without serrated line behind anterior edge, posterior margin smooth ventrally, in apical half only weakly widened, posterior margin smooth dorsally. Metatibia wide and short, widest at middle, ratio of width/ length: 1/ 2.6; dorsal margin sharply carinate, with two groups of spines, basal group at one third, apical group at three quarters of metatibial length, basally with a few short single setae; lateral face weakly convex, finely and sparsely punctate; ventral edge finely serrated, with three robust nearly equidistant setae; medial face smooth, apex interiorly near tarsal articulation bluntly truncate and slightly concavely sinuate. Tarsomeres ventrally with sparse, short setae, smooth, neither laterally nor dorsally carinate; metatarsomeres with a strongly serrated ridge ventrally, glabrous; first metatarsomere slightly shorter than following two tarsomeres combined and as long as dorsal tibial spur. Protibia short, bidentate, distal tooth sharply pointed at apex; anterior claws symmetrical, basal tooth of inner claw sharply truncate at apex.

Aedeagus: Fig. 3I–K. Habitus: Fig. 3L.

Etymology. The name of the new species is derived from the type locality, Sa ko lia.

Variation. Body length: 6.4–8.1 mm, length of elytra: 4.4–5.2 mm, body width: 4.2–5.3 mm. Colour varies from entirely dark reddish brown to nearly black, often with dark pronotum and brown elytra. Female: antennal club composed of 4 antennomeres, first joint of club slightly shorter than the club, club slightly shorter than remaining antennomeres combined.

Neoserica (s.l.) *tahianensis* Ahrens, Fabrizi & Liu, sp. n.

http://zoobank.org/3BCE3BC2-46A3-45AB-8408-4422458D3F95
Figs 4A–D, 6

Type material examined. Holotype: ♂ "Hainan I. (C.): Ta Hian (TaSianKwang) 600m. VI-10-35 J.L. Gressitt" (BPBM). Paratypes: 1 ♂, 1 ♀ "Yinggen, Hainan, Guangdong, 10.VII.1960, 200m, leg. Zhang Xuezhong" (IZAS), 1 ♂ "Tongshi, Hainan, Guangdong, 31.VII.1960, 340m, leg. Li Suofu" (IZAS), 3 ♂♂, 3 ♀♀ "Shuiman, Hainan, Guangdong, 29.V.1960, 640m, leg. Zhang Xuezhong" (IZAS, ZFMK), 1 ♂ "Tongshi, Hainan, Guangdong, 6.VIII.1960, 340m, leg. Li Suofu" (IZAS).

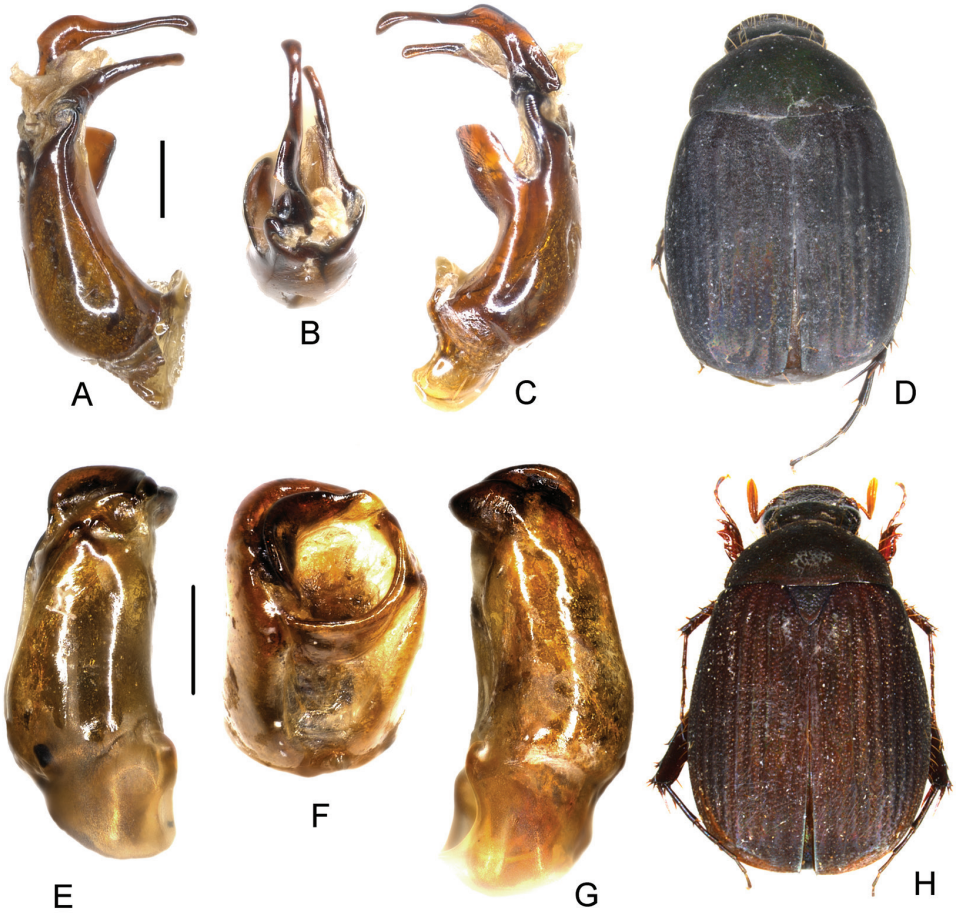

Figure 4. A–D *Neoserica tahianensis* Ahrens, Fabrizi & Liu, sp. n. (holotype) **E–H** *N. silvestris* Brenske (China: Nu Shan) **A, E** aedeagus, left side lateral view **C, G** aedeagus, right side lateral view **B, F** parameres, dorsal view **D, H** habitus. Scale bars: 0.5 mm. Habitus not to scale.

