ZooKeys 456: 1–28 (2014)
doi: 10.3897/zookeys.456.8570
http://zookeys.pensoft.net

RESEARCH ARTICLE

A peer-reviewed open-access journal
ZooKeys
Launched to accelerate biodiversity research

The family Carabodidae (Acari, Oribatida) VIII. The genus *Machadocepheus* (first part) *Machadocepheus leoneae* sp. n. and *Machadocepheus rachii* sp. n. from Gabon

Nestor Fernandez[1,2], Pieter Theron[2], Christine Rollard[3], Sergio Leiva[4]

1 *National Council of Scientific and Technological Research, Argentina (CONICET). Subtropical Biological Institut (IBS). Evolutive Genetic Laboratory FCEQ y N , Misiones National University. Felix de Azara 1552, 6°, (3300) Posadas Misiones Argentina* **2** *Research Unit for Environmental Sciences and Management, North-West University, Potchefstroom Campus, 2520, South Africa* **3** *Muséum National d'Histoire Naturelle, Département Systématique et Evolution, Unité OSEB, Section Arthropodes, 57 rue Cuvier. 75231, Paris cedex 05. France* **4** *Fellowship, National Institute Agricultural Technology (INTA). Experimental Rural Agency, Aimogasta .5310. La Rioja. Argentina*

Corresponding author: *Nestor Fernandez* (nestorfernand51@yahoo.fr)

Academic editor: *V. Pesic* | Received 15 September 2014 | Accepted 20 October 2014 | Published 21 November 2014

http://zoobank.org/836EC595-7ECF-4EB3-8C10-8FDF2E4E2365

Citation: Fernandez N, Theron P, Rollard C, Leiva S (2014) The family *Carabodidae* (Acari, Oribatida) VIII. The genus *Machadocepheus* (first part) *Machadocepheus leoneae* sp. n. and *Machadocepheus rachii* sp. n. from Gabon. ZooKeys 456: 1–28. doi: 10.3897/zookeys.456.8570

Abstract

The genus *Machadocepheus*, being one of the more complex genera of the Carabodidae family, is briefly outlined to demonstrate this complexity. Descriptions of two new species from Gabon, *M. leoneae* **sp. n.** and *M. rachii* **sp. n.** are given.

Keywords

Carabodidae, *Machadocepheus leoneae* sp. n., *Machadocepheus rachii* sp. n., Gabon

Copyright *Nestor Fernandez et al.* This is an open access article distributed under the terms of the Creative Commons Attribution License (CC BY 4.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

Introduction

This genus was created by Balogh in 1958 (page 20), with type species *Machadocepheus excavatus* Balogh, 1958 (page 21), but in very brief text lacking figures. Mahunka (1986) redefined the genus (page 97) and supplied very brief figures of dorsal, lateral and ventral views (Figures 42, 43, 44); the type species *M. excavatus* was redescribed (page 125) and figures 96 (anterior view) and 97 (bothridium and sensillus) added.

The species *Machadocepheus papuanus* Balogh, 1970 (from New Guinea), was instated as the type species of the genus *Guineobodes*, erected by Mahunka 1987, and is considered by Subias (2004 updated 2014) to be a subgenus of *Pasocepheus* Aoki, 1976, as *Pasocepheus* (*Guineobodes*) (Mahunka 1987). *Machadocepheus manguiati* Corpus-Raros, 1979 was designated the type species of *Philippobodes* J & P Balogh, 1992, considered by Subias (2004, updated 2014) as synonym of *Bathocepheus* Aoki, 1978, transferring the species to *Bathocepheus manguiati* (Corpus-Raros, 1979).

Machadocepheus foveolatus Mahunka, 1978, was designated type species of the genus *Mauribodes* J & P. Balogh, 1992, and subsequently *Mauribodes* was considered by Subias (*op. cit*) as synonym of *Diplobodes* (*Kalloia*) Mahunka, 1985. Subias recombined *Mauribodes foveolatus* (Mahunka, 1978) as *Diplobodes* (*Kalloia*) *foveolatus* (Mahunka, 1978). The genus *Kalloia* was created by Mahunka 1985, with *K. simpliseta* Mahunka, 1985 as type species; however at present, this species has been recombined as *Machadocepheus* (*Kalloia*) *simpliseta* (Mahunka, 1985).

Machadocepheus longus Balogh, 1962 was subsequently designated type species of *Tuberocepheus* Balogh & Mahunka, 1969, while *Machadocepheus sagitta* Balogh & Mahunka, 1966 was designated type species of the genus *Sagittabodes* J & P Balogh, 1992.

More recently, Subias (*op. cit*.) divided *Machadocepheus* into two subgenera, *Machadocepheus* and *Sagittabodes*, the first subgenus with *Machadocepheus* (*Machadocepheus*) *exacavatus* as type and the second with *Machadocepheus* (*Sagittabodes*) *sagitta* (Balogh & Mahunka, 1966) as type.

With regard to Subias's recombination of genera and currently accepted classification of *Machadocepheus*, the changes were published and necessitate justification. We studied type material in order to not accepted. This paper specifically establishes the series of characters for the genus, and future papers will discuss other problems in terms of classification, in order to state reasons why the authors agree with some changes and disagree with others.

The genus is also complex in terms of the deposition of the type *Machadocepheus excavatus* Balogh, 1958 (see above). Balogh indicated in page 1 of his paper that "Les types des formes nouvelles que je decris ici font partie des collections du Musée Royal du "Congo Belge, a Tervuren", without further indications, but Mahunka 1986 indicated rather confusingly in the text of the redescription (page 125) "Examined types series: Holotype and 62 paratypes.Ang.4370-1: Angola: Riv.Tchimboma, affl. E du Cuango-Muque, galerie forestière des sources. Alto Chicapa, I:VIII.1954. Station, Holotype and 30 paratypes: IRAT, 30 paratypes (1107-PO-55): HNHM, 2 paratypes: MHNG. Other material 1 specimen: Ang.16888: Angola, Environs de Dundo forêt

de la Luanchino, 28.III.1962 (SANJINJE et BARROS MACHADO coll) 6 paratypes from the same sample: Holotype and 2 paratypes in the MRAT, 3 paratypes (1102-PO-85): HNHM, 1 paratype : MHNG».

First of all, the type material is not housed at the Museum Tervuren, and Mahunka never differentiated between IRAT and MRAT; MRAT most probably refers to the Musée Royal du Congo Belge Tervuren, and we suppose that the type material discussed by Balogh in 1958, and possibly that of Mahunka 1986, is housed in the latter.

Other problems with the type deposition include: Mahunka indicated: "Holotype and 62 paratypes (Holotype and 30 paratypes IRAT; 30 paratypes HNHM and 2 paratypes MHNG (total holotype, plus 62 paratypes)"; but in the last part of text indicated 6 paratypes: "Holotype and 2 paratypes MRAT, 3 paratypes HNHM and 1 paratype MHNG". That, two holotypes are referred to, one in 1954 and another 1962, with 68 paratypes, 62 from 1954 and 6 from 1962.

We studied most species cited, except for *Machadocepheus manguiati* Corpuz-Raros, 1979, which we were unable to obtain, and *Machadocepheus longus* Balogh, 1964, which was not available on loan from HNHM. We were fortunate to later obtain large quantities of specimens (from Madagascar) in the Betsch Collection of the Muséum National d'Histoire Naturelles (MNHN), Paris, France, and were able to conduct observations using both SEM and optical microscopy. The situation *Machadocepheus longus* Balogh, 1964 will the subject of a subsequent paper.

This paper, the eighth in the series on the revision of the family Carabodidae will be structured as follows: initial studies of a series of new species, making use of SEM and optical microscopy in order to permit understanding of the structures involved. Thereafter, we aim to study type material where only optical microscopy studies are available (or possible), with the intention of clarifying the taxonomy of *Machadocepheus* and related genera.

Material and methods

Specimens studied by means of optical microscopy were macerated in lactic acid and observed in the same medium using the open-mount technique (cavity slide and cover slip) described by Grandjean (1949) and Krantz and Walter (2009). Drawings were made using a Zeiss Axio Scope (Carl Zeiss Microscopy GmbH, Jena, Germany) compound microscope equipped with a drawing tube.

Specimens were also studied with the aid of Scanning Electron Microscopy (SEM). Specimens preserved in ethanol were carefully rinsed by sucking them into a Pasteur pipette several times, after which they were transferred to buffered glutaraldehyde (2,5 %) in Sörensen phosphate buffer (pH 7,4; 0,1 m) for two hours. After postfixation for two hours in buffered 2% OsO4 solution and being rinsed in buffer solution, all specimens were dehydrated in a series of graded ethanols and dried in a critical point apparatus. After mounting on Al-stubs with double sided sticky tape, specimens were gold coated in a sputter apparatus (Alberti and Fernandez 1988). The critical point appar-

atus used was an Emitech K 850 (Quorum Technologies Ltd., Ashford, Kent, United Kingdom) and the sputter a Jeol JFC-1200 (Jeol Ltd. Tokyo, Japan) (metalized 80").

SEM observations were very complex, due to limited numbers and anatomic particularities shown by specimens. Two different types of SEM were used in order to obtain observations of adequate quality: 1) Tescan Vega II LSU (Tescan Orsay Holdings, Kohoutovice, Czech Republic) (Direction of Collections-SEM-EDS-MNHN) and 2) Hitachi SU3500 (Hitachi High-Technologies Europe, Krefeld, Germany) (Plateau technique de Microscopie Electronique et de Microanalyse (PMEM) (MNHN) using accelerating voltage of 15 Kv and 10 Kv respectively.

In the legends to Figures, images obtained with Tescan Vega II LSU are indicated with a small number 1 and those obtained with Hitachi SU3500, with a small number 2.

Measurements taken: total length (tip of rostrum to posterior edge of notogaster); width (widest part of notogaster) in micrometers (μm).

Leg chaetotaxy studies executed with the aid of standard, polarized and phase contrast microscopes are provisional, due to the fact that only adult specimens were available for study. Setal formulae of the legs include the number of solenidia (in parentheses); tarsal setal formulae include the famulus (ε).

Morphological terminology and abbreviations

Morphological terms and abbreviations used are those developed by F. Grandjean (1928–1974) (*cf.* Travé and Vachon 1975; Norton & Behan-Pelletier (in Krantz and Walter 2009); Fernandez et al. 2013; Fernandez et al. 2013a, b; Fernandez et al. 2013. For setal types Evans 1992: 73; and for ornamentation of cuticular surfaces Murley 1951 (in Evans *op. cit*: 9) were used.

Institutions

MNHN: Muséum National d'Histoire Naturelle, Paris, France; MNHG: Museum Natural History Geneva; HNHM: Hungarian Natural History Museum; MRAT: probably Musée Royal du Congo Belge Tervuren; IRAT: unknown.

New taxa descriptions

***Machadocepheus leoneae* sp. n.**
http://zoobank.org/FAF67C3C-7615-451F-93E2-F7720CBA5597
Figures 1–37

Etymology. The specific epithet is dedicated in homage to Mrs. Leone Hudson, our efficient and helpful collaborator who enormously facilitated our work.

Material examined. Holotype and four paratype females. Holotype ♀ Makokou, northeastern province of Ogoové-Ivindo, 500 m alt. dense evergreen humid forest, I.1974, Y. Coineau, deposited in MNHN (Muséum National d'Histoire Naturelle, Paris).

Paratypes. Same data as holotype, 4 ♀ (2 in MNHN; 2 in MNHG). All specimens are preserved in 70% ethanol.

Type locality. Makokou, province of Ogoové-Ivindo, northeastern Gabon; situated at 0°34'0"N, 12°52'0"E. Material used for SEM observations not deposited.

Diagnosis adult female. Elongate animals; *ro*, *in*, notogastral, sub-capitular, epimeral, genital, aggenital, adanal, anal setae, simple; *le*, lanceolate, barbate. Prodorsum truncate pyramid shape; elevated interlamellar process, divided sagittally by a deep furrow into two promontories; *in* setae situated anteriorly, directing posteriorly. Deep posterior prodorsal depression. Sensillus uncinate, curving upward; bothridial ring and bothridial tooth present; *ro* setae curving, directing medially; *le* setae situated ventrally on lamellar apical zone. Lamellae lacking lamellar tip; lamellar furrow with deeper medial structure; superior cornea of naso convex elevation. Notogaster characteristic: notogastral anterior depression with three anterior transversally aligned parallel cuticular folds; posterior zone with two large cavities, separated by longitudinal ridge, terminating in c_1 setae, which are positioned on triangular convexity. Elevated medial notogastral zone with three pairs of aligned medial promontories with *da*, *dm*, *dp* setae and lateral semicircular promontories that bear *la*, *lm*, *lp*, h_1, h_2, setae. Behind elevated zone, posterior notogastral depression slightly concave; near circumgastric depression, a more or less flat zone with small protuberances present.

Notogastral setae, fifteen pairs (holotrichy unideficient): c_1, c_2, c_3, *da*, *dm*, *dp*, *la*, *lm*, *lp*, h_1, h_2, h_3, p_1, p_2, p_3.

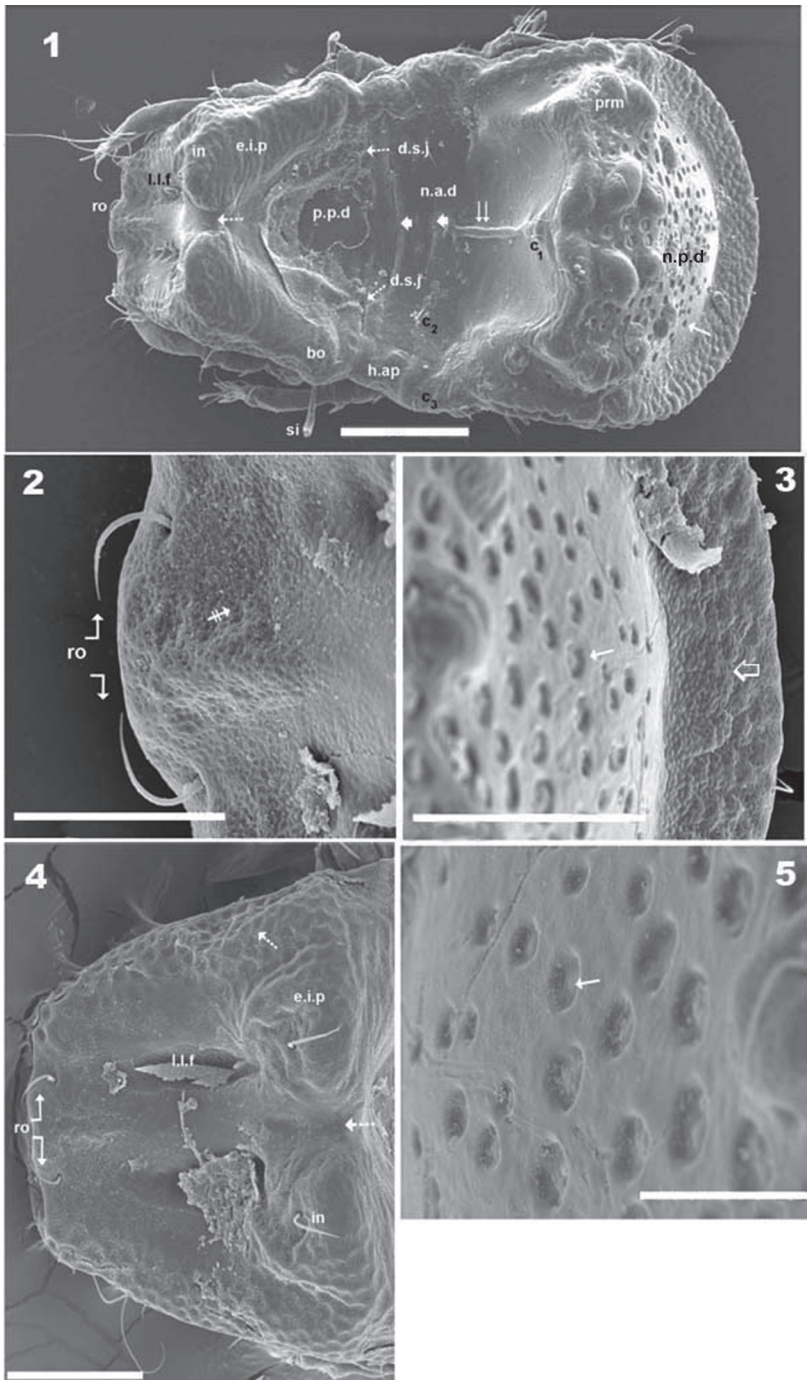
Supratutorial depression with three pocket depressions, one internal, another anterior and a third posterior to supratutorial depression. Bothridia cup-shaped with smooth bothridial ring and bothridial tooth. Lyrifissures *ih*, *ips* present. Subcapitular setae *h* on large promontories. Epimere 1 with two promontories; epimere 2, one promontory; epimere 3 two promontories; epimere 4 two promontories. Epimeral chaetotaxy 3-1-3-3; anterior aggenital furrow present. Genital plate small in relation to anal plate; four pairs of genital setae; two pairs of anal setae; aggenital and adanal setae similar in length and shape; lyrifissures *iad* well discernible between ad_3 and ad_2. Several large and small depressions visible on lateral anal plate.

Description. ***Measurements***. SEM: 501 μm (515–424) × 310 μm (327–295) (measurements on four specimens). Light microscopy: 512 μm (519–443) × 318 μm (338–301) (measurements on five specimens).

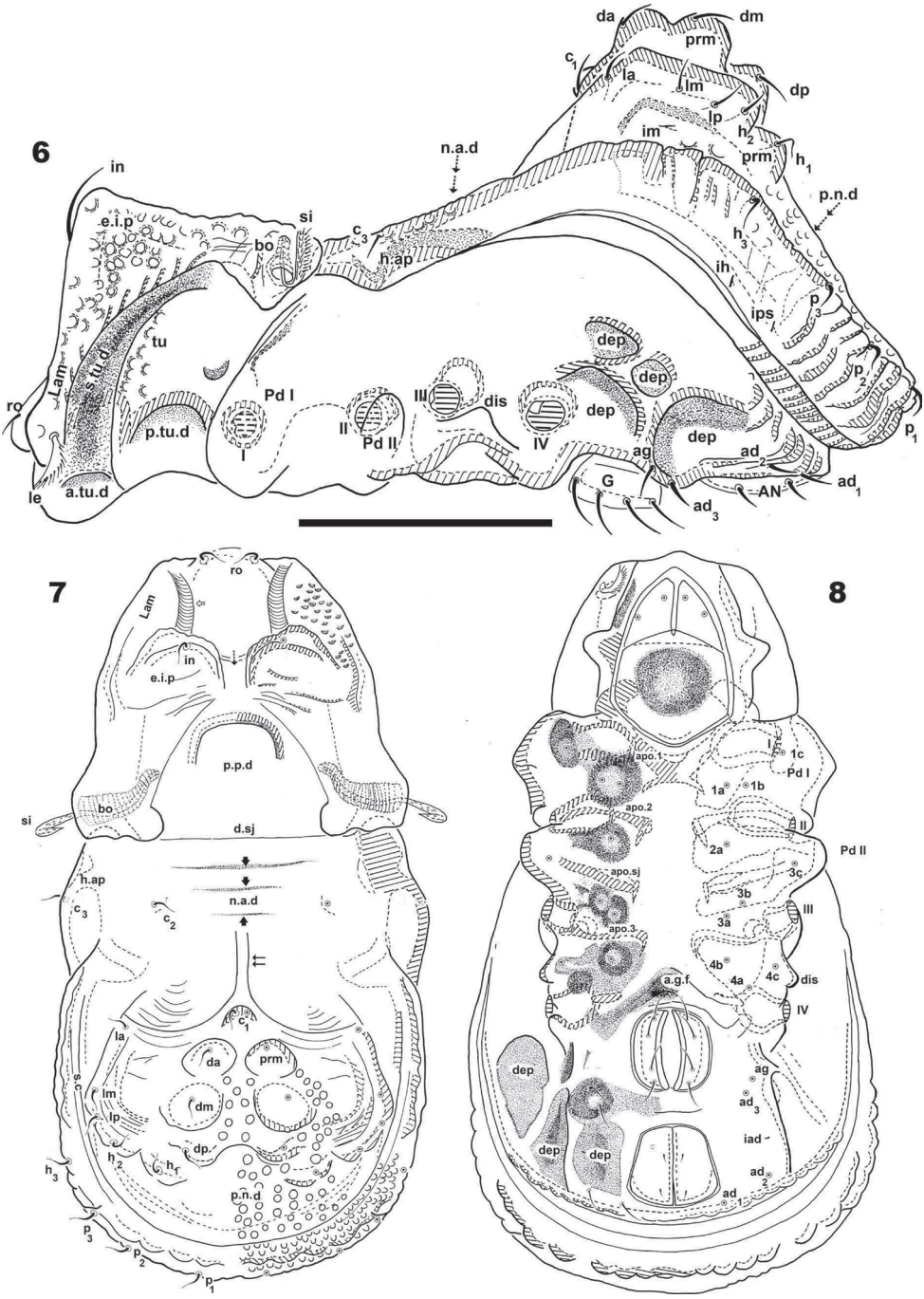
Shape. Elongate ovoid (Figures 1, 7).

Colour. Specimens without cerotegument, light to dark brown, observed in reflected light.

Cerotegument. Thin layer (0.8–1.7 μm) covering entire body and legs (Figures 15, 32 indicated by ⇪), permitting observation only of the more prominent cuticular microsculpture (Figures 13, 25, 32). When removed, detailed microsculpture becomes visible (Figures 16, 32), however complete removal was necessary for optical microscopy.



Figures 1–5. *Machadocepheus leoneae* sp. n., adult female. SEM observations. **1** dorsal view (1) **2** anterior zone of prodorsum, dorsal view (1) **3** posterior notogastral zone, dorsal view (1) **4** prodorsum, dorsal view (1) **5** fovea, posterior notogastral zone, dorsal view (2). Abbreviations: see "Material and methods". Scale bar: **1** = 100 μm; **2** = 30 μm; **3–4** = 50 μm; **5** = 20 μm.



Figures 6–8. *Machadocepheus leoneae* sp. n., adult female. Optical observations. **6** lateral view **7** dorsal view **8** ventral view. Abbreviations: see "Material and methods". Scale bar: **6–8** = 145 μm.

Integument. Two sizes of ornamentations: *Small:* 0.7–1.7 μm: 1) slightly foveate distributed throughout body (except notogastral zone near circumgastric depression *s.c*) (Figures 2, 13, 15, 17, 18 indicated by ↟); 2) small protuberances, notogastral zone near *s.c* (Figures 3, 27, 30 indicated by ⇦). *Large:* 5–10 μm. Foveate, two types: 1) simple rounded fovea, situated in the elevated zone of notogaster (Figures 1, 3, 5, 9, 27, 30, 31, 32 indicated by ↑); 2) polyhedral fovea (distributed side by side), situated on prodorsum, lateral notogastral zone, and near *la* setae (Figures 4, 9, 10, 13, 25, 28 indicated by ↓).

Setation. Setae *ro*, *in*, notogastral, sub-capitular, epimeral, genital, aggenital, adanal, anal: simple (Figures 4, 6, 7, 14, 17, 18, 19, 20, 21, 23, 24, 25, 28, 32); *le*, lanceolate, barbate (Figure 16, 21, 25).

Prodorsum. Shape: Truncate pyramid (Figure 6, 9, 10); truncate triangle in dorsal view (Figure 1, 4, 7); truncate inverted triangle in frontal view (Figures 19, 28).

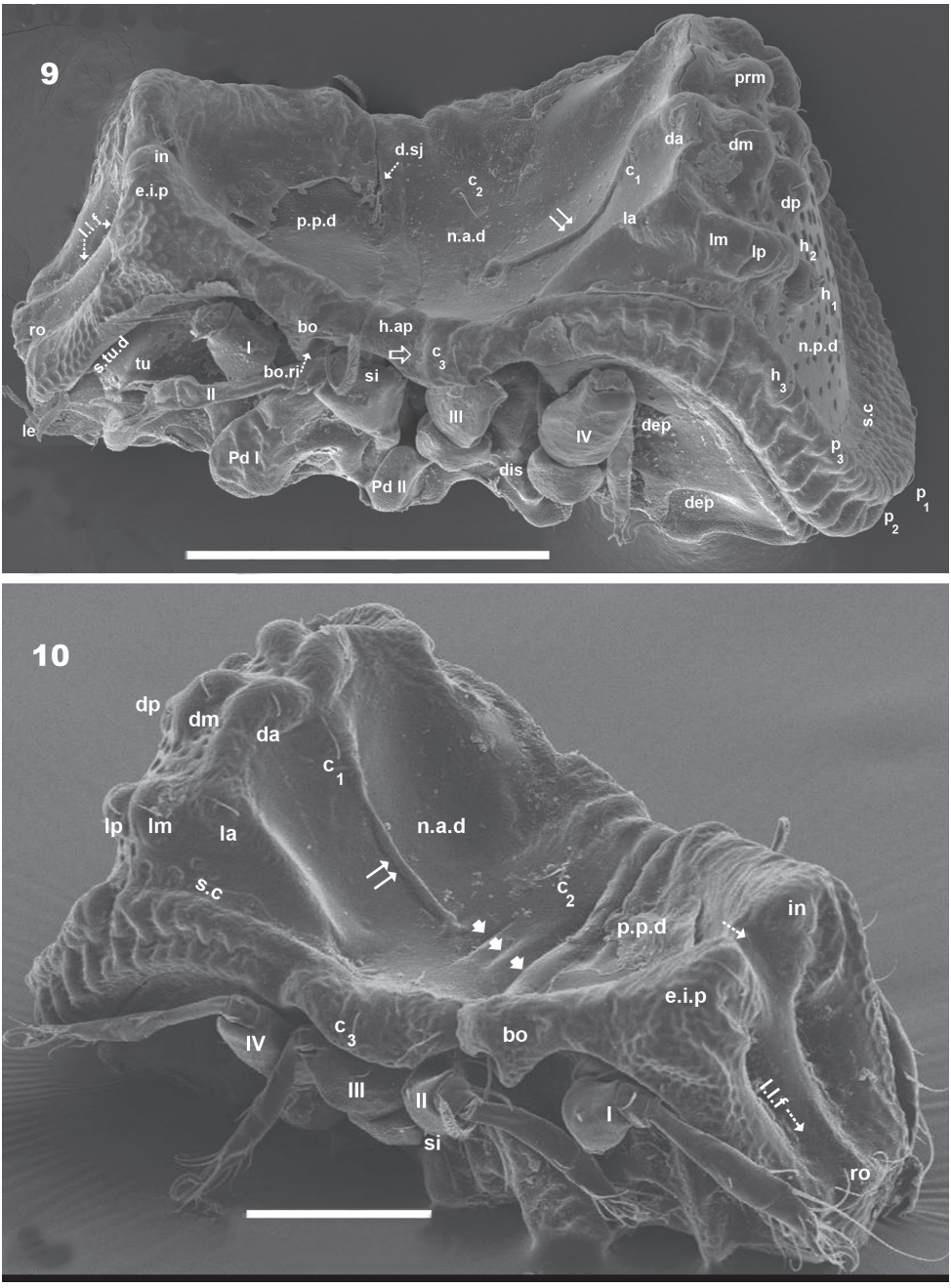
Large elevated interlamellar process (*e.i.p*) (Figures 6, 9, 10,12), large deep furrow dividing *e.i.p* sagittally into two promontories (Figures 6, 9, 10, 19, 27, 28, indicated by ↟). Posterior prodorsal zone (*p.p.d*) deeply depressed (Figures 1, 7, 9, 10, 27, 29); depression continuous with notogastral anterior depression (*n.a.d*); dorsosejugal furrow (*d.sj*) (Figures 1, 7, 9, 10, 29) evidently separating *p.p.d* and *n.a.d*. Three pairs of setae; size *in*>*le*>*ro* (Figures 6, 19, 21). Sensillus uncinate, curving upward (Figure 13), bothridial ring (*bo.ri*) and bothridial tooth (*bo.to*) present.

Setae *ro* inserted slightly anteriorly or at level of *le* insertion (Figures 19, 21); curving, directing interiorly; apical tips not touching each other (Figures 2, 4); *in* setae inserted on anterior zone of *e.i.p* promontories, curving, directing backward, paraxial to medial plane; inserted slightly externally to *ro* insertion level (Figures1, 4, 6, 7, 10, 19, 28); *le* setae situated ventrally on lamellar apical zone (Figures 6, 16, 19, 21, 25, 26).

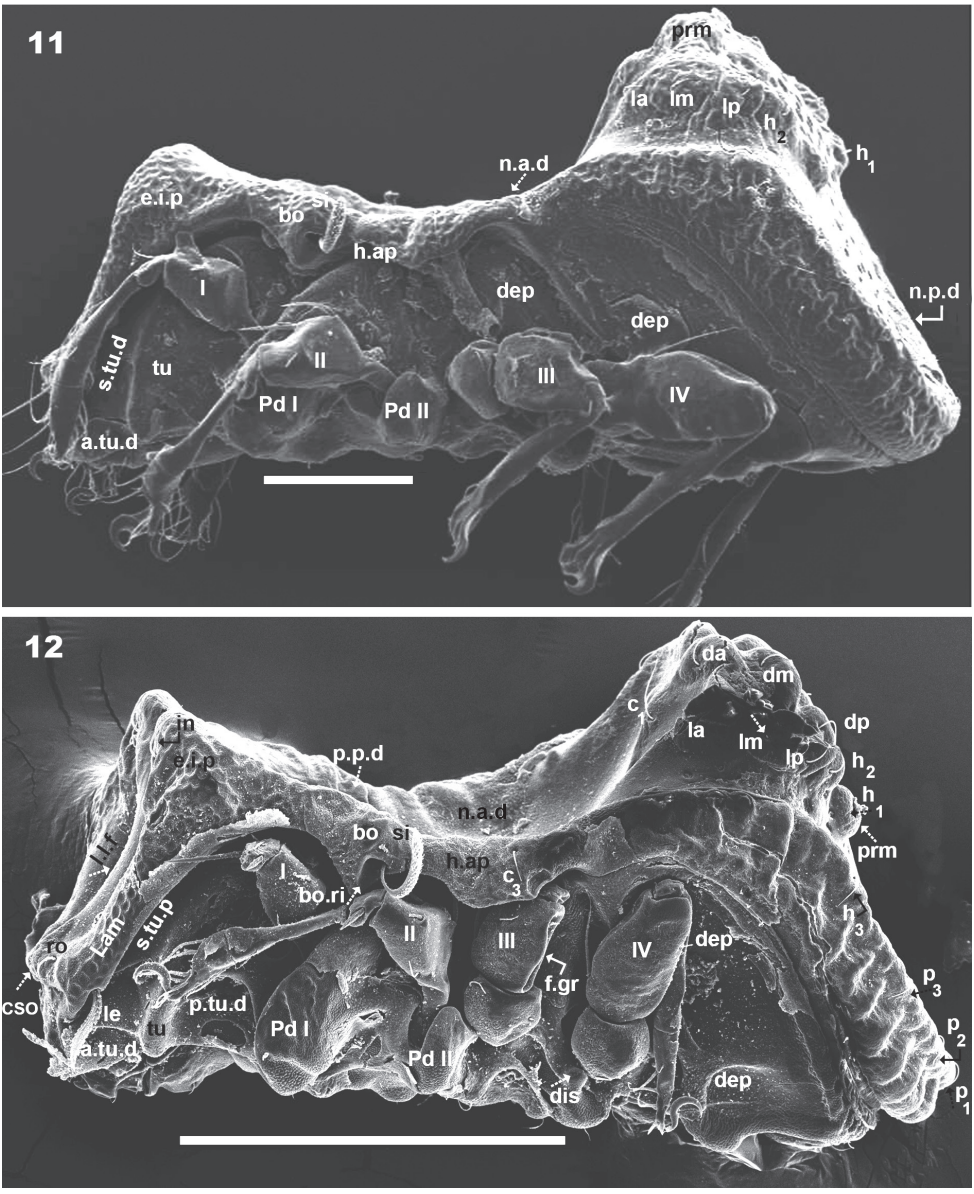
Rostral margin slightly rectangular to hexagonal (Figures 19, 28). Lamellae run dorso laterally, without lamellar tips (Figures 16, 21, 25, 26); *le* setae inserted ventrally (Figure 25); inner paraxial margin of lamellae demarcated by large deep furrow (*l.l.f*) (Figures 9, 10,12, 19, 28). In frontal view (Figures 19, 28) *l.l.f* showing deeper medial zone. The superior cornea of naso (*cso*) clearly visible as convex elevation situated at more or less same level as *ro* setal insertion (Figures 19, 25).

Notogaster. Shape: in dorsal view anterior part rectangular and posterior part oval (Figures 1, 7); in lateral view, anterior part clearly concave in medial zone and rectilinear exteriorly, rest convex with irregular promontories (Figures 6, 9, 10, 11, 12); *d.sj* narrow, rectilinear, well delimited (Figures 1, 7, 9); notogastral anterior depression (*n.a.d*) ovoid and conspicuous. Fifteen pairs (holotrichous, unideficient) of notogastral setae; c_1, c_2, c_3, *da*, *dm*, *dp*, *la*, *lm*, *lp*, h_1, h_2, h_3, p_1, p_2, p_3.

The notogaster has: anterior depression (*n.a.d*) occupying anterior notogastral zone; elevated zone situated in medial to posterior part of notogaster; posterior to elevated zone, slightly concave notogastral posterior depression (*n.p.d*) (Figures 1, 6, 7, 9, 27, 11), terminating in more or less flat slightly inclined zone with small protuberances (Figure 3 indicated by ⇦); Circumgastric depression (*s.c*) present anterior to zone of small protuberances (Figures 7, 9, 27).

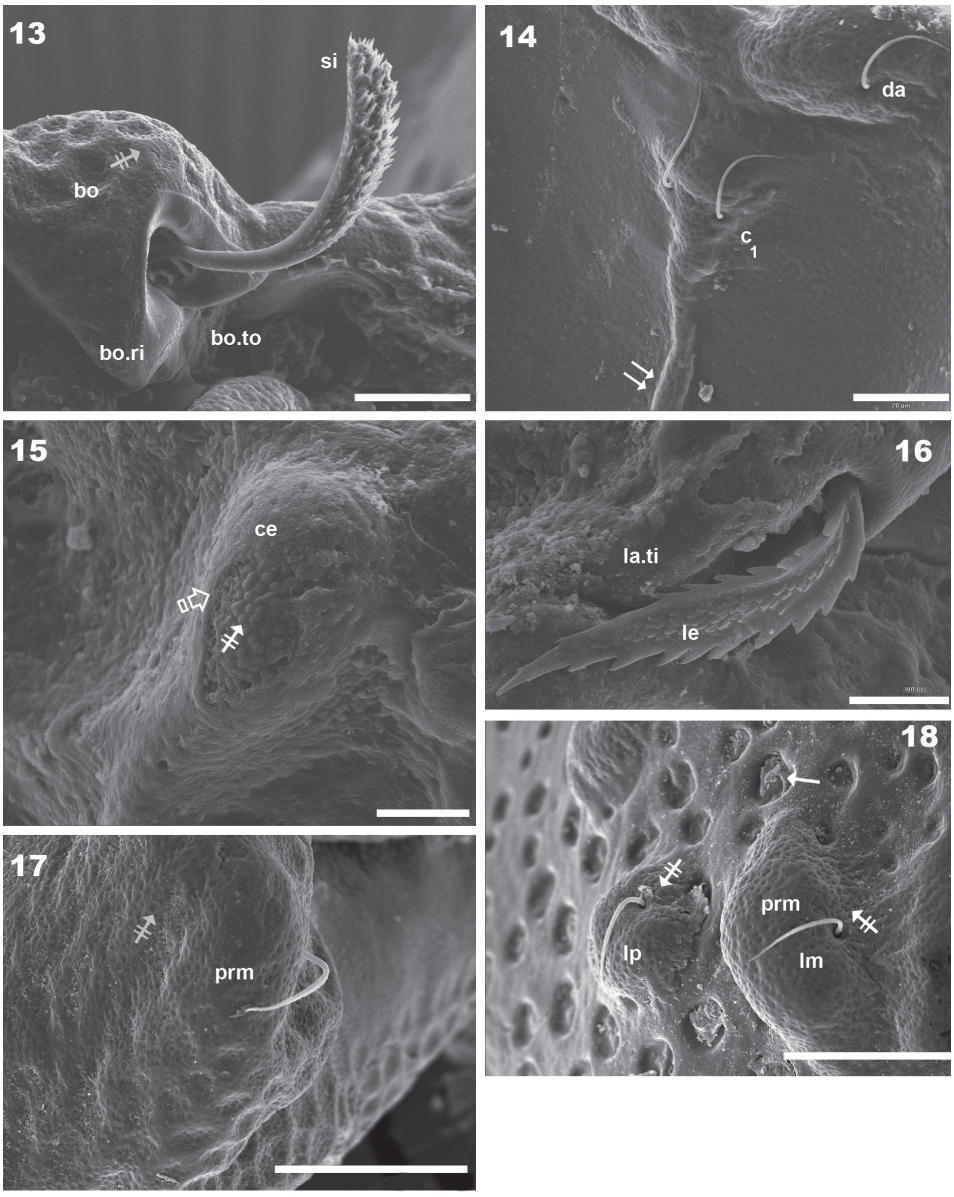


Figures 9–10. *Machadocepheus leoneae* sp. n., adult female. SEM observations. **9** dorsal inclined view (2) **10** dorsal anteroposterior view (1). Abbreviations: see "Material and methods". Scale bars: **9** = 200 μm; **10** = 100 μm.



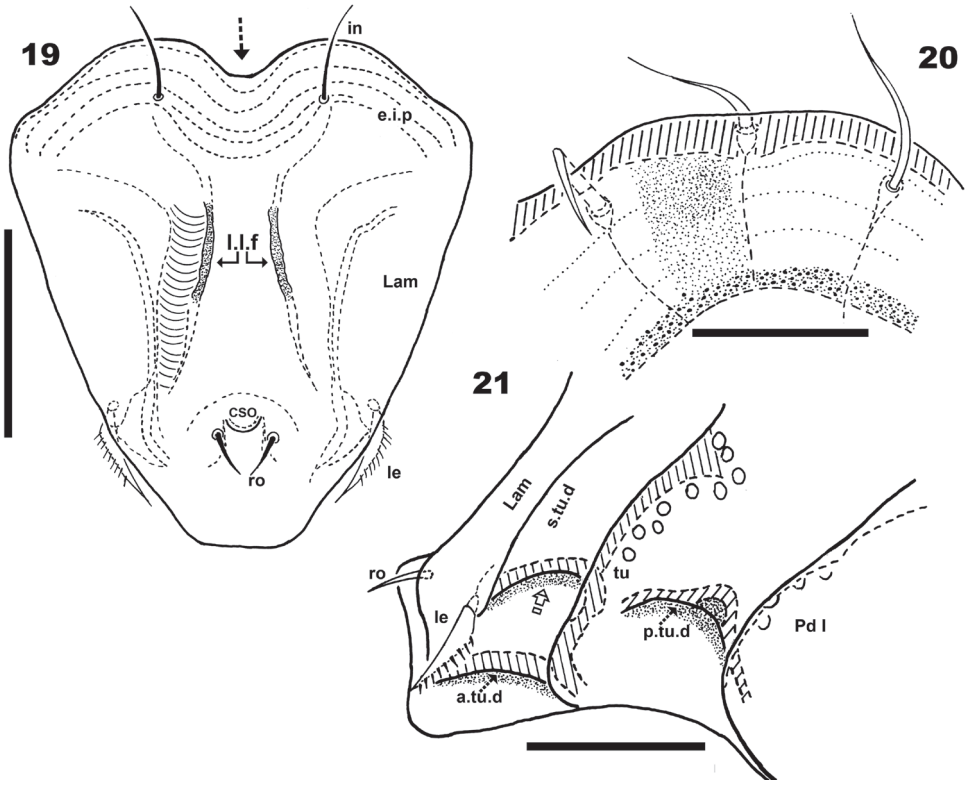
Figures 11–12. *Machadocepheus leoneae* sp. n., adult female. SEM observations. **11** lateral view **12** inclined lateral view. Abbreviations: see "Material and methods". Scale bar: **11** = 100 μm; **12** = 200 μm.

Complex *n.a.d*, three transversally aligned parallel cuticular folds situated posterior to *d.sj* (Figures 1, 7, 10 indicated by ⬟). In posterior zone, two large concavities, separated by longitudinal ridge (Figures 1, 7, 9, 10, 14 indicated by ⇈). Ridge terminating in triangular shape, situated near first pair of protuberances on elevated zone bearing *da* setae. Triangular zone of cord termination bearing c_1 setae (Figures 1, 7, 10, 14).



Figures 13–18. *Machadocepheus leoneae* sp. n., adult female. SEM observations. **13** bothridium and sensillus, lateral view (1) **14** posterior zone of notogastral anterior depression (2) **15** promontories with and without cerotegumental layer (2) **16** lamellae anterior zone, lateral view (2) **17** promontories with dorso-central setae (1) **18** lateral promontories with *lm*, *lp*, setae (1). Abbreviations: see "Material and methods". Scale bar: **13–14** = 20 μm; **15–16** = 10 μm; **17–18** = 30 μm.

Elevated zone presenting a series of aligned medial promontories (three pairs, variably developed) bearing setae *da*, *dm*, *dp*; and lateral semi-circular promontories bearing setae *la*, *lm*, *lp*, h_1, h_2. Setae c_3 situated on humeral apophysis (*h.ap*), c_2 laterally



Figures 19–21. *Machadocepheus leoneae* sp. n., adult female. Optical observations. **19** frontal view **20** Promontories, lateral view **21** prodorsum anterior zone, lateral view. Abbreviations: see "Material and methods". Scale bar: **19–21** = 100 μm.

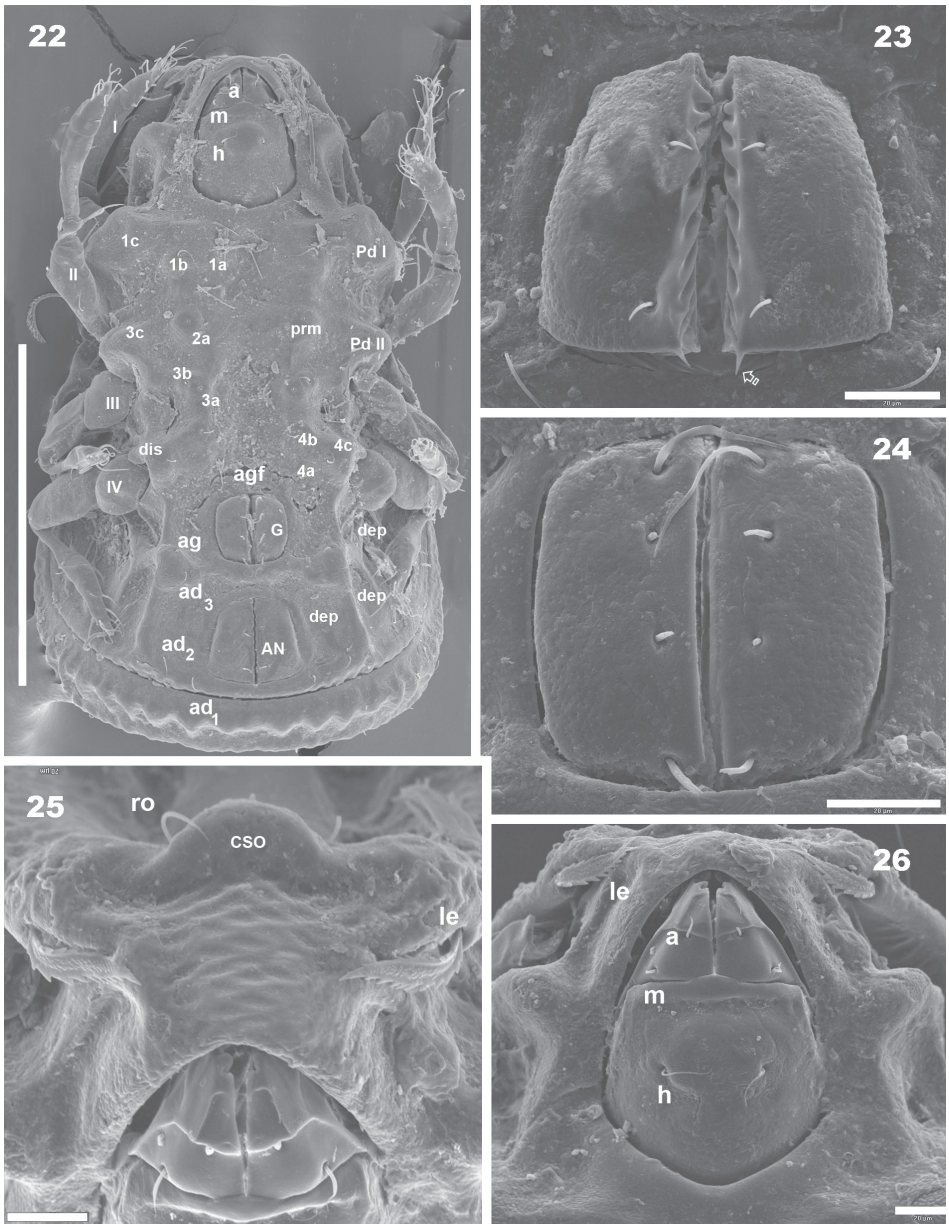
situated near *h.ap*, but in the depression on *n.a.d* (Figures 1, 7, 9, 10, 27, 32). Four pairs of setae, h_3, p_1, p_2, p_3 situated marginally.

Humeral apophysis (*h.ap*) very long, clearly visible as a pronounced projection, giving characteristic shape to anterior zone of notogaster (Figures 6, 9, 10, 11, 12).

Lateral region (Figures 6, 9, 10, 11, 12). Lamellae (*lam*) easily discernible, large, without sharp *la.ti*, and with rounded elevated zone at level of *le* insertion (Figure 16, 21).

Tutorium (*tu*): rod-like curving ridge, clearly visible (Figures 11, 12). Between lamellae and tutorium, deep supratutorial depression (*s.tu.d*) running parallel to both structures; pocket depression (*a.tu.d*) anteriorly and posterior pocket depression (*p.tu.d*) present; small depressions posterior to *p.tu.d* as well as others situated on the interior of *s.tu.d* (Figure 21 indicated by ⇧).

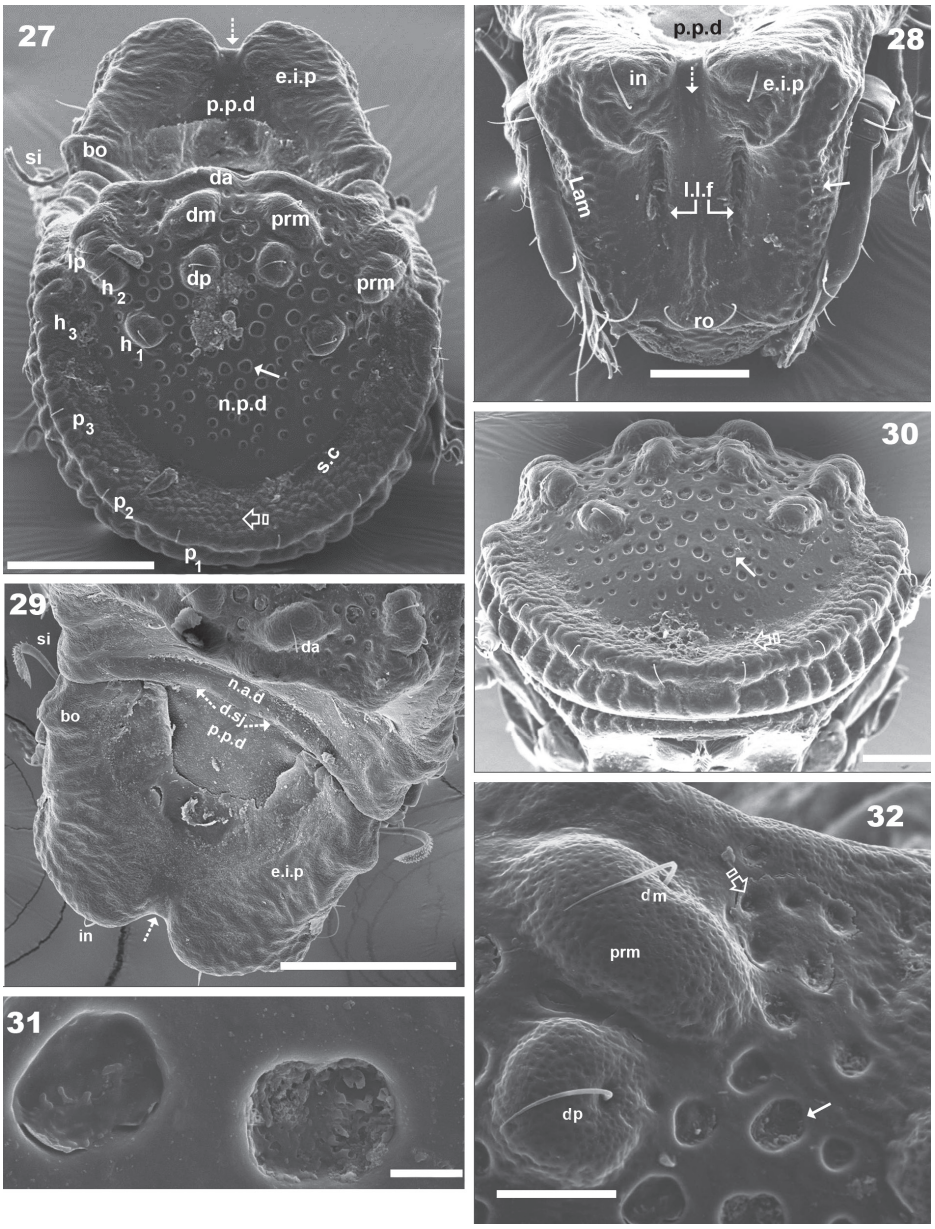
Bothridia cup-shaped with smooth bothridial ring (*bo.ri*); *bo.ri* incomplete, with bothridial tooth (*bo.to*) clearly discernible (Figures 6, 9, 10, 11, 12, 13). Sensillus uncinate, arching apex (Figure 13). Pedotectum I: prominent extended lamina covering first acetabulum, rounded apex. Pedotectum II: small ovoid lamina (Figures 6, 9). Humeral apophysis (*h.ap*) long, extended structure, rounded apex, basally curved; anterior tip overlapping posterior of bothridium (Figures 11, 12).



Figures 22–26. *Machadocepheus leoneae* sp. n., adult female. Optical observations. **22** ventral view (2) **23** anal plate (1) **24** genital plate (1) **25** aspis frontal view (2) **26** infracapitulum and surrounding zone (1). Abbreviations: see "Material and methods". Scale bar: **22** = 200 μm; **23–26** = 20 μm.

Notogastral promontories bearing setae clearly discernible (Figures 11, 12, 17, 18); promontories show several internal layers as in Figure 20.

Only lyrifissures *ih* and *ips* clearly visible. Discidium easily discernible as triangular structure with rounded apex. Several large depressions (*dep*) clearly discernible behind acetabulum IV (Figures 6, 9).



Figures 27–32. *Machadocepheus leoneae* sp. n., adult female. Optical observations. **27** posterior general view (1) **28** fontal view (1) **29** prodorsum and anterior notogastral zone, posterior view (2) **30** notogastral posterior view (2) **31** notogastral ornamentation, rounded fovea (2) **32** promontories with *dm*, *dp* setae (1). Abbreviations: see "Material and methods". Scale bar: **27–29** = 100 μm; **28–32** = 50 μm.

Ventral region. Infracapitulum with setae *h*, *m*, *a* clearly visible; setae *h* situated on large promontories (Figure 29). Epimere slightly elevated, delimited by shallow furrow (*bo.1*, *bo.2*, *bo.sj*). Epimere1 with two well delimited promontories, bearing setae *1a*,

1b; epimere 2 only one promontory, bearing setae *2a*; epimere 3 with two promontories, bearing setae *3a* and *3b*; epimere 4 bearing two promontories with setae *4a* and *4b* (Sidorchuk and Norton 2010). Apodemes (*apo.1*, *apo.2*, *apo.3* and *apo.4*) clearly discernible (Figures 8, 22). Epimeral chaetotaxy 3-1-3-3; Pd I, Pd II and *dis* easily discernible; aggenital furrow *a.g.f* clearly visible, situated anteriorly to genital plate. Genital plate small relative to anal plate (Figure 22); four pairs of long genital setae (Figure 24); anal plate with two pairs of setae; one pair situated anteriorly and the other posteriorly, both setae small, but well discernible; plate terminating in small sharp tip (Figure 23). Aggenital and adanal setae similar, long, simple; *ag* and ad_3, situated on promontory; ad_2, ad_1, situated laterally at level of posterior tip of anal plate (Figure 8, 22). Lyrifissures *iad* clearly discernible, situated laterally between ad_3 and ad_2 outside *dep*. Laterally to anal plate and marginally to ventral shield, several large and small depressions (Figures 8, 22).

Posterior view. This view is very important, permitting clarification of several interesting aspects such as: a) the cuticular microsculpture and the *n. p.d* (Figure 27); b) the *p.p.d* and its relation to the *n.a.d*, as well as the related position of *d.sj*. (Figure 29); c) the relative positions of *e.i.p* and *p.p.d* (Figure 27); d) related position of central and lateral notogastral promontories (Figures 27, 30); e) disposition of *s.c* (Figure 27) and f) shape and distribution of setae and promontories (Figure 32).

Legs (Figures 33-37). All legs monodactyle. Setal formulae I (1-4-3-4-15-1) (1-2-2); II (1-4-3-3-16-1) (1-1-2); III (2-3-1-2-15-1) (1-1-0); IV (1-2-1-2-12-1) (0-1-0). Figure 36 showing shape of anterior setae, tarsus II. Observation of the shape of especially (*u*), (*p*), difficult in optical observations. Setae *ft*` absent from tarsus I, but present on tarsus II in all specimens studied.

Tibia I: solenidion φ_1 on small apophysis; tibia I, II, setae *d* present, situated near solenidion. Femur IV presenting a conspicuous ventral carina.

Machadocepheus rachii **sp. n.**
http://zoobank.org/6787E360-4484-44A2-8DAD-5A73F7D7E633
Figures 38–72

Etymology. The specific epithet is dedicated in homage to Mr Rachid Kebir of Muséum National d'Histoire Naturelles, Paris, who assisted us with great kindness and friendship on many occasions over the past 20 years .

Material examined. Holotype and four Paratype females. Makokou, northeastern province of Ogoové-Ivindo, 500 m. alt.dense evergreen humid forest, I.1974, Y. Coineau, deposited in MNHN. Paratypes. Same data as holotype, 4 ♀ (2 in MNHN; 2 in MNHG). All specimens preserved in 70% ethanol. Type locality. Makokou, province of Ogoové-Ivindo, northeastern Gabon; situated at 0°34'0"N, 12°52'0"E. Material used for SEM observations not deposited.

Diagnosis adult female. Thin cerotegumental layer covering entire body, giving the impression of a smooth surface. Setae *ro*, *in*, notogastral, sub-capitular, epimeral, genital, aggenital, adanal, anal, simple sharply tipped; *le* lanceolate, barbate.

Polyhedral prodorsum; interlamellar process elevated, divided sagittally by large deep furrow; *in* setae situated anteriorly, directing posteriorly. Conspicuous deep posterior prodorsal depression present. Bothridium cup-shaped; bothridial ring and bothridial tooth present. Sensillus uncinate, upturned; *le* setae situated ventrally on apical zone of lamellae. Lamellae running dorsolaterally, lacking lamellar tip; large, deep, shallow lamellar furrow demarcating paraxial lamellar margin. Superior cornea of naso clearly visible as convex elevation situated anterior to insertion level of *ro* setae.

Anterior part of notogaster rectangular; posterior part oval with some irregularities and less conspicuous promontories, dorsosejugal furrow narrow, rectilinear, hardly discernible. Fifteen pairs of notogastral setae (holotrichy unideficient), c_1, c_2, c_3, *da*, *dm*, *dp*, *la*, *lm*, *lp*, h_1, h_2, h_3, p_1, p_2, p_3. Notogaster presenting: notogastral anterior depression; elevated zone; slightly concave posterior depression. Notogastral anterior depression simple, with transversally aligned parallel cuticular folds. Elevated zone with three pairs of poorly developed promontories that bear *da*, *dm*, *dp* setae; and lateral semicircular, poorly developed promontories, that bear *la*, *lm*, *lp*, h_1, h_2 setae. Humeral apophysis long, clearly visible.

Tutorium: rod-like curving cuticular thickening; supratutorial depression present; along with three pocket-shaped depressions, one anterior tutorial depression, one posterior tutorial depression and a small depression situated internally to supratutorial depression. Pedotecta I, prominent extended lamina, rounded apex; Pedotecta II small, ovoid lamina. Lyrifissures *ih*, *ips* clearly visible. Discidium: polyhedral structure with rounded apex. Depressions behind acetabulum IV; one of them elongated, concealing tarsus during folding legs process. Series of aligned depressions in medial zone. Epimeral chaetotaxy 3–1-3–3; anterior genital furrow clearly visible; four pairs of long genital setae; two pairs of small anal setae; anal plate terminating in small sharp tip; aggenital and adanal setae similar length; lyrifissures *iad* not discernible.

