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RESEARCH ARTICLE

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A new species of *Socarnes* Boeck, 1871 (Crustacea, Amphipoda, Lysianassidae) from Korean waters

Young-Hyo Kim[1,†], Ed A. Hendrycks[1,‡]

1 *Canadian Museum of Nature, Research and Collections, P.O. Box 3443, Station D, Ottawa, Canada K1P 6P4*

† *http://zoobank.org/1194DE92-AFFD-408D-8E09-FDC8EDA9BAC6*
‡ *http://zoobank.org/2FAD7817-1822-49F7-BAD6-2F2DB632747A*

Corresponding author: *Young-Hyo Kim* (amphipod74@gmail.com)

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Abstract

A new species of lysianassid amphipod belonging to the genus *Socarnes* Boeck was collected from Korean coastal waters. This is the first record of the genus *Socarnes* from Korea. The new species is fully illustrated and extensively compared with related species. A key to *Socarnes* species is provided.

Keywords

Amphipoda, lysianassid, *Socarnes*, new species, Korea, key, taxonomy

Introduction

The subfamily Lysianassinae Dana, 1849 is a large group of the family Lysianassidae, with 29 genera. Among these genera, *Socarnes* has close affinity to the *Concarnes*, *Socarnoides*, *Socarnella*, *Socarnopsis*, and *Socarnella* by having a simple gnathopod 1 and cleft telson. However, the *Socarnes* is further characterized by the protruded upper lip, apically serrated palp of maxilla 1, and biarticulated outer ramus of uropod 3.

Species of *Socarnes* are widely distributed and are found in shallow to deep water, from the Arctic to the tropical South Pacific including temperate regions (Mediterranean and East Asia). Ecologically, they are well known scavengers (Lowry and Stoddart 1994;

Hall-Spencer and Bamber 2007). The genus is relatively small, being comprised of 10 species. Hitherto, only two species of the subfamily Tryphosinae belonging to the family Lysianassidae, *Orchomenella obtusa* (Sars, 1895) and *O. japonica* Gurjanova, 1962 have been recorded in Korea (KSSZ 1997, Jung and Kim 2008), even though the family Lysianassidae is one of the most speciose. This is the first record of the genus *Socarnes* from Korea and brings the total recorded number of lysianassid species to three from Korea. Many more are to be expected with increased sampling in this area, considering the high diversity of the group. A key to the world *Socarnes* species is also provided.

Material and methods

Specimens were collected with a hand-net from various algae, seagrass and coral rubble from shallow waters of Gyeongpo, Tongyeong-si, Korea. The specimens were fixed with 80% ethyl alcohol and dissected in glycerol on Cobb's aluminum hollow slides. Permanent mounts were made using polyvinyl lactophenol with lignin pink added. Drawings and measurements were performed with the aid of a drawing tube, mounted on an Olympus SZX 12 stereomicroscope and Olympus BX 51 interference contrast compound microscope. The body length was measured from the tip of rostrum to the end of the telson, along the dorsal parabolic line of the body. Nomenclature of the terms 'tooth', 'spine' and 'seta' follows Barnard and Karaman (1991) and terminology of the setae of the mandibular palp follows Lowry and Stoddart (1993). Type specimens are deposited at the National Institute of Biological Resources (NIBR), Incheon, Korea, Department of Biological Science, Dankook University (DKU), Cheonan, Korea and the Canadian Museum of Nature (CMN), Ottawa, Canada.

Taxonomy

Genus *Socarnes* Boeck, 1871
http://species-id.net/wiki/Socarnes
(Korean Name : Min-son-gin-pal-yeop-sae-u-sok, new)

Type species. *Lysianassa vahlii* Krøyer, 1838

Diagnosis. Lateral cephalic lobe acutely projecting. Mouthparts forming quadrate bundle. Upper lip protruded strongly beyond epistome with rounded lobe. Maxilla 1, palp serrate apically. Gnathopod 1 simple. Uropod 2, inner ramus with or without notch. Uropod 3, outer ramus biarticulate, longer than inner ramus. Telson cleft.

Species composition. The genus contains 11 species as follows: *Socarnes allectus* Andres, 1981; S. *bidenticulatus* (Bate, 1858); *S. erythrophthalmus* Robertson, 1892; *S. filicornis* (Heller, 1866); *S. hartmani* Hurley, 1963; *S. rurutu* Lowry & Stoddart, 1994; *S. septimus* Griffiths, 1975; *S. tiendi* Lowry & Stoddart, 1994; *S. tongyeongensis* sp. n. (this study); *S. tuscarora* Lowry & Stoddart, 1994 and *S. vahlii* (Krøyer, 1838).

***Socarnes tongyeongensis* sp. n.**
http://zoobank.org/2E99DBF6-302F-49BC-9605-7562A2DAF5FC
http://species-id.net/wiki/Socarnes_tongyeongensis
Korean name: Tong-yeong-gin-pal-yeop-sae-u, new
Figures 1–4

Type material. Holotype: female, 9.3 mm, NIBRIV0000282400, Gyeongpo, Pungwha-ri, Sanyang-eup, Tongyeong-si, Gyeongsangnam-do, Korea, 34°49'47"N, 128°22'21"E, Y.H. Kim, 24 August 2005. Paratypes: two females, 7.2, 11.3 mm, CMNC 2013-0003, same station data as holotype; six females, 6.3–10.7 mm, DKU 201301, same station data as holotype.

Description. Holotype, **female**, NIBRIV0000282400.

Body (Fig. 2A) 9.3 mm long. Eye medium, reniform, black. Lateral cephalic lobe apically triangular, pointed. Upper lip protruded beyond epistome in large rounded lobe. Pereonites 1–7 dorsally smooth. Pleonites 1–3 (Fig. 2B) dorsally smooth, with very fine setae. Epimeron 2 with small posteroventral tooth. Epimeron 3 with rounded-quadrate posteroventral corner. Epimera 2–3 slightly deeper than epimeron 1. Urosomite 1 shallowly concave anterodorsally, with fine setae. Urosomite 3 with 1 small dorsal spine on each side.

Antenna 1 (Fig. 2C) short, 1.46 × head, weakly setose; peduncular article 1 stout, 0.6 × as wide as long; peduncular article 3 short, 0.67 × flagellum article 1, with transverse row of aesthetascs distomedially; length ratio of peduncular articles 1–3 = 1.00 : 0.32 : 0.16; flagellum 6-articulate, slightly shorter than peduncle, each article bearing long aesthetascs; accessory flagellum 5-articulate, 0.54 × primary flagellum.

Antenna 2 (Fig. 2D) slender, moderately setose, subequal in length to antenna 1; peduncular article 4 2.44 × article 5; flagellum 10-articulate, proximal article slightly shorter than peduncular article 5, subequal in length to second and third articles combined.

Lower lip (Fig. 2E) with broad outer lobe covered with patch of pubescence medially, mandibular process thin and blunt apically.

Left mandible (Fig. 2F) incisor simple, smooth, blunt apically; lacinia mobilis simple, slender, and curved; accessory setal row with 3 small blunt spines; molar elongate and forms a setose ridge; palp triarticulate, set below molar level, proximal segment short, article 2 elongate 1.63 × article 3, with 8 A2 setae and 1 E2 seta, distal article covered with patch of pubescence laterally, with 2 D3 setae and 4 unequal E3 setae.

Maxilla 1 (Fig. 2G) inner plate small, narrowing distally with 2 weakly plumose apical setae; outer plate armed with 11 (3–6 multi dentate) spine-teeth in 7/4 arrangement; palp curved, broad, biarticulate, proximal segment short, subrectangular, distal one extending beyond end of outer lobe, serrate apically without terminal setae.

Maxilla 2 (Fig. 2H) inner plate with dense pubescence medially, apical margin with 2 rows of simple or pectinate setae; outer plate subequal in width to inner and slightly longer, with simple and pectinate setae apically.

Maxilliped (Fig. 2I) inner plate slender, reaching beyond article 1 of palp, with 3 apical nodular spines and an oblique row of 5 plumose setae; outer plate broad, sub-

Figure 1. *Socarnes tongyeongensis* sp. n., female, 8.8 mm, Gyeongpo, Pungwha-ri, Sanyang-eup, Tongyeong-si, Korea.

quadrate, distal margin subtruncate, reaching less than distal end of article 2 of palp, lacking apical setae or spines except 2 unequal simple setae medially; palp slender, 4-articulate, article 2 elongate, medial margin with 15 simple setae, article 3 subrectangular; distal article falcate, 0.55 × article 3.

Gnathopod 1 (Fig. 3A) coxa large, subquadrate, 0.56 × as wide as long, anterior margin slightly concave, broadly rounded anteroventrally; basis subrectangular, width 0.37 × length, subequal in length to merus - dactylus combined, with 5 simple setae anteriorly; merus and carpus with cluster of simple setae posterodistally and denticulate patches posteriorly; propodus characteristic in form, simple, gradually narrowing distally, 0.85 × carpus, with long simple setae on the medial and posterior margins; dactylus falcate, short.

Gnathopod 2 (Fig. 3B) coxa subrectangular, width 0.45 × length, gradually broadened distally; basis linear, elongate; ischium elongate, subequal in length to carpus, with cluster of 5 simple setae posterodistally; carpus broadly convex posteriorly, anterolateral surface with patch of spinules; propodus subovate, minutely chelate, rather elongated, narrowing anterodistally, posterior margin straight, length 0.51 × carpus, with surface covered by tiny spinules, medially with 4 rows of simple setae, palm obtuse; dactylus small, short, stubby, slightly less than palmar corner.

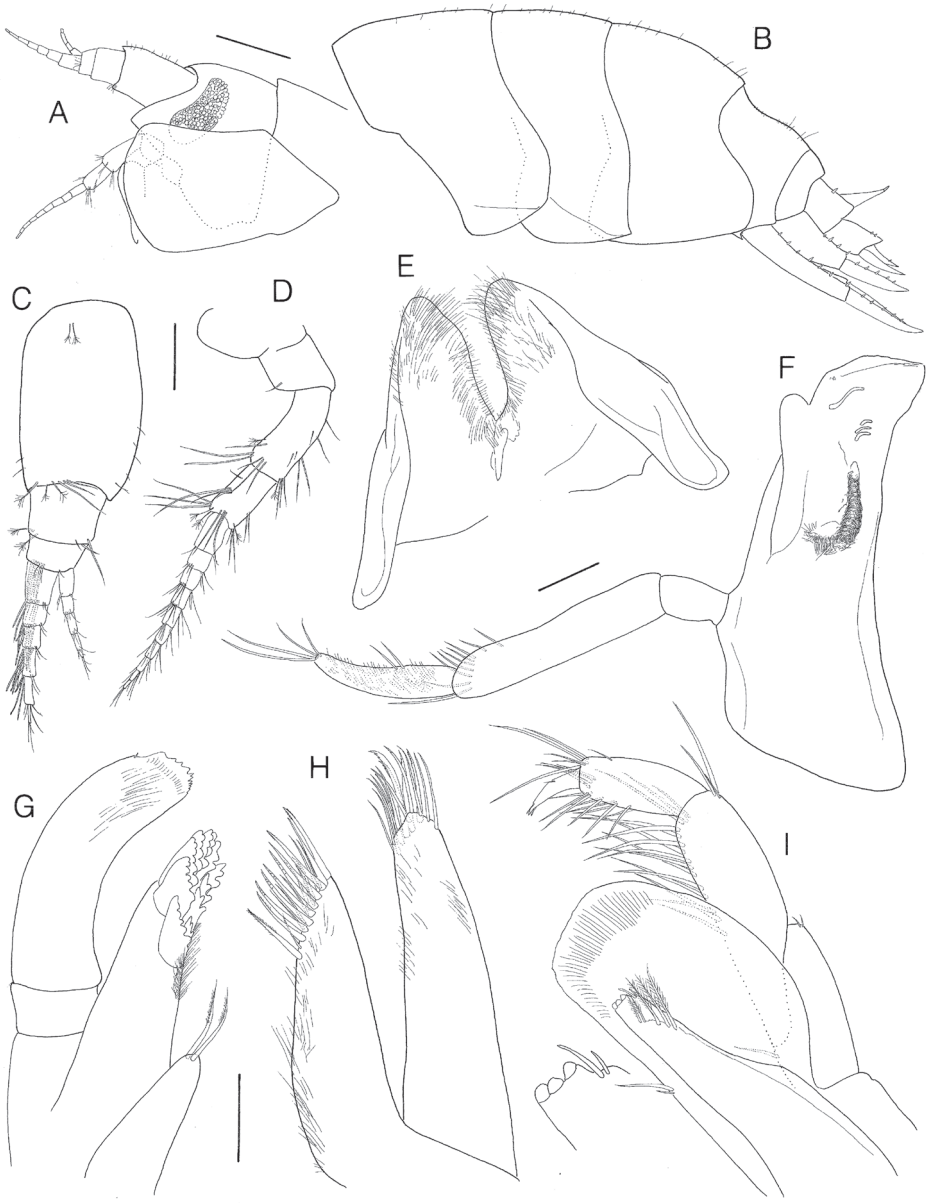

Figure 2. *Socarnes tongyeongensis* sp. n., holotype, female, 9.3 mm, Gyeongpo, Pungwha-ri, Sanyang-eup, Tongyeong-si, Korea. **A** head **B** Pleonites **C** antenna 1 **D** antenna 2 **E** lower lip **F** left mandible **G** maxilla 1 **H** maxilla 2 **I** maxilliped. Scale bars: 0.5 mm (**A**, **B**), 0.2 mm (**C**, **D**), 0.1 mm (**E–I**).

Pereopod 3 (Fig. 3C) coxa similar in shape but slightly narrower (× 0.9) than that of gnathopod 2; ischium to carpus with simple setae on posterior margins; propodus subrectangular, with a row of 8 stiff setae posteriorly and 2 small spines posterodistally; dactylus length 0.5 × propodus.

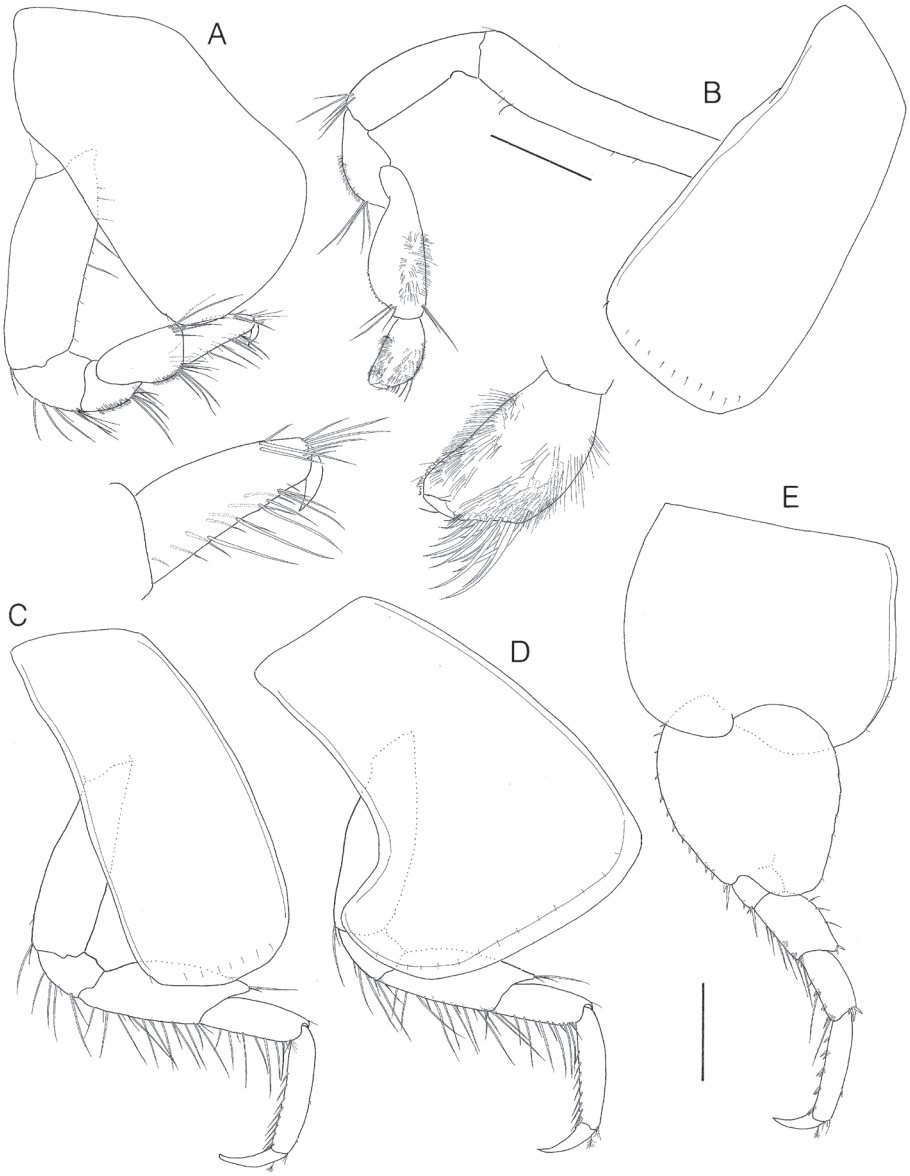

Figure 3. *Socarnes tongyeongensis* sp. n., holotype, female, 9.3 mm, Gyeongpo, Pungwha-ri, Sanyang-eup, Tongyeong-si, Korea. **A** gnathopod 1 **B** gnathopod 2 **C** pereopod 3 **D** pereopod 4 **E** pereopod 5. Scale bars: 0.4 mm.

Pereopod 4 (Fig. 3D) similar to pereopod 3 except coxa broader (× 1.78) than that of pereopod 3, posterodistal lobe strong, posterior margin strongly excavate.

Pereopod 5 (Fig. 3E) coxa large, width 1.21 × length, equilobate, posterior lobe broader than anterior; basis subovate, roundly expanded posteriorly, width 0.84 ×

length, posterodistal lobe reaching beyond ischium, with row of 12 spines anteriorly and unequal triad spines anterodistally; merus subequal in length to carpus, with long setae and small spines anteriorly; propodus subrectangular, 1.56 × carpus, with 5 clusters of spines anteriorly; dactylus falcate, 0.44 × propodus.

Pereopod 6 (Fig. 4A) coxa quadrangular, with rounded corners, subequal in length and width, weakly bilobate; basis subovate, broadly rounded, expanded posteriorly, width 0.84 × length, anterodistal margin with row of spines, posterior margin straight; ischium lined with long setae anteriorly; merus broad, width 0.65 × length, subequal in length to carpus, lined with 4 long setae anteriorly and 1 long spine anterodistally; propodus subrectangular, 1.17 × carpus, with 5 clusters of 2 spines on anterior margin.

Pereopod 7 (Fig. 4B) similar to pereopod 6, but coxa nonlobate, basis larger than that of pereopod 6, more broadly rounded, weakly serrulate posteriorly and with slight posterodistal truncation; anterior margins of ischium and merus lacking long setae.

Uropod 1 (Fig. 4C) peduncle subrectangular, 1.43 × outer ramus, with row of 6 dorsolateral spines, 1 apicolateral spine; outer ramus subequal in length to inner, dorsolateral margin with 5 spines, inner ramus with 4 dorsolateral and 2 medial spines.

Uropod 2 (Fig. 4D) peduncle subequal in length to outer ramus, with row of 4 dorsolateral and 1 apicomedial spines; rami subequal in length, outer with row of 5 dorsolateral spines, inner ramus with weak constriction and 3 dorsolateral spines.

Uropod 3 (Fig. 4E) peduncle longer than outer ramus, with subacute distolateral flange, 2 dorsolateral and 1 dorsomedial spines; rami lanceolate; outer ramus biarticulate, 1.14 × inner ramus, proximal article with 2 plumose setae and 1 spine laterally, distal article short, 0.12 × proximal article; inner ramus with 1 proximomedial seta and 3 lateral spines.

Telson (Fig. 4F) subtriangular, width 1.33 × length, moderately cleft (50%), with two pairs of penicillate setae and 2 setules on dorsal surface, each lobe rounded with 1 spine and 1 penicillate seta apically.

Male. Unknown.

Remarks. The new species is morphologically similar to *Socarnes vahlii* (Krøyer, 1838) in size, in the short dactylus of gnathopod 2 and constricted inner ramus of uropod 2. However, the new species is obviously distinguished from *S. vahlii* (different characters of *S. vahlii* in brackets) by the combination of the following features: 1) gnathopod 2, propodus subequal to half the length of carpus and narrowing anterodistally (vs less than half the length of carpus and broadened distally); 2) epimeron 3 with rounded posterior corner (vs obtusely truncated posterior corner); 3) telson broad, length 1.3 × width, moderately cleft, about half of its length (vs narrow, length 1.6 × width, cleft > the middle of its length). The redescription of *S. vahlii* (Krøyer, 1838) by Nagata (1965), which is the only species of the genus recorded in Japan, was brief and lacked illustrations. He mentioned that his specimens were in agreement with Sars' figures (1895, Pl.16, fig. 2) except for the shape of the posteroventral corner of epimeron 3, which is similar to *S. erythrophthalmus* Robertson, 1892 and *S. tongyeongensis* sp. n. Our specimens show morphological similarities to the redescription of Nagata (1965). However, as we have not had the opportunity to examine the material of Nagata (1965), we cannot confidently determine whether Nagata's specimens are

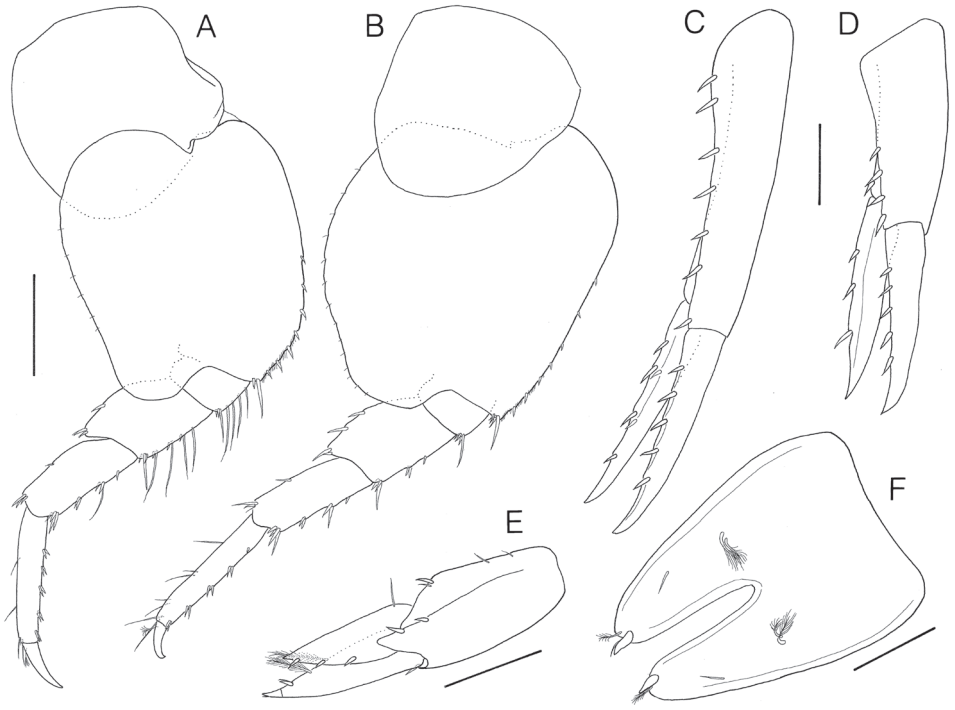

Figure 4. *Socarnes tongyeongensis* sp. n., holotype, female, 9.3 mm, Gyeongpo, Pungwha-ri, Sanyang-eup, Tongyeong-si, Korea. **A** pereopod 6 **B** pereopod 7 **C** uropod 1 **D** uropod 2 **E** uropod 3 **F** Telson. Scale bars: 0.4 mm (**A**, **B**), 0.2 mm (**C–E**), 0.1 mm (**F**).

conspecific with ours, despite the geographic proximity. Therefore at this time we conservatively maintain Nagata's specimens as *S. vahlii* until a detailed, comparative study can be made on the type material. Given the great geographic distance however, we would expect Nagata's specimens to differ from *S. vahlii*, as that species was recorded from Greenland, North Western Atlantic and Arctic Oceans.

Etymology. The species name is derived from the type locality, Tongyeong-si located on the south coast of Korea.

Distribution. Gyeongpo, Pungwha-ri, Sanyang-eup, Tongyeong-si, Gyeongsangnam-do, Korea.

Key to species of *Socarnes*

1 Body small, < 5 mm.....**2**
– Body medium to large, > 5 mm.....**3**
2 Telson cleft 50% of its length.....***S. erythrophthalmus* Robertson, 1892**
– Telson cleft > 50% of its length.....***S. septimus* Griffiths, 1975**
3 Epimeron 3 with posteroventral tooth .....***S. hartmani* Hurley, 1963**

– Epimeron 3 without posteroventral tooth **4**
4 Body large, > 30 mm; epimeron 3 with midposterior process..... ..... ***S. bidenticulatus*** **(Bate, 1858)**
– Body medium, < 30 mm; epimeron 3 without midposterior process..... **5**
5 Telson deeply cleft, > 65% of its length; maxilliped, outer plate reaching beyond palp article 2 ..... **6**
– Telson moderately cleft, < 65% of its length; maxilliped, outer plate < palp article 2..... **7**
6 Lateral cephalic lobe subacute ..... ***S. allectus*** **Andres, 1981**
– Lateral cephalic lobe rounded ..... ***S. filicornis*** **(Heller, 1866)**
7 Gnathopod 2, dactylus reaching palmar corner; epimeron 3 posteroventrally narrowly rounded **8**
– Gnathopod 2, dactylus short, < palmar corner; epimeron 3 posteroventrally rounded-quadrate **10**
8 Gnathopod 2, palm strongly concave..... ***S. tiendi*** **Lowry & Stoddart, 1994**
– Gnathopod 2, palm obtuse **9**
9 Pereopod 4, posterior margins of merus-carpus weakly setose; pereopod 7, basis with rounded posteroventral margin; telson cleft about 50% of its length .... ***S. rurutu*** **Lowry & Stoddart, 1994**
– Pereopod 4, posterior margins of merus-carpus strongly setose; pereopod 7, basis with truncate posteroventral margin; telson cleft > 60% of its length.... ..... ***S. tuscarora*** **Lowry & Stoddart, 1994**
10 Gnathopod 2, propodus medially broad, narrowing anterodistally; telson broad, length 1.3 × width, cleft about 50% of its length ..... ***S. tongyeongensis*** **sp. n.**
– Gnathopod 2, propodus stubby, broadened distally; telson narrow, length 1.6 × width, cleft >50% of its length..... ***S. vahlii*** **(Krøyer, 1838)**

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RESEARCH ARTICLE

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Morphology of adult and juvenile instars of *Galumna obvia* (Acari, Oribatida, Galumnidae), with discussion of its taxonomic status

Sergey G. Ermilov[1], Gerd Weigmann[2], Andrei V. Tolstikov[1]

1 *Tyumen State University, Tyumen, Russia* **2** *Free University of Berlin, Institute of Zoology, Berlin, Germany*

Corresponding author: *Sergey G. Ermilov* (ermilovacari@yandex.ru)

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Abstract

The adult instar of the oribatid mite, *Galumna obvia* (Berlese, 1914), is redescribed in detail, on the basis of specimens from Finland. The morphology of juvenile instars of *G. obvia* is described and illustrated for the first time, and compared to that of other species of the family Galumnidae. The position of the insertion of the lamellar seta in adults proved variable in studied European populations, being either on or medial to the lamellar line. Since the genera *Galumna* and *Pergalumna* are currently distinguished only by the relative positions of the seta and line, specimens of *G. obvia* in some populations show an intermediate situation between other studied *Galumna* species – with lamellar seta on or lateral of lamellar line – and *Pergalumna* with lamellar seta at a distinct distance medially of lamellar line. A detailed reevaluation of the two genera is needed.