Diagnosis. *Neoserica tahianensis* Ahrens, Fabrizi & Liu, sp. n. is in external appearance and genital morphology similar to *N. obscura* and *N. allobscura*. *Neoserica tahianensis* differs by the large ventral process of the phallobase and by the shape of its parameres: the right paramere is slightly longer than in *N. obscura*, the left one does not possess a dorsal lobe.

Description. Body length: 6.5 mm, length of elytra: 4.3 mm, body width: 4.3 mm. Body short-oval, dark brown, elytra black, abdomen dark brown, dorsal surface except anterior labroclypeus dull, head and pronotum with some greenish shine, pronotum and elytra glabrous.

Labroclypeus subtrapezoidal, distinctly wider than long, widest at base, lateral margins weakly convex, convergent anteriorly; anterior angles strongly rounded; anterior margin shallowly sinuate medially, margins moderately reflexed; surface weakly convex,

shiny, base dull, finely and densely punctate, mixed with a few larger punctures bearing each an erect seta; frontoclypeal suture distinctly incised, weakly curved medially; smooth area in front of eye convex, nearly as long as wide; ocular canthus short and triangular (1/3 of ocular diameter), sparsely punctate, without terminal seta. Frons with fine and moderately dense punctures, with a few long erect setae beside eyes and behind lateral frontoclypeal suture. Eyes small, ratio diameter/ interocular width: 0.42. Antenna with ten antennomeres, club (♂) with four antennomeres and straight, slightly longer than remaining antennomeres combined. Mentum convexly elevated and flattened anteriorly.

Pronotum transverse, widest at base, lateral margins evenly convex and moderately convergent anteriorly; anterior angles distinctly produced and sharp, posterior angles blunt and weakly rounded at tip; anterior margin straight, with a fine complete marginal line; surface densely and finely punctate, glabrous, with minute setae in punctures (100× magnification); lateral border densely setose; hypomeron distinctly carinate basally, not produced ventrally. Scutellum triangular, with fine, dense punctures, glabrous.

Elytra short-oval, widest shortly behind middle, striae finely impressed, finely and densely punctate, intervals weakly convex, with sparse, fine punctures concentrated along striae, except a few robust setae on sutural interval glabrous; epipleural edge robust, ending at nearly blunt external apical angle of elytra, epipleura densely setose; apical border without a fine fringe of microtrichomes (visible at 100× magnification).

Ventral surface dull, finely and densely punctate; metasternum nearly glabrous except a few long robust setae on disc, punctures with minute setae (100× magnification); metacoxa glabrous, with a few single setae laterally; abdominal sternites finely and densely punctate, with a transverse row of coarse punctures, each bearing a short robust seta, last sternite half as long as penultimate one. Mesosternum between mesocoxae as wide as the mesofemur, with a semi-circular ridge bearing long setae. Ratio of length of metepisternum/ metacoxa: 1/ 2.2. Pygidium dull, moderately convex, coarsely and densely punctate, without smooth midline, with a few long setae along apical margin.

Legs short; femora moderately shiny, with two rudimentary longitudinal rows of setae, finely and sparsely punctate, glabrous; metafemur with anterior margin acute, without serrated line behind anterior edge, posterior margin smooth ventrally, in apical half only weakly widened, posterior margin smooth dorsally. Metatibia wide and short, widest at middle, ratio of width/ length: 1/ 2.7; dorsal margin sharply carinate, with two groups of spines, basal group at one third, apical group at three quarters of metatibial length, basally with a few short single setae; lateral face weakly convex, finely and sparsely punctate; ventral edge finely serrated, with three robust nearly equidistant setae; medial face smooth, apex interiorly near tarsal articulation bluntly truncate and slightly concavely sinuate. Tarsomeres ventrally with sparse, short setae, smooth, neither laterally nor dorsally carinate; metatarsomeres with a strongly serrated ridge ventrally, glabrous; first metatarsomere slightly shorter than following two tarsomeres combined and slightly shorter than dorsal tibial spur. Protibia short, bidentate, distal tooth sharply pointed at apex; anterior claws symmetrical, basal tooth of inner claw sharply truncate at apex.

Aedeagus: Fig. 4A–C. Habitus: Fig. 4D.

Etymology. The name of the new species is derived from the type locality, Ta Hian.

Variation. Body length: 6.5–7.1 mm, length of elytra: 4.3–4.6 mm, body width: 4.3–4.7 mm. Colour varies from entirely reddish brown to nearly completely black, often reddish elytra and pronotum with a dark margin. Female: Antennal club composed of 4 antennomeres, first joint of club slightly shorter than the club, club slightly shorter than remaining antennomeres combined.