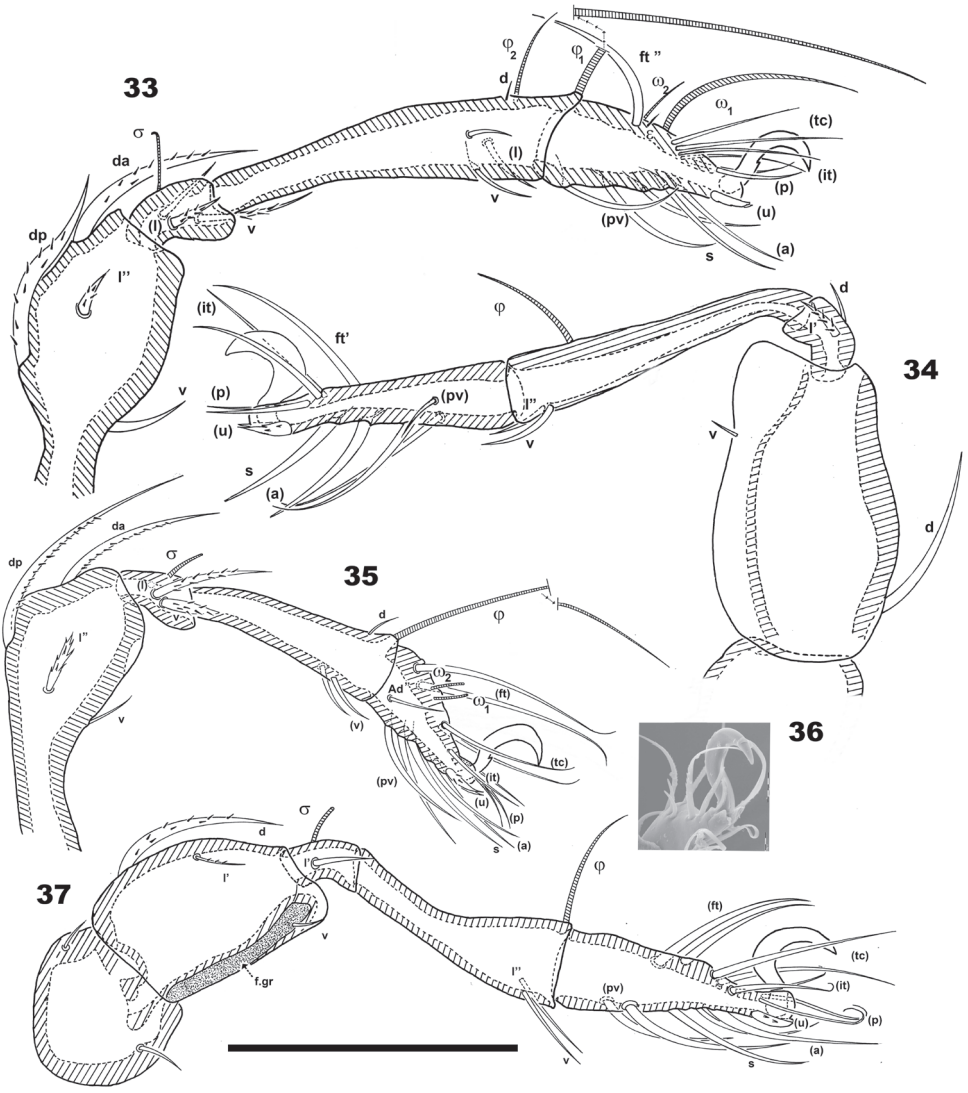
Description. ***Measurements***. Light microscopy: 421 μm (396–426) × 262 μm (238–268) (on six specimens). SEM microscopy: 416 μm (398–416) × 176 μm (173–181) (on six specimens, not deposited).

Shape. Ovoid (Figures 38, 41).

Colour. Specimens without cerotegument, light to dark brown, when observed in reflected light.

Cerotegument. Thin layer 1.5 μm (1.3–2.5) covering the entire body and legs (Figures 38, 41, 42, 44, 47, 48, 49 indicated by ⇡, 52, 53, 56, 57, 58, 59, 63), permitting observation of only large cuticular microsculptures (Figures 44, 46, 48, 53, 58, 59, 62), giving the impression of a smooth surface. Complete removal was necessary for optical microscopy, once removed, detailed microsculpture became visible (Figure 63).

Integument. Two sizes of ornamentations: *Small* 1.2–3.5 μm, 1) small ovoid to irregular protuberances, distributed throughout prodorsum and notogaster (except notogastral zone near *s.c*) (Figure 49) 2) irregular elongate protuberances, notogastral zone near *s.c* (Figures 41, 58, 61 indicated by ⇪). *Large* 7.2–7.9 μm, two types: 1) simple rounded fovea (Figure 63), situated on posterior part of elevated zone of notogaster (Figures 41, 58, 59, 62 indicated by ⬘); 2) polyhedral fovea (distributed side by

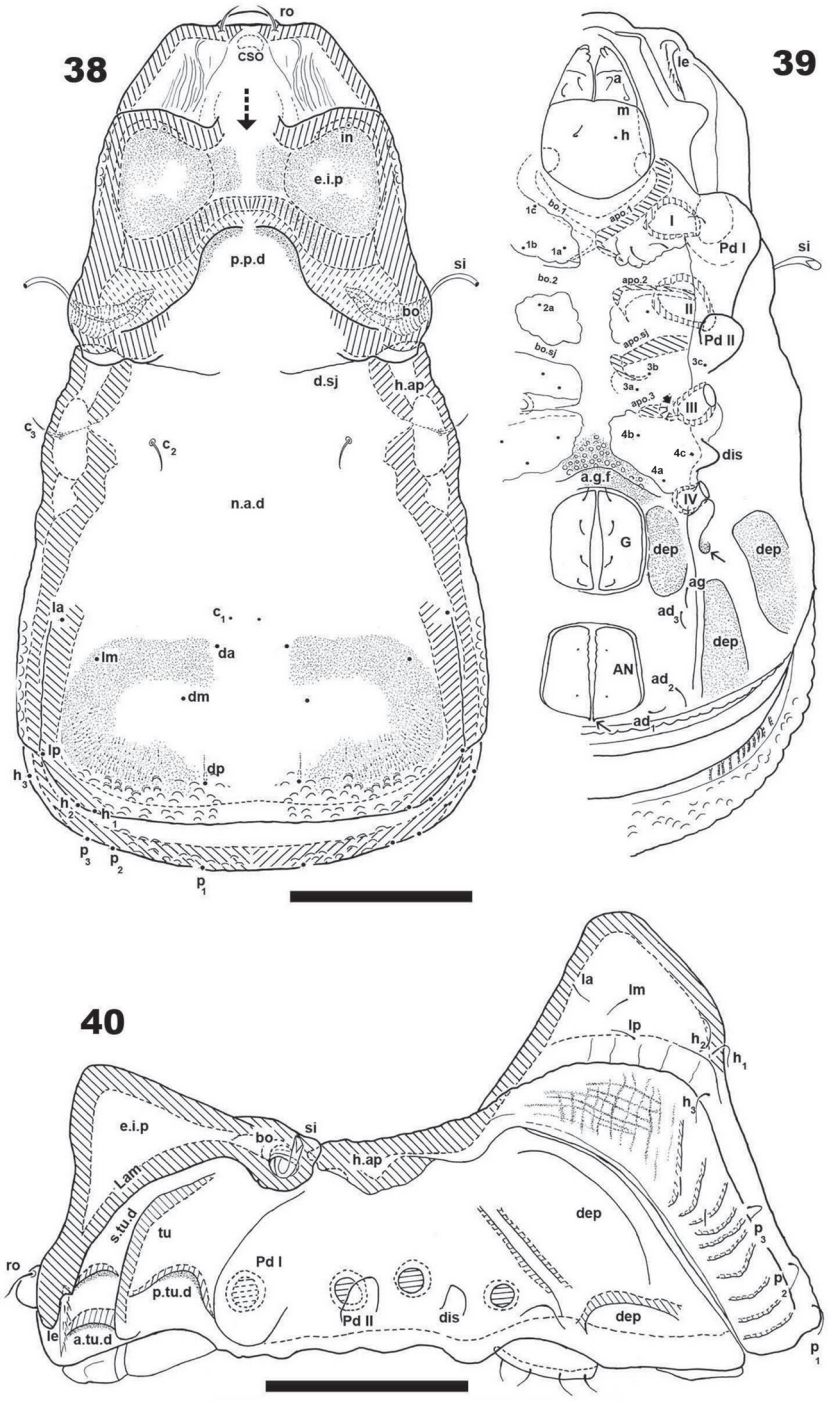


Figures 33–37. *Machadocepheus leoneae* sp. n., adult female. Optical observations. **33** leg I antiaxial view **34** leg IV antiaxial view **35** leg II antiaxial view **36** apical zone, leg II(1) **37** leg III, antiaxial view. Abbreviations: see "Material and methods". Scale bars: **35–37** = 50 μm; **36** = 10 μm.

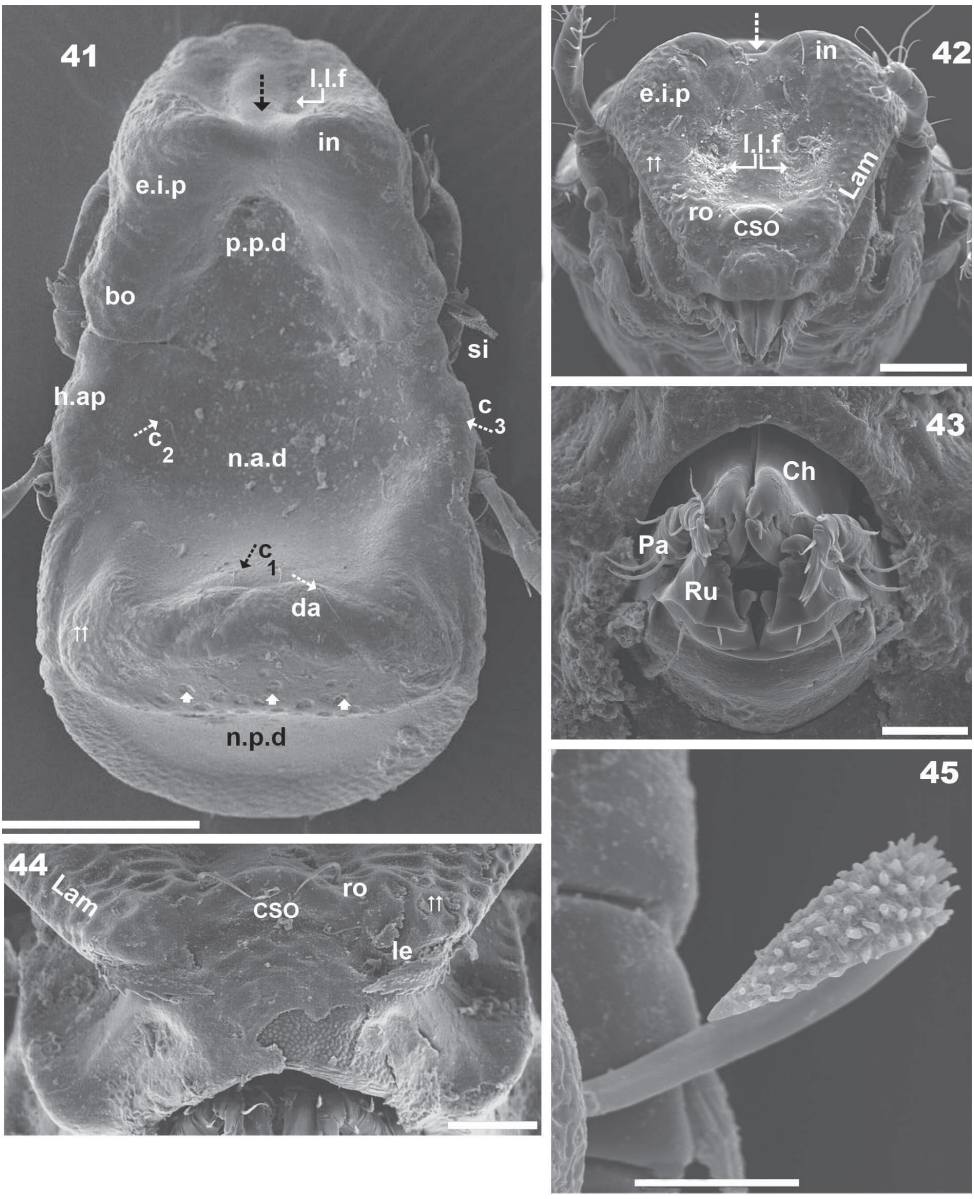
side), situated on prodorsum (*e.i.p*, lamellae, near *ro* insertion, bothridium), notogaster (elevated zone, lateral zone) (Figures 41, 42, 48, indicated by ⇈).

Setation. Setae *ro*, *in*, notogastral, subcapitular, epimeral, genital, aggenital, adanal, anal: simple, sharply tipped (Figure 60) (Figures 38, 39, 40, 42, 44, 48, 52, 53, 57, 58, 59, 62, 51); *le* lanceolate, barbate (Figures 44, 55, 56).

Prodorsum. Polyhedral (dorsal view) (Figures 38, 41); triangular (lateral view) with strong obliquely decreasing anterior part (Figures 40, 46, 47). Interlamellar process

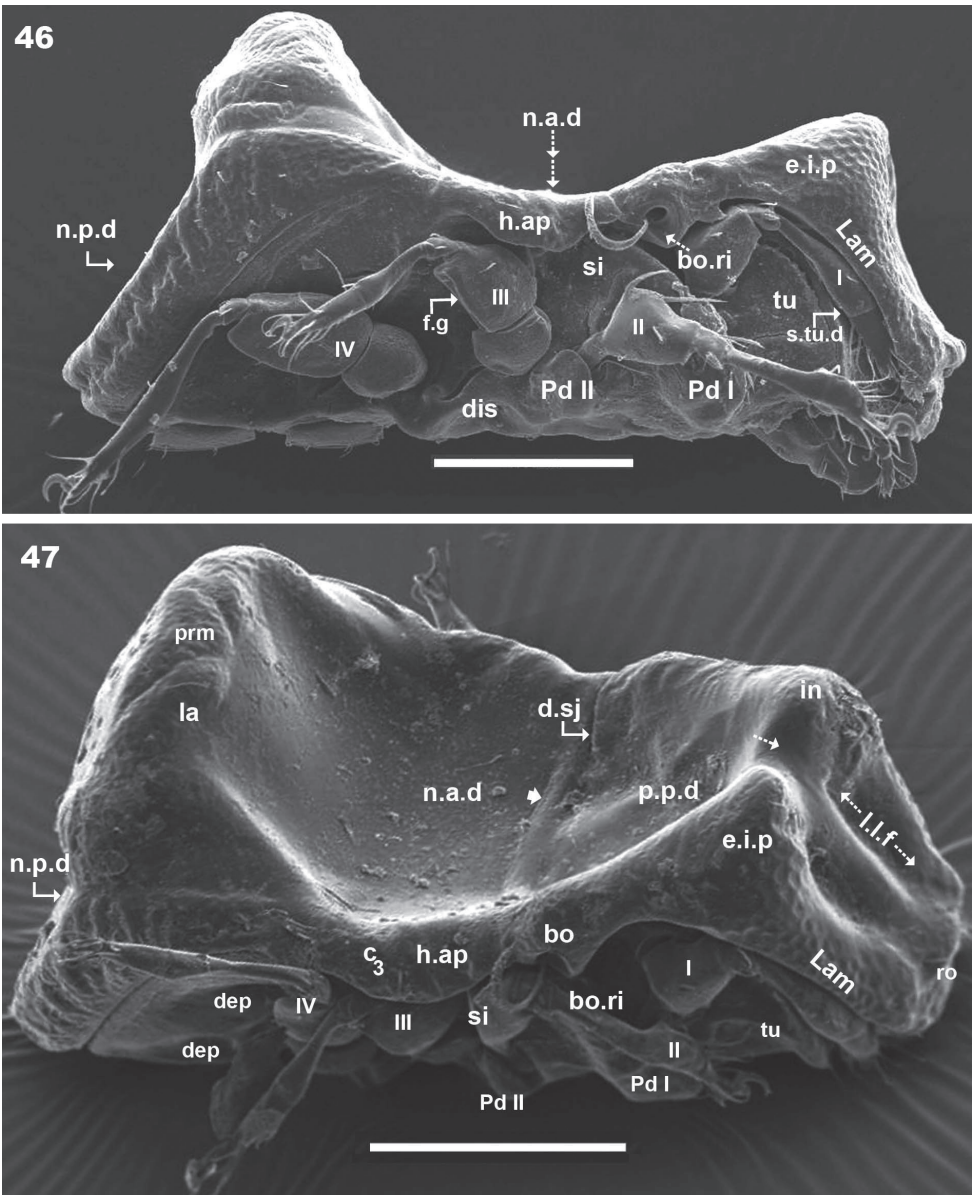


Figures 38–40. *Machadocepheus rachii* sp. n., adult female.Optical observations. **38** dorsal view **39** ventral view **40** lateral view. Abbreviations: see "Material and methods". Scale bar: **38–40** = 90 μm.



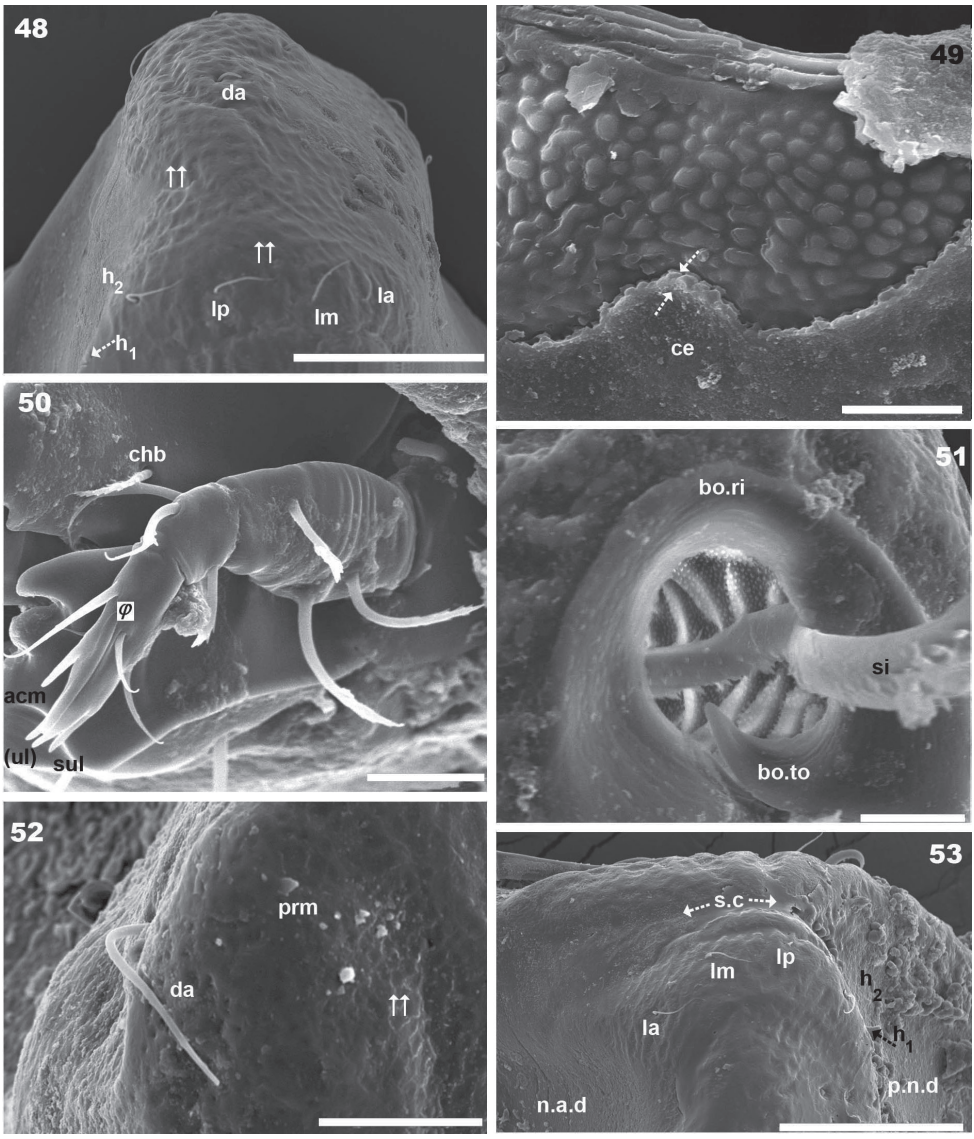
Figures 41–45. *Machadocepheus rachii* sp. n., adult female. SEM observations. **41** dorsal view (2) **42** prodorsum, frontal view (1) **43** gnathosoma, frontal view (1) **44** aspis, frontal view (1) **45** sensillus (1). Abbreviations: see "Material and methods". Scale bar: **41** = 100 μm; **42** = 50 μm; **43–44** = 20 μm; **45** = 10 μm.

(*e.i.p*) elevated (Figures 40, 46, 47), divided sagittally into two promontories by large deep furrow (Figures 41, 42, 47, 58 indicated by ⇣), *in* setae situated anteriorly and directing posteriorly (Figures 42). Conspicuously depressed posterior prodorsal zone (*p.p.d*) (Figures 38, 41, 47, 58). Three pairs of setae; sizes *in*>*le*>*ro*. *Ro* setae clearly



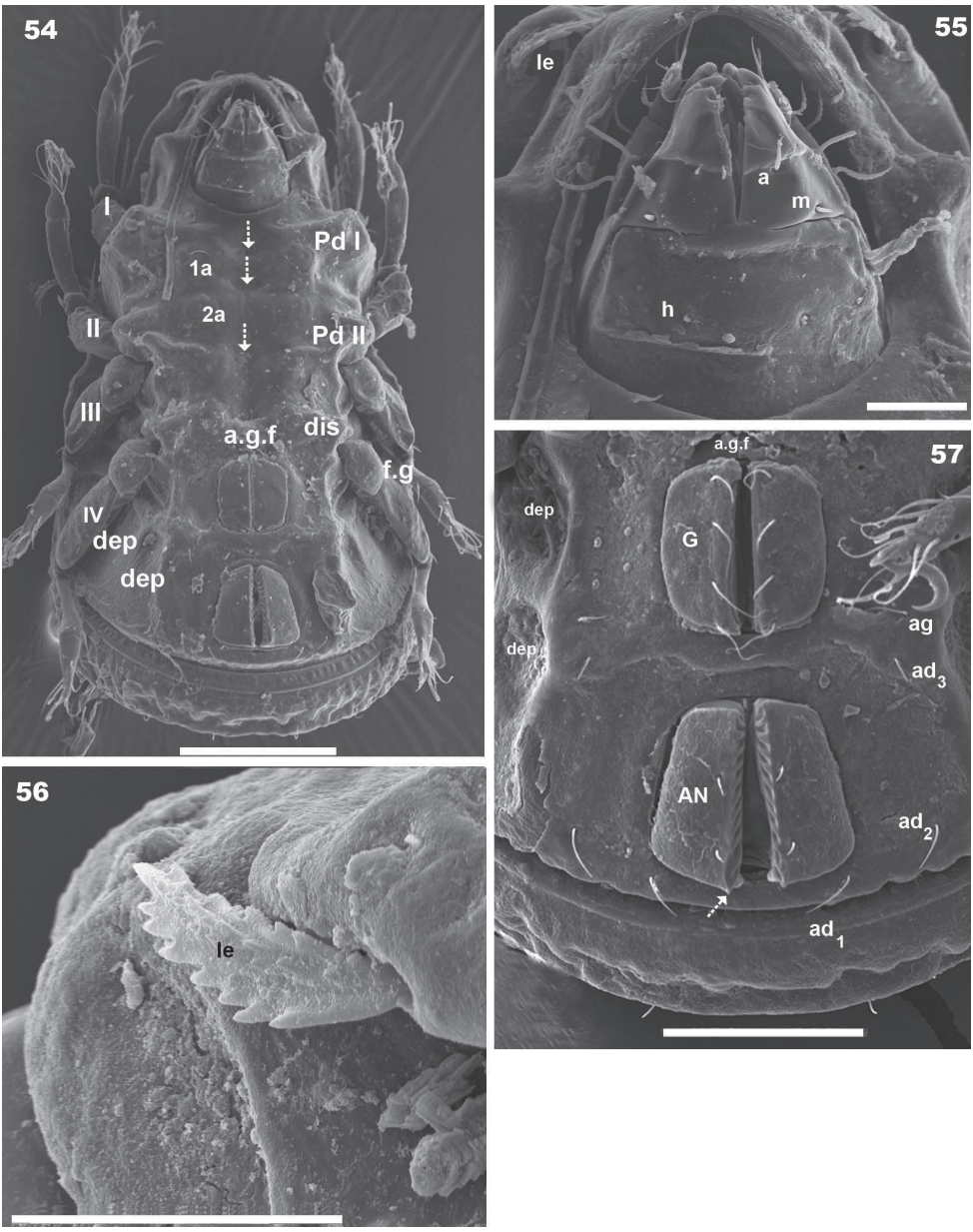
Figures 46–47. *Machadocepheus rachii* sp. n., adult female. SEM observations. **46** lateral view (2) **47** inclined lateral view (1). Abbreviations: see "Material and methods". Scale bar: **46–47** = 100 μm.

visible in frontal view (Figures 42, 44), situated in medial zone, inserted posterior to insertion level of *le*; rounded structure between *ro* setae, probably vestigial superior cornea of naso *cso* (Figures 42, 44); *bo* cup-shaped, *bo.ri* smooth; bothdial tooth present (Figures 46, 51). *Si* uncinate, upturned (Figures 46, 51); *le* setae situated ventrally on apical zone of lamellae (Figures 42, 44, 56).



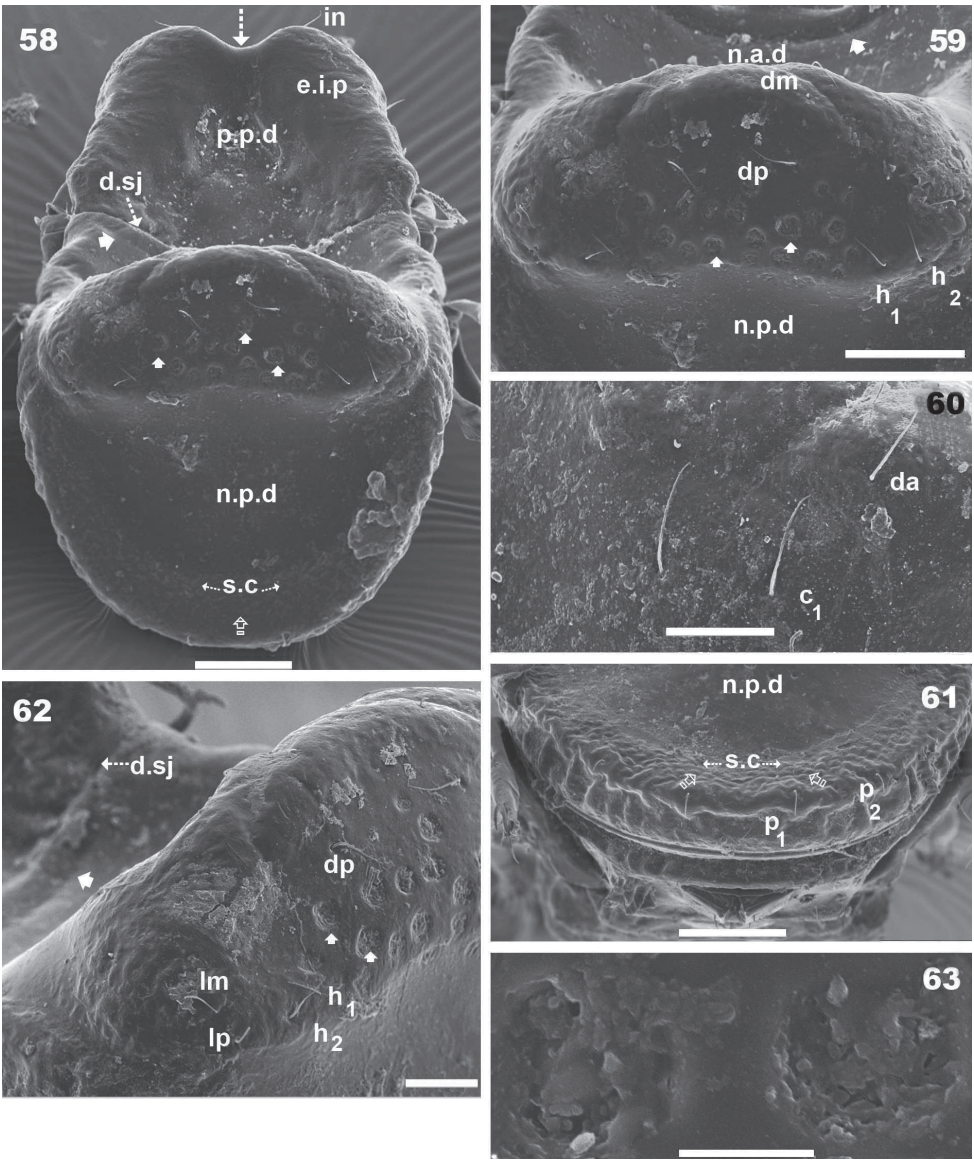
Figures 48–53. *Machadocepheus rachii* sp. n., adult female. SEM observations. **48** elevated notogastral zone (1) **49** tegument (1) **50** palp (1) **51** bothridia (1) **52** promontory with *da* setae (1) **53** elevated lateral notogastral zone (1). Abbreviations: see "Material and methods". Scale bar: **48** = 40 μm; **49, 51** = 5 μm; **50, 52** = 10 μm; **52; 53** = 50 μm.

Rostral margin slightly rectangular to hexagonal (Figures 42, 44). Lamellae running dorso laterally, lacking lamellar tip (Figures 42, 44, 56); large deep furrow (*l.l.f*) demarcating inner paraxial margin of lamellae (Figures 41, 42, 47). In frontal view (Figure 42), *l.l.f* showing a deeper medial zone. The superior cornea of naso (*cso*) clearly visible as convex elevation situated anterior to *ro* setal insertion level (Figures 42, 44).



Figures 54–57. *Machadocepheus rachii* sp. n., adult female. SEM observations. **54** ventral view (2) **55** subcapitulum, ventral view (1); **56** genito-anal zone (1) **57** lamellar tip (2). Abbreviations: see "Material and methods". Scale bar: **54** = 100 μm; **55, 56** = 20 μm; **57** = 50 μm.

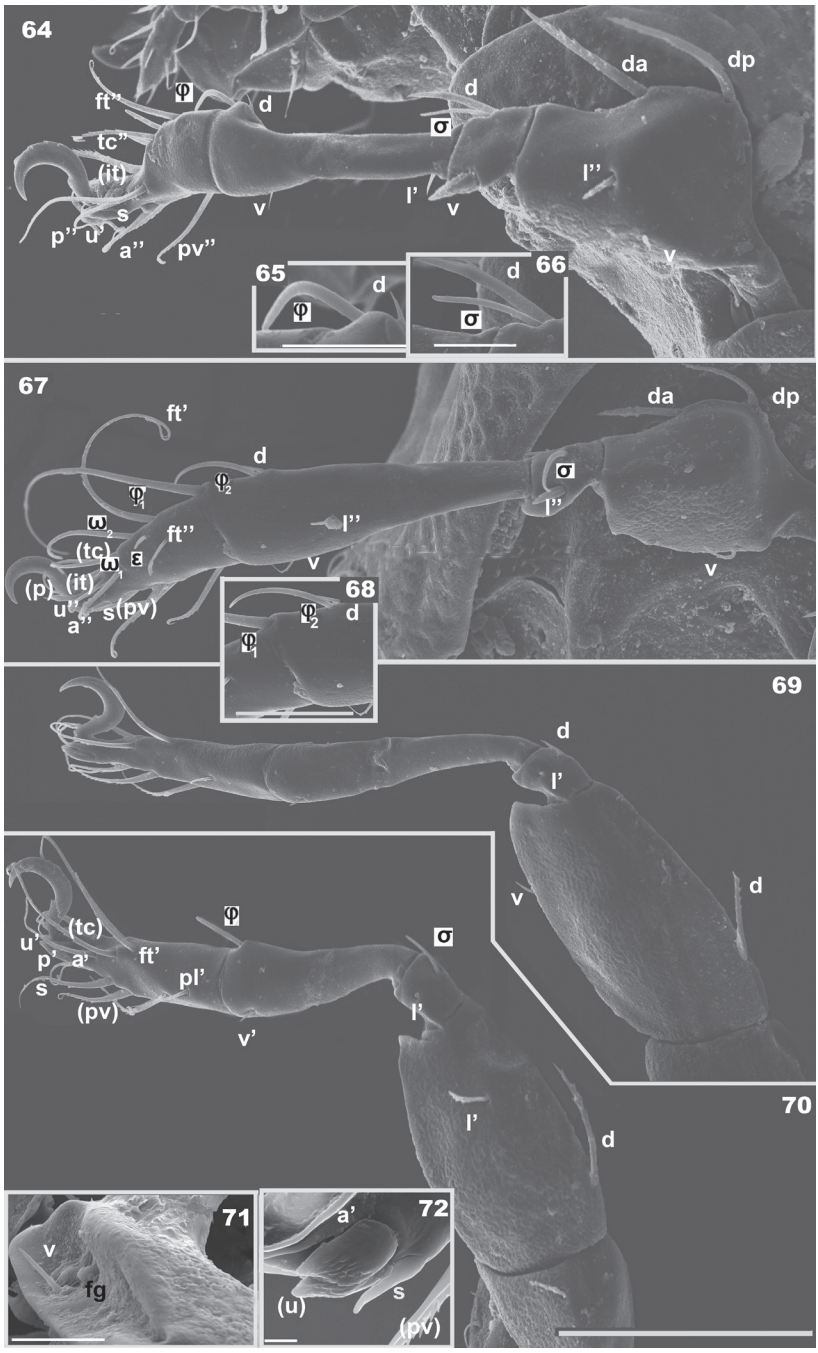
Notogaster. Shape: dorsal view, anterior part rectangular and posterior part oval (Figures 38, 41, 58); in lateral view, anterior part rectilinear, with clearly concave medial zone and rectilinear exteriorly, rest triangular to polyhedral with some irregularities and unremarkable promontories (Figures 40, 46, 47, 48, 53); *d.sj* narrow, rectilinear,



Figures 58–63. *Machadocepheus rachii* sp. n., adult female. SEM observations. **58** posterior view (2) **59** notogastral elevated zone; dorsoposterior view (2) **60** notogaster, zone insertion *c* and *d* (2) **61** notogastral posterior zone; posterior view (2) **62** notogastral elevated zone, posterolateral view (2) **63** notogastral ornamentations (2). Abbreviations: see "Material and methods". Scale bar: **58, 59, 61** = 50 μm; **60, 62** = 20 μm; **63** = 5 μm.

hardly discernible (Figures 41, 47); notogastral anterior depression (*n.a.d*), ovoid and conspicuous.

Fifteen pairs (holotrichy unideficient) of notogastral setae: c_1, c_2, c_3, *da*, *dm*, *dp*, *la*, *lm*, *lp*, h_1, h_2, h_3, p_1, p_2, p_3.



Figures 64–72. *Machadocepheus rachii* sp. n., adult female. SEM observations. **64** leg II, antiaxial view (1) **65** solenidion φ and dorsal setae of Tibia II (1) **66** solenidion σ and dorsal seta of genu II (1) **67** leg I, antiaxial view (1) **68** solenidion φ_2 and dorsal setae of Tibia II (1) **69** leg IV, antiaxial view(1) **70** leg III antiaxial view (1) **71** femoral groove, femur leg III (2) **72** apical zone, tarsus III (1). Abbreviations: see "Material and methods". Scale bars: **64, 67, 69, 70** = 50 μm; **65, 66, 71** = 10 μm; **68** = 20 μm, **72** = 2 μm.

Notogaster presenting: 1) *n.a.d* occupying anterior notogastral zone; 2) elevated zone situated in posterior third of notogaster; 3) slightly concave *n.p.d* situated posterior to elevated zone (Figures 41, 46, 47, 48); 4) slightly inclined more or less flat zone situated behind *s.c*, with irregularly elongated protuberances (Figures 41, 58, 61 indicated by ⇪); circumgastric depression (*s.c*) hardly discernible (Figures 53, 58, 61).

Simple *n.a.d* (Figures 38, 41, 47) with many hardly discernible transversally aligned parallel cuticular folds situated posterior to *d.sj* (Figures 47, 58, 59, 62 indicated by ⬆). Elevated zone presenting series of aligned flat medial promontories (three pairs, poorly developed) bearing setae *da*, *dm*, *dp* and lateral poorly developed semicircular promontories, bearing setae *la*, *lm*, *lp*, h_1, h_2.

Humeral apophysis (*h.ap*) very long, clearly visible (Figures 38, 41) but best observed in lateral view (Figures 46, 47).

Lateral region (Figures 40, 46, 47, 48). Palp clearly discernible (Figure 50), *sul*ζ (*ul*ζ), *acm*ζ; solenidium ω very long, extending to level of eupathidia. Cheliceral setae *chb* clearly visible (Figure 50).

Lamellae (*lam*) easily discernible, large, lacking sharp *la.ti*, with elevated zone at *le* insertion level (Figure 40, 46, 47, 56).

Tutorium (*tu*): rod-like curving ridge; *s.tu.d* a deep depression running between lamellae and tutorium; pocket depressions *a.tu.d*, *p.tu.d* present; another small depression situated internally to *s.tu.d* (Figure 40 indicated by ⇪).

Bothridia cup-shaped, *bo.ri* incomplete, *bo.to* present, clearly discernible (Figures, 46, 47, 51). Sensillus uncinate, arched, curving upward (Figure 45, 46, 47). Pd I: prominent extended lamina, rounded apex; Pd II: small ovoid lamina (Figures 40, 46, 47); *h.ap* long extending structure, rounded apex, basally curved; anterior tip overlapping posterior bothridial posterior part (Figures 40, 46, 47).

Notogastral promontories and setae very clearly discernible (Figures 47, 52, 53).

Only lyrifissures *ih* and *ips* clearly visible. Discidium easily discernible as polyhedral structure with rounded apex. Several depressions (*dep*) clearly discernible behind acetabulum IV; one of them elongated, concealing the tarsus during leg folding process (Figure 40).

Ventral region. Infracapitulum with setae *h*, *m*, *a* clearly visible (Figures 39, 55). Epimeres slightly elevated, delimited by shallow furrow (*bo.1*, *bo.2*, *bo.sj*). In medial zone a series of aligned depressions (Figure 54 indicated by ⇣); Apodemes (*apo.1*, *apo.2*, *apo.sj*, *apo.3*) well discernible (Figures 39). Epimeral chaetotaxy 3–1-3–3; *Pd I*, *Pd II* and *dis* well discernible; *a.g.f* clearly visible, situated anteriorly to genital plate (Figures 39, 54). Genital plate small relative to anal plate (Figures 54, 57); four pairs of long genital setae (Figure 57); anal plate with two pairs of small but clearly discernible setae; plate terminating in small sharp tip (Figure 57, indicated by ⇡); *ag* and ad_3 equal in length; ad_2 and ad_1 situated laterally at level of posterior end of anal plate (Figure 57). Lyrifissure *iad* not discernible. Particular depression behind acetabulum IV (Figure 39 indicated by ↖). Several large depressions laterally to anal and genital plates and marginally to ventral shield (Figures 39, 54, 57).

Posterior view. This view permits clarification of several aspects such as: a) shape of the *e.i.p* and large depression in the anterior medial zone (Figure 58 indicated by ↓); b) shape and depth of *p.p.d* (Figure 58); c) shape and disposition of *d.sj* (Figure 58, 62 indicated by ⇣); d) disposition of the transversal cuticular folds situated behind *d.sj* (Figures 58, 59, 62, indicated by ⬘); e) disposition, shape and distribution of setae and cuticular ornamentations on elevated notogastral zone (Figures 58, 59, 62). f) disposition of *sc* and the zone with irregularly elongated protuberances (Figures 58, 61 indicated by ⇪).

Legs (Figures 64–72). All legs monodactyle. Setal formulae I (1-4-2-4-16-1) (1-2-2) (Figure 67); II (1-4-3-2-15-1) (1-1-2) (Figure 64) III (2-3-1-2-13-1) (1-1-0) (Figure 70); IV (1-2-2-2-12-1) (0-1-0) (Figure 69).

Seta *d* of tibia I associated with φ_2 (Figure 68). Setae *d* on tibia II small (Figure 65), situated behind φ, not associated with solenidion; setae *d*, genu II (Figure 66), large, situated behind and associated with σ. Femur III with femoral groove *f.g*, difficult to observe in antiaxial view (Figure 70), but well developed, containing seta *v* (Figure 71); disposition of setae on tarsus III: (*u*), *s*, (*a*) (Figure 72) particular *s* situated anterior to (*a*). Femur IV presenting a conspicuous ventral carina (Figure 69).

Discussion

Intricate structural shapes and the need to observe specimens from various angles and positions made many structures difficult to understand when only using optical observation. Comparing these species with others from the same genus was greatly complicated by very short and superficial original descriptions, and some errors were detected in descriptions of various species of the genus *Machadocepheus* as well as in related genera (*Bathocepheus*, see Fernandez et al. 2013; *Tuberocepheus* see Fernandez et al. 2014). Much care had to be taken not to create any further confusion in the genus *Machadocepheus* and related genera, and for the reasons cited above we deemed it necessary to continue our study of a number of related genera in a series, discussed in future papers, to try to understand the existing problems.

Acknowledgements

Our gratitude to the reviewers of the manuscript for valuable comments towards improving this paper.

This work is based on research supported in part by the National Research Foundation of South Africa (UID) 85288. Any opinions, findings and conclusions or recommendations expressed are those of the authors and therefore the NRF does not accept any liability in regard thereto.

References

Alberti G, Fernandez N (1988) Fine structure of a secondarily developed eye in the fresh water moss mite, *Hydrozetez lemnae* (Coggi, 1899) (Acari: Oribatida). Protoplasma 146: 106–117. doi: 10.1007/BF01405919

Aoki J (1958) Eine neue Gattung von Carabodidae aus der Insel Hachijo, Japan (Acarina: Oribatei). Zoological Magazine (Dobutsugaku Zasshi) 67(12): 28–30.

Aoki J (1976) Oribatid mites from the IBP study area, Pasoh Forest Reserve , West Malaysia. Nature and Life in Southeast Asia 7: 39–59.

Aoki J (1978) New carabodid mites (Acari: Oribatei) from the Bonin Islands. Memoirs National Science Museum (Tokyo) 11: 81–89.

Balogh J (1958) Oribatides nouvelles de l'Afrique tropicale. Revue de Zoologie et Botanique Africaine 58(1/2): 1–34.

Balogh J (1962) Recherches sur la faune endogeé de Madagascar – VII – Oribates (Acariens) Nouveaux II. Naturaliste malgache 13: 121–151.

Balogh J (1970) New oribatids (Acari) from New Guinea II. Acta Zoologica Academiae Scientiarum Hungaricae 16(3/4): 291–344.

Balogh J, Balogh P (1992) The Oribatid mites Genera of the World Hungarian natural History Museum, 131 pp.

Balogh J, Mahunka S (1966) New oribatids (Acari) from South Africa. Acta Zoologica Academiae Scientiarium Hungarica 12(1/2): 1–23.

Balogh J, Mahunka S (1969) The scientific Results of the Hungarina Soil Zoological Expedition to South America – 10 Acari: Oribatids collected by the Second Expedition I. Acta Zoologica Hungarica 15(1/2): 1–21.

Coineau Y (1974) Eléments pour une monographie morphologique, écologique et biologique des Caeculidae (Acariens). Mémoires du Muséum National d'Histoire Naturelle 22 Zool. 81: 1–299.

Corpuz-Raros LA (1979) Philippine Oribatei (Acarina). I. Preliminary list of species and descriptions of forty new species. Philippine Agriculturist 62: 1–82.

Evans GO (1992) Principles of Acarology. CAB International, Cambridge, 563 pp.

Fernandez N, Travé J (1984) La variabilitè chaetotaxique et la néotrichie gastronotique des Hydrozetidae (Oribates). Acarologia 25(4): 407–417.

Fernandez N, Theron P, Rollard C (2013) The family Carabodidae (Acari: Oribatida) I. Description of a new genus, *Bovicarabodes* with three new species, and the redescription of *Hardybodes mirabilis* Balogh, 1970. International Journal of Acarology 39(1): 26–57. doi: 10.1080/01647954.2012.741144

Fernandez N, Theron P, Rollard C, Leiva S (2013a) Revision of the family Carabodidae (Acari: Oribatida) III. Redefinition of *Meriocepheus peregrinus* Aoki, 1973; *Bathocepheus concavus* Aoki, 1978; and *Opisthocepheus kirai* Aoki, 1976. International Journal of Acarology 39(4): 327–340. doi: 10.1080/01647954.2013.781675

Fernandez N, Theron P, Rollard C, Leiva S (2013b) The family Carabodidae (Acari: Oribatida) V. The genus *Congocepheus* (first part), with redescriptions of *Congocepheus heterotrichus* Balogh

1958, *Congocepheus orientalis* Mahunka 1987 and *Congocepheus hauseri* Mahunka 1989. International Journal Acarology 39(8): 600–614. doi: 10.1080/01647954.2013.858771

Fernandez N, Theron P, Rollard C, Tiedt L (2013) Family Carabodidae (Acari: Oribatida) V. The genus *Congocepheus* Balogh, 1958 (second part), with a redescription of *Congocepheus involutus* Mahunka, 1997, and descriptions of two new species. Zoosystema 35(4): 551–579. doi: 10.5252/z2013n4a8

Fernandez N, Theron P, Rollard C, Tiedt L (2014) Revision of the family Carabodidae (Acari: Oribatida) VI. *Mangabebodes kymatismosi* gen. n., sp. nov and *Antongilibodes paulae* gen. n., sp. n., (Acari: Oribatida; Carabodidae) from Madagascar. International Journal Acarology 40(4): 296–319. doi: 10.1080/01647954.2014.914972

Grandjean F (1949) Observation et conservation des très petits Arthropodes. Bulletin du Muséum d'Histoire Naturelle (Paris) 21(2): 363–370.

Grandjean F (1965) Complément de mon travail de 1953 sur la classification des Oribates. Acarologia 7(4): 713–734.

Krantz GW, Walter DE (2009) A Manual of Acarology. Texas Tech. University Press, Lubbock, 807 pp.

Mahunka S (1978) Neue und interessante Milben aus dem Genfer Museum XXXIV. A compendium of the Oribatid Acari fauna of Mauritius, Reunion and Seychelles Is. II. Revue Suisse Zoologie 85(2): 307–340.

Mahunka S (1985) Mites (Acari) from St. Lucia (Antilles). 2. Oribatida. Acta Zoologica Hungarica 31(1–3): 119–179.

Mahunka S (1986) A survey of the family Carabodidae, C.L. Koch, 1836 (Acari: Oribatida). Acta Zoologica Hungarica 32(1–2): 73–135.

Mahunka S (1986) Oribatids from Africa (Acari:Oribatida) III. Folia Entomologica Hungarica 47(1/2): 41–76.

Mahunka S (1987) A survey of the family Carabodidae C.L.Koch 1836 (Acari: Oribatida) II. Acta Zoologica Hungarica 33(3/4): 399–434.

Norton RA, Behan-Pelletier VM (2009) Oribatida. In: Krantz GW, Walter DE (Eds) A Manual of Acarology. Texas Tech University Press, Lubbock, Texas, 430–564. doi: 10.1007/s10493-010-9408-2

Sidorchuk EA, Norton RA (2010) Redescription of the fossil oribatid mite *Scutoribates perornatus*, with implications for systematics of Unduloribatidae (Acari: Oribatida). Zootaxa 2666: 45–67.

Subías LS (2004) (Database updated 2014) Listado sistemático, sinonímico y biogeográfico de los ácaros oribátidos (Acariformes, Oribatida) de mundo (excepto fósiles). Graellsia 60: 3–305. http://www.ucm.es/info/zoo/Artropodos/Catalogo.pdf [cited 2013 May]

Travé J, Vachon M (1975) François Grandjean 1882–1975 (notice biographique et bibliographique). Acarologia 17(1): 1–19.

ZooKeys 456: 29–47 (2014)
doi: 10.3897/zookeys.456.7741
http://zookeys.pensoft.net

RESEARCH ARTICLE

A peer-reviewed open-access journal
ZooKeys
Launched to accelerate biodiversity research

Description of *Parvocalanus leei* sp. n. (Copepoda, Calanoida, Paracalanidae) in Western Korea, with comments on the taxonomic position of *Paracalanus arabiensis* Kesarkar & Anil, 2010

Seong Yong Moon[1], Seok-Hyun Youn[1], Ho Young Soh[2]

1 *Fisheries and Ocean Information Division, National Fisheries Research and Development Institute, Busan 619-705, South Korea* **2** *Faculty of Marine Technology, Chonnam National University, Yeosu 550-749, South Korea*

Corresponding author: *Seong Yong Moon* (moonsy7744@gmail.com)

Academic editor: *D. Defaye* | Received 18 April 2014 | Accepted 1 October 2014 | Published 21 November 2014

http://zoobank.org/074C99C6-B8F9-44B9-893A-5A53CD8EFBEB

Citation: Moon SY, Youn S-H, Soh HY (2014) Description of *Parvocalanus leei* sp. n. (Copepoda, Calanoida, Paracalanidae) in Western Korea, with comments on the taxonomic position of *Paracalanus arabiensis* Kesarkar & Anil, 2010. ZooKeys 456: 29–47. doi: 10.3897/zookeys.456.7741

Abstract

A new species of paracalanid calanoid copepod *Parvocalanus leei* **sp. n.**, is described from specimens collected in shallow waters of Western Korea. The new species is closely similar to *Parvocalanus arabiensis* (Kesarkar & Anil, 2010), *P. crassirostris* (F. Dahl, 1894), *P. latus* Andronov, 1972, and *P. scotti* (Früchtl, 1923) in having two short terminal spines on the distal segment of the fifth leg and a similar rostrum in the female, but can be readily distinguished from its congeners by the body size, relative length of antennules, segmentation of endopod of leg 1, and pattern of ornamentation of spinules on legs 1 to 4 in the female. The taxonomic position of *Parvocalanus arabiensis* and the validity of the genus *Parvocalanus* Andronov, 1970 are also discussed.

Keywords

Copepoda, Calanoida, Paracalanidae, *Parvocalanus*, *Paracalanus*, new species, taxonomy, Korea

Copyright *Seong Yong Moon et al.* This is an open access article distributed under the terms of the Creative Commons Attribution License (CC BY 4.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

Introduction

Most of the species of the family Paracalanidae Giesbrecht, 1892 are distributed across both northern and southern hemispheres, with about 80 species in eight genera having been described thus far (Boxshall and Halsey 2004; Vives and Shmeleva 2007; Bradford-Grieve 2008). Six out of the eight paracalanid genera accounting 12 species have been recorded thus far in Korean waters (*Acrocalanus* Giesbrecht, 1888, *Bestiolina* Andronov, 1991, *Calocalanus* Giesbrecht, 1888, *Mecynocera* I. C. Thompson, 1888, *Paracalanus* Boeck, 1865, and *Parvocalanus* Andronov, 1970) (Yoo 1995; Soh et al. 2013). The genus *Parvocalanus* Andronov, 1970 contains six valid species (Boxshall and Halsey 2004). It is one of the major constituents of the calanoid assemblage of shallow waters worldwide (Robertson et al. 1988; Beltrão et al. 2011; Chen et al. 2011). They are generally small-sized, varying from 0.5 to 1.5 mm in body length, and play an important role as primary consumers in marine ecosystems (Araujo 2006; Lenz 2012). In Korean waters, two species of *Parvocalanus* have been reported thus far: *Parvocalanus crassirostris* (F. Dahl, 1894) (as *Paracalanus crassirostris*) (Yoo, 1995) and *Parvocalanus elegans* Andronov, 1972 (Soh et al. 2013). They share many of the characteristics of *Paracalanus* Boeck, 1865, but differ in the following features: a short, blunt rostrum; short terminal spines on the distal segment of female P5; and absence of dorsal hump in the male (Andronov 1970). These prominent features were used by Andronov (1970) to transfer *Paracalanus crassirostris*, *P. dubia*, *P. scotti*, and *P. serratipes* to the genus *Parvocalanus*. However, most of *Parvocalanus* species are difficult to identify because of their similar aspect and poor original descriptions.

During an investigation of planktonic copepods collected in shallow waters of Western Korea, we identified a new species of *Parvocalanus* which had been previously overlooked. In this study, we describe it and provide keys to all genera of Paracalanidae and species within *Parvocalanus*. Additionally, we evaluate the taxonomic position of *Paracalanus arabiensis* Kesarkar & Anil, 2010.

Materials and methods

Copepods were collected in shallow waters at Mokpo, Western Korea (Fig. 1), on 23 August 2013 with a 0.2 mm mesh-size plankton net. For morphological examination, samples were fixed in 5% natural formalin-seawater solution, and later cleared in 70% lactic acid for 1 to 2 hours before dissection in a drop of lactophenol using a wooden slide procedure (Humes and Gooding 1964). Dissected body parts and appendages were examined under a compound microscope up to × 1,000. Drawings were made with the aid of a drawing tube equipped on the microscope. Body size of individuals was measured from the head to tip of the caudal rami excluding caudal setae using a stage micrometer. Morphological terminology followed Huys and Boxshall (1991). Abbreviations used in text and figures are as follows: s, seta; ae, aesthetasc; P1–P5, legs 1 to 5, respectively. Specimens are deposited in the National Institute of Biological Resources (NIBR), Incheon, Korea.

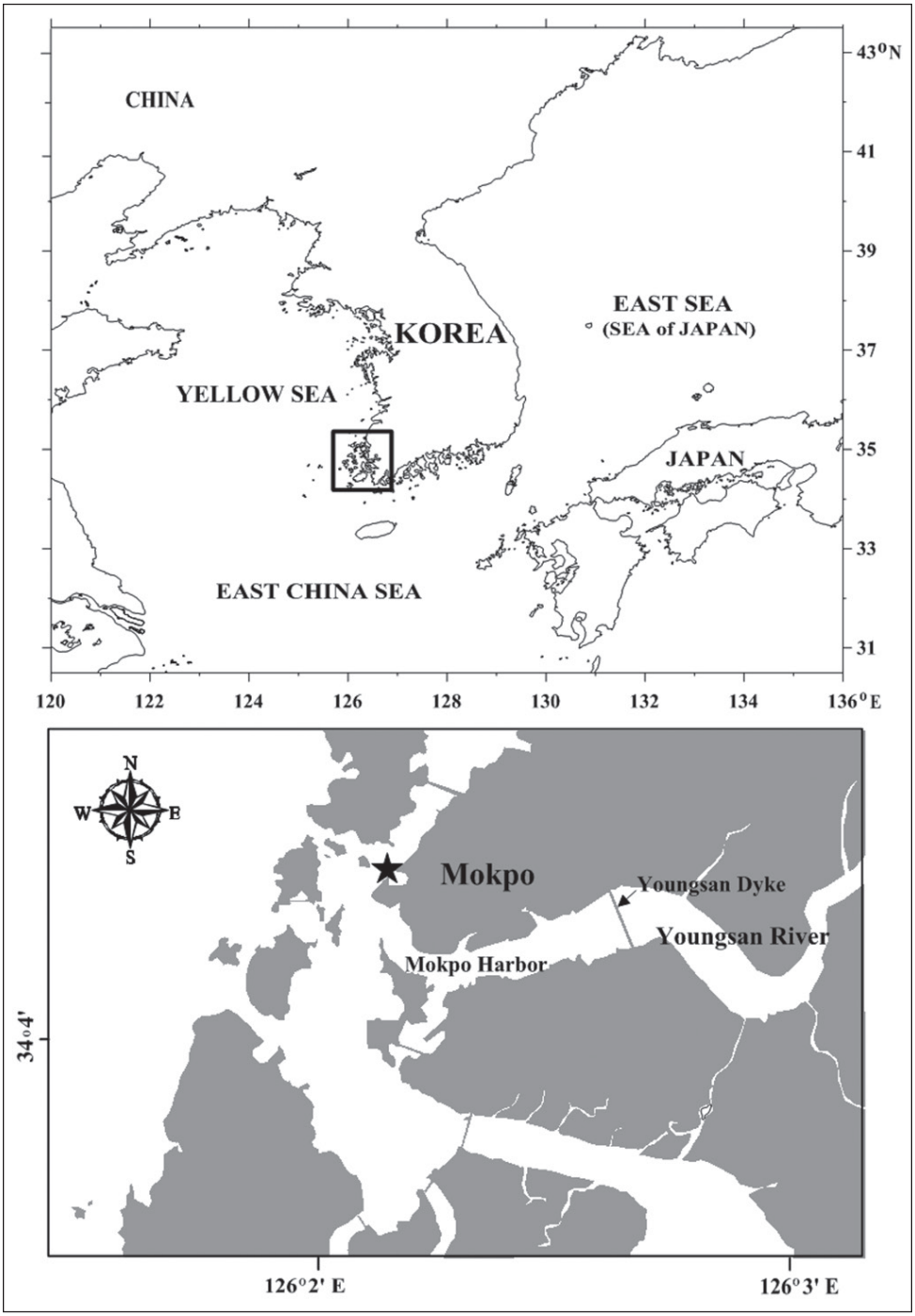


Figure 1. Map of sampling stations in the shallow waters of Mokpo, southern Korea.

Systematics

Order Calanoida G. O. Sars, 1903
Family Paracalanidae Giesbrecht, 1893
Genus *Parvocalanus* Andronov, 1970

***Parvocalanus leei* sp. n.**
http://zoobank.org/C45C228A-4E84-4E83-95F1-D2FAEE57F0D0
Figs 2–6

Type material. Adult female holotype, 0.93 mm (NIBRIV0000302101) and adult male allotype, 0.62 mm (NIBRIV0000302102) preserved undissected in 70% ethanol, collected from the Yellow Sea, Korea (34°46'10"N, 126°20'24"E). Paratypes: 20 females (NIBRIV302103) and 10 males (NIBRIV302104) preserved in 70% ethanol, 21 August 2013. Dissected paratypes (5 females, 3 males) are kept in collection of the senior author. Description below is based on paratypes.

Type locality. Shallow waters of Mokpo (34°46'10"N, 126°20'24"E), Western Korea.

