

JellyWeb: an interactive information system on Scyphozoa, Cubozoa and Staurozoa

Stefano Martellos¹, Luca Ukosich¹, Massimo Avian¹

¹ *University of Trieste, Department of Life Sciences, via L. Giorgieri 10, I-34127 Trieste, Italy*

Corresponding author: *Stefano Martellos* (martelst@units.it)

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Abstract

Identification of organisms is traditionally based on the use of “classic” identification keys, normally printed on paper. These keys have several drawbacks: they are mainly based on the systematics, requiring identification of orders, families and genera at first; they are written by experts for other experts, in a specific scientific jargon; they have a “frozen” structure (sequence of theses/antitheses); once published, they cannot be changed or updated without printing a new edition. Due to the use of computers, it is now possible to build new digital identification tools, which: 1) can be produced automatically, if the characters are stored in a database; 2) can be freed from the traditional systematics, giving priority to easy-to-observe characters, incl. those usually uncommon to the classical keys, such as ecology and distribution; 3) can be updated in real time once published on-line; 4) can be available on different media, and on mobile devices. An important feature of these new digital tools is their “collaborative” nature. They can be enriched by the contribution of several researchers, which can cooperate while maintaining rights and property of the resources and data they contribute to the system. JellyWeb, the information system on Scyphozoa, Cubozoa and Staurozoa has been developed in Trieste since 2010. The system was created with the aim of – potentially – becoming a starting point for a wide collaborative effort in developing a user-friendly worldwide digital identification system for jellyfishes.

Keywords

Biodiversity informatics, Cnidaria, FRIDA, identification, jellyfish, Medusozoa

Introduction

Since the Rio Earth Summit in 1992, access to biodiversity information has become a fundamental task. Biodiversity data are targeted by several efforts of digitalization and aggregation, most of which focus on primary biodiversity data, i.e. natural history collection specimens and field records. Some of these efforts produced wide global networks, e.g. the GBIF (Global Biodiversity Information Facility; Berendsohn et al. 2010, King et al. 2010), which, together with the BioCASE (Biodiversity Collection Access for Europe, Holetschek et al. 2012), is mobilizing ca. 600 millions of records. Primary biodiversity data are mostly used in modeling the distribution of the taxa, and in predicting the effect of climate changes and anthropic pressure on endangered or alien invasive taxa. Taxon related information (nomenclature, auto-ecology, etc.) become the focus of similar large scale efforts only in the last years (Martellos and Attorre 2012, Martellos 2014). The GBIF itself is starting to aggregate checklist data (GBIF 2010), while other efforts are focused on molecular data (Field et al. 2011, Holetschek et al. 2012, Wieczorek et al. 2012), and to ecological information (Fegraus et al. 2005). In the field of hydrobiology, some recent examples can be Fish-SPRICH (Brosse et al. 2013) and Fish-AMAZBOL (Carvajal-Vallejos et al. 2014). In the case of jellyfishes, online resources are however scarce, but some relevant exceptions (e.g., the Jellyfish Dataset Initiative, <http://www.bco-dmo.org/dataset/526852>).

Digital identification keys are a particular case in the world of biodiversity informatics. Since the development of the DELTA language (Dallwitz 1980), efforts aiming at creating online digital identification keys followed several approaches. The resulting products differ in usability, accessibility, size, etc. (Nimis and Martellos 2009, Hagedorn et al. 2010, Randlane et al. 2010, Martellos and Nimis 2015). With the development of FRIDA (FRiendly IDentificAtion, Martellos 2010), the researchers of the Department of Life Sciences, University of Trieste, aimed at producing a simple but effective instrument for the development of digital identification keys in collaborative efforts. This led to the publication – in the framework of project *Dryades*, and of the EU projects KeyToNature (<http://www.keytonature.eu>), SiiT (<http://www.siit.eu>) and CSMON-LIFE (LIFE13 ENV/IT/842, <http://www.csmon-life.eu>) – of ca. 600 different digital identification keys for several groups of organisms.

As far as Scyphozoa, Cubozoa and Staurozoa are concerned, there are digital databases hosting taxonomic information, such as WoRMS (World Register of Marine Species, <http://www.marinespecies.org/>), as well as paper printed keys to genera (as an example, see Cornelius 1997; other keys are listed in Morandini et al., 2005). Few examples of digital resources are available in the web, often limited to specific geographic regions, as the Cubozoan and scyphozoan key of the Carolinian Biogeographic Province (Calder 2009), the key to the Scyphozoa and Cubozoa of the South Atlantic Bight (Calder and King 2008), and, as far as the Mediterranean is concerned, the web site MeteoMeduse (Boero 2013, <http://meteomeduse.focus.it/>). The latter, however, is an example of citizen science observatory, and does not provide an identification key. To our knowledge, no comprehensive digital identification tools to species of these taxa exist.

By combining taxonomical, ecological, and morphological and anatomical features into an information system, we developed the so called JellyWeb, a simple tool which allow to researchers and laypersons to identify Scyphozoa, Cubozoa and Staurozoa to the species level. This paper presents the results of this effort, available online at the URL <http://dryades.units.it/jelly>.