Neoserica silvestris group

Diagnosis. Body moderately small (7–8 mm), oval, moderately convex; unicoloured black or reddish-brown, dorsal surface dull or with some iridescent shine, nearly glabrous. Antenna with 10 antennomeres, dark; antennal club of ♂ composed of 4 antennomeres, in ♀ of 3 antennomeres, but club shorter than remaining antennomeres combined. Hypomeron basally carinate. Protibia bidentate. Metatibia at apex moderately sinuate close to tarsal articulation. Metafemur with serrated line adjacent to anterior margin. Metatibia moderately wide, with serrated longitudinal line in basal half.

Remarks. The species group is based on *Neoserica silvestris* Brenske, 1902, and proposed here to accommodate the species closely related to *N. silvestris.*

Distribution. So far only known from China and northern Myanmar.

Key to the Chinese species of the *Neoserica silvestris* group:

1 Labroclypeus with a distinct transverse elevation. Antennal club only little longer than the remaining antennomeres combined. ..... ***N. silvestris***

– Labroclypeus flat. Antennal club more than 1.5 times as long as the remaining antennomeres combined. **2**

2 Left paramere shorter and less widely sinuated, its tip is directed straight forward ..... ***N. minor***

– Left paramere longer and more widely sinuated, its tip is not straight but curved interiorly. ..... ***N. pseudosilvestris* Ahrens, Fabrizi & Liu sp. n.**

Neoserica (s.l.) *silvestris* Brenske, 1902

Figs 4E–H, 6

Neoserica silvestris Brenske, 1902: 61.

Type material examined. Syntypes: 2 ♂♂ "Ho-chan/ coll. Thery" (BMNH), 1 ♀ "China Ho-chan/ *Serica silvestris* typ. Brsk./ coll. Brenske" (ZMHB).

Additional material examined. CHINA: 1 ex. "China: (Yunnan) Nujiang Lisu Aut. Pref., Nu Shan, 7 km NNW Caojian, 2420m, 25°43'29"N 99°07'57"E (shrubs, litter, moss shifted) 11.VI.2007 leg. D. Wrase/ DA1553" (ZFMK), 4 ex. "China Sichuan Moxi, VI.1993 M. Hackel lgt." (CN), 1 ex. (♀) "China: Sichuan; Moxi; 29.13N 102.10E, 1600m, 2.vii.1998/ 1998 China Expedition J. Farkac, D. Kral, A. Smetana & J. Schneider" (CP), 8 ex. "Sichuan 1950 m Luding, Xin Shing 1.VI.1990 A. Vigna leg." (CS), 1 ex. "Sichuan, Moxi Gongashan Mts. 28.VI.-2.VII.1994 Bolm lgt. 1650 m" (CP), 1 ex. "China, E Hubei, 7-10.V. Dabie Shan, 31.1N 115.8E Wujiashan forest park Jaroslav Turna leg., 2004" (ZFMK), 3 ♂♂ "China: Sichuan; Wolong Reserve, Sigulian Shan, 31º09'N 103º06'E v.2006, 1500-1800m V. Siniaev" (ZFMK), 12 ex. "Yunnan 2900-3500m 27.01N 100.12E 1993 Yulongshan mts. 24-26/5. Vit Kuban leg." (CP), 5 ex. "Yunnan 2200-2500m 24.57N 98.45E 8-16/5 Gaoligong mts. Vit Kuban leg. 1995" (CP), 2 ex. "C-China, Shaanxi, Qinling Shan, 6km E of Xunyangba 1000-1300m, 23.V.-13.VI. Leg. C. Holzschuh 2000" (CP), 6 ex. "C China, W Sichuan, Luding Xian, Moxi, 9-14.vii.1999, V. Benes leg." (CP), 1 ex. "China-Shaanxi, Daba Shan, Shou Man vil., 32°14'N, 108°34'E, 25.v.-14.vi.2000, 1000m, Siniaev & Plutenko leg." (CP), 1 ex. "China: Yunnan prov., Gaoligongshan mts.; 90km W of Baoshan; S. Becvar leg.; 26.-29.v.1995" (CP), 2 ex. "China, 1000-1300m, Shaanxi, Qinling mts., Xunyangba (6km E) 23,v.-13.vi.1998, J.H. Mashal leg. (CP), 1 ex. (♀) "China, Daxue Shan Mts., Sichuan, Gongga Shan Mt., Moxi, 11-13.vii.1999, 1700m, 29°39'N, 102°06'E, V. Siniaev & A. Plutenko lgt." (CP), 1 ex. "China: N-Yunnan Baiyungshan (Bai Railing Mts.) 2400 m Yong Ren, VII-2003 leg. Ying et al." (ZFMK), 1 ♂ "China: Hunan; Mupu Mt. 1600m, Pingjiang VIII-2003, leg. Li et al." (ZFMK), 2 ♀♀ "China West Sichuan Moximian Luding Co. 13.-18.7.94 Benes" (ZFMK), 2 ex. (♀) "Yunnan 2000-3000m 25.11N 100.24E Weibaoshan mts. W slope 25-28/6.92 Vit Kuban leg." (ZFMK), 1 ex. "Den Shiang Uen nr Ningyuenfu/ viii. 9-10-'28 8000-9500ft./ China DC Graham" (USNM), 1 ex. Chengtu 1933/ Szechwan China DC Graham XI-28 alt. 1700ft." (USNM), 1 ex. "Yachow dist. May '28 Coll'r Chen Gih Uen/ Szechuen China DC Graham" (USNM), 1 ex. "Kuanshan Szechwan China DC Graham 19-20-33 alt. 2200-5200ft." (USNM), 1 ♂, 2 ♀♀ "Heilongtan, Kunming, Yunnan, 5.IV.1956, 1900m, leg. Huang Keren *etc.*" (IZAS), 1 ♂ "Heilongtan, Kunming, Yunnan, 5.IV.1956, 1900m, leg. Huang Keren" (IZAS), 1 ♂ "Lomgmenhe, Xingshan, Hubei, 21.VI.1993, 1260m, leg. Li Hongxing" (IZAS), 1 ♂ "Kunming, Yunnan, 7.VI.1955, 1900m, leg. Li Xiwen" (IZAS), 1 ♂ "Menghai, Xishuangbanna, Yunnan, 18.VII.1958, 1200-1600m, leg. Wang Shuyong" (IZAS), 1 ♂ "Institute of Agricultural Sciences, Bijie, Guizhou, leg. Yang, No. 55" (IZAS), 1 ♂ "Botany Garden, Guiyang, Guizhou, 1981" (IZAS), 1 ♂ "Louguantai, Qinling, 30.V.1951" (NWAFU), 1 ♂ "Mt. Taishan, Shangdong, 31.V.1956" (IZAS), 1 ♂ "Xinxing, Luding, Sichuan, 15.VI.1983, 1900m, leg. Chen Yuanqing" (IZAS), 1 ♂ "Yunlong, Yunnan, 20.VI.1981, 2450m, leg. Liao Subai" (IZAS), 1 ♂ "Mts. Lushan, Yiyuan, Shandong, 19.V.2007, leg. Wang Fengyan, Wang Jiliang, Wu Qiqi" (HBUM). **MYANMAR:** 2 ♂♂ "Myanmar (Burma) Provinz Kachin State Kanphat/ Grenze zu China 24.V.2006 leg. Michael Langer, Stefan Naumann & Swen