Keywords

Oribatida, *Galumna obvia*, morphology, supplementary description, juvenile instars, ontogeny, insertions of lamellar setae

Introduction

The oribatid mite *Galumna obvia* (Oribatida, Galumnidae) was described by Berlese (1914) as *Oribata obvius*. This species has a semicosmopolitan distribution, being known from the Palearctic and Neotropical regions, i.e. from the USA, South Africa,

Santa Elena Islands, Vietnam, and Hawaii (references were summarized by Subías 2004, updated 2013).

The original description and several redescriptions of adult *G. obvia* (see below, *Taxonomic history*) were incomplete, lacking measurements of morphological structures and information about leg setation and solenidia, and morphology of the gnathosoma. Further, lateral and ventral views of the idiosoma, which have important traits in this family, were insufficiently studied and illustrated. The present paper provides a detailed description and illustrations of *G. obvia* on the basis of 10 specimens collected in Finland as a reference population. Our data and a literature review show variation in the insertion of lamellar setae, relative to the lamellar line; since this insertion is considered important in distinguishing *Galumna* from *Pergalumna*, we discuss the generic position of *G. obvia*.

Additionally, we described and illustrated the morphology of juvenile instars of *G. obvia*. The family Galumnidae comprises more than 450 species, however, the full series of juvenile instars has been studied in detail only for eight species: *Acrogalumna longiplumna* (Berlese, 1904) (Seniczak et al. 2012), *Allogalumna alamellae* (Jacot, 1935) (Seniczak et al. 2012), *Galumna alata* (Hermann, 1804) (Seniczak et al. 2012), *Galumna zachvatkini* Grishina, 1982 (Grishina 1982), *Pergalumna nervosa* (Berlese, 1914) (Sengbusch 1954; Seniczak 1972; Grishina 1977; Seniczak et al. 2012), *Pilogalumna crassiclava* (Berlese, 1914) (Seniczak and Seniczak 2007), *Pilogalumna ornatula* Grandjean, 1956 (Seniczak and Seniczak 2007), and *Pilogalumna tenuiclava* (Berlese, 1908) (Seniczak 1972; Seniczak and Seniczak 2007). In addition, Sengbusch (1954) briefly described all juvenile instars of *Galumna ithacensis* (Jacot, 1929).

Also, the juvenile instars have been described incompletely and/or illustrated in several species briefly, namely: *Acrogalumna longiplumna* (Grandjean 1935), *Dicatozetes numidicus* Bernini, 1984 (Bernini 1984), *Dicatozetes uropygium* (Grandjean, 1928) (Grandjean 1928), *Galumna alata* (Michael 1884), *Galumna louisianae* (Jacot, 1929) (Woodring 1965), *Galumna parva* Woodring, 1965 (Woodring 1965), *Galumna tarsipennata* Oudemans, 1914 (Travé 1970), *Galumna* sp. (Zachvatkin 1953), *Orthogalumna terebrantis* Wallwork, 1965 (Wallwork 1965), *Pergalumna nervosa* (Cooreman 1941), *Pergalumna emarginata* (Banks, 1895) (Rockett and Woodring 1966), *Pilogalumna ornatula* (Grandjean 1956a), *Pilogalumna tenuiclava* (Grandjean, 1933), and *Vaghia carinata* (Travé, 1955) (Travé 1955).

Grandjean (1953) summarized the main generic characteristics of juvenile instars of Galumnidae.

Material and methods

Specimens of *Galumna obvia* were collected at the following locality: Finland, 64°24'10.78"N, 25°26'7.86"E, Päijänne National Park, Virmailansaari Island, near Padasjoki, 80 m a.s.l., Piceetum vaccinioso-hylocomiosum plant association, moss

cover on stones and soil litter, 15.07.2013, collected by Andrei V. Tolstikov. The material collected in the field contained 10 adults, five larvae, two protonymphs and one deutonymph.

Comparative material for the taxonomic discussion originates from one Portuguese and some German locations:

– Ribeira de Aljezur, Atlantic coast area of West-Algarve, Portugal, 37.347°N, 8.846°W, floodplain forest, 2011. Weigmann's collection (*G. tarsipennata*);

– River Oder Valley, Criewen; North-East Germany, 53,012°N, 14,233°E, moist deciduous forest, 1999. Weigmann's collection (*G. obvia*);

– "Berlin 1"; Berlin-Lübars, 52,62°N, 13,37°E, moist meadow, 1986. Weigmann's collection (*G. obvia*);

– "Berlin 2"; Postfenn, 52,498°N, 13,24°E, degraded moor, 1997. Weigmann's collection (*G. obvia*);

– "Berlin 3"; Berlin-Spandau, Teufelsbruch, 52,579°N, 13,205°E, moor area, 1997. Weigmann's collection (*G. obvia, G. alata*);

– "Berlin 4"; Berlin-Charlottenburg, 52,5°N, 13,35°E, park forests, 1995. Weigmann's collection (*G. lanceata*);

– "Oldesloe"; Brenner Moor, near Oldesloe, Schleswig-Holstein, North-West Germany, 53,78°N, 10,33°E, salty moor complex, 1973. Weigmann's collection (*G. obvia*).

Specimens were mounted in lactic acid on temporary cavity slides for measurement and illustration. All body measurements are presented in micrometers. Body length was measured in lateral view, from the tip of the rostrum to the posterior edge of the ventral plate. Notogastral width refers to the maximum width in dorsal aspect. Lengths of body setae were measured in lateral aspect. Formulae for leg setation are given in parentheses according to the sequence trochanter–femur–genu–tibia–tarsus (famulus included). Formulae for leg solenidia are given in square brackets according to the sequence genu–tibia–tarsus. General terminology used in this paper mostly follows that summarized by Grandjean (see Travé and Vachon for references), Weigmann (2006), and Norton and Behan-Pelletier (2009).

Taxonomic history of *Galumna obvia* (Berlese, 1914)

Oribates obvius Berlese, 1914: 119, pl. 1: 1. (type locality: Florence, Italy)
Galumna obvius: Sellnick 1928 (9); Willmann 1931 (138, fig. 302).
Galumna obvia: Zachvatkin 1953 (158, Fig. 65); Shaldybina 1975 (353, fig. 887); Mahunka 1992 (246); Mahunka and Mahunka-Papp 1995 (86, 210, fig. 161); Weigmann 2006 (373, Fig. 197); Bayartogtokh 2011 (339, fig. 87E).
Galumna obvium: Pérez-Iñigo 1993 (77, fig. 25a).
Galumna "elimata" sensu van der Hammen 1952; nec C.L. Koch 1841: Aoki 1966 (774, figs 13–15); Sellnick 1960 (56); Wallwork 1977 (232, fig. 91c).

There is some confusion regarding the validity of *Galumna obvia*, which was declared as junior synonym of *G. elimata* (described as *Oribates elimatus* Koch, 1841 in CMA 31.5) firstly by Jacot (1929: 4) in the context of the discussion on the type species of *Zetes* Koch, 1835, a question which is not relevant for the synonymy of the species. The original figure of Koch's *O. elimatus* shows clearly long interlamellar setae, but the original description of *G. obvia* by Berlese (1914, tav. 10: 1) shows clearly very short interlamellar setae, confirmed by the type study of Mahunka (1992) who refered to the redescription of Shaldybina (1975: 353, fig. 887) being in accordance to Berlese's species. Berlese himself (Berlese 1914: 122, Tav. 10: 7) published his interpretation of *G. elimata* (Koch) with the remark that it is different from *G. obvia*. Mahunka (1992: 242, fig. 57) figured *G. elimata* Koch (sensu Berlese) after a slide in the Berlese collection and declared the specimen in Berlese's slide 153/29 as lectotype. We follow the interpretations of Mahunka (1992) as did Weigmann (2006) that *G. elimata* Koch and *G. obvia* Berlese are distinct species. Consequently, the synonymization of *G. obvia* with *G. elimata* as senior synonym by Jacot (1929) must be rejected. The interpretations of van der Hammen (1952) and others (see above) under the name "*G. elimata*" are based on Jacot (1929) and refer to *G. obvia*.

Supplementary description of adult *Galumna obvia*

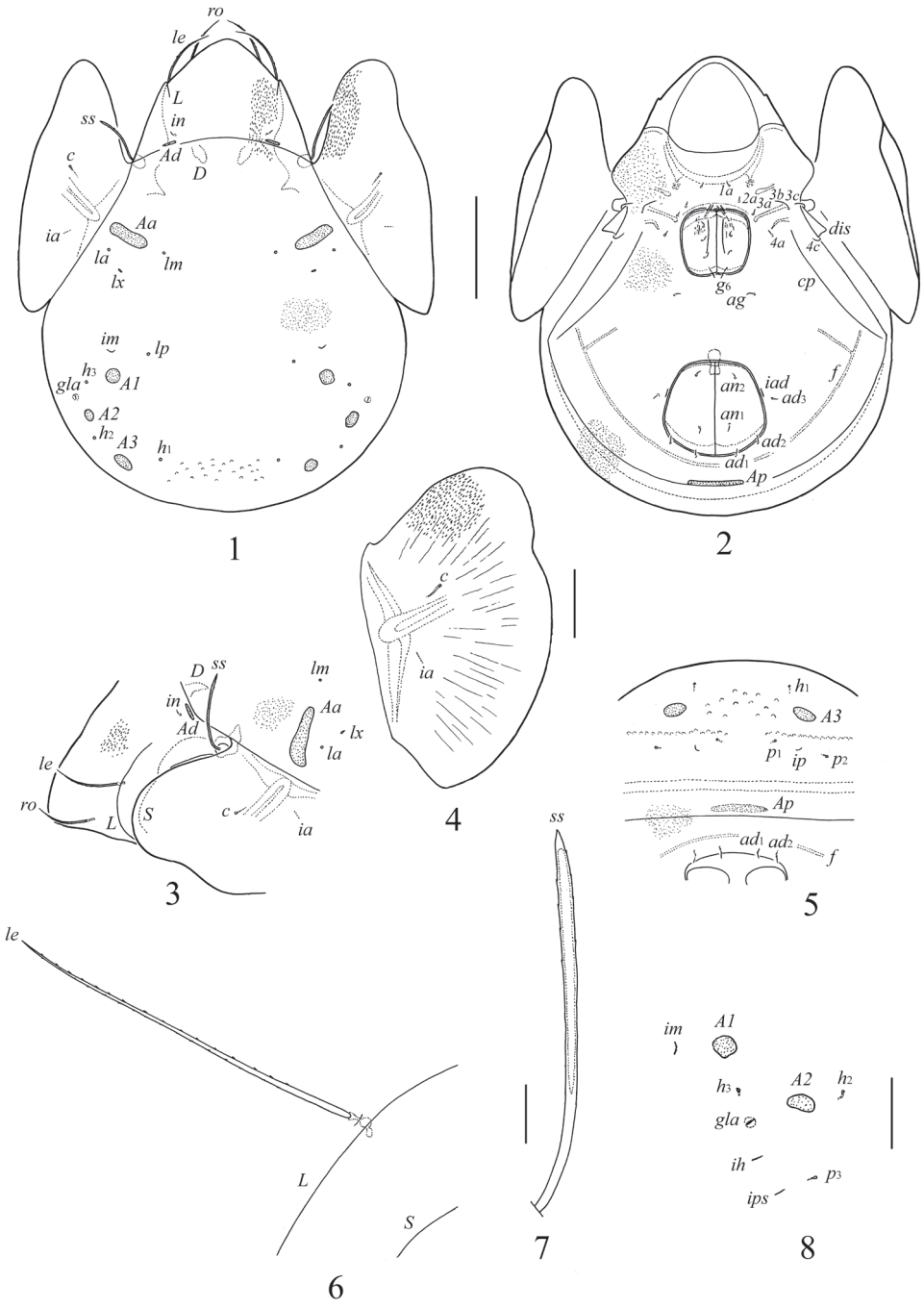
Figs 1–20

Measurements. Body length 846–898, width 630–647 (10 specimens, three males and seven females).

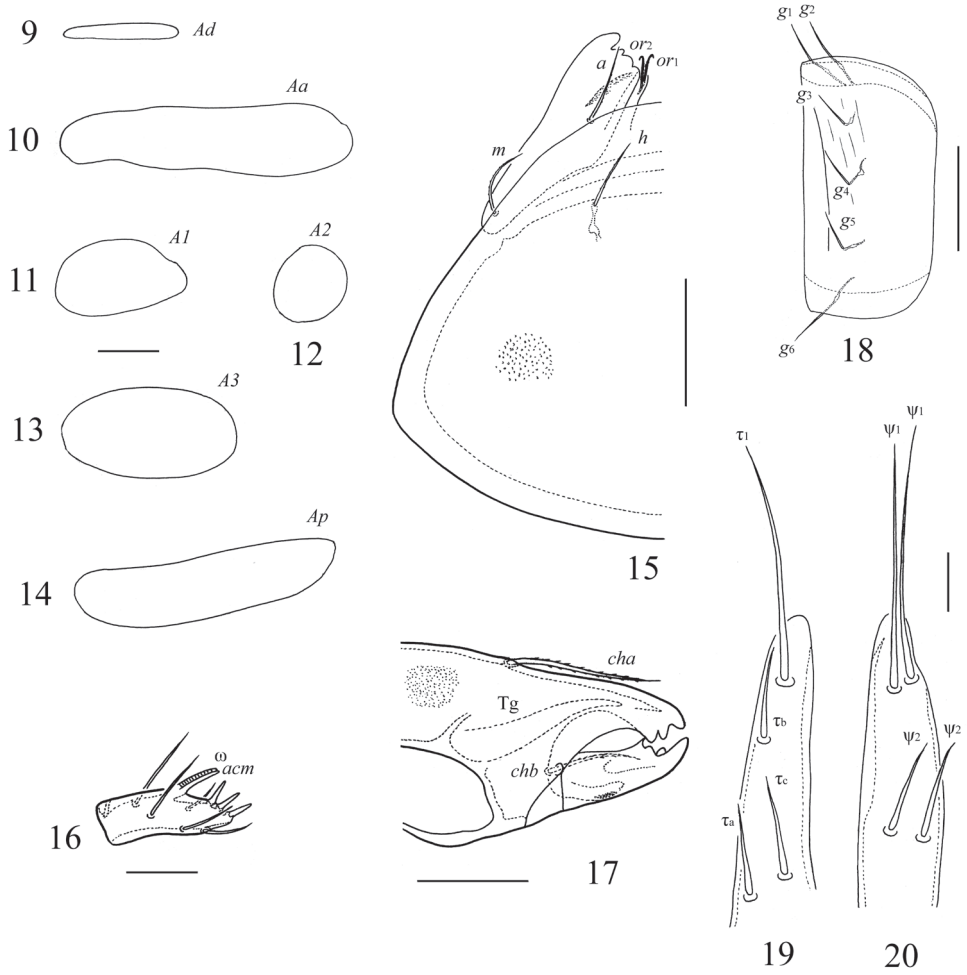
Integument. Body color brown to brownish-black. Body surface microfoveolate (well visible under high magnification); foveolae rounded (diameter up to 1) or represented by short lines (on prodorsum and pteromorphs). Posterior part of ventral plate with long, light furrow (*f*), located posterior and lateral to anal plates. Genital plates with one strong longitudinal fold located medial to genital setae; additional, short, weakly visible folds present in several specimens.

Prodorsum. Rostrum broadly rounded. Rostral (*ro*) and lamellar (*le*) setae setiform, barbed. Interlamellar setae (*in*) short, thin, smooth. Sensilli (*ss*) long, with weakly developed, elongate, barbed head pointed distally. Exobothridial setae absent. Relative length of prodorsal setae: *ss* ≈ *le* > *ro* > *in*; measurements given in Table 1. Lamellar (*L*) and sublamellar (*S*) lines distinct, parallel. Insertions of lamellar setae located medially to the lamellar lines, very close to them. Porose areas *Ad* (28–45 × 4–8), transversely oriented, thin, located posterolateral to interlamellar setae.

Notogaster. Anterior notogastral margin well developed. Dorsophragmata (*D*) of medium size. Notogastral setae represented by 10 pairs of alveoli. Four pairs of porose areas present: *Aa* (77–131 × 16–32) transversly oriented, elliptical to weakly boot-shaped; *A1* (24–57 × 24–32) and *A2* (24–53 × 20–28) round or oval; *A3* (28–69 ×



Figures 1–8. *Galumna obvia*, adult: **1** dorsal view **2** ventral view (gnathosoma and legs not shown) **3** anterior part of body, lateral view **4** pteromorph **5** posterior view **6** lamellar seta and parts of lamellar and sublamellar lines **7** sensillus **8** dorso-lateral part of notogaster, lateral view. Scale bars 200 μm (**1–3, 5**), 100 μm (**4**), 20 μm (**6–8**).



Figures 9–20. *Galumna obvia*, adult: **9** porose area *Ad* **10** porose area *Aa* **11** porose area *A1* **12** porose area *A2* **13** porose area *A3* **14** porose area *Ap* **15** subcapitulum, right half, ventral view **16** palptarsus **17** anterior part of chelicera **18** genital plate, left **19–20** lobes of ovipositor. Scale bars 20 μm (**9–14, 16, 19, 20**), 50 μm (**15, 17, 18**).

20–36) oval. All porose areas well visible, but without distinct margins. Alveoli of setae *la* inserted posterior to *Aa*. Median pore absent. All lyrifissures distinct; *im* located anterior to *A1*. Opisthonotal gland openings (*gla*) located anterolateral to *A2*.

Gnathosoma. Subcapitulum longer than wide (188–200 × 172–176). Subcapitular setae (*a*, *m*, *h*) similar in length (28–36), setiform, slightly barbed. Adoral setae (or_1, or_2) (16–20) setiform, barbed. Palps (147–155) with setation 0–2–1–3–9(+ω); solenidion straight. Chelicerae (225–241) with two setiform, barbed setae; *cha* (65–73) longer than *chb* (45–53). Trägårdh's organ (Tg) distinct, elongate conical.

Epimeral and lateral podosomal regions. Apodemes 1, 2, sejugal and 3 well visible. Seven pairs of setiform, smooth epimeral setae observed; setal formula: 1–1–3–2. Setae

Table 1. Comparison of body setae measurements of *Galumna obvia* during ontogeny

Character	Larva	Protonymph	Deutonymph	Adult
	n=5	n=2	n=1	n=10
Length of prodorsal setae:				
– rostral setae	53–61	57–61	69	86–98
– lamellar setae	45–53	53–57	61	143–164
– interlamellar setae	32–36	36–45	41	8–12
– sensilli	73–82	77–86	102	143–164
– exobothridial setae	32–36	45–49	45	Absent
Length of gastronotic setae:				
– c_3	45	45	45	Absent
– h_2	20–24	4–6	8	Absent
– p_2, p_3	Absent	14–16	20	Absent
– other gastronotic setae	4	4–6	8	Absent
Length of epimeral setae	8–12	12–16	16	*3b*, *3c*, *4c* (28–36); *1a*, *2a*, *4a*, *4b* (12–20)
Length of anogenital setae:				
– genital setae	Absent	12–16	16	12–20
– aggenital setae	Absent	Absent	16	8–16
– anal setae	Absent	Absent	Absent	8–16
– adanal setae	Absent	Absent	16	8–16

Table 2. Leg setation and solenidia of adult *Galumna obvia*

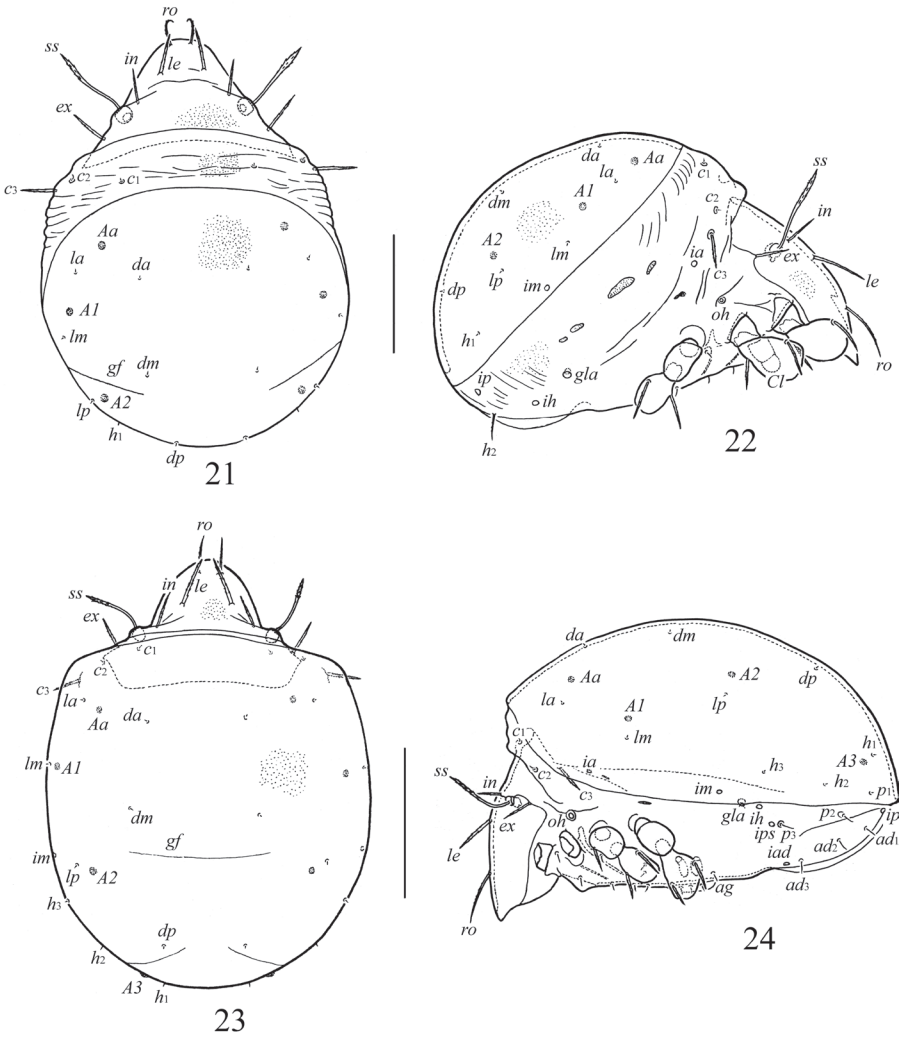
Leg	Trochanter	Femur	Genu	Tibia	Tarsus
I	*v'*	*d, (l), bv"*	*(l), v',* σ	*(l), (v),* φ_1, φ_2	*(ft), (tc), (it), (p), (u), (a), s, (pv), v', (pl), l", e,* ω_1, ω_2
II	*v'*	*d, (l), bv"*	*(l), v',* σ	*(l), (v),* φ	*(ft), (tc), (it), (p), (u), (a), s, (pv),* ω_1, ω_2
III	*v'*	*d, ev'*	*l',* σ	*l', (v),* φ	*(ft), (tc), (it), (p), (u), (a), s, (pv)*
IV	*v'*	*d, ev'*	*d, l'*	*l', (v),* φ	*ft", (tc), (p), (u), (a), s, (pv)*

Roman letters refer to normal setae (*e* to famulus), Greek letters to solenidia. Single prime (') marks setae on anterior and double prime (") setae on posterior side of the given leg segment. Parentheses refer to a pseudosymmetrical setae

3b, *3c* and *4c* longer than *1a*, *2a*, *4a* and *4b* (Table 1). Discidia (*dis*) triangular. Circumpedal carinae (*cp*) distinct.

Anogenital region. Six pairs of genital (g_1–g_6), one pair of aggenital (*ag*), two pairs of anal (an_1, an_2) and three pairs of adanal (ad_1–ad_3) setae setiform, thin, smooth (Table 1). Anterior edge of genital plates with two setae. Adanal setae ad_3 inserted laterally or slightly postero-laterally to lyrifissures *iad*. Postanal porose area (*Ap*, 73–110 × 12–24) transversly oriented, oblong. Ovipositor of typical form for Galumnidae (Ermilov 2010): elongate, narrow (327–369 × 65–69); length of lobes 151–164, length of cylindrical distal part 176–205. Each lobes with four thin, smooth setae: $\psi_1 \approx \tau_1$ (82–98) longer than $\psi_2 \approx \tau_a \approx \tau_b \approx \tau_c$ (36–41). Coronal setae *k* short, thorn-like (12–16).

Legs. Morphology of leg segments, setae and solenidia typical for Galumnidae (Ermilov and Anichkin 2011a, 2011b). Formulae of leg setation and solenidia: I (1–4–3–4–20) [1–2–2], II (1–4–3–4–15) [1–1–2], III (1–2–1–3–15) [1–1–0], IV (1–2–2–3–12) [0–1–0]; homology of setae and solenidia indicated in Table 2.