Etymology. The species is named after Mrs. Jungah Lee, wife of senior author (S.Y. Moon), as a small token of appreciation for her encouragement and support to senior author.

Description. Female. (Based on female paratype). Body (Fig. 2A, B) 0.92 mm, plump. Prosome length 2.7 times as long as urosome including caudal rami, 3.6 times as long as urosome excluding caudal rami. Prosome 5-segmented: cephalosome and first pedigerous somite completely fused, 1.49 times longer (467 μm) than wide (313 μm); fourth and fifth pedigerous somites completely separated (Fig. 2A, B). Proportional length (%) of prosomites as 68.2:11.6:10.4:5.5:4.3=100. Rostrum (Fig. 3A) short, broad, about 23 μm long. Urosome 4-segmented (Figs 2A, B, 3B): genital double-somite symmetrical, swollen anterolaterally, 1.12 times wider (81 μm) than long (72 μm); genital system remarkably symmetrical with paired gonopores located each side, genital operculum (Fig. 3C) located midventrally, rounded, about one-third as long as genital double-somite. Caudal rami (Figs 2A, B, 3B) nearly symmetrical, 2.4 times longer (66 μm) than wide (27 μm), each with row of hairs on anterior inner margin and 5 caudal setae: seta II and VI spiniform; III, IV, and VII setiform and plumose. Proportional length (%) of urosomites and caudal rami as 28.3:9.5:10.4: 27.2: 24.6 = 100.

Antennule 25-segmented (Fig. 2C); extending to midlength of anal somite; ancestral segments II to IV and XXVII-XXVIII completely fused. Segmentation and setation pattern as follows: I-2s + 1ae, II-IV – 4s + 1ae, V – 1s + 1ae, VI – 1s, VII – 1s + 1ae, VIII – 1s, IX – 1s + 1ae, X – 1 spine + 1s, XI – 1s + 1ae, XII – 1s + 1ae, XIII – 1s, XIV – 1 spine+ 1ae, XV – 1s, XVI – 1s + 1ae, XVII – 1s, XVIII – 1s + 1ae, XIX – 1s + 1ae, XX – 1s, XXI – 1s + 1ae, XXII – 1s + 1ae, XXIII – 1s, XXIV – 1s + 1s, XXV – 1s + 1s, XXVI – 1s + 1s, XXVII-XXVIII – 5s + 1ae. Ancestral segments I to XXV with row of spinules on posterior surface. Ancestral segment X and XIV with short spiniform process on distal margin of dorsal surface.

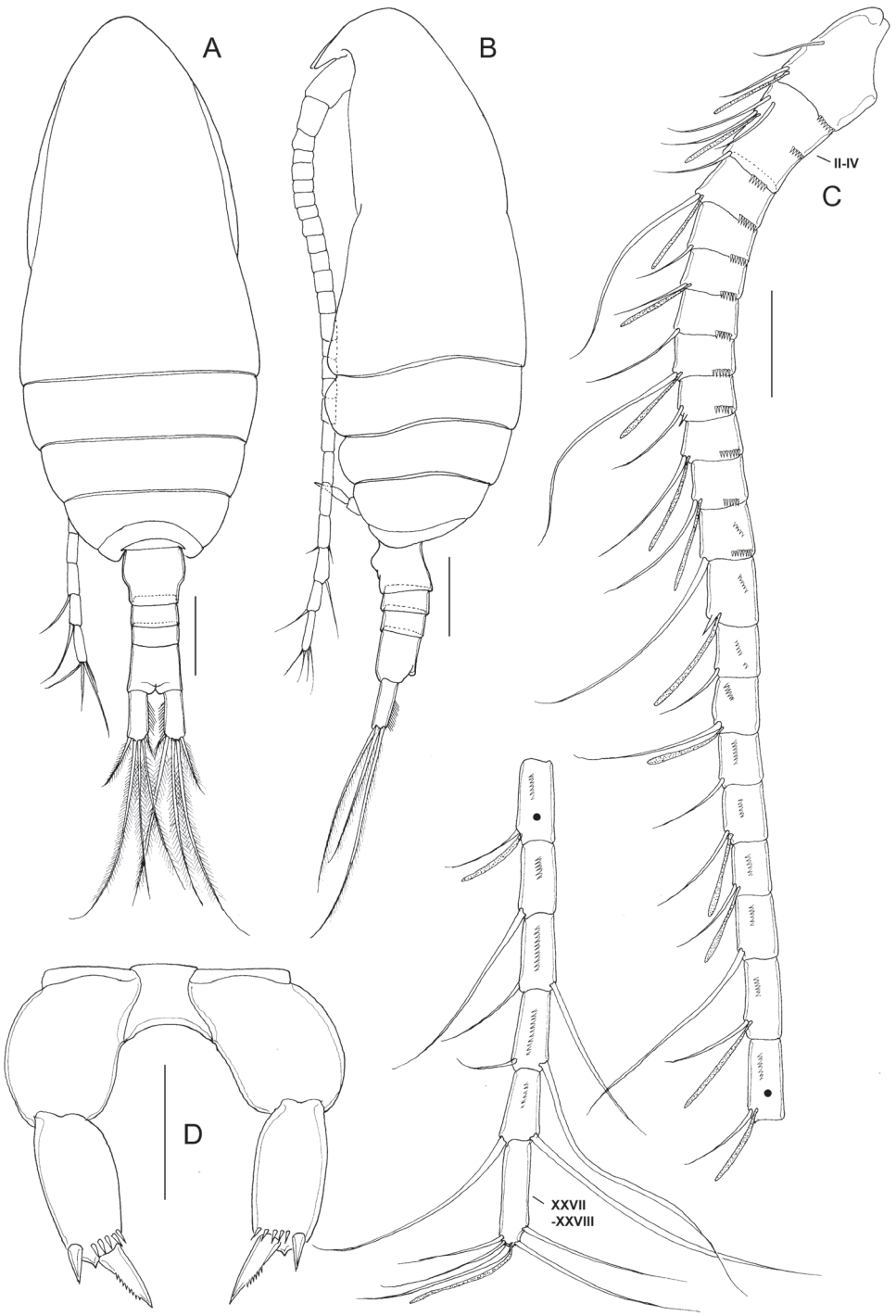


Figure 2. *Parvocalanus leei* sp. n., paratype adult female. **A** habitus, dorsal view **B** habitus, lateral view **C** Antennule **D** P5. Scale bars: **A, B** = 0.1 mm; **C** = 0.05 mm; **D** = 0.025 mm.

Antenna (Fig. 3D) biramous; coxa with two setae; basis with single seta; endopod 2-segmented, first endopodal segment with 2 setae; second endopodal segment with 8 setae about midway of inner margin, 7 setae terminally, and oblique row of tiny spinules midway and subdistally on outer margin; exopod 7-segmented, setal formula 1, 3, 1, 1, 1, 1, 4.

Mandible (Fig. 3E, F): gnathobase well developed, cutting edge with short teeth and dorsal single seta (Fig. 3F). Mandibular palp biramous; basis with 4 setae; exopod 5-segmented, setal formula 1, 1, 1, 1, 2; endopod 2-segmented, proximal and distal segments with 4 and 11 setae, respectively; oblique row of tiny spinules subterminally on distal segment.

Maxillule (Fig. 3G): praecoxa and coxa partially fused; praecoxal arthrite with 14 elements, and with several rows of spinules on anterior surface; coxal endite with 3 setae, coxal epipodite with 9 setae; proximal basal endite with 3 setae, distal basal endite with 4 setae; endopod 3-segmented, setal formula 3, 3, 7; exopod unsegmented with 11 marginal setae.

Maxilla (Fig. 3H): precoxa and coxa completely fused, each with two endites, posteromedial surface furnished with setules; proximal praecoxal endite with 6 setae, distal endite with 3 setae; coxal endites each with 3 setae; coxal epipodite seta present; basis with 4 setae and row of spinules subterminally; endopod 4-segmented, first and second segments incompletely separated with setal formula of 1, 2, 2, 3.

Maxilliped (Fig. 4A): syncoxa robust with setal formula 1, 2, 3, 4 and oblique rows of spinules on anterior surface; basis with 3 setae and setules on medial surface; endopod 6-segmented, first and second segments completely separated with setal formula 2, 3, 4, 3, 3+1, 4.

P1 (Fig. 4B): coxa with spinules anterolaterally and subterminally; basis with inner seta; exopod 3-segmented, first to third exopodal segments with spinules subterminally and terminally; endopod unsegmented, with row of spinules anteriomedially.

P2 (Fig. 4C): coxa with spinules on posterior magin; basis unadorned; exopod 3-segmented, first and second segments with row of spinules on anterodistally, third exopodal segment with denticles on outer proximal edge; endopod 3-segmented, first segment smooth; second segment with spinules anterodorsally and posterodistally; third endopodal segment with row of spinules posterolaterally.

P3 (Fig. 4D): coxa with spinules posteromedially; basis unadorned; exopod 3-segmented, first segment smooth; second segment with row of spinules anterodistally and posterodistally; third exopodal segment with denticles on outer proximal edge and spinules on anterior margin; endopod 3-segmented, first segment smooth; second segment with spinules anterodorsally and posterodistally; third endopodal segment with row of spinules anterolaterally.

P4 (Fig. 4E): basis unadorned; exopod 3-segmented, first segment with row of spinules posterodistally; spinules absent on anterior margin of third exopodal segment; endopod 3-segmented, first segment smooth; second segment with spinules posterodistally; third endopodal segment with row of spinules anteromedially.

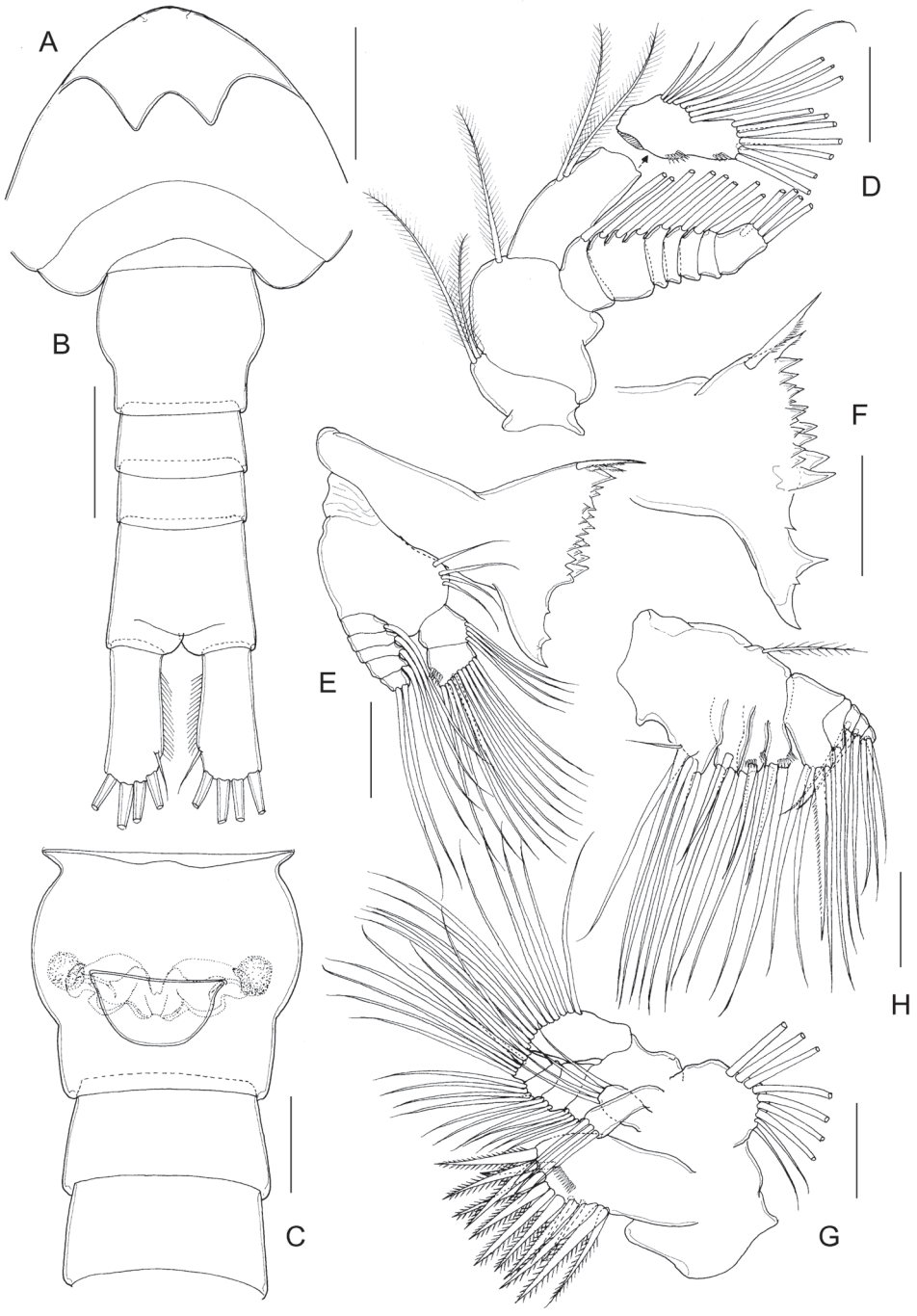


Figure 3. *Parvocalanus leei* sp. n., paratype adult female. **A** rostrum, ventral view **B** urosome, dorsal view **C** genital double-somite, ventral view **D** antenna **E** mandible **F** mandibular palp **G** maxillule. Scale bars: **A**–**C** = 0.05 mm; **D**–**G** = 0.025 mm.

Armature formula of swimming legs 1–4 (P1–P4) as follows (Roman numerals indicate spines, Arabic numerals indicate setae):

Legs	Coxa	Basis	Exopod segment	Endopod segment
P1	0-0	0-1	0-1;0-1;II,I,4	1,2,3
P2	0-1	0-0	I-1;I-1;II,I,5	0-1;0-2;2,2,3
P3	0-1	0-0	I-1;I-1;II,I,5	0-1;0-2;2,2,3
P4	0-1	0-0	I-1;I-1;II,I,5	0-1;0-2;2,2,3

P5 (Fig. 2D) 2-segmented, proximal segment smooth, unarmed; distal segment 2.15 times as long (31 μm) as wide (14 μm) with row of spinules subdistally and with two unequal terminal spines, inner distal spine longest, denticulated along distal part of outer margin.

Male. (Based on male paratype): Body (Fig. 5A, B) 0.53 mm, plumper than female. Prosome length 2.6 times as long as urosome including caudal rami. Prosome 5-segmented: cephalosome without dorsal hump and first pedigerous somite completely fused, 1.31 times longer (281 μm) than wide (213 μm); fourth and fifth pedigerous somites completely separated (Fig. 5A, B). Proportional length (%) of prosomites 60.5:13.5:13.5:12.5=100. Rostrum as in female. Urosome 5-segmented; first urosomal somite longest; proportional length (%) of urosomites 25.2: 20.3: 16.6: 14.6: 23.3=100. Caudal rami nearly symmetrical, about 2.2 times longer than wide, each with 5 setae, setae I and II wanting.

Antennule (Fig. 5C) 19-segmented, extending to distal part of third urosomite; ancestral segments I-IV, V-VIII, IX-X, XI-XII, and XXVII-XXVIII completely fused. Segmentation and setation as follows: segment 1 (fused ancestral segments I-IV), 7s+5ae; segment 2 (fused V-VIII), 3s+7ae; segment 3 (fused IX-X), 1s+1 spine+1ae; segment 4 (fused XI-XII), 1s+ 2ae; segments 5 (XIII) and 6 (XIV), 1s+1ae each; segment 7 (XV), naked; segment 8 (XVI), 1s+1ae; segment 9 (XVII), naked; segment 10 (XVIII), 1s+1ae; segment 11 (XIX), naked; segment 12 (XX), 1s+1ae; segment 13 (XXI), 1s; segment 14 (XXII), 1s+1ae; segment 15 (XXIII), 1s+1ae; segment 16 (XXIV) 1s+1s; segment 17 (XXV), 1s+1s+1ae; segment 18 (XXVI), 1s+1ae; segment 19 (XXVII-XXVIII), 5s+1ae.

Antenna (Fig. 5D) biramous but vestigial; coxa and basis completely fused, both unarmed; endopod 2-segmented, proximal endopodal segment naked; distal segment with 5 setae about midway of inner margin and with 6 terminal setae; exopod 5-segmented, setal formula 0, 1, 1, 1, 2.

Mandible (Fig. 5E) coxal gnathobase lacking; basis unarmed; exopod 5-segmented, setal formula 1, 1, 1, 1, 2; endopod 2-segmented, first endopodal segment with single seta, second endopodal segment with 8 setae.

Maxillule (Fig. 5F) vestigial presumed coxal epipodite with 5 setae.

Maxilla (not figured) vestigial.

Maxilliped (Fig. 5G): comprising robust syncoxa, basis, and 3-segmented endopod; syncoxa with a single seta and row of tiny spinules on inner distal edge; basis medially with single stout seta; proximal endopodal segment with 6 setae, of which distal seta robust; second segment with single seta; distal segment with 3 setae.

Swimming legs seta and spine formula and ornamentation (Fig. 6A–D) generally as in female, but with some differences, as follows: P1 (Fig. 6A) lacks posterior spinules on coxa, the basis and endopod are unadorned, and the third exopodal segment lacks of row of spinules on posterior surface; P2 (Fig. 6B) has the second and distal endopodal segments with denticles on outer edge; distal endopodal segment without row of spinules on mediolateral margin; P3 (Fig. 6C) has the second and distal endopodal segments with denticles on outer edge; second exopodal segment without row of spinules on the posterodistal margin; and P4 (Fig. 6D) has the second and distal endopodal segments with denticles on outer edge; and first exopodal segment without row of spinules on the anterodistal margin.

P5 (Fig. 6E) strongly asymmetrical and uniramous: right P5 5-segmented and longer than second urosomal segment; basis and first exopodal segment unarmed; second exopodal segment with pointed process on distomedial angle; distal segment with two pointed processes, inner tiny. Left leg 3-segmented; distal segment with tiny outer apical spine, inner apical spine long, 9 times as long as outer spine.

Variation. Body length ranged from 0.75–0.92 mm (mean±sd, 0.84±0.05, *N*=10) in females and 0.49–0.69 mm (mean±sd, 0.55±0.07, *N*=6) in males. Variability was found in number of spinules on posterior surface of P1–P4 in both sexes, on posterodistal margin of female P5, on the length/width ratio of second segment of female P5 (2.15–2.54 times as long as wide; mean±sd; 2.31±0.12, *N*=5), and on ornamentation of denticles on the second and distal exopodal segments of P2–P4 in female.

Distribution. *Parvocalanus leei* sp. n. generally occurred together with other paracalanids, such as *Bestiolina coreana* Moon, Lee & Soh, 2010, *Parvocalanus crassirostris*, and *Paracalanus parvus* s. l. at the collection sites in the Yellow Sea, Korea on 21 August 2013. This new species is predominantly found in shallow waters with temperature above approximately 20 °C and 32 psu in the Mokpo Harbor, Western Korea.

Remarks. The adult female of *Parvocalanus leei* sp. n. is very similar to *P. arabiensis* (Kesarkar & Anil, 2010), *P. crassirostris*, *P. latus* Andronov, 1972, and *P. scotti* (Früchtl, 1923). All them share the short and blunt rostrum and the elongate distal segment of P5, with the inner terminal spine less than three times the length of the outer terminal spine. Nevertheless, the new species differs from *P. arabiensis* as follows: (1) the body length is higher than 0.7 mm in the new species, but less than 0.7 mm in *P. arabiensis*; (2) the antennule extends up to the medial margin of third urosomite in the new species, but only to the posterior margin of genital double-somite in *P. arabiensis*; (3) the endopod of P1 is unsegmented in the new species, but 2-segmented in *P. arabiensis*; (4) the inner spine of P5 is less than 1.7 times longer than outer terminal spine of P5 in the new species, but more than 1.7 times longer than in *P. arabiensis*; and (5) there is no ornamentation of denticles on the distal edge of the third exopodal segment of P4 in the new species, vs. denticles present in *P. arabiensis*.

The female of *Parvocalanus leei* closely resembles *P. crassirostris*, but is larger (more than 0.7 mm in length compared to less than 0.7 mm); the fourth and fifth pedigerous somites are separated (vs. partially fused in *P. crassirostris*); the antennules extend to the medial margin of anal somite (vs. approximately to second urosomite in *P. crassirostris*);

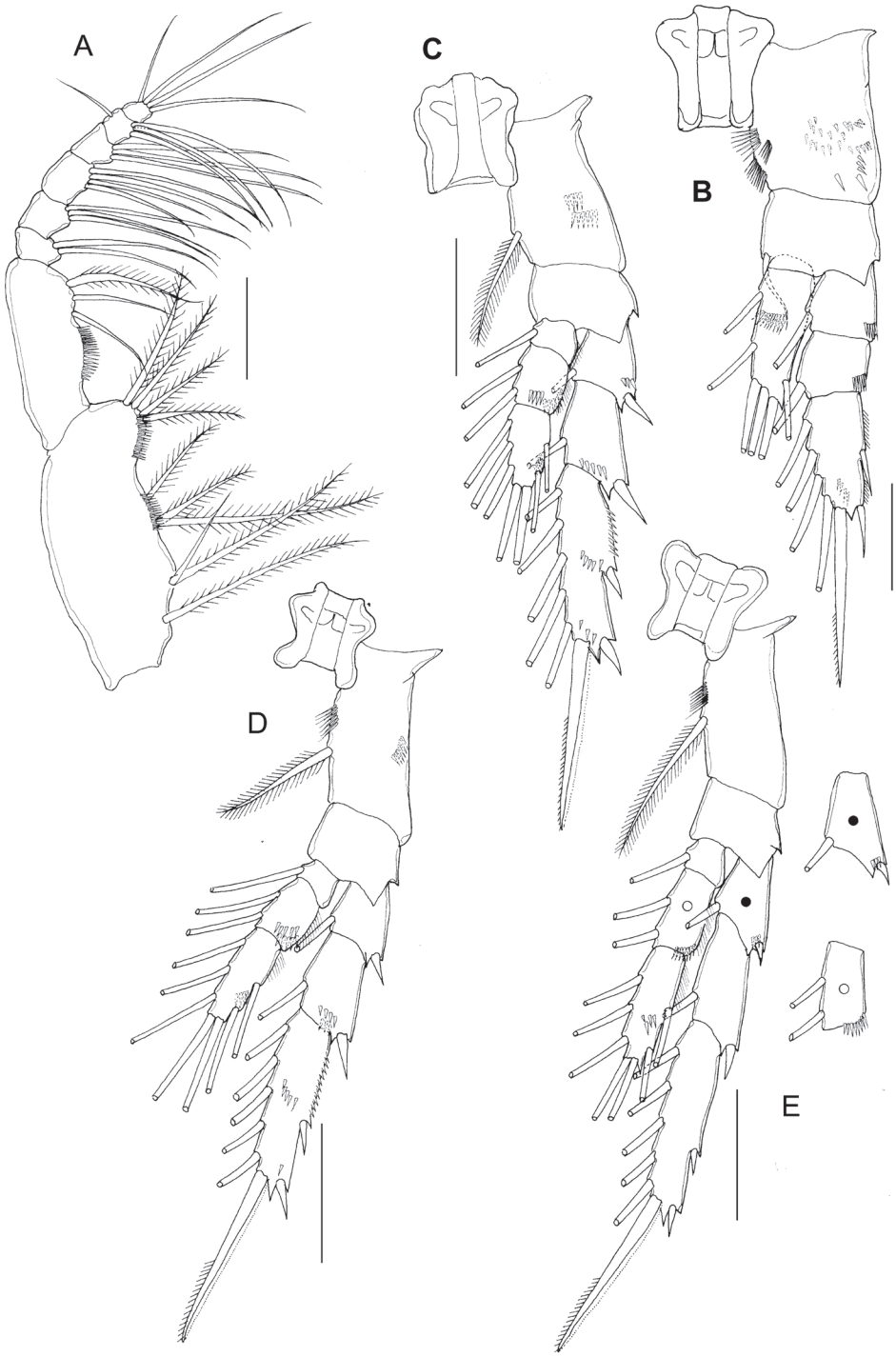


Figure 4. *Parvocalanus leei* sp. n., paratype adult female. **A** maxilliped **B** leg 1, dorsal view **C** leg 2, dorsal view **D** leg 3, dorsal view **E** leg 4, dorsal view. All scale bars 0.05 mm.

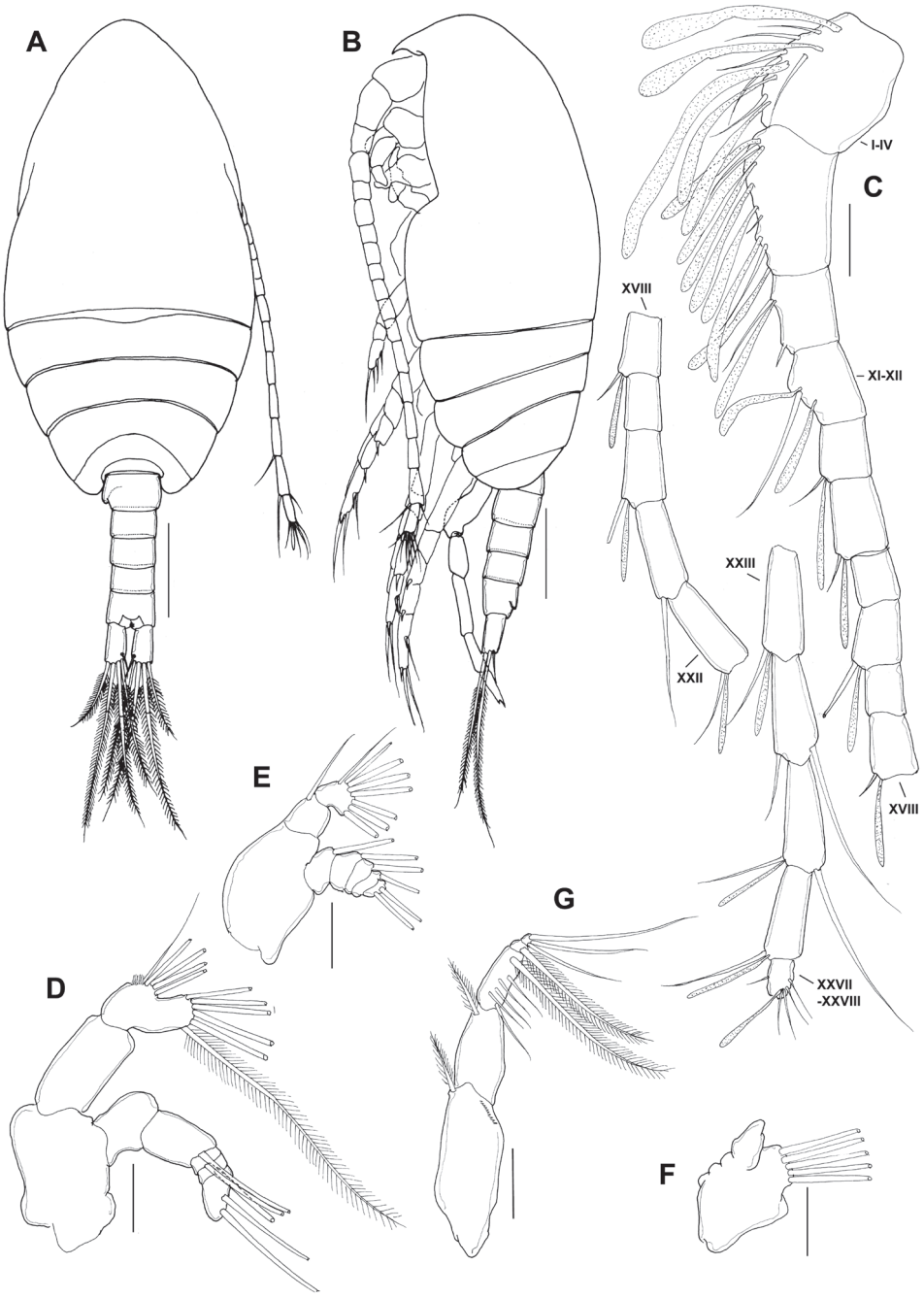


Figure 5. *Parvocalanus leei* sp. n., paratype adult male. **A** habitus, dorsal view **B** habitus, lateral view **C** antennule **D** antenna **E** mandible **F** maxillule **G** maxilliped. Scale bars: **A**, **B** = 0.1 mm; **C**–**G** = 0.025 mm.

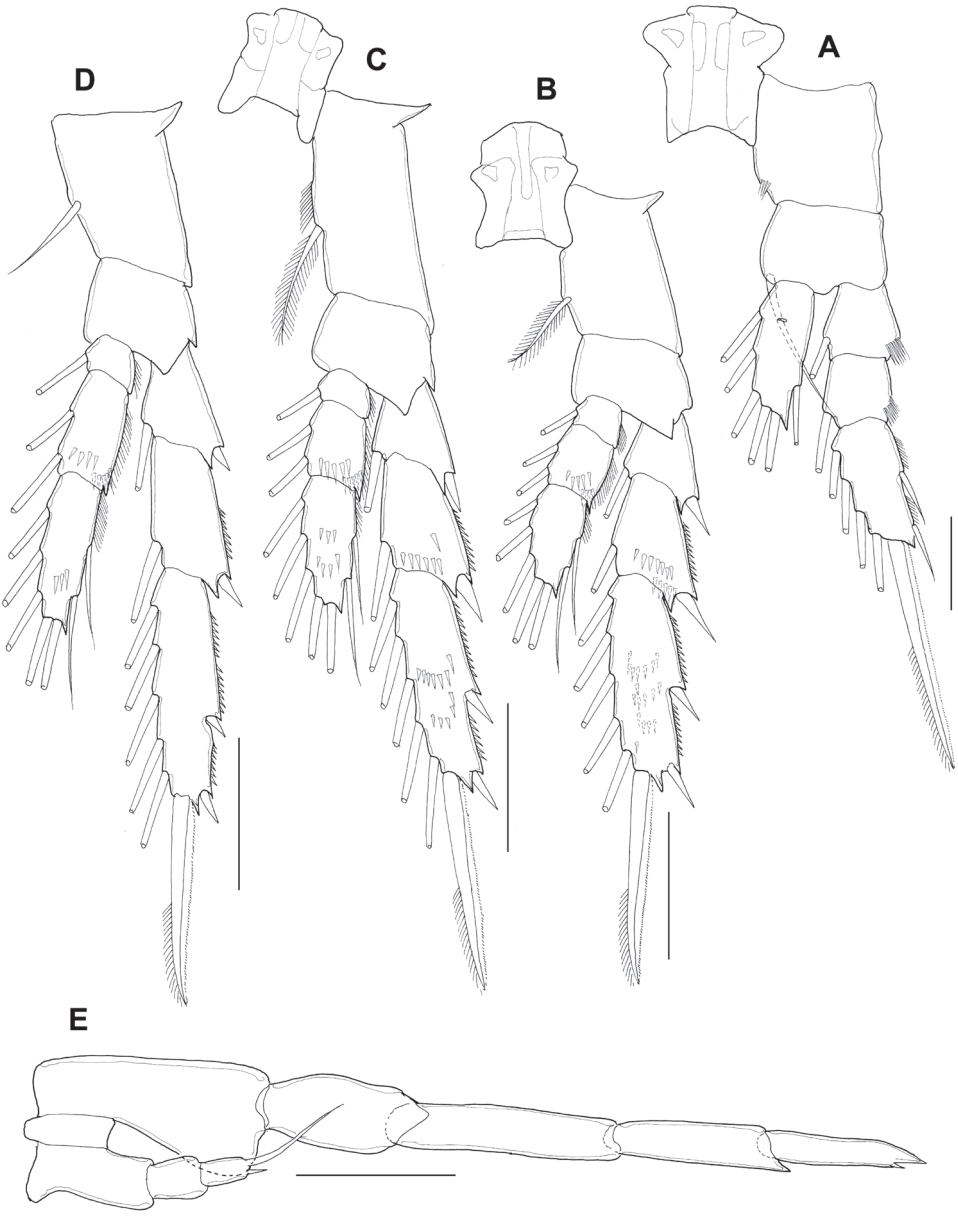


Figure 6. *Parvocalanus leei* sp. n., paratype adult male. **A** Leg 1, dorsal view **B** Leg 2, dorsal view **C** Leg 3, dorsal view **D** Leg 4, dorsal view **E** Leg 5, dorsal view. All scale bars 0.05 mm.

the length/width ratio of the distal segment of P5 is lower than 2.5 (vs. more than 3 in *P. crassirostris*); and there is a row of spinules on the distal end of the second segment of P5 (vs. row absent in *P. crassirostris*).

The new species shares with *Parvocalanus latus* the similar body shape and the P5 ornamentation in the female, but differs in the following features: (1) the body is more than 0.7 mm in length (vs. less than 0.7 mm in *P. latus*); (2) the antennule is comparatively shorter, reaching only the medial margin of anal somite (vs. reaching the end of caudal rami in *P. latus*); and (3) the genital double-somite is swollen anterolaterally in the new species (vs. somite not swollen in *P. latus*).

The female of *Parvocalanus leei* can be readily differentiated from *Parvocalanus scotti* based on the following features: (1) the body is more than 0.7 mm (vs. less than 0.7 mm in *P. scotti*); (2) the antennule extends only to the medial margin of anal somite (vs. to the distal margin of caudal rami in *P. scotti*); (3) the length/width ratio of caudal rami is higher than 2 in the new species (vs. less than 2 in *P. scotti*), and (4) the length/width ratio of second segment of P5 is less than 3 (vs. more than 3 times in *P. scotti*).

Discussion

Kesarkar and Anil (2010) distinguished between *Paracalanus* Boeck, 1864 and *Parvocalanus* based on the following characteristics of the female, because all species had been previously described based only on the female: (1) basis of P1 with inner edge seta (vs. without inner edge seta in *Parvocalanus*); (2) P1 endopod 2-segmented (vs. endopod unsegmented or 2-segmented in *Parvocalanus*); and (3) second endopodal segment of P1 with 5 setae (vs. 6 setae in *Parvocalanus*). But these characteristics overlap in the two genera. Indeed, the genus *Parvocalanus* shows many similarities with *Paracalanus*, but differs in the following features: (1) rostrum short, broad and bifurcated in both sexes; (2) distal segment of P5 terminal spines short in the female; and (3) absence of a medial keel-like dorsal hump on the cephalosome of male. However, five species of *Parvocalanus* have been described and/or illustrated as having an inner seta on the basis of P1, namely: *P. arabiensis*, *P. dubia*, *P. leei* sp. n., *P. scotti*, and *P. serratipes*. A molecular phylogeny recently published discriminated the genera *Parvocalanus* and *Paracalanus* with well-supported nodes, with *Parvocalanus* placed as sister to the rest of paracalanid genera (Cornils and Blanco-Bercial 2013). But the morphological phylogeny assessed in parallel by the same authors failed to separate the two genera (Cornils and Blanco-Bercial 2013), although it should be remarked that the morphological dataset used was extremely poor due to the poorness of the original species descriptions.

Parvocalanus leei is distinguished from the rest of members of its genus based on the following characteristics of the female: fourth and fifth pedigerous somites completely separated, large size (more than 0.7 mm), and presence of spinules on the distal end of distal segment of P5. These differences are shown in Table 1. In the present study, we have re-examined the following combination of female features in order to separate species: (1) body shape and size; (2) relative length of antennule; (3) fusion of fourth and fifth pedigerous somites; (4) presence/absence of spinules on second

Table 1. Comparison of morphological characteristics of female *Parvocalanus* spp. A1, antennules; P1, swimming leg 1; P2, swimming leg 2; P4, swimming leg 4; P5, fifth leg.

Character	Swimming leg (P)	*P. arabiensis* (Kesarkar & Anil, 2010)	*P. crassirostris* (F. Dahl, 1894)	*P. dubia* (Sewell, 1912)	*P. elegans* Andronov, 1972	*P. latus* Andronov, 1972	*P. leei* sp. n.	*P. serratipes* (Sewell, 1912)	*P. scotti* (Früchtl, 1923)
Body length (mm)		0.55–0.60	0.5	0.74	0.48–0.50	0.42–0.47	0.75–0.92	1.1	0.64–0.67
Body form		Broad and short	Broad and short	Broad and short	Narrow and long	Broad and short	Broad and short	Broad and short	Broad and short
Fourth and fifth pedigerous somites		Partially fused	Partially fused	Completely fused	Separated	Separated	Separated	Completely fused	Partially fused
A1 extending to:		Almost to end of genital double-somite	Almost to second urosomite	Midlength to first urosomite	Almost to end of anal somite	Beyond caudal rami	Midlength to anal somite	Midlength to first urosomite	Beyond caudal rami
Basis of P1 inner seta		Present	X	Present	Absent	Absent	Present	Present	Present
Endopod of P1		2-segmented	X	2-segmented	Unsegmented	Unsegmented	Unsegmented	2-segmented	Unsegmented
Number of spinules on dorsal surface of first to third exopodal segments of P1–P4	P2	5, 4, 6	X	3, 0, 4	Absent	Absent	3, 5, 8	0, 4, 5	0, 5, 5
	P3	Absent	X	X	0, 6, 0	0, 6, 0	0, 4, 6	0, 4, 5	0 7, 7
	P4	Absent	X	X	Absent	Absent	Absent	Absent	0, 7, 0
Number of spinules on dorsal surface of second endopodal segment of P2–P4	P2	0, 3, 0	X	0, 4, 0	0, 3, 0	0, 3, 0	0, 4, 0	0, 6, 0	0, 4, 0
	P3	0, 7. 0	X	X	0, 4, 2	0, 4, 2	0, 5, 0	0, 4, 0	0, 6, 3
	P4	Absent	X	X	0, 3, 2	0, 3, 2	0, 0, 4	Absent	0, 4, 3
Length/width ratio of distal segment of P5		Twice as long as wide	Three times as long as wide	Four times as long as wide	Three times as long as wide	Twice as long as wide	Twice as long as wide	Four times as long as wide	Three times as long as wide
Row of spinules on distal segment of P5		Present	Absent	Present	Present	Absent	Present	Present	Present
Length ratio between inner and outer terminal spines of P5		2	< 2	= 3	3	> 3	< 2	> 2	> 2

endopodal and exopodal segments of P2 and P4; (5) presence/absence of spinules on distal end of distal segment of P5; (6) length/width ratio of second segment of P5; and (7) length ratio between inner and outer terminal spines of P5.

Parvocalanus crassirostris was originally described by F. Dahl (1894) as *Paracalanus crassirostris* from the mouth of the river Tocantins, Brazil, but the description was rather incomplete and based on the female only (see F. Dahl 1894: taf. I, figs 27 and 28). The populations of this species from estuarine and shallow waters of Korea closely resemble the Brazilian population, both having two short apical spines on the distal segment of P5, but the female of *P. leei* is larger than *P. crassirostris*, its fourth and fifth pedigerous somites are completely separated and the length/width ratio of distal segment of its P5 is lower (see Table 1). The populations of *P. crassirostris* from Japanese waters are very similar to *P. leei*, but differ in having an inner seta on the coxa of P1 in both sexes, a distal segment of female P5 devoid of a distal row of spinules, the male left P5 is 3-segmented (N=5) with the long apical spine (39 μm) 6.5 times as long as the short outer spine (6 μm), and the body is larger in both sexes (see Hiromi 1981). *Parvocalanus crassirostris* has a worldwide distribution throughout temperate and tropical regions (Razouls et al. 2005–2014) despite its morphological homogeneity. Kesarkar and Anil (2010) described the populations of this species from the Mondovi and Zuari estuaries, Goa, West coast of India, as a new species *Parvocalanus arabiensis* (Kesarkar and Anil 2010). However, these authors might have overlooked some previous morphological studies of *P. crassirostris* (Tanaka 1960; Shen and Lee 1963; Hiromi 1981; Bradford-Grieve 1994). Additionally, most of the *Parvocalanus* species were not described following modern standards and most of them need to be redescribed. Thus, the taxonomy, morphological variability and distribution of *P. crassirostris* is not well understood. These facts suggest that a more detailed research on its geographical variation in terms of morphological and molecular features is necessary for a better understanding of its evolutionary history.

Taxonomic review on *Paracalanus arabiensis* Kesarkar & Anil, 2010

Paracalanus arabiensis was originally described by Kesarkar and Anil (2010) based on 11 adult females collected from Mondovi and Zuari estuaries, Goa, west coast of India. The assignment of this taxon to *Paracalanus* was based on the examination of the literature, where figures of some of the presumed diagnostic features of the genus, such as presence of inner edge seta on basis of female P1, P1 endopod 2-segmented, and second endopodal segment of P1 with 5 setae were shown. However, it shares the generic characteristics of *Parvocalanus* (see Andronov 1970; Hiromi 1987; Boxshall and Halsey 2004). Two major differences between *P. arabiensis* and the members of *Parvocalanus* are the presence of inner seta on the basis of P1, and of a 2-segmented endopod in P1 with 5 setae on the distal segment in the former species. Since the presence or absence of inner seta on the P1 basis has been historically used to define some species

of *Parvocalanus*, we believe this feature is not relevant enough as to put this Arabian taxon in a genus different to *Parvocalanus*. We consider more appropriate to slightly modify the generic diagnosis of *Parvocalanus* to include "basis of P1 with or without inner seta" and "endopod of P1 unsegmented or 2-segmented" to accommodate *P. arabiensis* within this genus. *Parvocalanus arabiensis* (Kesarkar & Anil, 2010), comb. n. resembles *P. crassirostris* in the small body size, the short and bifurcate rostrum, ending in two acute points, and in the presence of two short terminal spines on the female P5. But they can be readily distinguished based on rostrum appearance; the relative length of terminal spines of female P5; and the presence/absence of a medial keel-like dorsal hump on the cephalosome of male.

As an update we report that *Parvocalanus* has eight nominal species including the one described herein: *P. arabiensis*, *P. crassirostris*, *P. dubia* (Sewell, 1912), *P. elegans*, *P. latus* Andronov, 1972, *P. leei* sp. n., *P. scotti*, and *P. serratipes* (Sewell, 1912). A key to all genera and species of Paracalanidae is provided below.

Key to the genera of Paracalanidae (amended from Boxshall and Halsey 2004)

1 Distal endopodal segment of P2 setal formula 1, 2, 2 ..... ***Mecynocera***
– Distal endopodal segment of P2 setal formula not 1, 2, 2 ..... **2**
2 Distal endopodal segment of P2 setal formula 1, 2, 3; female P5 reduced ... **3**
– Distal endopodal segment of P2 setal formula 2, 2, 3; female P5 not reduced **4**
3 Outer margins of second and distal exopodal segments of P2 to P4 ornamented with strong spinules; distal endopodal segment of P3 and P4 with setal formula 2, 2, 3; female P5 strongly reduced ..... ***Acrocalanus***
– Outer margins of second and distal exopodal segments of P2 to P4 lacking spinular ornamentation; distal endopodal segment of P3 and P4 with setal formula 1, 2, 3; female P5 strongly reduced to pair of rounded lobes..... ***Bestiolina***
4 Right fifth leg lacking in both sexes; outer margins of third exopodal segment of P2 to P4 lacking spinulations in female ..... ***Delibus***
– Fifth legs symmetrical in female; small right P5 present in male **5**
5 Inner seta on basis of P1 present; outer distal margin of third exopodal segment of P2 to P4 conspicuously serrated..... ***Paracalanus***
– Inner seta on basis of P1 absent or present; outer distal edges of third exopodal segment of P2 to P4 smooth in female **6**
6 Median keel-like dorsal hump present on the cephalosome of male; rostrum with slender paired filaments in both sexes; male right P5 3 or 4-segmented; female P5 3 or 4-segmented..... ***Calocalanus***
– Medial keel-like dorsal hump absent on the cephalosome of male; rostrum short and broad, bifurcate, terminating in two acute points; male right P5 4-segmented; female P5 endopod 1 or 2-segmented ..... ***Parvocalanus***

Key to the species of *Parvocalanus* (based on adult female)

1 Fourth and fifth pedigerous somites completely fused; distal segment of female P5 long and slender, approximately 4 times as long as wide, with row of spinules on distal end..... **2**

– Fourth and fifth pedigerous somites not fused; distal segment of female P5 less than 5 times as long as wide, with/without row of spinules on distal end **3**

2 Body length less than 1 mm; dorsal surface of second endopodal segment of P2 without spinulation .....***P. dubia* (Sewell, 1912)**

– Body length more than 1 mm; dorsal surface of second endopodal segment of P2 with spinulation .....***P. serratipes* (Sewell, 1912)**

3 Body narrow and long; fourth and fifth pedigerous somites completely separated ..... ***P. elegans* Andronov, 1972**

– Body broader and shorter; fourth and fifth pedigerous somites completely separated or partially fused.....**4**

4 P 1endopod 2-segmented; Al extending almost to end of genital double-somite ..... ***P. arabiensis* (Kesarkar & Anil, 2010)**

– P1 endopod unsegmented; A1 extending over to genital double-somite.....**5**

5 Inner seta on basis of P1 absent; A1 extending beyond caudal rami; inner terminal spine more than three times length of outer terminal spine..... .....***P. latus* Andronov, 1972**

– Inner seta on basis of P1 absent or present; A1 not reaching caudal rami; inner terminal spine less than three times length of outer terminal spine.....**6**

6 Inner seta on basis of P1 absent; fourth and fifth pedigerous somites partially fused; A1 extending approximately to second urosomite; row of spinules on distal segment of P5 absent ..... ***P. crassirostris* (F. Dahl, 1894)**

– Inner seta on basis of P1 present; fourth and fifth pedigerous somites partially fused or completely separated; A1 extending over to second urosomite; row of spinules on distal segment of P5 present **7**

7 Fourth and fifth pedigerous somites completely separated; A1 extending to medial margin of anal somite; dorsal surface of second exopodal segment of P4 without spinulation; length/width ratio of distal segment of P5 lower than 3..... .....***P. leei* sp. n.**

– Fourth and fifth pedigerous simites partially fused; A1 extending to beyond caudal rami; dorsal surface of second exopodal segment of P4 with spinules; length/width ratio of distal segment of P5 higher than 3..... .....***P. scotti* (Früchtl, 1923)**

Acknowledgements

We sincerely thank two anonymous reviewers for helpful comments. This research was supported by a grant from National Fisheries Research and Development Institute

(NFRDI) of the Republic of Korea (RP-2014-ME-032) and by a grant from the National Institute of Biological Resources (NIBR) funded by the Ministry of Environment (MOE) of the Republic of Korea.

References

Andronov VN (1970) Some problems of taxonomy of the family Paracalanidae (Copepoda). Zoologicheskii Zhurnal 49: 980–985. [in Russian]

Araujo HMP (2006) Distribution of Paracalanidae species (Copepoda, Crustacea) in the continental shelf off Sergipe and Alagoas states, Northeast Brazil. Brazilian Journal of Oceanography 54: 173–181. doi: 10.1590/S1679-87592006000300001

Beltrão R, Monde M, Ueda H (2011) Characteristics and regional classification of the copepod community in Ariake Bay with note on comparison with 3 decades ago. Journal of Oceanography 67: 47–58. doi: 10.1007/s10872-011-0005-8

Boxshall GA, Halsey SH (2004) An Introduction to Copepod Diversity. The Ray Society, London, 966 pp.

Bradford-Grieve JM (1994) The Marine Fauna of New Zealand: Pelagic Calanoid Copeopda: Megacalanidae, Calanidae, Paracalanidae, Mecynoceridae, Eucalanidae, Spinocalanidae, Clausocalanidae. New Zealand Oceanographic Institute Memoir 102: 1–160.

Bradford-Grieve JM (2008) *Mecynocera clausi* I.C. Thompson, 1888 (Copepoda: Calanoida) is a paracalanid. Zootaxa 1852: 59–64.

Chen M, Chen B, Harrison P, Liu H (2011) Dynamics of mesozooplankton assemblages in subtropical coastal waters of Hong Kong: A comparative study between a eutrophic estuarine and a mesotrophic coastal site. Continental Shelf Research 31: 1075–1086. doi: 10.1016/j.csr.2011.03.011

Cornils A, Blanco-Bercial L (2013) Phylogeny of the Paracalanidae Giesbrecht, 1888 (Crustacea: Copepoda: Calanoida). Molecular Phylogenetics and Evolution 69: 861–872. doi: 10.1016/j.ympev.2013.06.018

Dahl F (1894) Die Copepoden fauna des unteren Amazonas. Berichte der Naturforschenden Gesellschaft zu Freiburg 8: 10–23.

Hiromi J (1981) Three species of paracalanid copepods in the neighbouring waters of Japan. Bulletin of Plankton Society of Japan 28: 153–164.

Hiromi J (1987) Present knowledge and problems of taxonomy of the family Paracalanidae. Bulletin of the College of Agriculture and Veterinary Medicine, Nihon University 44: 147–159.

Humes AG, Gooding RU (1964) A method for studying the external anatomy of copepods. Crustaceana 6:238–240. doi: 10.1163/156854064X00650

Huys R, Boxshall GA (1991) Copepod Evolution. The Ray Society, London, 468 pp.

Kesarkar KS, Anil AC (2010) New species of Paracalanidae along the west coast of India: *Paracalanus arabiensis*. Journal of the Marine Biological Association of the United Kingdom 90: 399–408. doi: 10.1017/S002531540999049X

Lenz PH (2012) The biogeography and ecology of myelin in marine copepods. Journal of Plankton Research 34: 575–589. doi: 10.1093/plankt/fbs037

Razouls C, de Bovée F, Kouwenberg J, Desreumaux N (2005–2014) Diversity and Geographic Distribution of Marine Planktonic Copepods. http://copepodes.obs-banyuls.fr/en [accessed 2014-02-14]

Robertson AI, Dixon P, Daniel PA (1988) Zooplankton dynamics in mangrove and other nearshore habitats in tropical Australia. Marine Ecology Progress Series 43: 139–150. doi: 10.3354/meps043139

Shen C-J, Lee F-S (1963) The estuarine Copepoda of Chiekong and Zaikong Rivers, Kwangtung Province, China. Acta Zoologica Sinica 15: 571–596.

Soh HY, Moon SY, Wi JH (2013) Invertebrate fauna of Korea, vol. 21, no. 27, Marine Planktonic Copepods. Flora and Fauna of Korea Series: National Institute of Biological Resources, 151 pp.

Tanaka O (1960) Pelagic Copepoda. Biological Results of the Japanese Antarctic expedition, 10. Specil. Publs. Seto Marine Biological Laboratory, 95 pp.

Vives F, Shmeleva AA (2007) Fauna Iberica. Vol. 29. Crustacea, Copépodos Marinos I. Calanoida. Museo Nacional de Ciencias Naturales, Consejo Superior de Investigaciones Científicas. Madrid, 1152 pp.

Yoo K-I (1995) Illustrated Encyclopedia of Fauna and Flora of Korea, Vol. 35. Marine Zooplankton. Ministry of Education, Seoul, 415 pp.

ZooKeys 456: 49–57 (2014)
doi: 10.3897/zookeys.456.8598
http://zookeys.pensoft.net

RESEARCH ARTICLE

A peer-reviewed open-access journal
ZooKeys
Launched to accelerate biodiversity research

Micromyzus platycerii sp. n. (Hemiptera, Aphididae) – a new fern-feeding aphid species from Thailand

Ewa Mróz[1], Łukasz Depa[2], Taksin Artchawakom[2], Jacek Gorczyca[1]

1 *Department of Zoology, University of Silesia, Bankowa 9, 40-007 Katowice, Poland* **2** *Sakaerat Environmental Research Station, Nakhon Ratchasima Province, Wang Nam Khieo District, Thailand*

Corresponding author: *Ewa Mróz* (ewa.mroz@us.edu.pl)

Academic editor: *R. Blackman* | Received 16 September 2014 | Accepted 21 October 2014 | Published 21 November 2014

http://zoobank.org/7F2E4433-EBE5-4E97-8DCC-A44470D22FBC

Citation: Mróz E, Depa Ł, Artchawakom T, Gorczyca J (2014) *Micromyzus platycerii* sp. n. (Hemiptera, Aphididae) – a new fern-feeding aphid species from Thailand. ZooKeys 456: 49–57. doi: 10.3897/zookeys.456.8598

Abstract

A new fern-feeding aphid species, *Micromyzus platycerii*, collected in Sakaerat Research Station in Thailand, is described.

Keywords

Sakaerat Research Station, *Platycerium*, Macrosiphini

Introduction

There are approximately 66 species of fern-feeding aphids worldwide, belonging to 18 genera (Blackman and Eastop 2006). A few of them are polyphagous species more commonly found on angiosperms, but most of them are specialized on ferns. Most of these specialized genera occur in tropical and subtropical regions and their geographical ranges overlap considerably.

Among them are two very similar and probably related fern-feeding aphid genera: *Micromyzella* Eastop and *Micromyzus* van der Goot. *Micromyzella* comprises around 12 species, inhabiting mainly south-east Africa but also the Philippines and Indonesia (Remaudière and Autrique 1985). Its main morphological characteristics are 2–3 setae on first tarsal segments (including 1 sensory, peg-like seta) and, in alate females, darkly colored wing veins with the radial sector moderately curved (Blackman and

Copyright *Ewa Mróz et al.* This is an open access article distributed under the terms of the Creative Commons Attribution License (CC BY 4.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

Eastop 2006). *Micromyzus* is similar, but usually with 4 setae on the first tarsal segments (including 2 sensory peg-like setae) and, in alate females, heavily bordered wing veins and a strongly curved radial sector. It comprises about 10 species, distributed mainly in south-east Asia.

The Sakaerat Environmental Research Station (SERS) is situated on the edge of Thailand's Khorat Plateau approximately 300 km north-east of Bangkok (SERS 2014). It was created in 1977, as a site for research on dry evergreen and dry dipterocarp tropical forest (Trisurat 2010). Other vegetation types in the biosphere reserve include bamboo forests, forest plantations and grasslands. During the field studies in SERS in January 2014, samples of fern-feeding aphids were collected. Here we describe a new species of fern-feeding aphid belonging to the genus *Micromyzus*, collected recently in Sakaerat Environmental Research Station.

Material and methods

Type material

no. UŚ 28.01.A/2014, 1 apterous viviparous female, labeled: Holotype; 1 apterous and 1 alate viviparous females, labeled: Paratypes; leg. J. Gorczyca
no. UŚ 28.01.B.1/2014, 4 apterous viviparous females, labeled: Pataypes; leg. J. Gorczyca
no. UŚ 28.01.B.2/2014, 1 alate viviparous female, labeled: Paratype; leg. J. Gorczyca
Collection site: 14°29'50.4"N; 101°55'20.9"E.
Collection data: Sakaerat Research Station, Thailand; 28.01.2014;

All slides are deposited in the collection of the Department of Zoology, University of Silesia (UŚ).

Measurements and diagnostic, morphological features follow Takahashi 1925, Miyazaki 1968, Noordam 2004 and Blackman and Eastop 2006.

Descriptions

***Micromyzus platycerii* Mróz & Depa, sp. n.**
http://zoobank.org/2B599791-2ED2-4D4B-AC09-1A2E8A1AAB11

Etymology. Named after its host plant, from which it was collected: *Platycerium coronarium* (Konig) Desv.

Diagnosis. The species belongs to the genus *Micromyzus*, because its alate female has dark-bordered wing veins and strongly curved radial sector. The new species differs from other representatives of the genus *Micromyzus* (including *M. katoi sensu* Eastop 1966) by:

– longer siphunculi: 2.57–3.08 of cauda vs. less than 2.4 in *M. katoi*, *M. vandergooti*
– different ratio of VIa/VIb: apterae 3.87–4.29 (but alatae: 4.54–4.75) vs. 4.4–6.0 in *M. katoi*;

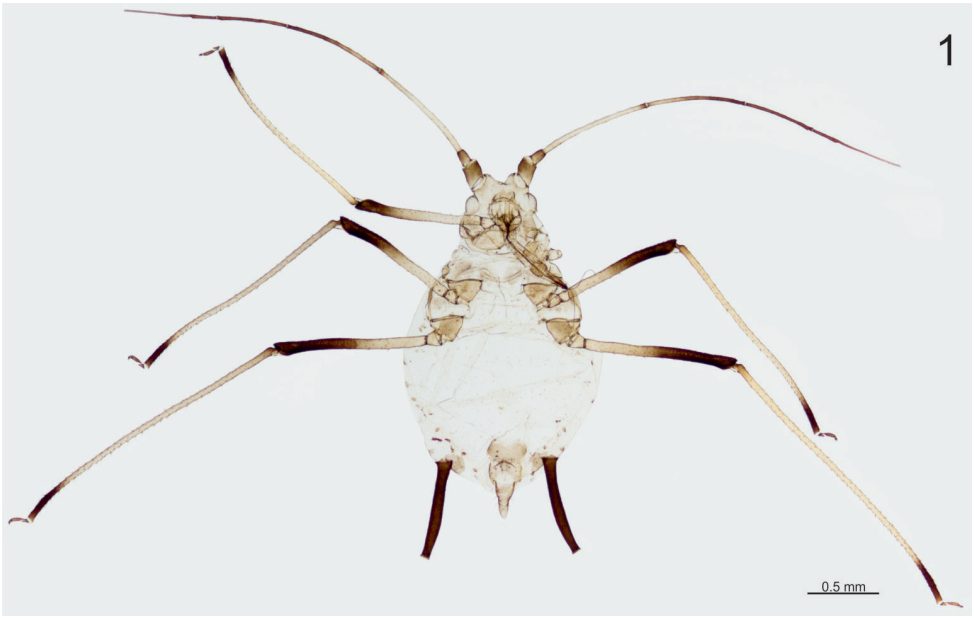


Figure 1. Microscopic slide of the holotype specimen – apterous viviparous female of *Micromyzus platycerii*.