Loeffler coll. M. Langer/ Nachtfang/ 1642m N26°08'512" E098°34'582" " (ZFMK), 1 ♂ "Myanmar (Burma) Provinz Kachin State ca 20 km N von Panwar 23.V.2006 leg. Michael Langer, Stefan Naumann & Swen Loeffler coll. M. Langer/ Nachtfang/ 2180m N25°43'302" E098°23'353" " (ZFMK).

Redescription. Body length: 8.1 mm, length of elytra: 4.0 mm, body width: 3.8 mm. Body short-oval, black to dark brown, antenna yellow, dorsal surface except labroclypeus dull or with iridescent or greenish shine, pronotum and elytra glabrous.

Labroclypeus subtrapezoidal, distinctly wider than long, widest at base, lateral margins strongly convex, convergent anteriorly; anterior angles strongly rounded; anterior margin distinctly sinuate medially, margins moderately reflexed; surface with a convex transverse ridge, moderately shiny, coarsely and very densely punctate, with a few erect setae anteriorly; frontoclypeal suture finely incised, evenly curved; smooth area in front of eye convex, 1.5 times as wide as long; ocular canthus short and triangular (1/3 of ocular diameter), densely and finely punctate, with one terminal seta. Frons with fine and sparse punctures, with two long erect setae beside eyes. Eyes small, ratio diameter/ interocular width: 0.51. Antenna with ten antennomeres, club (♂) with four antennomeres and straight, slightly longer than remaining antennomeres combined. Mentum convexly elevated and flattened anteriorly.

Pronotum transverse, widest at base, lateral margins evenly convex and weakly convergent anteriorly; anterior angles distinctly produced and sharp, posterior angles blunt and moderately rounded at tip; anterior margin convex, with a very fine but complete marginal line; surface densely and finely punctate, glabrous, with minute setae in punctures (100× magnification); lateral border densely setose; hypomeron distinctly carinate basally, not produced ventrally. Scutellum triangular, with fine, dense punctures, glabrous.

Elytra oval, widest in posterior third, striae finely impressed, finely and densely punctate, intervals weakly convex, with dense, fine punctures concentrated along striae, glabrous except a few single, short setae on penultimate lateral interval; epipleural edge robust, ending at convex external apical angle of elytra, epipleura densely setose; apical border with a fine fringe of microtrichomes (visible at 100× magnification).

Ventral surface dull, finely and densely punctate; metasternum nearly glabrous except a few long robust setae on disc, punctures with minute setae (100× magnification); metacoxa glabrous, with a few single setae laterally; abdominal sternites finely and densely punctate, with a transverse row of coarse punctures, each bearing a short robust seta, last sternite half as long as penultimate one. Mesosternum between mesocoxae as wide as the mesofemur, with a semi-circular ridge bearing long setae. Ratio of length of metepisternum/ metacoxa: 1/ 1.49. Pygidium dull, strongly convex, finely and densely punctate, without smooth midline, with a few long setae along apical margin.