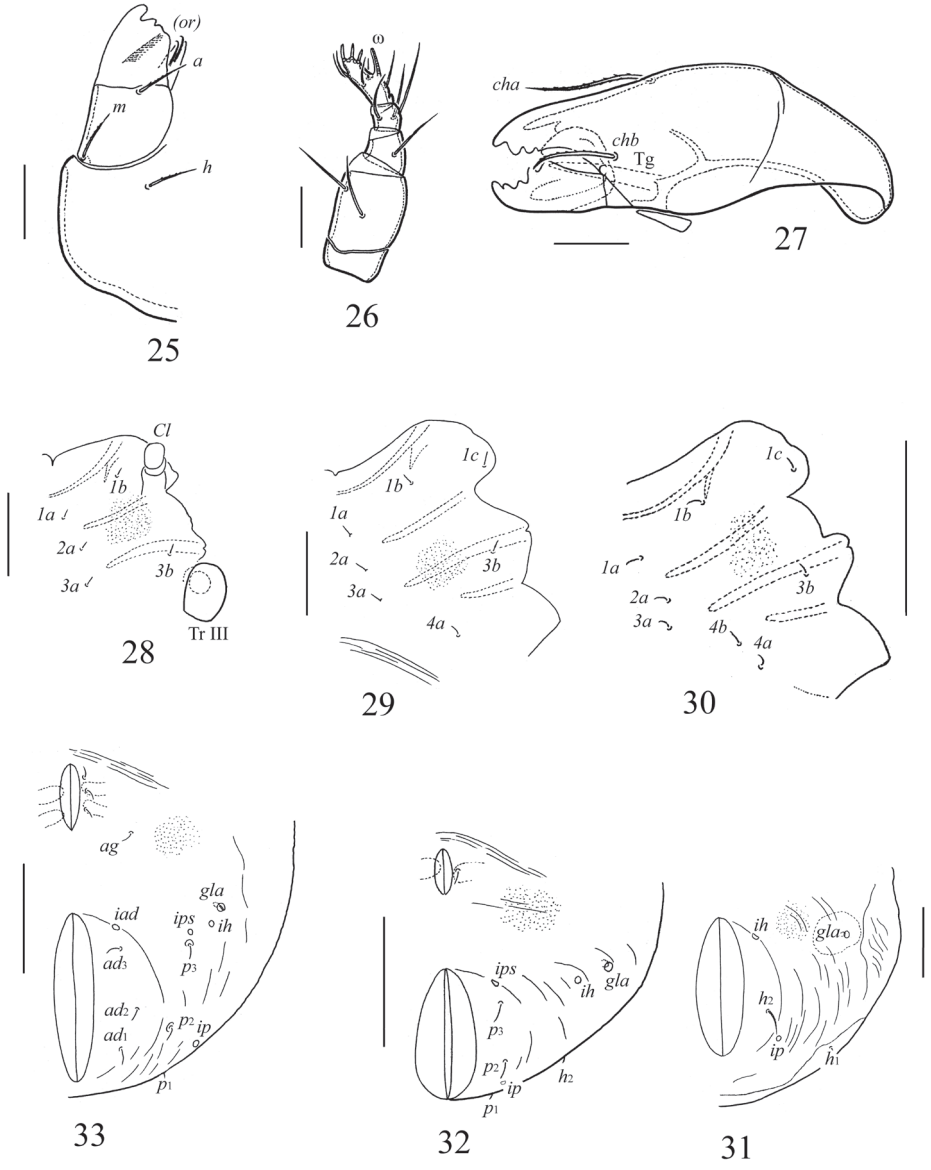
Figures 21–24. *Galumna obvia*, juvenile instars: **21** larva, dorsal view **22** larva, lateral view (gnathosoma and legs except basal parts not shown) **23** deutonymph, dorsal view **24** deutonymph, lateral view (gnathosoma and and legs except basal parts not shown). Scale bars 100 μm (**21, 22**), 200 μm (**23, 24**).

Larva, proto- and deutonymph

(Figs 21–30)

Dimensions. Length: larva 344–352 (five specimens), protonymph 431, 435 (two specimens), deutonymph 564 (one specimen). Width: larva 246–254, protonymph 332, 336, deutonymph 431.

Integument. Prodorsum, gastronotic shield, gnathosoma and legs light brownish; dorsosejugal and epimeral regions and lateral sides colorless to yellowish. Sclerotized



Figures 25–33. *Galumna obvia*, juvenile instars: **25** subcapitulum, right half, ventral view **26** palp **27** chelicera **28** epimeral region of larva **29** epimeral region of protonymph **30** epimeral region of deutonymph **31** anogenital region of larva **32** anogenital region of protonymph **33** anogenital region of deutonymph. Scale bars 20 μm (**25–27**), 50 μm (**28, 29, 31**), 100 μm (**30, 32, 33**).

body cuticle microfoveolate (diameter foveolae up to 1); soft dorsosejugal, lateral and anogenital regions region with some folds.

Prodorsum. Relatively short, about 1/2 length of gastronotic region. Rostrum broadly rounded. Rostral, lamellar, interlamellar and exobothridial setae setiform,

Table 3. Development of leg setation of *Galumna obvia* during ontogeny.

	Trochanter	Femur	Genu	Tibia	Tarsus
Leg I					
Larva	–	*d*, *bv"*	*(l)*, σ	*(l)*, *v'*, φ_1	*(ft)*, *(tc)*, *(p)*, *(u)*, *(a)*, *s*, *(pv)*, *(pl)*, *e*, ω_1
Protonymph	–	–	–	–	ω_2
Deutonymph	–	*(l)*	–	φ_2	–
Leg II					
Larva	–	*d*, *bv"*	*(l)*, σ	*l'*, *v'*, φ	*(ft)*, *(tc)*, *(p)*, *(u)*, *(a)*, *s*, *(pv)*, ω_1
Protonymph	–	–	–	–	–
Deutonymph	–	*l"*	–	*l"*	ω_2
Leg III					
Larva	–	*d*, *ev'*	*l'*, σ	*v'*, φ	*(ft)*, *(tc)*, *(p)*, *(u)*, *(a)*, s, *(pv)*
Protonymph	–	–	–	–	–
Deutonymph	*v'*	–	–	*v"*	–
Leg IV					
Protonymph	–	–	–	–	*ft"*, *(p)*, *(u)*, *(pv)*
Deutonymph	–	*d*, *ev'*	*d*, *l'*	*v'*, φ	*(tc)*, *(a)*, *s*

See Table 1 for explanations. Setae are listed only for the instar in which they first appear.

barbed, inserted on small tubercles. Sensilli with long stalk and weakly developed, lanceolate, barbed head. Relative length of prodorsal setae: *ss* > *ro* > *le* > *in* ≈ *ex*; measurements compared in Table 1.

Gastronotic region. Dorsal gastronotic region with large, well-bordered shield (macrosclerite) in all juvenile instars. Transversal gastronotic furrow present (*gf*), poorly visible. Lateral sides with several small, elongate sclerites (smaller and weakly visible in nymphs than in larva). Larva with 11 pairs of gastronotic setae, proto- and deutonymphs with 15 pairs. Setae c_1–c_3 and p_2–p_3 (in deutonymph) on small sclerites. Gastronotic shield with seven pairs of setae (*da*, *dm*, *dp*, *la*, *lm*, *lp*, h_1) in larva, 10 pairs (*da*, *dm*, *dp*, *la*, *lm*, *lp*, h_1–h_3, p_1) in proto- and deutonymphs. Gastronotic setae c_3 longest, straight, barbed; h_2 in larva shorter, setiform, slightly barbed; p_2, p_3 in proto- and deutonymph setiform, smooth; other setae very short, thin, smooth (Table 1). Porose areas rounded, poorly visible: larva with three pairs (6–8, *Aa*, *A1*, *A2*), proto- (8) and deutonymph (12) with four pairs (*A3* present additionally). Cupules *ia*, *im* and *ip* clearly visible. Humeral organ (*oh*) well developed.

Gnathosoma. Similar to that of adult instar.

Epimeral region. Setal formulae for epimeres: larva 3–1–2 (larval seta *1c* scale-like, covering tip of retracted Claparède's organ); protonymph 3–1–2–1; deutonymph 3–1–2–2. Epimeral setae setiform, smooth (Table 1).

Anogenital region. Ontogenetic genital, aggenital, adanal, anal formulae (larva to deutonymph): 0–1–3, 0–0–1, 0–0–3, 0–0–0, respectively. All setae setiform, thin, smooth (Table 1). Paraproctal setae absent. Cupules *ih*, *ips*, *iad* and opisthonotal gland openings clearly visible, appearing in normal ontogenetic pattern.

Legs. Ontogeny of leg setae and solenidia given in Table 3.

Comparison

The adult specimens of *Galumna obvia* collected in Finland correspond to earlier redescriptions (Willmann 1931; Zachvatkin 1953; Aoki 1966; Wallwork 1977; Mahunka 1992; Pérez-Íñigo 1993; Mahunka and Mahunka-Papp 1995; Weigmann 2006; Bayartogtokh 2011) and material in the personal collection of G. Weigmann in terms of general appearance: reatively large body; short, thin interlamellar setae; long, setiform rostral and lamellar setae; sensilli with weakly developed, lanceolate head; four pairs of notogastral porose areas, *Aa* and *Ap* being transversely elongate; and short ventral setae. However, the adults from Finland are distinguishable by the presence of a long furrow on the ventral plate, which is not mentioned in other descriptions. We consider this difference as intraspecific variability (perhaps geographical), which should be taken into account in any future identification of this species.

Juvenile instars (larva, proto- and deutonymph) of *Galumna obvia* correspond to those of other Galumnidae in many characters (cf Michael 1884; Grandjean 1928, 1935, 1953, 1956a; Cooreman 1941; Zachvatkin 1953; Sengbusch 1954; Travé 1955, 1970; Wallwork 1965; Woodring 1965; Rockett and Woodring 1966; Seniczak 1972; Grishina 1977, 1982; Bernini 1984; Seniczak and Seniczak 2007; Seniczak et al. 2012). These include: gastronotum covered by gastronotic shield (macrosclerite); gastronotic setae not on shield inserted on microsclerites; prodorsal setae long or medium size; sensilli long, lanceolate; larva with 11 or 12 pairs (seven pairs inserted on gastronotic shield) and nymphal instars – with 15 pairs (10 pairs inserted on gastronotic shield) of gastronotic setae; gastronotic shield with three (in larva) or four (in nymphal instars) pairs of weakly visible porose areas); humeral organ present; genital formula 0–1–3–5, aggenital formula 0–0–1–1, adanal formula 0–0–3–3, anal formula 0–0–0–2. Juvenile instars of *Galumna obvia* can be distinguished from those of other Galumnidae as follows.

– From *Pilogalumna* (*P. crassiclava*, *P. ornatula*, *P. tenuiclava*) by: the length of prodorsal setae (*ro* longest in *G. obvia* versus *in* longest in *Pilogalumna* species); length of gastronotic setae of *c*-series (c_3 of medium size, c_1 and c_2 short, $c_3 > c_1 \approx c_2$ in *G. obvia* versus c_3 and c_2 of medium size, c_1 short, $c_3 > c_2 > c_1$ in *Pilogalumna* species); and number of gastronotic setae and length of setae h_1 in larval instar (11 pairs – h_3 absent, h_1 short in *G. obvia* versus 12 pairs – h_3 present, h_1 of medium size in *Pilogalumna* species).

– From *Acrogalumna* (*A. longipluma*) by: the length of prodorsal setae (*ro* longest in *G. obvia* versus *le* longest in *A. longipluma*); the length of gastronotic setae of *c*-serie (c_3 of medium size, c_1 and c_2 short, $c_3 > c_1 \approx c_2$ in *G. obvia* versus c_3 and c_2 of medium size, c_1 short, $c_3 > c_2 > c_1$ in *A. longipluma*).

– From *Allogalumna* (*A. alamellae*) by: the length of prodorsal setae (*ro* > *le* > *in* in *G. obvia* versus *in* > *ro* ≈(>) *le* in *A. alamellae*); the length of gastronotic setae of *c*-serie (c_3 of medium size, c_1 and c_2 short, $c_3 > c_1 \approx c_2$ in *G. obvia* versus c_3 and c_2 of medium size, c_1 short, $c_3 \approx c_2 > c_1$ in *A. alamellae*).

– From *Galumna* species: from *G. alata* by the length of prodorsal setae (*ro* > *le* > *in* in *G. obvia* versus *in* > *ro* > *le* in larva, *in* ≈(>) *le* > *ro* in nymphal instars in *G. alata*),

the length of gastronotic setae of *c*-series (c_3 of medium size, c_1 and c_2 short, $c_3 > c_1 \approx c_2$ in *G. obvia* versus c_3 and c_2 of medium size, c_1 short, $c_2 > c_3 > c_1$ in *G. alata*); from *G. zachvatkini* by the length of gastronotic setae (c_3 of medium size, c_1, c_2 and other dorsal setae short, $c_3 > c_1 \approx c_2$ in *G. obvia* versus c_1, c_2, c_3 and other dorsal setae well developed, of medium size, $c_1 \approx c_2 \approx c_3$ in *G. zachvatkini*), and number of gastronotic setae in larval instar (11 pairs – h_3 absent in *G. obvia* versus 12 pairs – h_3 present in *G. zachvatkini*).

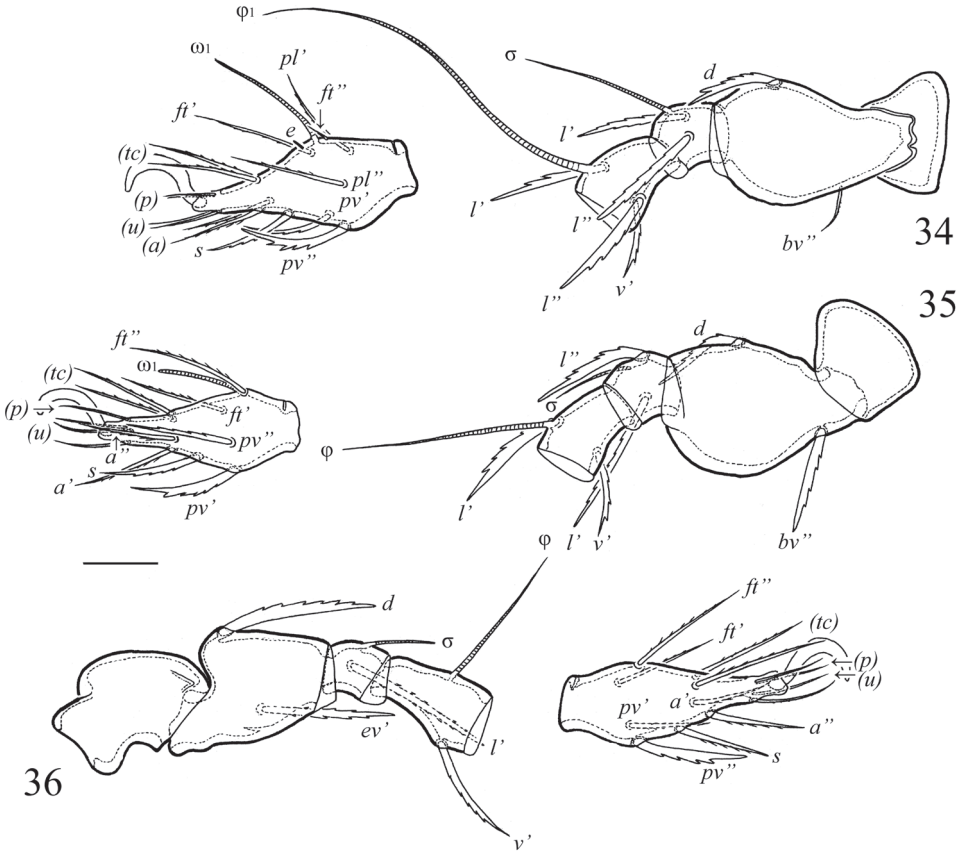
– From *Pergalumna* (*P. nervosa*) by: the length of prodorsal setae (*ro* > *le* > *in* in *G. obvia* versus *le* ≈(>) *ro* > *in P. nervosa*); the length of gastronotic setae of *c*-serie and number of gastronotic setae and length of setae h_1 in larval instar (c_3 of medium size, c_1 and c_2 short, $c_3 > c_1 \approx c_2$, 11 pairs setae present – h_3 absent in *G. obvia* versus c_3 and c_2 of medium size, c_1 short, $c_3 \approx c_2 > c_1$, 12 pairs setae present – h_3 present in *P. nervosa*).

Thus, the diagnostic morphological characters of Galumnidae juvenile instars are not numerous and can be summarized as: the length of rostral, lamellar and interlamellar setae; the number of gastronotic setae in larval instar; the length of gastronotic setae of *c*-series, *dp*, h_1; the presence or absence of a transverse furrow on gastronotic shield and genital and adanal macrosclerites on the ventral side in nymphal instars); and body size.

Taxonomic discussion: the position of seta *le* in species of *Galumna* and *Pergalumna*

In the Finnish population of *G. obvia*, the lamellar seta (*le*) inserts medial to the lamellar line, at a distance of about 5 μm; no distinct variability is observed. The conventional definition of the genus *Galumna* includes the differential character "lamellar seta on (at) the lamellar line" in contrast to the definition of the genus *Pergalumna* Grandjean, 1936, originally as subgenus with the differential character "lamellar seta in some distance medially to the lamellar line" (Grandjean 1936; cf. keys of Sellnick 1960, Pérez-Iñigo 1993, Weigmann 2006). Following a strict interpretation of the *le* position, the Finnish population of *G. obvia* could be regarded as a *Pergalumna* species. To resolve this will require a detailed reevaluation of *Galumna* and a comparison with *Pergalumna*.

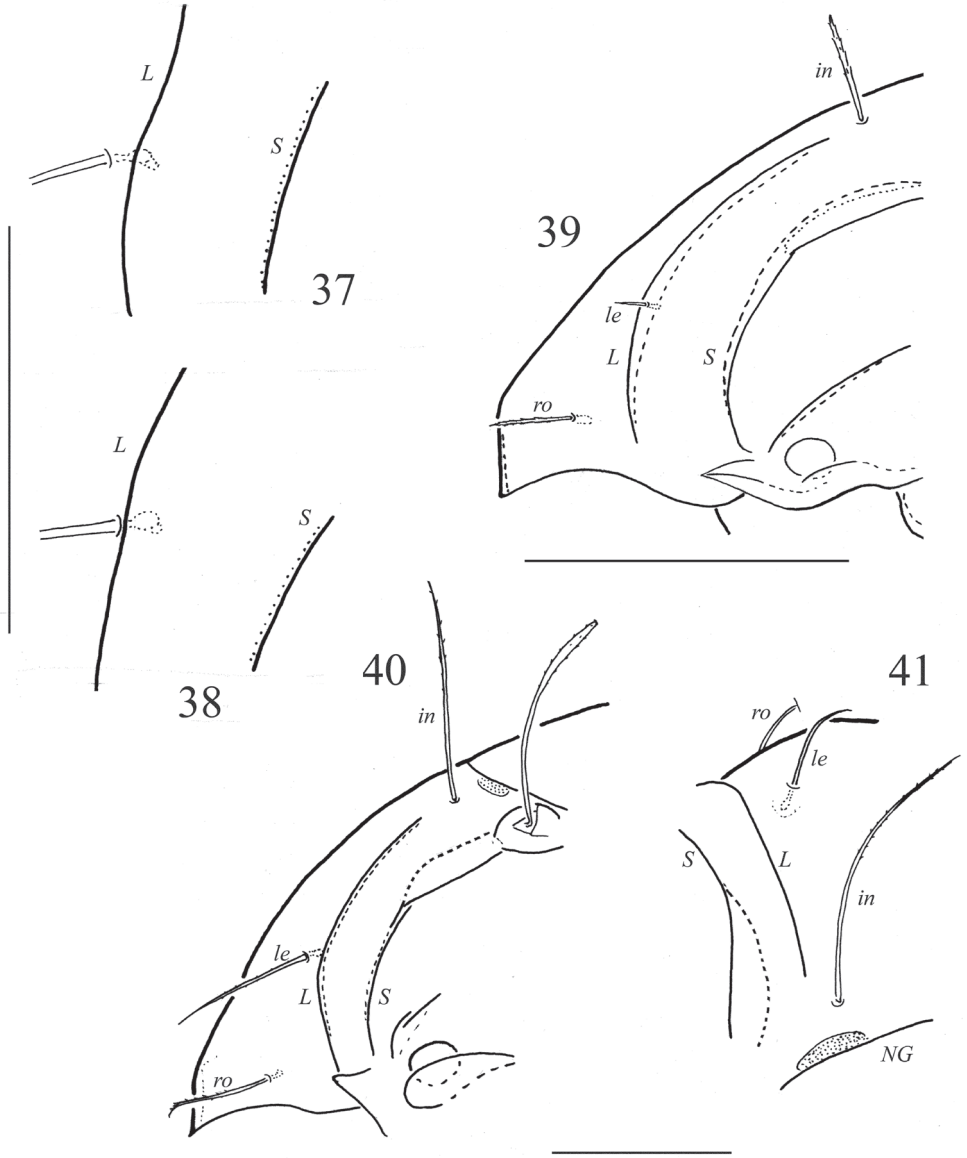
We compared the characters of the Finnish population of *G. obvia* with those in some other European populations, especially from northwest to northeast of Germany; and we found no convincing character combinations to exclude the Finnish population from *Galumna obvia*, regarding body size (indicated for German populations with 705–845 μm total body length: Weigmann 2006), setation, shapes and positions of porose areas on notogaster, sensillus shape and other characters which are used in literature to define *G. obvia*. Concerning the position of setae *le* relative to the lamellar line, we found remarkable variability. In some populations or specimens, the seta *le* has some distance, continuously up to 6 μm, in median direction from the lamellar line; in other populations or single specimen *le* inserts strait at the lamellar line



Figures 34–36. *Galumna obvia*, juvenile instars: **34** leg I, left, antiaxial view **35** leg II, left, antiaxial view **36** leg III, right, paraxial view. Scale bar 20 μm.

on the median side (cf. Figs 37 and 38): In populations "Oder valley" (n=2) – 0–1 μm, "Berlin 1" (n=3) – 5–6 μm, "Berlin 2" (n=6) – 1–5 μm, "Berlin 3" (n=3) – 0–1 μm, "Oldesloe" (n=6) – 0–4 μm. In all populations we observed a small variability, partly with different ranges. Unfortunately, we have no information about Berlese's typical population in Italy.

These slight differences of the position of seta *le* raise a similar question with regard to other *Galumna* species. Since species descriptions, redescriptions and illustrations are often not sufficiently precise, we give only selective examples. In the type species of *Galumna*, *G. alata* (Hermann, 1804), Grandjean (1936: 97) figured in his very accurate redescription the setae *le* on the lamellar line. In material of one of the coauthors (G.W.; location "Berlin 3") of *G. alata*, the insertion of *le* is a short distance laterally from the lamellar line. The latter position of *le* is described in several other *Galumna* species, e.g. *G. asiatica* Grishina, 1981 (Bayartogtokh and Weigmann 2005); *G. dimorpha* Krivolutsky, 1952 (Bayartogtokh and Weigmann



Figures 37–41. Adults of Galumnidae: **37** *Galumna obvia*, lamellar region of prodorsum, lateral view (specimen from Berlin) **38** *Galumna obvia*, lamellar region of prodorsum, lateral view (specimen from Oder Valley, North-East Germany) **39** *Galumna paragibbula*, lateral view of prodorsum **40** *Pergalumna nervosa*, lateral view of prodorsum **41** *Pergalumna nervosa*, dorso-frontal view of left part of prodorsum (depressed mounted specimen). Abbreviation: *NG* – notogastral shield. Scale bar 100 μm.

2005); *G. gibbula* Grandjean, 1956 (Grandjean 1956b:p. 144, 145 as *G. tarsipennata gibbula*); *G. lanceata* Oudemans, 1900 (from three urban sites "Berlin 4", actually studied within this project); *G. paragibbula* Weigmann 2011(cf. Fig. 39); *G.*

tarsipennata Oudemans, 1914 (Travé 1970 from France; actually studied (G.W.) from floodplain forest, South Portugal).

Comparing the position of seta *le* in strict lateral aspect in *Pergalumna nervosa* (Fig. 40) and in *Galumna obvia* (Figs 6, 37), there seems to be less difference: in both species the seta seems to be inserted a short distance medially from the lamellar line. Yet in dorso-frontal aspect without parallactic error, the distance between *le* and the lamellar line is about 27 µm in *P. nervosa* (Fig. 41), in *G. obvia* at most 6 µm.

As a preliminary conclusion, most studied *Galumna* species have the seta *le* inserted a short distance lateral to the lamellar line; in *G. alata* the seta is positioned on the line or lateral to it. *Galumna obvia* is the only species observed with a *le* insertion medial to the lamellar line or in some specimens on it. The latter two species both show some variability of the *le* insertion.

The differentiation of the genera *Galumna* and *Pergalumna*, defined by Grandjean (1936) by means of the insertion of seta *le*, is called into question by the variable character state in *Galumna obvia*. This single differentiation character is of questionable value to discriminate genera as monophyletic entities, and the character is a simple one with a tendency to variability. Nevertheless, it is convenient to split the *Galumna-Pergalumna* complex in two parts for determination in keys: in *Galumna* "*le* is inserted on the lamellar line", in *Pergalumna* "medially at an obvious distance". We propose to maintain both genera provisionally until a desirable multifactorial phylogenetic analysis is performed.

An analogous case in the family Malaconothridae relates to the single argument to differentiate *Malaconothrus* Berlese, 1904 from *Trimalaconothrus* Berlese, 1916, by the typological characters "monodactylous or tridactylous legs". This character state is easy to distinguish but obviously without phylogenetical value. Colloff and Cameron (2013) provided a multifactorial analysis for several species of both genera. They found no reasonable pattern to confirm either genera as monophyletic: as a result *Trimalaconothrus* was considered a junior synonym; *Malaconothrus* and *Tyrphonothrus* Knülle, 1957, could be established as valid taxa without the number of claws being a key character.