Methods

Data were collected from several sources in literature. The most relevant are Kramp (1961), WoRMS (<http://www.marinespecies.org/>), the Scyphozoan Wiki (<http://thescyphozoan.ucmerced.edu/>), and Mills (1999-). Further sources are listed in Balboni 2008, Benci 2008, Sarto 2009, Sola 2009, Coral 2012, Benci 2012, Savonitto 2012, Ukosich 2014. Other paper are under consideration, and will lead to adding to the database other species for several genera, such as *Atolla* (*A. russelli*, *A. gigantea*, *A. chuni*), *Aurelia* (*A. marginalis*), *Chironex* (*C. yamaguti*), *Cyanea* (*C. lamarkii*, *C. rosea*, *C. annaskala*, *C. tzetlinii*, and several other species), *Desmonema* (*D. comatum*, *D. scoresbyanna*), *Drymonema* (*D. gorgo*, *D. larsoni*), *Nausithoe* (*N. marginata*), *Pelagia* (*P. benovici*) *Tripedalia* (*T. binata*).

The information system is freely available online at the URL <http://dryades.units.it/jelly>. It organizes data collected in the last five years by the research unit headed by Massimo Avian, at the Dept. of Life Sciences of the University of Trieste. The researchers which contributed to the project agreed on distributing the data under a Creative Commons, share alike, by attribution 3.0 (CC 3.0 by-sa) license.

The software of the information system has been developed in PHP language. The data are stored in a MySQL database. The system is equipped with a multi-entry query interface (Hagedorn et al. 2010), which operates on both a taxonomic database, and a database of nine easily recognizable morphological characters (see below). The multi-entry interface allows complex queries, which can be a first step in the identification of an organism. The multi-entry query system returns lists of taxa, on which the identification process can continue by using a digital identification system. The latter has been developed by using the FRIDA (FRiendly IDentificAtion) package (Martellos 2010). It operates on a morpho-anatomical database, which hosts ca. 200 characters for several infra-generic taxa of Scyphozoa, Cubozoa and Staurozoa (a revision of the content of the database due to recent taxonomic advancements is ongoing). The output of the digital identification system is a digital identification key to the remaining taxa, which can be used by an interactive interface, or printed out as a dichotomous, illustrated key. The whole key can also be exported in a stand-alone version for mobile devices (Nimis et al. 2012).

The query interfaces have been developed according to the results of several usability tests, conducted in the framework of projects KeyToNature and SiiT, as detailed in Martellos and Nimis (2015). The system is under continuous development, following users' input.

Results

JellyWeb hosts several information pages and two query system. The home page (<http://dryades.units.it/jelly>) provides access to several sections: information, describing how the system works; survey area; query (detailed below); checklist, listing all taxa alphabetically by genus and species name, and providing access to their taxon pages; credits.

The query system is made of two parts.

- 1) Multi-entry interface (Fig. 1). The first interface of the query system provides the users with the opportunity of specifying a set of nine easily observable characters, and/or scientific name and family. The morphological characters are:
 - Jellyfish sessile / swimming;
 - Umbrella shaped like a cube or a box / not shaped like a cube or a box;
 - Tentacles present / absent;
 - Tentacles isolated / grouped in clusters;
 - Umbrella with a coronal groove / without a coronal groove;
 - Umbrella flat / not flat;
 - Oral arms absent / 4 / more than 4;
 - Jellyfish with filaments (oral arm appendages) / without filaments;
 - Jellyfish with scapulae / without scapulae.

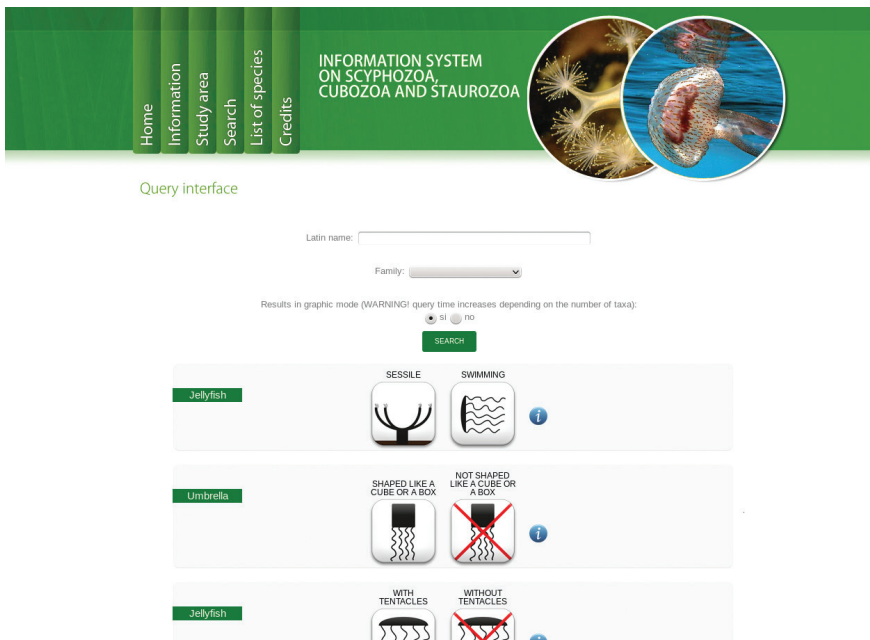


Figure 1. Multi-entry interface. The multi-entry interface allows to combine the states of several morphologic and anatomic characters, together with taxonomic information, to query the database.