Legs short; femora moderately shiny, with two longitudinal rows of setae, finely and sparsely punctate, glabrous; metafemur with anterior margin acute, with a continuous, serrated line behind anterior edge, posterior margin smooth ventrally, in apical half only weakly widened, posterior margin smooth dorsally. Metatibia moderately wide and short, widest at middle, ratio of width/ length: 1/ 2.95; dorsal margin sharply

carinate, with two groups of spines, basal group shortly behind middle, apical group at 4/5 of metatibial length, in basal half with a serrated line beside dorsal margin ending at basal group of spines, beside it with a few single short setae; lateral face longitudinally convex, finely and densely punctate, smooth along middle; ventral edge finely serrated, with three robust nearly equidistant setae; medial face smooth, apex interiorly near tarsal articulation bluntly truncate and slightly concavely sinuate. Tarsomeres sparsely and finely punctate dorsally, with sparse, short setae ventrally, neither laterally nor dorsally carinate; metatarsomeres with a strongly serrated ridge ventrally, glabrous; first metatarsomere slightly shorter than following two tarsomeres combined and one third of its length longer than dorsal tibial spur. Protibia short, bidentate, distal tooth sharply pointed at apex, external margin bluntly widened at middle; anterior claws symmetrical, basal tooth of inner claw sharply truncate at apex.

Aedeagus: Fig. 4E–G. Habitus: Fig. 4H.

Variation. The colour varies from totally black or reddish brown to black with reddish brown elytra. Female: Antennal club also composed of 3 antennomeres, however, the club is slightly shorter than in males, and the first joint of club is slightly shorter.

Neoserica (s.l.) *minor* (Arrow, 1946), comb. n.

Figs 5A–D, 6

Aserica minor Arrow, 1946a: 15.

Type material examined. Syntype: ♂ "N. E. Burma Kambaiti 7000 ft. 24/5.1934/ N. E. Burma R. Malaise B. M. 1945-71/Co-Type/ Aserica minor Arrow co-type" (BMNH).

Additional material examined. 1 ♂ "China, W Yunnan prov., mts. 60km E Tengchong, 2200m, 19.-22.v.2006, S. Murzin & I. Shokhin" (CP).

Redescription. Body length: 7.2 mm, length of elytra: 5.2 mm, body width: 4.4 mm. Body short-oval, black to dark brown, antenna yellow, dorsal surface except labroclypeus dull, pronotum and elytra glabrous.

Labroclypeus subtrapezoidal, distinctly wider than long, widest at base, lateral margins weakly convex, convergent anteriorly; anterior angles moderately rounded; anterior margin distinctly sinuate medially, margins moderately reflexed; surface nearly flat, moderately shiny, coarsely and very densely punctate, with a few erect setae anteriorly; frontoclypeal suture finely incised, convexly bent at middle; smooth area in front of eye convex, 1.2 times as wide as long; ocular canthus short and triangular (1/3 of ocular diameter), densely and finely punctate, with one terminal seta. Frons with coarse and dense punctures, glabrous. Eyes small, ratio diameter/ interocular width: 0.51. Antenna with ten antennomeres, club (♂) with four antennomeres and straight, 1.7 times as long as remaining antennomeres combined. Mentum convexly elevated and flattened anteriorly.

Pronotum transverse, widest at base, lateral margins in basal half nearly straight and moderately convergent, in anterior half evenly convex and weakly convergent