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RESEARCH ARTICLE

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Taxonomic revision of the genus *Stenocyphus* Marshall (Coleoptera, Curculionidae) from Brazil

M. Guadalupe del Río[1,†], Analía A. Lanteri[2,‡]

1 *División Entomología, Museo de La Plata, Paseo del Bosque s/n, 1900 La Plata, Argentina*

† *http://zoobank.org/FD12181E-6F75-4AF6-8B80-7DC068DBBF01*
‡ *http://zoobank.org/E4337FAC-2532-4BCE-B167-A5808E4FD804*

Corresponding author: *M. Guadalupe del Río* (guadalupedelrio@yahoo.com)

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Abstract

Stenocyphus Marshall, 1922 (Entiminae, Naupactini) includes three species: the type species *S. bituberosus* (Gyllenhal, 1833), *S. tuberculatus* (Hustache, 1938), **comb. n.** herein transferred from *Neoericydeus* Hustache, 1938, and *S. sextuberosus* **sp. n.** The genus is endemic to the Atlantic forests of the states of Espirito Santo, Rio de Janeiro and São Paulo, Brazil and is mainly characterized by the presence of humped elytra bearing large conical tubercles on the intervals 5, or 3 and 5, or 3, 5 and 7. It shares some external morphological characters with *Hadropus* Schoenherr, 1826 and the Brazilian species of *Cyrtomon* Schoenherr 1823, but its phylogenetic position is uncertain. Herein we provide a diagnostic key to separate *Stenocyphus* from those genera, generic and species redescriptions or descriptions, a key to species, habitus photographs, line drawings of genitalia, and a discussion of the patterns of elytral tubercles in unrelated genera of Neotropical broad-nosed weevils.

Keywords

Systematics, weevils, elytral tubercles, Naupactini, Entiminae, new combination, new species, Neotropical Region

Introduction

Stenocyphus was described by Marshall (1922) as a monotypic genus of Entiminae Schoenherr, 1823, tribe Naupactini Gistel, 1848, based on the type species *Cyphus bituberosus* Gyllenhal, 1833. It is endemic to Brazil, where it occurs in the Atlantic province of the Neotropical region sensu Morrone (2006). Although it was included in diagnostic keys of Naupactini by Emden (1944) and Hustache (1947), *Stenocyphus* was never revised.

The main objective of this contribution is to redescribe *Stenocyphus,* as well as its type species *S. bituberosus* (Gyllenhal), to describe a new species, *S. sextuberosus*, and to accommodate one species transferred from *Neoericydeus* Hustache, 1938, *N. tuberculatus* (Hustache, 1938), establishing the new combination *Stenocyphus tuberculatus*. We provide habitus photographs of the three species, drawings of female and male genitalia, and a discussion on probable generic relationships and development of elytral tubercles in other Neotropical Entiminae.

Materials and methods

Specimens of *Stenocyphus* are scarce in entomological collections throughout the world and probably rare in nature. We have examined material from the following institutions:

AMNH American Museum of Natural History, New York, USA. Lee Herman.
BMNH Natural History Museum, British Museum of Natural History. Chrystopher Lyal.
DZUP Departamento de Zoologia, Universidade Federal do Paraná, Curitiba, PR, Brazil. Germano Rosado-Neto.
MCZ Museum of Comparative Zoology, Harvard University, Cambridge, USA. Brian Farrell.
MNHN Muséum National d' Histoire Naturelle, Paris, France. Hélène Perrin.
MNRJ Museo Nacional de Rio de Janeiro, RJ, Brazil. Miguel Monné.
MZSP Museu de Zoologia da Universidade de São Paulo, SP, Brazil. Sergio Vanin.
NHRS Naturhistoriska Riksmuseet, Stockholm, Sweden. Bert Vicklund.
USNM National Museum of Natural History, Smithsonian Institution, Washington D.C., USA. Steven Lingafelter.

Dissections were made according to standard entomological techniques. Photographs and drawings were done with a digital camera (Micrometrics 391CU, 3.2 m) and a camera lucida attached to a stereoscopic microscope Nikon SMZ1000. Measurements were taken with an ocular micrometer. Measurements, with their abbreviations are as follows: LB, total body length, measured along midline, from apex of rostrum to apex of elytra; LS, standard body length, measured along midline, from anterior margin of pronotum to elytral apex. LA, maximum length of antenna; LC, maximum

length of club; WC, maximum width of club; LR, length of rostrum; WF, width of forehead between anterior margin of eyes; WR, width of rostrum measured across apex (excluding scrobes); LP, maximum length of pronotum; WP, maximum width of pronotum; LE, maximum length of elytra; WE, maximum width of elytra.

Taxonomic treatment

***Stenocyphus* Marshall, 1922**
http://species-id.net/wiki/Stenocyphus
Figs 1–26

Stenocyphus Marshall, 1922:183; Dalla Torre et al. 1936:8 (catalogue); Emden 1944:512 (in key); Hustache 1947:6 (in key); Blackwelder 1947:792 (checklist); Wibmer and O'Brien 1986:51 (checklist); Alonso-Zarazaga and Lyal 1999:165 (catalogue).

Type species. *Cyphus bituberosus* Gyllenhal *in* Schoenherr 1833:622.

Diagnosis. Species medium-sized (LB: 10-16 mm long; LS: 8.4-13.0 mm long); body elongate, slender; integument densely covered with dull whitish, cream, or tan vestiture, composed of overlapping scales and scattered seta-like scales or setae (Figs 1–6). Rostrum short, with distinct lateral carinae (Fig 7). Antennae slender, setose, moderately long; scape exceeding posterior margin of eyes. Pronotum slightly truncate-conical, impressed on disc and flanks. Elytra humped, with strongly bisinuate base and prominent humeri, bearing conical tubercles on elytral intervals 5, or 3 and 5, or 3, 5 and 7 (Figs 1–6). Metatibial apex with broad, squamose corbel, and apical comb about 2× longer than dorsal comb. Aedeagus with long, curled flagellum.

Redescription. Species medium-sized to large (LB: female 12.7–16.0 mm long, male 10.6–13.5 mm long; LS: female 10.1–13.0 mm, male 8.4–9.8 mm).

Integument black, densely covered with dull whitish, cream or tan vestiture; scales subcircular and striate; seta-like scales pale, short, decumbent on rostrum, pronotum and elytra, and moderately long on elytral tubercles, venter and legs (longer and denser on inner and outer face of tibiae).

Rostrum (Fig 7) short (LR/WR: 1.00–1.21), sides slightly convergent toward apex (WF/WR: 1.20–1.50); dorsum strongly depressed; rostral carinae strong, subparallel, reaching anterior margin of eyes; median groove linear, exceeding hind margin of eyes; epistome broad, impressed, covered with subcircular small scales; scrobes scarcely visible from dorsum, slightly curving downwards, ending below eyes; gular angle very open (about 140–160°). Mandibles covered with creamy dispersed scales and coarse yellowish setae on external face; prementum subcordiform or subcircular, without long setae.

Antennae (Figs 8–10) (LB/LA: 2.47–3.00) slender, setose; scape exceeding posterior margin of eyes, slightly shorter than funicle; funicular article 2, 1.50–1.79× longer than article 1, articles 3 to 7, 2–3× longer than wide; club acuminate oval (LC/WC: 2.14–2.80).

Head. Eyes moderately convex; preocular impression distinct; postocular constriction slight. Forehead flat; vertex slightly convex.

Pronotum (Figs 1–3) moderately transverse (WP/LP: 1.16–1.32), with subparallel flanks on posterior 2/3, converging towards apex on anterior 1/3; pronotal disc and flanks longitudinally and/or irregularly impressed; anterior margin slightly curved backwards; hind margin moderately to strongly bisinuate, with posterior angles projected backwards.

Scutellar shield subtriangular or suboval, covered with cream or whitish scales.

Elytra (Figs 1–6) elongate, with maximum width behind midlength (LE/WE: 1.54–1.79; LE/LP: 2.13–3.27); base strongly bisinuate, projecting towards pronotum; humeri slightly to strongly prominent, without tooth; disc flat to slightly convex, elevated towards declivity; punctures of striae shallow to moderately deep, with one small oval scale on bottom; surface of intervals transversely undulate; intervals 5, or 3 and 5, or 3, 5 and 7 with tubercles; apical declivity abrupt, with distinct subapical callus; apex entire (not bifid), subacute. Metathoracic wings present, well developed.

Legs. Fore coxae tangent, slightly closer to anterior margin than to posterior margin of prosternum; protibiae curved inwards near apex, with distinct mucro and 6–8 small denticles on inner face (except in *S. tuberculatus*, lacking mucro and denticles); metatibial apex distinctly expanded; corbels broad, densely covered with scales; apical comb about 2× longer than dorsal comb; tarsomeres 1 and 2 elongate.

Abdomen (Figs 11–13). Intercoxal portion about 1.75× as wide as cavities of metacoxae; ventrite 2 about 1.20× as long as ventrites 3+4.

Female genitalia. Sternite VIII (Figs 14–16) subrhomboidal, slightly to moderately sclerotized, apex bearing long setae; apodeme 2–3× as long as plate. Ovipositor (Figs 17–19) slender, long (about 2/3 of abdomen), slightly curved on lateral view, with or without coarse setae along external sides of posterior 2/3 of baculi; coxites slightly sclerotized with short setae; baculi subparallel to slightly divergent towards base; styli well developed. Spermatheca (Figs 20–22) with subcylindrical or subglobose body, conical nodulus, indistinct or slightly developed ramus and short to moderately long cornu (not or reaching opening of gland); spermathecal duct membranous, narrow, as long as half length of ovipositor; spermathecal gland 2× as long as spermatheca.

Male genitalia. Penis (Figs 23–26) as long as ventrites 1–5, about 1.45–1.50× as long as temones, slightly curved in lateral view, with rounded apex and large ostium. Endophallus with curled flagellum.

Sexual dimorphism. Males slenderer and smaller than females; antennae slightly longer; pronotum less transversal and longer in relation to elytral disc (LE/LP: 2.13–3.05 in males; LE/LP: 2.90–3.27 in females); elytra more elongate (LE/WE: 1.62–1.79 in males; LE/WE: 1.54–1.57 in females), with tubercles slightly smaller than in females.

Distribution. *Stenocyphus* is distributed along the coastal hills of eastern Brazil, in Espirito Santo, Rio de Janeiro and São Paulo states. This area corresponds to the Atlantic province of the Neotropical region sensu Cabrera and Willink (1980), or Brazilian Atlantic Forest according to the biogeographic scheme of Morrone (2002, 2006). It

is characterized by a pluvial forest of trees of 30–40 meters high, with a lower stratum rich in palms, lianas and epiphytes.

***Stenocyphus bituberosus* (Gyllenhal, 1833)**
http://species-id.net/wiki/Stenocyphus_bituberosus
Figs 1, 4, 8, 11, 14, 17, 20, 23–24

Cyphus bituberosus Gyllenhal in Schoenherr 1833: 622.
Neocyphus bituberosus: Bedel 1883: 23.
Stenocyphus bituberosus: Marshall 1922: 184.

Diagnosis. *Stenocyphus bituberosus* is easily distinguished by the presence of one pair of large conical tubercles, slightly directed backwards, on posterior 2/3 of elytral interval 5, near declivity. This species differs from *S. sextuberosus* in the following characters: body larger, scape of antennae slightly shorter, elytra with a single pair instead of three pairs of tubercles, intercoxal portion of abdomen slightly broader than cavity of metacoxae, spermatheca slender and aedeagus not flattened towards apex in lateral view.

Redescription. LB: female (Figs 1, 4) 12.7–15.6 mm long; male 11.2–12.7 mm long (LS: female 10.1–12.2 mm; male 8.5–9.8 mm).

Vestiture uniformly whitish or tan.

Rostrum (Fig 7) (LR/WR: 0.98–1.15) with sides slightly convergent toward apex (WF/WR: 1.23–1.45); preocular impression slight; prementum subcordiform.

Antennae (Fig 8) (LB/LA: 2.49–3.00) with scape slightly exceeding posterior margin of eyes; funicular article 2, 1.50–1.79× as long as article 1; club oval (LC/WC: 2.14–2.37).

Pronotum (Figs 1, 4) (WP/LP: 1.19–1.32) longitudinally impressed on disc and flanks; hind margin moderately bisinuate.

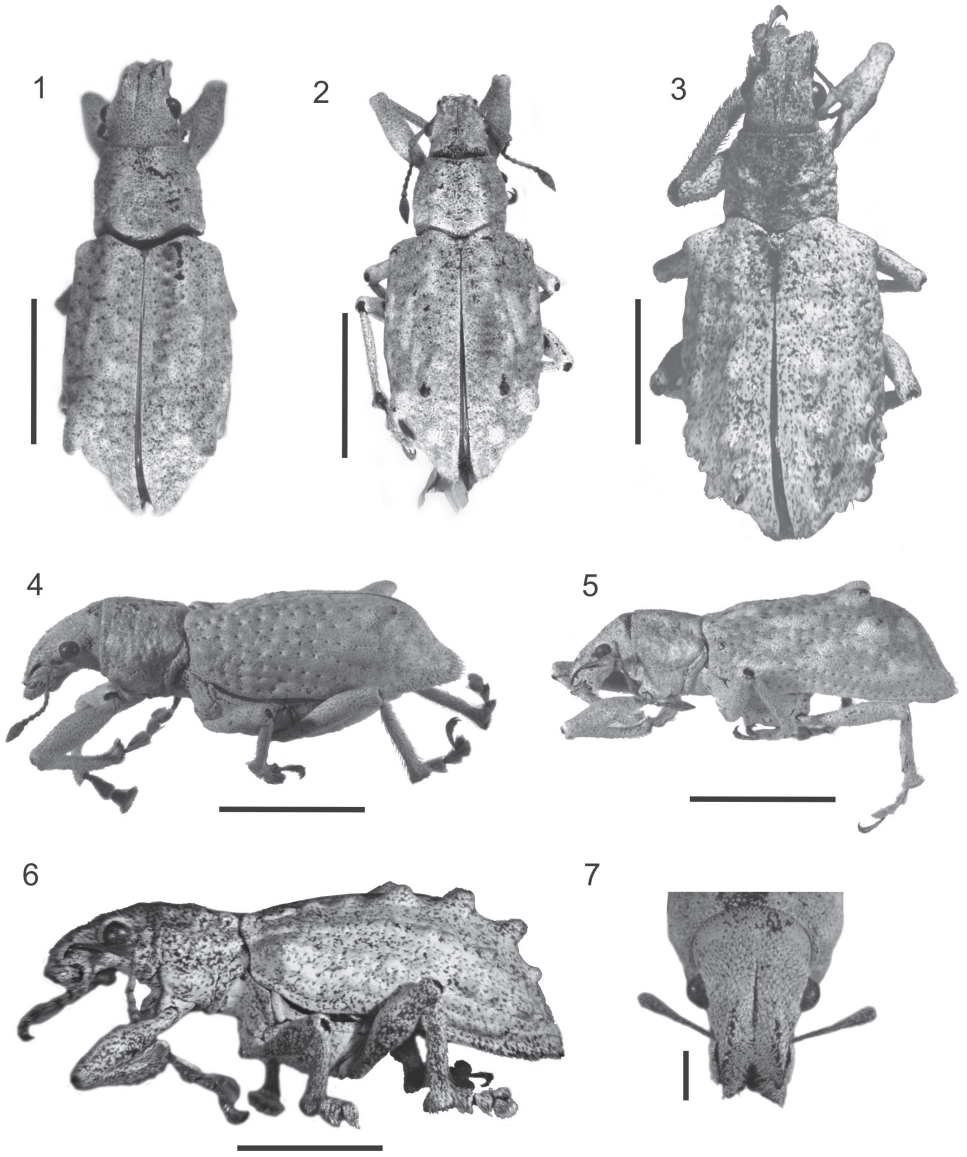
Scutellar shield subtriangular, covered with cream colored, lanceolate scales.

Elytra (Figs 1, 4) slender (LE/WE: 1.54–1.77; LE/LP: 2.67–3.00), with a pair of conical tubercles directed backwards, on posterior 2/3 of interval 5 near declivity; humeri slightly prominent; disc flat, slightly elevated towards declivity; punctures of striae deep; intervals slightly wavy (with undulating transverse impressions).

Legs. Protibiae slender, setose, with distinct mucro and 6–8 small denticles on inner face; mesotibiae with minute mucro and without denticles ; metatibiae without mucro or denticles; corbels broad, covered with cream colored scales; apical comb almost 2× as long as dorsal comb.

Abdomen (Fig 11). Intercoxal portion about 1.75× as wide as cavities of metacoxae.

Female genitalia. Sternite VIII (Fig 14) with plate 2.13× as long as apodeme. Ovipositor (Fig 17) without setae along sides of subparallel baculi; styli slightly visible from ventral view. Spermatheca (Fig 20) with subcylindrical, slender body, short nodulus, curved towards opening of gland, indistinct ramus and moderately long cornu



Figures 1–7. Photographs of *Stenocyphus* spp. **1–3** habitus dorsal view **4–6** habitus lateral view **7** head and rostrum dorsal view. **1, 4, 7** *S. bituberosus* **2, 5** *S. sextuberosus* **3, 6** *S. tuberculatus*. Scales: 5 mm; rostrum and head 1 mm.

(reaching opening of gland); spermathecal duct as long as half length of ovipositor; spermathecal gland 2× as long as spermatheca.

Male genitalia. Penis (Figs 23–24) about 1.45× as long as temones. Endophallus with two lateral long sclerites and a flagellum.

Material examined. *Type material.* Lectotype of *Cyphus bituberosus* female, pinned, from Brazil, NHRS, labeled as type. Here designated to fix the concept of *Cyphus bituberosus* and to ensure the universal and consistent interpretation of the same.

Other material. BRAZIL. No loc: (1♀ USNM, 1♂ MNRJ), col. Bovie thru Buchanan (1♂ USNM), Deyr (2♀♀, 1♂ MCZ), Gorham (1♀ MCZ), Bowdetch (1♂ MCZ), Bruch (1♀ MLP), Pascoe (1♀ BMNH), Schoenherr coll (3♀♀ 1♂ NHRS). *São Paulo*: Embú, 5-III-1972, Lane col. (1♂ MZSP). *Rio de Janeiro:* no loc., 1905, Fry coll (1♂ BMNH). *Espirito Santo:* no loc. (2♀♀ AMNH).

Distribution. Brazil, states of São Paulo, Rio de Janeiro and Espirito Santo.

Infraspecific variation. Variation in *Stenocyphus bituberosus* is mainly related to body size, morphometrics and extent of development of the elytral tubercles.

***Stenocyphus sextuberosus* del Río & Lanteri, sp. n.**
http://zoobank.org/DDDBFEDD-9539-489B-97E1-9FA36AEE4F64
http://species-id.net/wiki/Stenocyphus_sextuberosus
Figs 2, 5, 9, 12, 15, 18, 21, 25, 26

Diagnosis. The new species *Stenocyphus sextuberosus* is easily distinguished by the presence of three pairs of tubercles on the elytral disc, two on interval 3 and one on interval 5. The largest pair of tubercles is slightly directed backwards, placed on the posterior 2/3 of interval 3, and followed by a small one; the tubercle on interval 5 is large but rounded and is placed near the declivity. The other species of *Stenocyphus* bear two (*S. bituberosus*) or more than six elytral tubercles (*S. tuberculatus*). *Stenocyphus sextuberosus* also differs from the closest species *S. bituberosus* in the following characters: body slightly smaller, scape of antennae slightly longer, elytra with three pairs of tubercles instead of one pair, intercoxal portion of abdomen slightly broader than cavities of metacoxae, spermatheca more globose and aedeagus flattened towards apex in lateral view. The main differences with *S. tuberculatus* are in the shape of the scutellar shield (triangular instead of suboval), the presence of mucro and denticles on the protibiae, the absence of rows of setae along sides of the ovipositor, and the shape of the spermatheca (with apex of nodulus shorter, curved towards opening of gland, and indistinct ramus).

Description. LB: female (Figs 2, 5) 13.6 mm long; male 10.6–11.3 mm long (LS: female 10.9 mm; male 8.4–9.5).

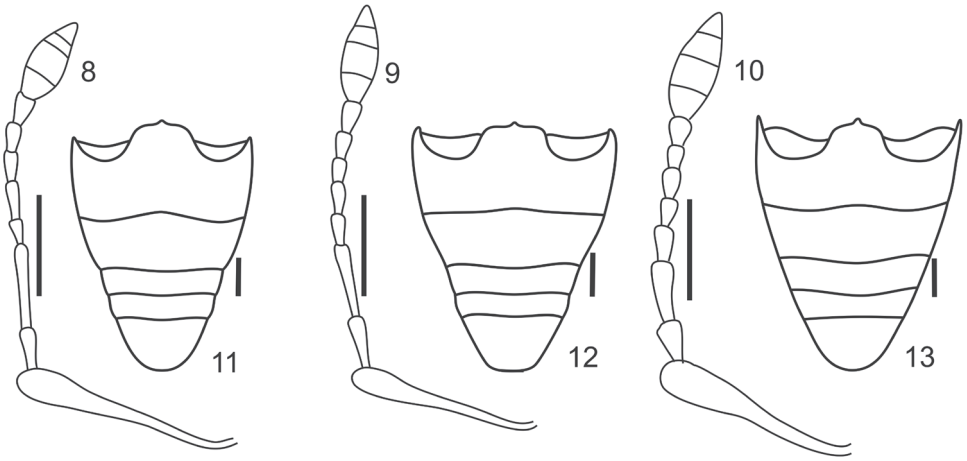
Vestiture uniformly tan.

Rostrum (Fig 2) (LR/WR: 1.18) with sides slightly convergent toward apex (WF/WR: 1.43); preocular impression slight; prementum subcordiform.

Antennae (Fig 9) (LB/LA: 2.60) with scape almost reaching anterior margin of pronotum; funicular article 2, 1.65× as long as article 1; club oval (LC/WC: 2.40).

Pronotum (Figs 2, 5) (WP/LP: 1.25) longitudinally impressed on disc and flanks; hind margin moderately bisinuate.

Scutellar shield subtriangular, densely covered with cream colored, lanceolate scales.



Figures 8–13. Antennae and ventrites of *Stenocyphus* spp. **8–10** left antenna **11–13** ventrites. **8, 11** *S. bituberosus* **9, 12** *S. sextuberosus* **10, 13** *S. tuberculatus*. Scales: 1 mm.

Elytra (Figs 2, 5) slender (LE/WE: 1.57; LE/LP: 3.27), with three pairs of tubercles on posterior third, two on interval 3 and one on interval 5, the latter between the other two: first pair on interval 3 large, slightly directed backwards, second pair on interval 3 small, and tubercles on interval 5 large but rounded; humeri slightly prominent; disc flat, slightly elevated towards declivity; punctures of striae deep; intervals slightly wavy except the distinctly elevated and light colored anterior 1/4 of interval 3 and anterior 2/4 of interval 5.

Legs. Protibiae slender, setose, with distinct mucro and 5–7 minute denticles on inner face; mesotibiae with minute mucro and without denticles; metatibiae without mucro and denticles; corbels broad, covered with cream colored scales; apical comb almost 2× as long as dorsal comb.

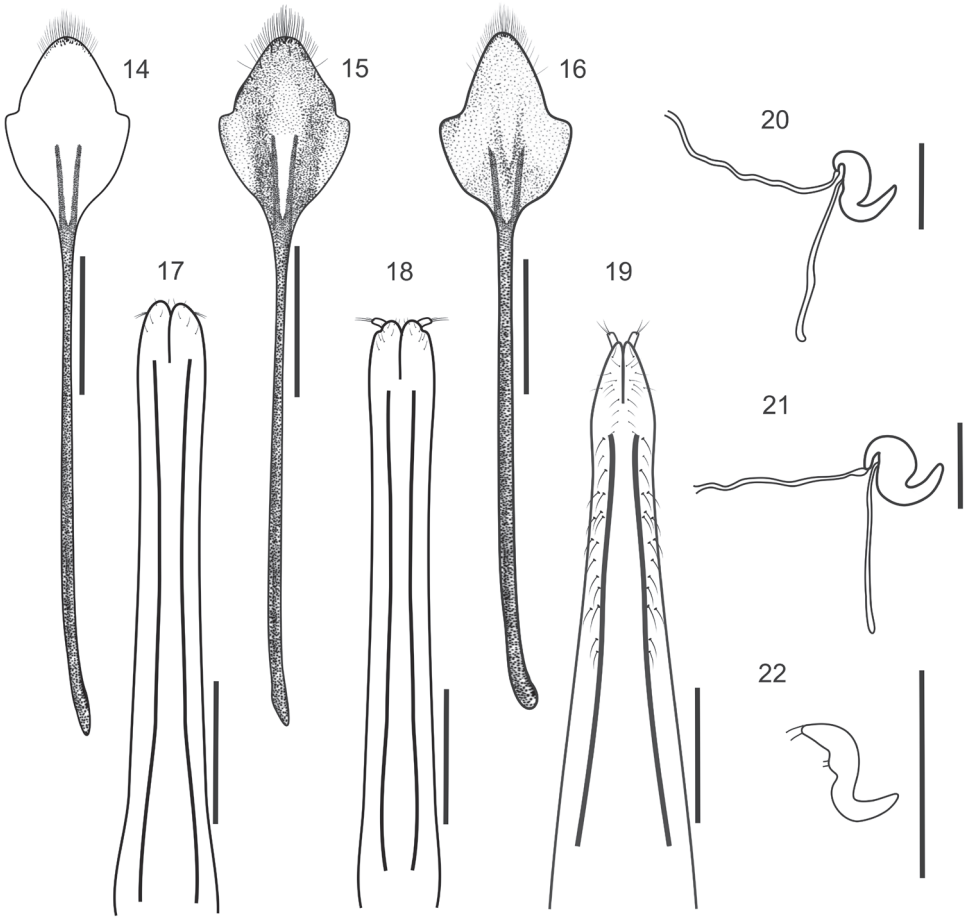
Abdomen (Fig 12). Intercoxal portion about 1.25× as wide as cavity of metacoxae.

Female genitalia. Sternite VIII (Fig 15) with plate 3× as long as apodeme. Ovipositor (Fig 18) without setae along sides of subparallel baculi; styli directed outwards. Spermatheca (Fig 21) with subglobose body, short nodulus curved towards opening of gland, indistinct ramus and moderately long cornu (reaching opening of gland); spermathecal duct membranose, as long as half length of ovipositor; spermathecal gland 2× as long as spermatheca.

Male genitalia. Penis (Figs 25–26) about 1.5× as long as temones, flattened towards apex in lateral view. Endophallus with spines at proximal end and a flagellum.