– higher ratio of siphunculus length/diameter of siphunculus in the middle: apterae: 8.17–8.98, alatae 7.04–8.86 vs. 5–8 in *M. katoi sensu* Eastop, 1966;
– lack of dorsal sclerotisation vs. dorsal sclerotic crossbars in *M. diervillae*, *M. mawphlangensis*;
– pale cauda vs. dark cauda in *M. niger*;
– pale tibiae vs. dark tibiae in *M. osmundae*, *M. nikkoensis*;
– higher number of accessory hairs on ultimate rostral segment than in *M. pojanii*;
– lower number of secondary rhinaria on antennal segment III than in *M. hangzhouensis*.

The following key may be applied, which is a modification of the last part of the key to apterae on *Polypodium* and other fern-feeding aphids from Blackman and Eastop (2006). Using their key, *M. platycerii* will run to couplet 52, where the siph./cauda ratio is discriminatory:

52 SIPH 2.5–3.7 × cauda **53**
– SIPH 1.6–2.4 × cauda **57**
53 SIPH tapering/cylindrical, or slightly swollen subapically, at least 10 × longer than their width at midlength **54**
– SIPH slightly swollen in middle (cigar-shaped), less than 10 × longer than their width at midlength **56**
54 R IV+V 1.34–1.62 × HT II, and bearing 8–15 accessory hairs. Dorsum with extensive dark sclerotisation, not segmentally divided ..... ***Micromyzella davalliae***

–	R IV+V 0.85–1.05 × HT II, with only 2–6 accessory hairs. Dorsum pale or with broad dusky sclerotic cross bands **55**
55	R IV+V with 2 accessory hairs. Cauda much paler than SIPH, with several or all of hairs short and blunt ..... ***Micromyzella sleonensis***
–	R IV+V with 5–6 accessory hairs. Cauda dusky/dark with all hairs fine-pointed ..... ***Micromyzus pojanii***
56	R IV+V c.1.1 × HT II, with 4 accessory hairs. Dorsum mainly pale, with a fragmented spinal patch on ABD TERG 1–3 ..... ***Micromyzus mawphlangensis****
–	R IV+V 1.67–2.25 × HT II, with 8–12 accessory hairs **61**
57	HT II 0.104–0.118 mm long. R IV+V 1.05–1.24 × HT II. SIPH thin and cylindrical **58**
–	HT II 0.07–0.09 mm long. R IV+V 1.25–2.3 × HT II. SIPH rather thick, often somewhat cigar-shaped **59**
58	First tarsal segments all with 2 hairs. Cauda dark. ANT BASE VI 0.132–0.155 mm. R IV+V 0.81–0.92 × ANT BASE VI..... ***Micromyzella kathleenae***
–	First tarsal segments all with 3 hairs. Cauda pale. ANT BASE VI 0.099–0.127 mm. R IV+V 0.91–1.13 × ANT BASE VI..... ***Micromyzella sophiae***
59	R IV+V 1.7–2.3 × HT II and bearing 8–14 accessory hairs. ANT PT/BASE 4.4–6.0 ..... ***Micromyzus katoi*** **group**
–	R IV+V 1.2–1.7 × HT II and bearing 4–9 accessory hairs. ANT PT/BASE 2.5–4.6 ..... **60**
60	SIPH 1.6–2.0 × cauda. ANT III without rhinaria (?). ANT PT/BASE 2.5–3.3. First tarsal segments with 3 or 4 hairs ..... ***Micromyzus vandergooti****
–	SIPH 2.0–2.3 × cauda. ANT III usually with 1 or more rhinaria. ANT PT/BASE 3.0–4.6. First tarsal segments with 2 or 3 hairs ... ***Micromyzella filicis***
61	Dorsum uniformly dark..... ***Micromyzella pterisoides***
–	Dorsum pale, membranous..... ***Micromyzus platycerii*** **sp. n.**

Descriptions. Apterous viviparous female (Fig. 1) (measurements based on 6 specimens). Body in life brown, with reddish eyes. Body 2.16–2.68 mm long (incl. cauda), weakly pigmented. Head weakly sclerotised, with sparse and minute spicules on well developed, diverging frontal tubercles (Fig. 2). Antenna 6 segmented, 2.96–3.23 mm long, 1.20–1.26 of body length, covered with short setae, shorter than basal diameter of antennal segment III. Antennal segments I and II dusky, antennal segment III pale, with darker tip and 1- 2 secondary rhinaria on basal part, 0.68–0.81 mm long; antennal segment IV darker towards the end, 0.61–0.72 mm long; antennal segment V dark, 0.42–0.51 mm long; antennal segment VI dark, VIa: 0.17–0.19 mm, VIb: 0.74–0.77 mm, ratio VIa/VIb 3.87–4.29. Rostrum 0.71–0.82 mm long, reaching to the hind coxae, 0.28–0.34 of body length, 0.91–1.16 of the length of antennal segment III. Ultimate rostral segment 0.186–0.192 mm long, 1.81–2.00 of the second segment of hind tarsus, with 8–11 accessory setae.

Prothorax sclerotised, mesothorax with marginal and spinal sclerites, metathorax with marginal sclerites only. Mesothoracic furca not separated, weakly pigmented.

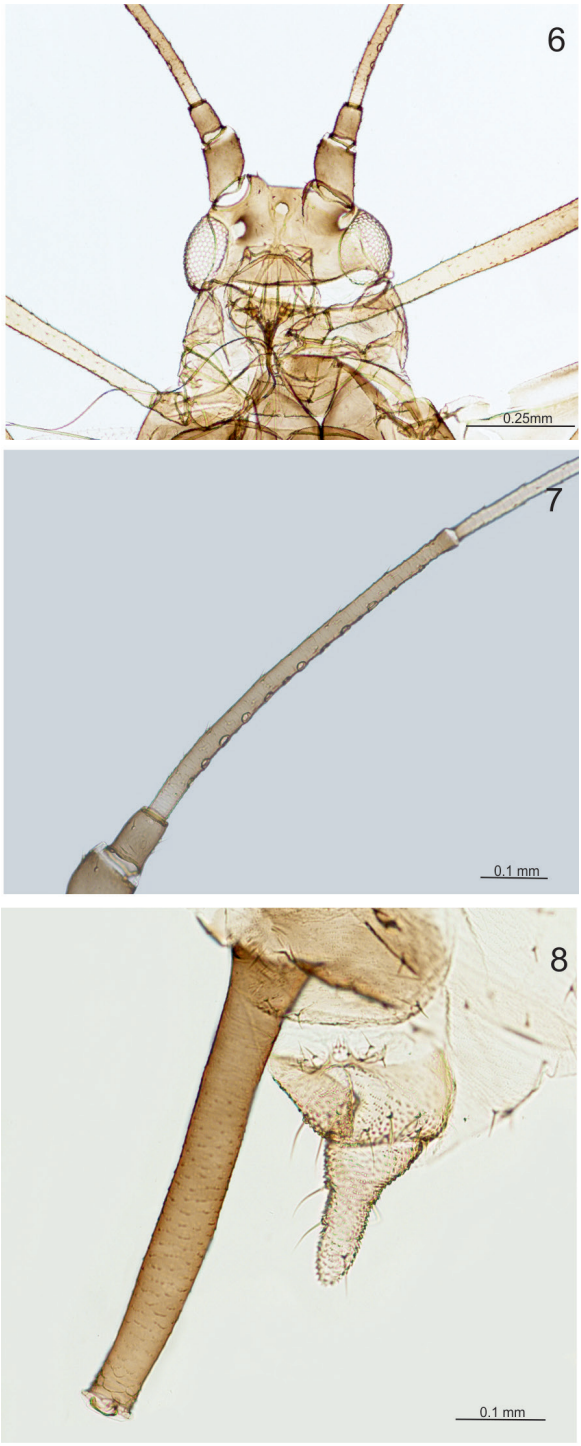
Figures 2–4. Morphological features of apterous viviparous female of *M. platycerii*: **2** head and rostrum **3** tarsus of hind leg **4** cauda and apex of siphunculus.

Figure 5. Microscopic slide of the paratype specimen – alate viviparous female of *Micromyzus platycerii*.

Legs covered by short, pointed hairs, shorter than the middle diameter of tibia. Distal half of femora dark; tibiae pale except for dark apices, tarsi black. Ventral side of each first tarsal segment with one thick, pointed, peg-like seta and two thinner setae (Fig. 3). Second segment of tarsus 0.096–0.103 mm long.

Abdomen membranous, with single, very small marginal scleroites, sometimes bearing a small marginal tubercle on abdominal tergite II or III. Small antesiphuncular and bigger postsiphuncular sclerites present. Each tergite with a row of short, pointed setae. Reniform spiracles placed at the posterior end of small scleroits. Siphunculi dark, slightly swollen in the middle, discretely imbricated, with 2–3 rows of distinct imbrications just below the apex (Fig. 4), 0.59–0.69 mm long, 2.57–2.77 of cauda. Subgenital plate broadly elliptical, 0.26–0.31 mm wide, with 2–3 longer setae on its anterior border and a row of shorter setae at its posterior border. Cauda pale, finger-shaped with broader base, 0.22–0.27 mm long, with 4–5 setae (Fig. 4).

Alate viviparous female (Fig. 5) (measurements based on 2 specimens). Body in life brown, 1.95–1.97 mm long (incl. cauda). Head sclerotised, dark and smooth, with low, divergent frontal tubercles, only delicately imbricated; covered sparsely with a few short, pointed setae (Fig. 6). Compound eyes well developed, with triommatidium. Antennae 2.63–2.69 mm long, 1.35–1.36 of body length; antennal segments I–III darker than IV–VI. Length of antennal segments: III 0.56–0.59, IV 0.55–0.56, V 0.42–0.43, VIa 0.15–0.17, VIb 0.73–0.76, ratio of VIb/VIa 4.54–4.75. Antennal segment III with 11–14 secondary rhinaria along its entire length (Fig. 7), segment



Figures 6–8. Morphological features of alate viviparous female of *M. platycerii*: **6** head **7** 3rd antennal segment **8** cauda and apex of siphunculus.

covered with setae shorter than 0.5 of its basal diameter. Rostrum 0.85–0.90 mm long, 1.43–1.59 of the length of antennal segment III, 0.43–0.46 of body length, reaching past hind coxae. Ultimate rostral segment 0.18–0.19 mm long, 2.00–2.07 of the second segment of hind tarsus, with 8–9 accessory setae.

Thorax heavily sclerotised. Wings with very dark pigmentation of veins and their borders, especially on proximal cubital vein (Fig. 2). Media of fore wing with two forks. Radial sector strongly curved. Legs dusky, with darker apices of femora and tibiae, covered with short pointed setae. Tarsi dusky, first segment with 3 setae, including one sensory peg-like seta; second segment of hind tarsus 0.09 mm long.

Abdomen membranous, with transverse rows of short, pointed setae and with marginal sclerites only. Antesiphuncular and postsiphuncular sclerites well developed. Reniform spiracles placed at the posterior end of small scleroits. Genital plate broadly oval, 0.23–0.26 mm wide, with two setae on the anterior edge and 4–6 setae on the posterior edge. Siphunculi 0.50–0.51 mm long, 2.60–3.08 of the length of cauda, clavate, slightly swollen in the middle, dusky, with 2–3 rows of distinct imbrications at the apex, just below weakly developed flange (Fig. 8). Cauda finger-shaped, pale, 0.17–0.19 mm long, with 4–5 setae.

Biology. The brown, shiny aphids were feeding on young shoots of *Platycerium coronarium*, in great numbers on the undersides of leaves.

Taxonomic comments

Micromyzus platycerii sp. n. has 3 hairs on first tarsal segments, including one peg-like, sensory seta, which is a characteristic of the genus *Micromyzella* Eastop. The key presented by Su et al. (2014) leads to undeterminable point 9, with morphological features of apterae similar to *Micromyzella*, but of alatae similar to *Micromyzus*. However, species in the genus *Micromyzus*, including *M. katoi*, also have 3 setae on first tarsal segments (Noordam 2004, Miyazaki 1968). The generic classification of the collected specimens was primarily based on the morphology of wing, which in its pigmentation and strongly curved radial sector undoubtedly puts it into the genus *Micromyzus* (Blackman and Eastop 2006). (In a key to alate morphs by Noordam (2004) it is stated that the forewings of *M. katoi* are not bordered with black, but this is evidently a typographic error, and the forewing is correctly illustrated in the same work).

Viviparous females of *Micromyzus platycerii* sp n. are morphologically very similar to *M. katoi*. Both species have a membranous abdomen, dark siphunculi, clavate in shape and with a few rows of imbrications, pale cauda with 4–5 setae and darker tips of antennal segments (Takahashi 1925). They most resemble the Australian "*Micromyzus ? katoi*" of Eastop (1966), the only discriminant character being the ratio of length to middle diameter of siphunculi, which seems to be higher in the new species. From the illustration in Eastop's work, this ratio is lower (c. 5.75) in the alate morph of the Australian *M. katoi* than in alate of the new species (7.04–8.86). Furthermore, according to Blackman and Eastop's (2006) key, apterae of *M. katoi* (including Eastop's *M. katoi*)

have a siphunculus/cauda ratio of 2.4 or less, whereas in apterae of the new species it is well above this value.

The observed differences, including the variable chaetotaxy of the first tarsal segments, put in question taxonomic relations within the *Micromyzus*/*Micromyzella* group and indicate a strong need for revision of the fern-feeding aphids of the tropical and subtropical region.

Acknowledgements

We wish to thank Dr. Roger L. Blackman for helpful comments and two anonymous referees for their valuable remarks on the manuscript.

References

Blackman RL, Eastop V (2006) Aphids on World's herbaceous plants and shrubs. Wiley, Chichester, 1439 pp. http://www.aphidsonworldsplants.info

Eastop VF (1966) A taxonomic study of Australian Aphidoidea (Homoptera). Australian Journal of Zoology 14: 399–392. doi: 10.1071/ZO9660399

Miyazaki M (1968) A revision of the fern aphids of Japan with descriptions of three new species (Homoptera: Aphididae). Insecta Matsumurana 31(3): 13–24.

Noordam D (2004) Aphids of Java – Part V – Aphidini (Homoptera: Aphididae). Zoologische Verhandelingen Leiden 346: 7–83.

Remaudière G, Autrique (1985) Contribution à l'écologie des aphides africains. Études FAO: Production Végétale et Protection des Plantes 64: 1–214.

SERS (2014) Sakaerat Environmental Research Station. MAB Biosphere Reserves Directory. http://www.unesco.org/mabdb/br/brdir/directory/biores.asp?mode=gen&code=THA+01 [accessed on 09.06.2014]

Su XM, Jiang LY, Qiao GX (2014) The fern-feeder aphids (Hemiptera: Aphididae) from China: a generic account, descriptions of one new genus, one new species, one new subspecies, and keys. Journal of Insect Science 14: 1–23. doi: 10.1093/jis/14.1.23

Takahashi R (1925) Aphididae of Formosa. Report of Government Research Institute, Department of Agriculture, Formosa, 16: 1–65.

Trisurat Y (2010) Land use and forested landscape changes at Sakaerat Environmental Research Station in Nakhon Ratchasima Province, Thailand. Ekológia (Bratislava) 29(1): 99–109. doi: 10.4149/ekol_2010_01_99

ZooKeys 456: 59–73 (2014)
doi: 10.3897/zookeys.456.8140
http://zookeys.pensoft.net

RESEARCH ARTICLE

A peer-reviewed open-access journal
ZooKeys
Launched to accelerate biodiversity research

Afrotropical Ophioninae (Hymenoptera, Ichneumonidae): an update of Gauld and Mitchell's revision, including two new species and an interactive matrix identification key

Pascal Rousse[1,2], Simon van Noort[1,3]

1 *Natural History Department, Iziko South African Museum, PO Box 61, Cape Town, 8000, South Africa* **2** *Department of Botany and Zoology, Evolutionary Genomics Group, Stellenbosch University, Private Bag X1, Stellenbosch 7602, South Africa* **3** *Department of Biological Sciences, University of Cape Town, Private Bag, Rondebosch, 7701, South Africa*

Corresponding author: *Pascal Rousse* (rousse.pascal@wanadoo.fr)

Academic editor: *G. Broad* | Received 18 June 2014 | Accepted 20 October 2014 | Published 21 November 2014

http://zoobank.org/9F75A786-090F-44B7-BA16-5DE91F34B62B

Citation: Rousse P, van Noort S (2014) Afrotropical Ophioninae (Hymenoptera, Ichneumonidae): an update of Gauld and Mitchell's revision, including two new species and an interactive matrix identification key. ZooKeys 456: 59–73. doi: 10.3897/zookeys.456.8140

Abstract

The revision of the Afrotropical Ophioninae is updated, based on the examination of about 800–900 individuals in the South African and European museum collections. A robust interactive matrix key was built to provide quick and reliable identifications. The key is available online at http://www.waspweb.org. Two new species are described: *Dicamptus maxipol* **sp. n.** and *Enicospilus gauldetmitchellorum* **sp. n.** Numerous new distribution and biological records are provided, and noticeable morphological intraspecific variations are detailed. *Enicospilus batus* Gauld & Mitchell, **syn. n.** is considered as a junior synonym of *E. luebberti* (Enderlein).

Keywords

Africa, distribution records, host records, identification keys, Madagascar, parasitoid wasp, systematics, taxonomy

Copyright *Pascal Rousse, Simon van Noort.* This is an open access article distributed under the terms of the Creative Commons Attribution License (CC BY 4.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

Introduction

The subfamily Ophioninae is one of the two major subfamilies of Ichneumonidae that have been extensively revised in the Afrotropical region. The revision of the Ophioninae is mainly due to Gauld and Mitchell (1978) where they keyed and provided detailed descriptions for the nearly 200 species they treated in the collections of the major natural history museums housing African material. They could thus emphasise the high endemism of this fauna, 98% of these species are not reported from outside of Subsaharan Africa.

It is of note that very few amendments have been brought to their work since the revision was published, except three new species descriptions (Gauld 1982; Rousse and Villemant 2012) and some phylogenetic rearrangements (Gauld 1980; Gauld 1985; Quicke et al. 2005). Meanwhile, several expeditions led by the Iziko South African Museum in southern and tropical Africa produced a large amount of new ophionine material available for investigation. Here we provide new taxonomic, biological and distribution data extracted from examination of this material. In addition to updating Gauld and Mitchell's revision, an improved key in a new matrix format is providedto simplify the identification of Ophioninae in the region.

Material and methods

Depositories

BMNH Natural History Museum, London, UK (Gavin Broad).
CASC California Academy of Science, San Fransisco, USA (Brian Fisher).
MHNR Muséum d'Histoire Naturelle de La Réunion, Saint Denis, France (Sonia Ribes).
MNHN Muséul National d'Histoire Naturelle, Paris, France (Claire Villemant).
MRAC Muséum Royal de l'Afrique Centrale, Tervueren, Belgium (Eliane de Coninck).
NMSA KwaZulu-Natal Museum, Pietermaritzburg, South Africa (Burgert Muller).
SAMC Iziko South African Museum, Cape Town, South Africa (Simon van Noort).

Photographs

Specimens were point mounted on black, acid-free card for examination (using a Leica M205C stereomicroscope with LED light source), photography and long term preservation. Images were acquired using the Leica LAS 4.4 imaging system, which comprised a Leica® Z16 microscope with a Leica DFC450 Camera with 0.63× video objective attached. The imaging process, using an automated Z-stepper, was managed using the Leica Application Suite V 4.4 software installed on a desktop computer. Lighting was achieved using techniques summarized in Buffington et al. (2005), Kerr et al. (2008) and Buffington and Gates (2009). All images presented in this paper are available at http://www.waspweb.org.

Terminology and abbreviations

The terminology follows Gauld and Mitchell (1978), but we preferred to use here the terms mesosoma and metasoma rather than alitrunk and gaster. Most morphological terms are also defined on HymaToL and HAO websites. The following morphometric abbreviations are used:

B: body length, from torulus base to apex of metasoma (mm).
F: fore wing length, from tegula base to wing apex (mm).
ML (malar line index): shortest distance between eye and mandible / basal mandibular width.
CT (clypeus transversality index): distance between outer edges of tentorial pits / median height of clypeus.
POL (post-ocellar line index): shortest distance between posterior ocelli / posterior ocellus longest diameter.
OOL (oculo-ocellar line index): shortest distance between eye and posterior ocellus / posterior ocellus longest diameter.
FI (frontal index of head, Gauld and Mitchell 1978): maximum diameter of anterior ocellus / distance between eyes through maximum diameter of anterior ocellus.
Fl_{1-2} (relative length of flagellomeres 1 and 2): length of flagellomere 1 (annellus excluded) / length of flagellomere 2.
Fl_{20} (elongation index of 20th flagellomere): length / width of flagellomere 20.
AI, CI, ICI, SDI, NI (alar indices, Gauld and Mitchell 1978): see Fig. 1.

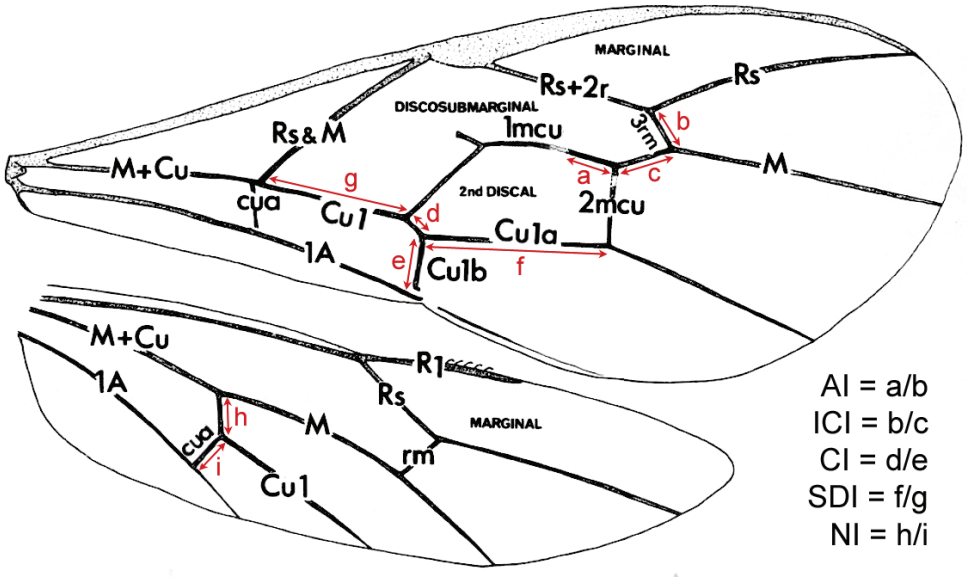


Figure 1. Wing venation terminology and alar indices (after Gauld and Mitchell 1978).

Material examined and key development

Nearly 500 individuals were examined in the SAMC collections. We examined 300–400 more housed in the BMNH, MRAC, and MNHN collections. An interactive matrix key was developed for their quick and reliable identification. This key was initially produced based on the data extracted from Gauld and Mitchell's revision, and thereafter tested with the examined material. Uncertain identifications were cross-checked with Gauld and Mitchell's key and descriptions, and the matrix key was then amended to fit the unreported variability. Each species was coded somewhat loosely to limit the risk of false negative results when selecting limital states of characters. Specific attention was paid to species described on a reduced number of individuals to deal with the subsequent reduced range of known variability.

Results

Taking into account the taxonomic updates post Gauld and Mitchell's revision, including the present one, we acknowledge here a total of 194 species of Ophioninae in the Afrotropical region oncluding *Skiapus coalescens* Morley 1917 which is now included in Ophioninae (Quicke et al. 2005). A few individuals could not be definitively attributed to a given species, but only two individuals are unambiguously new species, which are described below. We also provide a list of new distribution or biological records. Some of these are not actually new because they are mentioned in Gauld and Mitchell (1978), but all of them are not yet reported in the Taxapad reference database (Yu et al. 2012). Finally, we provide a list of significant morphological intra-specific variation, with one in particular leading us to consider *Enicospilus batus* Gauld & Mitchell, syn. n. as a junior synonym of *E. luebberti* (Enderlein).

Identification keys

The matrix includes these 194 species and their known intra-specific variability. Furthermore, the dichotomous key provided in Gauld and Mitchell (1978) has been digitized and updated. Both keys are available at http://www.waspweb.org.

Taxonomic descriptions

***Dicamptus maxipol* Rousse & van Noort, sp. n.**
http://zoobank.org/8C1C347B-4AD0-4FB2-A126-242C3FEA947C
Figs 2–3

Type material (verbatim label data). HOLOTYPE ♀: SOUTH AFRICA, W. Cape, West Coast Fossil Park, (5.5 km 270° W Langebaanweg) 32°57.759'S, 18°05.519'E,

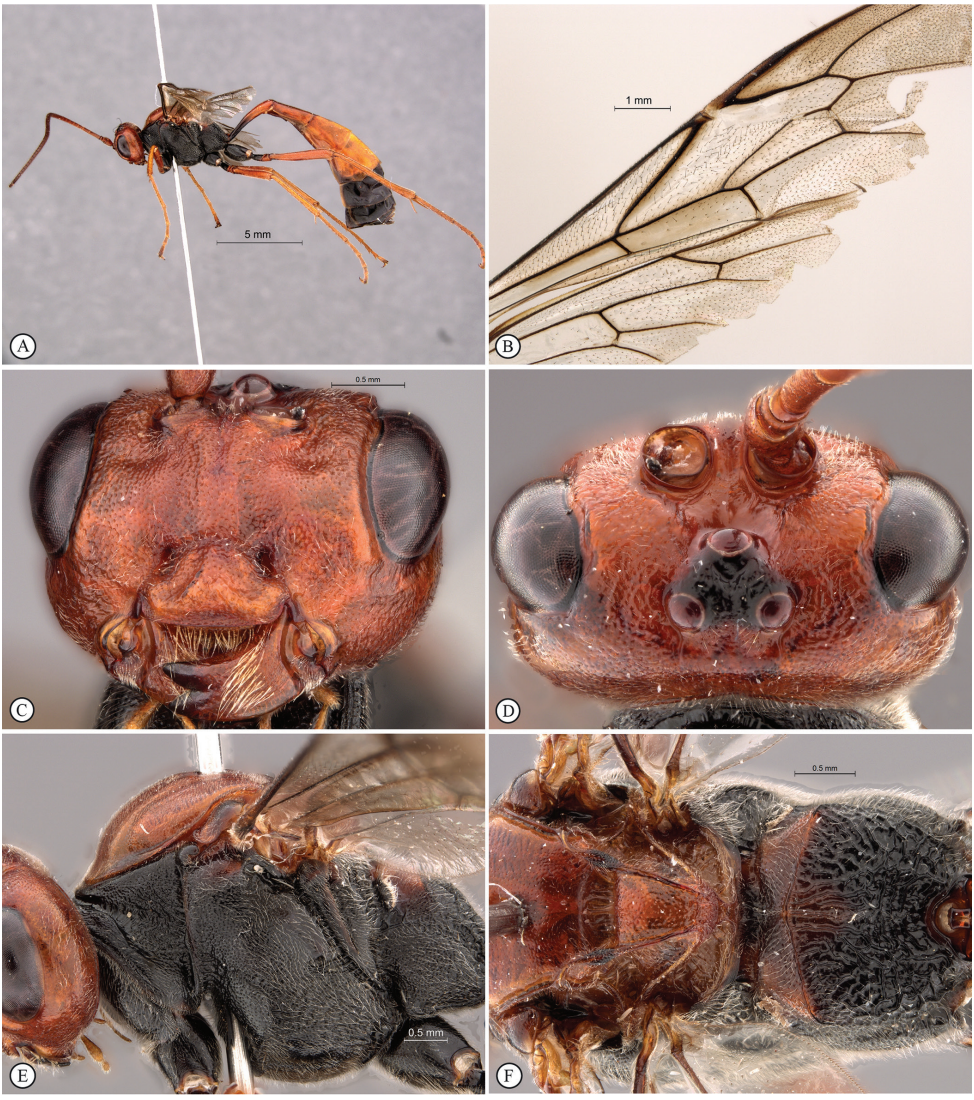


Figure 2. *Enicospilus maxipol* Holotype female. **A** habitus lateral view **B** wings **C** head anterio-ventral view **D** head dorsal view **E** head, mesosoma, lateral view **F** mesosoma, dorsal view.

9–16 Oct 2002, S. van Noort, Malaise trap LW02-R4-M96, Rehabilitated slimes dam, SAM-HYM-P049469 (SAMC).

Diagnosis. Orange with inter-ocellar area, most of mesosoma and apex of metasoma black; mandible not twisted, with a central tuft of hairs; clypeus wide, long and flat in profile; antenna short and stout with 56 flagellomeres; mesosoma laterally coarsely punctate to rugose-punctate, dorsally densely and more finely punctate; mesoscutum with notaulus distinct and relatively long; mesopleuron with epicnemial carina not distinct above lower corner of pronotum; propodeum anteriorly densely punctate, posteriorly coarsely rugose-reticulate; disco-submarginal cell with fenestra

developed but without distinct sclerite; fore tibia with dense and long spines on outer surface; fore tibial spur with a vestigial basal membrane.

Differential diagnosis. Differentiated from all other *Dicamptus* species in the world by the absence of distinct sclerites in the disco-submarginal cell; in the Afrotropical region, it seems related to *D. neavei* Gauld & Mitchell, 1978, which shares the dense spines on the tibia, the exceptionally reduced ocelli and a somewhat similar colour pattern; *D. neavi* is, however, a tropical species with shorter antennae, a stouter metasoma, and distinctly different alar indices with a distinct proximal sclerite in the disco-submarginal cell. In Gauld and Mitchell's key (1978), *D. maxipol* is included in the following modified first couplet:

1	Fore wing with no alar scerite in the disco-submarginal cell; ocelli strongly reduced (FI < 0.25); South Africa ..... ***D. maxipol***
–	Fore wing with one (rarely two) distinct sclerite(s) in the disco-submarginal cell; ocelli reduced to enlarged (FI ≥ 0.25) **1a**
1a	Fore leg with 4th tarsal segment quadrate .....

Description. FEMALE (holotype). B 20.8; F 11.5; ML 1.2; CT 1.2; OOL 2.0; POL 1.2; FI 20%; F_{1-2} 1.7; F_{20} 1.2; AI 1.1; CI 0.5; ICI 0.7; SDI 1.1; NI 2.0.

Color. Orange interspersed with black; black: inter-ocellar area, entire mesosoma except for mesonotum and metanotum, base of tergite 1, tergite 5 and following, all coxae and trochanters except trochantelli; antenna orange, slightly darkening toward apex; wings hyaline, venation dark reddish to black except for pterostigma anteriorly light reddish.

Head. Mandible short and stout, without longitudinal groove, with a central tuft of long hairs, upper tooth barely longer than lower tooth; malar line long; clypeus long and wide, coarsely and densely punctate, rather flat in profile, somewhat swollen medially and ventrally, ventral margin strongly impressed; face strongly transverse, densely and coarsely punctate; frons rather smooth, upper head densely punctate; gena moderately swollen behind eyes; occipital carina complete and strong; antenna short and stout with 56 flagellomeres.

Mesosoma. Pronotum, mesopleuron and metapleuron coarsely and densely punctate, fading to rugose-punctate ventrally; anterior margin of pronotum simple; epicnemial carina short, indistinct above lower corner of pronotum; posterior transverse carina of mesosternum complete though ventrally weak; submetapleural carina not expanded anteriorly; mesoscutum densely and more finely punctate; notaulus long, moderate, distinct to anterior third of mesoscutum; scutellum densely punctate, carinate almost to apex; propodeum with anterior area densely punctate, anterior transverse carina complete, posterior area coarsely rugose-reticulate, abruptly declivous in profile and mid-posteriorly concave. *Wings.* Disco-submarginal cell with fenestra developed, without any distinct sclerite except a weak quadra centrally; *Rs+2r* hardly sinuate, slightly bent and thickened near pterostigma; *Rs&M* distal to *cu-a* by about its own width; hind wing with 7 hamuli. *Legs.* Fore tibia with dense and long spines on outer surface; fore tibial spur with a vestigial membrane basally to macrotrichial

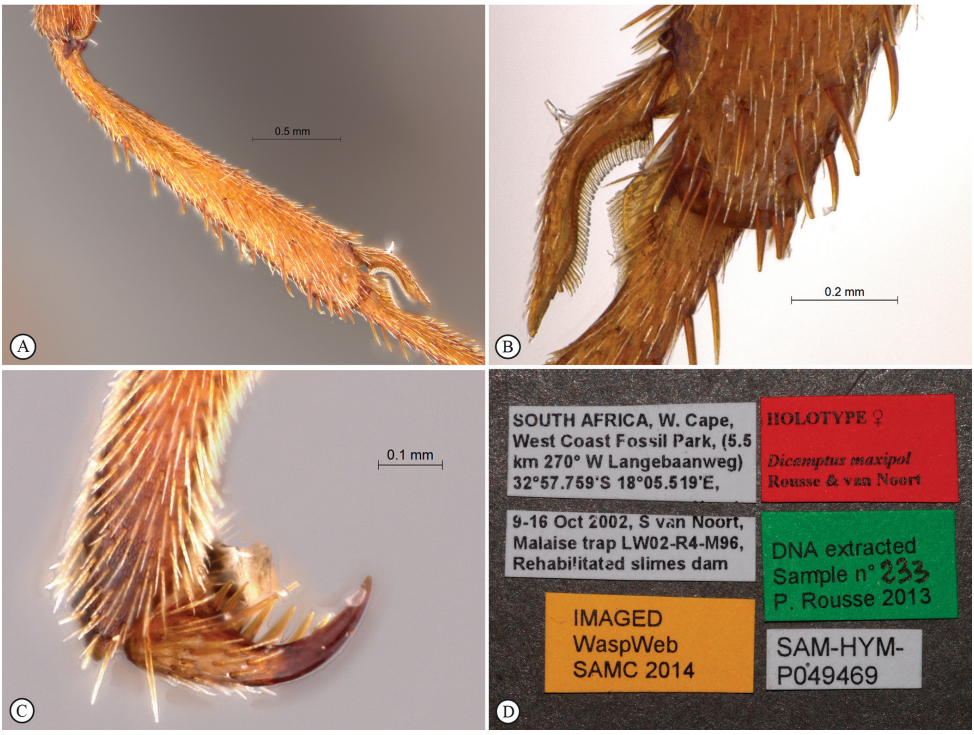


Figure 3. *Enicospilus maxipol* Holotype female. **A** fore tibia **B** fore tibial apex with spur, first tarsal segment **C** fore tarsal claws **D** data labels.

comb, membrane barely less than 0.1× length of spur; hind coxa in profile 1.8× as long as high; hind trochantellus mid-dorsally 0.2× as long as wide; hind tarsal claws symmetrical with 8 pectinae.

Metasoma. Slender; tergite 2 in profile 2.7× longer than high; thyridium large, oval, separated from anterior margin of tergite 2 by 1.3× its own length; ovipositor not reaching beyond metasomal apex.

MALE. Unknown.

Etymology. Named after the unusually reduced ocelli, and as a result the large POL. Noun in apposition.

Distribution. South Africa (Western Cape).

***Enicospilus gauldetmitchellorum* Rousse & van Noort, sp. n.**
http://zoobank.org/5F861712-DBF0-41CC-9854-00DEB2913E86
Fig. 4

Type material (verbatim label data). HOLOTYPE ♀: **Tanzania**, Mkomazi Game Reserve, Ibaya Camp, 3.58S 37.48E, 18 April 1996, light trap, S. van Noort, open *Combretum* bushland, SAM-HYM-P015183 (SAMC).

Diagnosis. Yellow orange overall, head paler yellow; mandible with upper tooth distinctly longer than lower tooth; clypeus hardly convex in profile, its ventral margin barely concave and in-turned; occipital carinae complete; gena moderately swollen behind eye; ocelli moderately enlarged; antenna with 56 flagellomeres; pronotum unspecialized; mesopleuron and metapleuron closely and deeply punctate; epicnemial carina laterally indistinct; posterior transverse carina of mesosternum complete and noticeably strong; submetapleural carina slightly broadened anteriorly; notaulus vestigial; propodeum basally punctate, posteriorly coarsely and concentrically striate; fore wing without any sclerite in disco-submarginal cell; fore tibia with dense spines on outer surface; thyridium very shallow.

Differential diagnosis. Readily differentiable from all other *Enicospilus* in Afrotropical, Oriental and Australasian regions by the combination of the absence of alar sclerites and the dense spines on fore tibia. The swollen genae and the wing venation make it somewhat related to *E. leucocotis*, but this latter is strongly larger, with only sparse spines on tibia and slenderer antenna. In Gauld and Mitchell's key (1978), *E. gauldetmitchellorum* is included in the following modified eighth couplet:

8	Fore tibia with dense and long spines, spines basally far closer than their own mean length; Tanzania..... ***E. gauldetmitchellorum***
–	Fore tibia with distinctly sparser spines, or no spine..... **8a**
8a	Head, when viewed dorsally.....

Description. FEMALE (holotype). B 18.8; F 11.5; ML 0.3; CT 1.6; OOL 0.1; POL 0.4; FI 50%; F_{1-2} 1.4; F_{20} 2.2; AI 0.6; CI 0.7; ICI 0.6; SDI 1.3; NI 2.8.

Color. Yellowish orange overall with face and orbits paler yellow and apex of metasoma slightly infuscate.

Head. Mandible basally constricted, apically parallel-sided and slightly twisted, with upper tooth distinctly longer than lower tooth (greatly worn by abrasion in holotype); outer mandibular surface sparsely setose, without longitudinal groove; labrum 0.3× as long as wide; clypeus in profile hardly convex, its ventral margin barely concave and in-turned; clypeus and face finely and moderately densely punctate; gena moderately swollen behind eye; occipital carina complete; ocelli slightly enlarged; antenna with 56 flagellomeres.

Mesosoma. Pronotum mid-dorsally long, anterior margin simple; mesoscutum densely punctate, notaulus vestigial; scuto-scutellar groove smooth; scutellum densely and shallowly punctate, barely longer than basally wide, carinate to near its apex; mesopleuron and metapleuron closely and deeply punctate, punctures arranged longitudinally but without distinct striation; epicnemial carina short, indistinct above lower corner of pronotum; submetapleural carina weakly broadened anteriorly; posterior transverse carina of mesosternum complete and strong; propodeum with anterior area finely, shallowly and densely punctate, anterior transverse carina complete, posterior area coarsely and concentrically striate *Wings.* Disco-submarginal cell with fenestra developed, without any distinct sclerite; *Rs+2r* sinuate; *cu-a* basal to *Rs&M* by 0.3×

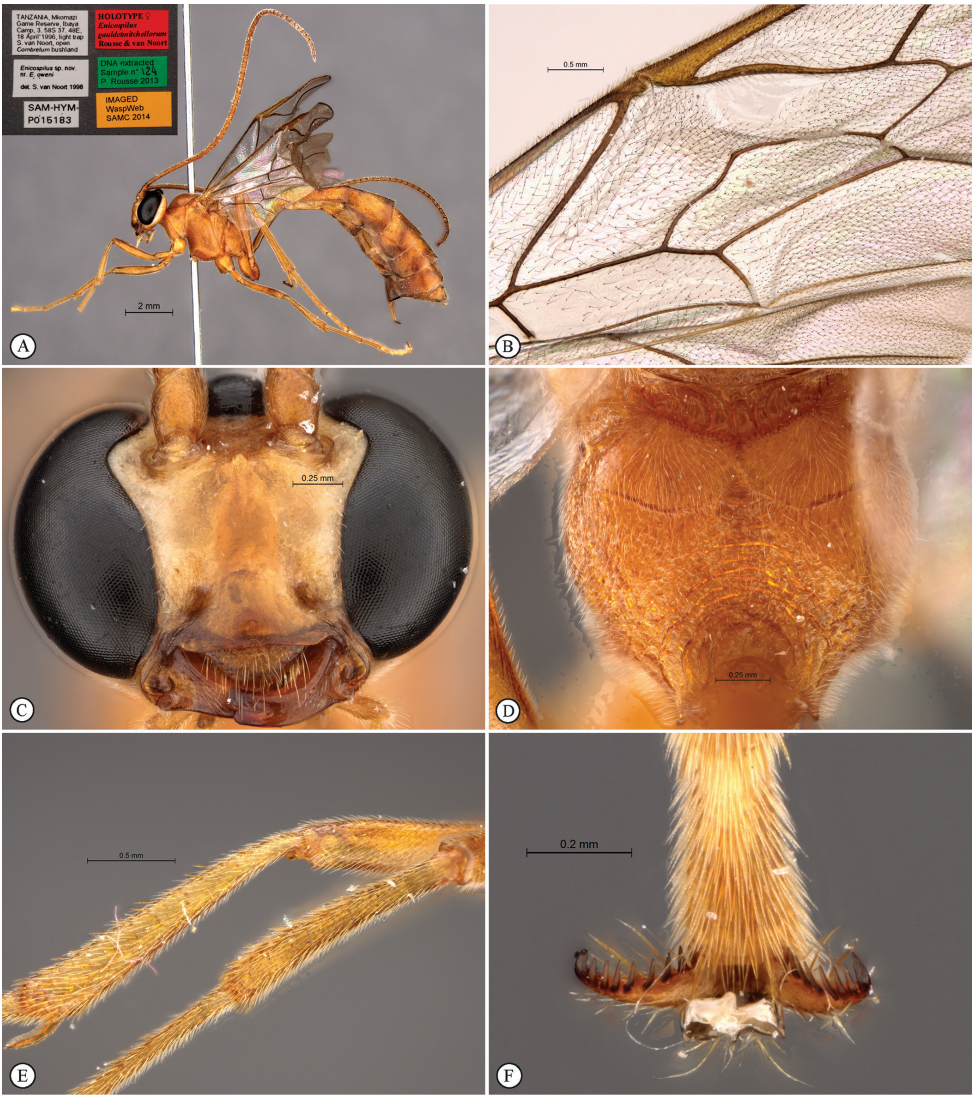


Figure 4. *Enicospilus gauldetmitchellorum* Holotype female. **A** habitus lateral view **B** wings **C** head anterio-ventral view **D** propodeum dorsal view **E** fore tibia, mid tibia **F** fore tarsal claws.

cu-a length; hind wing with 6 hamuli and 1A basally straight. *Legs.* Fore tibia with numerous dense and long spines on outer surface, basally separated by far less than their own length; hind coxa elongate, in profile 2.4× as long as high; hind trochantellus mid-dorsally 0.2× as long as wide, its apical margin simple; hind tarsal claws symmetrical with 8 pectinae, pectinae long and acute.

Metasoma. Slender; tergite 2 in profile 3.2× longer than high; thyridium very shallow, elongate, separated from anterior margin of tergite 2 by 1.7× its own length; ovipositor acute not reaching beyond metasomal apex.

MALE. Unknown.

Etymology. This species was probably mentioned in Gauld and Mitchell (1978) as an undescribed specimen close to *E. leucocotis*. Let give Gauld what belongs to Gauld (updated after Mark 12:17).

Distribution. Tanzania.

New distribution records

Provided are the verbatim label data. Only unambiguous identifications are listed. All geographical coordinates are also available on a separate file as Suppl. material 1. If not indicated on the labels, the coordinates were found on Fuzzy Gazeeter http://isodp.hof-university.de/fuzzyg/query/ and Google Earth http://www.google.com/earth/

Dicamptus pulchellus (Morley, 1912). **The Gambia:** 1♀ Kombo Nth district, Bilijo Forest Park, xi.1992, M. Söderlung coll., SAM-HYM-P049471 (SAMC).

Euryophion latipennis (Kirby, 1896). **South Africa:** 1♀ Kwazulu-Natal, Itala Game Reserve, xii.1992, S. van Noort coll., SAM-HYM-P044187 (SAMC); 1♀ 1♂ same label data except: xii.1999, SAM-HYM-P044163 and SAM-HYM-P044185 (SAMC); **Zambia:** 1 specimen [apex of metasoma lacking] Southern Province, Choma Nansa farm xii.1993, A.J. Gardiner coll., SAM-HYM-P044072 (SAMC).

Laticoleus palpalis Gauld & Mitchell, 1978. **Kenya:** 1♀ Eastern Province, Kenplains, x.1984, C.F. Dewhurst coll. (BMNH).

Laticoleus unicolor (Szépligeti, 1908). **Botswana:** 1♀ Xugana [verbatim label data, locality unknown], xi.1979, B.H. Lamoral coll., SAM-HYM-P049474 (SAMC).

Lepiscelus distans (Seyrig, 1935). **South Africa:** 1♀ Kwazulu-Natal, Itala Game Reserve, xii.1999, S. van Noort coll, SAM-HYM-P044186 (SAMC); 1♀ Limpopo, junction Crocodile and Marico Rivers, ii.1918, R. Tucker coll., SAM-HYM-P006194 (SAMC); 2♂♂ Mpumalanga, Nelspruit, i.1939, R.F. Lawrence coll., SAM-HYM-P006193 (SAMC); **Zimbabwe:** 1♂ Essexvale, ii.1963, SAM-HYM-P006228 (SAMC).

Skiapus coalescens (Morley, 1917). **The Gambia:** 1♀ Kombo Nth district, Bilijo Forest Park, xi.1992, M. Söderlung coll., SAM-HYM-P049477 (SAMC).

Enicospilus albiger (Kriechbaumer, 1894). **Zambia:** 1♂ South Luangwa near. Mfuwe, xii.2011, A. Gumovsky coll., SAM-HYM-P049484 (SAMC).

Enicospilus babaulti (Seyrig, 1935). **Malawi:** 1♀ Nyika National Park, Juniper forest, ix.1999, R.J. Murphy coll., SAM-HYM-P021341 (SAMC); **South Africa:** 1 specimen [metasoma lacking] ii.1917, C.J. Swierstra coll., SAM-HYM-P001398 (SAMC); **Zimbabwe:** 1♀ Chirinda forest, xi.1955, SAM-HYM-P006247 (SAMC).

Enicospilus bebelus Gauld & Mitchell, 1978. **Gabon:** 1♀ Province Ogoové–Maritime, Réserve des Monts Doudou, iii.2000, S. van Noort coll., SAM-HYM-P041707 (SAMC).

Enicospilus betanimenus (Saussure, 1892). **Ethiopia:** 2♀♀ Adola, xi.1941, SAM-HYM-P047374 and SAM-HYM-P006253 (SAMC); **Zimbabwe:** 2♀♀ Bulawayo ii.1971, D.K.B. Wheeler coll, SAM-HYM-P006286 (SAMC).

Enicospilus bicoloratus Cameron, 1912. **Zimbabwe:** 1♀ Matopos, ii.1963, SAM-HYM-P006265 (SAMC).

Enicospilus camerunensis (Enderlein, 1921). **Mayotte:** 1♀ Dembéni, iii.2013, G. Cazenove coll. (MHNR).

Enicospilus divisus (Seyrig, 1935). **Uganda:** 1♂ Kibale National Park, Kanyawara, viii.2008, S.van Noort coll., SAM-HYM-P049506 (SAMC).

Enicospilus drakensbergi Gauld & Mitchell, 1978. **Tanzania:** 1♂ South Pare Mountains, alt. c. 1700m, xi.1995, S. van Noort coll., SAM-HYM-P014698 (SAMC).

Enicospilus equatus Gauld & Mitchell, 1978. **Central African Republic:** 2♀♀ 1♂ Préfecture Sangha-Mbaéré, Réserve Spéciale de Forêt Dense de Dzanga-Sangha, v.2001, S. van Noort coll., SAM-HYM-P049510–P049512 (SAMC).

Enicospilus finalis Gauld & Mitchell, 1978. **Central African Republic:** 5♀♀ Préfecture Sangha-Mbaéré, Parc National de Dzanga-Ndoki, v.2001, S. van Noort coll., SAM-HYM-P049514 –P049517 (SAMC); **Mozambique:**1 specimen [apex of metasoma broken] Mt Gorongoza, ix.1957, SAM-HYM-P006229 (SAMC).

Enicospilus oculator Seyrig, 1935. **Zimbabwe**1♀ Tuli, v.1959, SAM-HYM-P006232 (SAMC).

Enicospilus hova Gauld & Mitchell, 1978. **Uganda:** 1♂ Kibale National Park, Kanyawara, viii.2008, S.van Noort coll., SAM-HYM-P049513 (SAMC).

Enicospilus luebberti (Enderlein, 1914). 4♀♀ **Botswana:** 1♀ Xugana [verbatim label data, locality unknown], xi.1979, B.H. Lamoral coll. (NMSA).

Enicospilus mamatsus Gauld & Mitchell, 1978. **South Africa:** 1♀ Northern Cape, Sterboom farm, 1599 m, v–vii 2010, S. van Noort, SAM-HYM-P054077 (SAMC).

Enicospilus mnous Gauld & Mitchell, 1978. **Tanzania:** 3♀♀, Mkomazi Game Reserve, xi.1995, H.G. Robertson coll. and S. van Noort colls, SAM-HYM-P014159, SAM-HYM-P014161 and SAM-HYM-P014170 (SAMC); 2♀♀ same label data except: iv.1996, S. van Noort coll., SAM-HYM-P014156 and SAM-HYM-P014706 (SAMC).

Enicospilus nesius Gauld & Mitchell, 1978. **Central African Republic:** 1♀ Préfecture Sangha-Mbaéré, Parc National de Dzanga-Ndoki, v.2001, S. van Noort coll., SAM-HYM-P054079 (SAMC).

Enicospilus pallidus (Taschenberg, 1875). **Tanzania:** 8♀♀, Mkomazi Game Reserve, xi–xii.1995 and iv.1996, S. van Noort coll., SAM-HYM-P014157–P0141578, SAM-HYM-P014171–P014175 and SAM-HYM-P015200 (SAMC).

Enicospilus polemus Gauld, 1982. **South Africa:** 1♀ Kwazulu-Natal, Itala Game Reserve, xii.1999, S. van Noort coll., SAM-HYM-P044207 (SAMC); **Tanzania:** 1♀ Mkomazi Game Reserve, iv–v.1996, S. van Noort coll., SAM-HYM-P015666 (SAMC).

Enicospilus quietus (Seyrig, 1935). **Namibia:** 1♀ Namib-Naukluft Park, x.1997, S. van Noort coll., SAM-HYM-P020721 (SAMC); 1♂ Otavi, xii.1918, R.M. Lightfoot coll., SAM-HYM-P006278 (SAMC); 1♀ Ondangua Ovamboland, 1921, K.H.

Bernard coll., SAM-HYM-P006199 (SAMC); 2 specimens [metasomas lacking] Otjiperongo, i.1931, J.S. Brown coll., SAM-HYM-P047375 (SAMC).

Enicospilus rubens (Toquinet, 1896). **Madagascar:** 1♀ Majunga Province, Maintirano District, iii.2008, M.Irwin and R.Harin'Hala colls, MG-44-26 (CASC).

Enicospilus rundiensis Bischoff, 1915. **Namibia:** 1♀ 1♂ Kaross, 1925, SAM-HYM-P001381 (SAMC); 1♀ Warmbad, 1925, SAM-HYM-P001382 (SAMC); 1 specimen [apex of metasoma broken] Narubis, 1921, K.H. Barnard coll., SAM-HYM-P006277 (SAMC); 1 specimen [metasoma lacking] Otjiperongo, i.1931 J.S. Brown coll., SAM-HYM-P006276 (SAMC); **Zimbabwe:** 1♀ Harare, vi.1961, SAM-HYM-P006225 (SAMC).

Enicospilus ruscus Gauld & Mitchell, 1978. **Kenya:** 1♂ Nguruman, vii.2008, S. van Noort coll., SAM-HYM-P054106 (SAMC).

New host records

Enicospilus betanimenus (Saussure, 1892). 2♀♀ from Zimbabwe SAM-HYM-P006286 (SAMC) ex *Achaea catella* Guenée, 1852 (Lepidoptera: Noctuidae).

Enicospilus dubius (Tosquinet, 1896). 2♀♀ from South Africa (SAMC SAM-HYM-P001508) ex *Ctenoplusia limbirina* (Guenée) (Lepidoptera: Noctuidae).

Enicospilus dolosus (Tosquinet, 1896). 1♀ from Reunion (M. Bippus, *com. pers.*) ex *Anomis flava* (Fabricius) (Lepidoptera: Noctuidae).

Enicospilus leucocotis (Tosquinet, 1896). 2♀♀ from South Africa (SAMC SAM-HYM-P046967 and SAM-HYM-P046968) ex *Mesocelis montana* (Hübner) (Lepidoptera: Lasiocampidae).

Enicospilus mauritii (Saussure, 1892). 1♂ from Reunion ex *Callopistria maillardi maillardi* (Guenée) (Lepidoptera: Noctuidae) feeding on *Dryopteris bernieri* (Pteridophyta: Dryopteridaceae) (Robert 2012).

Enicospilus luebberti (Enderlein, 1914). 1♂ from South Africa (SAMC SAM-HYM-P006196) ex *Graphania atavistis* (Hampson) (Lepidoptera: Noctuidae).

Morphological variations

Enicospilus bebelus Gauld & Mitchell, 1978. 1♂ from Central African Republic (SAMC SAM-HYM-P049492) and 1♀ from Gabon (SAMC SAM-HYM-P041707) with mesosoma interspersed with dark testaceous and black markings, and tergite 1 basally black; otherwise similar to original description.

Enicospilus oculator Seyrig, 1935. 1♀ from Zimbabwe (SAMC SAM-HYM-P006232) with central sclerite totally absent, upper tooth twice as long as lower tooth, and numeric indices slightly different: FI 80%, AI 1.0, fore wing length 14 mm. Otherwise similar to Gauld and Mitchell (1978) description.

Enicospilus grandiflavus Townes, 1973. 1♀ from South Africa (SAMC SAM-HYM-P049521) with entire head strongly darkened, nearly black. Otherwise similar to Gauld and Mitchell (1978) description.

Enicospilus expeditus (Tosquinet, 1896). 1♀ 1♂ from South Africa (SAMC SAM-HYM-P054068) with hind tarsal claws less pectinate than figured in Gauld and Mitchell (1978), and with tergite 1 basally black and mesosoma largely interspersed with dark markings. Otherwise similar to Gauld and Mitchell (1978) description.

Enicospilus luebberti (Enderlein, 1914). Numerous specimens from South Africa (SAMC-HYM-P006210–21, P001454–55, P006196 and P054076), Bostwana (NMSA), and Kenya (BMNH) showed the following non-correlated variations: inter-ocellar area and metasomal apex yellowish-orange to totally black, antenna with 48–62 flagellomeres, longitudinal groove on mandible more or less impressed, proximal sclerite more or less elongate and central sclerite variously sclerotized. These variations encompass the definition of *E. batus* Gauld & Mitchell, 1978, syn. n., described on a single specimen, which is hereby recognized as a junior synonym of *E. luebberti*.

Acknowledgments

Many thanks to the above mentioned curators and their staff for welcoming us during our visits. We are also grateful to CABI publishing for their copyright agreement, and to all beta testers of the matrix key for their feedback. Simon van Noort was funded by South African NRF (National Research Foundation) grants: GUN 2068865; GUN 61497; GUN 79004; GUN 79211; GUN 81139. Pascal Rousse was funded by SABI (South African Biodiversity Initiative) NRF post-doctoral fellowship GUN 81609, Claude Leon Foundation post-doctoral fellowship, and Société Entomologique de France (Bourse Germaine Cousin). Both authors were fully nutritionally supported by Jungle Oats™ (with a consensual preference for the green box). Part of the South African field work conducted by SvN was funded by the National Science Foundation under PlatyPBI grant No. DEB-0614764 to N.F. Johnson and A.D. Austin. Field work in Central African Republic was supported by WWF-US and WWF-CARPO. The Ministers of Water, Forests and the Environment and the High Commissioners for tertiary Education and Research of the Central African Republic granted permission to carry out the inventory survey and to export the specimens as part of the WWF-US CAR field expedition conducted in 2001. Fieldwork in Gabon was funded by the World Bank through WWF-US. WWF-Gabon provided logistical support. Collecting and export permits were kindly granted by Monsieur Emile Mamfoumbi Kombila, Directeur de la Faune et de la Chasse, Libreville. Cape Nature; the Eastern Cape Department of Environmental Affairs and the Northern Cape Department of Nature and Environmental Conservation provided collecting permits for South Africa. The Ugandan Wildlife Authority and UNCST provided permits to conduct research sampling in Uganda.

References

Buffington ML, Burks R, McNeil L (2005) Advanced techniques for imaging microhymenoptera. American Entomologist 51: 50–54.

Buffington ML, Gates M (2009) Advanced imaging techniques II: using a compound microscope for photographing point–mount specimens. American Entomologist 54: 222–224.

Cameron P (1912) On the Hymenoptera from Belgian Congo in the Congo Museum, Tervueren. Annales de la Société Entomologique de Belgique 56: 357–401.

Enderlein G (1914) Hymenoptera IV: Ichneumonidae. In: Michaelsen W (Ed.) Beiträge Zur Kenntnis Der Land-Und Süsswasserfauna Deutsch-Südwestafrikas. Band 1. Hamburg, Germany, 11–233.

Enderlein G (1921) Beiträge zur Kenntnis aussereuropäischer Ichneumoniden V. Über die Familie Ophionidae. Stettiner Entomologische Zeitung 82: 3–45.

Gauld ID (1980) An analysis of the classification of the *Ophion* genus-group (Ichneumonidae). Systematic Entomology 5: 59–82. doi: 10.1111/j.1365-3113.1980.tb00400.x

Gauld ID (1982) A revised key of the *Enicospilus antefurcalis* (Szépligeti) (Hymenoptera: Ichneumonidae) species group of the Afrotropical region. Bulletin of Entomological Research 72: 33–38. doi: 10.1017/S0007485300050264

Gauld ID (1985) The phylogeny, classification and evolution of parasitic wasps of the subfamily Ophioninae (Ichneumonidae). Bulletin of the British Museum (Natural History), Entomology series 51: 61–185.

Gauld ID, Mitchell PA (1978) The taxonomy, distribution and host preferences of African parasitic wasps of the subfamily Ophioninae (Hymenoptera, Ichneumonidae). Commonwealth Institute of Entomology, Slough, England.