For each character, an information popup window with images and text detailing the most relevant features is accessible by clicking on the question mark button. The result of a query is a list of taxa (Fig. 2). For each taxon an image is displayed (if available, see below). A link provides access to the taxon page (Fig. 3), which displays a description, as well as all the images available in the system, with credits and metadata, and other information (when available). Taxon pages can host a virtually unlimited amount of information and images, and/or provide access to external resources through HTML links.

- 2) Digital identification key. The results page of the multi-entry interface allows to generate an interactive identification key to remaining taxa. The key can be used through a simple single entry interface (Fig. 4, Hagedorn et al. 2010), or printed out as a textual, illustrated dichotomous key. At each step of the identification process users can list out the remaining taxa, or print an illustrated key. By clicking on a taxon name, the corresponding taxon page is shown (Fig. 3). Each key generated by this system is different from the others, since they contain a different number of infra-generic taxa. Normally, the lower the number of taxa is, the easier the resulting key. A key to all the taxa currently included in our databases can also be generated, and is provided below.

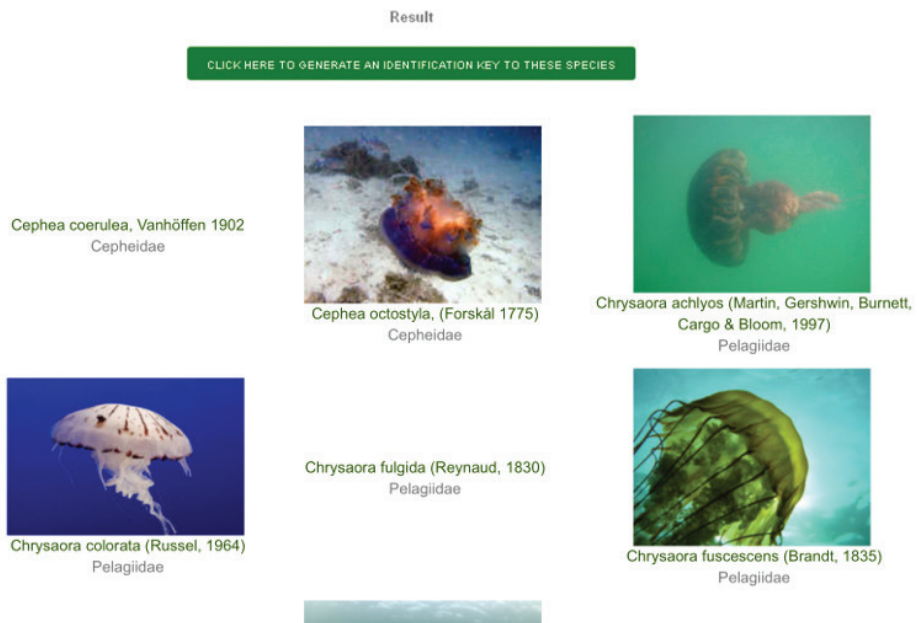


Figure 2. List of taxa. The result of a query made by using the multi-entry interface is an illustrated list of infra-generic taxa.

Home

Information

Study area

Search

List of species

Credits

INFORMATION SYSTEM
ON SCYPHOZOA,
CUBOZOA AND STAUROZOA



Aurelia aurita (Linnaeus, 1758)



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SYSTEMATIC POSITION
 Classis: Scyphozoa
 SubClassis: Discomedusae
 Ordo: Semeiostomae
 Familia: Ulmaridae (ex Aureliidae)
 SubFamilia: Aurelinae
 Genus: *Aurelia* (Péron & Lesueur, 1809)
 Species: *A. aurita* (Linnaeus, 1773)

SYNONYMS
Aurelia coerulea

COMMON NAMES
 Moon Jellyfish

MORPHO-ANATOMICAL CHARACTERISTICS
 Genus *Aurelia*

- tentacles arising from the side of exumbrella, above the margin
- lappet-like structures arising from the side of exumbrella above the margin
- bell margin divided in 8 or 16 broad velar lobes
 - 8 rhopalia, each with 2 ocelli
- some or all radial canals with anastomosing branches
- with ring canal
- invaginated gonads with external subgenital pits

Aurelia aurita

- flat thin bell, diameter up to 40 cm, smooth surface
- very transparent
- numerous thin short tentacles of various colours
- 8 broad velar lappets
- 4 linear thick oral arms, with densely crenulated margins, as long as bell's radius
- 4 interradial stomach pouches, each with a line of gastric filaments, just centripetal to gonads
- 8 rhopalia and 8 adradial canals unbranched, others 16 branched with anastomoses
- 4 evident brilliant horseshoe-shaped gonads, lining gastric pouches

GEOGRAPHICAL AND SEASONAL DISTRIBUTION
 Coastal species, Circum-Boreal distribution, occurring usually at spring

STING EFFECTS
 The venom of *A. aurita* contains potent lethal demonecrotic, vasopermeability and hemolytic factors, but great differences have been reported concerning the dangerousness of specimens from different zones of the world. Specimens from Red Sea were stated to be most dangerous, causing local pain, pibonection, urticaria, ulcerations. In other zones, usually causing only local itching, but may possible cross-reaction between venom of *Aurelia* and ones of *C. quinquacirrita*, *Chironex fleckeri* and *Physalia physalis*

Figure 3. Taxon page. A typical taxon page displays an image, a description, as well as all the other images available in the system, together with credits and metadata. Taxon pages can host a virtually unlimited amount of data, links and media.