Etymology. The name of the new species is an adjective that refers to the six tubercles present on the elytral disc, a distinct character that allows differentiation from the remaining species of *Stenocyphus.*

Material examined. Holotype female, 13.6 mm long, pinned, with genitalia in a separate microvial. Original label: "Cantareira, São Paulo, 30-XII-1939, Halik" "HOLOTYPE/ *Stenocyphus*/ *sextuberosus*/ del Río & Lanteri"[red printed label]. De-



Figures 14–22. Female terminalia of *Stenocyphus* spp. **14–16** sternites VIII **17–19** ovipositors, ventral view **20–22** spermatheca with spermathecal duct and gland. **14, 17, 20** *S. bituberosus* **15, 18, 21** *S. sextuberosus* **16, 19, 22** *S. tuberculatus*. Scales: 1 mm.

posited at USNM. **Paratypes.** Males, pinned, from the same locality as holotype, 1-II-1962, Halik (1 USNM), 23-XII-1959, Halik (1 MZSP). Male, pinned, from Rio de Janeiro, Itatiaia, PN, 1100m, 8–13-XII-2004, Monné MA, Monné ML & Mermudes col. (1 MZSP).

Distribution. Brazil, states of São Paulo and Rio de Janeiro.

***Stenocyphus tuberculatus* (Hustache, 1938), comb. n.**
http://species-id.net/wiki/Stenocyphus_tuberculatus
Figs 3, 6, 10, 13, 16, 19, 22

Compsus tuberculatus Hustache, 1938: 73.

Neoericydeus tuberculatus: Kuschel 1955:280; O'Brien and Peña 2012 (in key).

Diagnosis. *Stenocyphus tuberculatus* is easily distinguished by the presence of three series of conical tubercles along elytral intervals 3, 5 and 7, from base to apex, with the largest tubercles placed near the declivity of interval 3. It also differs from the other two species of *Stenocyphus* by the following characters: elytral disc with fine, dark, erect setae scattered on posterior 2/3, rostrum almost subparallel-sided; scutellar shield suboval; elytral disc slightly convex and elevated towards declivity, with indistinct punctures of striae; all tibiae with indistinct mucro and denticles; protibiae broad and densely setose; ovipositor with coarse setae along external sides of apical 2/3 of baculi; spermathecae slender, with moderately long nodulus, not curved towards opening of gland.

Redescription. LB: female (Figs 3, 6) 16 mm long (LS: 13 mm). Vestiture whitish, except on dorsum of rostrum, head and pronotum which are tan coloured. Elytral disc with fine, dark, erect setae scattered on posterior 2/3.

Rostrum (Fig 3) (LR/WR: 1.00) with sides very slightly convergent toward apex (WF/WR: 1.20). Eyes larger than in the other two species; preocular impression strong; prementum subcircular.

Antennae (Fig 10) (LB/LA: 2.67) with scape exceeding posterior margin of eyes, almost reaching anterior margin of pronotum; funicular article 2, 1.53× as long as article 1; club elongate (LC/WC: 2.80).

Pronotum (Figs 3, 6) (WP/LP: 1.16) with irregular impressions on disc and flanks; hind margin strongly bisinuate.

Scutellar shield suboval, covered with subcircular whitish scales.

Elytra (Figs 3, 6) moderately broad (LE/WE: 1.55; LE/LP: 3.25), with three series of conical tubercles along intervals 3, 5 and 7, small on anterior third and large near declivity; humeri strongly prominent; disc slightly convex, elevated towards apical declivity; punctures of striae indistinct; intervals flat, except those having tubercles.

Legs. All tibiae with indistinct mucro and denticles; protibiae broad, densely setose; metatibial apex with broad corbel, covered with brown scales; apical comb more than 2× longer than dorsal comb.

Abdomen (Fig 13). Intercoxal portion as wide as cavities of metacoxae.

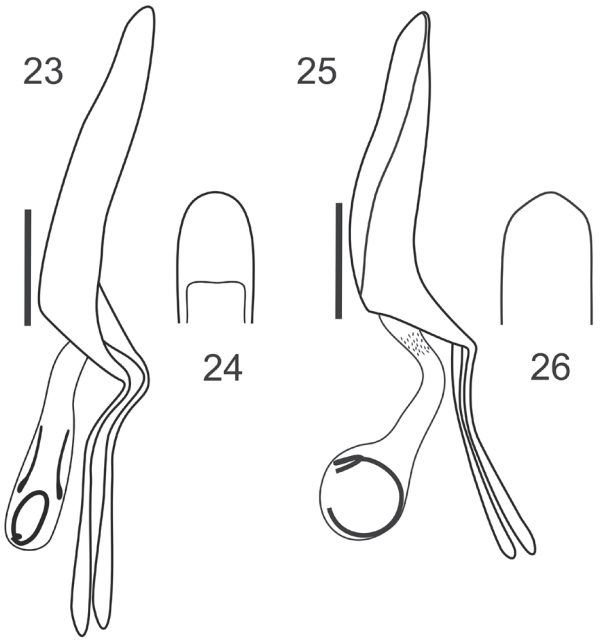
Female genitalia. Sternite VIII (Fig 16) with plate about 2.5× as long as apodeme. Ovipositor (Fig 19) with coarse setae along external sides of apical 2/3 of baculi; baculi divergent towards base; styli directed backwards. Spermatheca (Fig 22) with slender subcylindrical body, moderately long nodulus, not curving towards opening of gland, distinct ramus and short cornu (not reaching opening of gland); spermathecal duct and gland not seen.

Male. Unknown.

Material examined. *Type material.* Holotype of *Compsus tuberculatus* Hustache, female, pinned, from Brazil, Espirito Santo, MNHN, labeled as type.

Other material. BRAZIL. *Espirito Santo*: Santa Teresa, 28/11/1966, C. T. & C. Elias (1♀ DZUP).

Distribution. Brazil, state of Espirito Santo.



Figures 23–26. Male genitalia, aedeagi. **23, 25** lateral view **24, 26** apex in ventral view. **23–24** *S. bituberosus* **25–26** *S. sextuberosus*. Scales: 1 mm.

Remarks. *Stenocyphus tuberculatus* (Hustache) was originally described in *Compsus* Schoenherr, 1823 (Entiminae: Eustylini) and transferred to *Neoericydeus* (Entiminae: Naupactini) by Kuschel (1955). Based on the characters of the rostrum, this species clearly belongs to Naupactini and not to Eustylini, however, we do not agree with its placement in *Neoericydeus*, a South American genus with three species that needs revision. The type species *N. gratiosus* Hustache, 1938 lacks elytral tubercles and shows a vestiture of greenish or bluish iridescent scales, interrupted with setose black maculae on the pronotum and elytra, the same as in the genera *Ericydeus* Pascoe, 1880 and *Briarius* [Fischer de Waldheim] 1829 (see Lanteri 1995; Lanteri and del Río 2003).

The characters of *N. tuberculatus* are typical of *Stenocyphus*, thus this species is herein transferred to this genus as *Stenocyphus tuberculatus*. The other two species of *Stenocyphus* are more similar to each other in most characters, and they lack the rows of setae on each side of the baculi of the ovipositor. Unfortunately, male genitalia could not be studied due to the absence of material.

The Brazilian species of Naupactini distributed in Espirito Santo state are usually strongly differentiated from other congeners ranging in southern distributions (e.g. Rio de Janeiro and São Paulo states). The pattern of morphological differentiation along the Brazilian Atlantic forests seen in *Stenocyphu*s is also present in species of *Briarius*, *Cyrtomon* Schoenherr, 1823, *Ericydeus* and *Teratopactus* Heller, 1921 (Lanteri 1990a, 1995, Lanteri and del Río 2003, del Río et al. 2006).

Key to species of *Stenocyphus*

1 Elytral disc with one pair of large conical tubercles, slightly directed backwards, on posterior two thirds of interval 5, near declivity. Scutellar shield suboval. Protibiae without mucro and denticles. Ovipositor with coarse setae along external sides of apical 2/3 of baculi ..... ***S. bituberosus*** (Figs 1, 4)

– Elytral disc with more than one pair of tubercles. Scutellar shield subtriangular. Protibiae with mucro and denticles. Ovipositor without coarse setae along sides of baculi **2**

2 Elytral disc with three pairs of tubercles, two on interval 3 and one on interval 5. The largest pair of tubercles slightly directed backwards, placed on posterior 2/3 of interval 3, and followed by a small one; tubercle on interval 5, large but rounded and placed near declivity. Penis flattened towards apex in lateral view..... ***S. sextuberosus*** (Figs 2, 5)

– Elytral disc with three series of conical tubercles along intervals 3, 5 and 7, from base to apex, with largest tubercles placed near declivity of interval 3. Penis not flattened towards apex in lateral view.... ***S. tuberculatus*** (Figs 3, 6)

Discussion

In a preliminary cladogram of the Naupactini genera, *Stenocyphus* shows an uncertain, position (del Río and Lanteri 2010), however, it is probably related to a group of genera characterized by the presence of humped elytra (disc progressively elevated from the base to the beginning of the elytral declivity) and broad squamose corbels. Several external features resemble the genus *Cyrtomon* (senior synonym of *Cyphus* Germar, 1824), particularly those of the type species *Cyrtomon gibber* (Pallas, 1781). However, the species of *Cyrtomon* differ as follows: absence of the typical elytral tubercles of *Stenocyphus;* external surface of the prementum bears long easily visible setae; dorsal comb of the metatibiae is longer than the apical comb; male and female genitalia very different, especially the penis (with typical arrow-pointed apex, having one central and two lateral points, and a distinct sclerite in the endophallus), spermatheca (with long, subcylindrical nodulus, well developed ramus, and wide, curled and strongly sclerotized spermathecal duct, same as in *Priocyphus* Hustache, 1939) (see Lanteri 1990a, b). In *Stenocyphus* the apex of the penis is rounded and it bears a curled flagellum, the spermathecae have a conical nodulus, indistinct or small ramus, and narrow, membranous spermathecal duct. Moreover, in *S. tuberculatus* the ovipositor bears a row of setae along each side of the baculi, as in some species of the genera *Naupactus* Dejean, 1821 and *Teratopactus* (see del Río et al. 2006).

Another Brazilian Naupactini with humped elytra that could be related to *Stenocyphus* is *Hadropus* Schoenherr, 1826; however, in this genus the antennae, rostrum and elytra are much shorter, the epistome is very distinct, and the spermatheca has a

characteristic shape (with indistinct nodulus and strongly prominent ramus) (see del Río and Lanteri 2011) similar to that of *Enoplopactus* Heller, 1921 (see Lanteri 1990c).

In the same area of the elytra where *Stenocyphus* has the typical tubercles (intervals 3, 5 and 7, near declivity), *Cyrtom*on *gibber* has a pair of impressions, and the single species of *Hadropus*, *H. albiceris* (Germar, 1824) shows distinct tufts of erect, dark setae. Something similar has been observed in species of *Briarius* and *Ericydeus* (Lanteri 1995; Lanteri and del Río 2003).

The presence of tubercles on the elytral disc is a distinct feature of other Neotropical Entiminae that bear humped elytra, lacking close relationship with *Stenocyphus*. For example *Compsus bituberculatus* Kirsch, 1889 (Eustylini Lacordaire, 1863) shows a single pair of tubercles as does *Stenocyphus bituberosus.* Within the tribe Naupactini the elytral tubercles are also present in the Central American monotypic genus *Tetragonomus* Champion, 1911 (type species *T. tuberosus* Champion, 1911) and in several Brazilian species of *Platyomus* Sahlberg, 1823 (senior synonym of *Pseudocyphus* Schaeffer, 1905) e.g. *P. agonista* (Germar, 1824), *P. duponti* Boheman, 1833, *P. gyllenhali* Boheman, 1840, *P. hystricosus* (Germar, 1824), *P. nodipennis* C.R. Sahlberg, 1823, *P. piscatorius* (Germar, 1824), *P. prasinus* Boheman, 1833, *P. silvermanni* Rosenschoeld, 1840, and *P. wahlenbergii* Boheman, 1840, however, most morphological evidence indicates that neither *Tetragonomus* nor *Platyomus* are closely related to *Stenocyphus.*

Key to genera probably related to *Stenocyphus*

1 External surface of the prementum with long easily visible setae; metatibiae with dorsal comb longer than apical comb ..... ***Cyrtomon***

– External surface of the prementum without visible setae; metatibiae with dorsal comb shorter than apical comb **2**

2 Rostrum wider than long (LR/WR: 0.73–0.83). Epistome very narrow, well defined by a denuded line. Antennae with scape not exceeding half of eye. Elytra very short (L/W: 1.30–1.55) with tuft of dark erect setae-like scales on intervals 1 and 3 near declivity ..... ***Hadropus***

– Rostrum as wide as long, to longer than wide (L/W: 1.00–1.21). Epistome broad, not well defined. Antennae with scape exceeding posterior margin of eyes. Elytra elongate (L/W: 1.55–1.80) with different number of tubercles on intervals 5, or 3 and 5, or 3, 5 and 7, near declivity or along the intervals ..... ***Stenocyphus***

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Redescription and new records of *Ulomimus indicus* Bates, 1873 (Coleoptera, Tenebrionidae, Tenebrioninae)

Shanshan Liu[1], Guodong Ren[1], Ottó Merkl[2]

1 *College of Life Sciences, Hebei University, Baoding, 071002, P. R. China* **2** *Hungarian Natural History Museum, H-1088 Budapest, Baross utca 13, Hungary*

Corresponding author: *Guodong Ren* (gdren@hbu.edu.cn; shanllshan@126.com)

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Abstract

Ulomimus indicus Bates, 1873 of the tribe Ulomini is recorded for the first time from China (Guangxi and Hainan), Indonesia (Sumatra) and Thailand (Chiang Dao). A redescription of the male and the first description of the female are also provided.

Keywords

China, Coleoptera, Indonesia, new country records, Tenebrionidae, Thailand, *Ulomimus*, Ulomini

Introduction

Ulomimus indicus and the monotypic genus *Ulomimus* were described by Bates (1873) from "East India". The species was later mentioned to occur in Sri Lanka (Kaszab 1979) and in Vietnam (Kaszab 1980, Merkl 1992).

Ulomimus is a member of the tribe Ulomini. This tribe is characterized by the presence of placoid sensoria on the antennae, the primitive ("lagrioid") type of labrum and the exposed posterior part of the 7th abdominal tergite (Matthews and Bouchard 2008). The tribe includes about 40 genera and an estimated 400 described species. It is fairly speciose in the Old and New World tropics, but very few species extend into the Nearctic ecozone (Aalbu et al. 2002) and into the Euro-Siberian region of the Palaearctic ecozone (Löbl et al. 2008). More than half of the known species have been described from the Indomalaya ecozone (Oriental Realm), where Sundaland is the

richest in species. However, the overwhelming majority of the described species belong to the genus *Uloma* Dejean, 1821.

Ulomimus is very similar and closely related to the Oriental genus *Cneocnemis* Gebien, 1914. In *Ulomimus* the antennomere 6 is transverse and bears one placoid sensorium (antennomere 6 is subequal in length and width and without placoid sensorium in *Cneocnemis*), the pronotum is widest in anterior 1/3 (widest at base in *Cneocnemis*), and apicale of aedeagus with small oblique lateral notch (without notch in *Cneocnemis*).

These two genera are similar to the widely distributed genus *Uloma*. The antennomeres 5 to 10 of *Uloma* are strongly transverse, forming a more or less distinct club, and have several placoid sensoria on their distal edge, which are arranged in complete rings on antennomeres 7 to 10. Antennae of *Cneocnemis* and *Ulomimus* are more elongate, only the antennomeres 6 or 7 to 10 are transverse (much less than in *Uloma*), the placoid sensoria are fewer in number, and do not form complete rings. The pronotum of most *Uloma* species is sexually dimorphic – males have large anterior impression and low protuberances. The pronotum of the males and females are the same in *Cneocnemis* and *Ulomimus.*

In the present paper, the distribution range of the species is revised through the inclusion of new records from China, Indonesia and Thailand. A redescription of the male and a description of the female (including diagnostic features) are also provided.

Material and methods

The illustrations were made using a Nikon SMZ800 dissecting microscope (equipped with a camera lucida). The photos were taken with a Leica M205A stereomicroscope equipped with a Leica DFC 450 digital microscope camera. All measurements were made in millimeter. The specimens examined are deposited in the Museum of Hebei University (MHBU), Baoding, China, in the Hungarian Natural History Museum, Budapest, Hungary (HNHM) and in the National Museum of Nature and Science, Tokyo (now in the Masumoto Collection, NMNS).

Taxonomy

Ulomimus Bates, 1873

http://species-id.net/wiki/Ulomimus

Ulomimimus Bates, 1873: 201; Neave 1940b: 608.
Ulomi[mi]mus: Rye 1873: 288.
Ulomimus: Gebien 1911: 399; Lucas 1920: 665; Gebien 1914: 33; Gebien 1940: 770 [577]; Kaszab 1979: 88; Kaszab 1980: 175; Merkl 1992: 263.
Pseuduloma Fairmaire, 1893: 27; Gebien 1911: 404; Carter 1926: 508; Neave 1940a: 1011.

Type species. *Ulomimus indicus* Bates, 1873.

Diagnosis. Antennae short, antennomeres 6 to 10 gradually widened, 11 large, nearly globose. Pronotum with narrow and complete basal bead. Protarsi dilated with a brush of dense short hairs beneath, and protarsomere 4 much smaller than 2 and 3. Protibia strongly triangularly widened near apex, with large tooth on ventral surface. Aedeagus linearly truncate at apex in dorsal view, parameres with a small notch behind each apical corner.

Remarks. The original spelling of the generic name is *Ulomimimus*. Rye (1873) mentioned the name as *Ulomi[mi]mus,* which is regarded as unjustified emendation. Neave (1940b) considered *Ulomimus* as an "err. Pro *Ulomimimus* Bates, 1873". However, all other authors used *Ulomimus*, so *Ulomimus* should be an unjustified emendation by Rye (1873) in prevailing usage, which is according to the Art. 33.2.3.1 of the ICZN (1999) is deemed a justified emendation.

It is unknow for the authors of the present paper who synonymised *Pseuduloma* with *Ulomimus*. Carter (1926) mentioned *Pseuduloma* as a distinct genus, when transferred *Alphitobius torridus* Carter, 1911 (now belonging to *Scotoderus* Perroud, 1864, see Matthews and Bouchard 2008) to this genus. Neave (1940a) also considered *Pseuduloma* as a valid genus. However, Gebien (1940) used *Pseuduloma* as a synonym of *Ulomimus*.

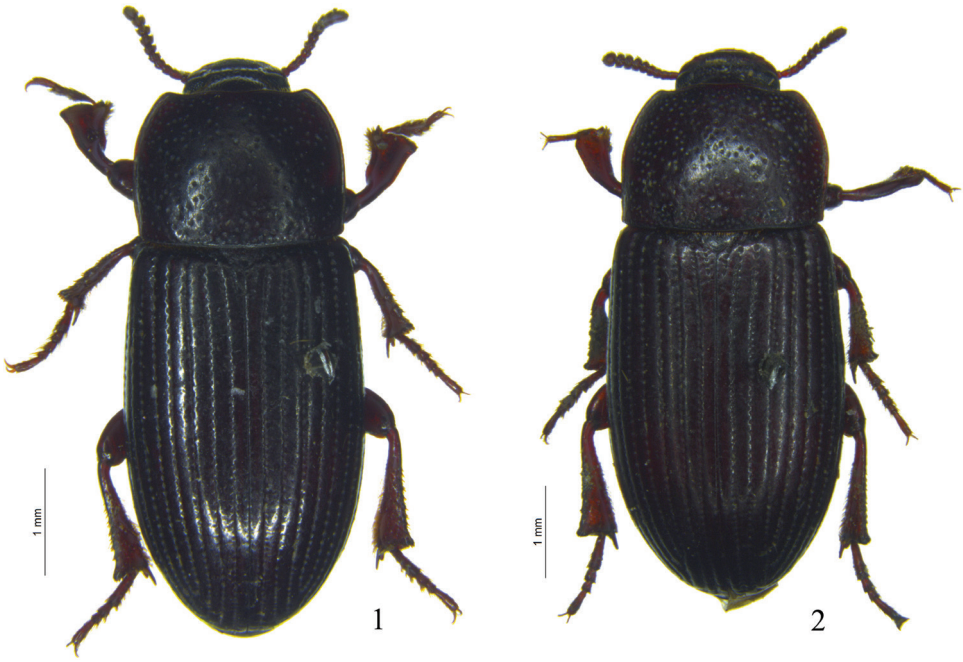
***Ulomimus indicus* Bates, 1873**
http://species-id.net/wiki/Ulomimus_indicus
Figs 1–13

Ulomimimus indicus Bates, 1873: 202.
Ulomimus indicus: Gebien 1911: 399; Gebien 1940: 770 [577]; Kaszab 1979: 88; Kaszab 1980: 175; Merkl 1992: 263.
Pseuduloma cribricollis Fairmaire, 1893: 27; Gebien 1911: 404.

Original description. "Oblong, sub–parallel, moderately convex; brownish–black, shining, the mentum, antenna, palpi, tarsi, labrum, and margins of epistoma ferruginous, the legs chestnut–red; head coarsely and closely reticulate–punctate; prothorax punctured–sparsely on the disc–the punctures large, deep, rounded, and partly filled in with an apparent exudation of an ashy tint; scutellum smooth; elytra with nine (including the extreme marginal one) fine but deep striae, and a short scutellar one, the striae punctured (the punctures being much wider than the striae, the elytra appear crenulate–striate), the 4th and 5th striae shortest and united at some distance from the apex; intervals convex posteriorly, very minutely and sparsely punctured; pro– and mesosterna, flanks of pro– and mesothorax, and base of epipleural fold, strongly and closely punctured; metasternum, abdomen, and femora sparingly punctured, abdominal joints rugulose at the base. Long. corp. 4 lin.

Hab.: East India; one example."

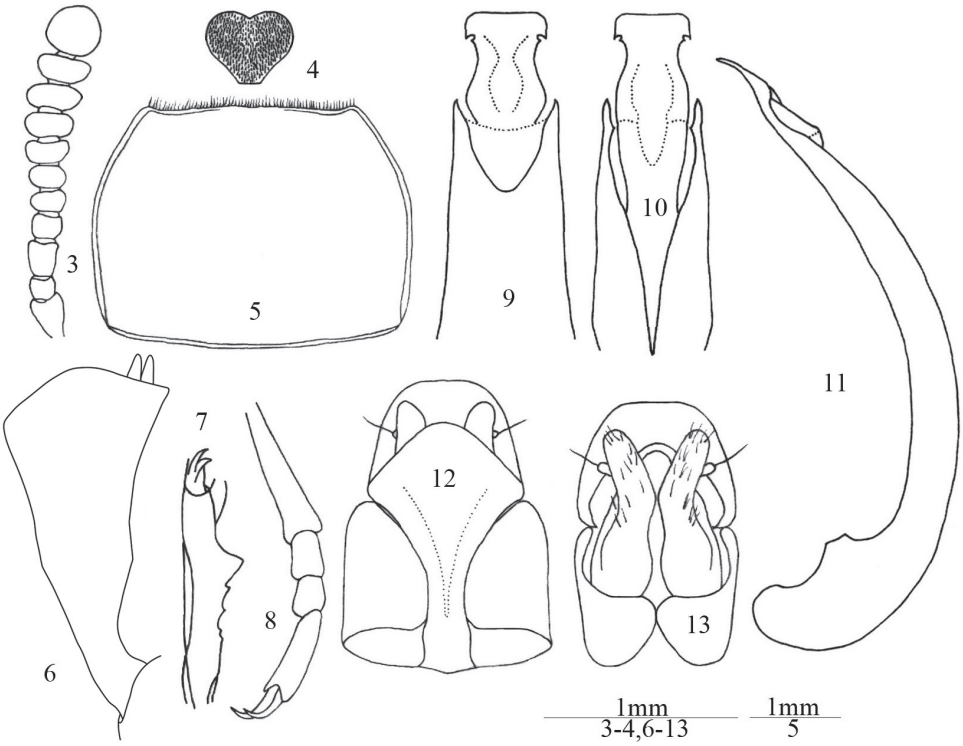
Redescription. Male. Body length 8.0–9.0 mm; width 3.5–4.0 mm. Body (Fig. 1) elongate, elliptical, black or dark brown. Antennae, mouthparts and legs slightly



Figures 1–2. *Ulomimus indicus* Bates, 1873. **1** Male **2** female.

paler. Head transverse, with small punctures on anterior half, and with sparse large punctures on posterior half; labrum transversely rectangular, densely punctate, scattered with short and yellow hairs; clypeus densely punctate, anterior margin truncate; frontoclypeal suture deeply impressed; genae feebly convex and slightly extended, temples reduced; eyes transverse, with 5–6 facets at narrowest point in lateral view; frons weakly convex, with large punctures; mentum (Fig. 4) cordate, truncate basally, with short and very dense yellow pubescence; ligula deeply emarginate anteriorly, depressed in middle; maxillary palp with narrowly trapezoidal terminal palpomere. Antennae (Fig. 3) short, not reaching half of pronotum; antennomere 1 thick, 2 very short, 3 long and narrow, 4 and 5 short, 6 to 10 gradually widening, 11 nearly globose, ratio of the length (width) of antennomeres 2–11 as follows: 4 (6): 8 (6): 5 (7): 5 (7): 5 (8): 4 (9): 5 (10): 5 (12): 5 (11): 11 (11). Antennomere 6 with one placoid sensorium on inner anterior corner, 7 with two placoid sensoria on inner corner, 8 to 9 with a few on inner and outer corners.

Pronotum (Fig. 5) transverse, about 1.35 times as wide as long, widest at anterior 1/3, with large punctures widely spaced in middle but becoming denser toward sides; anterior margin emarginate with narrow bead interrupted in middle, and with dense short hair fringes; lateral margins arcuate, strongly narrowing forward and less so from widest point to base, with narrow bead; basal margin slightly convex, with narrow bead; anterior angles nearly rectangular, posterior angles obtuse. Prosternum with sparse and large punctures, prosternal process rounded in lateral view, with small



Figures 3–13. *Ulomimus indicus* Bates, 1873. **3** Antenna, male, dorsal view **4** mentum, male, ventral view **5** pronotum, male, dorsal view **6** protibia, male, dorsal view **7** protibia, male, lateral view **8** metatarsus, male, dorsal view **9** apical aedeagus, dorsal view **10** apical aedeagus, ventral view **11** aedeagus, lateral view **12** ovipositor, dorsal view **13** ovipositor, ventral view.

subapical tubercle. Mesoventrite with deep triangular impression; mesepisternum, metepimeron and metepisternum coarsely and sparsely punctate.

Scutellum triangular, impunctate. Elytra distinctly punctato–striate, intervals weakly convex, very finely and sparsely punctate, lateral margins visible only at humeri in dorsal view. Epipleura sparsely and coarsely punctate in basal 1/3.