Kerr PH, Fisher EM, Buffington ML (2008) Dome lighting for insect imaging under a microscope. American Entomologist 54: 198–200.

Kirby WF (1896) A list of the Orthoptera, Hymenoptera and Hemiptera collected by Miss Kingley on the River Ogove, with descriptions of some new genera and species. Ann. Mag. Nat. Hist. 18: 257–269. doi: 10.1080/00222939608680451

Kriechbaumer J (1894) Hymenoptera Ichneumonidae a medico nautico Dr. Joh. Brauns in itinere secundo ad oras Africae lecta. Berliner Entomologische Zeitschrift 39: 297–318. doi: 10.1002/mmnd.18940390215

Morley C (1912) A revision of the Ichneumonidae based on the collection in the British Museum (Natural History) with descriptions of new genera and species Part I. Tribes Ophionides and Metopiides. British Museum, London, 88 pp.

Morley C (1917) On some South African Ichneumonidae in the collection of the South African Museum. Annals of the South African Museum 17: 191–229.

Quicke DLJ, Fitton MG, Broad G, Crocker B, Laurenne NM, Miah MI (2005) The parasitic wasp genera *Skiapus*, *Hellwigia*, *Nonnus*, *Chriodes*, and *Klutiana* (Hymenoptera, Ichneumonidae): recognition of the Nesomesochorinae stat. rev. and Nonninae stat. n. and transfer of *Skiapus* and *Hellwigia* to the Ophioninae. Journal of Natural History 39: 2559–2578. doi: 10.1080/00222930500102546

Robert Y (2012) La fougère, le papillon et la guèpe (Pteridophyta: Dryopteridaceae: Lepidoptera: Noctuidae; Hymenoptera: Ichneumonidae, Ophioninae). Cahiers Scientifiques de l'Océan Indien Occidental 3: 19–20.

Rousse P, Villemant C (2012) Ichneumons in Reunion Island: a catalogue of the local Ichneumonidae (Hymenoptera) species, including 15 new taxa and a key to species. Zootaxa 3278: 1–57.

Saussure Hd (1892) Histoire naturelle des Hymenoptères. Histoire Physique Naturelle et Politique de Madagascar 20: 1–590.

Seyrig A (1935) Hymenoptera. II. Ichneumonidae: Cryptinae, Pimplinae, Tryphoninae et Ophioninae. Mission Scientifique de l'Omo 3: 1–103.

Szépligeti G (1908) Hymenoptera: Braconidae & Ichneumonidae. Wissenschaftliche Ergebnisse der Schwedischen Zoologischen Expedition nach dem Kilimandjaro, dem Meru und den umgebenden Massaisteppen 16: 25–96.

Taschenberg EL (1875) Zur Kenntnis der Gattung *Ophion* Fab. Zeitung Für Gesammten Naturwissenschaften 46: 421–438.

Tosquinet J (1896) Contributions à la faune entomologique de l'Afrique. Ichneumonides. Mémoires de la Société Entomologique de Belgique 5: 1–430.

Townes HK, Townes M (1973) A catalogue and reclassification of the Ethiopian Ichneumonidae. Memoirs of the American Entomological Institute 19: 1–416.

Yu DSK, van Achterberg C, Horstmann K (2012) Taxapad 2012. Ichneumonoidea 2011. Database on flash-drive, Ottawa, Canada. http://www.taxapad.com

Supplementary material 1

Afrotropical Ophioninae: coordinates of the new distribution records.

Authors: Pascal Rousse, Simon van Noort

Data type: distribution data

Explanation note: Summary of the collection localities and their geographical data listed as new distribution records for Afrotropical Ophioninae

Copyright notice: This dataset is made available under the Open Database License (http://opendatacommons.org/licenses/odbl/1.0/). The Open Database License (ODbL) is a license agreement intended to allow users to freely share, modify, and use this Dataset while maintaining this same freedom for others, provided that the original source and author(s) are credited.

ZooKeys 456: 75–83 (2014)
doi: 10.3897/zookeys.456.8584
http://zookeys.pensoft.net

RESEARCH ARTICLE

A peer-reviewed open-access journal
ZooKeys
Launched to accelerate biodiversity research

Three new species of the myrmecophilous genus *Doryloxenus* from China (Coleoptera, Staphylinidae, Aleocharinae)

Xiao-Bin Song[1], Li-Zhen Li[1]

1 *Department of Biology, College of Life and Environmental Sciences, Shanghai Normal University, 100 Guilin Road, Xuhui District, Shanghai 200234, P. R. China*

Corresponding author: *Li-Zhen Li* (lizhenli@shnu.edu.cn)

Academic editor: *J. Klimaszewski* | Received 15 September 2014 | Accepted 31 October 2014 | Published 21 November 2014

http://zoobank.org/10B0FA86-AB6F-40BA-8F19-1BFB8A6FA777

Citation: Song X-B, Li L-Z (2014) Three new species of the myrmecophilous genus *Doryloxenus* from China (Coleoptera, Staphylinidae, Aleocharinae). ZooKeys 456: 75–83. doi: 10.3897/zookeys.456.8584

Abstract

Three new species of the pygostenine genus *Doryloxenus* Wasmann, *viz.*, *D. aenictophilus* **sp. n.** (from Zhejiang), *D. tangliangi* **sp. n.** (from Zhejiang), and *D. songzhigaoi* **sp. n.** (from Yunnan), are described, illustrated and distinguished from the Asian congeners. An identification key to the Chinese species is given.

Keywords

Pygostenini, *Doryloxenus*, myrmecophilous, army ant, new species, China

Introduction

The myrmecophilous genus *Doryloxenus* Wasmann currently contains 36 species worldwide (Jacobson and Kistner 1975; Jacobson 1980; Naomi 1996; Pace 1998; Kistner et al. 2003; Assing 2009), among which three are known from China: *D. hongkongensis* Pace (Hongkong), *D. rougemonti* Pace (Hongkong), and *D. yunnanus* Assing (Yunnan). Members of *Doryloxenus* are commonly found in association with the army ant genus *Dorylus*, but symbiotic hosts of all Chinese *Doryloxenus* remain unknown.

In 2013, the senior author and his colleagues surveyed the myrmecophilous and termitophilous staphylinidae at Longwangshan Natural Reserve, Zhejiang (Fig. 4A) and

Copyright *Xiao-Bin Song, Li-Zhen Li.* This is an open access article distributed under the terms of the Creative Commons Attribution License (CC BY 4.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

Zizhi Village, Yunnan (Fig. 4C), and collected a series of aleocharine beetles from the colonies of army ant *Aenictus* sp. and *Dorylus orientalis*. A closer examination of this material revealed three new species of the genus *Doryloxenus*, which are described herein.

Material and methods

Holotypes and most of the paratypes are deposited in the Insect Collection of the Shanghai Normal University, Shanghai, China (SNUC), and some of paratypes are deposited in the Kyushu University Museum, Fukuoka, Japan (KUM).

Specimens were killed with ethyl acetate and preserved in 75% ethanol before dissection; photos of habitus were taken by a Canon EOS 7D with an MP-E 65mm macro photo lens; photos of characteristic pattern were taken by a Canon G9 Camera mounted on an Olympus CX31 microscope.

The following abbreviations are applied in the text: **BL** – body length, from the anterior margin of the head to the posterior margin of the abdominal tergite VIII; **FBL** – forebody length, from the clypeal anterior margin to the posterior margin of elytra; **HL** – head length, from the clypeal anterior margin to the occipital constriction; **PL** – length of the pronotum along the midline; **HW** – width of the head across the eyes; **PW** – maximum width of the pronotum.

Taxonomy

Doryloxenus Wasmann

Doryloxenus Wasmann, 1898: 101 (original description, type species: *Doryloxenus cornutus* Wasmann, 1898); Jacobson and Kistner 1975: 299 (key, diagnosis).

Remarks. The genus is most similar to *Odontoxenus* Kistner in general appearance. It can be easily separated from *Odontoxenus* by the eyes having no part of their surface on the anterior margin of the head, the quadrate mesocoxal cavity, and the shorter mesosternum (Jacobson and Kistner 1975). *Doryloxenus* is also similar to *Pygoplanus* Kistner by the limuloid shape, but can be distinguished from it by the different shapes of the mandibles and labrum, the maxillary palpus distinctly longer than the setulate galea (Kistner et al. 2003).

Doryloxenus aenictophilus sp. n.

http://zoobank.org/0499D286-4426-4DF2-A379-02BC548E288F
Fig. 1

Type material. Holotype: China: ♂, labeled 'CHINA: Zhejiang Province, Huzhou City, Anji County (安吉县), Longwangshan (龙王山), alt. 1330m, 30°24'15.53"N,

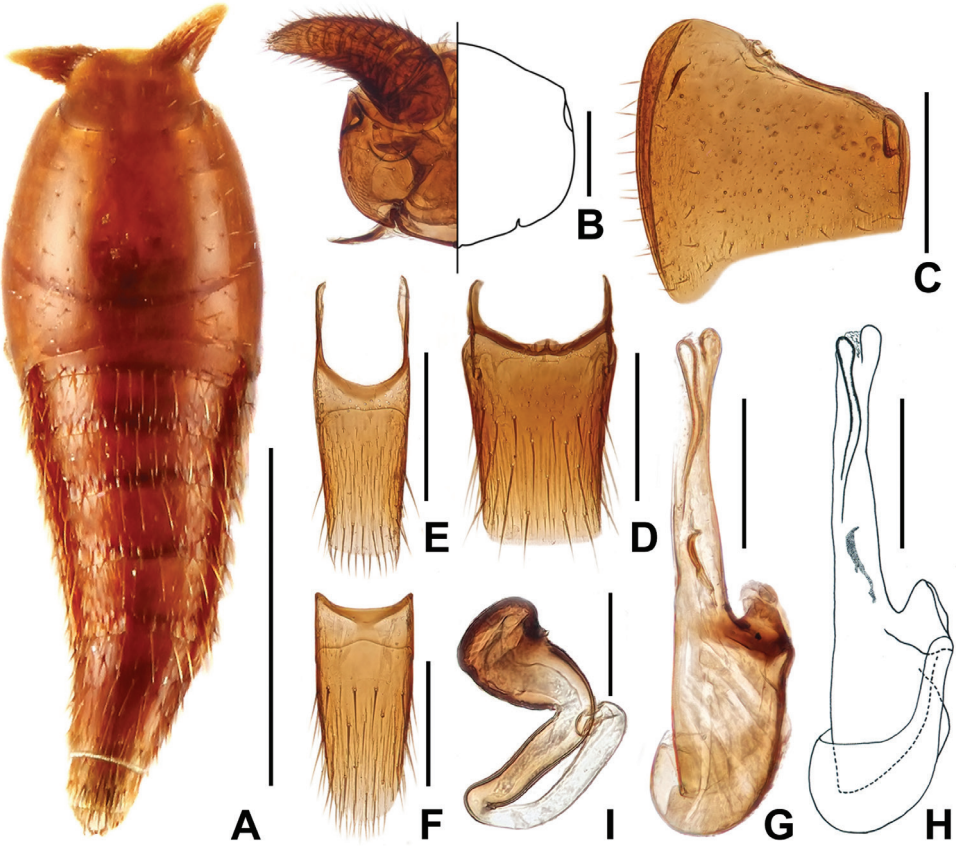


Figure 1. *Doryloxenus aenictophilus* sp. n. **A** habitus **B** head **C** Elytron **D** tergite VII **E** tergite VIII **F** sternite VIII **G** median lobe of aedeagus, in lateral view **H** ditto **I** spermatheca. Scales (mm): **A** = 0.5; **B, G, H** = 0.1; **C, F** = 0.2; **I** = 0.05.

119°26'36.81"E, 14-V-2013, X.-B. Song leg., from a colony of *Aenictus* sp. / HOLOTYPE [red], *Doryloxenus aenictophilus* sp. n., Song & Li det. 2014, SNUC'. **Paratype: China:** 1♂, 1♀, 8 sex?, same data as holotype, bearing the following label: 'PARATYPE [yellow], *Doryloxenus aenictophilus* sp. n., Song & Li det. 2014'. (SNUC, KUM).

Comparative notes. *Doryloxenus aenictophilus* is most similar to *D. tangliangi* described below by the forebody sparsely covered with yellow setae and the macrochaetotaxy of tergites II–V: 6, 4, 4, 4, 4. It differs from *D. tangliangi* by the smaller eyes, the shorter elytra and the reduced hind wings. The new species is also similar to the unique blind and wingless species *D. coecus* Kistner by the light color and the short elytra, but can be easily distinguished from it by the presence of small eyes, the different macrochaetotaxy of abdominal tergites II–VIII.

Description. Body (Fig. 1A) smooth, glossy. Coloration: Light reddish-brown overall.

Head shaped as in Fig. 1B, sparsely covered with yellow setae; eyes small. Pronotum (Fig. 1A) wider than long, about 1.44 times as wide as long; disc sparsely covered

with yellow setae. Elytra (Fig. 1A, C) short, wider than long, about 3.72 times as wide as long; disc sparsely covered with yellow setae, with a row of setae on lateral margins. Hind wings reduced. Abdomen wedge-shaped; posterior margins of tergite II–VI with a row of very long yellowish setae; abdominal tergite VII (Fig. 1D) truncate at apex, with 2 pairs of macrochaetae at the anterior 1/3; tergite VIII (Fig. 1E) slightly truncate at apex, with 1 pair of lateral macrochaetae; sternite VIII shaped as in Fig. 1F. Macrochaetotaxy of abdominal tergites II–VIII: 6, 4, 4, 4, 4, 4, 2.

Male. Median lobe of aedeagus shaped as in Fig. 1G–H.

Female. Spermatheca with apical part strongly swollen, shaped as in Fig. 1I.

Measurements. BL: 1.48–1.61; FBL: 0.64–0.68; PL: 0.33–0.35; PW: 0.48–0.51; PW/PL: 1.42–1.45; HW/PW: 0.51–0.56.

Distribution. East China: Zhejiang.

Symbiotic host. *Aenictis* sp. (Fig. 5A–B). According to the key provided by Jaitrong and Yamane (2011), the host ant should belong to the *A. ceylonicus* group. This is the first record of a *Doryloxenus* associated with *Aenictus* ant together with the next new species.

Biological notes. Eleven *Doryloxenus aenictophilus* were sifted together with a large series of *D. tangliangi* from the colony of *Aenictus* sp. nesting under a rock. One individual was observed riding on the head of a worker ant.

Etymology. The specific name is a combination of '*Aenictus*', generic name of the ant host, and the Greek stem '*philos*', meaning 'to be fond of'.

***Doryloxenus tangliangi* sp. n.**
http://zoobank.org/BBD8E915-9ED8-4361-B3E1-0F500BB2BAD2
Fig. 2

Type material. Holotype: China: ♂, labeled 'CHINA: Zhejiang Province, Huzhou City, Anji County (安吉县), Longwangshan (龙王山), alt. 1330m, 30°24'15.53"N, 119°26'36.81"E, 14-V-2013, X.-B. Song leg., from a colony of *Aenictus* sp. / HOLOTYPE [red], *Doryloxenus tangliangi* sp. n., Song & Li det. 2014, SNUC'. **Paratype: China:** 5♂, 3♀, 102sex?, same data as holotype, bearing the following label: 'PARATYPE [yellow], *Doryloxenus tangliangi* sp. n., Song & Li det. 2014'. (SNUC, KUM).

Comparative notes. *Doryloxenus tangliangi* is most similar to *D. aenictophilus* described above by the forebody sparsely covered with yellow setae and the macrochaetotaxy of tergites II–V: 6, 4, 4, 4, 4. It differs from *D. aenictophilus* by the larger eyes, the relatively long elytra, as well as the different shapes of the aedeagus and spermatheca.

Description. Body (Fig. 2A) smooth, glossy. Coloration: Light reddish-yellow overall.

Head shaped as in Fig. 2B, sparsely covered with long yellowish setae; eyes large. Pronotum (Fig. 2A) wider than long, about 1.44 times as wide as long; disc sparsely covered with long yellowish setae. Elytra (Fig. 2A, C) about 2.73 times as wide as long; disc sparsely covered with long yellowish setae, with a row of setae on lateral margins. Abdomen wedge-shaped; posterior margins of tergite II–VI with a row of very long

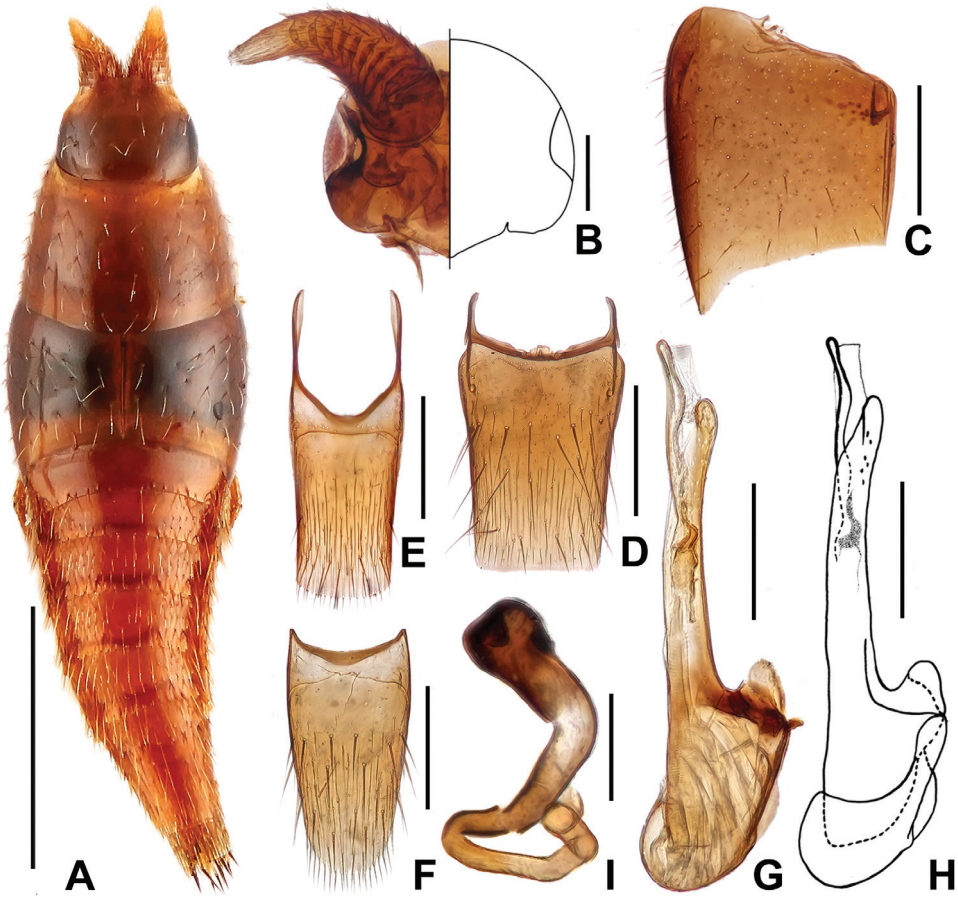


Figure 2. *Doryloxenus tangliangi* sp. n. **A** habitus **B** head **C** Elytron **D** tergite VII **E** tergite VIII **F** sternite VIII **G** median lobe of aedeagus, in lateral view **H** ditto **I** spermatheca. Scales (mm): **A** = 0.5; **B, G, H** = 0.1; **C, F** = 0.2; **I** = 0.05.

yellowish setae; abdominal tergite VII (Fig. 2D) truncate at apex, with 2 pairs of macrochaetae at the anterior 1/3 and 3 pairs near apex ; tergite VIII (Fig. 2E) slightly truncate at apex, with 1 pair of lateral macrochaetae and 2 pairs near apex; sternite VIII shaped as in Fig. 2F. Macrochaetotaxy of abdominal tergites II–VIII: 6, 4, 4, 4, 4, 10, 6.

Male. Median lobe of aedeagus shaped as in Fig. 2G–H.

Female. Spermatheca with apical part strongly swollen, shaped as in Fig. 2I.

Measurements. BL: 1.70–1.93; FBL: 0.77–0.86; PL: 0.34–0.37; PW: 0.51–0.52; PW/PL: 1.38–1.53; HW/PW: 0.63–0.67.

Distribution. East China: Zhejiang.

Symbiotic host. *Aenictus* sp. (Fig. 5A–B).

Biological notes. Most of the specimens were sifted from a colony of *Aenictus* ant, at least four individuals were observed riding on the abdomen of worker ants (Fig. 4B).

Etymology. Dedicated to Dr. Liang Tang, who found the colony of the host ants.

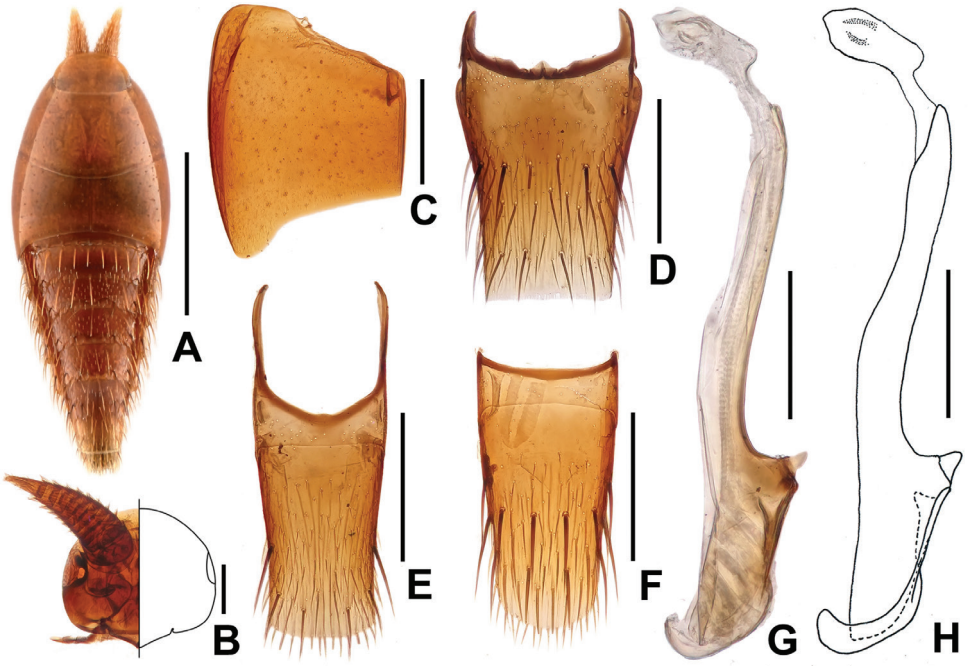


Figure 3. *Doryloxenus songzhigaoi* sp. n. **A** habitus **B** head **C** Elytron **D** tergite VII **E** tergite VIII **F** sternite VIII **G** median lobe of aedeagus, in lateral view **H** ditto. Scales (mm): **A** = 0.5; **B, G, H** = 0.1; **C, F** = 0.2.

***Doryloxenus songzhigaoi* sp. n.**
http://zoobank.org/CFB4FD49-5CA3-4DAD-97F5-BB77C22FA480
Fig. 3

Type material. Holotype: China: ♂, labeled 'CHINA: Yunnan, Tengchong City, Mingguang Town (明光乡), Zizhi Vill. (自治村), Donghe (东河), alt. 2400m, 25°42'57"N, 98°35'42"E, 30-IV-2013, X.-B. Song leg., from a colony of *Dorylus orientalis* / HOLOTYPE [red], *Doryloxenus songzhigaoi* sp. n., Song & Li det. 2014, SNUC'. **Paratype: China:** 3♂, same data as holotype, bearing the following label: 'PARATYPE [yellow], *Doryloxenus songzhigaoi* sp. n., Song & Li det. 2014'. (SNUC).

Comparative notes. *Doryloxenus songzhigaoi* is most similar to *D. nepalensis* Naomi in general appearance, but can be easily separated from it by the different macrochaetotaxy of abdominal tergites II–VIII. The new species can be distinguished from the other congener known from the Gaoligong Shan, *D. yunnanus*, by the slender tergite VIII, rounded apex of sternite VIII, and different shape of the aedeagal median lobe.

Description. Body (Figs 3A, 4D) smooth, glabrous. Coloration: Light reddish-yellow overall.

Forebody shaped as in Fig. 3A, with sparse punctation. Head shaped as in Fig. 3B. Pronotum (Fig. 3A) about 1.71 times as wide as long. Elytra (Fig. 3A, C) about 2.55 times as wide as long. Abdomen wedge-shaped; posterior margins of tergite II–VI

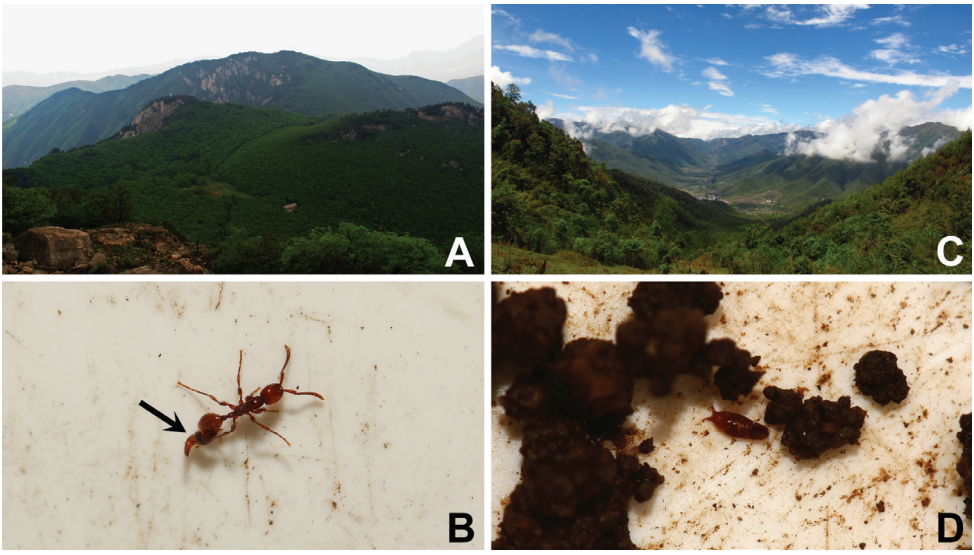


Figure 4. A Longwangshan Natural Reserve **B** *D. tangliangi* riding on the abdomen of an *Aenictus* ant **C** Type locality of *D. songzhigaoi* (Donghe, Zizhi Village) **D** *D. songzhigaoi*, habitus.

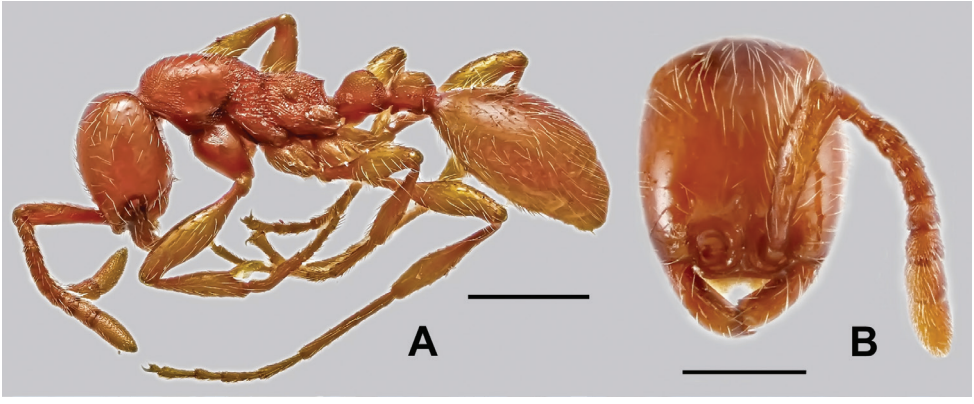


Figure 5. Host ant of *D. aenictophilus* and *D. tangliangi* **A** *Aenictus* sp., in lateral view **B** ditto, head in full face view. Scales (mm): **A** = 0.5; **B** = 0.3.

with a row of very long yellowish setae; abdominal tergite VII (Fig. 3D) truncate at apex, with 2 pairs macrochaetae at middle and 3 pairs near apex; tergite VIII (Fig. 3E) slightly truncate at apex, with 1 pair of lateral macrochaetae and 2 pairs near apex; sternite VIII shaped as in Fig. 3F. Macrochaetotaxy of abdominal tergites II–VIII: 4, 2, 4, 4, 4, 10, 6.

Male. Median lobe of aedeagus shaped as in Fig. 3G–H.

Female. Unknown.

Measurements. BL: 1.51–1.61; FBL: 0.69–0.72; PL: 0.31–0.33; PW: 0.53–0.56; PW/PL: 1.66–1.74; HW/PW: 0.56–0.64.

Distribution. Southwest China: Yunnan.
Symbiotic host. *Dorylus orientalis* Westwood, 1835.
Etymology. Named after Mr. Zhi-Gao Song, the senior author's father.

Key to the species of *Doryloxenus* from China

1 Forebody glabrous, with sparse and fine punctation **2**
– Forebody sparsely covered with yellow setae **5**
2 Body broad; abdominal tergites and paratergites sparsely covered with setae ... **3**
– Body slender; abdominal paratergites without setae. (Hongkong) ..... ***D. hongkongensis* Pace**
3 Posterior margin of elytra slightly concave **4**
– Posterior margin of elytra truncate. (Hongkong) ..... ***D. rougemonti* Pace**
4 Abdominal sternite VIII rounded at apex; aedeagus shaped as in Fig. 3G–H. (Yunnan) ..... ***D. songzhigaoi* sp. n.**
– Abdominal sternite VIII slightly truncate at apex; aedeagal distal crest well developed, apical lobe curved ventrad at the middle. (Yunnan) ..... ***D. yunnanus* Assing**
5 Eyes generalized in size; elytra relatively long; hind wings. (Zhejiang) ..... ***D. tangliangi* sp. n.**
– Eyes small; elytra short; hind wings reduced. (Zhejiang) ... ***D. aenictophilus* sp. n.**

Acknowledgements

We thank Mr. Weeyawat Jaitrong for sending reprints. We are especially grateful to Dr. Munetoshi Maruyama and Mr. Weeyawat Jaitrong for offering many helpful suggestions during this study. We thank Cong-Chao Dai, Jia-Yao Hu, Liang Tang and Zhong Peng (both Shanghai, China) for their support during the field work. Two anonymous reviewers critically read the manuscript and provided helpful advice. The study is supported by the National Natural Science Foundation of China (No. 31101659 and No. 31172134, 31201734) and Shanghai Normal University (DZL125).

References

Assing V (2009) New species and additional records of Homalotini, Athetini, Pygostenini, and Lomechusini from Yunnan, China (Coleoptera: Staphylinidae: Aleocharinae). Linzer biologische Beiträge 41(1): 485–507.

Jacobson HR (1980) Additional species and records from Africa of the myrmecophilous tribe Pygostenini (Coleoptera, Staphylinidae). Annales historic-naturales Musei natioalis hungarici 72: 133–138.

Jacobson HR, Kistner DH (1975) A manual for the indication of the Pygostenini, the natural history of the myrmecophilous tribe Pygostenini. Sociobiology 1: 201–335.

Jaitrong W, Yamane S (2011) Synopsis of *Aenictus* species groups and revision of the *A. currax* and *A. laeviceps* groups in the eastern Oriental, Indo-Australian, and Australasian regions. Zootaxa 3128: 1–46.

Kistner DH, Berghoff SM, Maschwitz U (2003) Myrmecophilous Staphylinidae (Coleoptera) associated with *Dorylus* (*Dichthadia*) *laevigatus* (Hymenoptera: Formicidae) in Malaysia with studies of their behavior. Sociobiology 41(1): 209–266.

Naomi S (1996) Two new species of the tribe Pygostenini (Coleoptera, Staphylinidae, Aleocharinae) from Taiwan and Nepal. Entomological Review of Japan 51: 23–26.

Pace R (1998) Aleocharinae della Cina: Parte IV (Coleoptera, Staphylinidae). Revue Suisse de Zoologie 105: 911–982.

ZooKeys 456: 85–107 (2014)
doi: 10.3897/zookeys.456.8465
http://zookeys.pensoft.net

RESEARCH ARTICLE

A peer-reviewed open-access journal
ZooKeys
Launched to accelerate biodiversity research

Description of six new species of *Lycocerus* Gorham (Coleoptera, Cantharidae), with taxonomic note and new distribution data of some other species

Yuxia Yang[1], Junyan Su[1], Xingke Yang[2]

1 *College of Life Sciences, Hebei University, Baoding 071002, Hebei Province, China* **2** *Key Laboratory of Zoological Systematics and Evolution, Institute of Zoology, Chinese Academy of Sciences, Beijing 100101, China*

Corresponding author: *Yuxia Yang* (yxyang@hbu.edu.cn)

Academic editor: *L. Penev* | Received 22 August 2014 | Accepted 20 October 2014 | Published 21 November 2014

http://zoobank.org/71EC0955-E0A6-48A8-88AE-9C4F1E3BD53D

Citation: Yang Y, Su J, Yang X (2014) Description of six new species of *Lycocerus* Gorham (Coleoptera, Cantharidae), with taxonomic note and new distribution data of some other species. ZooKeys 456: 85–107. doi: 10.3897/zookeys.456.8465

Abstract

Six new species of *Lycocerus* Gorham are described, *L. gracilicornis* **sp. n.** (China: Sichuan), *L. longihirtus* **sp. n.** (China: Yunnan), *L. sichuanus* **sp. n.** (China: Sichuan), *L. hubeiensis* **sp. n.** (China: Hubei), *L. napolovi* **sp. n.** (Vietnam: Sa Pa) and *L. quadrilineatus* **sp. n.** (Vietnam: Sa Pa), and provided with illustrations of habitus, antennae and aedeagi of male or and antennae, abdominal sternites VIII and genitalia of female. *L. rubroniger* Švihla, 2011 is synonymized with *L. obscurus* Pic, 1916. *L. hickeri* Pic, 1934 and *L. obscurus* are provided with illustrations of abdominal sternites VIII of female. Nine species are recorded from China for the first time, *L. bicoloripennis* (Pic, 1924), *L. caliginostus* Gorham, 1889, *L. jendeki* Švihla, 2005, *L. malaisei* (Wittmer, 1995), *L. obscurus*, *L. olivaceus* (Wittmer, 1995), *L. purpureus* Kazantsev, 2007, *L. ruficornis* (Wittmer, 1995) and *L. semiextensus* (Wittmer, 1995), and *L. ruficornis* is also recorded for Myanmar for the first time.

Keywords

Taxonomy, *Lycocerus*, new species, synonym, new records, China, Vietnam, Myanmar

Copyright *Yuxia Yang et al.* This is an open access article distributed under the terms of the Creative Commons Attribution License (CC BY 4.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

Introduction

Lycocerus Gorham, 1889 *sensu lato* (Okushima 2005) is one of the largest genera of cantharid beetles, with more than 300 species widely distributed in the Oriental and eastern Palaearctic Regions (Kazantsev and Brancucci 2007). The species of *Lycocerus* in a strict sense, which are characterized by the broad antennomeres and the red, generally densely pubescent pronotum and elytra, from Indochina and adjacent regions, were revised by Kazantsev (1999); later some similar species were added by Švihla (2011) and Okushima and Yang (2013). Following these studies, six new species from China and Vietnam, which are similar to *L. hickeri* Pic, 1934, were discovered recently. The new species are described here under the names of *L. gracilicornis* sp. n., *L. longihirtus* sp. n., *L. sichuanus* sp. n., *L. hubeiensis* sp. n., *L. napolovi* sp. n. and *L. quadrilineatus* sp. n.

Additionally, *L. rubroniger* Švihla, 2011 is considered to be a junior synonym of *L. obscurus* Pic, 1916. Besides, nine species are recorded from China for the first time: *L. bicoloripennis* (Pic, 1924), *L. caliginostus* Gorham, 1889, *L. jendeki* Švihla, 2005, *L. malaisei* (Wittmer, 1995), *L. obscurus*, *L. olivaceus* (Wittmer, 1995), *L. purpureus* Kazantsev, 2007, *L. ruficornis* (Wittmer, 1995) and *L. semiextensus* (Wittmer, 1995), and *L. ruficornis* is also a first record for Myanmar.

Material and methods

The material is preserved in the following collections, and the primary types were returned to the collections from which they were borrowed or were otherwise deposited in public museums.

CAS	California Academy of Sciences, San Francisco, USA;
IZAS	Institute of Zoology, Chinese Academy of Sciences, Beijing, China;
MCSNG	Museo Civico di Storia Naturale “Giacomo Doria”, Genova, Italy;
MHBU	Museum of Hebei University, Baoding, China;
MNHN	Muséum national d’Histoire naturelle, Paris, France;
NHMB	Naturhistorisches Museum Basel, Switzerland;
NMPC	Narodni muzeum, Praha, Czech Republic;
ZIN	Zoological Institute, Russian Academy of Sciences, St. Petersburg, Russia.

The genitalia of both sexes and abdominal sternites VIII of females were dissected and cleared in 10% KOH solution, and the female genitalia was dyed with hematoxylin. Habitus photos were taken with a Leica M205 A microscope, multiple layers were stacked using Combine ZM (Helicon Focus 5.3). Line drawings were made with the aid of camera lucida attached to a Leica MZ12.5 stereomicroscope, then edited in CorelDRAW 12 and Adobe Photoshop 8.0.1.

Complete label data are listed for type specimens, using brackets “[ ]” for our remarks and comments, [p] indicating that the following data are printed and [h] that

they are handwritten. Quotation marks are used to separate data from different labels and a backslash "\" to separate data from different lines of the same label.

Body length was measured from the anterior margin of the clypeus to the elytral apex and body width across the humeral part of elytra. Morphological terminology of female genitalia follows that of Brancucci (1980). The abbreviations in the figures are as follows, ag: accessory gland; co: coxite; di: diverticulum; tg9: abdominal tergite IX; sd: spermathecal duct; sp: spermatheca; ov: median oviduct; va: vagina.

Taxonomy

Lycocerus hickeri species-group

Diagnosis. Antennae (Fig. 7) nearly filiform, or middle antennomeres slightly widened apically, nearly long-triangular (Figs 8−15), present with narrow longitudinal to round smooth impressions along outer margins of antennomeres IV−XI in male. Pronotum subquadrate, with lateral margins slightly to moderately diverging posteriorly. Elytra elongate, red, more or less darkened at elytral interstices, present with more or less developed elytral venation and costate, surface rugulose-lacunose, densely and coarsely punctate, matt, combined with sparse, short, decumbent reddish-brown pubescence and much longer, semierect reddish-brown pubescence and erect black pubescence. Tarsal claws variable, either simple in both sexes, or pro- and meso-outer claws with basal projections in both sexes or in female while simple in male, or pro- and meso-inner and outer claws with basal projections in female while simple in male. Female genitalia (Figs 39−41): vagina stout and extended apically as a thick duct; diverticulum and spermathecal duct arising from the end of the duct of vagina; diverticulum moderately long, thin and spiral; spermathecal duct much thicker than diverticulum; spermatheca as thick as spermathecal duct at basal portion, abruptly narrowed apically, thin and spiral at apical portion, much longer than diverticulum, provided with moderately long and thin accessory gland.

Distribution. China (Yunnan, Sichuan, Hubei); Vietnam (Sa Pa).

Remarks. This species group could be distinguished from other species of *Lycocerus* by the characteristic sculpture and pubescence of elytra. The female genitalia of the species are very similar, but each could be differentiated by the structure of aedeagus, abdominal sternite VIII of female, antennae, pronotum and tarsal claws of both sexes.

Key to the species of *Lycocerus hickeri* species-group

1 Pro- and meso-outer tarsal claws each with a basal projection in male..... **2**
– All claws simple in male..... **4**
2 Pronotum nearly as long as wide; aedeagus: dorsal plate of each paramere with inner margin nearly arcuate ..... ***L. longihirtus* sp. n.**

– Pronotum distinctly longer than wide; aedeagus: dorsal plate of each paramere with inner margin bisinuate **3**

3 Aedeagus: ventral process of each paramere even and nearly straight in lateral view ..... ***L. sichuanus* sp. n.**

– Aedeagus: ventral process of each paramere narrowed at base and slightly bent dorsally in lateral view ..... ***L. hubeiensis* sp. n.**

4 Pronotum nearly as long as wide, with lateral margins slightly diverging posteriorly **5**

– Pronotum longer than wide, with lateral margins moderately diverging posteriorly **6**

5 Antennae with middle antennomeres widened apically; elytra not darkened at elytral interstices, elytral venation well-developed, distinctly costate ..... ***L. hickeri* Pic, 1934**

– Antennae nearly filiform; elytra darkened at the second elytral interstices, elytral venation slightly developed, not costate ..... ***L. gracilicornis* sp. n.**

6 Elytra black at all elytral interstices; pronotum distinctly longer than wide; aedeagus: ventral process of each paramere normal, nearly straight in lateral view, dorsal plate with inner margin nearly straight, outer angle obtuse-angled ..... ***L. quadrilineatus* sp. n.**

– Elytra black at the first and second elytral interstices; pronotum slightly longer than wide; aedeagus: ventral process of each paramere flattened and twist in middle in ventral view, distinctly bent dorsally in lateral view, dorsal plate with inner margin distinctly protuberant in middle, outer angle triangular and bent ventrally ..... ***L. napolovi* sp. n.**

Taxonomy

Lycocerus hickeri Pic, 1934

Fig. 34

Lycocerus hickeri Pic, 1934: 46.
Athemellus hickeri: Kazantsev, 1999: 119.

Type specimens examined. Lectotype ♀ (NHMB): [p] "Asia, China", [p] "coll. Richard \ Hicker, Wien", [h] "hickeri n. sp.", [p] "Athemus \ hickeri (Pic) \ det. S. Kasantsev 1996", [p] "LECTOTYPUS", [p] "CANTHARIDAE \ CANTH00000915".

Distribution. China.

Remarks. This species was described on the basis of female types, and its locality is not accurate within China. Here the abdominal sternite VIII (Fig. 34) of the female is illustrated for the first time: it is largely and roundly emarginated in middle and both sides of posterior margin, the portion between middle and lateral emarginations acute-angled at apex.

***Lycocerus gracilicornis* Y. Yang & X. Yang, sp. n.**
http://zoobank.org/7EC71583-2FC5-4151-B4E7-A6B7E4BD550F
Figs 1, 7, 16–18

Type material. Holotype ♂ (IZAS): CHINA, Sichuan, Yajiang to 5km of Litang, 2595m, leg. Gan-Yan Yang. Paratypes: CHINA, Sichuan: 2♂♂ (IZAS): Yajiang, Hekou, Shanbeihou, 2838m, 27.V.2009, leg. Gan-Yan Yang; 1♂ (IZAS): Yajiang, 24.V.2009, leg. Feng Yuan; 1♂ (IZAS): Yajiang, Bajiaolou, 29.V.2009, leg. Zhi-Liang Wang [the above are all transliterated from Chinese labels]; 1♂ (NHMB): "CHINA, Sichuan prov., Mts W. Bamei, 3750m, 12.08.2005, leg. S. Murzin".

Distribution. China (Sichuan).

Description. Male (Fig. 1). Body black, mandibles dark brown, pronotum red, with a large black marking in center of disc, elytra red, distinctly darkened almost along the whole length of the second elytral interstices, slightly darkened at the first elytral interstices.

Head evenly narrowed behind eyes, surface densely and finely punctate, semilustrous, covered with dense, fine, yellowish brown decumbent pubescence; eyes moderately protruding, head width across eyes moderately wider than anterior margin of pronotum; terminal maxillary palpomeres long-triangular, arcuate and sharp at apical one-third length of inner margins; antennae (Fig. 7) filiform, extending to apical one-third length of elytra, antennomeres II slightly longer than wide at apices, III–XI nearly parallel-sided, III about 2.5 times as long as wide, IV about one-third longer than III, XI slightly longer than X and pointed at apices, IV–XI each with a small round smooth impression at apical part of outer margin.

Pronotum nearly as long as wide, widest near posterior margin, anterior margin arcuate, anterior angles rounded, lateral margins slightly diverging posteriorly, posterior angles rectangular, posterior margin slightly arcuate and narrowly bordered, disc moderately convex at posterolateral parts, surface punctate and pubescent like that of head, semilustrous.

Elytra about 5.5 times longer than pronotum, 4.0 times as long as humeral width, which about one-third wider than posterior margin of pronotum, lateral margins nearly parallel, elytral venation slightly developed, not costate.

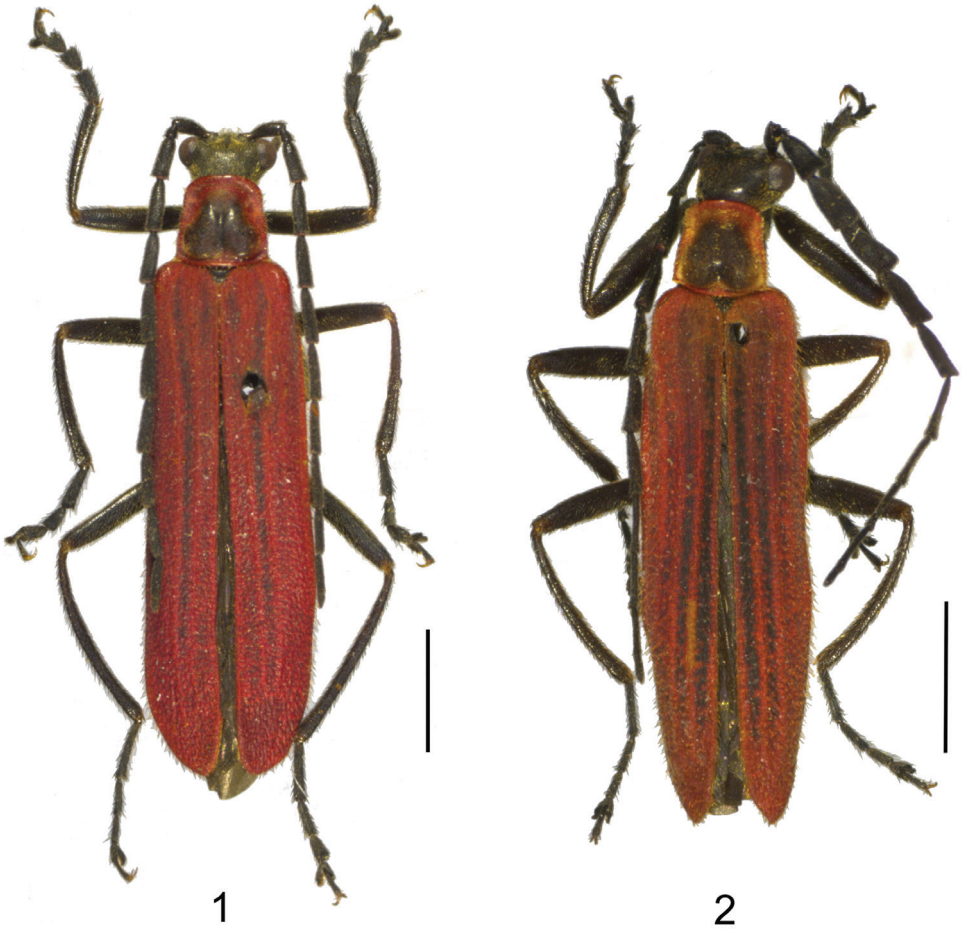
All tarsal claws simple.

Abdominal sternite IX long-triangular. Aedeagus (Figs 16–18): ventral process of each paramere normal and rounded at apex, distinctly narrowed at base and slightly bent dorsally in lateral view; dorsal plate slightly shorter than ventral process, abruptly narrowed at inner apical portion, with inner angle rounded, outer angle obtuse-angled, inner margin sinuate, apical margin rounded; laterophyse with apex pointed laterodorsally to outer angle of dorsal plate.

Female. Unknown.

Body length (males): 8.0–10.0 mm; width: 2.0–2.2 mm.

Etymology. This specific name is derived from Latin *gracilis* (narrow) + *cornu* (horn), referring its antennomeres III–XI nearly parallel-sided.



Figures 1–2. Male habitus, dorsal view: **1** *Lycocerus gracilicornis* sp. n. **2** *L. longihirtus* sp. n. Scale bars: 2.0 mm.

Diagnosis. This species is similar to *L. hickeri* Pic, but the antennae filiform, with antennomeres III−XI nearly parallel-sided; elytral venation less developed and the second elytral interstices darkened.

***Lycocerus longihirtus* Y. Yang & X. Yang, sp. n.**
http://zoobank.org/ED7AEC94-EC7F-4D6B-9B32-39F1DD945BC6
Figs 2, 8, 19–21

Type material. Holotype ♂ (MHBU): CHINA, Yunnan, Yunlong, Tianchi Nat. Res., 9.VII.2011, leg. Hao-Yu Liu. Paratype: 1♂ (MHBU): same data as holotype. [Both transliterated from Chinese labels].

Distribution. China (Yunnan).

Description. Male (Fig. 2). Body black, mandibles dark brown, pronotum red, with a large black marking in center of disc, elytra red, black almost along the whole

length of the first and second elytral interstices, more or less darkened at the third and fourth elytral interstices.

Head evenly narrowed behind eyes, surface densely and finely punctate, semilustrous, covered with dense, fine, yellowish brown decumbent pubescence; eyes moderately protruding, head width across eyes moderately wider than anterior margin of pronotum; terminal maxillary palpomeres long-triangular, arcuate and sharp at apical one-third length of inner margins; antennae (Fig. 8) extending to apical one-third length of elytra, antennomeres II nearly as long as wide at apices, III–XI flattened, III–VIII obliquely widened apically, nearly long-triangular, III about twice as long as wide at apices, IV slightly longer than III, IX–XI nearly parallel-sided, XI slightly longer than X and pointed at apices, IV–XI each with an oval to round smooth impression at apical part of outer margin.

Pronotum nearly as long as wide, widest near posterior margin, anterior margin arcuate, anterior angles rounded, lateral margins slightly diverging posteriorly, posterior angles rectangular, posterior margin slightly arcuate and narrowly bordered, disc moderately convex at posterolateral parts, surface punctate and pubescent like that of head, semilustrous.

Elytra about 5.8 times longer than pronotum, 4.0 times longer than humeral width, which about one-third wider than posterior margin of pronotum, lateral margins nearly parallel, elytral venations moderately developed, slightly costate.

Pro- and meso-outer tarsal claws each with a basal projection.

Abdominal sternite IX long-triangular. Aedeagus (Figs 19–21): ventral process of each paramere normal and rounded at apex, distinctly narrowed at base and slightly bent dorsally in lateral view; dorsal plate distinctly shorter than ventral process, evenly narrowed apically, with inner angle widely rounded, outer angle obtuse-angled, inner margin nearly arcuate, apical margin rounded, around with long pubescence; laterophyse with apex pointed laterodorsally to outer angle of dorsal plate.

Female. Unknown.

Body length (males): 8.0–9.0 mm; width: 1.8–2.0 mm.

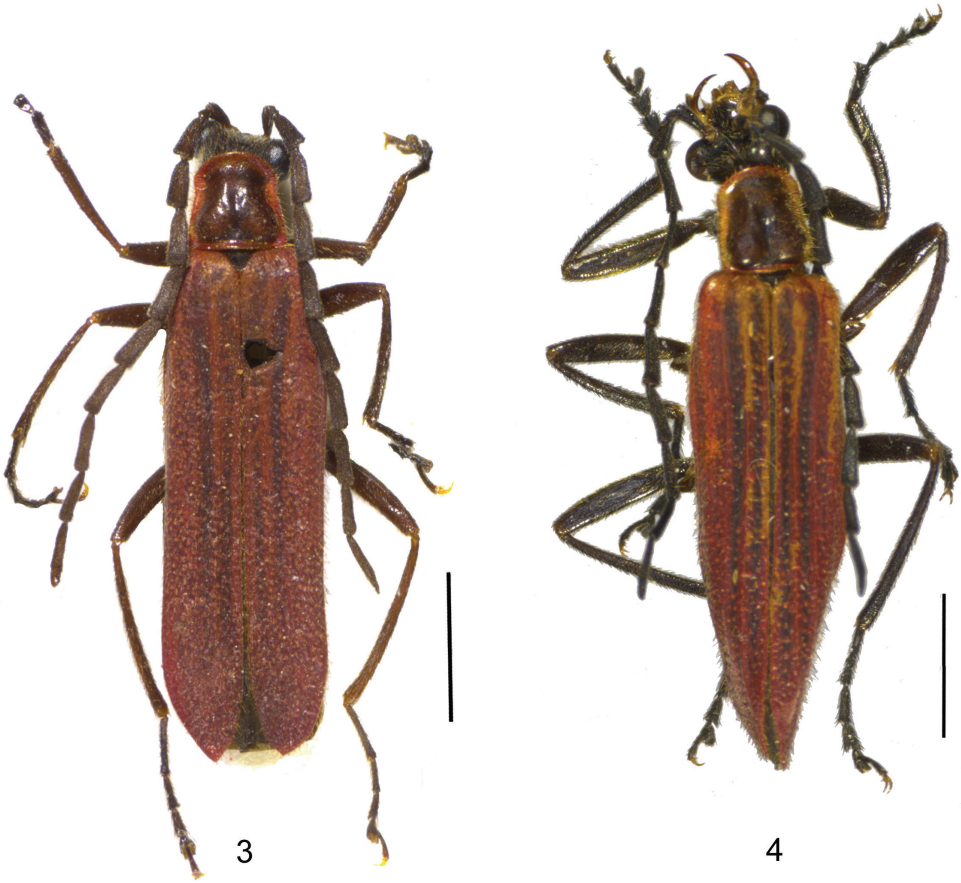
Etymology. This specific name is derived from Latin *longus* (long) and *hirtus* (hairy), referring to its aedeagus: dorsal plate of each paramere covered with long pubescence along apical margin.

Diagnosis. This species is similar to *L. gracilicornis* sp. n., but the antennomeres III–VIII widened apically, nearly long-triangular; elytral venation moderately developed, slightly costate; aedeagus: dorsal plate of each paramere evenly narrowed apically, inner margin arcuate, apical margin around with long pubescence.

Lycocerus sichuanus Y. Yang & X. Yang, sp. n.

http://zoobank.org/36C64C4C-983D-40D0-A440-D76A11086E74
Figs 3, 9–10, 22–24, 35, 39

Type material. Holotype ♂ (IZAS): CHINA, Sichuan, Mt. Emei, Xixiangchi, 1800–2000m, 12.VII.1957, leg. Zong-Yuan Wang. Paratypes: CHINA, Sichuan: 1♂ (IZAS): Mt. Emei, Jiulaodong, 1800–1900m, 26.VII.1957, leg. Ke-Ren Huang; 1♀



Figures 3–4. Male habitus, dorsal view: **3** *Lycocerus sichuanus* sp. n. **4** *L. hubeiensis* sp. n. Scale bars: 2.0 mm.

(IZAS): same locality, 31.VII.1957, leg. You-Cai Yu; 1♀ (IZAS): same locality, 30.VII. 1957, leg. You-Cai Yu; 1♀ (IZAS): same locality, 14.VIII.1957, leg. Zong-Yuan Wang [the above are all transliterated from Chinese labels]; 1♂ (NHMB): "CHINA, Sichuan prov., 70km West Chengdu, Qingcheng Hou Shan mts., 30°44'N, 103°08'E, 1500m, 8.–14.VI.2005, leg. S. Murzin".

Distribution. China (Sichuan).

Description. Male (Fig. 3). Body black, mandibles dark brown, pronotum red, with a large dark brown marking, which almost extending to all margins of disc, elytra red, nearly black at the whole length of the first and second elytral interstices, more or less darkened at the third and fourth elytral interstices.

Head evenly narrowed behind eyes, surface densely and finely punctate, semilustrous, covered with dense, fine, yellowish brown decumbent pubescence; eyes strongly protruding, head width across eyes distinctly wider than anterior margin of pronotum; terminal maxillary palpomere long-triangular, nearly truncate and sharp at apical one-third length of inner margin; antennae (Fig. 10) extending to apical one-third length

of elytra, antennomeres II nearly as long as wide at apices, III–XI flattened, III–VIII obliquely widened apically, nearly long-triangular, III about twice as long as wide at apices, IV slightly longer than III, IX–XI nearly parallel-sided, XI slightly longer than X and pointed at apices, IV–XI each with an oval to round smooth impression at apical part of outer margin.

Pronotum distinctly longer than wide, widest near posterior margin, anterior margin rounded, anterior angles rounded, lateral margins moderately diverging posteriorly, slightly sinuate at anterior portion, posterior angles rectangular, posterior margin slightly arcuate and narrowly bordered, disc moderately convex at posterolateral parts, surface punctate and pubescent like that of head, semilustrous.

Elytra about 4.7 times longer than pronotum, 3.7 times longer than humeral width, which about one-third wider than posterior margin of pronotum, lateral margins nearly parallel, elytral venations moderately developed, slightly costate.

Pro- and meso-outer tarsal claws each with a basal projection.

Abdominal sternite IX long-triangular. Aedeagus (Figs 22–24): ventral process of each paramere normal and rounded at apex, even and nearly straight in lateral view; dorsal plate slightly shorter than ventral process, evenly narrowed at inner apical portion and slightly widened at inner angle, with inner angle acute-angled, outer angle obtuse-angled, inner margin bisinuate, apical margin rounded; laterophyse with apex pointed laterodorsally to outer angle of dorsal plate.

Female. Similar to the male, but eyes less protruding; antennae (Fig. 9) shorter, extending to basal one-third length of elytra, antennomeres III about twice as long as wide at apices, IV–XI without impressions; pronotum nearly as long as wide, disc slightly convex on posterolateral parts; elytra with lateral margins slightly diverging posteriorly; abdominal sternite VIII (Fig. 35) roundly emarginated in middle and triangularly emarginated on both sides of posterior margin, the portion between middle and lateral emarginations obtuse-angled at apex; internal reproductive organ of genitalia see Fig. 39.

Body length (both sexes): 8.0–10.0 mm; width: 1.8–2.0 mm.

Etymology. This specific name is derived from its locality, Sichuan Province, China.