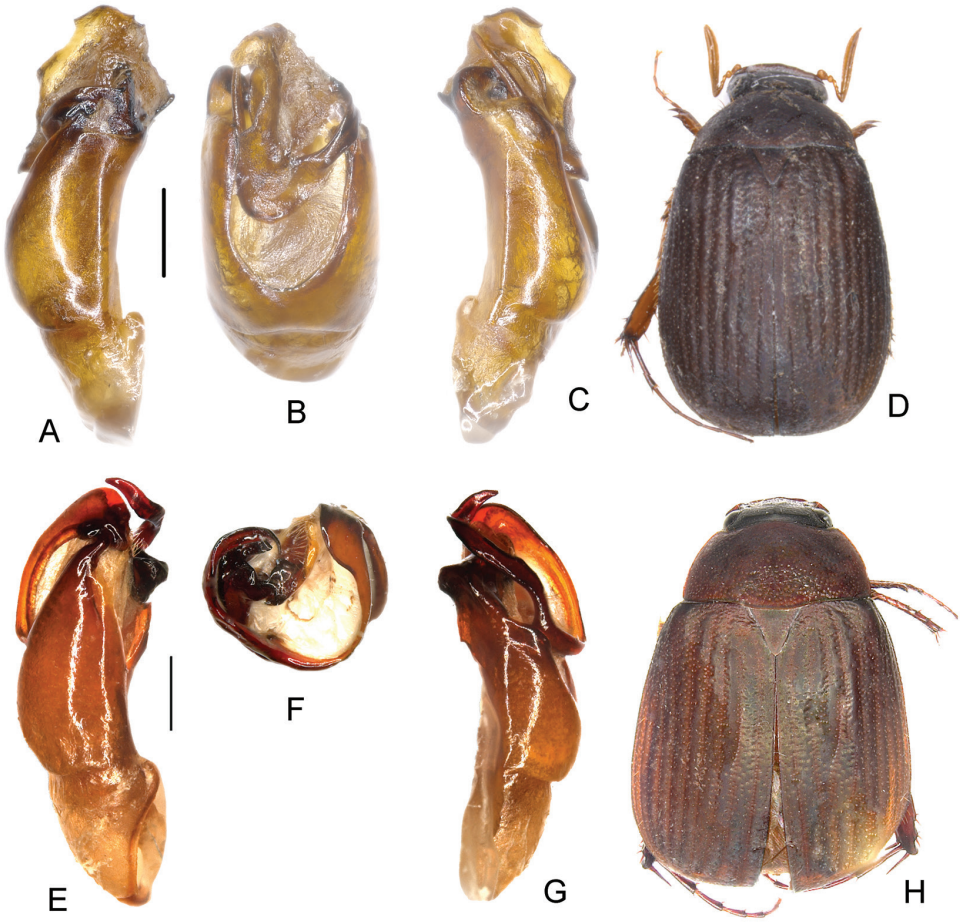

Figure 5. A–D *Neoserica minor* (Arrow) (China: 60km E Tengchong), **E–H** *N. pseudosilvestris* Ahrens, Fabrizi & Liu, sp. n. (holotype). **A, E** aedeagus, left side lateral view **C, G** aedeagus, right side lateral view **B, F** parameres, dorsal view **D, H** habitus. Scale bars: 0.5 mm. Habitus not to scale.

anteriorly; anterior angles distinctly produced and sharp, posterior angles blunt and moderately rounded at tip; anterior margin convex, with a very fine but complete marginal line; surface densely and finely punctate, glabrous, with minute setae in punctures (100× magnification); lateral border densely setose; hypomeron distinctly carinate basally, not produced ventrally. Scutellum triangular, with fine, dense punctures, glabrous.

Elytra oval, widest in posterior third, striae finely impressed, finely and densely punctate, intervals weakly convex, with dense, fine punctures concentrated along striae, glabrous except a few single, short setae on penultimate lateral interval; epipleural edge robust, ending at convex external apical angle of elytra, epipleura densely setose; apical border with a fine fringe of microtrichomes (visible at 100× magnification).

Ventral surface dull, finely and densely punctate; metasternum nearly glabrous except a few long robust setae on disc, punctures with minute setae (100× magnification); metacoxa glabrous, with a few single setae laterally; abdominal sternites finely and densely punctate, with a transverse row of coarse punctures, each bearing a short robust seta, last sternite half as long as penultimate one. Mesosternum between mesocoxae as wide as the mesofemur, with a semi-circular ridge bearing long setae. Ratio of length of metepisternum/ metacoxa: 1/ 1.52. Pygidium dull, strongly convex, finely and densely punctate, without smooth midline, with a few long setae along apical margin.

Legs moderately long; femora moderately shiny, with two longitudinal rows of setae, finely and sparsely punctate, glabrous; metafemur with anterior margin acute, with a continuous, serrated line behind anterior edge, posterior margin smooth ventrally, in apical half only weakly widened, posterior margin smooth dorsally. Metatibia narrow and moderately long, widest at middle, ratio of width/ length: 1/ 3.35; dorsal margin sharply carinate, with two groups of spines, basal group shortly behind middle, apical group at 4/5 of metatibial length, in basal half with a serrated line beside dorsal margin ending at basal group of spines, beside it with a few single short setae; lateral face longitudinally convex, finely and densely punctate, smooth along middle; ventral edge finely serrated, with three robust nearly equidistant setae; medial face smooth, apex interiorly near tarsal articulation bluntly truncate and slightly concavely sinuate. Tarsomeres sparsely and finely punctate dorsally, with sparse, short setae ventrally, neither laterally nor dorsally carinate; metatarsomeres with a strongly serrated ridge ventrally, glabrous; first metatarsomere slightly shorter than following two tarsomeres combined and one third of its length longer than dorsal tibial spur. Protibia short, bidentate, distal tooth sharply pointed at apex, external margin bluntly widened at middle; anterior claws symmetrical, basal tooth of inner claw sharply truncate at apex.

Aedeagus: Fig. 5A–C. Habitus: Fig. 5D. Female unknown.

Neoserica (s.l.) *pseudosilvestris* Ahrens, Fabrizi & Liu, sp. n.

http://zoobank.org/E594F234-FBCF-4DB3-9404-F7D3BAED567F
Figs 5E–H, 6

Type material examined. Holotype: ♂ "[China] Yunnan, Yakou, 2012-V-11/ LW-1319" (IZAS).

Diagnosis. *Neoserica pseudosilvestris* Ahrens, Fabrizi & Liu sp. n. is in external appearance very similar to *N. minor* (Arrow). The new species differs by the longer left paramere being more widely sinuated and having the tip not straight but curved interiorly.