Protibia (Figs 6–7) with two equal apical spurs; narrow at base, then explanate on both inner and outer edges, outer edge forming blunt subapical angulation, inner edge slightly concave at middle; outer edge without denticulation; inner edge fringed with yellow hairs becoming denser and longer toward apex; dorsal surface with low and blunt longitudinal keel and with fine and sparse punctures; ventral surface with sharp longitudinal keel and sharp tooth at middle (Fig. 7), ventral surface with a few coarse punctures and short, sparse, thick hairs. Protarsomeres 2 to 4 dilated, with long, sparse yellow dorsal hairs and dense, yellow ventral hair pads. Mesotibia and metatibia gradually dilated toward apex, outer edge with small denticles and sparse, long hairs. Length ratio of metatarsomeres 1 to 4 (Fig. 8) as follows: 10: 3: 3: 7.

Abdominal ventrites finely and sparsely punctate, punctuation denser and subcontiguous toward lateral portions; last ventrite with deep apical groove.

Aedeagus (Figs 9–11) with basale parallel–sided; apicale broad at base, constricted at middle, widening and truncate at apex in dorsal view, with longitudinal depression in ventral view, slightly curved in lateral view; with small oblique notch at posterior corners of widened apical part.

Female (Fig. 2). Mentum cordate, without dense pad of pubescence, but with sparse hairs and coarse wrinkles. Protibia with shape similar to or narrower than that of male, ventral surface concave, without keel and large tooth. Protarsomeres 2 to 4 not dilated and without ventral hair pads. Ovipositor (Figs 12–13) with coxites relatively smooth, bearing long sensorial hairs and a few short hairs at base.

Examined materials. 1♀ (MHBU): China, Guangxi, Tian'e County, 14 September 2002, M. Bai leg; 1♂, 1♀ (HNHM), 2♂♂, 2♀♀ (MHBU): China, Hainan, Baisha County, Nankai Town, Shenbo Village, 1 June 2007, Y. B. Ba leg; 1♀ (NMNS): Thailand, Chiang Dao Hill Resort, 10–11 November 2012, K. Masumoto & K. Takahashi leg; 1♀ (HNHM): Indonesia, Sumatra, Dolok Merangir, 25 June 1970, collector unknown; 1♂ (HNHM): Indonesia, Sumatra, Palembang, date unknown, W. Knappert leg.

Distribution. "East India" (Bates 1873); Sri Lanka (Kaszab 1979); Vietnam (Fairmaire 1893, Kaszab 1980, Merkl 1992); Thailand, Indonesia/Sumatra, China/Guangxi and Hainan Provinces (new records).

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RESEARCH ARTICLE

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Ophioderma peruana, a new species of brittlestar (Echinodermata, Ophiuroidea, Ophiodermatidae) from the Peruvian coast

Tania Pineda-Enríquez[1,†], Francisco A. Solís-Marín[1,‡], Yuri Hooker[2,§], Alfredo Laguarda-Figueras[1,|]

1 *Colección Nacional de Equinodermos "M. Elena Caso M.", Laboratorio de Sistemática y Ecología de Equinodermos, Instituto de Ciencias del Mar y Limnología, Universidad Nacional Autónoma de México, Ciudad Universitaria s/n Deleg. Coyoacán CP 04510 México* **2** *Laboratorio de Biología Marina, Facultad de Ciencias y Filosofía, Universidad Peruana Caytano Heredia, Av. Honorio Delgado 430, Urb. Ingeniería, S.M.P. Lima, Perú*

† *http://zoobank.org/29C721AC-5981-485C-B257-C496113060EA*
‡ *http://zoobank.org/A2417F0D-CA2A-4BE2-A6F0-C8991F4B90EA*
§ *http://zoobank.org/094F1EA7-A5E6-4625-B36A-898EA2F93AC2*
| *http://zoobank.org/D8F6D077-9DA7-4BDB-B7BA-73009E7EE032*

Corresponding author: *Tania Pineda-Enríquez* (tania_pinedae@hotmail.com)

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Abstract

Ophioderma peruana **sp. n.** is a new species of Ophiodermatidae, extending the distribution of the genus *Ophioderma* to Lobos de Afuera Island, Peru, easily distinguishable from its congeners by its peculiarly fragmented dorsal arm plates. Dense granules, rounded or polygonal cover the disc, the radial shields may be naked or completely covered by granules. A good character for recognizing this species in the field is the dorsal side of the disc which is brown with disc granules lighter cream and brown, the arms are mottled with whitish spots and the ventral part of the disc on the interradial part is brown and the radial part bright yellow.

Keywords
Taxonomy, Ophiodermatidae, *Ophioderma peruana*, new species

Introduction

Species of *Ophioderma* have a distinctive shape and color and are distributed across the Mediterranean Sea, Atlantic Ocean and off the American Pacific coast. The genus *Ophioderma* has had an interesting taxonomic history since 1840 when Müller & Troschel, described the genus, being the type species *Ophioderma longicauda* (Bruzelius, 1805) recognized by H.L. Clark in 1915. In the past, the classification of *Ophioderma* has been unstable, classified as the genus *Ophiura*, in the 19th century (e.g. Lyman 1860, 1882). The first taxonomist to arrange the numerous species under the name *Ophioderma* was H.L. Clark (1915), A.M. Clark (1976) and Melville (1980), formally separating the previously controversial genus *Ophiura* from *Ophioderma*. However, Ziesenhenne (1955) made the latest revision of the genus *Ophioderma* when 21 species were known (Stöhr et al. 2009). *Ophioderma* is now well-established and comprises a large, widespread genus of brittlestars. Up to until now, *Ophioderma* comprises 27 species, 21 of which are distributed in the Atlantic Ocean and six in the Pacific Ocean. *Ophioderma* can be found in coral reefs, seagrass, coral rubble and under rocks and typically found together with other shallow-water genera, such as *Ophiocoma*, *Ophiothrix*, *Ophiolepis* and *Ophiactis*. Bathymetric distribution of the genus extends from shallow water to 50 m and is restricted to tropical and temperate seas. The characters used to separate the species are the shape of the disc granules, the disc size, arm length, shape and degree of fragmentation of dorsal arm plates, number of arm spines and color (Stöhr et al. 2009). However, the genus remains poorly studied; for example, it has been recently discovered that the species *O. longicauda* shows cryptic speciation and represents a species complex (Stöhr et al. 2009, Boissin et al. 2011).

As part of a program since 1999 to sample the coast of Peru in order to discover new or previously unreported echinoderm species, different localities have been sampled along the coastline and adjacent islands (from littoral to 30 m depth). At Lobos de Afuera Islands, Lambayeque, Peru (06°55'5"S, 80°42'5"W) a total of 39 echinoderm species have been reported, including six ophiuroids (*Ophiactis mirabilis, Ophiothrix spiculata, Ophiocoma aethiops, Ophioderma panamensis* and *Ophionereis annulata*), one of which is described in this paper as a new species of *Ophioderma* (Hooker et al. 2005).

Peruvian echinoderms are represented by 215 species: Crinoidea (1 species), Asteroidea (64 species), Ophiuroidea (42 species), Echinoidea (35 species) and Holothuroidea (73 species) (Hooker et al. 2013). Only two species belonging to the genus *Ophioderma* have been reported for Peruvian waters: *O. panamensis* Lütken, 1859 and *O. teres* (Lyman, 1860). Even though the new species, is easily distinguishable from its congeners, by the number of fragmented dorsal arm plates.

Materials and methods

Samples were taken by SCUBA in the intertidal zone at Lobos de Afuera Island, Lambayeque, Peru (Fig. 1) due to its complexity and it's southernmost limit for many echinoderm species (Hooker et al. 2005). After collection, specimens were placed inside plastic bags with seawater for transportation. The animals were then relaxed in a solution of 4% magnesium chloride and seawater. After labeling, fixation of the specimens was done with 70% ethyl alcohol. Some specimens were dried and photographed in the laboratory under a SZ-ST Olympus dissecting microscope. Holotype and paratypes have been preserved in alcohol and dried, respectively. The specimens are deposited at the Colección Nacional de Equinodermos "M. Elena Caso M." of the Instituto de Ciencias del Mar y Limnología, Universidad Nacional Autónoma de Mexico (UNAM–ICML) and in the Laboratorio de Biología Marina, Facultad de Ciencias y Filosofía, Universidad Peruana Caytano Heredia, Lima, Peru (CZA). Abbreviations used in this paper are: DD: disc diameter, AL: arm length; AW: arm width.

Only 13 specimens of the new species of *Ophioderma* were collected on different localities along the Pacific coast, but they are sufficiently distinctive and unique to establish a new species.

Taxonomy

Family Ophiodermatidae Ljungman, 1867

Genus *Ophioderma* Müller & Troschel, 1840
http://species-id.net/wiki/Ophioderma

Type species. *Ophioderma longicauda* (Bruzelius, 1805).

Diagnosis. (modified from Müller and Troschel 1840) The dorsal and ventral surfaces of the disc are covered by granules. Sometimes these granules cover the radial and adoral shields. Oral papillae are broader than long, rectangular or conical in shape. There are three to five teeth. The oral shields are oval, pentagonal or triangular in shape. Each interradial space has four genital slits; the first two are on the distal side of the oral shield and the second are parallel to the arms and near the disc edge. The arms are cylindrical proximally and conical distally. The dorsal arm plates are broader than long and can be fragmented. The lateral arm plates are semi-lunar in outline and have six to thirteen arm spines that are large, rectangular or conical in shape. There are two tentacle scales per segment.

Remarks. There are six known species of the genus reported for the eastern and southern Pacific in addition to the new species described here.

Ophioderma peruana **Pineda-Enríquez, Solís-Marín, Hooker & Laguarda-Figueras, sp. n.**
http://zoobank.org/10BFEA05-4299-4C52-9B0C-89CCAC178E9C
http://species-id.net/wiki/Ophioderma_peruana

Type specimen. Holotype, CZA-363, Lobos de Afuera Island, Peru, 6°56'16.8"S; 80°43'22.7"W, intertidal, under rocks, October 9th, 2007.

Type locality. Peru: Lobos de Afuera Island, 6°56'16.8"S; 80°43'22.7"W, intertidal, under rocks, October 9th, 2007.

Other type material. Paratype, CZA-364, Lobos de Afuera Island, Peru, 6°56'16.8"S; 80°43'22.7"W, intertidal, October 9th, 2007; paratype, CZA-365, Lobos de Afuera Island, Peru, 6°56'16.8"S; 80°43'22.7"W, intertidal, October 9th, 2007; paratype, UNAM-ICML 3.234.0, Lobos de Afuera Island, Peru, 6°56'16.8"S; 80°43'22.7"W, intertidal, under rocks, October 9th, 2007 (Fig. 2).

Diagnosis. Disc pentagonal, elevated and covered with dense granules that are somewhat rounded or polygonal, but more or less dispersed. The radial shields can be completely covered by the granules or scarcely covered. The dorsal arm plates are fragmented; in addition there are some smaller and tiny fragments that resembles granules of the dorsal disc, only visible on the proximal plates (not evident in all the arm segments). Nine or ten flattened and elongated oral papillae. Granules also cover the adoral shields. Ten arm spines, the ventral is the largest, reaching the next tentacle scale.

Description of holotype. CZA-363: disc diameter 36.3 mm, arm length 120.6 mm, arm width 7.6 mm (Fig. 2).

Disc. Disc pentagonal, broad and flat, covered by granules; the dorsal granules are closely packed and have the same size on the middle and periphery of the disc, these granules are rounded and polygonal. The radial shields are almost fully covered by granules with only a small section exposed; the size is 3.81 mm and fit 9.5 times the disc diameter; the disc scales are small and imbricated, oval shape with polygonal borders, the interradial scales are smaller than the radial ones. Jaws with seven to nine oral papillae; the two distal ones are stout and longer than broad. The oral papillae have rounded edges and are almost of the same size and shape. The oral shields are broader than long, triangular in shape with convex proximal sides and are surrounded by granules that are slightly larger than those on the interradial disc surface. The adoral shields are rectangular and covered by larger and taller granules than those on the dorsal disc, which are contiguous. Four genital slits on each interradii; the two proximal ones are touching the oral shield and are located between the distal part of the oral shields and the first lateral arm plate; the two distal genital slits are placed between the fifth and and the sixth arm segment and close to the periphery of the disc.

Arms. The basal portion of the arm is 7.6 mm broad and the arm length is 120.6 mm. The dorsal arm plates occupy less than ¼ of the arm, are 4.6 times wider than long and rectangular, fragmented in six pieces that differ in shape; there are some granules on the proximal portion and sparcely distributed on the distal portion. The

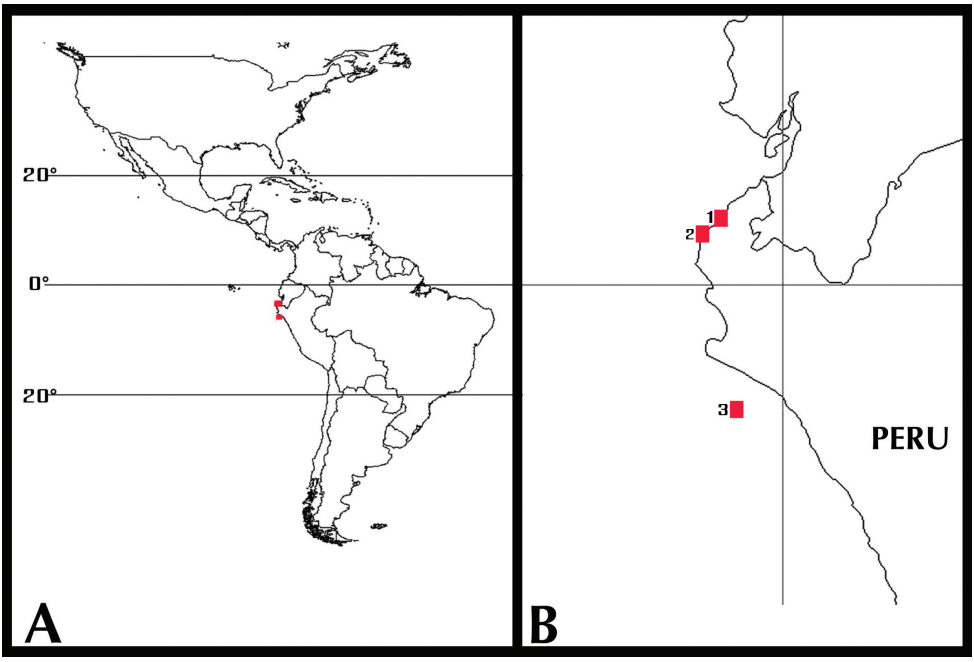

Figure 1. Collecting sites of *Ophioderma peruana* sp. n. **A** complete map of America **B 1** Hooker Reef, Punta Sal **2** Quebrada Verde, El Ñuro **3** Lobos de Afuera Island, Peru.

lateral arm plates have a half-circle shape, and occupy a sub-ventral position; with ten arm spines conical, large and slightly flattened with a rounded tip, half segment length decreasing slightly in size dorsally. The ventral-most arm spine is the longest and widest, almost the size of the segment. The ventral arm plates are contiguous, broader than long, the proximal plates are elongated in comparison to the distal plates. Two tentacle scales on each side of the ventral plate; the adradial tentacle scale is oval in shape, twice as long as wide and the abradial tentacle scale triangular in shape, with the straight side touching the ventral arm plate (Fig. 3).

Color. Specimen preserved in alcohol. The dorsal side of the disc is light brown and the arms are darker brown, the dorsal arm plates of each segment are ornamented with a double row of tiny, whitish, rounded spots; the spines are brown except the two ventral ones that are cream color, like the ventral side of the arms; the jaws are white; the ventral side of the disc in the proximal part is white and the distal part is slightly darker; the oral shields are mottled. Dry specimens, have the dorsal side of the disc pale brown, the arms are brown with black and white spots; the tentacle feet are yellowish. Live specimens in the field could be identified by this color pattern: the dorsal side of the disc is brown with the disc granules lighter cream and brown; the arms are mottled with whitish spots; the ventral disc interradii are brown and arms under the disc are bright yellow.

Paratype variations. On the smallest specimen (14 mm DD; 35 mm AL; 4 mm AW) the radial shields are completely naked with white spots (same color pattern as

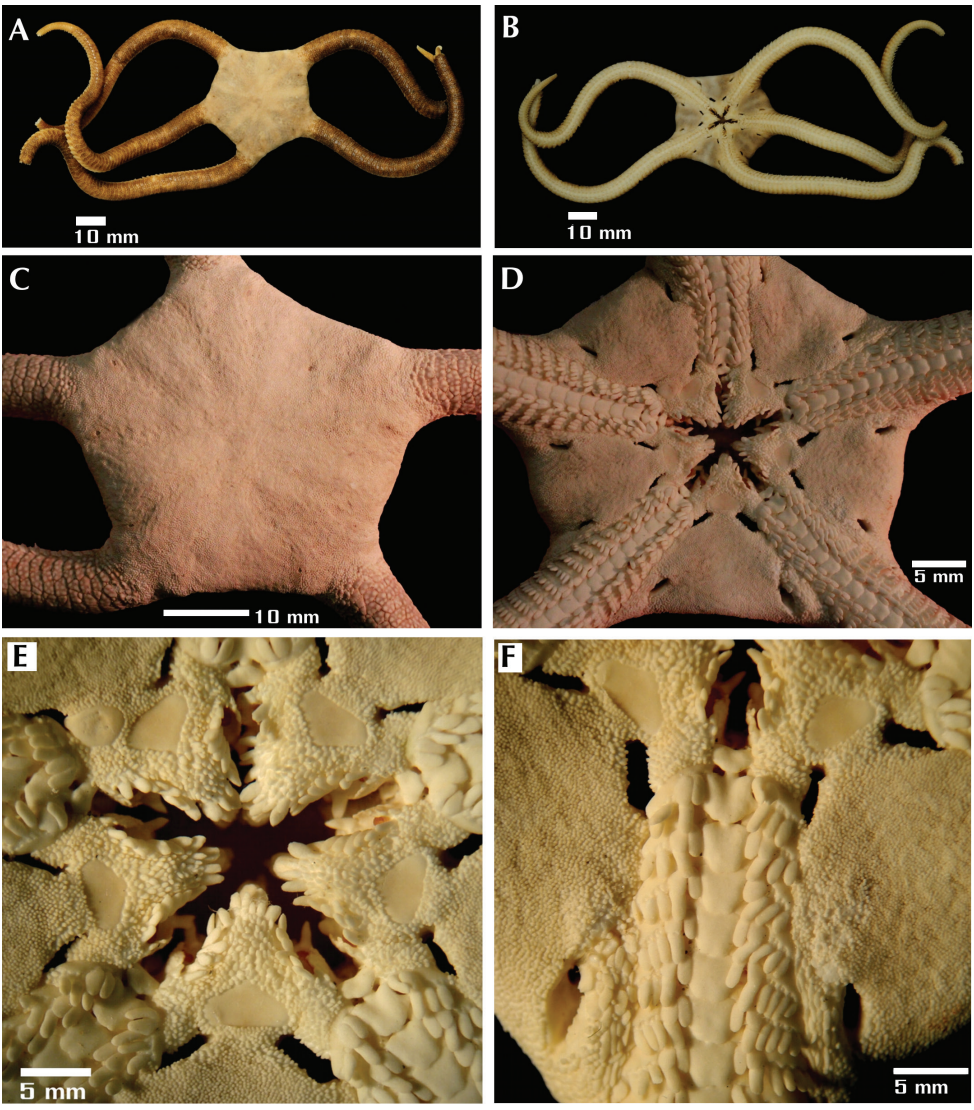

Figure 2. *Ophioderma peruana* sp. n., holotype (CZA-363). **A** aboral view **B** oral view **C** aboral disc and basal portion of the arms **D** oral disc and basal portion of the arms **E** jaws **F** oral portion of the disc and pair of genital slits.

the dorsal arm plates), oval and surrounded by the disc granules by the disc granules, scarcely covered (in specimens with 40–42 mm DD) or completely naked (in specimens with14–35 mm DD). On certain segments of the arm, the dorsal arm plates are not as fragmented, with only two or three pieces. The presence of granules along the arm is not evident as in the holotype. In some specimens (22–31 mm DD) the radial shields are also completely naked. The oral shields are twice as wide as long, proximally elongated but the shape may vary in specimens. In two specimens (30 mm; 42 mm DD) the radial

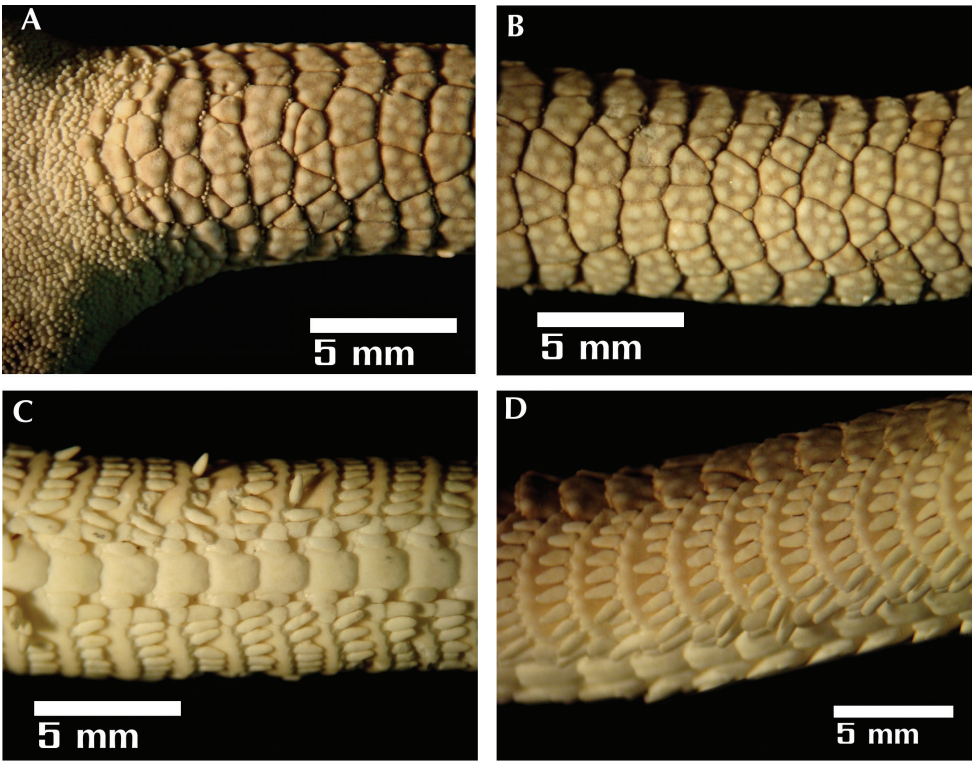

Figure 3. *Ophioderma peruana* sp. n., holotype (CZA-363). **A** basal portion of the arms with fragmented dorsal arm plates **B** dorsal arm plates fragmented in several pieces **C** ventral arm plates and tentacle scales **D** lateral view of the arm spines.

shields are naked and/or covered by granules. The radial shields are completely covered by granules and dorsal arm plates are fragmented in only a single specimen (35 mm DD) (Fig. 4). Therefore, as the animal grows, the radial shields become more covered in granules and the dorsal arm plates are fragment further.

Distribution. Only known from the coast of Peru. Lobos de Afuera Island, Lambayeque, Peru; intertidal (type locality); Quebrada Verde, El Ñuro, Peru, 9 m; 4°13'39.3"S, 81°12'30.0"W and Hooker Reef, Punta Sal, Peru; 14 m; 3°57'14.20"S, 80°57'48.50"W (Fig. 1).

Etymology. Named after the type locality.

Remarks. The new species is distinguishable by its thick and rounded granules on the disc, the number of fragments of the dorsal arm plates, which can be more than six with other smaller fragments. The distal border of the dorsal arm plates, from the base to the middle part of the arm, supports some granules similar to those on the dorsal part of the disc.