Dichotomous key to all taxa

This key was automatically generated by the system, and contains all the infra-generic taxa currently stored in our databases at the date October 30, 2015. When a taxon is added to the system the key automatically changes. Hence, the key an user will obtain in the future will be slightly – or completely – different. The keys are not the transposition of an existing paper printed key, but are automatically generated by the system from a database for morphological and anatomical characters by using the package FRIDA (Martellos 2010).

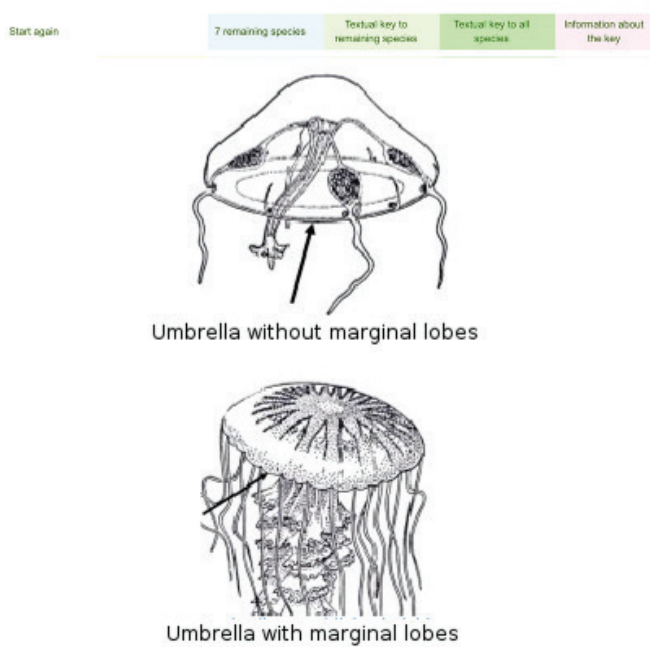


Figure 4. Single entry digital identification key. The digital identification key to remaining taxa is generated from the results of the multi-entry query system. It is used through a single entry interface, and can be printed out as a textual, illustrated dichotomous key as well.

1	Medusa sessile.....	2
–	Medusa swimming	34
2 (1)	Medusa without aboral peduncle.....	
	.....<i>Lucernariopsis vanhoeffeni</i> (Browne, 1910)	
–	Medusa with aboral peduncle	3
3 (2)	Medusa with sense organs: rhopalioids (anchors).....	4
–	Medusa without sense organs.....	15
4 (3)	Coronal muscle divided.....	5
–	Coronal muscle unbroken	10
5 (4)	Calyx not conical.....	6
–	Calyx conical	7
6 (5)	Calyx quadro-pyramidal	<i>Halichlystus borealis</i> Uchida, 1933
–	Calyx pyramidal, octangular	<i>Halichlystus salpinx</i> Clark, 1863
7 (5)	Marginal anchors fairly large, egg-shaped.....	
	.....<i>Halichlystus stejnegeri</i> Kishinouye, 1899	
–	Not as above.....	8

8 (7)	Marginal anchors very large, biscuit-shaped.....	<i>Halichystus antarcticus</i> Pfeffer, 1889
–	Not as above.....	9
9 (8)	Marginal anchors kidney-shaped, with a short, cylindric stalk	<i>Halichystus auricula</i> (Rathke, 1806)
–	Marginal anchors small, oval. <i>Halichystus kerguelensis</i> Vanhöffen, 1908	
10 (4)	Peduncle single-chambered.....	<i>Manania hexaradiata</i> (Broch, 1907)
–	Peduncle with 4 perradial chambers.....	11
11 (10)	Gonads not united by a transverse circumferential membrane (claustrum) which divide each of the 4 perradial stomach pouches into an outer and an inner space.....	<i>Stenoscyphus inabai</i> (Kishinouye, 1893)
–	Gonads united by a transverse circumferential membrane (claustrum) which divide each of the 4 perradial stomach pouches into an outer and an inner space.....	12
12 (11)	Calyx as long as wide.....	<i>Manania gwilliami</i> Larson & Fautin, 1989
–	Calyx longer than wide.....	13
13 (12)	Calyx with dark herringbone pattern	<i>Manania distincta</i> (Kishinouye, 1910)
–	Calyx without dark herringbone pattern.....	14
14 (13)	Arms twice as long as broad.....	<i>Halimocyathus platypus</i> Clark, 1863
–	Arms short.....	<i>Manania bandi</i> Larson & Fautin, 1989
15 (3)	Peduncle with 4 perradial chambers.....	16
–	Peduncle single-chambered.....	22
16 (15)	Peduncle with muscle in the septa	17
–	Peduncle without muscle in the septa	18
17 (16)	On each arm about 9 tentacles	<i>Depastrum cyathiforme</i> (M. Sars, 1846)
–	On each arm about 25 tentacles	<i>Depastromorpha africana</i> Carlgren, 1935
18 (16)	Gonads united by a transverse circumferential membrane (claustrum) which divide each of the 4 perradial stomach pouches into an outer and an inner space.....	19
–	Gonads not united by a transverse circumferential membrane (claustrum) which divide each of the 4 perradial stomach pouches into an outer and an inner space.....	20
19 (18)	On each arm 60–80 tentacles	<i>Craterolophus convolvulus</i> (Johnston, 1835)
–	On each arm about 30 tentacles	<i>Craterolophus macrocystis</i> von Lendenfeld, 1884
20 (18)	Arms adradial	<i>Kishinouyea nagatensis</i> (Oka, 1897)
–	Arms interradiat.....	21
21 (20)	Arms larger at base than <i>S. tsingtaoensis</i>	<i>Sasakiella cruciformis</i> Okubo, 1917