Description. Body length: 8.0 mm, length of elytra: 6.1 mm, body width: 5.1 mm. Body short-oval, black to dark brown, antenna yellow, dorsal surface except labroclypeus dull, pronotum and elytra glabrous.

Labroclypeus subtrapezoidal, distinctly wider than long, widest at base, lateral margins strongly convex, convergent anteriorly; anterior angles moderately rounded;

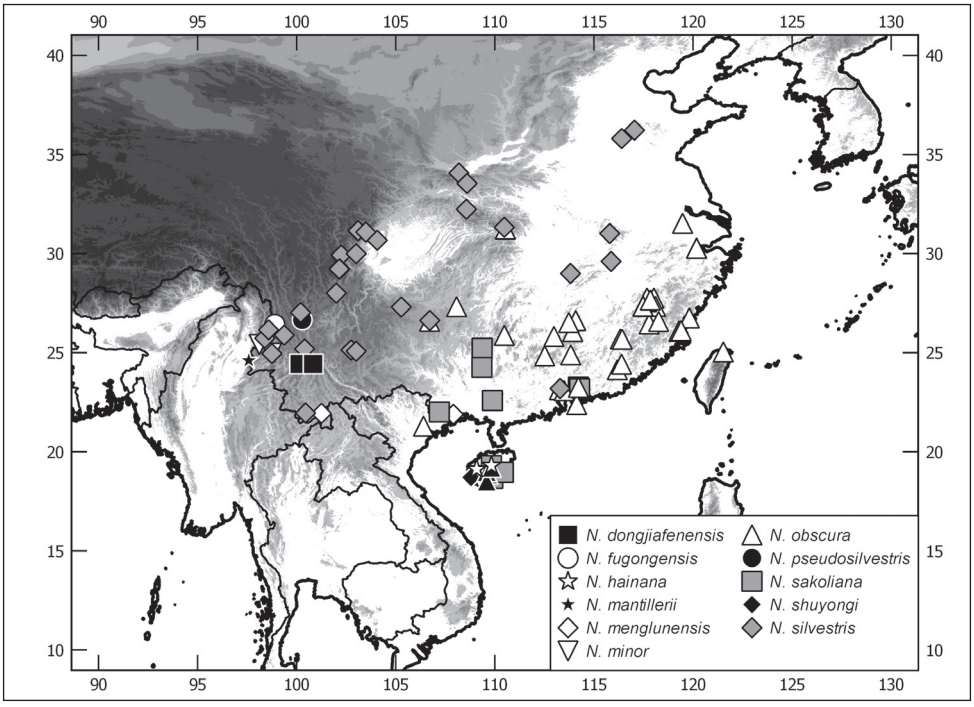

Figure 6. Distribution of the species of the *Neoserica obscura*, *N. lubrica* and *N. silvestris* groups [in China].

anterior margin distinctly sinuate medially, margins moderately reflexed; surface nearly flat, shiny, finely and very densely punctate, with a few erect setae anteriorly; frontoclypeal suture finely incised, convexly bent at middle; smooth area in front of eye convex, 1.3 times as wide as long; ocular canthus long and subtriangular (nearly half of ocular diameter), densely and finely punctate, with one terminal seta. Frons with moderately coarse and dense punctures, with two single erect setae beside eyes. Eyes small, ratio diameter/ interocular width: 0.54. Antenna with ten antennomeres, club (♂) with four antennomeres and straight, 1.7 times as long as remaining antennomeres combined. Mentum convexly elevated and flattened anteriorly.

Pronotum transverse, widest at base, lateral margins evenly convex and weakly convergent anteriorly; anterior angles distinctly produced and sharp, posterior angles blunt and moderately rounded at tip; anterior margin convex, with a very fine but complete marginal line; surface densely and finely punctate, with minute setae in punctures (100× magnification); lateral border densely setose; hypomeron distinctly carinate basally, not produced ventrally. Scutellum triangular, with fine, dense punctures, punctures on basal midline less dense, with minute setae in punctures.

Elytra oval, widest in posterior third, striae finely impressed, finely and densely punctate, intervals weakly convex, with dense, fine punctures concentrated along striae, glabrous except a few single, short setae on penultimate lateral interval; epipleural

edge robust, ending at convex external apical angle of elytra, epipleura densely setose; apical border with a fine fringe of microtrichomes (visible at 100× magnification).

Ventral surface dull, finely and densely punctate; metasternum nearly glabrous except a few long robust setae on disc, punctures with minute setae (100× magnification); metacoxa glabrous, with a few single setae laterally; abdominal sternites finely and densely punctate, with a transverse row of coarse punctures, each bearing a short robust seta, last sternite half as long as penultimate one. Mesosternum between mesocoxae as wide as the mesofemur, with a semi-circular ridge bearing long setae. Ratio of length of metepisternum/ metacoxa: 1/ 1.5. Pygidium dull, strongly convex, coarsely and densely punctate, without smooth midline, with a few long setae on apical quarter, otherwise punctures with minute setae.