In Peruvian waters, *O. panamensis* and *O. teres* are found on the same localities, in addition to the new species; it differs from other Peruvian species in shape and size of the tentacle scales and in the shape of the arm spines. It differs from *O. teres* by the smaller size and density of the granules on the disc. These granules are similar to

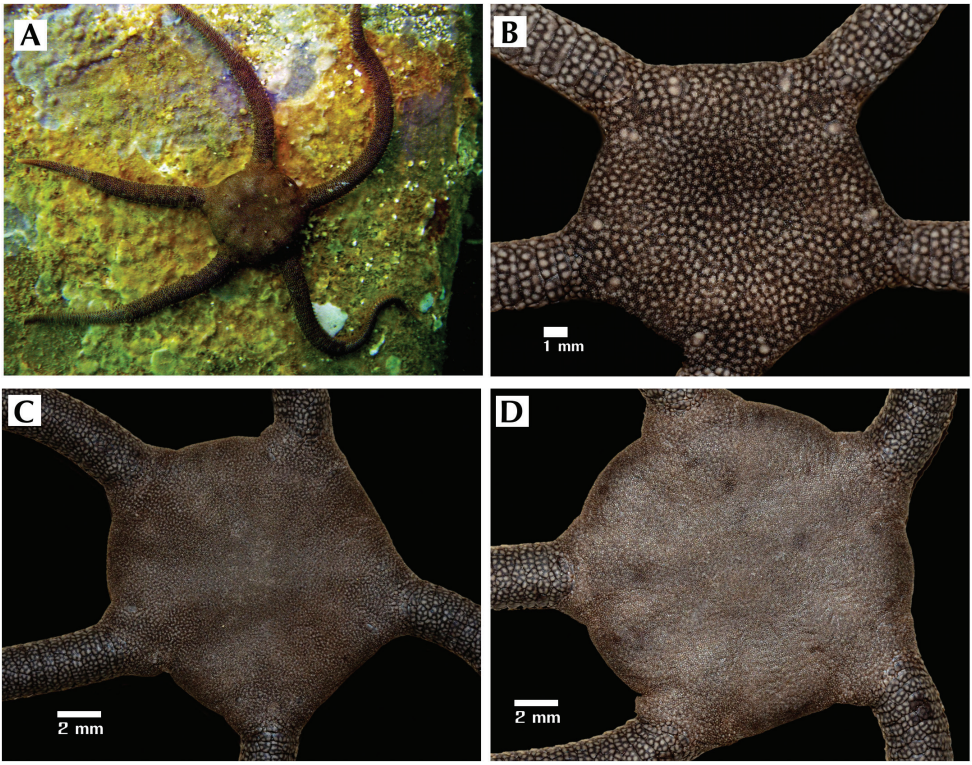

Figure 4. *Ophioderma peruana* sp. n. non-type preserved material (alcohol) showing different colors variations. **A** specimen *in situ* **B** CZA-394 (14 mm DD) radial shields naked **C** CZA-392 (28 mm DD) radial shields naked **D** CZA-390 (35 mm DD) radial shields covered by disc granules.

those present on *O. sodipallaresi*, the main difference is that on the latter species they are somewhat more scattered than in *O. teres*, while in *O. peruana* sp. n. the dorsal granules are closely packed and have the same size on the middle and periphery of the disc, being rounded and polygonal. *Ophioderma sodipallaresi* differs in having only two to three fragments, whereas *O. teres* have a similar number to *O. peruana* sp. n. The shape and size of the tentacle scales in *O. teres* are similar to *O. peruana* sp. n., oval and elongated, whereas in *O. sodipallaresi* the abradial tentacle scale is longer than wide and the adradial scale is smaller, almost triangular or oval. The ventralmost arm spines are largest in all three species, and the others increase in size from dorsal to ventral. In *O. peruana* sp. n. the arm spines are thick and conical, similar to *O. sodipallaresi*, which are pointed, thick and short, but differing in size. Meanwhile, in *O. teres* the arm spines are almost flat with pointed tips. In comparison with the other West Pacific ophiodermatids species, *O. panamensis* and *O. vansyoci* differs from *O. peruana* sp. n. by presenting the radial shields naked, just bordered by the granulation of the disc; in contrast with *O. variegata* and *O. pentacantha* that has the radial shields covered by the disc granules, while in *O. peruana* sp. n. the radial shields could be naked or covered by

the granules. *Ophioderma vansyoci* presents the dorsal arm plates fragmented in three pieces. The number of arm spines are variable, *O. pentacantha* has five, *O. vansyoci* has seven, *O. panamensis* and *O. variegata* has eight, while *O. peruana* sp. n. presents ten, *O. sodipallaresi* seven arm spines and *O. teres* nine arm spines. *Ophioderma variegata* and *O. pentacantha* presents the adoral shields slightly naked, in comparison with *O. panamensis*, *O. vansyoci*, *O. sodipallaresi*, *O. teres* and *O. peruana* sp. n. that presents the adoral shields covered by the disc granules. Among its congeners in the Caribbean Sea, *O. peruana* sp. n. is more similar to *O. squamosissima* and *O. guttata* sharing fragmented dorsal arm plates (more than six pieces) but differs from the later ones in the absence of the smaller scales on the dorsal arm plates, by having different shape of disc granules (rounded and polygonal in *O. peruana* sp. n., flattened, elongated and polygonal shape in *O. squamosissima* and flattened, shorter and polygonal in *O. guttata*), in addition to its geographic distribution. The rest of the *Ophioderma* species distributed in the Caribbean Sea either lacks fragmented arm plates (*O. appressa, O. brevicauda, O. brevispina, O. phoenium* and *O. rubicunda*) or some segments of the dorsal arm plates could be fragmented (*O. cinerea*).

Key to the Pacific Ocean species of *Ophioderma*

1 Radial shields either naked or covered by granules, disc and dorsal side of the arms mottled **2**

– Radial shields always naked, disc and dorsal side of the arm not mottled **6**

2 Dorsal arm plates fragmented **3**

– Dorsal arm plates not fragmented **5**

3 Nine to ten arm spines, the ventral-most thicker than long, somewhat flat; oral shields triangular-shaped; adoral shields covered by granules; tentacle scales subequal, oval-shaped ..... ***Ophioderma teres* Lyman, 1860**

– The pair of tentacle scales are of different size..... **4**

4 Nine arm spines, the ventralmost is the largest and pointed; oral shields slightly pentagonal in shape, the adoral shields covered by granules; the dorsal arm plates are fragmented into two or three pieces; disc granules are somewhat more scattered oval-shape; radial shields covered by granules; the abradial tentacle scale is longer than wide ..... ***Ophioderma sodipallaresi* Caso, 1986**

– Ten arm spines, the ventralmost longest; oral shields triangular; adoral shields covered by granules, dorsal arm plates completely fragmented (more than six pieces), disc granules oval-shaped, densely placed; radial shields naked or covered by granules; the abradial tentacle scale is two times longer than wide .... ***Ophioderma peruana* sp. n.**

5 Arms three times disc diameter; oral shields oval-shaped, longer than wide; adoral shield naked; eight arm spines... ***Ophioderma variegata* Lütken, 1856**

– Arms five times disc diameter; radial shields covered in granules; oral shields pentagonal; adoral shields naked; five short arm spines half the length of the

arm segment, the ventral-most is wider than long.....
..... ***Ophioderma pentacantha*** **H. L. Clark, 1917**

6 Dorsal arm plates not fragmented; arms three times disc diameter; radial shields completely naked; oral shields wider than long; adoral shields covered by granules; eight arm spines ..... ***Ophioderma panamensis*** **Lütken, 1859**

– Dorsal arm plates fragmented into three pieces; disc granules flattened; radial shields convex and naked; oral shields pentagonal; adoral shields covered by granules; seven arm spines..... ***Ophioderma vansyoci*** **Hendler, 1996**

Discussion

The new species clearly belongs to the genus *Ophioderma* Müller & Troschel, 1840. Its large size makes it a conspicuous component of the eastern Pacific shallow-water echinoderm fauna. *Ophioderma peruana* sp. n. has been collected at the same sites as one of its congeners, *O. panamensis*.

Presently 28 valid species and two highly doubtful species (*O. propinqua* Koehler, 1895 and *O. tongana* Lütken, 1872) should now be recognized as part of the genus *Ophioderma.* The genus is well wide-spread, but most speciose in the western Atlantic Ocean with 18 species, from New York, USA, to the coast of Brazil: *O. anitae* Hotchkiss, 1982, *O. appressa* (Say, 1825), *O. besnardi* Tommasi, 1970, *O. brevicauda* Lütken, 1856, *O. brevispina* (Say, 1825), *O. cinerea* Müller & Troschel, 1842, *O. devaneyi* Hendler & Miller, 1984, *O. divae* Tommasi, 1971, *O. elaps* Lütken, 1856, *O. ensifera* Hendler & Miller, 1984, *O. guttata* Lütken, 1859, *O. holmesii* (Lyman, 1860), *O. januarii* Lütken, 1856, *O. pallida* (Verrill, 1899), *O. phoenium* H.L. Clark, 1918, *O. rubicunda* Lütken, 1856, *O. squamosissima* Lütken, 1856.

In the Indian Ocean *O. wahlbergii* Müller & Troschel, 1842, has been recorded, while *O. longicauda* (Bruzelius, 1805) occurs in the Mediterranean Ocean and some eastern Atlantic localities.

In the Pacific Ocean there are seven species, from California, USA to the coast of Chile: *O. panamensis* Lütken, 1859, *O. pentacantha* H.L. Clark, 1917, *O. sodipallaresi* Caso, 1986, *O. teres* (Lyman, 1860), *O. vansyoci* Hendler, 1996, *O. variegata* Lütken, 1856, and *O. peruana* sp. n.

Only one species of fossil *Ophioderma* has been described, *O. bonaudoae* Martinez & Del Rio, 2008, from the late Miocene of Argentina.

Ophioderma peruana sp. n. is the third record of a species of *Ophioderma* for the Tropical Peruvian Eastern Pacific. It is the second *Ophioderma* species reported from Lobos de Afuera Island, Quebrada Verde, El Ñuro and Hooker Reefs. The Peruvian sea is considered one of the most productive in the world because of an intense upwelling system off most of its coastline (Hooker et al. 2013). It is important to continue the research in this area, because besides being the southern limit of distribution of Panamic fauna, the remote Lobos de Afuera Islands could be an area of endemism, due to less frequent dispersal from the mainland (Hooker et al. 2005).

Ophioderma propinqua Koehler, 1895, and *O. tongana* Lütken, 1872, have been described from the Indo-west Pacific. With the exception of the mistaken identification of *O. tongana* from Simon's Bay, South Africa (see Mortensen 1933; A.M. Clark and Rowe 1971, A.M. Clark and Courtman-Stock 1976), these two species have not been reported in over 100 years since they were first described. Their validity is therefore doubtful and their identification within the genus *Ophioderma* must be considered suspect.

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RESEARCH ARTICLE

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The ant genus *Carebara* Westwood in the Arabian Peninsula (Hymenoptera, Formicidae)

Mostafa R. Sharaf[1,†], Abdulrahman S. Aldawood[1,‡]

1 *Plant Protection Department, College of Food and Agriculture Sciences, King Saud University, Riyadh 11451, PO Box 2460, Kingdom of Saudi Arabia*

† *http://zoobank.org/E2A42091-0680-4A5F-A28A-2AA4D2111BF3*
‡ *http://zoobank.org/477070A0-365F-4374-A48D-1C62F6BC15D1*

Corresponding author: *Mostafa R. Sharaf* (antsharaf@gmail.com)

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Abstract

The ant genus *Carebara* of the Arabian Peninsula is revised. *Carebara abuhurayri* Sharaf & Aldawood, 2011 is synonymized under *Carebara arabica* Collingwood & van Harten, 2001. *Carebara arabica* is redescribed and a Neotype is fixed based on a specimen collected from southwestern Kingdom of Saudi Arabia. A new species, *C. fayrouzae* **sp. n.** is described from Saudi Arabia based on queens, major and minor workers. Keys to major and minor workers of the two Arabian *Carebara* species are given.

Keywords

Saudi Arabia, Palearctic region, Myrmicinae, key, taxonomy, new species

Introduction

The ant genus *Carebara* Westwood, 1840, *sensu* Fernández (2004), contains more than 180 described species (Bolton et al. 2006) and is distributed worldwide in the subtropics and tropics with regional taxonomic treatments available for the Palearctic (Ettershank 1966, Weber 1950, Xu 1999, Guénard and Dunn 2012), Afrotropical including Madagascar (Weber 1950, Brown 2000, Taylor 2010, Frank Azorsa, unpublished data), Neotropics (Brown 2000), Indo-Malayan (Bingham 1903), Oriental (Terayama 1996, Terayama 2009) and Australian (Taylor and Brown 1985, Shattuck 1999). Hitherto, Fernández (2004) remains the most important and comprehensive treatment of the genus for the Western Hemisphere. Five genera, *Oligomyrmex* Mayr,1867, *Paedalgus* Forel, 1911, *Afroxyidris* Belshaw & Bolton,1994, *Parvimyrma*, Eguchi & Bui, 2007 and *Neoblepharidatta* Sheela & Narendran, 1997 have been synonymized under *Carebara* (Fernández 2004).

However, very little taxonomic or biological information is available on the genus *Carebara* throughout its range (Bharti and Kumar 2013), especially in the Arabian Peninsula (Aldawood et al. 2011). The scarcity of information may be due to the cryptic nature of species, tiny body size, and the difficulty in collecting these ants requiring leaf litter sifting and the use of Berlese funnels for extraction. Members of the genus are subterranean and often associated with decaying wood and leaf litter (Bolton 1973, Longino 2004, Aldawood et al. 2011, Bharti and Kumar 2013).

Carebara was originally recorded from the Arabian Peninsula by Collingwood and van Harten (2001) with their description of *Oligomyrmex arabicus* based on minor and major workers collected from Al Kawd, near Abyan, Republic of Yemen. Ten years later, we described a new species of *Carebara*, *C. abuhurayri* Sharaf & Aldawood based on minor workers from the southwestern mountains of Kingdom of Saudi Arabia (KSA) (Aldawood et al. 2011).

Several nest series of a species very similar to *C. arabica* were collected from four different localities in the southwestern region of KSA. Minor and major workers matched the brief original description of *C. arabica*. In addition, two major workers of *C. abuhurayri* were collected from its type locality and are very similar to the major workers of *C. arabica*. Further comparisons of this newly collected material indicated that *C. abuhurayri* is a synonym of *C. arabicus*.

Minor workers of another *Carebara* species that appeared to be undescribed were collected from Riyadh, KSA. Repeated efforts to find nests of this species that contained all castes were unsuccessful; however, a colony that contained minor and major workers and several alate queens (males unknown) was collected in eastern KSA, confirming the novelty of this taxon.

In the present work, a new species, *C. fayrouzae* sp. n., is described based on queens, major, and minor workers. *Carebara arabica* is redescribed and detailed new measurements are given. A Neotype of *C. arabica* from a locality in KSA Arabia near the Republic of Yemen is designated. *Carebara abuhurayri* is synonymized with *C. arabica*. Keys to major and minor workers of the two known Arabian Peninsula species are given.

Material and methods

Measurements and indices

TL Total Length (HL+ Mandible length+ ML + Petiole Length + Postpetiole length + Gaster length).
HW Head Width; maximum width of head behind eyes in full face view.
HL Head Length; maximum length of head, excluding mandibles.
SL Scape Length; excluding basal neck.
EL Eye Length; maximum diameter of eye.
ML Mesosoma Length; length of mesosoma in lateral view, from the point at which pronotum meets cervical shield to posterior base of propodeal lobes or teeth.
PRW Pronotal width, maximum width in dorsal view.
PL Petiole Length; maximum length measured in dorsal view, from anterior margin to posterior margin.
PW Petiole Width; maximum width measured in dorsal view.
PPL Postpetiole Length; maximum length measured in dorsal view.
PPW Postpetiole Width; maximum width measured in dorsal view.

Indices:

SI Scape Index (SL × 100/HW).
CI Cephalic Index (HW × 100/HL).

All measurements are in millimeters and follow the standard measurements of Fernández (2004).

Acronyms of museums:

BMNH Natural History Museum, London, United Kingdom.
CASC California Academy of Science Collection, San Francisco, California, USA.
KSMA King Saud University Museum of Arthropods, King Saud University, Riyadh, KSA.
MCZC Museum of Comparative Zoology, Harvard University, Cambridge, MA, USA.
MHNG Muséum d'Histoire Naturelle, Geneva, Switzerland.
NHMB Naturhistorisches Museum, Basel, Switzerland.
SEMC Division of Entomology (Snow Entomological Collections), University of Kansas Natural History Museum, Lawrence, Kansas, USA.
WMLC World Museum Liverpool, Liverpool, United Kingdom.

Results

Key to Arabian *Carebara*

Major worker

1 Smaller species (TL 1.77–2.76); antennae 10-segmented; concolorous brownish, antennae and legs yellowish; posterior margin of head strongly concave and posterior corners with a pair of teeth or horns, appearing blunt in profile; cephalic dorsum dull, with fine, dense, regular and longitudinal rugulae; lateral margins of postpetiole in dorsal view rounded.....***arabica***

– Larger species (TL 3.27–5.00); antennae 9-segmented; bicolored, head and mesosoma brownish, petiole and postpetiole brownish yellow, antennae, legs and gaster clear yellowish; posterior margin of head feebly concave and posterior corners rounded, without teeth or horns; cephalic dorsum smooth and shining except anterior part of head finely, longitudinally rugulose; lateral margins of postpetiole distinctly angular in dorsal view.....***fayrouzae* sp. n.**

Minor worker

1 Antennae 10-segmented; eyes minute, with a single ommatidium (present in all individuals); body pilosity subdecumbent or appressed and much scarce; anterolateral sides of head very finely longitudinally striated; lower halves of mesopleuron, metapleuron, petiole and postpetiole areolate-rugose; propodeal dorsum nearly half as long as propodeal declivity in profile.....***arabica***

– Antennae 9-segmented; eyes as rudimentary ommatidium (absent in some individuals); body pilosity erect to suberect and dense; entire body smooth without any type of surface sculpture; propodeal dorsum as long as declivity, appearing as a continuous curve in profile.....***fayrouzae* sp. n.**

Carebara arabica (Collingwood & van Harten, 2001)

http://species-id.net/wiki/Carebara_arabica
Figs 1–6

Oligomyrmex arabica Collingwood & van Harten, 2001:564, figs 2–4 (s. w.). **Neotype** major worker. SAUDI ARABIA, Almajardah, Wadi Khat, 10.xi.2012, 19.08913°N, 41.97126°E, 513 m, by leaf litter sifting (M. R. Sharaf leg) (KSMA) (CASENT0906367). Holotype major worker, YEMEN, Al Kawd (misspelled AI Kowd), 13.088622°, 45.364722°, viii.1999, in light-trap, (van Harten & Al Haruri), paratypes, 7 minor workers, same data as holotype [not in WMLC, all presumably lost]. Combination in *Carebara*: new combination (unpublished) (Bolton 2012).

Carebara abuhurayri Sharaf & Aldawood, in Aldawood et al. 2011:63, figs 1–12 (w). Holotype minor worker, SAUDI ARABIA, Al Bahah, Al Mukhwah, Zei

Ein Archaeological Village (sometimes written Dhi Ain archaeological village), 19.91667°N; 41.43333°E, 741 m., 18.v.2010 (M. R. Sharaf Leg.), paratypes, 7 minor workers, same data as the holotype (KSMA) [examined]. Syn. n.

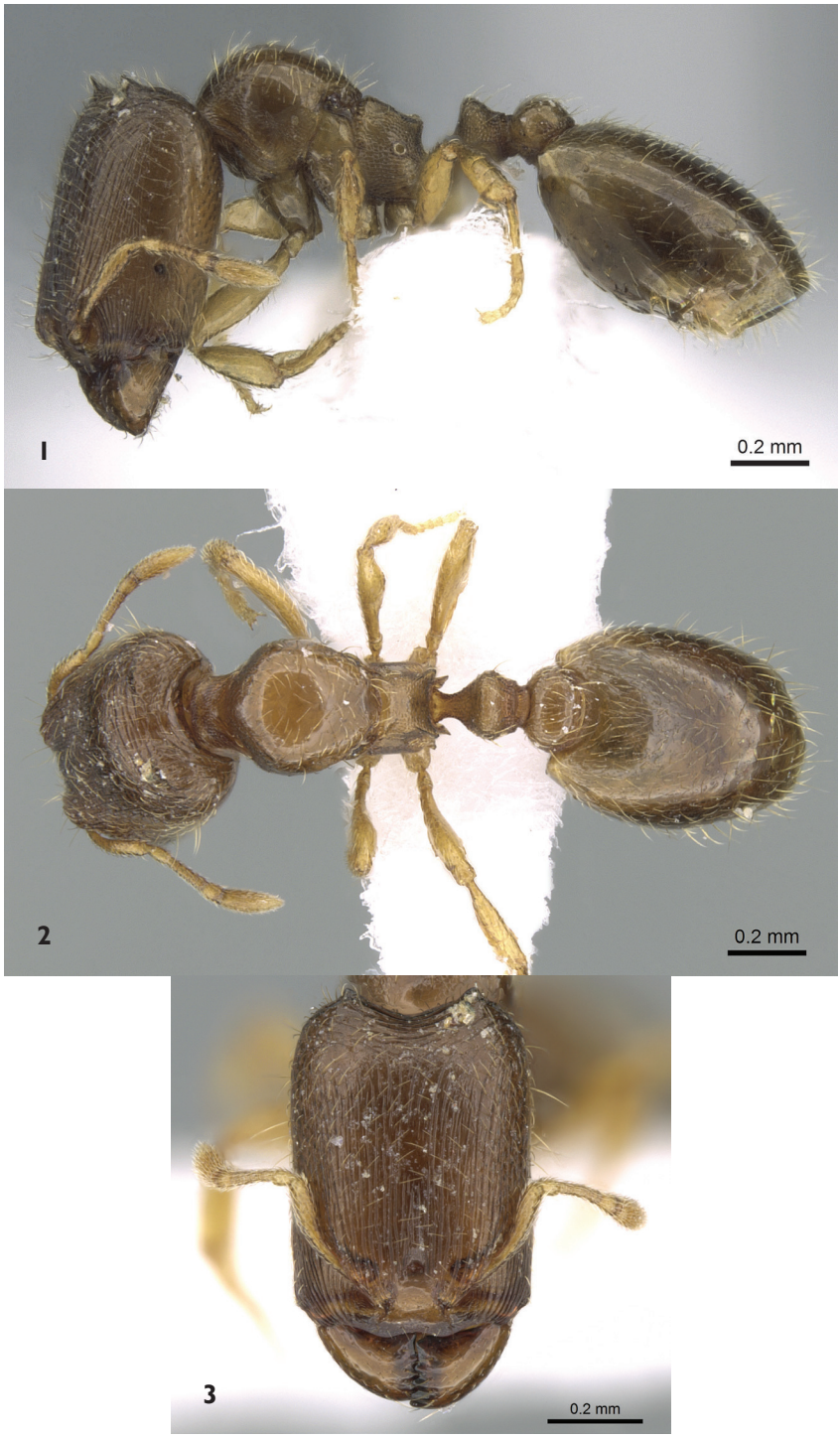
Additional material. (3 major workers, 5 minor workers (CASENT0906368)) same data as the neotype; 6 major workers, 6 minor workers, SAUDI ARABIA, Wadi Bagara, 10.xi.2012, 18.79287°N, 42.01857°E, 436m, by leaf litter sifting (M. R. Sharaf leg.); 1 major worker, 9 minor workers, SAUDI ARABIA, Wadi Aljora, near Abadan, 12.xi.2012, 17.29263°N, 43.07010°E, 465 m, by leaf litter sifting (M. R. Sharaf leg.); 12 minor workers, SAUDI ARABIA, Fayfa, Agriculture Research Station, 6.iv.2013, 17.28671°N, 43.14390°E, 879m, (M. R. Sharaf leg.); 5 minor workers, SAUDI ARABIA, Fayfa, Agriculture Research Station, 5.iv.2013, 17.28671°N, 43.14390°E, 879m, (M. R. Sharaf leg.) **[KSMA]**; 1 major worker, SAUDI ARABIA, Al Bahah, Al Mukhwah, Zei Ein Archaeological Village, 19.9294°N; 41.4417°E, 741 m., 15.v.2011, (M. R. Sharaf Leg.); 1 major worker, SAUDI ARABIA, Al Bahah, Al Mukhwah, Dhi Ain Archaeological Village, 19.928°N; 41.4419°E ±50 m, 735 m., (B. L. Fisher Leg.), 23.ix.2011, Coll. Code BLF27577 **[CASC]**.

Description. Neotype major worker. TL 2.45, HL 0.71, HW 0.52, SL 0.26, ML 0.59, PRW 0.35, PL 0.15, PW 0.17, PPL 0.12, PPW 0.21, SI 50, CI 73.

Major workers. TL 1.77-2.76, HL 0.56-0.72, HW 0.44-0.52, SL 0.22-0.28, ML 0.49-0.63, PRW 0.29-0.35, PL 0.12-0.19, PW 0.12-0.17, PPL 0.11-0.18, PPW 0.14-0.25, SI 48-64, CI 69-80 (N=10).

Holotype major worker. TL 2.53, HL 0.75, HW 0.36, SL 0.63 **(**Collingwood and van Harten 2001) [Presumably lost]. (In the original description, the HW and SL for major are given wrongly as 0.36 and 0.63 respectively, from the illustration they would be ca. HW 0.55 and SL 0.30).

Major worker. (Figs 1–3) Head rectangular (HL ~ 1.38 × HW) with strongly concave posterior margin and straight parallel sides; mandibles smooth and shining; masticatory margin armed with five teeth; eyes with a single oval ommatidium; anterior clypeal margin shallowly concave; antennae ten segmented with a two segmented club; scapes very short (mean SI = 54); posterior margin of head transversally carinate and posterior corners with a pair of outgrowths, appearing as blunt teeth in lateral view. Promesonotum strongly convex; metanotal area with apparent vestigial wing bases; metanotal groove deep; propodeal spines blunt, short and broadly based; petiole distinctly broader than long in dorsal view. Postpetiole clearly broader than long and broader than petiole in dorsal view. Gaster smooth and shining. Sculpture: cephalic dorsum and area in front of eyes finely densely regularly longitudinally rugulose; the ground-sculpture a fine, dense, conspicuous granulation; lateral cephalic dorsum from the posterior margin of eyes to posterior margin of head faintly and densely granulate; promesonotum smooth and shining; anepisternum smooth and shining; katepisternum and propodeum densely, transversely and conspicuously reticulate-punctate; petiole densely irregularly reticulate; postpetiole dorsum smooth and shining. Pilosity: head hairs long and sparse; petiole with two pairs of long backward directed hairs;



Figures 1–3. *Carebara arabica*, major worker. **1** body in profile **2** body in dorsal view **3** head in full-face view (antweb.org, CASENT0906367).

postpetiole with three pairs of long hairs; gaster with few scattered long suberect hairs and abundant subdecumbent short hairs. Colour: concolorous brownish.