–	Arms narrower at base than <i>S. cruciformis</i>	
	..... <i>Sasakiella tsingtaoensis</i> Ling, 1937	
22 (15)	Peduncle without muscle in the septa	
	..... <i>Lucernariopsis campanulata</i> (Lamouroux, 1815)	
–	Peduncle with muscle in the septa	23
23 (22)	Marginal lobes (arms) faintly developed.....	24
–	Marginal lobes (arms) well developed	26
24 (23)	Tentacles reduced	<i>Lipkea stephensoni</i> Carlgren, 1933
–	Not as above.....	25
25 (24)	Tentacles not true	<i>Lipkea ruspoliana</i> Vogt, 1886
–	Tentacles rudimentary	<i>Lipkea sturdzi</i> (Antipa, 1893)
26 (23)	Tentacles up to 60 on each arm	27
–	Tentacles more than 60 on each arm.....	28
27 (26)	Subumbrellar margin with 4 perradial pigment spots.....	
	..... <i>Stylocoronella riedli</i> Salvini-Plawen, 1966	
–	Subumbrellar margin without 4 perradial pigment spots	
	..... <i>Stylocoronella variabilis</i> Salvini-Plawen, 1987	
28 (26)	Peduncle rudimentary.....	<i>Lucernaria australis</i> Vanhöffen, 1908
–	Peduncle true.....	29
29 (28)	Peduncle as long or longer than height of calyx.....	30
–	Peduncle shorter than height of calyx.....	31
30 (29)	Tentacles 100–140 on each arm. <i>Lucernaria quadricornis</i> O.F.Müller, 1776	
–	Tentacles 700–850 on each arm.....	<i>Lucernaria walteri</i> (Antipa, 1892)
31 (29)	Tentacles 80 or less on each arm	
	..... <i>Lucernaria infundibulum</i> Haeckel, 1880	
–	Tentacles more than 80 on each arm.....	32
32 (31)	Peduncle 1/3 as long as height of calyx	
	..... <i>Lucernaria haeckeli</i> (Antipa, 1892)	
–	Not as above.....	33
33 (32)	Peduncle less than 1/3 of the height of calyx.....	
	..... <i>Lucernaria bathyphila</i> Haeckel, 1880	
–	Peduncle about half as long as height of calyx.....	
	..... <i>Lucernaria sainthilairei</i> (Redikorzev, 1925)	
34 (1)	Medusa with calix.....	
	<i>Tesserantha connectens</i> , Haeckel, 1880 – Warning: some authors debate on the validity of swimming Stauromedusae (see Rodriguez et al. 2011)	
–	Medusa with umbrella.....	35
35 (34)	Exumbrella divided by a circular and deep coronal groove	36
–	Exumbrella not divided by a circular and deep coronal groove.....	64
36 (35)	Tentacles from 4 to 6.....	37
–	Tentacles 8 or more	42
37 (36)	Rhopalia 4.....	38
–	Rhopalia 6.....	39