Diagnosis. This species is similar to *L. hubeiensis* sp. n., but differs from the latter by the antennae of female much narrower, antennomeres III about twice as long as wide at apices; aedeagus: ventral process of each paramere even and nearly straight in lateral view; abdominal sternite VIII of female with the portion between middle and lateral emarginations of posterior margin obtuse-angled at apex.

***Lycocerus hubeiensis* Y. Yang & X. Yang, sp. n.**

http://zoobank.org/1DB00DF3-2E20-45D5-B126-BA23BD1E80AB

Figs 4, 11–12, 25–27, 36, 40

Type material. Holotype ♂ (MHBU): CHINA, Hubei, Dalaoling Nat. Res., 1200m, 9.VII.2011, leg. Xue-Song Guan. Paratypes: CHINA, Hubei: 1♀ (MHBU): Dalaol-

ing Nat. Res., 1200m, 9.VII.2011, leg. Xiao-Long Yang; 1♀ (MHBU): same data, 10.VII.2011; 1♂ (MHBU): Badong, Lvcongpo, 1700m, 18.VII.2006, leg. Jun-Hua Wan; 1♀ (MHBU): Badong, Tiansanping, 1500m, 14.VII.2006, leg. Ping Hu; 1♀ (MHBU): Shennongjia, Bajiaomiao, 900−1300m, 17.VII.2003, leg. Yuan He; 1♀ (MHBU): same locality, 19.VII.2003, leg. Jun Ma; 1♂ (MHBU): Shennongjia, Wenshui Forestry, 1700−2000m, 20.VII.2003, leg. Hua He; 1♀ (MHBU): Wufeng, Houhe, 21.VII.2002, leg. Ying Shi; 1♀ (IZAS): Xingshan, Longmenhe, 1300m, 15.VI.1993, leg. Jian Yao; 1♀ (IZAS): same locality, 1350m, 18.VII.1993, leg. Xiao-Lin Chen; 1♀ (IZAS): same locality, 1400m, 22.VII.1993, leg. Shi-Mei Song; 1♀ (IZAS): same locality, 1670m, 23.VII.1993, leg. Xing-Ke Yang. [All are transliterated from Chinese labels].

Distribution. China (Hubei).

Description. Male (Fig. 4). Body black, mandibles dark brown, pronotum red, with a large dark brown marking, which almost extending to all margins of disc, elytra red, nearly black at the whole length of the first and second elytral interstices, more or less darkened at the third and fourth elytral interstices.

Head evenly narrowed behind eyes, surface densely and finely punctate, semilustrous, covered with dense, fine, yellowish brown decumbent pubescence; eyes strongly protruding, head width across eyes distinctly wider than anterior margin of pronotum; terminal maxillary palpomere long-triangular, nearly truncate and sharp at apical one-third length of inner margin; antennae (Fig. 12) extending to apical one-third length of elytra, antennomeres II nearly as long as wide at apices, III−XI flattened, III−IX obliquely widened apically, nearly long-triangular, III about twice as long as wide at apices, IV slightly longer than III, X−XI nearly parallel-sided, XI slightly longer than X and pointed at apices, IV−XI each with an oval to round smooth impression at apical part of outer margin.

Pronotum distinctly longer than wide, widest near posterior margin, anterior margin rounded, anterior angles rounded, lateral margins moderately diverging posteriorly, slightly sinuate at anterior portion, posterior angles rectangular, posterior margin slightly arcuate and narrowly bordered, disc moderately convex at posterolateral parts, surface punctate and pubescent like that of head, semilustrous.

Elytra about 5.3 times longer than pronotum, 3.7 times longer than humeral width, which about one-third wider than posterior margin of pronotum, lateral margins nearly parallel, elytral venations moderately developed, slightly costate.

Pro- and meso-outer tarsal claws each with a basal projection.

Abdominal sternite IX long-triangular. Aedeagus (Figs 25–27): ventral process of each paramere normal and rounded at apex, distinctly narrowed at base and slightly bent dorsally in lateral view; dorsal plate distinctly shorter than ventral process, evenly narrowed at inner apical portion and slightly widened at inner angle, with inner angle acute-angled, outer angle obtuse-angled, inner margin bisinuate, apical margin rounded; laterophyse with apex pointed laterodorsally to outer angle of dorsal plate.

Female. Similar to male, but eyes less protruding; antennae (Fig. 11) shorter, extending to elytral midlength, antennomeres III−XI distinctly widened, III about 1.6 times

longer than wide at apices, IV–XI without impressions; pronotum nearly as long as wide, disc slightly convex on posterolateral parts; elytra with lateral margins slightly diverging posteriorly; abdominal sternite VIII (Fig. 36) largely and roundly emarginated in middle and both sides of posterior margin, the portion between middle and lateral emarginations rounded at apex; internal reproductive organ of genitalia see Fig. 40.

Body length (both sexes): 7.5–11.0 mm; width: 1.5–2.3 mm.

Etymology. This specific name is derived from its locality, Hubei Province, China.

Diagnosis. This species is similar to *L. sichuanus* sp. n. in the aedeagus, but differs from the latter by the antennae of female much wider, antennomeres III about 1.6 times longer than wide at apices; aedeagus: ventral process of each paramere narrowed at base and slightly bent dorsally in lateral view; abdominal sternite VIII of female with the portion between middle and lateral emarginations of posterior margin rounded at apex.

***Lycocerus napolovi* Y. Yang & X. Yang, sp. n.**

http://zoobank.org/18BFD8BA-1595-4EBF-9E4A-A6F75C805965

Figs 5, 13, 28–30

Type material. Holotype ♂ (ZIN): "Vietnam N, (Sa Pa), Lao Cai prov., 250km from Hanoi bearing 310#, Sa Pa vill. env., Hoang Lien Son Nat. Res., 1250-1300m, 15.-21.6.1998, leg. A. Napolov".

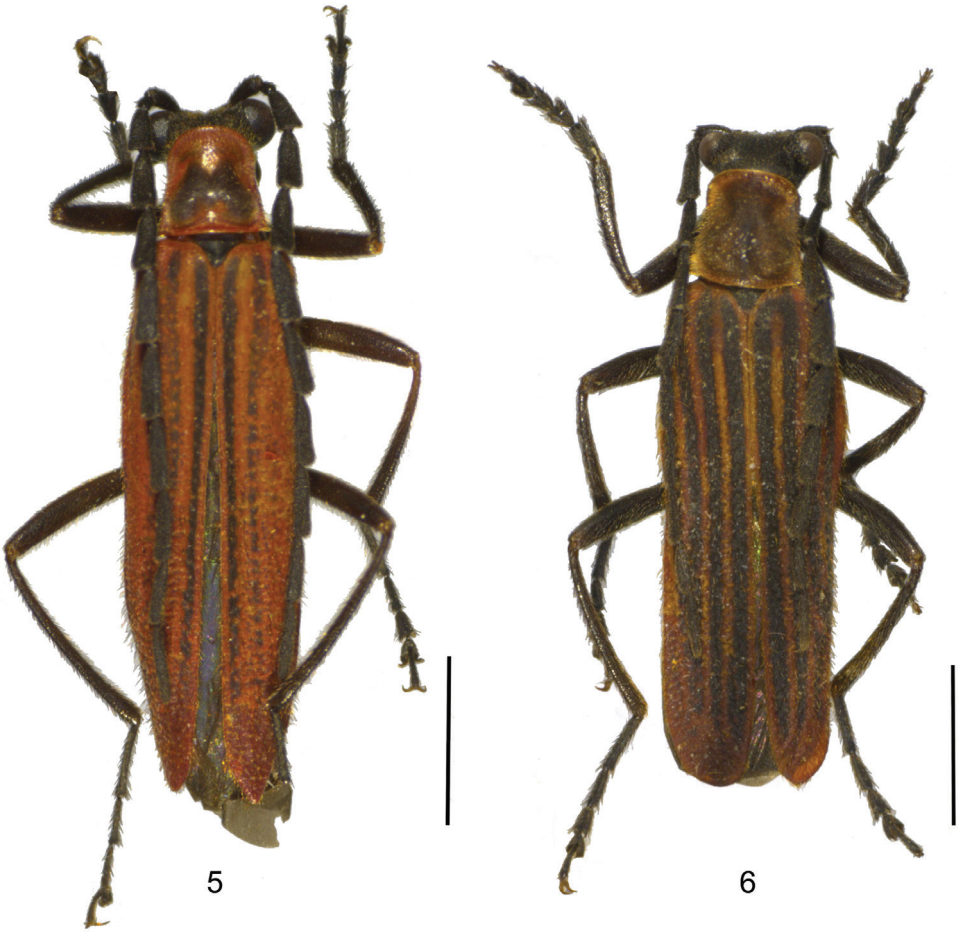
Distribution. Vietnam (Sa Pa).

Description. Male (Fig. 5). Body black, mandibles dark brown, pronotum red, with a large black marking in center of disc, elytra red, nearly black at the whole length of the first and second elytral interstices.

Head evenly narrowed behind eyes, surface densely and finely punctate, semilustrous, covered with dense, fine, yellowish brown decumbent pubescence; eyes strongly protruding, head width across eyes distinctly wider than anterior margin of pronotum; terminal maxillary palpomere long-triangular, nearly truncate and sharp at apical one-third length of inner margin; antennae (Fig. 13) almost extending to apical one-fourth length of elytra, antennomeres II nearly as long as wide at apices, III–XI flattened, III–IX obliquely widened apically, nearly long-triangular, III about twice as long as wide at apices, IV slightly longer than III, X–XI nearly parallel-sided, XI slightly longer than X and pointed at apices, IV–XI each with a short narrow longitudinal smooth impression at apical part of outer margin.

Pronotum distinctly longer than wide, widest near posterior margin, anterior margin rounded, anterior angles rounded, lateral margins moderately diverging posteriorly, slightly sinuate at anterior portion, posterior angles rectangular, posterior margin slightly arcuate and narrowly bordered, disc moderately convex at posterolateral parts, surface punctate and pubescent like that of head, semilustrous.

Elytra about 5.3 times longer than pronotum, 4.0 times longer than humeral width, which about one-third wider than posterior margin of pronotum, lateral margins nearly parallel, elytral venations moderately developed, slightly costate.



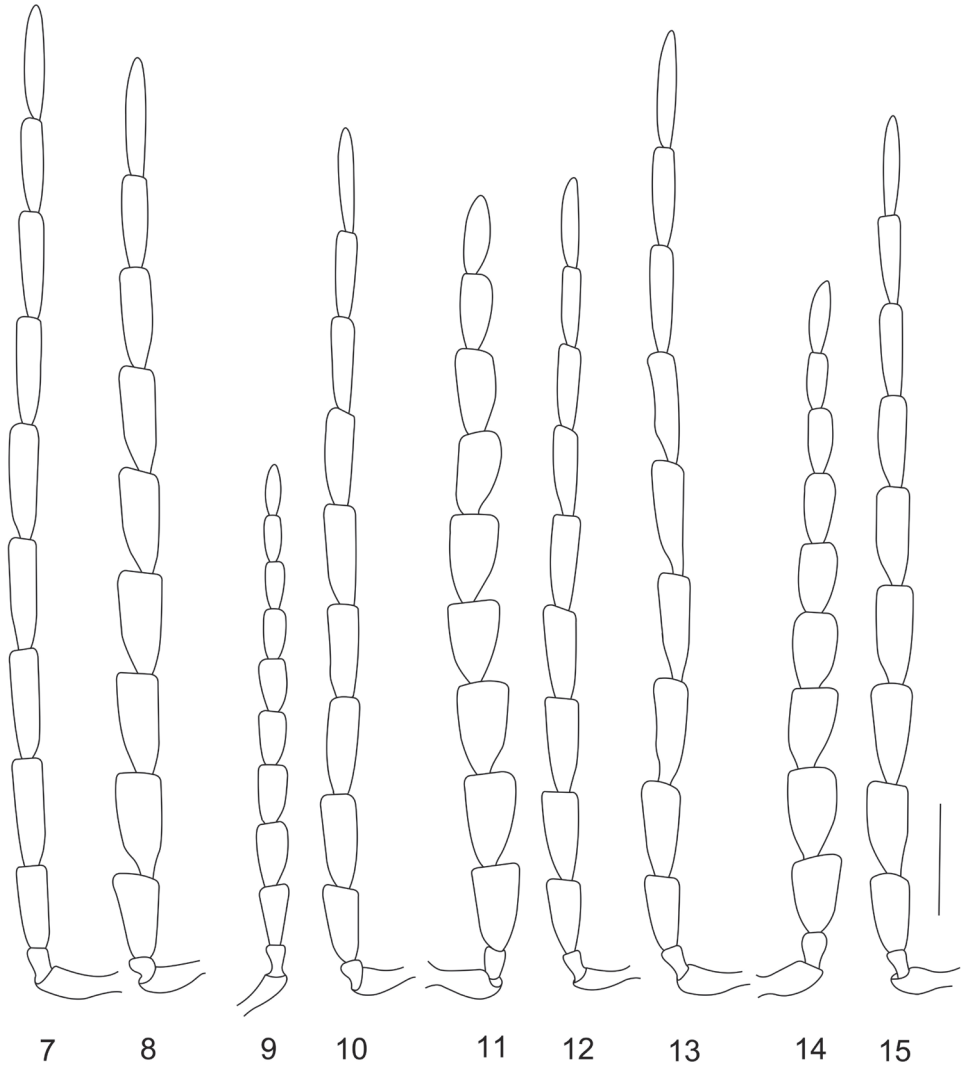
Figures 5–6. Male habitus, dorsal view: **5** *Lycocerus napolovi* sp. n. **6** *L. quadrilineatus* sp. n. Scale bars: 2.0 mm.

All tarsal claws simple.

Abdominal sternite IX long-triangular. Aedeagus (Figs 28–30): ventral process of each paramere flattened, twist in middle and tapered at apex in ventral view, slightly narrowed at base and distinctly bent dorsally in lateral view; dorsal plate slightly shorter than ventral process, abruptly narrowed at inner apical portion, with a longitudinal ridge in middle of basal portion, membranous between inner margin and the ridge, inner angle rectangular, outer angle acute-angled and bent ventrally, inner margin distinctly protuberant in middle, apical margin nearly straight, around with long pubescence; laterophyse with apex pointed laterally to outer apical angle of dorsal plate.

Female. Unknown.

Body length (male): 9.0 mm; width: 1.5 mm.

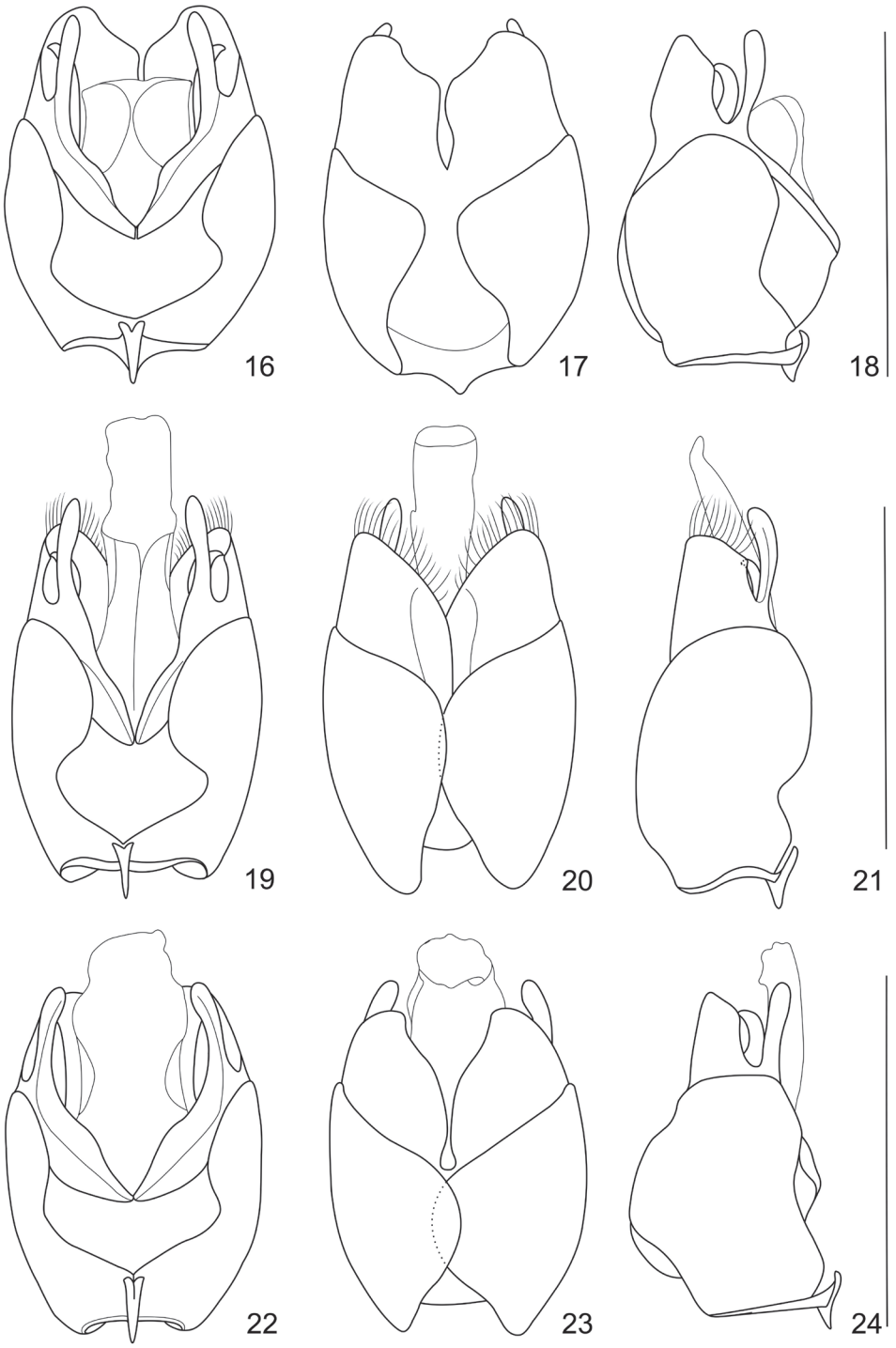


Figures 7–15. Antennae, dorsal views (**7, 8, 10, 12, 13, 15** male; **9, 11, 14** female): **7** *Lycocerus gracilicornis* sp. n. **8** *L. longihirtus* sp. n. **9–10** *L. sichuanus* sp. n.; **11–12** *L. hubeiensis* sp. n. **13** *L. napolovi* sp. n. **14–15** *L. quadrilineatus* sp. n. Scale bar: 1.0 mm.

Etymology. Patronymic, dedicated to its collector, Alexander Napolov (Riga, Latvia).

Diagnosis. This species could be easily distinguished from others by its aedeagus: ventral process of each paramere slightly flattened and twist in middle in ventral view, distinctly bent dorsally in lateral view, dorsal plate with a longitudinal ridge in middle of basal portion, membranous between inner margin and the ridge.

Remarks. The left mesoleg and right metatarsomeres II–V of the holotype are missing.



Figures 16–24. Aedeagus (**16, 19, 22** ventral view; **17, 20, 23** dorsal view **18, 21, 24** lateral view): **16–18** *Lycocerus gracilicornis* sp. n. **19–21** *L. longihirtus* sp. n. **22–24** *L. sichuanus* sp. n. Scale bars: 1.0 mm.

***Lycocerus quadrilineatus* Y. Yang & X. Yang, sp. n.**
http://zoobank.org/EC8B55E5-A8DD-482B-8E79-BFE872697E21
Figs 6, 14–15, 31–33, 37, 41

Type material. Holotype ♂ (ZIN): "N. Vietnam, Sa Pa env., 1200m, 20.V.1999, leg. Ozlov". Paratypes: 1♀ (ZIN): same data as holotype; 1♀ (ZIN): "ВЬЕТНАМ [Vietnam] горы, у ШАА-ГА [Sa Pa], 1600–2000m, 5.6.1963г, Каьакое [Kabakov]".

Distribution. Vietnam (Sa Pa).

Description. Male (Fig. 6). Body black, mandibles dark brown, pronotum red, with a large dark brown marking, which almost extending to all margins of disc, elytra red, nearly black at the whole length of all elytral interstices.

Head evenly narrowed behind eyes, surface densely and finely punctate, semilustrous, covered with dense, fine, yellowish brown decumbent pubescence; eyes strongly protruding, head width across eyes distinctly wider than anterior margin of pronotum; terminal maxillary palpomere long-triangular, nearly truncate and sharp at apical one-third length of inner margin; antennae (Fig. 15) extending to apical one-fourth length of elytra, antennomeres II nearly as long as wide at apices, III–XI flattened, III–IX obliquely widened apically, nearly long-triangular, III about twice as long as wide at apices, IV slightly longer than III, X–XI nearly parallel-sided, XI slightly longer than X and pointed at apices, IV–XI each with a round smooth impression at apical part of outer margin.

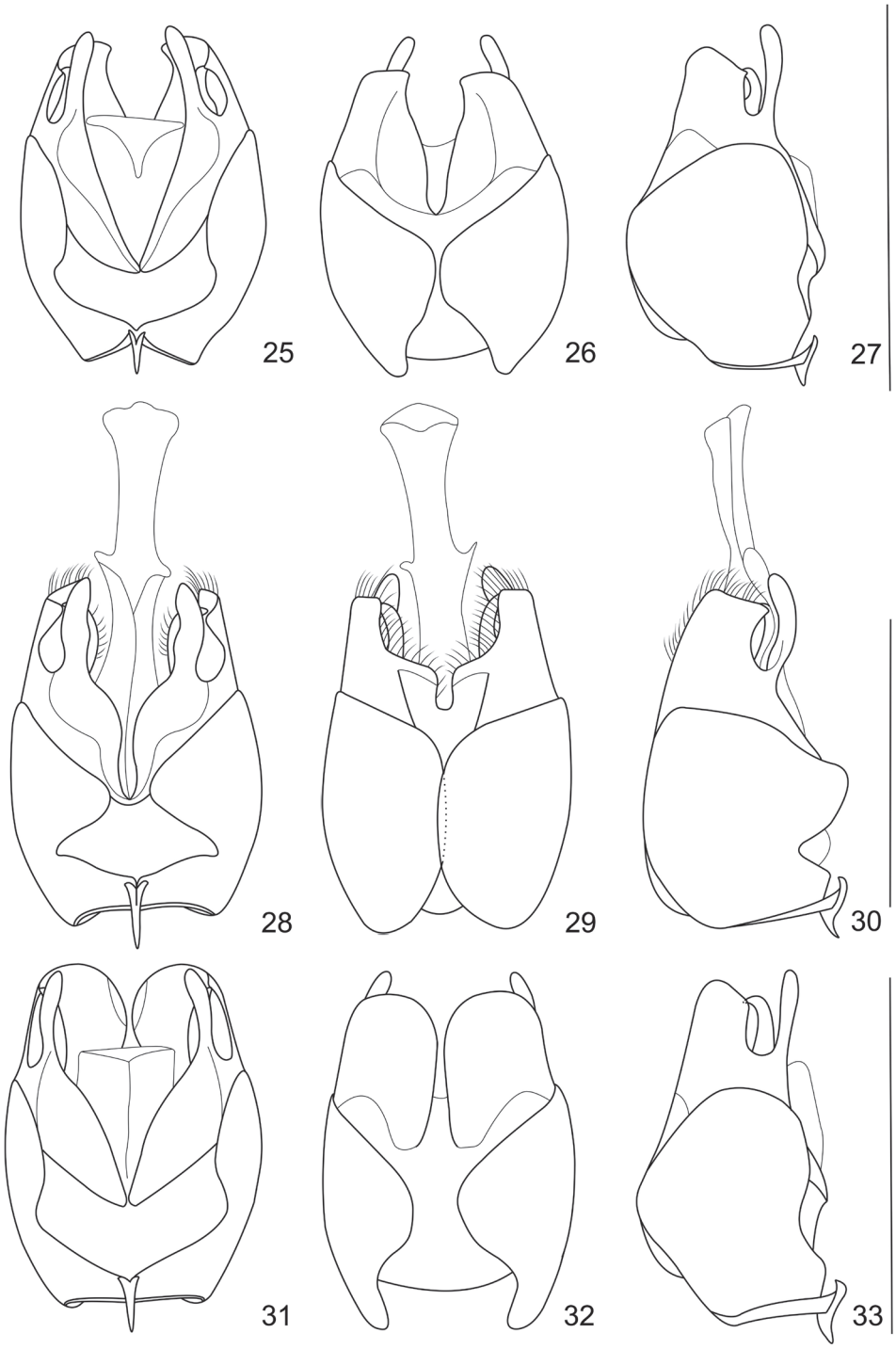
Pronotum slightly longer than wide, widest near posterior margin, anterior margin rounded, anterior angles rounded, lateral margins moderately diverging posteriorly, slightly sinuate at anterior portion, posterior angles rectangular, posterior margin slightly arcuate and narrowly bordered, disc moderately convex at posterolateral parts, surface punctate and pubescent like that of head, matt.

Elytra about 4.3 times longer than pronotum, 3.5 times longer than humeral width, which about one-third wider than posterior margin of pronotum, lateral margins nearly parallel, elytral venations well-developed, moderately costate.

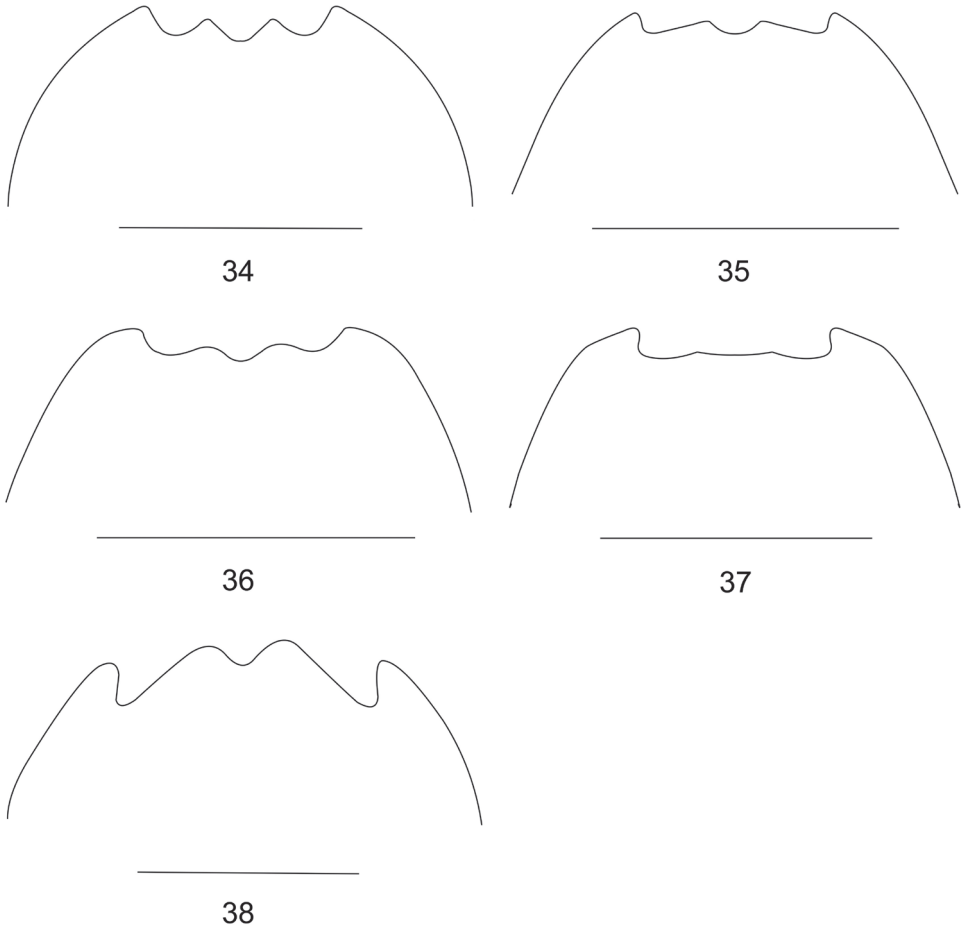
All tarsal claws simple.

Abdominal sternite IX long-triangular. Aedeagus (Figs 31–33): ventral process of each paramere normal and rounded at apex, even and nearly straight in lateral view; dorsal plate slightly shorter than ventral process, not narrowed apically, with inner angle rounded, outer angle obtuse-angled, inner margin nearly straight, apical margin rounded; laterophyse with apex pointed laterodorsally to outer angle of dorsal plate.

Female. Similar to the male, but eyes less protruding; antennae (Fig. 14) shorter, extending to basal one-third length of elytra, antennomeres III about 1.1 times longer than wide at apices, IV–XI without impressions; pronotum nearly as long as wide, disc slightly convex on posterolateral parts; elytra with lateral margins slightly diverging posteriorly; pro- and meso-outer and inner tarsal claws each with a basal projection; abdominal sternite VIII (Fig. 37) very slightly emarginated in middle and largely emarginated on both sides of posterior margin, the portion between middle and lateral



Figures 25–33. Aedeagus (**25, 28, 31** ventral view **26, 29, 32** dorsal view **27, 30, 33** lateral view): **25–27** *Lycocerus hubeiensis* sp. n. **28–30** *L. napolovi* sp. n.; **31–33** *L. quadrilineatus* sp. n. Scale bars: 1.0 mm.



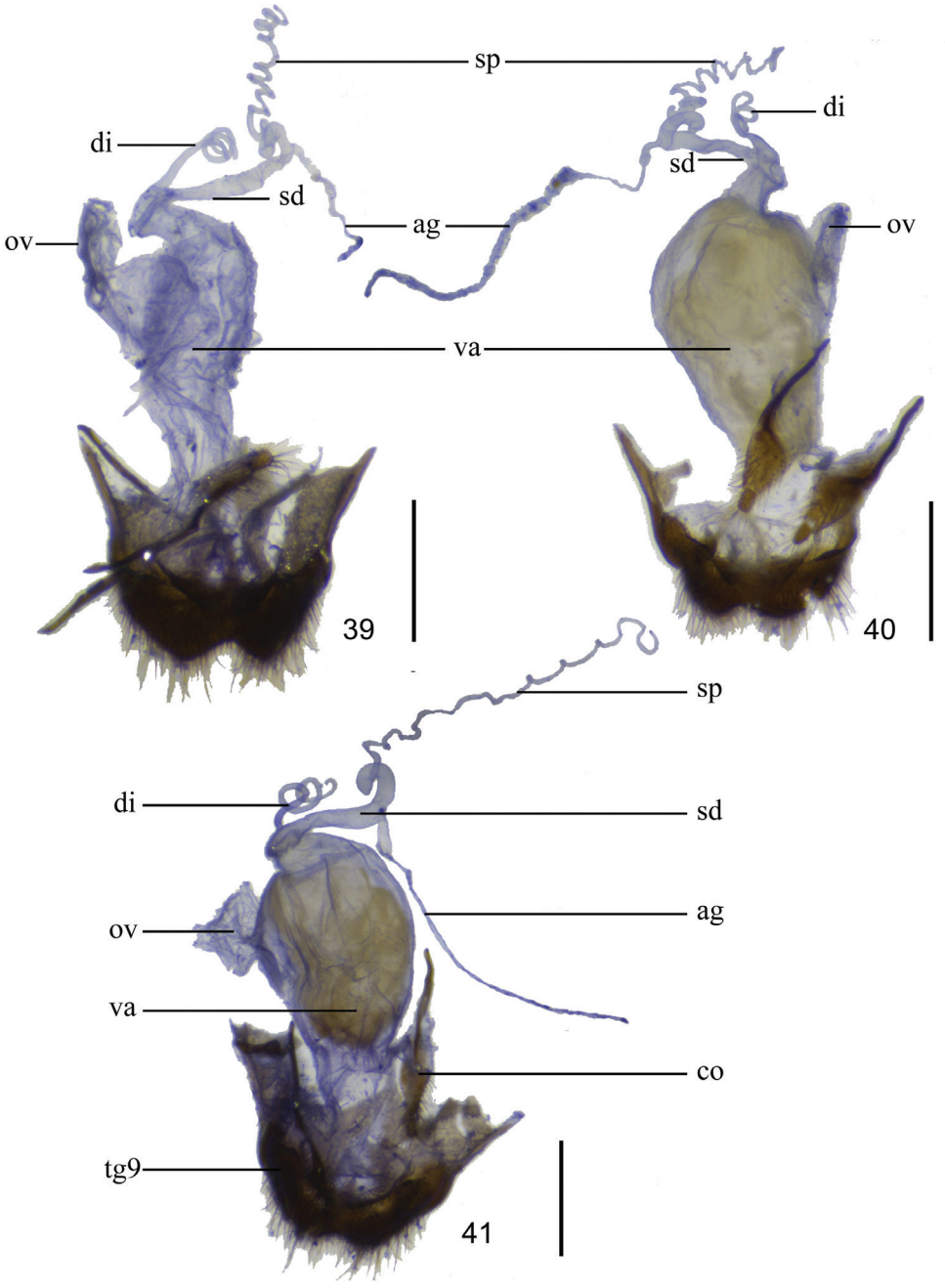
Figures 34–38. Abdominal sternite VIII of female, ventral view: **34** *Lycocerus hickeri* (Pic, 1934) **35** *L. sichuanus* sp. n. **36** *L. hubeiensis* sp. n. **37** *L. quadrilineatus* sp. n. **38** *L. obscurus* Pic, 1916. Scale bars: 1.0 mm.

emarginations indistinctly angled at apex; internal reproductive organ of genitalia see Fig. 41.

Body length (both sexes): 8.5−10.0 mm; width: 2.0−2.2 mm.

Etymology. The specific name is derived from Latin *quadrus* (four) and *linea* (stripe), referring to its elytra darkened at all of the four elytral interstices.

Diagnosis. This species can be easily distinguished from other species by the elytra darkened at all elytral interstices, elytral venation well-developed; all claws simple in male, pro- and meso-outer and inner tarsal claws each with a basal projection in female; aedeagus: dorsal plate of each paramere not narrowed apically.



Figures 39–41. Female genitalia, lateral view: 39. *Lycocerus sichuanus* sp. n.; **40** *L. hubeiensis* sp. n. **41** *L. quadrilineatus* sp. n. Scale bars: 0.5 mm.

New faunistic records

***Lycocerus bicoloripennis* (Pic, 1924)**

Cantharis bicoloripennis Pic, 1924: 478.
Athemus (s.str.) *bicoloripennis*: Wittmer 1995: 273, Figs 137, 138.

Type material examined. Holotype: 1 ♂ (MNHN): [p]"MUSEUM PARIS \ SIKKIM \ DARDJILING \ HARMAND 1890", [h]"Det. M. Pic (Digoin) \ Cantharis \ bicoloripennis \ n. sp.", [h]"Athemus \ bicoloripennis \ (Pic) \ det. W. Wittmer", [p]"HOLOTYPUS".

Additional material examined. CHINA, Xizang: 1 ♂ (IZAS): Nyalam, Zham, 2200m, 28.VI.1975, leg. Zi-Qing Wang; 1 ♂, 1 ♀ (HBUM): Zham, 5.–6.VII.2004, leg. Yi-Bin Ba & Ai-Min Shi.

Distribution. China (new record: Xizang); Nepal, India (Kazantsev and Brancucci 2007).

***Lycocerus caliginostus* Gorham, 1889**

Lycocerus caliginostus Gorham, 1889: 110.
Lycocerus vittaticollis Champion, 1926: 255. [Synonymized by Kazantsev 1999: 130].

Type material examined. Lectotype of *Lycocerus caliginostus*: 1♀ (MNHN): without locality data, [h]"Lycocerus \ caliginosus \ Gorh.", [p] "TYPE".

Paratype of *Lycoerus vittaticollis*: 1♀ (NHMB): [p]"Birmah \ Ruby-mines", [p]"Doherty", [p]"Frey Coll. \ 1905.100.", [p]"♀", [p]"Para \ type", [p]"Lycoerus \ (?) vittaticollis, \ Champ. ", [p]"E.M.M. 1926 \ det. G.C.C.", [h]"L. \ vittaticollis \ Champ. \ det. W. Wittmer", [h]"Athemus \ caliginosus (Gorh.) \det. S. Kazantsev 1996", [p]"CANTHARIDAE \ CANTH00002784", [p]"Naturhistorisches \ Museum Basel \ Coll. W. Wittmer".

Additional material examined. CHINA, Yunnan: 1♀ (IZAS): Menghai, Nannuoshan, 1100–1500m, 27.IV.1957, leg. Guang-Ji Hong; 1♀ (IZAS): Xiaomengyang, 850m, 3.V.1957, leg. Panfilov; 1♂ (IZAS): same data, 2.IV.1957, leg. Ling-Chao Zang; 1♂ (IZAS): Menghai, Nannuoshan, 1250m, 24.IV.1957, leg. Panfilov; 1♂ (IZAS): Xishuangbanna, Mengsong, 1600m, 23.IV.1958, leg. Fu-Ji Pu; 1♀ (IZAS): same data, 25.IV.1958, leg. Chun-Pei Hong; 1♀ (IZAS): same data, leg. Yi-Ran Zhang; 1♀ (IZAS): same data, 22.IV.1958, leg. Xu-Wu Meng; 1♀ (IZAS): same data, 23.IV.1958, leg. Shu-Yong Wang; 1♂ (IZAS): same data, 22.IV.1958, leg. Shu-Yong Wang; 1♂ (IZAS): Cheli, Shihuiyao, 750m, 27.IV.1958, leg. Panfilov; 1♀ (IZAS): Simao, 1300m, 31.IV.1957, leg. Bushchik.

Distribution. China (new record: Yunnan); Laos, Thailand, Myanmar (Kazantsev 1999).

Lycocerus jendeki Švihla, 2005

Lycocerus jendeki Švihla, 2005: 94, figs 48–51.

Type material examined. Holotype: 1♂ (NMPC): [p]"LAOS north, 5–11.V.1997, \ 20 km NW Louang Namtha, \ N21°09.2, E 101°18.7, \ alt. 900±100 m, \ E. Jendek & O. Šauša leg.", [p]"HOLOTYPUS \ Lycocerus \ jendeki sp. nov. \ V. Švihla det. 2005".

Additional material examined. CHINA, Yunnan: 1♂ (IZAS): Simao, Rd. Kunluo, 1350m, 11.V.1957, leg. Fu-Ji Pu; 1♀ (IZAS): Xishuangbanna, Meng'a, 1050–1080m, 10.V.1958, leg. Shu-Yong Wang.

Distribution. China (new record: Yunnan); Laos.

Lycocerus malaisei (Wittmer, 1995)

Athemus (s.str.) *malaisei* Wittmer, 1995: 277, figs 144–145, 195.

Type material examined. Holotype: 1♂ (NHMB): [p]"N. E. BURMA \ Kambaiti, 7000 ft \ 24/5 1934 \ R. Malaise", [h]"malaisei", [p]"HOLOTYPE", [p]"Naturhistorisches \ Museum Basel \ coll. W. Wittmer".

Additional material examined. CHINA, Yunnan: 1♂ (IZAS): 60km E tengchong, 2200m, 19.–22.V2006, leg. S. Murzin & I. Shokhin; 1♂ (CAS): Longling County, Longjiang Township, Xiaoheishan Forest Reserve, Guchengshan, 2020m, N24.82888°/E098.76001°, 26.V.2005, stop# 2005-030A, D.H.Kavanaugh & C.E. Griswold collectors [CASENT 6004806]; 1♂ (CAS): same data [CASENT 1035946]; 1♂ (CAS): same data [CASENT 1035947]; 1♀ (CAS): same data [CASENT 1035948]; 1♀ (CAS): Longyang County, Bawan Township, Nankang Yakou just N of pass, N24.83178°/E098.76472°, 2180m, 25.V.2005, stop# 2005-029B, D.H. Kavanaugh & C.E. Griswold collectors [CASENT 1035849].

Distribution. China (new record: Yunnan); Myanmar.

Lycocerus obscurus Pic, 1916

Fig. 38

Lycocerus obscurus Pic, 1916: 13.
Lycocerus obscurus var. *diversus* Pic, 1916: 13. [Synonymized by Kazantsev 1999: 134].
Lycocerus rubroniger Švihla, 2011: 12, Figs 13, 64–66. **syn. n.**

Type material examined. Lectotype of *Lycocerus obscurus*: 1♀ (MNHN): [h] "Xieng Khuang" [LAOS, Xieng Khouang]. Paralectotypes: 2♀♀(MNHN): same data as lectotype; 1♀ (MNHN): "X. K."; 1♀ (MNHN): "Xieng Khuang \ 17-III-1919 \ R. Vitalis de Salvaza".

Lectotype of *Lycocerus obscurus* var. *diversus*: 1♀ (MNHN): [h]"Xieng Khuang \ ex Vitalis", [h]"L. obscurus v. \ diversus Pic ", [h]"type", [h]"obscurus \ v. diversus", [p]"TYPE", [h]"LECTOTYPUS \ L. obscurus v. \ diversus Pic \ S. Kazantsev det.".

Additional material examined. CHINA, Guangxi: 2♂♂, 2♀♀ (IZAS): Jingxi, 840m, 1.IV.1998, leg. Chun-Sheng Wu.

Supplementary description. Female. Similar to male, but eyes less protruding; antennae shorter, extending to basal one-third length of elytra; pronotum wider; abdominal sternite VIII (Fig. 38) largely emarginated in middle and on both sides of posterior margin, the portion between middle and lateral emarginations distinctly protuberant and rounded at apex.

Body length (both sexes): 10.0–12.5 mm; width: 2.5–3.0 mm.

Distribution. China (new record: Guangxi); Laos (Kazantsev 1999).

Remarks. Based on the examination of the types of *Lycocerus obscurus* Pic, 1916 and some additional material at our disposal, we found no difference between it and *L. rubroniger* Švihla, 2011, which was presented with an adequate photo of the habitus and illustrations of aedeagus in the original publication. Therefore, *L. rubroniger* is synonymized with *L. obscurus* here, and provided with the supplementary description and illustration of abdominal sternite VIII of female.

Lycocerus olivaceus (Wittmer, 1995)

Athemus (s.str.) *olivaceus* Wittmer, 1995: 219, Fig. 57.

Type material examined. Holotype: 1♂ (NHMB): [h]"Shillong \ Assam", [h]"26.4.1971 \ T. Sen Gupta", [h]"Athemus s.str. \ olivaceus \ Wittm. \ det. W. Wittmer", [p]"HOLOTYPUS", [p]"Naturhistorisches \ Museum Basel \ coll. W. Wittmer", [p]"CANTHARIDAE \ CANTH00001639".

Additional material examined. CHINA, Yunnan: 1♂, 2♀♀ (IZAS): Gongshan, Dulong, Kongdang, 21.V.2007, leg. Yan-Lei Li.

Distribution. China (new record: Yunnan); India.

Lycocerus purpureus Kazantsev, 2007

Lycocerus purpureus Kazantsev, 2007: 54 [replacement name for *Athemus* (*Andrathemus*) *purpurascens* Wittmer, 1978, nec Pic, 1911].

Athemus (*Andrathemus*) *purpurascens* Wittmer, 1978: 155, Fig. 5. [Preoccupied by *Cantharis purpurascens* Pic, 1911: 143, synonymized with *Lycocerus rubripennis* (Hope, 1831)].

Type material examined. Holotype: 1♂ (NHMB): [p]"Dechhi Paka 3300m \ 19.-20.5." [p]"Nat.-Hist. Museum \ Basel-Bhutan \ Expedition 1972", [h]"Athemus subg.

\ Andrathemus \ purpurascens \ Wittm. \ det. W. Wittmer", [p]"HOLOTYPUS", [p]"CANTHARIDAE \ CANTH00001271".

Additional material examined. CHINA, Xizang: 1♂, 1♀ (IZAS): Nyingtri, 3050m, 3.VIII.1983, leg. Yin-Heng Han.

Distribution. China (new record: Xizang); Bhutan (Kazantsev and Brancucci 2007).

***Lycocerus ruficornis* (Wittmer, 1995)**

Athemus (s.str.) *ruficornis* Wittmer, 1995: 232, Figs 77, 180.

Type material examined. Holotype: 1♂ (NHMB): [p]"THAI, 10.-16.V.1991 \ CHIANG DAO 600m \ 15°24'N 98°55'E \ Vit Kubáň leg.", [p]"Thailand 91 \ Thanon Thong Chai \ D. Král & V. Kubáň", [h]"A. \ ruficornis \ Wittm. \ det. W. Wittmer", [p]"HOLOTYPUS", [p]"CANTHARIDAE \ CANTH00002524".

Additional material examined. CHINA, Yunnan: 1♂ (IZAS): Xishuangbanna, Meng'a, 1050−1080m, 2.V.1958, leg. Shu-Yong Wang; 1♀ (IZAS): Xishuangbanna, Xiaomengyang, 850m, 8.VII.1957, leg. Ling-Chao Zang. [MYANMAR]: 2♂♂ (MCSNG): Burma, Tenasserim, Thagalà, IV.1887, Fea.

Distribution. China (new record: Yunnan); Myanmar (new record); Thailand.

***Lycocerus semiextensus* (Wittmer, 1995)**

Athemus (*Andrathemus*) *rubripennis* Pic: Wittmer 1978: 158, Fig. 9 (parte).

Athemus (*Andrathemus*) *semiextensus* Wittmer, 1995: 264, Figs 123−124.

Type material examined. Holotype: 1♂ (NHMB): [p]"E-Nepal \ Koshi \ M. Brancucci", [p]"Gufa-Gorza \ 2800-2100m \ 4.VI.1985", [h]"REM \ 94 \ 4.7", [h]"Athemus s.str. \ semiextensus \ Wittm. \ det. W. Wittmer", [p]"HOLOTYPUS", [p]"CANTHARIDAE \ CANTH00001301".

Additional material examined. CHINA, Xizang: 1♂ (IZAS): Droma, 2800m, 8.VI.1961, leg. Lin-Yao Wang; 1 ♀ (IZAS): same data, 7.VI.1961; 1 ♂ (IZAS): same data, 5.VI.1961; 1 ♀ (IZAS): same data, 6.VI.1961.

Distribution. China (new record: Xizang); India, Bhutan, Nepal (Kazantsev and Brancucci 2007).

Acknowledgments

We are grateful to the late Dr. Michel Brancucci not only for providing a chance to the first author to visit and study in the Naturhistorisches Museum Basel for one year, but also for providing valuable suggestions in studying the taxonomy of Cantharidae. Also, we thank Dr. Vladimir Švihla (NMPC), Dr. David H. Kavanaugh (CAS), Dr. Boris A.

Korotyaev (ZIN), Dr. Roberto Poggi (MCSNG) and Mr. Antoine Mantilleri (MNHN) for their kind help in accessing the cantharid collections under their charges.

The present study was supported by the National Natural Science Foundation of China (Nos. 31172135, 41401064), the Knowledge Innovation of Chinese Academy of Sciences (Nos. KSCX2-EW-G-4, KSCX2-EW-Z-8) and the Natural Science Foundation of Hebei Province (No. C2013201261).

References

Brancucci M (1980) Morphologie comparée, evolution et systématique des Cantharidae (Insecta: Coleoptera). Entomologica Basiliensia 5: 215–388.

Champion GC (1926) Some Indian Coleoptera (21). The Entomologist's Monthly Magazine 62: 243–256.

Gorham HS (1889) Descriptions of new species and of a new genus of Coleoptera of the family Telephoridae. Proceedings of the Zoological Society of London 1889: 96–111, pl. 10.

Kazantsev SV (1999) Revision of *Lycocerus* Gorham of Indochina and adjacent regions, with the description of *Walteria*, a new genus (Coleoptera, Cantharidae). Entomologica Basiliensia 21: 115–134.

Kazantsev SV (2007) New Acts and Comments: Cantharidae. In: Löbl I, Smetana A (Eds) Catalogue of Palaearctic Coleoptera, Vol. 4. Apollo Books, Stenstrup, 47–54.

Kazantsev SV, Brancucci M (2007) Cantharidae. In: Löbl I, Smetana A (Eds) Catalogue of Palaearctic Coleoptera, Vol. 4. Apollo Books, Stenstrup, 234–298.

Okushima Y (2005) A taxonomic study on the genus *Lycocerus* (Coleoptera, Cantharidae) from Japan, with zoogeographical considerations. Japanese Journal of Systematic Entomology, Monographic Series, Matsuyama 2: 1–383.

Okushima Y, Yang YX (2013) Two new species of the subfamily Cantharinae (Coleoptera, Cantharidae) from Taiwan. Elytra, Tokyo, n. s. 3(1): 89–96.

Pic M (1916) Diagnoses génériques et spécifiques. Mélanges Exotico-Entomologiques 18: 2–20.

Pic M (1924) Nouveaux Malacodermes asiatiques. Bulletin du Muséum d'Histoire Naturelle (Paris) 30: 475–482.

Pic M (1934) Neue exotische Coleopteren (Malacodermata). III. Entomologischer Anzeiger 14: 45–47, 54–55.

Švihla V (2005) New taxa of the subfamily Cantharinae (Coleoptera: Cantharidae) from southeastern Asia with notes on other species II. Acta Entomologica Musei Nationalis Pragae 45: 71−110.

Švihla V (2011) New taxa of the subfamily Cantharinae (Coleoptera: Cantharidae) from southeastern Asia, with notes on other species III. Zootaxa 2895: 1–34.

Wittmer W (1978) Ergebnisse der Bhutan-Expedition 1972 des Naturhistorisches Museums in Basel. Coleoptera: Fam. Cantharidae (4. Teil) und Bemerkungen zu einigen Arten aus angrenzenden Gebieten. Entomologica Basiliensia 3: 151–161.

Wittmer W (1995) Zur Kenntnis der Gattung *Athemus* Lewis (Col. Cantharidae). Entomologica Basiliensia 18: 171–286.

ZooKeys 456: 109–138 (2014)
doi: 10.3897/zookeys.456.8413
http://zookeys.pensoft.net

RESEARCH ARTICLE

A peer-reviewed open-access journal
ZooKeys
Launched to accelerate biodiversity research

On the *Domene* species of China, with descriptions of four new species (Coleoptera, Staphylinidae)

Benedikt Feldmann[1], Zhong Peng[2], Li-Zhen Li[2,3]

1 *Juistweg 1, 48159 Münster, Germany* **2** *Department of Biology, College of Life and Environmental Sciences, Shanghai Normal University, Shanghai, 200234, P. R. China*

Corresponding author: *Li-Zhen Li* (pz0617@163.com)

Academic editor: *V. Assing* | Received 9 August 2014 | Accepted 30 October 2014 | Published 21 November 2014

http://zoobank.org/46990558-1AF0-4774-9A01-DFAF08B665AE

Citation: Feldmann B, Peng Z, Li L-Z (2014) On the *Domene* species of China, with descriptions of four new species (Coleoptera, Staphylinidae). ZooKeys 456: 109–138. doi: 10.3897/zookeys.456.8413

Abstract

Material of the paederine genus *Domene* Fauvel, 1873 from China is examined. Nine species were identified, four of them described previously, one unnamed (represented exclusively by females), and four are newly described: *D. cultrata* **sp. n.** (Gansu, Hubei, Shaanxi); *D. cuspidata* **sp. n.** (Gansu, Shaanxi, Sichuan); *D. chenae* **sp. n.** (Guangxi); *D. reducta* **sp. n.** (Sichuan). A lectotype is designated for *Domene reitteri* Koch, 1939; a neotype is designated for *Domene chengpengi* Li, 1990. *Domene derzuuzalai* Gusarov, 1992 is placed in synonymy with *D. chengpengi*. Previous records of two Japanese species from China are most likely based on misidentifications and considered erroneous. Thus, the *Domene* fauna of China is currently composed of twelve described species. A key to the *Domene* species of China is provided. The distributions of eleven species are mapped.

Keywords

Coleoptera, Staphylinidae, Paederinae, *Domene*, Palaearctic region, China, new species, lectotype designation, neotype designation, new synonymy, additional records, key to species

Copyright *Benedikt Feldmann et al.* This is an open access article distributed under the terms of the Creative Commons Attribution License (CC BY 4.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

Introduction

In contrast to the West Palaearctic *Domene* fauna, which can be considered rather well-studied, the known inventory of the East Palaearctic and Oriental faunas, which have received less taxonomic attention, is still incomplete. Prior to the present study, eleven species had been recorded from China, including Taiwan, three of them very recently: *D. alesiana* Assing & Feldmann, 2014 (Taiwan); *D. chenpengi* Li, 1990 (Jilin); *D. crassicornis* (Sharp, 1874) (Jilin); *D. curtipennis* Sharp, 1889 (Liaoning); *D. dersuuzalai* Gusarov, 1992 (Beijing); *D. firmicornis* Assing & Feldmann, 2014 (Zhejiang); *D. immarginata* Assing & Feldmann, 2014 (Yunnan); *D. malaisei* Scheerpeltz, 1965 (Yunnan); *D. procera* Eppelsheim, 1886 (Northeast Territory); *D. reitteri* Koch, 1939 (Zhejiang), and *D. scabripennis* Rougemont, 1995 (Taiwan) (Eppelsheim 1886; Koch 1939; Scheerpeltz 1965; Coiffait 1982; Li et al. 1990; Li 1992; Gusarov 1992; Rougemont 1995; Smetana 2004; Assing and Feldmann 2014). Except for *D. chengpengi*, which is listed as incertae sedis by Smetana (2004), all the Chinese *Domene* species have been attributed to the subgenus *Macromene* Coiffait; for a comment on the subgeneric concept of *Domene* currently in use see Assing and Feldmann (2014).

In recent years we obtained numerous *Domene* specimens from several public and private collections. Nine species were identified, four of which are described for the first time.

Material and methods

The examined material is deposited in the following public and private collections:

HNHM	Hungarian Natural History Museum, Budapest (Gy. Makranczy)
NHMB	Naturhistorisches Museum, Basel (M. Geiser, I. Zürcher)
NHMW	Naturhistorisches Museum Wien (H. Schillhammer)
MNHUB	Museum für Naturkunde der Humboldt-Universität, Berlin (J. Frisch)
SNUC	Insect Collection of Shanghai Normal University, Shanghai
RMS	Riksmuseum, Stockholm (B. Viklund)
cAss	private collection Volker Assing, Hannover
cFel	private collection Benedikt Feldmann, Münster
cPüt	private collection Andreas Pütz, Eisenhüttenstadt
cRou	private collection Guillaume de Rougemont, Oxford
cSch	private collection Michael Schülke, Berlin
cSme	private collection Aleš Smetana, Ottawa

The genitalia and other dissected parts were mounted on plastic slides and attached to the same pin as the respective specimens. Photographs were taken with a Canon EOS 7D camera with a MP-E 65 mm macro lens or with a Canon G9 camera

mounted on an Olympus CX31 microscope. The map is created using MapCreator 2.0 (primap) software.

The following abbreviations are used in the text, with all measurements in millimeters:

Total length (**TL**): length of body from anterior margin of mandibles (in resting position) to abdominal apex.
Length of forebody (**FL**): length of forebody from anterior margin of mandibles to posterior margin of elytra.
Head length (**HL**): length of head from anterior margin of frons to posterior constriction of head.
Head width (**HW**): maximum width of head.
Length of antenna (**AnL**).
Neck width (**NW**): maximum width of neck.
Length of pronotum (**PL**).
Width of pronotum (**PW**).
Elytral length (**EL**): length at suture from apex of scutellum to elytral hind margin.
Elytral width (**EW**): combined width of elytra.
Length of metatibia (**TiL**).
Length of metatarsus (**TaL**).
Width of segment VI (**AW**).
Length of aedeagus from apex of ventral process to base of aedeagal capsule (**AL**).

The type labels are cited in the original spelling; different labels are separated by slashes.

Results

Thirteen *Domene* species, ten of them exclusive and one of them unnamed, are known from China (including Taiwan). Four species are described for the first time, a new synonymy is proposed and two species are deleted from the list of Chinese *Domene* species.

Based on the male sexual characters, mainly the shape and chaetotaxy of sternite VIII and the morphology of the aedeagus, as well as on external characters such as the punctation and sculpture of the head, pronotum and elytra, the Chinese representatives of *Domene* are attributed to five different species groups.

The *D. scabripennis* group: see Assing and Feldmann (2014). Note that the placement of *D. firmicornis* in this group is doubtful. Neither the male nor the female sexual characters suggest closer phylogenetic affiliations to any of the other species known from China.

The *D. malaisei* group comprises four species (*D. malaisei*, *D. cultrata*, *D. cuspidata*, *D. reducta*) distributed in the midwest and southwest of China. They share the following differential characters: large body size (length of forebody 4.70–5.50 mm); head and pronotum with moderately coarse and dense punctation; pronotum relatively large and oblong; protarsomeres I–IV weakly dilated in both sexes; elytra

with moderately coarse, not coriaceous and irregular macropunctation, with additional micropunctation, without distinct longitudinal elevations and without pronounced impressions; male sternite VII with modified short, stout, black setae; sternite VIII with shallow median impression, this impression with strongly modified, stout black setae, on either side of the deep and almost V-shaped posterior excision with a dense cluster of black setae; ventral process of aedeagus (in lateral view) not conspicuously slender, rather stout.

The *D. reitteri* group includes two species (*D. reitteri*, *D. chenae*) distributed in the east and south of China and is distinguished by the following character combination: moderately large body size (length of forebody 4.16–4.73 mm); head and pronotum with fine and dense punctation; pronotum large and moderately oblong; protarsomeres I–IV weakly dilated in both sexes; elytra without rough surface, with fine, dense and uniform punctation; male sternite VII with moderately to strongly modified short, stout, black setae; sternite VIII with shallow median impression, this impression with strongly modified stout black setae, on either side of the moderately deep and U-shaped posterior excision without cluster of setae; ventral process of aedeagus (in lateral view) relatively stout.

D. chenpengi and *D. procera* belong to two different species groups which comprise additional species from Japan. *Domene chenpengi* is closely related to *D. curtipennis* and allied species, *D. procera* is closely related to *D. crassicornis* and allied species. A detailed characterization of these species groups requires a revision of the *Domene* fauna of Japan.