Legs moderately long; femora moderately shiny, with two longitudinal rows of setae, finely and sparsely punctate, glabrous; metafemur with anterior margin acute, with a continuous, serrated line behind anterior edge, posterior margin smooth ventrally, in apical half only weakly widened, posterior margin smooth dorsally. Metatibia narrow and moderately long, widest at middle, ratio of width/ length: 1/ 3.75; dorsal margin sharply carinate, with two groups of spines, basal group at 3/5, apical group at 4/5 of metatibial length, in basal half with a serrated line beside dorsal margin ending at basal group of spines, beside it with a few single short setae; lateral face longitudinally convex, finely and densely punctate, smooth along middle; ventral edge finely serrated, with three robust nearly equidistant setae; medial face smooth, apex interiorly near tarsal articulation bluntly truncate and slightly concavely sinuate. Tarsomeres sparsely and finely punctate dorsally, with sparse, short setae ventrally, neither laterally nor dorsally carinate; metatarsomeres with a strongly serrated ridge ventrally, glabrous; first metatarsomere slightly shorter than following two tarsomeres combined and one third of its length longer than dorsal tibial spur. Protibia short, bidentate, distal tooth sharply pointed at apex, external margin bluntly widened at middle; anterior claws symmetrical, basal tooth of inner claw sharply truncate at apex.

Aedeagus: Fig. 5E–G. Habitus: Fig. 5H. Female unknown.

Etymology. The name of the new species is the combined Greek prefix "pseudo-" (false) and the species name "*silvestris*" (with reference to the resemblance to *N. silvestris*).

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References

Ahrens D (2004) *Monographie der Sericini des Himalaya (Coleoptera, Scarabaeidae).* Dissertation.de – Verlag im Internet GmbH, Berlin, 534 pp.

Ahrens D, Fabrizi S (2011) New species of Sericini from the Himalaya and adjacent mountains (Coleoptera: Scarabaeidae). Bonn zoological Bulletin 60(2): 139–164.

Ahrens D, Liu WG, Fabrizi S, Bai M, Yang XK (2014a) A taxonomic review of the *Neoserica* (sensu lato) *septemlamellata* group (Coleoptera: Scarabaeidae: Sericini). Zookeys 402: 76–102. doi: 10.3897/zookeys.402.7360

Ahrens D, Liu WG, Fabrizi S, Bai M, Yang XK (2014b) A taxonomic review of the *Neoserica* (sensu lato) *abnormis* group (Coleoptera: Scarabaeidae: Sericini). Zookeys 439: 28–82. doi: 10.3897/zookeys.439.8055

Ahrens D, Liu WG, Fabrizi S, Bai M, Yang XK (2014c) A revision of the species of the *Neoserica* (sensu lato) *vulpes* group (Coleoptera: Scarabaeidae: Sericini). Journal of Natural History. doi: 10.1080/00222933.2014.974707 [Online version; printed: 2015; Journal of Natural History 49(17–18): 1073–1130]

Arrow GJ (1946a) Entomological results from the Swedish Expedition 1934 to Burma and British India. Coleoptera: Melolonthidae. Arkiv for Zoologi 38A(9): 1–33.

Arrow GJ (1946b) Notes on *Aserica* and some related genera of melolonthine beetles, with descriptions of a new species and two new genera. Annals and Magazine of Natural History Series 11 13: 264–283.

Blanchard ME (1850) Catalogue de la collection Entomologique. Classes des Insectes. Ordre des Coléoptères. part.: Melolonthidae. Tom I. Mus. Hist. Nat. Paris, 1–128.

Brenske E (1898) Die *Serica*-Arten der Erde. Berliner Entomologische Zeitschrift 43: 205–403.

Brenske E (1902) Die *Serica* -Arten der Erde. VII. Berliner Entomologische Zeitschrift 47: 1–70.

Frey G (1972a) Neue Sericinen aus Indien und Indochina, sowie Abbildungen von Parameren bekannter Arten (Col., Scarab., Melolonthinae). Entomologische Arbeiten aus dem Museum Frey 23: 186–216.

Frey G (1972b) Neue Sericinen der Klapperich-Ausbeute aus Fukien des Alexander Koenig Museum in Bonn (Col., Scarab., Melolonth.). Entomologische Arbeiten aus dem Museum Frey 23: 162–177.

Liu WG, Fabrizi S, Bai M, Yang XK, Ahrens D (2014a) A taxonomic revision of the *Neoserica* (s.l.) *pilosula* group (Coleoptera, Scarabaeidae, Sericini). Zookeys 440: 89–113. doi: 10.3897/zookeys.440.8126

Liu WG, Fabrizi S, Bai M, Yang XK, Ahrens D (2014b) A taxonomic revision of the *Neoserica* (sensu lato) *calva* group (Coleoptera, Scarabaeidae, Sericini). ZooKeys 448: 47–81. doi: 10.3897/zookeys.448.8368

Liu WG, Fabrizi S, Bai M, Yang XK, Ahrens D (2014c) A review of the *Tetraserica* species of China (Coleoptera, Scarabaeidae, Sericini). ZooKeys 448: 83–121.

Liu WG, Bai M, Yang XK, Ahrens D (2015) New species and records of the *Neoserica* (sensu stricto) group (Coleoptera, Scarabaeidae, Sericini). Journal of Natural History 49(39–40): 2379–2395. doi: 10.1080/00222933.2015.1034208