38 (37)	Gonads almost equidistant	<i>Pericolpa campana</i> (Haeckel, 1880)	
–	Gonads in 4 pairs	<i>Pericolpa quadrigata</i> Haeckel, 1880	
39 (37)	Gonads 6	<i>Atorella arcturi</i> Bigelow, 1928	
–	Not as above		40
40 (39)	Gonads 8	<i>Atorella octogonus</i> Mills, Larson & Young, 1987	
–	Gonads 4		41
41 (40)	Gonads sac-like, swollen	<i>Atorella subglobosa</i> Vanhöffen, 1902	
–	Gonads leaf-shaped	<i>Atorella vanhoeffeni</i> Bigelow, 1909	
42 (36)	Rhopalia up to 6		43
–	Rhopalia more than 6		48
43 (42)	Rhopalia perradial, 4		44
–	Rhopalia interradial, 4		45
44 (43)	Coronal muscle divided	<i>Paraphyllina intermedia</i> Maas, 1903	
–	Coronal muscle unbroken	<i>Paraphyllina ransoni</i> Russel, 1956	
45 (43)	Marginal lappets 32	<i>Nauphantopsis diomedeeae</i> Fewkes, 1885	
–	Not as above		46
46 (45)	Gonads 4	<i>Periphyllopsis galathea</i> Kramp, 1959	
–	Gonads 8		47
47 (46)	Marginal lappets 16	<i>Periphylla periphylla</i> (Péron & Lesueur, 1809)	
–	Marginal lappets 24	<i>Periphyllopsis braueri</i> Vanhöffen, 1902	
48 (42)	Gonads 4 or 4 pairs		49
–	Gonads 8		53
49 (48)	Stomach pouches break up into numerous ragged-edged branches in the marginal lappets		50
–	Stomach pouches simple, radiating		51
50 (49)	Subumbrellar protuberances in 2 circles	<i>Linuche aquila</i> Mayer 1910	
–	Subumbrellar protuberances in 3 circles		
	.....	<i>Linuche unguiculata</i> (Schwartz, 1788)	
51 (49)	Gonads bean-shaped	<i>Palephyra indica</i> Vanhöffen, 1902	
–	Gonads crescent-shaped		52
52 (51)	Gonads with horns recurved	<i>Palephyra antiqua</i> Haeckel, 1880	
–	Gonads consisting of 3 swellings	<i>Palephyra pelagica</i> Haeckel, 1880	
53 (48)	Rhopalia > 8		54
–	Rhopalia 8 (Genus <i>Nausithoe</i> . The key refers to free-swimming stages only)		56
54 (53)	Gastric ostia with two pigmented spots	<i>Atolla vanhoeffeni</i> Russell, 1957	
–	Gastric ostia without pigmented spots		55
55 (54)	Species with 20–24 tentacles	<i>Atolla parva</i> Russell, 1958	
–	Species with usually 22, sometimes up to 32 tentacles		
	.....	<i>Atolla wyvillei</i> Haeckel, 1880	
56 (53)	Central disk with large pits		57
–	Central disk without pits		58
57 (56)	Central disk with radiating furrows .	<i>Nausithoe rubra</i> Vanhöffen, 1902	

–	Central disk without radiating furrows....	<i>Nausithoe atlantica</i> Broch, 1914
58 (56)	Gonads very small	<i>Nausithoe clausi</i> Vanhöffen, 1892
–	Not as above.....	59
59 (58)	Gonads of normal dimensions	<i>Nausithoe albatrossi</i> (Maas, 1897)
–	Gonads large.....	60
60 (59)	Central disk not thick nor finely punctured.....	<i>Nausithoe globifera</i> Broch, 1914
–	Central disk thick, finely punctured.....	61
61 (60)	Central disk with radiating furrows	<i>Nausithoe challengerii</i> (Haeckel, 1880)
–	Central disk without radiating furrows	62
62 (61)	Medusa with chocolate brown or carmine gonads and blue gastric cirri ..	<i>Nausithoe picta</i> Agassiz & Mayer, 1902
–	Medusa without chocolate brown or carmine gonads and blue gastric cirri.....	63
63 (62)	Gastric cirri not grouped in clusters	<i>Nausithoe punctata</i> (Kölliker, 1853)
–	Gastric cirri grouped in clusters	<i>Nausithoe limpida</i> Hartlaub, 1909
64 (35)	Opening of the subumbrellar cavity partly closed by an annular diaphragm (velarium).....	65
–	Opening of the subumbrellar cavity not closed by an annular diaphragm (velarium).....	88
65 (64)	Tentacles 8 or more	66
–	Tentacles from 4 to 6.....	76
66 (65)	Stomach pouches without diverticula	<i>Tripedalia cystophora</i> Conant, 1897
–	Stomach pouches with 8 diverticula.....	67
67 (66)	Gonads not four-leaved	<i>Chiroadectes maculatus</i> (Cornelius, Fenner & Hore, 2005)
–	Gonads four-leaved.....	68
68 (67)	Medusa with nematocysts on bell	69
–	Medusa without nematocysts on bell	71
69 (68)	Each pedalum with more than 4 fingers and tentacles.....	<i>Chiropsalmus quadrumanus</i> Müller, 1859
–	Each pedalum with 4 or less fingers and tentacles	70
70 (69)	Each pedalum with 2 fingers and tentacles.....	<i>Chiropsalmus zygonema</i> Haeckel, 1880
–	Each pedalum with 3–4 fingers and tentacles.....	<i>Chiropsalmus alipes</i> Gershwin, 2006
71 (68)	Medusa with mesenteries poorly developed	<i>Chiropsella bronzie</i> Gershwin, 2006
–	Not as above.....	72
72 (71)	Gastric saccules are functioning gonads....	<i>Chironex fleckeri</i> Southcott, 1956

–	Gastric saccules are not functioning gonads	73
73 (72)	Stomach pouches with 2 branched or feathered saccules	74
–	Stomach pouches with 2 unbranched saccules	75
74 (73)	Each pedalium with 9–11 fingers and tentacles.....	
 <i>Chirodropsus gorilla</i> Haeckel, 1880	
–	Each pedalium with 21 fingers and tentacles.....	
 <i>Chirodropsus palmatus</i> Haeckel, 1880	
75 (73)	Tentacles and fingers irregularly placed	
 <i>Chiropsoides buitendijki</i> (van der Horst, 1907)	
–	Tentacles and fingers not irregularly placed.....	
 <i>Chiropsoides quadrigatus</i> (Haeckel, 1880)	
76 (65)	Tentacles branched	<i>Manokia stiasnyi</i> Bigelow, 1938
–	Tentacles simple.....	77
77 (76)	Stomach with weakly developed mesenteries.....	78
–	Not as above.....	80
78 (77)	Sensory niches without well developed covering scale	
 <i>Copula sivickisi</i> Stiasny, 1926	
–	Sensory niches with covering scale above	79
79 (78)	Velarial canals 3–4 per octant... <i>Carybdea marsupialis</i> (Linnaeus, 1758)	
–	Velarial canals 2 per octant	<i>Carybdea rastonii</i> Haacke, 1886
80 (77)	Stomach without mesenteries	81
–	Stomach with well developed mesenteries.....	84
81 (80)	Exumbrella without nematocyst-warts.... <i>Alatina moseri</i> (Mayer, 1906)	
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Discussion