Domene (*Macromene*) *chenpengi* Li et al., 1990

Figs 1, 2A, 3

Domene chenpengi Li et al., 1990: 66.
Domene (*Macromene*) *dersuuzalai* Gusarov, 1992: 21; syn. n.

Type material. Neotype ♂, present designation: "China: Beijing, ca. 1400 m, Dongling Mts, 15.Vi.2001, Xiaolongmen, Liu Lang Yu / N39°97, E115°43 [sic], Mixed woodland litter, Leg. J. Cooter + P. Hlavá [sic] / Neotypus ♂ *Domene chenpengi* Li desig. B. Feldmann & Z. Peng 2014 / Domene chenpengi Li, det. B. Feldmann 2014" (MNHUB).

Comment: The original description is based on a single male specimen from Chang Chun [ca. 43°45'N, 125°27'E], Jing Yue, collected on 30.VII.1985 by Peng Chen (Li et al. 1990). Inquiries into the whereabouts of the holotype at the Northeast Normal University, where the holotype should be deposited, yielded no results. It was looked for in the respective collection, but not found (personal communication Xiu-Qing Yin, one of the authors in Li et al. 1990 and director of the biogeographical office of Northeast Normal University, e-mail 5 May, 2014; personal communication Jing-Ke Li, author of *D. chenpengi* and guest professor of the Harbin Normal University, e-mail 5 May, 2014). Thus, the type specimen must be regarded as lost. The insufficient

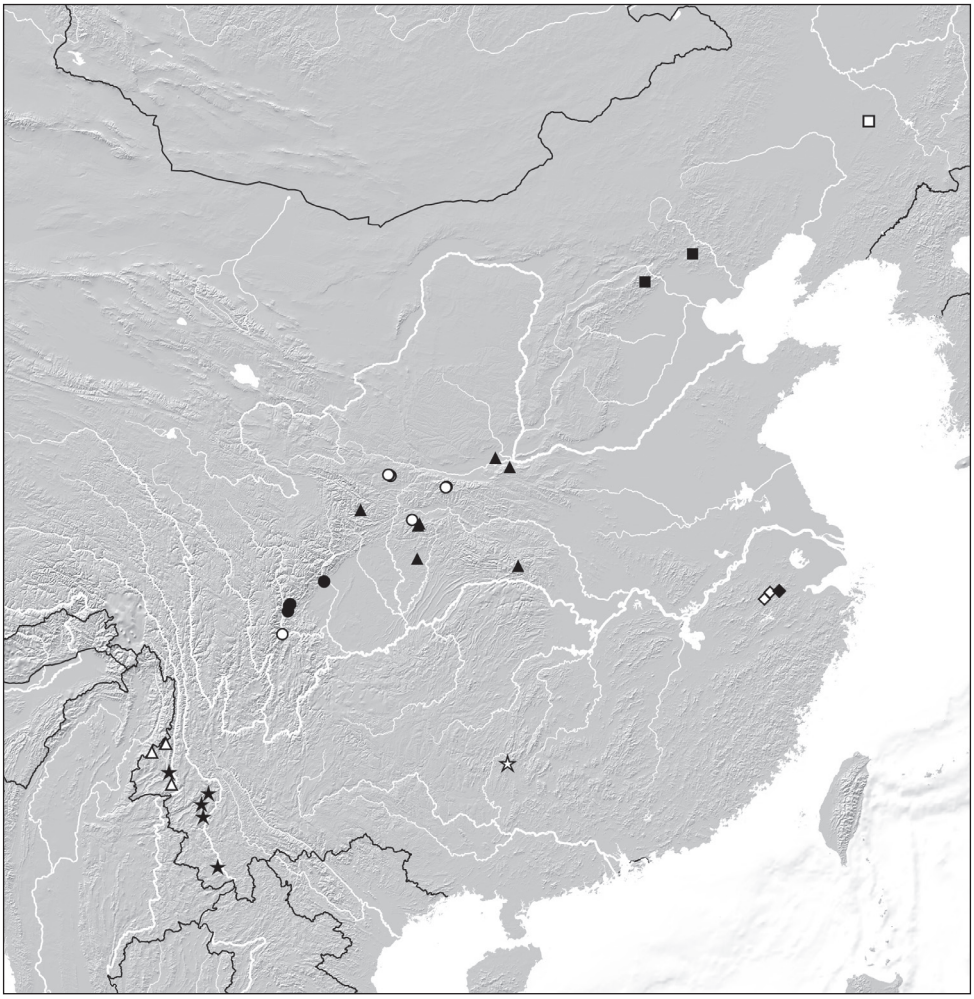


Figure 1. Distributions of *Domene* species in China: *D. chenpengi* (filled squares; type locality: open square); *D. firmicornis* (filled and open diamonds); *D. immarginata* (filled stars); *D. malaisei* (open triangles); *D. reitteri* (filled diamond); *D. chenae* (open star); *D. cultrata* (filled triangles); *D. cuspidata* (open circles); *D. reducta* (filled circles).

description of *D. chenpengi*, which fails to provide any illustration whatsoever, is in agreement with examined material previously identified as *D. dersuuzalai* from the Russian Far East and China, particularly regarding the habitus and the characteristic shape of the male sternite VIII with its shallow posterior excision. Moreover, the type locality of *D. chenpengi* accords with the known distribution of *D. dersuuzalai*. In the interest of stability of nomenclature, a neotype designation is deemed necessary to stabilize the present interpretation of *D. chenpengi* and the synonymy with *D. dersuuzalai.* To this end, a male from the Dongling mountains in Beijing, a locality reasonably close to the type locality, is designated as the neotype. Based on the detailed descrip-

tion of *D. dersuuzalai* (Gusarov 1992), the species is doubtlessly conspecific with the neotype of *D. chenpengi*; hence the synonymy proposed above.

Material examined (60 exs.). RUSSIAN FAR EAST: Primorskiy Kray: 2 exs., Vladivostok env., Sedanka, 28.VII.1992, leg. Beloborodov (NHMB, cFel); 3 exs., Vladivostok, 11.VII.1993, leg. Pütz & Wrase (cSch); 6 exs., N Vladivostok, "Seitengraben des Parwaja Rjetschka Tales", 1918–1920, leg. Frieb (NHMW, cFel); 1 ex., Kamenushka, 14.–15.VII.1992, leg. Beloborodov (NHMB); 7 exs., Partisansky district, Alexeyevskiy khrebet, 20 km E Sergeyevka, forests near Andreyevka river, 400–800 m, 26.–29. VII.1993, leg. Pütz & Wrase (cSch, cFel); 1 ex., S Artyom town, Ozernyy Kluytch river, 100–300 m, 10.V.–5.VI.2002, leg. Plutenko (cSch); 2 exs., Lazovskiy reserve, 9 km SE Kievka, lodge Petrova env., 3.–8.VI.1994, leg. Sundukov (cPüt); 1 ex., same data, but 9.–13.VI.1995 (cPüt); 1 ex., Lazovskiy district, Kovarinovo, 5 km NE Lazo, spring valley, 1.–5.VI.1995, leg. Sundukov (cFel); 1 ex., Lazovskiy reserve, Kordon Amerika, 134°03'01"E, 43°16'16"N, 14.–17.V.1999, leg. Sundukov (cSch); 2 exs., Lazovskiy reserve, Kordon Amerika, 18.–19.VI.1997, leg. Sundukov (cSch); 1 ex., Lazovskiy reserve, Kordon Petrova, 133°47'55"E, 42°52'14"N, 19.–20.IX.1999, leg. Sundukov (cSch); 1 ex., Lazovskiy reserve, Kordon Proselochny, 134°07'43"E, 43°00'34"N, 4.–6.X.1999, leg. Sundukov (cSch); 3 exs., Sikhote-Alin reserve, Jasnaya estuary, 26.VI.–4.VII.1998, leg. Sundukov (cAss, cSch); 1 ex., Siniy khrebet, 4 km E Evseevki, 7.–9.VIII.1999, leg. Shavrin (cSch); 1♂, 2 ♀♀ [identified by Gusarov 1995 as *D. dersuuzalai*], Arsenev env., 27.V.–5.VII.1991, leg. Sausa (NHMW). **Khabarovskiy Kray:** 3 exs., SE Boitsovo, 12 km NE Bikin, 250–350 m, 26.V.–4.VI.1990, leg. Schawaller (cSch). **Sakhalin:** 5 exs., Moneron Island, 15.VI.–6.VII.2002, leg. Plutenko (cSch, cFel). **CHINA: Beijing:**1 ♂, 5 ♀♀, Xiaolongmen, Yan Shan, Dongling Mts, 1400 m, 15.–16.VI.2001, leg. Hlavač & Cooter (cAss, cSch, cFel); 2 ♂♂, Xiaolongmen, Liu Lang Yu, Dongling Mts, 39°58'N, 115°26'E, ca. 1400 m, under fungoid *Juglans* bark, 15.VI.2001, leg. Cooter & Hlavač (cRou); 1 ♀, Xiaolongmen, Liu Lang Yu, Dongling Mts, 39°58'N, 115°26'E, ca. 1400 m, mixed forest litter, 15.VI.2001, leg. Cooter & Hlavač (cRou); 2 ♂♂, 1 ♀, Xiaolongmen, Mei Yao Yu, Dongling Mts, 39°58'N, 115°26'E, ca. 1400 m, mixed forest litter, 16.VI.2001, leg. Cooter & Hlavač (cRou, cFel); 1 ♂, 2 ♀♀, Miyun County, Wulin Shan, 40°36'N, 117°23'E, 750–850 m, 8.–9.VII.2006, leg. Shen & Tang (SNUC). **SOUTH KOREA:** 1 ♂, Gangwon-do, Seorak-san, 1.5 km S Han-gyeryeong pass rest station, roadside forest, 38°05'26"N, 128°24'03"E, 790 m, from wet, fungusy leaf litter, under trunk, rocks, sifted, 9.IX.2010, leg. Makranczy & al. (HNHM).

Redescription. Measurements (in mm) and ratios: TL 7.15–7.60, FL 3.80–3.95, HL 1.1–1.15, HW 1.00–1.08, AnL 2.55–2.65, NW 0.35–0.38, PL 1.19–1.23, PW 0.95–1.03, EL 0.98–1.03, EW 1.03–1.05, TiL 1.20–1.25, TaL 0.90–0.98, AW 1.08–1.13, AL 0.85–0.90, HL/HW 1.05–1.13, HW/PW 1.02–1.08, HL/PL 0.90–0.95, NW/HW 0.35–0.36, PL/PW 1.17–1.25, EL/PL 0.82–0.85.

Habitus as in Fig. 2A. Head and pronotum blackish brown; elytra brownish with anterior and posterior portions more or less extensively reddish brown; abdomen brownish; legs yellowish brown, except for the slightly paler tarsi; antennae light brown to yellowish brown.

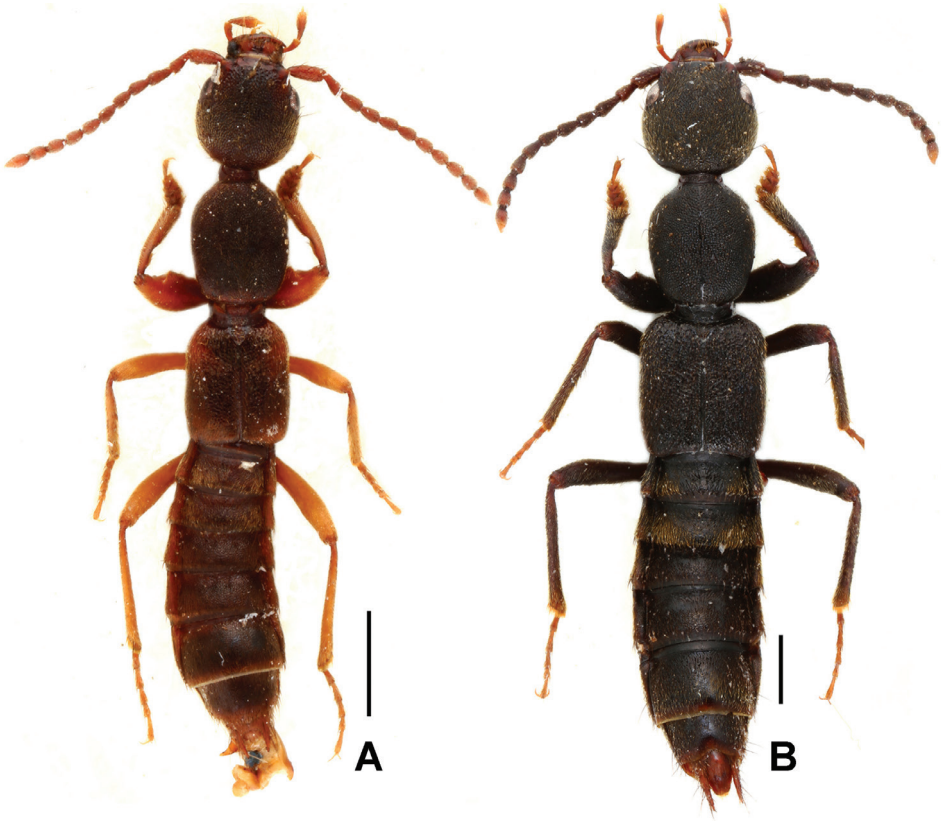


Figure 2. Habitus of *Domene* spp., **A** *D. chenpengi* **B** *D. firmicornis*. Scales: 1.0 mm.

Head orbicular, widest behind eyes; punctation (Fig. 3A) fine and very dense. All antennomeres longer than broad; antennomeres IV–X of equal length; antennomere I 1.9 times, II 1.2 times, III 1.3 times, XI 1.3 times as long as IV. Maxillary palpus slender, preapical joint about 2.5 times as long as broad.

Pronotum about as broad as head, widest in anterior third; lateral margins slightly convex in dorsal view; punctation (Fig. 3B) very fine with interstices forming narrow, longitudinal ridges.

Elytra without distinct longitudinal ridges; disc often more or less impressed; suture elevated in posterior three-fourths; macropunctation coarse, more or less dense and irregular on disc, interstices with shallow and irregular micropunctation; in lateral and posterior portions with distinctly finer and denser punctation. Hind wings present. Protarsomeres I–IV moderately dilated.

Abdomen with fine and very dense punctation on tergites III–VIII; interstices with microreticulation; tergite VIII more or less obtusely triangularly produced posteriorly (Fig. 3C); posterior margin of tergite VII with palisade fringe.

Male. Sternites III–VI unmodified; sternite VII (Fig. 3F) distinctly transverse, with shallow postero-median impression, this impression with a few modified short

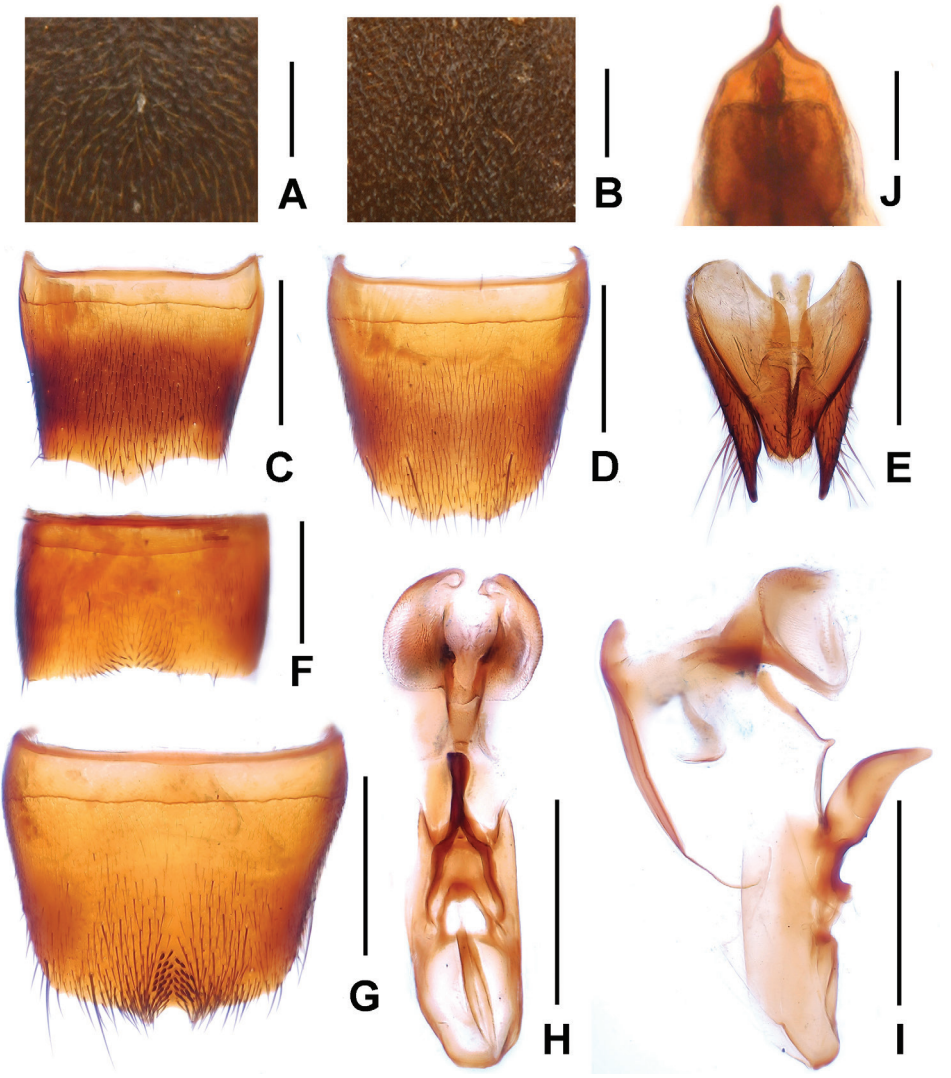


Figure 3. *Domene chenpengi*. **A** median dorsal portion of head **B** median portion of pronotum **C** female tergite VIII **D** female sternite VIII **E** female tergites IX–X. **F** male sternite VII **G** male sternite VIII **H** aedeagus in ventral view **I** aedeagus in lateral view **J** aedeagus in dorsal view. Scales: **A**–**B, J** 0.2 mm; **C**–**I** 0.5 mm.

and black setae posteriorly; sternite VIII (Fig. 3G) transverse, with pronounced impression posteriorly, this impression with distinctly modified short and stout black setae, posterior excision very small; aedeagus as in Figs 3H–J, ventral process stout and apically moderately acute in lateral view; apical portion of dorsal plate long and distinctly sclerotized, basal portion short.

Female. Posterior margin of sternite VIII (Fig. 3D) in the middle with shallow concave excision; genital segments with distinctly sclerotized structure (Fig. 3E).

Comparative notes. The similar external morphology, the similar chaetotaxy and shape of the male sternites VII and VIII, and especially the similar shape of the ventral process of the aedeagus suggest that *D. chenpengi* is closely allied to *D. curtipennis* from Japan. For illustrations of *D. curtipennis* see Gusarov (1992: figure 4). Besides its conspicuous male sexual characters, *D. chenpengi* is distinguished from the Chinese species of the *D. malaisei* and *D. scabripennis* groups and from *D. procera* by its smaller size alone, and from species of the *D. reitteri* group by its coarser and less densely punctate the elytra.

Distribution and natural history. The currently known distribution ranges from the Russian Far East and Northern China (Beijing, Jilin) to South Korea. The specimens were partly sifted from leaf litter in mixed forest habitats or found under bark and rocks. The elevations range from 100 up to 1400 m.

***Domene* (*Macromene*) *crassicornis* (Sharp, 1874)**

Lathrobium crassicornis Sharp, 1874: 59.

Comment. *Domene crassicornis* was recorded by Li et al. (1990) from Jilin, the only record of this species from China. This record is evidently based on a misidentification and probably refers to *D. procera*. Based on available evidence, the distribution of *D. crassicornis* is restricted to Japan and consequently does not include China. All revised material from the Russian Far East belongs to *D. procera*.

***Domene* (*Macromene*) *curtipennis* Sharp, 1889**

Domene curtipennis Sharp, 1889: 261.

Comment. The sole record of *D. curtipennis* from China is that by Li (1992) from Liaoning. It is almost certainly based on a misidentification. Based on available evidence, the distribution of *D. curtipennis* is restricted to Japan. All the examined material from the Russian Far East, South Korea and China belongs to *D. chenpengi*, suggesting that *D. curtipennis* does not occur in China.

***Domene* (*Macromene*) *firmicornis* Assing & Feldmann, 2014**

Figs 1, 2B, 4

Domene (*Macromene*) *firmicornis* Assing & Feldmann, 2014: 510.

Comment. Examined type specimens of this species are listed in an addendum in Assing and Feldmann (2014). The previously undescribed female sexual characters are

as follows: female tergite VIII (Fig. 4C) with shallow postero-median impression and distinctly concave posterior excision; female sternite VIII (Fig. 4D) about as long as broad, posterior margin concave in the middle; sclerotized structure in female genital segments (Fig. 4E) symmetric and very weakly sclerotized. For illustrations of *D. firmicornis* see Figs 2B, 4 and Assing and Feldmann (2014: figures 36–43).

Domene (*Macromene*) *malaisei* Scheerpeltz, 1965

Figs 1, 5, 6

Domene (*Macromene*) *malaisei* Scheerpeltz, 1965: 187.

Type material examined. Holotype ♀: "N. E. Burma, Kambaiti, 2000 m, 4/6.1934, Malaise / HOLOTYPUS [red label] / TYPUS Domene Malaisei O. Scheerpeltz [red label] / Domene Malaisei nov. spec. det. Scheerpeltz, 1941 / 3884 E91" (RMS).

Additional material examined (5 ♂♂, 9 ♀♀)**. CHINA: Yunnan:** 4 ♂♂, 5 ♀♀, Tengchong County, Mingguang, Zizhi, Donghe, 25°42'N, 98°34'E, 2100–2300 m, 01.V.2013, leg. Peng & Song (SNUC, cAss); 4 ♀♀, same data, but 25°42'N, 98°35'E, 2500 m, 30.IV.2013 (SNUC); 1 ♂, Dehong Dai Autonomous Prefecture, mountain range 31 km E Luxi, 24°29'31"N, 98°52'58"E, 2280 m, secondary pine forest with old deciduous trees, litter sifted, 3.VI.2007, leg. Pütz (cFel).

Redescription. Measurements (in mm) and ratios: Holotype: TL 8.90, FL 5.20, HL 1.38, HW 1.30, PL 1.45, PW 1.25, EL 1.50, HL/HW 0.94, HW/PW 1.10, HL/PL 0.89, PL/PW 1.16, EL/PL 1.03. Additional material: TL 7.90–9.20, FL 4.70–5.05, HL 1.24–1.33, HW 1.17–1.25, AnL 3.17–3.40, NW 0.40–0.46, PL 1.35–1.50, PW 1.15–1.25, EL 1.28–1.45, EW 1.44–1.53, TiL 1.57–1.65, TaL 1.14–1.33, AW 1.26–1.34, AL 1.07–1.18 HL/HW 1.06–1.07, HW/PW 0.99–1.01, HL/PL 0.89–0.93, NW/HW 0.34–0.38, PL/PW 1.15–1.20, EL/PL 0.95–0.97.

Habitus as in Fig. 5. Body black; legs with blackish brown profemora and brown protibiae, basal halves of metafemora light brown, distal halves gradually infuscate; antennae dark brown to brown.

Head orbicular, broadest across eyes; punctation (Fig. 6A) coarse, distinctly umbilicate, and very dense, interstices forming very narrow ridges. All antennomeres longer than broad; antennomeres IV–X of equal length; antennomere I 1.3 times, II 0.9 times, III 1.1 times, XI 1.1 times as long as IV. Maxillary palpus very slender, preapical joint 2.8–3.1 times as long as broad.

Pronotum nearly as broad as head, widest in the middle; lateral margins convex in dorsal view; punctation (Fig. 6B) somewhat coarser than that of head; midline with rudiment of fine glossy line.

Elytra without distinct longitudinal ridges; disc more or less weakly impressed; suture elevated in posterior three-fourths; macropunctation coarse, irregular, partly confluent, and partly somewhat seriate; interstices with shallow and irregular micropunctation. Hind wings fully developed. Protarsomeres I–IV moderately dilated.

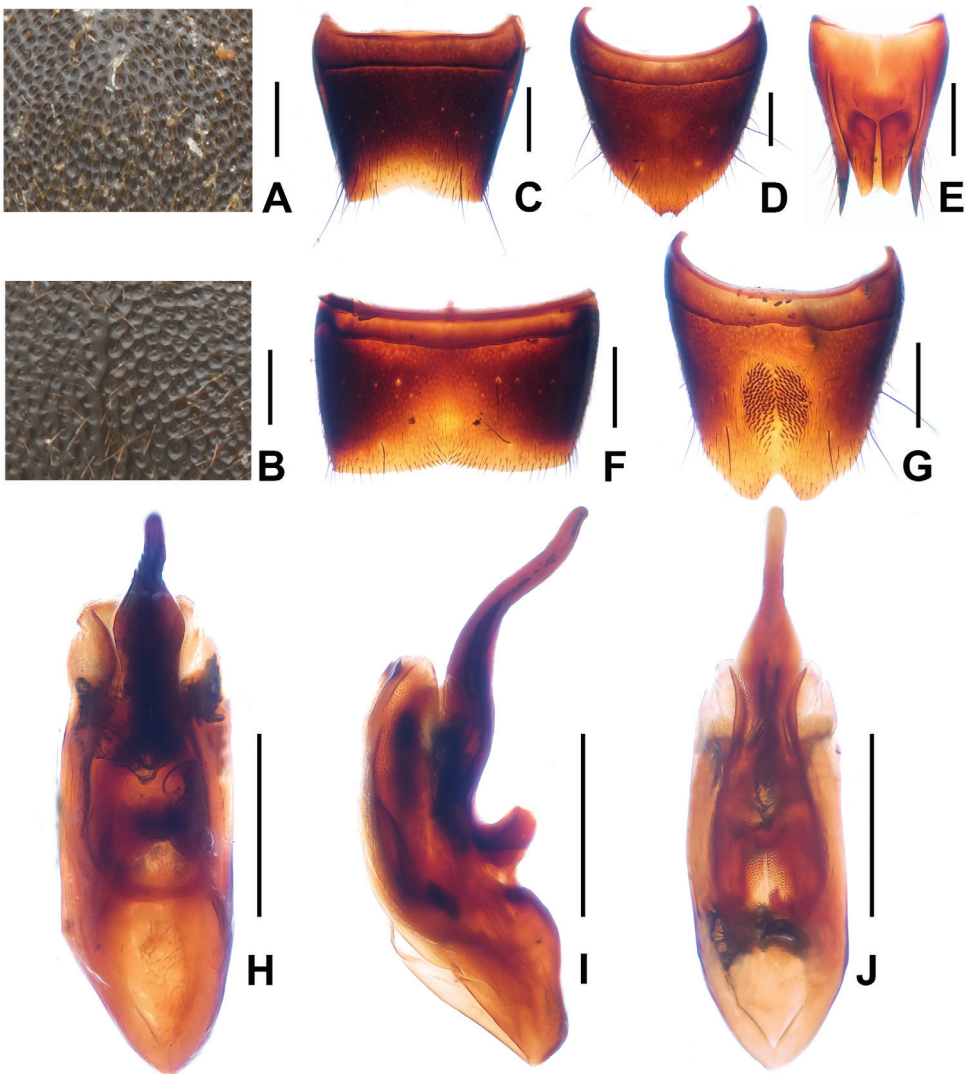


Figure 4. *Domene firmicornis*. **A** median dorsal portion of head **B** median portion of pronotum **C** female tergite VIIwI **D** female sternite VIII **E** female tergites IX–X. **F** male sternite VII **G** male sternite VIII **H** aedeagus in ventral view **I** aedeagus in lateral view **J** aedeagus in dorsal view. Scales: **A**–**B** 0.2 mm; **C**–**J** 0.5 mm.

Abdomen with fine and dense punctation on tergites III–VI; tergite VIII with dense pubescence, posterior margin of tergite VIII broadly and weakly convex (Fig. 6C); interstices with distinct microreticulation; posterior margin of tergite VII with palisade fringe.

Male. Sternites III–VI unmodified; sternite VII (Fig. 6F) distinctly transverse, with very shallow median impression posteriorly, this impression with sparse modified black setae, posterior margin broadly concave; sternite VIII (Fig. 6G) with shallow median impression posteriorly, this impression with stout black setae, posterior excision deep, almost V-shaped, on either side of the posterior excision with dense cluster of

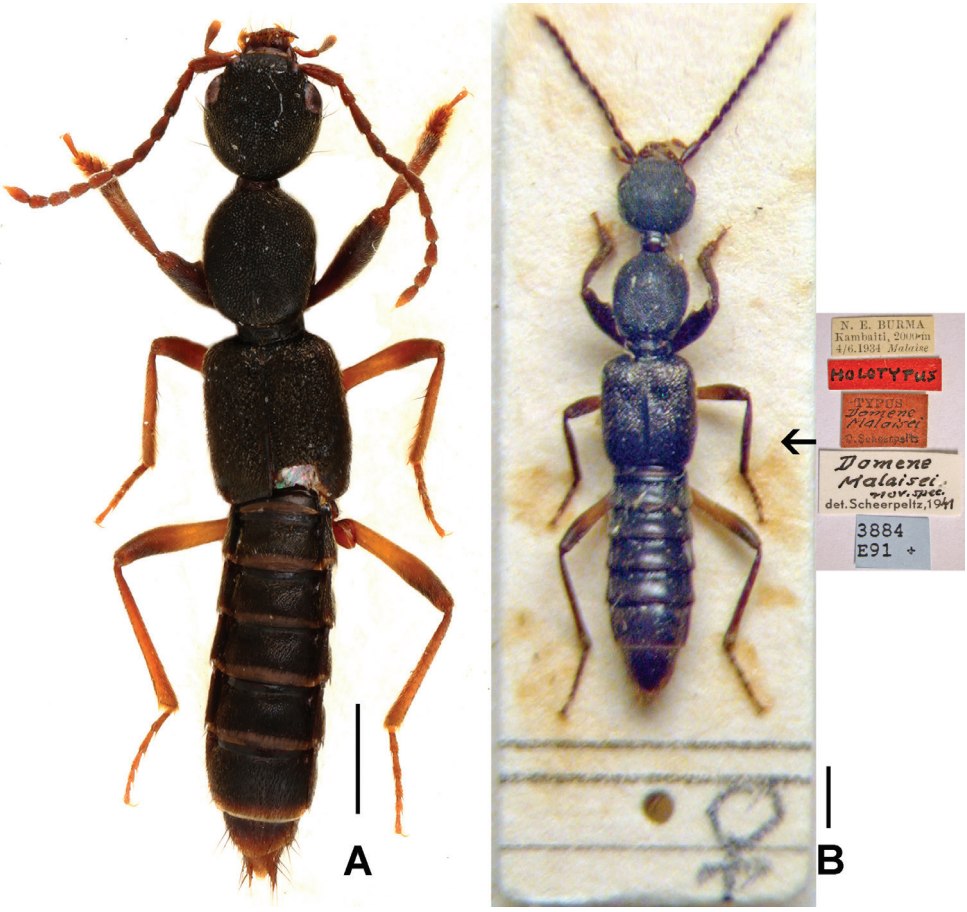


Figure 5. Habitus of *Domene malaisei*. **A** male **B** holotype. Scales: 0.5 mm.

dark setae; aedeagus as in Figs 6H–J, ventral process evenly curved and apically acute in lateral view; dorsal plate long, apical portion distinctly sclerotized and apically acute in lateral view, basal portion short.

Female. Posterior margin of sternite VIII (Fig. 6D) broadly convex; genital segments with an asymmetric and weakly sclerotized structure (Fig. 6E).

Comparative notes. The similar chaetotaxy and shape of the male sternite VIII and the similar shape of the ventral process of the aedeagus suggest that *D. malaisei* is closely allied to *D. reducta*. *Domene malaisei* is readily distinguished from other species of the group by on average darker coloration, smaller body size, the deeper posterior excision of the male sternite VIII, the evenly curved ventral process of the aedeagus and by the shape of the sclerotized structure in the female genital segments.

Distribution and natural history. The currently known distribution is confined to the type locality Kambaiti in northeastern Myanmar at the border with Yunnan, and two localities in western Yunnan (Fig. 1). The examined non-type specimens were sifted from forest leaf litter at altitudes of 2000–2500 m.

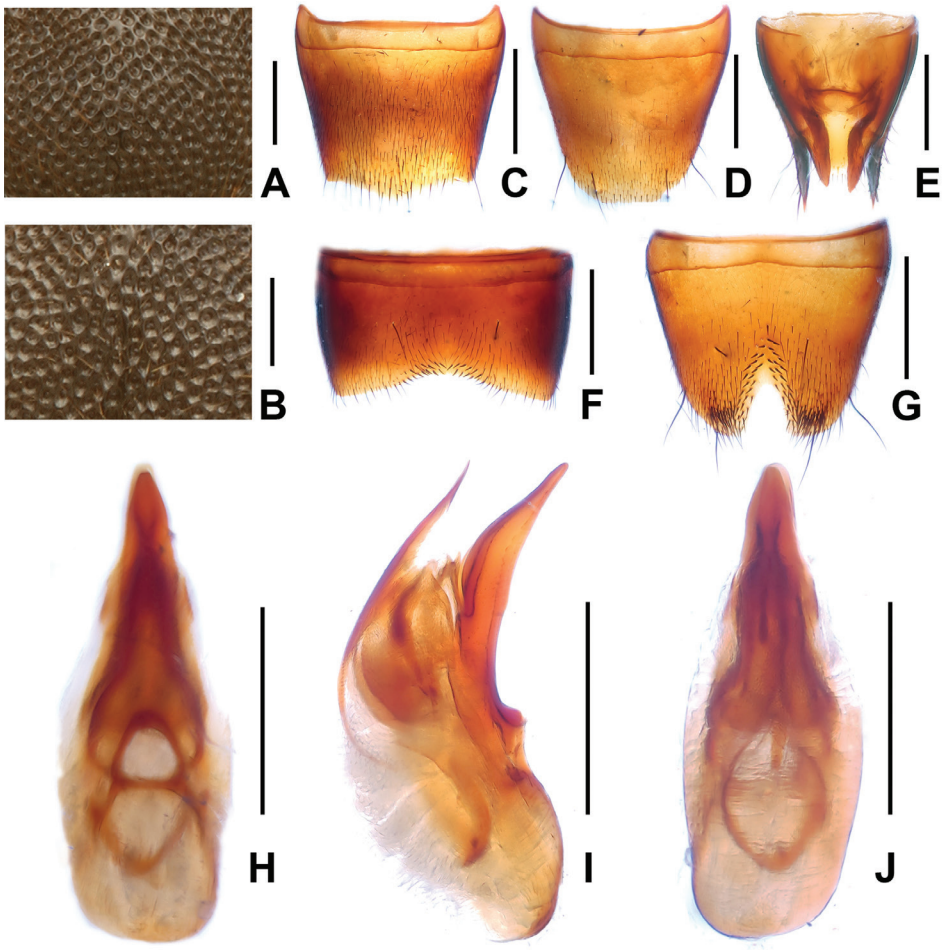


Figure 6. *Domene malaisei*. **A** median dorsal portion of head **B** median portion of pronotum **C** female tergite VIII **D** female sternite VIII **E** female tergites IX–X. **F** male sternite VII **G** male sternite VIII **H** aedeagus in ventral view **I** aedeagus in lateral view **J** aedeagus in dorsal view. Scales: **A**–**B** 0.2 mm; **C**–**J** 0.5 mm.

***Domene* (*Macromene*) *reitteri* Koch, 1939**

Figs 1, 7A, 8, 9

Domene (*Macromene*) *reitteri* Koch, 1939: 161

Type material examined. Lectotype ♂, present designation: "Tienmuschan, N. W China, Rtt. / Type / Domene Reitteri Koch det. C. Koch / Holotype 1956 det. Kamp / Holotypus Domene reitteri Koch / Domene reitteri Koch V. L. Gusarov det. 1993 / Lectotypus ♂, *Domene reitteri* Koch , desig. B. Feldmann 2010" (NHMB).

Paralectotypes 3 ♀♀: „Tienmuschan, N. W China, Rtt. / Cotype / Paratypus Domene reitteri Koch / Domene reitteri Koch V. L. Gusarov det. 1993"; 1 ex. (abdomen missing): "Tienmuschan, N. W China, Rtt. / Cotype" (NHMB).

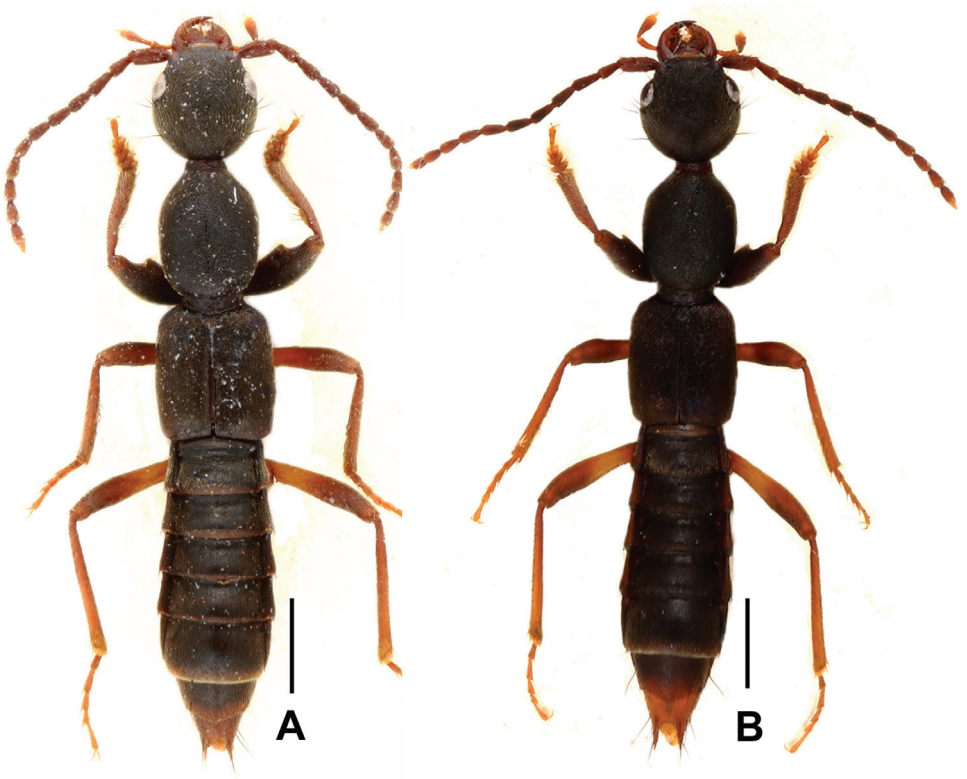


Figure 7. Habitus of *Domene* spp., **A** *D. reitteri* **B** *D. chenae*. Scales: 1.0 mm.

Comment. The original description of *D. reitteri* is based on an unspecified number of syntypes from "Tienmuschan (nordwestliches [sic] China) ex coll. E. Reitter" (Koch 1939). Five syntypes, one male, three females and one unsexed specimen, were located in the Koch collection at the Naturhistorisches Museum Basel. The male syntype is designated as the lectotype.

Additional material examined (87 ♂♂, 59 ♀♀)**. CHINA: Zhejiang:** 11 ♂♂, 7 ♀♀, Anji County, Longwang Shan, 30°23'59"N 119°26'26"E, 1300–1450 m, 14.V.2013, leg. Hu (SNUC); 31 ♂♂, 14 ♀♀, Longwang Shan, 30°24'28"N 119°26'37"E, 1050–1200 m, 15.V.2013, leg. Li & al. (SNUC); 15 ♂♂, 7 ♀♀, Longwang Shan, Qianmutian, 30°24'N 119°26'E, 1050–1250 m, 08.VI.2012, leg. Yin & Hu (SNUC, cAss); 1 ♂, Longwang Shan, 30°24'N 119°26'E, 1250–1450 m, 14.V.2013, leg. Chen & Pan (SNUC); 3 ♂♂, 5 ♀♀, Longwang Shan, Dongguan, 1250 m, 26.V.2009, leg. Feng & al. (SNUC); 3 ♂♂, 6 ♀♀, Longwang Shan, Qianmutian, 1300 m, 24.V.2009, leg. Feng & al.(SNUC); 8 ♂♂, 10 ♀♀, Longwang Shan, 950–1200 m, 25.IV.2006, leg. He (SNUC); 2 ♂♂, 3 ♀♀, Longwang Shan, Qianmutian, 1300 m, 29.V.2009, leg. Feng & al.(SNUC); 1 ♀, Longwang Shan, Qianmutian, 700–1325 m, 28.VII.2011, leg. Pan (SNUC); 1 ♂, 1 ♀, Tianmu Shan, 1200–1300 m, 25.–29.VII.2011, leg. Chen (SNUC); 2 ♂♂, 2 ♀♀, Tianmu Shan, 300 m, 17.V.2006, leg. Hu & Tang (SNUC); 1

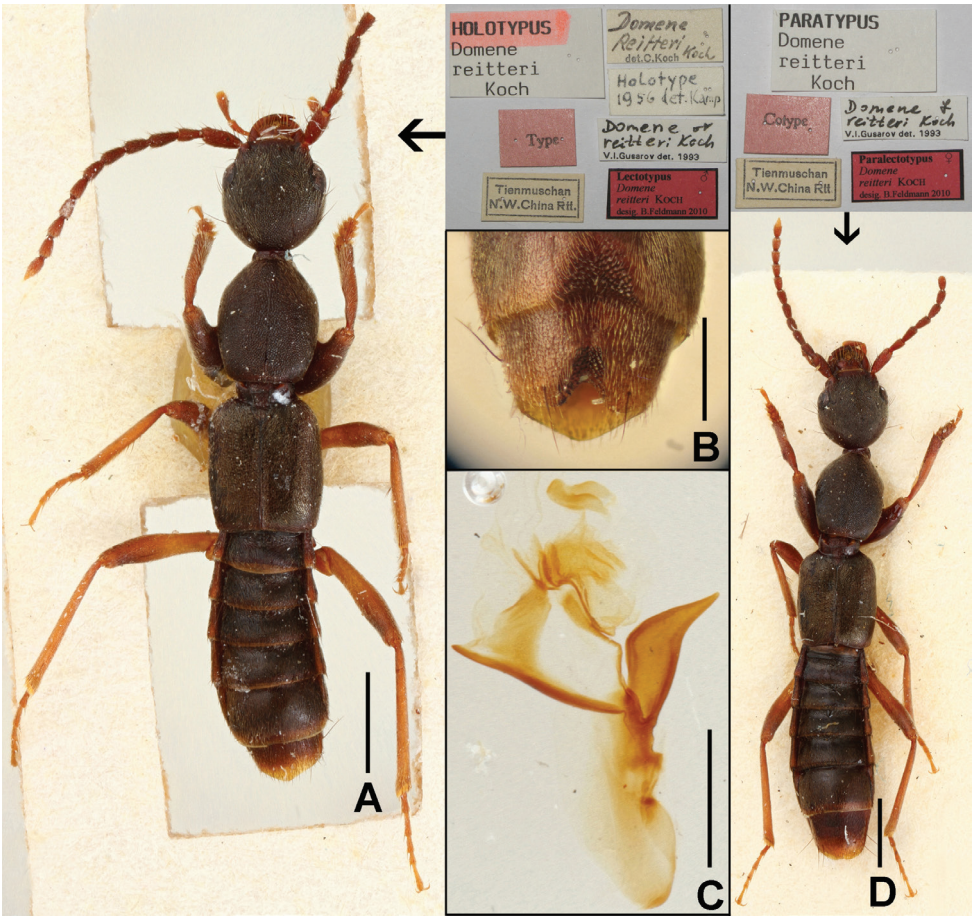


Figure 8. *Domene reitteri*. **A** lectotype **B** male sternite VII–VIII **C** aedeagus of lectotype in lateral view **D** paralectotype. Scales: **A, D** 1.0 mm; **B**–**C** 0.5 mm.

♀, Tianmu Shan, 1100 m, 24.VII.2011, leg. Hu & Tang (SNUC); 1 ♂, Tianmu Shan, 1500 m, 15.VIII.2010, leg. Hu (SNUC); 1 ♂, Tianmu Shan, 300–400 m, 29.V.2010, leg. Wang (SNUC); 1 ♂, East Tianmu Shan, 1050–1150 m, 13. IV.2011, leg. Peng & Zhu (SNUC); 2 ♂♂, Tianmu Shan, 13.VI.2009, leg. Song (SNUC); 2 ♂♂, Tianmu Shan, 1000 m, 2.V.2009, leg. Song (SNUC); 2 ♂♂, 1 ♀, Tianmu Shan, 1500 m, 15.VIII.2010, leg. Hu (SNUC); 2 ♂♂, 1 ♀, West Tianmu Shan N.R., path to peak of immortals ("Blind Alley"), 30°20'34"N, 119°25'51"E, 1100–1200 m, primary mixed forest, litter moss, sifted, 15.VI.2007, leg. Wrase (cSch, cFel).

Redescription. Measurements (in mm) and ratios: TL 5.78–8.62, FL 4.16–4.43, HL 1.07–1.17, HW 1.05–1.11, AnL 2.78–3.05, NW 0.37–0.41, PL 1.28–1.35, PW 1.02–1.06, EL 1.07–1.13, EW 1.12–1.20, TiL 1.39–1.44, TaL 0.89–0.96, AW 1.12–1.24, AL 1.07–1.17, HL/HW 1.02–1.05, HW/PW 1.03–1.05, HL/PL 0.84–0.87, NW/HW 0.35–0.37, PL/PW 1.25–1.28, EL/PL 0.84–0.89.

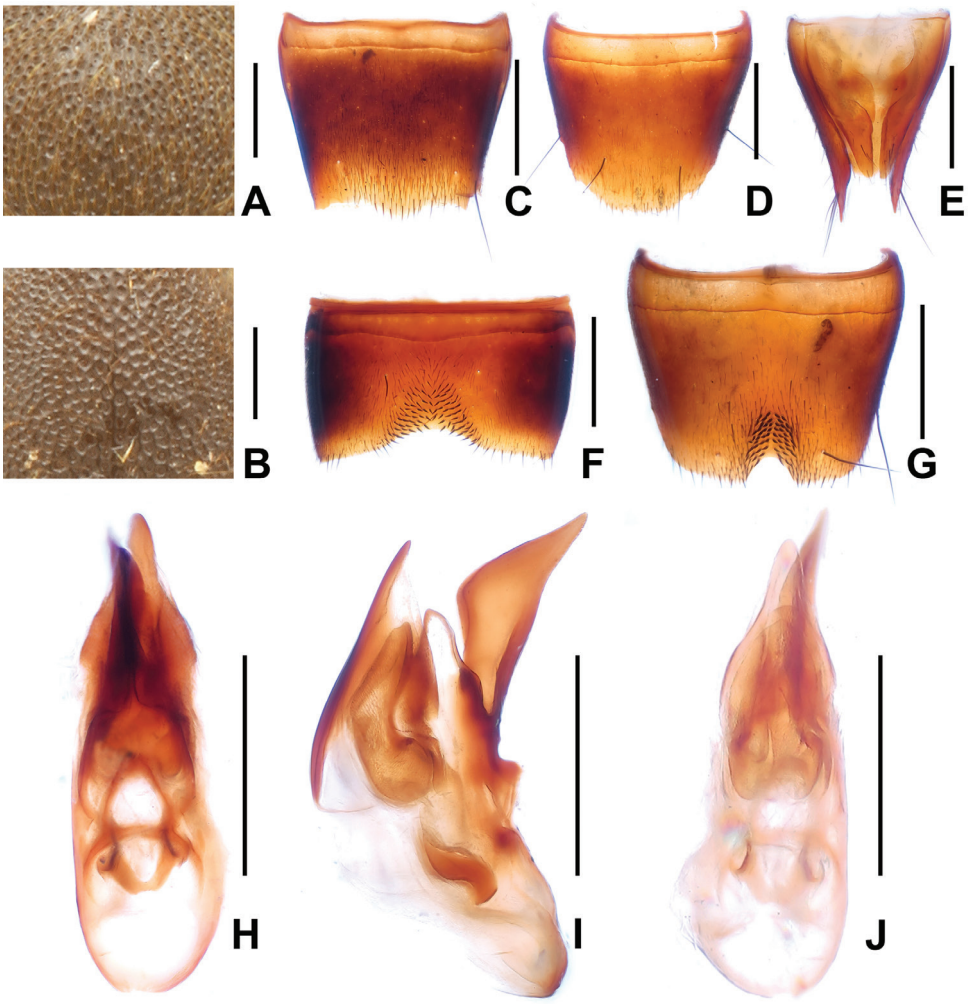


Figure 9. *Domene reitteri*. **A** median dorsal portion of head **B** median portion of pronotum **C** female tergite VIII **D** female sternite VIII **E** female tergites IX–X. **F** male sternite VII **G** male sternite VIII **H** aedeagus in ventral view **I** aedeagus in lateral view **J** aedeagus in dorsal view. Scales: **A**–**B** 0.2 mm; **C**–**J** 0.5 mm.

Habitus as in Figs 7A, 8A, 8D. Body blackish brown; legs with dark brown profemora and protibiae, basal halves of metafemora light brown, distal halves gradually infuscate; antennae brown to light brown.

Head orbicular, broadest across eyes; punctation (Fig. 9A) moderately coarse, weakly umbilicate, and very dense, interstices forming very narrow ridges. All antennomeres longer than broad; antennomeres IV–X of equal length; antennomere I 1.6 times, II 1.1 times, III 1.3 times, XI 1.3 times as long as IV. Maxillary palpus very slender, preapical joint 2.7–3.2 times as long as broad.

Pronotum slightly narrower than head, widest in the middle; lateral margins convex in dorsal view; punctation (Fig. 9B) somewhat coarser than that of head; midline with rudiment of a fine glossy line.

Elytra without distinct longitudinal ridges; suture weakly elevated; punctation very fine, dense and uniform; hind wings reduced. Protarsomeres I–IV dilated in both sexes.

Abdomen with punctation fine and dense on tergites III–VI, finer and somewhat sparser on tergite VIII, posterior margin of tergite VIII weakly convex in the middle (Fig. 9C); interstices with shallow microreticulation; posterior margin of tergite VII with palisade fringe.

Male. Sternites III–VI unmodified; sternite VII (Figs 8B, 9F) distinctly transverse, with median impression of triangular shape posteriorly, this impression with numerous distinctly modified, short and stout black setae; posterior margin distinctly concave in the middle; sternite VIII (Figs 8B, 9G) transverse, with pronounced and symmetric impression posteriorly, this impression with distinctly modified short and stout black setae, posterior excision small and U-shaped; aedeagus as in Figs 8C, 9H–J, ventral process stout and apically acute; dorsal plate with large and lamellate apical portion, and with short, thin basal portion; internal sac with membranous structures.

Female. Posterior margin of sternite VIII (Fig. 9D) broadly convex; genital segments with weakly asymmetric large and moderately sclerotized structure (Fig. 9E).

Comparative notes. The fine, dense and uniform punctation of the elytra, and the similar shape and chaetotaxy of the male sternite VII and sternite VIII suggest that *D. reitteri* is most closely allied to *D. chenae*. It is distinguished from *D. chenae* by the finer punctation of the head and pronotum, the numerous distinctly modified, short and stout black setae on the male sternite VII, the stouter ventral process of the aedeagus and by the shape of the sclerotized structure in the female genital segments.

Distribution and natural history. The distribution is confined to several localities in the Tianmu Shan range in the northwest of Zhejiang. The specimens were sifted from leaf litter in broad-leaved and primary mixed forests at altitudes of 300–1500 m.

***Domene* (*Macromene*) *chenae* Peng & Li, sp. n.**

http://zoobank.org/6F65882A-3C00-4988-A3C6-6FC9B0D57C9B

Figs 1, 7B, 10

Type material (2 ♂♂, 1 ♀)**.** Holotype ♂: "China: Guangxi Prov., Lingui County, Huping N. R., Anjiangping, 25°34'N, 109°57'E, 13.VII.2011 1,200 m, Zhu, Chen & Ma leg. / Holotypus ♂ *Domene chenae* sp. n., det Peng & Li. 2014" (SNUC). Paratypes: 1 ♂: same data as holotype (SNUC); 1 ♀: same data, but "He & Tang leg." (SNUC).

Etymology. The species is named after Yan Chen, who collected some of the type specimens.

Description. Measurements (in mm) and ratios: BL 7.95–8.17, FL 4.55–4.73, HL 1.20–1.24, HW 1.14–1.17, AnL 3.17–3.39, NW 0.43–0.46, PL 1.30–1.37,

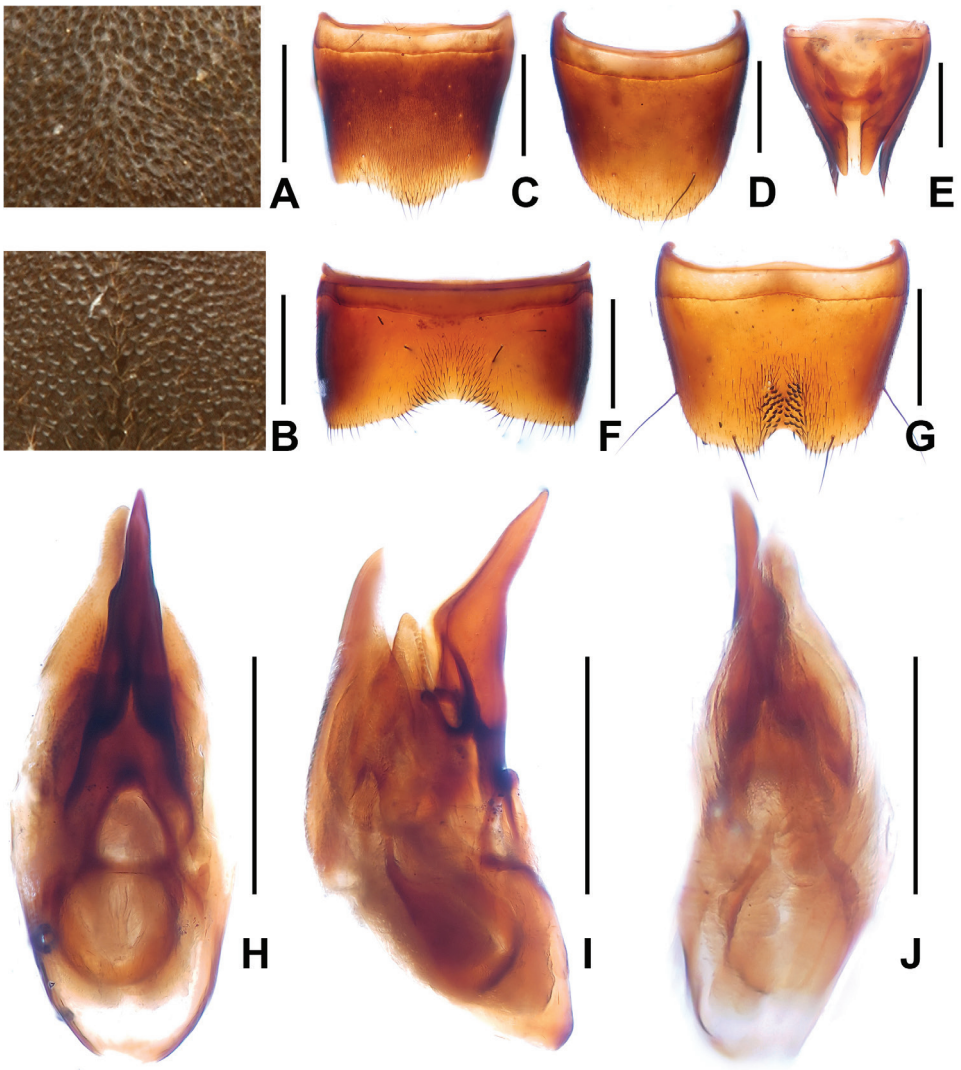


Figure 10. *Domene chenae*. **A** median dorsal portion of head **B** median portion of pronotum **C** female tergite VIII **D** female sternite VIII **E** female tergites IX–X. **F** male sternite VII **G** male sternite VIII **H** aedeagus in ventral view **I** aedeagus in lateral view **J** aedeagus in dorsal view. Scales: **A**–**B** 0.2 mm; **C**–**J** 0.5 mm.

PW 1.07–1.09, EL 1.11–1.13, EW 1.22–1.24, TiL 1.58–1.66, TaL 0.94–1.02, AW 1.26–1.30, AL 1.12, HL/HW 1.05–1.06, HW/PW 1.06–1.07, HL/PL 0.91–0.92, NW/HW 0.38–0.39, PL/PW 1.21–1.26, EL/PL 0.82–0.85.

Habitus as in Fig. 7B. Body black with distinctly paler abdominal apex; legs with blackish brown profemora and dark brown protibiae, basal halves of metafemora light brown, distal halves gradually infuscate; antennae brown to light brown.

Head orbicular, widest across eyes; punctation (Fig. 10A) coarse, distinctly umbilicate, and very dense, interstices forming very narrow ridges. All antennomeres longer

than broad; antennomeres IV–X of equal length; antennomeres I 1.6 times, II 0.9 times, III 1.1 times, XI 1.2 times as long as IV. Maxillary palpus very slender, preapical joint 2.8–2.9 times as long as broad.

Pronotum narrower than head, widest in the middle; lateral margins weakly convex in dorsal view; punctation (Fig. 10B) similar to that of head; midline with rudiment of a fine glossy line.

Elytra without distinct longitudinal ridges; suture elevated in posterior two thirds; punctation fine, dense and uniform; interstices without micropunctation. Hind wings probably present. Protarsomeres I–IV moderately dilated.

Abdomen with fine and dense punctation on tergites III–VIII; posterior margin of tergite VIII broadly and weakly convex (Fig. 10C); interstices with shallow microreticulation; posterior margin of tergite VII with palisade fringe.