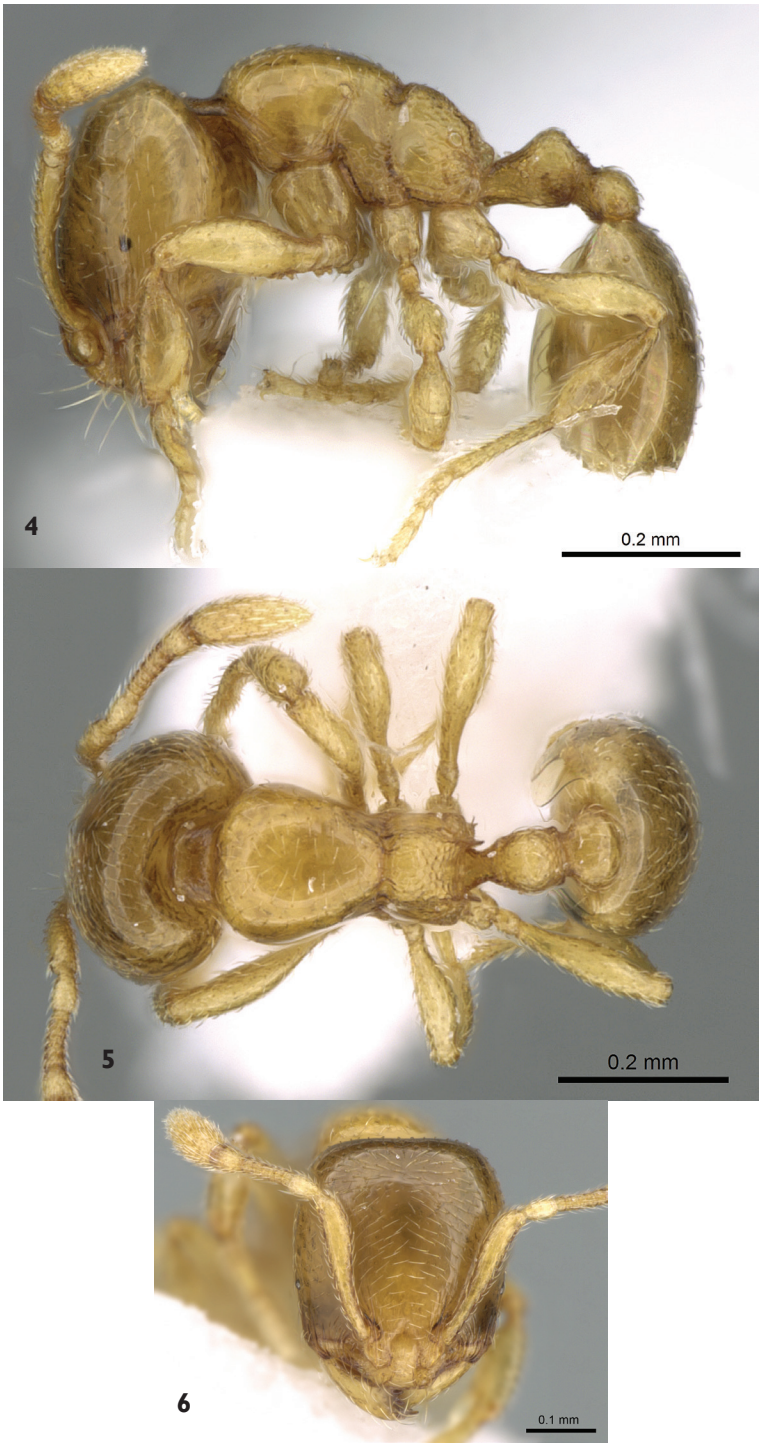
Minor workers. TL 0.99–1.13, HL 0.35–0.41, HW 0.29–0.32, SL 0.21–0.28, ML 0.31–0.34, PRW 0.17–0.19, PL 0.08–0.12, PW 0.07–0.08, PPL 0.05–0.07, PPW 0.08–09, SI 69–88, CI 74–89 (N=7).

Minor worker. (Figs 4–6) Head distinctly longer than broad (CI 74-89), with clearly convex sides and straight posterior margin; mandibles smooth and shining with relatively long yellow hairs and armed with four teeth; median portion of clypeus flat; in anterolateral view, clypeal lateral carinae strongly narrowed posteriorly between frontal lobes, then continued as a frontal triangle; eyes minute, with a single ommatidium; antennae ten segmented with a two segmented club; scapes broaden evenly from about mid-length and fail to reach head posterior margin by about one-third of the head length. Mesosoma in lateral view feebly convex; metanotal groove shallow but distinct, dorsally and laterally; propodeum obliquely angled; propodeal spiracle relatively large, circular, high and close to propodeal declivity; metapleural gland orifice prominent. Petiole longer than broad in dorsal view with short peduncle. Node of postpetiole lower than petiole and dorsally clearly convex and nearly as long as broad. Sculpture: Anterolateral sides of head very finely longitudinally striated; lower half of mesopleura, metapleura, petiole and postpetiole with areolate-rugose sculpture. Pilosity: appressed, cephalic dorsum with abundant scattered hair pits, few and short on mesosoma, petiole, postpetiole, and rare on first gastral tergite, underside of head with few short straight hairs. Clypeus with two pairs of standing hairs, central pair long and lateral pair shorter. Colour: Overall unicolorous yellow, smooth and shining.

Remarks. A recent search conducted by the senior author and Tony Hunter (Curator of Entomology, WMLC) failed to locate any original type material of *C. arabica* at the cited depository (Collingwood and van Harten 2001). Identification of this species has been difficult for non-specialists due to the brief original description and illustrations not indicating important diagnostic characters. Due to the apparent loss of all type material and the brief description, a Neotype from southwestern KSA is designated above for *C. arabica*.

Following the definition of Fernández (2004), *C. arabica* belongs to the *C. concinna* species complex that can be recognized by the following combination of characters: the minor workers are very small; the majors with massive heads; antennae nine to eleven-segmented, with a two segmented club; mandibles armed with four or five teeth; eyes present but reduced in both minor and major workers; metanotal groove distinct; propodeum armed with triangular teeth or denticles.

Biology. *Carebara arabica* was found in Fayfa, KSA nesting in leaf litter among *Azadirachta indica* A. Juss. (Meliaceae), *Artocarpus heterophyllus* Lam (Moraceae), and *Rosa damascena* Mill. (Rosaceae) trees and coexisting with an unidentified termite species. The other nest series from Wadi Bagara was found nesting in loose soil under roots of a Poaceae and near *Acacia* and Giant Milkweed, *Calotropis procera* (Aiton) (Asclepiadaceae). Other ants' associates included *Paratrechina jaegerskioeldi* (Mayr, 1904); *Tapinoma melanocephalum* F., 1793, and *Cardiocondyla* sp. An interesting ob-



Figures 4–6. *Carebara arabica*, minor worker. **4** body in profile **5** body in dorsal view **6** head in full-face view, (antweb.org, CASENT0906368).

servation concerning a nest series from Zei Ein Archaeological Village included major workers, an uncommon phenomenon as compared to other nests found in Wadi Khat, Wadi Bagara, Wadi Aljora, and Fayfa. Two major workers were collected by digging in soil. Numerous minor workers were observed foraging above ground and exiting and entering tiny nest entrances in compacted humid clay soil. No major workers were observed foraging above ground.

***Carebara fayrouzae* Sharaf, sp. n.**
http://zoobank.org/4E99379F-D985-4582-872A-A2B98D01F547
http://species-id.net/wiki/Carebara_fayrouzae
Figs 7–15

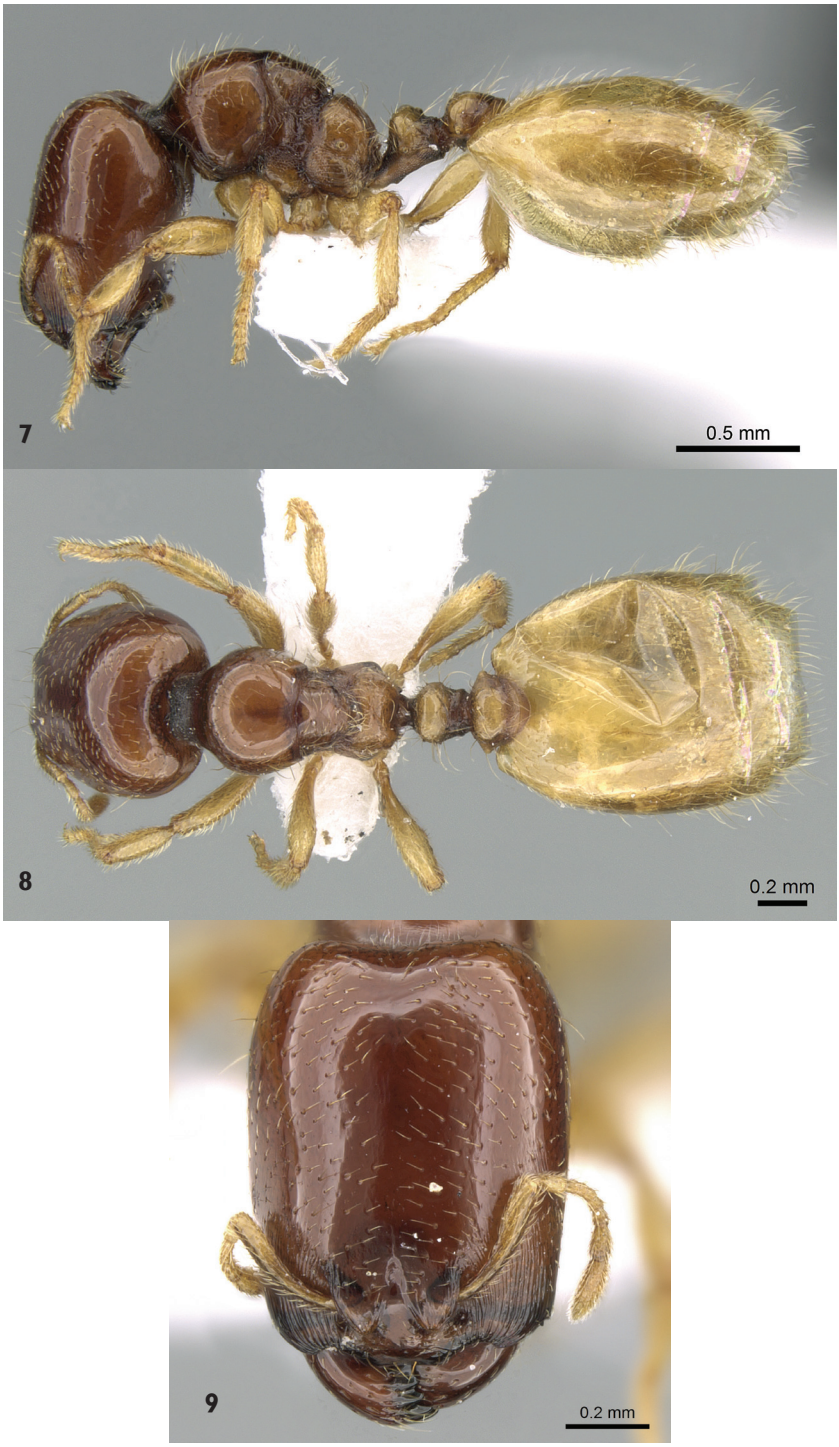
Type material. Holotype major worker. SAUDI ARABIA, Al Qatif, El Naft, Eastern Province, 26.51028°N, 49.96889°E, 30 m. 23.iii.2012 (M. R. Sharaf Leg.) (MRS0066); King Saud University Museum of Arthropods (KSMA), College of Food and Agriculture Sciences, King Saud University, Riyadh, KSA.

Paratypes. 28 minor workers (CASENT0280994), 16 major workers (CASENT0280975), 4 queens (CASENT0906362) with same locality and data as the holotype (KSMA); a single paratype specimen of minor and major workers, and queen are deposited in MHNG; NHMB; CASC; MCZC; SEMC; WMLC; BMNH; 2 minor workers, SAUDI ARABIA, Riyadh, Alhaeir, 24.59214°N, 46.74522°E, 24.iii.2009, lemon soil, Berlese funnel (Acarology lab team at Department of Plant Protection, KSU Leg.); 4 minor workers, SAUDI ARABIA, Riyadh, iii.1989, Soil fauna (no collector data); 2 minor workers, SAUDI ARABIA, N. Riyadh, Ammaryia, 5.iii.2010, 24.806402°N, 46.428845°E, 681m, Lettuce soil fauna, Berlese funnel (Acarology lab team at Department of Plant Protection, KSU Leg.) These paratypes are in KSMA; 1 minor worker, SAUDI ARABIA, Riyadh, Mezahmia, Rawdat Kharara, 24.38931°N, 46.24211°E, 712 m. 30.i.2011, (M. R. Sharaf Leg.) (CASC); 1 minor worker, SAUDI ARABIA, Riyadh, Al Rowayda, 25.88016°N,45.11563°E, 22.ii.2009, (M. R. Sharaf Leg.) (CASC) (All are paratypes).

Description. Holotype major worker. TL 3.62, HL 1.10, HW 0.72, SL 0.37, EL 0.05, ML 0.87, PRW 0.50, PL0.20, PW 0.25, PPL 0.20, PPW 0.27, SI 51, CI 65.

Paratype major workers. TL 3.27–5.00, HL 1.00–1.20, HW 0.72–0.87, SL 0.32–0.42, EL 0.05, ML0.85–1.12, PRW 0.50–0.60, PL 0.20–0.27, PW 0.22–0.30, PPL 0.20–0.27, PPW 0.27–0.40, SI 38–53, CI 65–78 (N=15).

Major worker. (Figs 7–9) Head longer than broad (HL = 1.5 × HW), with feebly concave posterior margin, rounded posterior corners and parallel sides; masticatory margin of mandibles armed with four teeth; antennae nine-segmented; antennal scapes very short; clypeus narrow and with weakly concave anterior margin; eyes very tiny (in some individuals eyes absent); ocelli absent. Mesosoma in profile with distinct promesonotal suture; promesonotum feebly concave; metanotum small and narrow; dorsal face of propodeum continuously sloping and curving into declivity without spine or



Figures 7–9. *Carebara fayrouzae* sp. n., major worker **7** body in profile **8** body in dorsal view **9** head in full-face view (antweb.org, CASENT0280975).

angle. Petiole in dorsal view little broader than long; petiolar peduncle short; petiolar ventral process distinct. Postpetiole in dorsal view nearly twice as broad as long, with acute lateral angles. Postpetiole in profile with distinct ventral process. Sculpture: Body smooth and glossy, anterior part of head finely, longitudinally rugulose, area between meso- and metapleura finely cross-ribbed. Pilosity: Head dorsum with scattered short hairs, rest of body with longer dense, yellow hairs. Colour: Bicolored species, head and mesosoma brownish, petiole and postpetiole brownish yellow, antennae, legs and gaster clear yellow.

Paratype minor workers. TL 1.66–1.94, HL 0.44–0.51, HW 0.29–0.44, SL 0.25–0.31, EL 0.007, ML0.49–0.53, PRW 0.22–0.31, PL 0.09–0.17, PW 0.09–0.14, PPL 0.07–0.09, PPW 0.09–0.12, SI 59–79, CI 78–100 (N=15).

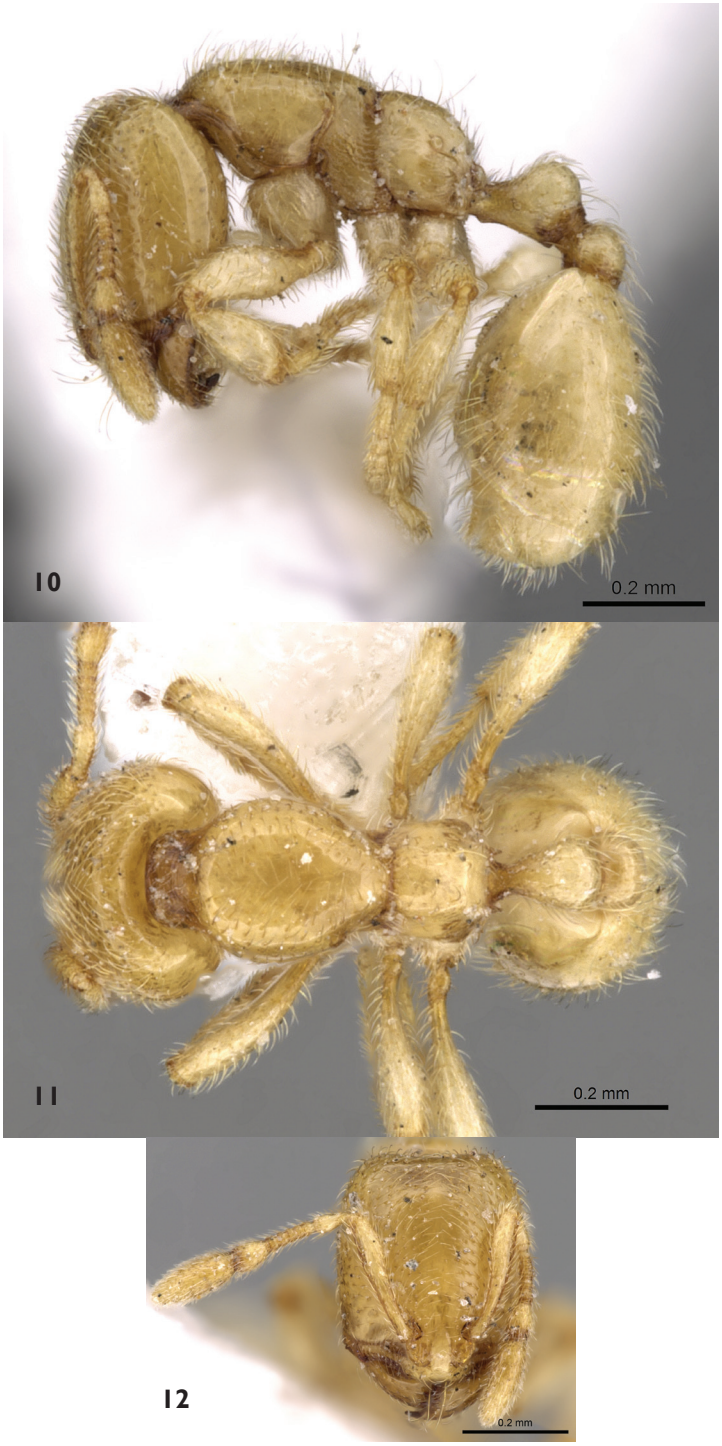
Minor worker. (Figs 10–12) Head distinctly longer than broad, with straight posterior margin and parallel sides; masticatory margin of mandibles armed with four teeth; antennae nine-segmented; scapes when laid back from their insertions fail to reach posterior margin of head by about one third of head width; anterior clypeal margin nearly straight; eyes with only one ommatidium (absent in some individuals). Mesosoma nearly flat in profile; promesonotal suture indistinct; metanotal groove distinct; propodeal dorsum meeting declivity in a continuous curve; propodeal spiracle in profile high and located above midline of propodeum. Petiole in profile shortly pedunculate, with blunt ventral process and in dorsal view slightly longer than broad. Node of postpetiole in dorsal view clearly broader than long and in profile distinctly lower than petiolar node. Colour: Unicolorous clear yellow, hairy, smooth and moderately shining.

Paratype queens. TL 9.75–10.75, HL 1.10–1.35, HW 1.45–1.50, SL 0.60–0.90, EL 0.35-0.45, ML3.25–3.50, PL 0.50–0.75, PW 0.65–0.70, PPL 0.50–0.60, PPW 0.85–1.00, SI 40–62, CI 107–136 (N=3).

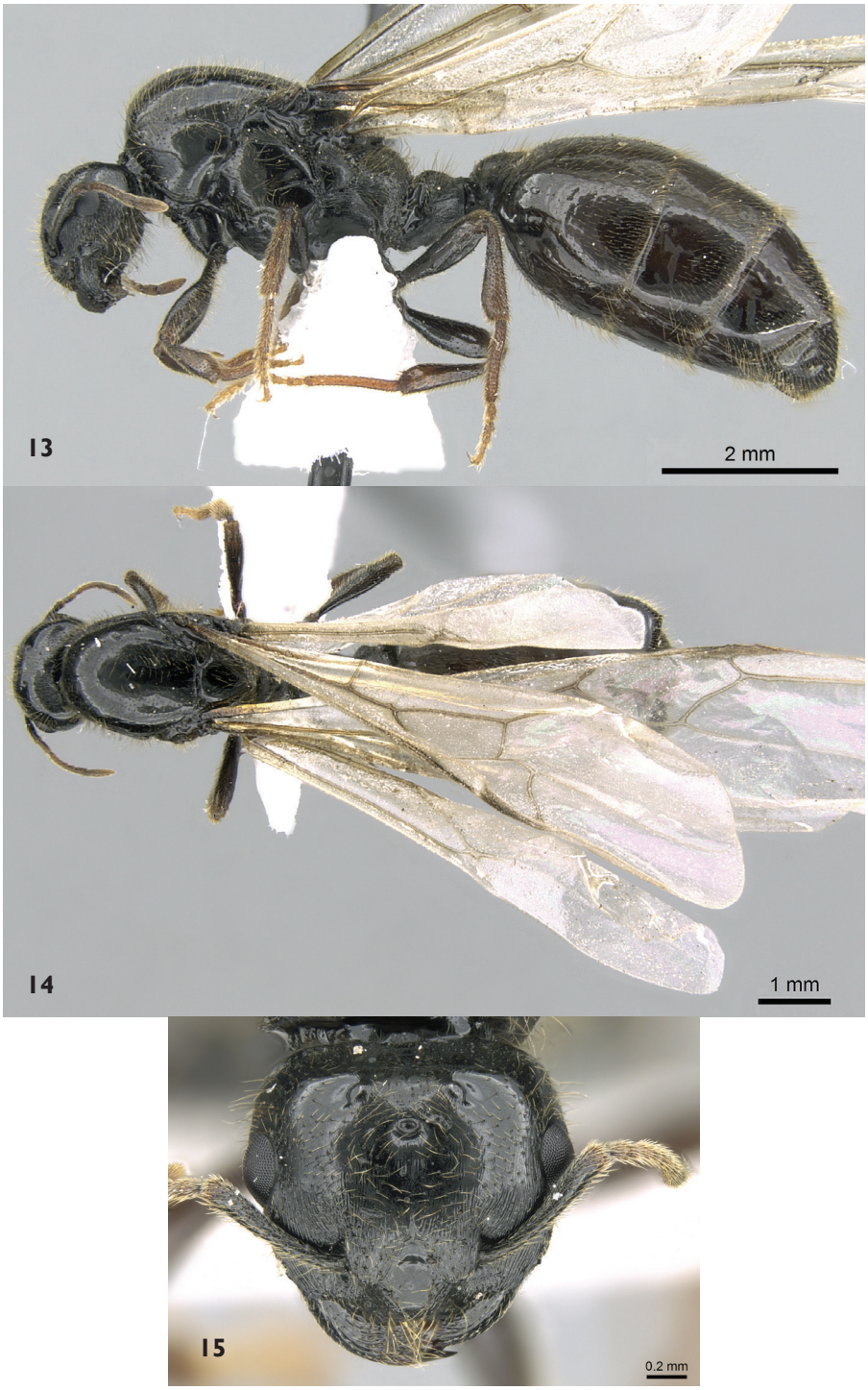
Queen. (Figs 13–15) Body enormous, notably larger than minor and major workers. Head triangular, broader than long (HW = 1.2 × HL), with straight posterior margin and strongly convex lateral margins; masticatory margin of mandibles armed with four teeth; antennae nine-segmented; antennal scapes when laid back from their insertions reach level of posterior margin of eyes; anterior clypeal margin convex, eyes large and multifaceted (about 0.27 × HW); ocelli present. Mesosoma robust, pronotum not exposed above, lying entirely beneath the mesonotum; propodeum unarmed; remaining characters modified as in myrmicine queens. Petiole in dorsal view longer than broad. Postpetiole very broadly attached to gaster and node in dorsal view distinctly broader than long. Sculpture: Anterior half of cephalic dorsum with fine longitudinal striations extend to before posterior level of eyes; median portion of clypeus, posterior half of head, mesosoma and gaster smooth and shining, petiole and postpetiole superficially and finely shagreenate. Pilosity: Whole body covered with abundant, long, yellow hairs. Colour: Uniformly black, funiculi, tibiae and tarsi blackish brown.

Male. Not known.

Comparative notes. This new species is the second member of the genus recorded from the Arabian Peninsula. According to Fernández (2004), *C. fayrouzae* belongs



Figures 10–12. *Carebara fayrouzae* sp. n., minor worker **10** body in profile **11** body in dorsal view **12** head in full-face view (antweb.org, CASENT0280994).



Figures 13–15. *Carebara fayrouzae* sp. n., Queen **13** body in profile **14** body in dorsal view **15** head in full-face view, (antweb.org, CASENT0906362).

to *C. lignata* species complex with nine antennal segments and unarmed propodeum. It does not resemble any of the American species (Fernández, pers. comm.), or Madagascar species (Azorsa, pers. comm.) and majors are easily distinguished from *C. arabica* of the *C. concinna* group, by the nine segmented antennae, the absence of cephalic posterolateral teeth and the smooth and shining cephalic dorsum. Superficially, *Carebara fayrouzae* resembles *C. afghana* (Pisarski, 1970) from Afghanistan in regard to the smooth and shining habitus and the absence of cephalic posterolateral teeth. *Carebara fayrouzae* can be easily distinguished by the bicoloured major workers, the nine-segmented antennae and the node of postpetiole which is broader than petiolar node in dorsal view. In *C. afghana*, major workers are concolorous yellow, antennae ten-segmented and node of postpetiole as broad as petiolar node in dorsal view.

Biology. This new species was found nesting in leaf litter under a large almond tree, *Prunus amygdalus* Batsch (Rosaceae) in a fenced area of a farm. The soil was composed of two layers, a thin upper clay layer organically enriched where most specimens were found foraging, and a lower thicker layer of loose sand where few specimens were found. Two beetle species were found coexisting with the ants, *Oryzaephilus surinamensis* (Silvanidae) and *Cryptophagus acutangulus* (Cryptophagidae).

Etymology. This new species is dedicated to Fayrouz Sharaf (the daughter of the senior author).

Discussion

The Arabian Peninsula is located on the line of contact between three major zoogeographical regions, the Palearctic, the Afrotropical and the Oriental regions; therefore, it is reasonable that it shares some faunal affinities with the mentioned regions. The central and eastern areas of the Arabian Peninsula belong to the Palearctic region with Eremic influence (Uvarov 1938, Büttiker and Wittmer 1979, Greathead 1980 and Larsen 1984, Sharaf et al. 2013); the southwestern region (Mountains of Al Sarawat and Asir to Yemen) belong to the Afrotropical region (Bodenheimer 1937, Nayman 1972, Zohary 1973, Sharaf et al. 2012 and Elhawagryi et al. 2013); whereas the north east, particularly near Iraqi and Kuwaiti borders and along mountains of eastern Oman belong to the Oriental region (Büttiker and Wittmer 1979).

In spite of the mentioned faunal affinities, the probability of *C. fayrouzae* to be an introduced or invasive species, is unlikely for two reasons, first, the new species is well represented very much inland in central Arabian deserts (Riyadh and adjacent areas), second, it does not resemble any of the Asian species, (*e.g.* the Indian species) (Bharti and Kumar 2013). The poverty of knowledge of the genus for adjacent countries east of the Arabian Gulf (*e.g.* Iran, Pakistan, etc.) makes the hypothesis difficult to test completely.

At present, two species of *Carebara* are now known from the Arabian Peninsula, *C. arabica* of the *concinna* species complex from the Republic of Yemen and KSA and *C. fayrouzae* sp. n. of the *lignata* species complex from KSA. The subterranean nature

and nesting habit in decaying wood or leaf litter of this ant group (Bolton 1973, Hölldobler and Wilson 1990, Bharti and Kumar 2013) no doubt has resulted in a paucity of information available about its ecology and biology (Aldawood et al. 2011, Bharti and Kumar 2013). It seems likely that *C. arabica* is a species of mountainous ecosystems of southwestern KSA and Republic of Yemen. In contrast, *C. fayrouzae* was found in desert ecosystems of the central and eastern regions of KSA.

Acknowledgments

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