Digital resources on biodiversity can be relevant not only to researchers, but also to laypeople, such as tourists or citizen scientists. The importance of involving citizens in understanding, monitoring and protecting biodiversity has been recently expressed by the European Commission, in the document “Establishing Horizon 2020” (EU Regulation no. 1291/2013). However, most of the biodiversity-related resources available in the Web – especially the ones dedicated to “difficult” groups, such as jellyfish – are normally devoted almost exclusively to experts (Martellos and Nimis 2015). Exposing scientific information in a form which can be accessible to everybody – without losing its content and informative value – can be a true revolution. Many citizens, especially if already interested in nature and aware of environmental issues (e.g. the presence of invasive alien species), are potentially interested in similar resources. Hence digital resources can be used to involve a wider amount of citizens in scientific tasks, such as the collection of those “big data” which are nowadays fundamental to researchers. The examples of OPAL initiative in the British Isles (<http://www.opalexplorenature.org>; accessed 08 August 2015) or, in the field of jellyfish, of MeteoMedusa (Boero 2013, Boero et al. 2013), and JellyWatch (<http://www.jellywatch.org/>; accessed 08 August 2015) are demonstrating the effectiveness of a citizen science approach in collecting scientific data.

JellyWeb is based on morpho-anatomic and taxonomic data, collected and organized in ca. 10 years of research. The development of the portal (Martellos and Nimis 2015) was based upon the experience of the European project KeyToNature (mainly devoted to digital identification) and of the project *Dryades* (devoted to the publication of biodiversity data in the web). This is the first portal devoted to organisms other than vascular plants developed by the research unit of the Dept. of Life Science of the University of Trieste. During its development, a particular attention was paid to user interfaces, in order to provide high quality scientific information in the most straightforward way, and to make it useable by the wider audience as possible.

The multi-entry interface can be useful to both researchers (whom can simply type the name of a taxon to retrieve related information or generate an identification key), and laypeople (whom can use it to start the identification of a jellyfish they have just seen on the seashore). As a further help, interactive keys are enriched by images and drawings of the most relevant characters. Since digital keys are generated in real time, on the basis of the list of remaining organisms, each query produces a different identification key.

Since identification is nowadays often based on molecular analysis, the system has been developed to host molecular data as well. In fact, several attempts to revise the taxonomy of the various taxa like the *Discomedusae* on the basis of morphological observations integrated with genetic analysis are underway, highlighting several critical points, such as the recognition of cryptic species in the *Aurelia* complex within the “traditional” species *Aurelia aurita* (Dawson and Jacobs 2001, Dawson and Martin 2001, Dawson 2003, Dawson et al. 2005, Ramšak et al. 2012), or even at higher taxonomic levels like the proposition of at least two new families within the *Semaeostomeae*

(Bayha and Dawson 2010, Strahler-Pohl et al. 2011). The integration of molecular information in a digital identification system by using the FRIDA software was studied by Bruni et al. (2012) for vascular plants.

Conclusion

JellyWeb is an accumulative system, which can potentially host all data on Scyphozoa, Cubozoa and Staurozoa, and even extend its aim to other groups of the phylum Cnidaria. However, a research group alone can hardly complete such a challenging task. The research unit at the University of Trieste plans to maintain and enrich JellyWeb, but its growth could be faster, if other research groups join this effort. A researcher, or a research group, can contribute to the system by:

- *Fostering a taxon* (such as a genus, or a family). This can be done by managing an instance of the FRIDA system. FRIDA allows to different authors to independently manage separate instances, while at the same time contributing to the same database of morphological and anatomical data, hence, generating updated multi-authored keys to any subset of taxa in the whole system (for a complete description see Martellos 2010). All the digital keys which are generated by the system give credit to the authors of all the data. The keys and all the data and images in JellyWeb are always distributed under a Creative Commons share alike, by attribution 3.0 license (CC 3.0 by-sa).
- *Contributing to the image archive*. High quality images of morphological and anatomical characters and of the whole organisms are probably the most relevant bottlenecks in the process of creating a portal such as JellyWeb. Especially when identifying a taxon, digital images are of capital relevance, both for choosing among the leads of each choice, and as visual census when an identification has been achieved. Several species of Scyphozoa, Cubozoa and Staurozoa are known for one or few specimens, and, even when the taxa are well known, high quality images are, however, scarce. JellyWeb was developed to host a virtually unlimited number of images for each taxon. Each image is displayed with credits to the author(s) and owner(s), institution(s), other metadata, and license.
- *Producing descriptions*. Another relevant bottleneck in developing digital identification keys and portals to one or more groups of organisms are their descriptions. While taxonomic descriptions can be found in books and papers, descriptions which could be actually useful to people other than researchers are difficult to produce. In our experience, to be appreciated by a wider audience, they should mix different sources of information, from ecology to taxonomy, from distribution to human uses, relevance for economy, etymology of the name, etc. Hence, their production is not a simple cut and paste, but a relevant effort of analysis and synthesis.