Male. Sternites III–VI unmodified; sternite VII (Fig. 10F) distinctly transverse, with median impression of triangular shape posteriorly, this impression with moderately modified dark setae, posterior margin broadly concave in the middle; sternite VIII (Fig. 10G) transverse, with shallow median impression posteriorly, this impression with distinctly modified stout and black setae, posterior excision small and U-shaped; aedeagus as in Figs 10H–J, ventral process more slender and curved, apically acute; dorsal plate with distinctly sclerotized apical portion, basal portion short.

Female. Posterior margin of sternite VIII (Fig. 10D) broadly convex; genital segments with weakly asymmetric, large and sclerotized structure (Fig. 10E).

Comparative notes. The fine, dense and uniform punctation of the elytra, and the similar shape and chaetotaxy of the male sternite VII and sternite VIII suggest that *D. chenae* is allied to *D. reitteri*. The species is distinguished from *D. reitteri* by the coarser punctation of the head and pronotum, the somewhat shorter elytra, the moderately modified dark setae of the male sternite VII, the differently shaped ventral process of the aedeagus and the more distinctly sclerotized structure in the female genital segments.

Distribution and natural history. The type locality is situated in Anjiangping to the northwest of Guilin, northern Guangxi (Fig. 1). The specimens were sifted from leaf litter and grass in broad-leaved forests at an altitude of 1200 m.

Domene (*Macromene*) *cultrata* Feldmann & Peng, sp. n.

http://zoobank.org/4792CF08-CAC7-44BF-9293-060F1E1DBA61
Figs 1, 11A, 12

Type material (10 ♂♂, 12 ♀♀)**.** Holotype: ♂, "China (Shaanxi) Qin Ling Shan, 110.06 E, 34.27 N, Hua Shan, 118 km E Xian, N valley, 1200–1400 m, leafy wd.sifted, 18./20.VIII.1995, Wrase / Sammlung M. Schülke Berlin / Holotypus ♂ *Domene cultrata* sp. n., det. B. Feldmann & Z. Peng 2014 " (cSch). Paratypes: 2 ♂♂, 3 ♀♀ (4 specimens are teneral): same label data as holotype (cSch, cRou, cFel);; 1 ♂: "China [28] S-Shaanxi, 34 km S Hanzhong, 32°44'22"N, 106°51'55"E, 1460

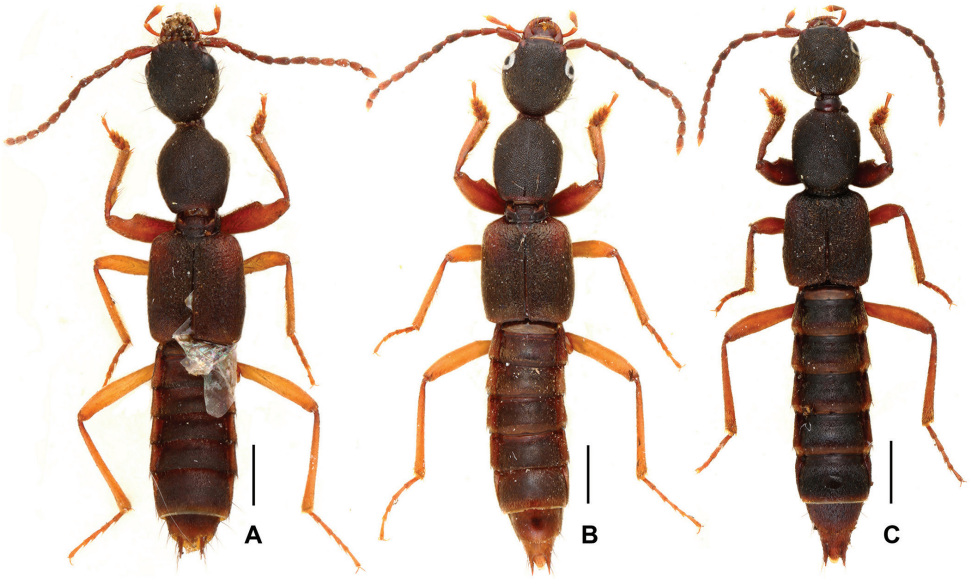


Figure 11. Habitus of *Domene* spp., **A** *D. cultrata* **B** *D. cuspidata* **C** *D. reducta*. Scales: 1.0 mm.

m, 14.VIII.2012, V. Assing" (cAss); 1 ♂: "China [27a] S-Shaanxi, Micang Shan, 42 km S Hanzhong, 32°40'52"N, 106°49'16"E, 1090 m, 14.VIII.2012, V. Assing" (cFel); 2 ♀♀: "China (S. Shaanxi), Micang Shan, 42 km S Hanzhong, 32°40'43"N, 106°48'33"E, 1090 m, (stream valley, shady S. slope, sec. mixed for., raked from roots of perennials, soil, under stones) 17.VIII.2012, D.W. Wrase (32)" (cSch, cFel); 1 ♂, 1 ♀: "China: Shaanxi, Qin Ling Shan, 110.06 E, 34.27 N, Hua Shan Mt. N Valley, 1200–1400 m, 118 km E Xian, sifted, 18./20.VIII.1995, leg. M. Schülke" (cSch); 1 ♀: "China: border Shaanxi–Sichuan [today Chongqing], Daba Shan pass, 20 km SSE Zhenping, 1700–1800 m, 31°44'N, 109°35'E, 9.VII.2001, A. Smetana [C96b]" (cSme); 1 ♂, 1 ♀: "China: Shaanxi Prov., Zhouzhi County, Houzhenzi, Qinling, West Sangongli Gou, N33.50.613 E107.48.524 / 17–19.V.2008 alt. 1,336 m, Hao Huang & Xu Wang leg." (SNUC); 1 ♂, 2 ♀♀: "China [17] S-Gansu, S Longnan, Min Shan, macchia, 33°05'24"N, 104°45'13"E, 1500 m, 6.VIII.2012, V. Assing"(cAss); 2 ♂♂, 2 ♀♀: "China (W-Hubei) Daba Shan, creek vall. 8 km NW Muyuping, 31°29'N, 110°22'E, 1540 m, (edge of small creek), 18.VII.2001, Wrase (16)" (cSch, cFel).

Etymology. The specific epithet is an adjective derived from the Latin noun culter (knife) and alludes to the shape of the ventral process of the aedeagus.

Description. Measurements (in mm) and ratios: BL 8.90–10.2, FL 5.38–5.50, HL 1.31–1.50, HW 1.22–1.39, AnL 3.22–3.62, NW 0.46–0.50, PL 1.48–1.62, PW 1.17–1.40, EL 1.46–1.63, EW 1.50–1.78, TiL 1.65–1.92, TaL 1.18–1.42, AW 1.37–1.53, AL 1.33–1.48, HL/HW 1.04–1.14, HW/PW 0.99–1.07, HL/PL 0.88–0.96, NW/HW 0.36–0.38, PL/PW 1.19–1.26, EL/PL 0.99–1.01.

Habitus as in Fig. 11A. Body dark brown; legs brownish yellow, with brown profemora and protibiae; antennae brown to light brown.

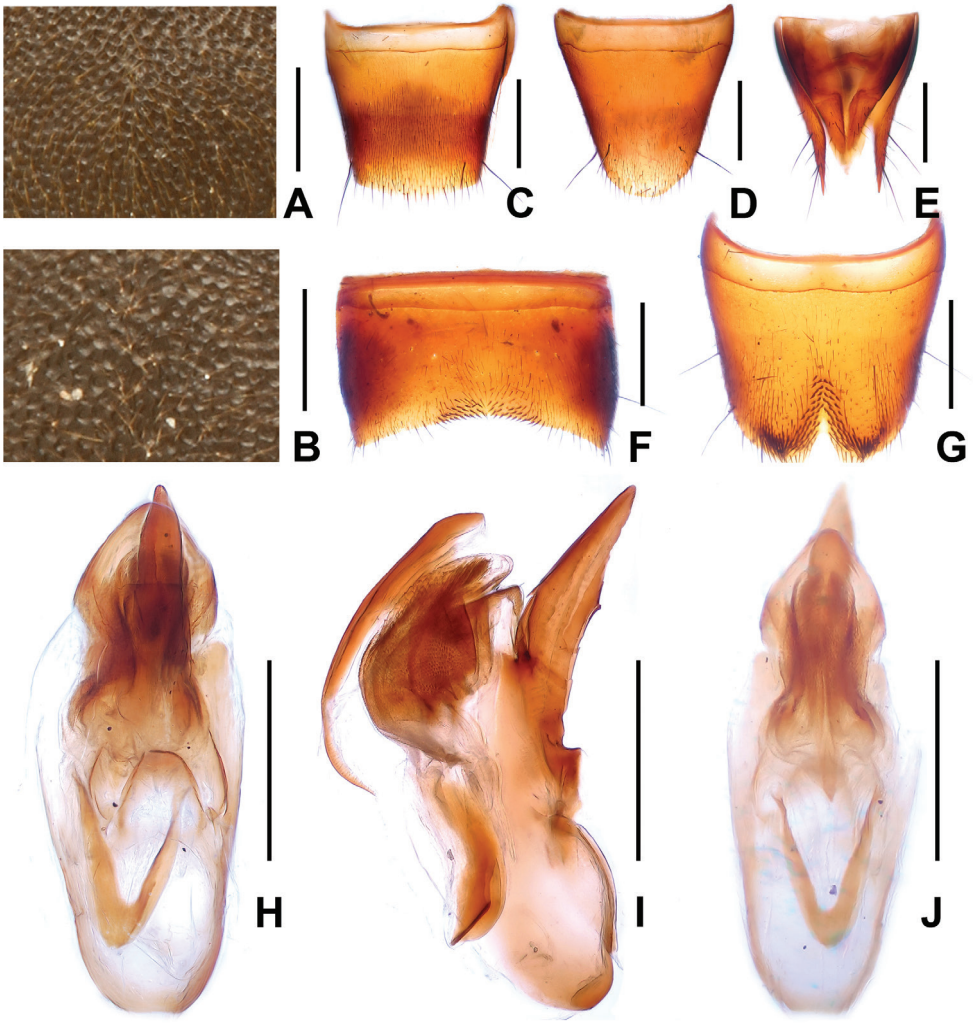


Figure 12. *Domene cultrata*. **A** median dorsal portion of head **B** median portion of pronotum **C** female tergite VIII **D** female sternite VIII **E** female tergites IX–X. **F** male sternite VII **G** male sternite VIII **H** aedeagus in ventral view **I** aedeagus in lateral view **J** aedeagus in dorsal view. Scales: **A**–**B** 0.2 mm; **C**–**J** 0.5 mm.

Head orbicular, widest behind eyes; punctation (Fig. 12A) coarse, umbilicate and dense, interstices forming very narrow ridges. All antennomeres longer than broad; antennomeres IV–X of equal length; antennomeres I 1.6 times, II 0.9 times, III 1.3 times, XI 1.4 times as long as IV. Maxillary palpus very slender, preapical joint 2.8–3.0 times as long as broad.

Pronotum about as wide as head, widest in the middle; lateral margins convex in dorsal view; punctation (Fig. 12B) similar to that of head; midline with rudiment of a fine glossy line.

Elytra without distinct longitudinal ridges; suture elevated in posterior two thirds; macropunctation coarse, irregular, partly confluent, and partly somewhat seriate; in-

terstices rugose, rendering elytra matt, with irregular and mostly barely visible micropunctation (visible in posterior part of elytra). Hind wings fully developed. Protarsomeres I–IV distinctly dilated.

Abdomen with fine and dense punctation on tergites III–VIII; posterior margin of tergite VIII broadly convex (Fig. 12C); interstices with distinct microreticulation; posterior margin of tergite VII with palisade fringe.

Male. Sternites III–VI unmodified; sternite VII (Fig. 12F) distinctly transverse, with shallow median impression posteriorly, this impression with sparse, strongly modified, short and stout black setae, posterior margin broadly concave; sternite VIII (Fig. 12G) with shallow median impression, this impression with distinctly modified stout black setae, posterior excision moderately deep and V-shaped, on either side of the posterior excision with dense cluster of dark setae; aedeagus as in Figs 12H–J, ventral process nearly straight and apically acute; dorsal plate with long, large and distinctly sclerotized apical portion, basal portion short and lamellate; internal sac with small sclerotized spines and with distinct membranous structures.

Female. Sternite VIII (Fig. 12D) distinctly oblong, posterior margin strongly convex; genital segments with asymmetric, slender and moderately sclerotized structure (Fig. 12E).

Intraspecific variation. *Domene cultrata* is subject to rather pronounced intraspecific variation of size, body proportions and coloration of the legs.

Comparative notes. Based on the similar chaetotaxy and shape of the male sternite VIII, and the shape of the ventral process of the aedeagus, *D. cultrata* belongs to the *D. malaisei* species group and is allied to *D. cuspidata*. It can be distinguished from other species of the group by the distinctly coarser macropunctation of the elytra, the differently shaped ventral process of the aedeagus, and the slender sclerotized structure in the female genital segments, from *D. malaisei* and *D. reducta* also by the shallower impression and the less deep posterior excision of the male sternite VIII.

Distribution and natural history. This species has been recorded from the Qinling Shan and Daba Shan, as well as from adjacent mountain ranges (Fig. 1). The specimens were sifted from leaf litter in forests or raked from roots of perennials and soil, or found under stones at altitudes of 1090–1800 m. Four specimens found in August are teneral.

Domene (*Macromene*) *cuspidata* Feldmann & Peng, sp. n.

http://zoobank.org/6E9BB0EB-775C-4C0B-BDB4-8F2B43FDEF26
Figs 1, 11B, 13

Type material (10 ♂♂, 24 ♀♀)**.** Holotype: ♂: "China: Shaanxi Prov., Hanzhong City, Nanzheng County, Yuanba Town, Liping National Forest Park / 32°50'N, 106°36'E, 15.VII.2012 1,400–1,600 m, Chen, Li, Ma, & Zhao leg. / Holotypus ♂ *Domene cuspidata* sp. n., det. B. Feldmann & Z. Peng 2014" (SNUC). Paratypes: 2

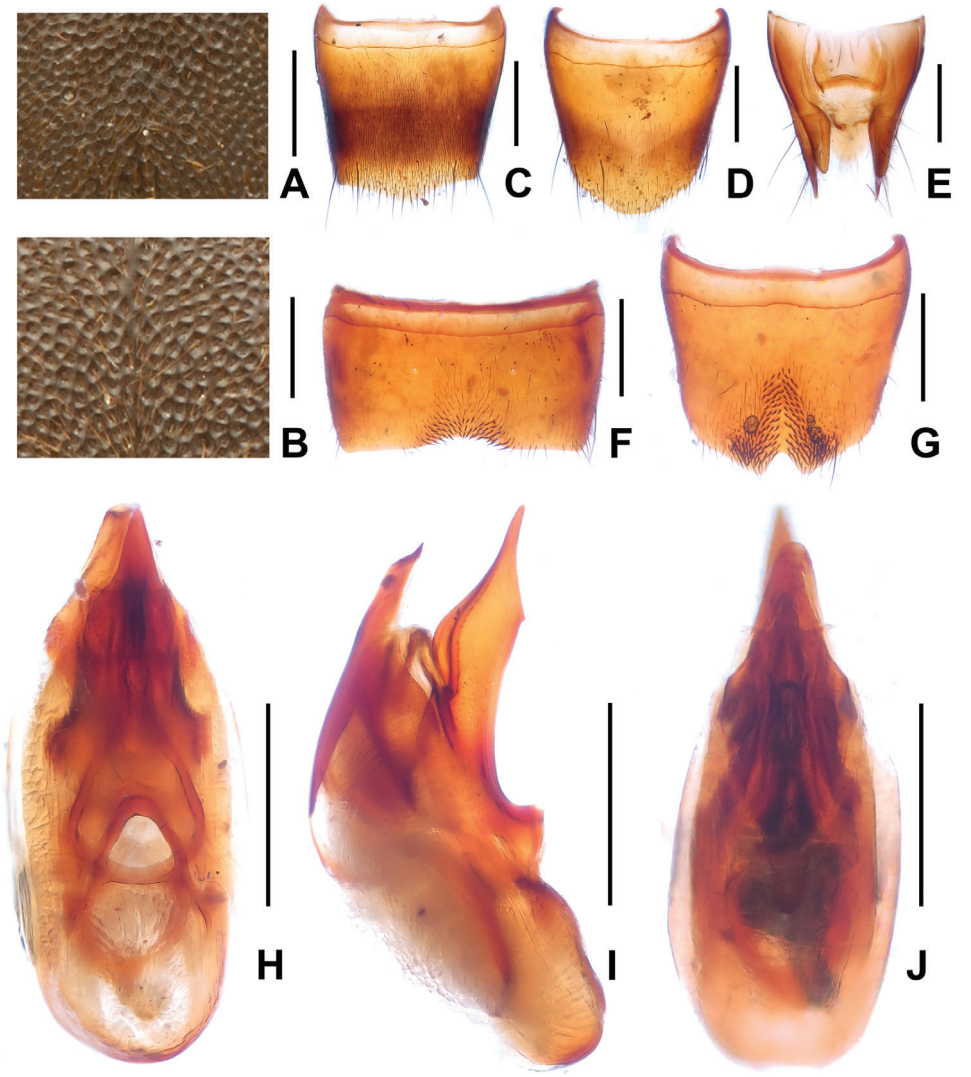


Figure 13. *Domene cuspidata*. **A** median dorsal portion of head **B** median portion of pronotum **C** female tergite VIII **D** female sternite VIII **E** female tergites IX–X. **F** male sternite VII **G** male sternite VIII **H** aedeagus in ventral view **I** aedeagus in lateral view **J** aedeagus in dorsal view. Scales: **A**–**B** 0.2 mm; **C**–**J** 0.5 mm.

♂♂, 11 ♀♀: same data as holotype (SNUC, cAss); 1 ♀: same data, but "16.VII.2012, Yu-Hong Pan leg." (SNUC); 1 ♀: same data, but "16.VII.2012, Li-Zhen Li leg." (SNUC); 3 ♀♀: same data, but "16.VII.2012" (SNUC); 1 ♀: "China, Shaanxi, Qinling Shan above Houzhenzi, 115 km WSW Xi'an, 1450 m, 33°50'N, 107°47'E, 5.VII.2001, A. Smetana [C95b]" (cSme); 1 ♂: "China [3] S-Gansu, N Chengxian, W-Qinling Shan, 34°08'24"N, 105°46'43"E, 1750 m, 28.VII.2012, V. Assing"

(cAss); 1 ♂: "China: S-Gansu [CH 12-03], W Qinling Shan, 43 km N Chengxian, 34°08'24"N, 105°46'43"E, 1750 m, moist valley with creek and ponds, meadow with Artemisia, 28.VII.2012, leg M. Schülke" (cSch); 1 ♀: "China: S-Gansu [CH 12-05], W Qinling Shan, 47 km N Chengxian, 34°10'17"N, 105°42'56"E, 1850 m, mixed secondary forest margin, litter sifted, 29.VII.2012, leg M. Schülke" (cSch); 1 ♂, 1 ♀: "China, S-Gansu [CH 12-05], W. Qinling Shan, 47 km N Chengxian, 34°10'20"N, 105°42'19"E, 1830 m, (creek valley, loam deposit on meadow with tall herbaceous vegetation,raked/dug, 29.VII.2012, D. W. Wrase" (cSch, cFel); 1 ♂, 3 ♀♀: "China: W-Sichuan, Ya'an Pref., Shimian Co., Daxue Shan, road betw. Anshunchang–Wanba, 12 km W Shimian, 1300 m, 9.VII.1999, leg. A. Pütz" (cPüt, cFel).

Etymology. The specific epithet is an adjective derived from the Latin noun cuspis (cusp) and refers to the apically acute ventral process of the aedeagus.

Description. Measurements (in mm) and ratios: BL 8.89–9.56, FL 5.12–5.34, HL 1.26–1.39, HW 1.20–1.30, AnL 3.17–3.61, NW 0.45–0.50, PL 1.48–1.57, PW 1.20–1.28, EL 1.42–1.50, EW 1.48–1.62, TiL 1.72–1.79, TaL 1.20–1.33, AW 1.35–1.49, AL 1.32–1.65, HL/HW 1.04–1.08, HW/PW 1.00–1.03, HL/PL 0.85–0.89, NW/HW 0.38–0.39, PL/PW 1.21–1.24, EL/PL 0.94–0.97.

External characters (Fig. 11B) as in *D. cultrata*, distinguished only by the distinctly less coarse macropunctation and less rugose interstices of the elytra rendering the elytra more shiny in *D. cuspidata*, and by the primary and secondary sexual characters:

Male. Sternites III–VI unmodified; sternite VII (Fig. 13F) distinctly transverse, with shallow postero-median impression, this impression with sparse strongly modified, short and stout black setae, posterior margin concave in the middle; sternite VIII (Fig. 13G) with extensive median impression, this impression with distinctly modified stout black setae, posterior excision less deep, V-shaped, on either side of the posterior excision with a dense cluster of dark setae; aedeagus as in Figs 13H–J, ventral process distinctly sclerotized, with slender and very acute apical portion; dorsal plate with long, large and distinctly sclerotized apical portion, basal portion short; internal sac with membranous structures.

Female. Sternite VIII (Fig. 13D) oblong, posterior margin broadly convex; genital segments with asymmetric, large and moderately sclerotized structure (Fig. 13E).

Comparative notes. Based particularly on the similar chaetotaxy and shape of the male sternite VIII and the shape of the ventral process of the aedeagus, *D. cuspidata* belongs to the *D. malaisei* species group and is closely allied to *D. cultrata*. It is distinguished from other species of the group by the apically more acute ventral process of the aedeagus and by the large, moderately sclerotized structure in the female genital segments, from *D. malaisei* and *D. reducta* also by the shallower impression and less deep posterior excision of the male sternite VIII.

Distribution and natural history. The species was recorded from the Qinling Shan and Dalou Shan (Fig. 1). The specimens were sifted from forest leaf litter and a loamy meadow with tall herbaceous vegetation at altitudes of 1300–1850 m. Six paratypes found in July are teneral.

***Domene* (*Macromene*) *reducta* Feldmann & Peng, sp. n.**
http://zoobank.org/17A30E81-7F93-4329-AF1B-32CE17E380E9
Figs 1, 11C, 14

Type material (5 ♂♂, 9 ♀♀)**.** Holotype ♂: "China: Sichuan Prov., Tianquan County, Labahe N. R., 30°09'N, 102°27'E, 29.VII.2006 1,900 m, Hu & Tang leg. / Holotypus ♂ *Domene reducta* sp. n., det. B. Feldmann & Z. Peng 2014" (SNUC). Paratypes: 1 ♂, 5 ♀♀ [all teneral], same label data as holotype (SNUC); 2 ♂♂, 1♀ [1 ♂, 1 ♀ teneral]: same data, but "Liangluxiang, 29°56'N, 102°23'E, alt. 1,500–1,700 m / 10.VII.2012, Dai, Peng & Yin leg." (SNUC); 1 ♀ [teneral]: same data, but "Liangluxiang, 29°56'N, 102°23'E, alt. 1,900–2,000 m, 10.VII.2012, Dai, Peng & Yin leg leg." (SNUC); 1 ♂: "China, Sichuan: Quing-cheng-Shan [ca. 30°53'N, 103°35'E], 1400–1700 m, 22.VI.1996, D. Erber" (cFel); 1 ♀: "China, W.Sichuan, (Ya'an Pref. Tianquan Co.), Jiajin Shan, valley above Labahe, N.R.ST., 57 km W Ya'an, 30°06'N, 102°25'E (light forest), 1800 m, 12.VII.1999, D.W. Wrase" (cFel); 1 ♀: "China: W-Sichuan, Ya'an Prefecture, Tianquan Co., Jiajin Shan, Tal oberh. Labahe, N.R.St., 57 km W. Ya'an, 30°06'N 102°25'E, Streu, Rinde, Pilze, 1800 m, 12.VII.1999, leg. M. Schülke" (cSch).

Etymology. The specific epithet (Latin, adjective: reduced) alludes to the minute sclerotized structure in the female genital segments.

Description. Measurements (in mm) and ratios: BL 8.95–10.84, FL 5.37–5.48, HL 1.42–1.48, HW 1.35–1.41, AnL 3.36–3.56, NW 0.50–0.55, PL 1.57–1.66, PW 1.28–1.35, EL 1.41–1.48, EW 1.63–1.70, TiL 1.81–1.87, TaL 1.28–1.31, AW 1.51–1.57, AL 1.52–1.54, HL/HW 1.04–1.06, HW/PW 1.03–1.05, HL/PL 0.89–0.91, NW/HW 0.37–0.39, PL/PW 1.22–1.24, EL/PL 0.88–0.91.

Habitus as in Fig. 11C. Body dark brown; legs light brown with darker profemora and protibiae; antennae brown to light brown.

Head orbicular, widest behind eyes; punctation (Fig. 14A) moderately coarse, distinctly umbilicate, and very dense, interstices forming very narrow ridges. All antennomeres longer than wide; antennomeres IV–X of equal length; antennomeres I 1.7 times, II 1.1 times, III 1.4 times, XI 1.2 times as long as IV. Maxillary palpus slender, preapical joint 3.2–3.5 times as long as broad.

Pronotum slightly narrower than head, widest in the middle; lateral margins convex in dorsal view; punctation (Fig. 14B) somewhat coarser than that of head; midline with rudiment of a fine glossy line.

Elytra without distinct longitudinal ridges; suture elevated in posterior three-fourths; macropunctation moderately coarse, irregular, partly confluent, and partly somewhat seriate; interstices with irregular micropunctation. Hind wings fully developed. Protarsomeres I–IV distinctly dilated.

Abdomen with fine and dense punctation on tergites III–VIII; posterior margin of tergite VIII broadly and weakly convex (Fig. 14C); interstices with shallow microreticulation; posterior margin of tergite VII with palisade fringe.

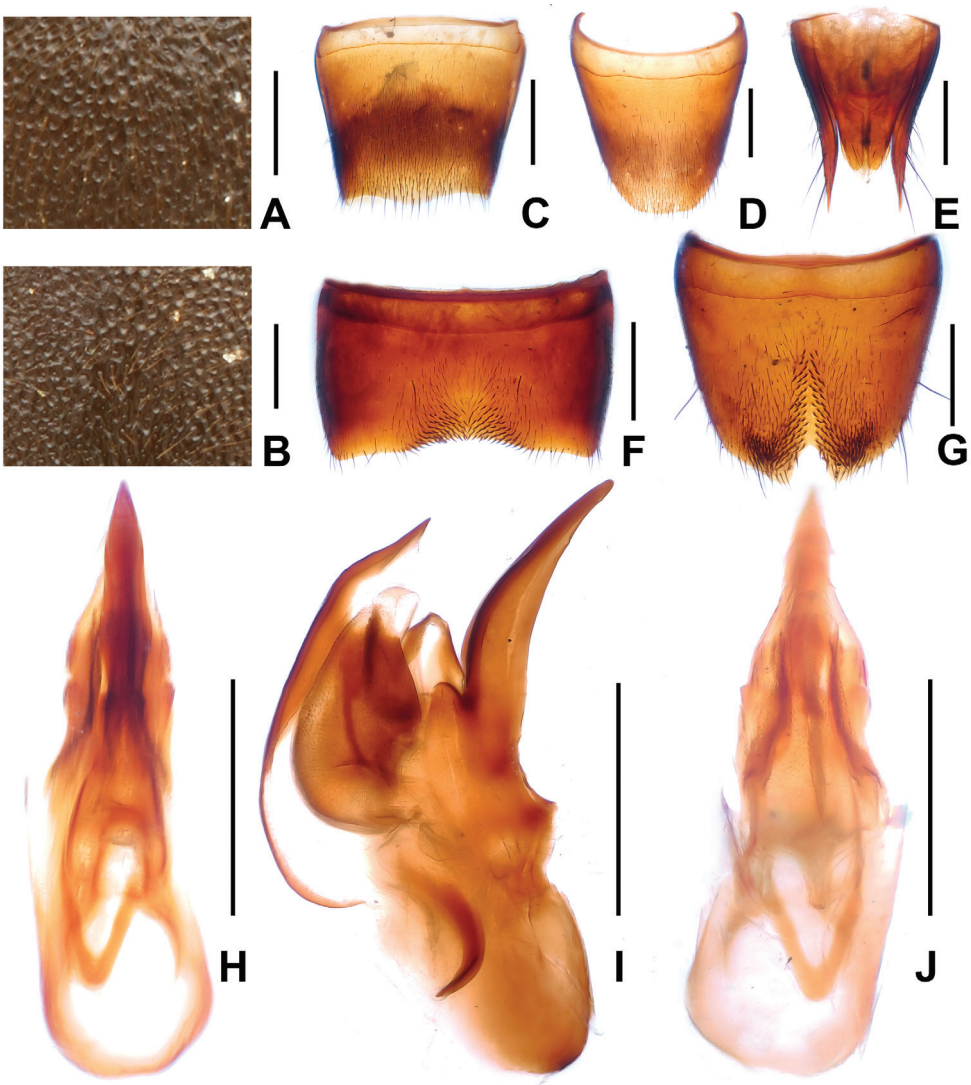


Figure 14. *Domene reducta*. **A** median dorsal portion of head **B** median portion of pronotum **C** female tergite VIII **D** female sternite VIII **E** female tergites IX–X. **F** male sternite VII **G** male sternite VIII **H** aedeagus in ventral view **I** aedeagus in lateral view **J** aedeagus in dorsal view. Scales: **A**–**B** 0.2 mm; **C**–**J** 0.5 mm.

Male. Sternites III–VI unmodified; sternite VII (Fig. 14F) distinctly transverse, with median impression of triangular shape posteriorly, this impression with strongly modified, short and stout black setae, posterior margin weakly concave in the middle; sternite VIII (Fig. 14G) with shallow and extensive median impression, this impression with stout black setae, posterior excision moderately deep and V-shaped, on either side of the posterior excision with a dense cluster of dark setae; aedeagus as in Figs 14H–J, ventral process long, slender, evenly curved and apically acute; dorsal plate with long and distinctly sclerotized apical portion, basal portion long and lamellate.

Female. Posterior margin of sternite VIII (Fig. 14D) broadly convex; genital segments with a small symmetric, weakly sclerotized structure (Fig. 14E).

Comparative notes. Based particularly on the similar chaetotaxy and shape of the male sternite VIII, and the shape of the ventral process of the aedeagus, *D. reducta* belongs to the *D. malaisei* species group and is closely related to *D. malaisei*. *Domene reducta* is distinguished from other species of the group by on average larger body size (especially from *D. malaisei*), the shape of the impression on the male sternite VIII, the long, slender, evenly curved ventral process of the aedeagus and by the symmetric, small and moderately sclerotized structure in the female genital segments.

Distribution and natural history. The species is known from the Qingcheng Shan and Hengduan Shan, central Sichuan (Fig. 1). The specimens were sifted from leaf litter and soil in evergreen broad-leaved forests at altitudes of 1400–1900 m. Nine paratypes found in July are teneral.

Domene (*Macromene*) sp.

Material studied. 5♀♀, Sichuan, Emei Shan, 29°34'N, 103°21'E, 1800–2400 m, sifted, 27.VI.–5.VII.2009, leg. Grebennikov (cSme, cAss).

Comment. The above brachypterous females undoubtedly represent an undescribed species distinguished from the other species known from China by the conspicuously large head and the distinctly impressed sutural portion of the elytra, from most species also by the short and narrow elytra and by the absence of a palisade fringe at the posterior margin of the male tergite VII.

Key to the *Domene* species of China

Because of some variability in size, body proportions, coloration, punctation and sculpture in most species, a positive identification (especially of the species of the *malaisei* group) requires the examination of the genitalia.

1 Head of flattened, subcircular shape. Male sternite VIII (Fig. 4G) with pronounced median impression with numerous distinctly modified short and stout black setae; aedeagus (Figs 4H–J) large (1.63–1.65 mm) with completely reduced dorsal plate. Posterior margin of female sternite VIII (Fig. 4D) with distinct median concavity. China: western Zhejiang (Fig. 1) .... ***D. firmicornis* Assing & Feldmann, 2014**

– Head less strongly flattened and of orbicular shape. Chaetotaxy and shape of male sternite VIII different; aedeagus smaller (< 1.60 mm) and with distinct dorsal plate. Female sternite VIII with more or less convex posterior margin... **2**

2 Smaller species; length of forebody ≤ 4.73 mm. Punctation of head and especially pronotum fine; male sternite VIII with small to very small (*D. chenpengi*) U-shaped excision posteriorly **3**

– Larger species; length of forebody ≥ 4.70 mm. Punctation of head and pronotum coarser. Male sternite VIII of different shape and chaetotaxy **5**

3 Punctation of pronotum very fine with interstices forming narrow, longitudinal ridges. Male sternite VII (Fig. 3F) with only few distinctly modified setae; male sternite VIII (Fig. 3G) with very small posterior excision; ventral process of aedeagus (Figs 3H–J) with relatively short and less stout apical portion. Female genital segments (Fig. 3E) with relatively small sclerotized structure. Russian Far East; South Korea; China: Beijing, Jilin (Fig. 1) ..... ***D. chenpengi*** **Li, 1990**

– Punctation of pronotum coarser. Male sternite VII with more numerous modified setae; male sternite VIII with deeper U-shaped excision. Female genital segments with more pronounced sclerotized structure **4**

4 Punctation of head and pronotum (Figs 10A–B) coarser. Male sternite VII (Fig. 10F) with numerous moderately modified dark setae; ventral process of aedeagus (Figs 10H–J) with slender apical portion (in lateral view). Female genital segments (Fig. 10E). China: Guangxi (Fig.1) ..... ***D. chenae*** **sp. n.**

– Punctation of head and pronotum less coarse (Figs 9A–B). Male sternite VII (Figs 8B, 9F) with numerous distinctly modified black setae; ventral process of aedeagus (Figs 8C, 9H–J) with stout apical portion (in lateral view). Female genital segments: Fig. 9E. China: western Zhejiang (Fig. 1) ..... ***D. reitteri*** **Koch, 1939**

5 Elytra with more or less pronounced longitudinal ridges. Male sternite VIII with few modified setae at most, on either side of posterior excision with cluster of black setae; aedeagus with thinner ventral process in lateral view **6**

– Elytra without distinct longitudinal ridges. Chaetotaxy of male sternite VIII different; aedeagus with stouter ventral process in lateral or ventral (*D. procera*) view **8**

6 Posterior margin of abdominal tergite VII without palisade fringe. Male sternite VII (Assing and Feldmann 2014: figure 23) with weakly and broadly concave posterior margin; aedeagus (Assing and Feldmann 2014: figures 25–26) with longer ventral process. China: western Yunnan (Fig. 1) ..... ***D. immarginata*** **Assing & Feldmann, 2014**

– Posterior margin of abdominal tergite VII with palisade fringe. Male sternite VII of different shape; aedeagus with shorter ventral process. Species from Taiwan **7**

7 Legs yellowish brown to reddish; antennae brown to dark brown. Male sternite VIII (Assing and Feldmann 2014: figure 7) with deeper and slightly narrower posterior excision; ventral process of aedeagus (Assing and Feldmann 2014: figure 8) weakly curved in lateral view. Central western Taiwan: Taichung Hsien: Anma Shan ..... ***D. scabripennis*** **Rougemont, 1995**

– Legs blackish-brown; antennae dark-brown to blackish-brown. Male sternite VIII (Assing and Feldmann 2014: figure 15) with shallower and broader posterior excision; ventral process of aedeagus (Assing and Feldmann 2014: figures 16–17) nearly straight in lateral view. Southern Taiwan: Kaohsiung Hsien ..... ***D. alesiana*** **Assing & Feldmann, 2014**

8 Habitus broader; head somewhat broader than pronotum. Punctation of head and pronotum coarser and less dense, surface therefore more shiny. Male sternite VIII with deeply and broadly U-shaped posterior excision, on either side of posterior excision with short, dense and dark peg-setae. Aedeagus (Coiffait 1982: figures 95, A–C). Russia: East Siberia, Far East; "Korea"; China: Northeast Territory..... ***D. procera*** **Eppelsheim, 1886**

– Habitus more slender; head about as broad as pronotum. Punctation of head and pronotum finer and denser, rendering them more matt. Male sternite VIII with V-shaped posterior excision, on either side of posterior excision with cluster of dense dark setae..... **9**

9 Coloration of body (Fig. 5) black. On average smaller species (FL: 4.70–5.20 mm). Male sternite VIII (Fig. 6G) with deeper posterior excision; aedeagus (Figs 6H–J) smaller (1.07–1.18 mm). Northeastern Myanmar; China: western Yunnan (Fig.1) ..... ***D. malaisei*** **Scheerpeltz, 1965**

– Coloration of body dark brown. On average larger species (FL: 5.12–5.50 mm). Male sternite VIII with less deep posterior excision; aedeagus larger (> 1.30 mm) **10**

10 Aedeagus (Figs 14H–J) larger (1.52–1.54 mm) and with longer, more slender ventral process. Female genital segments (Fig. 14E) with small symmetric, weakly sclerotized structure. China: central Sichuan (Fig. 1)..... ***D. reducta*** **sp. n.**

– Aedeagus smaller (< 1.48 mm) and with shorter, less slender ventral process. Female genital segments with asymmetric, moderately sclerotized structure... **11**

11 Punctation of elytra coarser and with more rugose interstices, surface nearly matt. Male sternite VII (Fig. 12F) with broadly concave posterior margin; male sternite VIII (Fig. 12G) with shallower impression; ventral process of aedeagus (Figs 12H–J) with less slender and less acute apical portion. Female genital segments (Fig. 12E) with smaller sclerotized structures. China: Gansu, Hubei, Shaanxi (Fig. 1) ..... ***D. cultrata*** **sp. n.**

– Punctation of elytra less coarse and with less rugose interstices, surface slightly more shiny. Posterior margin of male sternite VII (Fig. 13F) concave in the middle; male sternite VIII (Fig. 13G) with deeper impression; ventral process of aedeagus (Figs 13H–J) with more slender and more acute apical portion. Female genital segments (Fig. 13E) with larger sclerotized structure. China: Gansu, Shaanxi, Sichuan (Fig. 1)..... ***D. cuspidata*** **sp. n.**

Acknowledgements

All the collectors mentioned in the text are acknowledged for their field work. We are indebted to the colleagues indicated in the material section for the loan of material under their care. In particular, we would like to thank Volker Assing (Hannover) for his helpful comments and suggestions and his help in preparing the map. Two anonymous reviewers are thanked for comments on a previous version of the manuscript.

The study is supported by the National Natural Science Foundation of China (No. 31201734, 31101659 and No. 31172134), the Foundation of Shanghai Municipal Education Commission (No. 12YZ077 and No. 13YZ062) and Shanghai Normal University (DZL125 and B-9013-11-003127).

References

Assing V, Feldmann B (2014) On *Domene scabripennis* Rougemont and its close relatives (Coleoptera: Staphylinidae: Paederinae). Linzer Biologische Beiträge 46(1): 499–514.

Coiffait H (1982) Coléoptères Staphylinidae de la Région Paléarctique Occidentale. IV. Sous famille Paederinae. Tribu Paederini 1 (Paederi, Lathrobii). Nouvelle Revue d´Entomologie, Supplément 12(4): 1–440.

Eppelsheim E (1886) Neue Staphylinen vom Amur. Deutsche Entomologische Zeitschrift 30: 33–46.

Gusarov VI (1992) Novye i maloizvestnye palearkticheskie stafilinidy (Coleoptera, Staphylinidae). Soobshchenie 4. Vestnik Leningradskogo Universiteta (3): 11–25.

Koch C (1939) Über neue und wenig bekannte paläarktische Paederinae (Col. Staph.). III. Entomologische Blätter 35: 156–172.

Li JK (1992) The Coleoptera fauna of Northeast China. Jilin Education Publishing House, Changchun, 205 pp. [in Chinese, English title]

Li JK, Chen P, Yin XQ, Zhong WY, Zhao HY (1990) The geographical distribution of soil beetles in Jilin Province. Journal of Northeast Normal University 1: 59–74. [in Chinese]

Rougemont GM de (1995) A new *Domene* (*Macromene*) Coiffait from Taiwan (Coleoptera, Staphylinidae, Paederinae). Bulletin of the National Museum of Natural Science 5: 135–138.

Scheerpeltz O (1965) Wissenschaftliche Ergebnisse der Schwedischen Expedition 1934 nach Indien und Burma. Coleoptera Staphylinidae (except Megalopsidiinae et Steninae). Arkiv for Zoologi (2) 17: 93–371.

Smetana A (2004) Subfamily Paederinae Fleming, 1821. In: Löbl I, Smetana A (Eds) Catalogue of Palaearctic Coleoptera, Volume 2. Apollo Books, Stenstrup, 579–624.

ZooKeys 456: 139–146 (2014)
doi: 10.3897/zookeys.456.8862
http://zookeys.pensoft.net

FORUM PAPER

A peer-reviewed open-access journal
ZooKeys
Launched to accelerate biodiversity research

Italian natural history museums on the verge of collapse?

Franco Andreone[1], Luca Bartolozzi[2], Giovanni Boano[3], Ferdinando Boero[4], Marco A. Bologna[5], Mauro Bon[6], Nicola Bressi[7], Massimo Capula[8], Achille Casale[9], Maurizio Casiraghi[10], Giorgio Chiozzi[11], Massimo Delfino[12], Giuliano Doria[13], Antonio Durante[14], Marco Ferrari[15], Spartaco Gippoliti[16], Michele Lanzinger[17], Leonardo Latella[18], Nicola Maio[19], Carla Marangoni[8], Stefano Mazzotti[20], Alessandro Minelli[21], Giuseppe Muscio[22], Paola Nicolosi[23], Telmo Pievani[21], Edoardo Razzetti[24], Giorgio Sabella[25], Marco Valle[26], Vincenzo Vomero[8], Alberto Zilli[27]

1 *Museo Regionale di Scienze Naturali, Via G. Giolitti, 36, I-1023 Torino, Italy* **2** *Museo di Storia Naturale, Sezione Zoologica "La Specola", Via Romana, 17, I-50125, Firenze, Italy* **3** *Museo Civico di Storia Naturale, Via San Francesco di Sales, 188, I-10022 Carmagnola, Italy* **4** *DiSTeBa - Museo di Biologia Marina "Pietro Parenzan" - Università del Salento, I-73100 Lecce, Italy* **5** *Università Roma Tre, Dipartimento di Scienze, Viale G. Marconi, 446, I-00146 Roma, Italy* **6** *Museo di Storia Naturale, Santa Croce, 1730, I-30135 Venezia, Italy* **7** *Museo Civico di Storia Naturale, Via Dei Tominz, 4, I-34139 Trieste, Italy* **8** *Museo Civico di Zoologia, Via U. Aldrovandi, 18, I-00197 Roma, Italy* **9** *Università di Sassari, Dipartimento di Scienze della Natura e del Territorio, Zoologia, Via F. Muroni, 25, I-07100 Sassari, Italy* **10** *Università degli Studi di Milano-Bicocca, ZooPlantLab, Dipartimento di Biotecnologie e Bioscienze, Piazza della Scienza, 2, I-20126 Milano, Italy* **11** *Museo Civico di Storia Naturale, Corso Venezia, 55, I-20121 Milano, Italy* **12** *Museo di geologia e paleontologia, Dipartimento di Scienze della Terra, Via Valperga Caluso, 35, 10125 Torino, Italy* **13** *Museo Civico di Storia Naturale "G. Doria", Via Brigata Liguria, 9, I-16121 Genova, Italy* **14** *Museo di Storia Naturale del Salento, S.P. Calimera-Borgagne, km 1, I-73021 Calimera, Italy* **15** *Science journalist – Swim (Science writer in Italy), Via Jannozzi, 8, I-20097 San Donato Milanese, Italy* **16** *Viale Liegi, 48, I-00198 Roma, Italy* **17** *MUSE Museo delle Scienze, Corso del lavoro e della scienza, 3, I-80123 Trento, Italy* **18** *Museo Civico di Storia Naturale, Lungadige Porta Vittoria, 9, I-37129 Verona, Italy* **19** *Dipartimento di Biologia, Università degli Studi di Napoli Federico II, Via Cinthia, 21, I-80126 Napoli, Italy* **20** *Museo di Storia Naturale, Via F. de Pisis, 24, I-44100 Ferrara, Italy* **21** *Università di Padova, Dipartimento di Biologia, Via U. Bassi, 58/B, I-35131 Padova, Italy* **22** *Museo Friulano di Storia Naturale, Via Marangoni,*

Copyright *Franco Andreone et al.* This is an open access article distributed under the terms of the Creative Commons Attribution License (CC BY 4.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

39 – 41, I-33100 Udine, Italy **23** *Università di Padova, Museo di Zoologia, Via Jappelli, 1/a, I-35121 Padova, Italy* **24** *Università di Pavia, Museo di Storia Naturale, Piazza Botta, 9, I-27100 Pavia, Italy* **25** *Università di Catania, Dipartimento di Scienze Biologiche, Geologiche ed Ambientali, Via Androne, 81, I-95124 Catania, Italy* **26** *Museo Civico di Scienze Naturali "E. Caffi", Piazza Cittadella, 10, I-24129 Bergamo, Italy* **27** *Natural History Museum, Cromwell Road, London, SW7 5BD, UK*

Corresponding author: *Franco Andreone* (franco.andreone@regione.piemonte.it)

Academic editor: *Pavel Stoev* | Received 30 October 2014 | Accepted 18 November 2014 | Published 24 November 2014

Citation: Andreone F, Bartolozzi L, Boano G, Boero F, Bologna MA, Bon M, Bressi N, Capula M, Casale A, Casiraghi M, Chiozzi G, Delfino M, Doria G, Durante A, Ferrari M, Gippoliti S, Lanzinger M, Latella L, Maio N, Marangoni C, Mazzotti S, Minelli A, Muscio G, Nicolosi P, Pievani T, Razzetti E, Sabella G, Valle M, Vomero V, Zilli A (2014) Italian natural history museums on the verge of collapse? ZooKeys 456: 139–146. doi: 10.3897/zookeys.456.8862

Abstract

The Italian natural history museums are facing a critical situation, due to the progressive loss of scientific relevance, decreasing economic investments, and scarcity of personnel. This is extremely alarming, especially for ensuring the long-term preservation of the precious collections they host. Moreover, a commitment in fieldwork to increase scientific collections and concurrent taxonomic research are rarely considered priorities, while most of the activities are addressed to public events with political payoffs, such as exhibits, didactic meetings, expositions, and talks. This is possibly due to the absence of a national museum that would have better steered research activities and overall concepts for collection management. We here propose that Italian natural history museums collaborate to instate a "metamuseum", by establishing a reciprocal interaction network aimed at sharing budgetary and technical resources, which would assure better coordination of common long-term goals and scientific activities.

Keywords

Biodiversity, Italy, metamuseum, natural history museums

Italy and biodiversity

Italy is universally known for its history, culture, food and art. Almost everyone knows the towns of Venice, Florence, and Rome, the classical Roman history which inspires architecture, literature and movies, and Leonardo da Vinci's *Last Supper* and the *Mona Lisa*, which are among the most seen and reproduced paintings in the history of art. The list could go on for pages, but here we want to focus our attention on another invaluable and too often forgotten asset: natural history museums (NHMs) and the scientific specimens they preserve to document national (and international) biodiversity. A few numbers highlight the point: there are 12,000–13,000 species or subspecies of flowering plants in Europe, and approximately two thirds live in Italy. Furthermore, a rough count shows at least 160,000 animal species in Europe; in the recent Italian checklist their total for the country alone exceeds 56,000 (Minelli 1996).

Museum legacy

Similar to what has happened elsewhere, many Italian naturalists of 19th century, among which Orazio Antinori, Odoardo Beccari, Enrico Festa, Filippo De Filippi, Giacomo Doria, and Carlo Piaggia, visited remote areas of the world and documented biodiversity by collecting remarkable plant and animal specimens, which were deposited in Italian NHMs and became a great resource for studies and natural resources enhancement (Mazzotti 2011). NHMs act as the interface between science and the public, safeguarding scientific collections and promoting education (McCarter et al. 2001; Suarez and Tsutsui 2004). In fact, the scientific role of NHMs in life sciences is exceptionally relevant: to maintain and increase collections and to perform taxonomic studies. Taxonomy is indeed a science, which is particularly developed by curators, since type specimens – upon which the original descriptions are based – are usually deposited in their museum collections. Cataloguing world biodiversity is a specific museum mission, since this activity facilitates taxonomic activities and helps in protecting threatened species (Butler et al. 1998).

A plea for natural history museums

We, the curators, taxonomists, science philosophers, and other members of the scientific community, are alarmed by the situation in which most Italian NHMs currently find themselves, with a continuing loss of scientific relevance, decreasing economic investments, scarcity of qualified personnel, and increasingly high risk for the long-term preservation of their collections. We wish to call urgent attention to this serious problem to relevant policy and decision makers. Unlike other countries (e.g., England, France, Spain, and USA), a national museum acting as the main repository for the larger part of these historical and contemporary natural history collections was never established in Italy. Because of this absence, in part due to historical reasons (Ruffo 2006), specimens collected during explorations and surveys were scattered throughout the country and deposited in different museums. The major museums (more than seventy according to the Italian Association of Scientific Museums, ANMS) vary in size and management type. Some are run by universities (e.g., Florence, Padua, Pavia, Perugia, Pisa, etc.), and others by public administrations (PAs) managed by local authorities, mainly municipalities (e.g., Genoa, Milan, and Rome), or by foundations (e.g., Venice).

The importance of museums for taxonomic studies

While the existence of many scattered museums warranted until recently the material preservation of collections, it did not allow a proper development of the research component, which should accompany the constitution of scientific collections. In many

Figure 1. The herpetological gallery at the Museo di Storia Naturale, University of Florence (photograph by S. Bambi).

cases university departments, which were the first to put together specimens and arrange natural history collections, do not consider museum-based research rewarding in terms of academic impact (also because papers dealing with traditional taxonomy rarely get a high citation index) and focus on functional disciplines, such as genetics, population biology, and ecology. This led to the wish to create new laboratories, often achieved by repurposing rooms housing old - and frequently rather dusty - zoological or botanical collections, which typically had been neglected for decades. In some cases the university museums were maintained, but they were more often used for practical classes with students or for public exhibits, and only in a few cases were they fully developed. At the same time, NHMs managed by local PAs were often more interested in public events with political payoffs for administrators, such as exhibitions, didactic meetings, and expositions than to collection-based researches.

The relevance of research in museums

Scientific production is almost never considered as a parameter to evaluate the activity of curators in Italian NHMs. In general, the museum decision-makers appear to be not particularly focused on research activities carried out by their internal (curatorial) personnel. This is a striking difference with NHMs in other countries, where research represents a prominent and institutional product, which is evaluated regularly. As an

example, most museums in Germany are autonomous research institutions often designated as "Forschungsinstitut", as is the case with the Berlin, Bonn, and Frankfurt museums, and invest considerable economic resources into scientific activities, especially into management and implementation of reference collections and field-surveys in biodiversity hotspots. Nowadays, a commitment in fieldwork to increase scientific collections is not considered a priority by several Italian museums, and curators are rarely requested to carry out collecting campaigns or to study and catalogue biodiversity. In many cases they are only required to act as mere technicians in support of showy/public events, or as simple office-bearers following cultural and educational projects, while research is in most cases implicitly considered a secondary, time-consuming, and negligible activity. Although many curators tenaciously pursue their research line (mostly during their spare time), this is usually only possible in certain disciplines (such as entomology, malacology, and palaeontology), where taxonomy is still largely based on a morphological approach. On the other hand, laboratories with molecular tools and specialised technicians – nowadays quite commonplace in NHMs globally – are absent in Italian museums, thus seriously limiting capacities to carry out advanced biodiversity studies, to compete with foreign institutions, or to gain access to international funding.

Foreign versus Italian museums

An analysis of *H*-values attained by NHMs' curators showed that in other European countries (data from museums in Basel, Berlin, Bonn, Geneva, and the museums of the Senckenberg Gesellschaft) researchers affiliated to museums produce a higher number of indexed publications than in Italy (data from museums of Bergamo, Florence, Genoa, Milan, Padua, Pisa, Rome, Trento, Turin, Venice, and Verona), with a significant difference in *H*-index (9.96 ± 7.37 vs. 5.13 ± 5.11; Mann-Whitney text, $p < 0.05$). Despite hosting vast unique and invaluable collections, the absence of Italian NHMs from the group of institutions participating in SYNTHESYS, the European Union-funded integrated activities grant program, during the last ten years clearly betrays their management inadequacy (Bartolozzi 2013). The combination of recent economic cuts and loss of interest in scientific research by museum directions have brought the Italian NHMs to the brink of collapse and scientific irrelevance at the international level. Some museums have been closed to the public due to scarcity of funds and the difficulties in recovering from accidents: Udine has been closed since 1998 for renovation, that in Turin after an accidental explosion in 2013. Moreover, the number of curators working in these organisations has been dramatically decreasing for many years. While most European NHMs maintain a number of curators and technicians appropriate to their collection size (the curators at the Museum für Naturkunde in Berlin number approximately 30, while the figure for NHM in London exceeds 60), scientific personnel in Italian NHMs has become very insufficient or minimal, with some museums having the total scientific staff reduced to just one or two curators. During the last decade, retired curators have rarely been replaced and no recruitment has been undertaken for many years (in Genoa the last was in 1987, in Turin in 1991, and in Rome in 1993).

The danger of losing collections

We consider such a situation extremely alarming, especially for ensuring the long-term preservation of natural history collections. The state of collections scattered among several museums (most with little interest in the scientific role of their materials) is inadequate and inappropriate. In particular, we are concerned about the impending demise of important collections: the number of type specimens housed in Italian museums is indeed considerable (at least 150 mammal taxa have their original types housed in Italian NHMs) and their conservation requires serious scientific preservation (Fig. 1). Sadly, most of these types are still uncatalogued, and this task cannot be done without assuring persistence and regular turnover and increase of the curatorial personnel. Moreover, as a result of this lack of personnel, basic technical tasks for daily management and educational activities have necessarily become priorities in many museums, forcing curators to redirect their activities, and to reduce or cease their research and assistance to other scientists (Fig. 2).

Moving towards a metamuseum

We believe that the historical lack of a centralised museum has been detrimental for Italy. A large institution with a leading role and focused research could have facilitated scientific activity and political strategies on biodiversity as has happened elsewhere. The instigation of a centralised national museum is likely impracticable today, due to the fact that geopolitical conditions have changed. It is evident that scientific collections should be managed in a more efficient and unified way. Moreover, the Natural History Museum of Florence (one of the oldest in the world, dating to 1775), which owns some of the largest collections in Italy and maintains the old-time traditions of museum research in Italy, could be taken as an example and a possible repository of some national collections (Ruffo 2006, Gippoliti et al. 2014). An effective strategy is likely to be pursued through the association of most of the museums to form a sort metamuseum. This concept and idea were also reinforced on the occasion of a recent workshop held in Rome and organised by ANMS (the national association of natural history museums) and Accademia Nazionale delle Scienze, where the focus on scientific collections for research has been emphasised. The existing museums should establish a reciprocal interaction network, aimed at sharing budgetary and technical resources, assuring coordination of common long-term goals and scientific activities. The recent launch of CollMap (survey and mapping of the natural history collections) and "distributed institute of taxonomy" initiative by ANMS (Vomero 2013) is a further step in this direction. We suggest looking at the situation in Germany with the positive example of the Senckenberg Gesellschaft für Naturforschung and the Leibniz-Gemeinschaft, which demonstrate the connection between basic and applied sciences, integrating museums with universities, industries, and private partners. How this can be achieved is mostly a political matter, but cannot be postponed any longer and must

Figure 2. A technician caring at the entomological collection at the Museo Civico di Storia Naturale di Verona (photograph by L. Latella).

urgently be integrated into the political agenda of the Italian government. For now, we hope that the MIUR (Italian Ministry for Education, University and Research) and the MIBACT (Italian Ministry for the Cultural Heritage and Activities and the Tourism) will soon pay long-overdue attention to our NHMs and adopt suitable policies for the safeguarding of their collections and the improvement of the associated research. At the same time, we are well aware that strong support must also be sought through European funds and pro-active collaboration of all interested partners.

Acknowledgements

The authors express their gratitude to the many people and colleagues who provided interesting discussions. Our thanks are due to D. Austin for improving the English of our manuscript and to the editors for their careful work.

References

Bartolozzi L (2013) I musei naturalistici italiani nel contesto delle iniziative internazionali sulla biodiversità. Museologia Scientifica 9: 17–20.

Butler D, Gee H, MacIlwain C (1998) Museum research comes off list of endangered species. Nature 394(6689): 115–117. doi: 10.1038/28009

Gippoliti S, Amori G, Castiglia R, Colangelo P, Capanna E (2014) The relevance of Italian museum collections for research and conservation: the case of mammals. Rendiconti Lincei: Scienze Fisiche e Naturali 25: 351–357. doi: 10.1007/s12210-014-0304-2

Mazzotti S (2011) Esploratori perduti. Storie dimenticate di naturalisti italiani di fine Ottocento. Codice Edizioni, Torino, 312 pp.

Minelli A (1996) La checklist delle specie della fauna italiana - un bilancio del progetto. Bolletino del museo Civico di Storia Naturale di Verona 20(1993): 249–261.

McCarter J, Boge G, Darlow G (2001) Safeguarding the world's natural treasures. Science 294: 2100–2101. doi: 10.1126/science.1067223

Ruffo S (2006) Montalenti e la proposta di un museo naturalistico nazionale. Atti dei Convegni Lincei 228: 69–74.

Suarez AV, Tsutsui ND (2004) The value of museum collections for research and society. Bioscience 54(1): 66–74. doi: 10.1641/0006-3568(2004)054[0066:TVOMCF]2.0.CO;2

Vomero V (2013) Biodiversità, banche dati tassonomiche e musei scientifici. Il progetto nazionale CollMap come premessa per il lancio di un istituto diffuso italiano di tassonomia. Museologia Scientifica 9: 21–27.