Potential contributor can contact Massimo Avian (avian@units.it), to define the extent of their participation.

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A new species of open-air processional column termite, *Hospitalitermes nigriantennalis* sp. n. (Termitidae), from Borneo

Syaukani Syaukani¹, Graham J. Thompson², Herbert Zettel³, Teguh Pribadi⁴

1 Department of Biology, Faculty of Mathematics and Natural Science, Syiah Kuala University Darussalam 23111, Banda Aceh, Indonesia **2** Department of Biology, University of Western Ontario, 1151 Richmond Road North, London N6A 5B7, Ontario, Canada **3** Entomological Department, Natural History Museum Vienna, Burgring 7, 1010 Vienna, Austria **4** Department of Forestry, Faculty of Agriculture, PGRI University of Palangkaraya, Central Kalimantan 73112, Indonesia

Corresponding author: Syaukani Syaukani (syaukani@gmail.com)

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Abstract

A new species of open-air processional column termite is here described based on the soldier and worker castes from eight colonies in north Barito, central Kalimantan. *Hospitalitermes nigriantennalis* sp. n. is readily distinguished in the field from related *Hospitalitermes* spp. by the light brown to orangish coloration of the soldier head capsule that, further, is with vertex yellowish and nasus brownish. The soldier antenna and the maxillary and labial palps are blackish. By contrast, soldiers from other species of *Hospitalitermes* from this region have a uniformly black head capsule and antennae. Finally, *H. nigriantennalis* sp. n. has a minute indentation in the middle of the posterior part of head capsule, which further helps to differentiate this new species from other *Hospitalitermes* from the Indo-Malayan and Austro-Malayan regions.

Keywords

Termite, *Hospitalitermes*, new species, central Kalimantan, Borneo

Introduction

More than 2,900 living termite species (Engel et al. 2009) belonging to 281 genera have been described worldwide (Krishna et al. 2013). This diversity is partitioned among nine families, six of which (Kalotermitidae, Archotermopsidae, Hodotermitidae, Rhinotermitidae, Stylotermitidae, and Termitidae) are known from the Oriental region (Roonwal 1970). Three of these (Kalotermitidae, Rhinotermitidae and Termitidae) have been recorded in the Indo-Malayan sub-region of Asia (Ahmad 1965, Thapa 1981, Tho 1992).

The open-air processional column termites consist of three genera: *Hospitalitermes* Holmgren, 1912, *Lacessititermes* Holmgren, 1912 and *Longipeditermes* Holmgren, 1912 (Syaukani et al. 2011). Most species of this group are conspicuous because, unlike the vast majority of termites, workers and soldiers forage above ground or on leaf litter in processional columns (Tho 1992, Jones and Gathorne-Hardy 1995, Miura and Matsumoto 1998, Syaukani 2010, Syaukani et al. 2011). Almost all individuals are relatively quick moving, as evidenced by their disproportionately long legs. Further, they are heavily pigmented, which is presumably related to their above-ground lifestyle and camouflage on leaf litter (Jones and Gathorne-Hardy 1995). This three-genus group has been well described, and much is known about its distribution, caste system and feeding behavior (Kalshoven 1958, Roonwal 1970, Collins 1979, Jones and Gathorne-Hardy 1995, Miura and Matsumoto 1998, Jones and Brendell 1998).

Seven species have previously been recorded from Borneo: *H. hospitalis* (Haviland, 1898), *H. hospitaloides* (Holmgren, 1913), *H. rufus* (Haviland, 1898), *H. lividiceps* (Holmgren, 1913), *H. umbrinus* (Haviland, 1898), *H. flaviventris* (Wasmann, 1902) and *H. medioflavus* (Holmgren, 1913) (Krishna et al. 2013). In this paper the eighth species from this region is described.

Material and methods

Specimens of *Hospitalitermes nigriantennalis* sp. n. were collected from a processional column on the primary forest floor in Pararawen Nature Reserve, Muara Teweh, North Barito, Central Kalimantan (Borneo), Indonesia. The head, body (in profile), pronotum and antenna of the soldier caste (preserved in 70% ethanol) were photographed using a digital microscope (Olympus SZX12 and Nikon DS-Fi2, Japan). From these images, multi-focused montages were constructed using Helicon Focus 6.2.2 software (Helicon Soft Ltd. Kharkov Ukraine). General morphological terminology used for describing soldiers and workers follow Roonwal and Chhotani (1989), Sands (1998), Tho (1992) and Syaukani et al. (2011).

Measurements of the soldier body parts specifically follow precedent from Roonwal and Chhotani (1989) and Tho (1992). Head capsule length including nasus (HLN), head capsule length excluding nasus (HL), nasus length (NL), nasus index = NL/HL, maximum head width at anterior part (HWA), maximum head width at posterior part (HWP), maximum height of head capsule excluding postmentum (HH), pronotum length (PL), and pronotum width (PW). Measurements for the soldier caste are summarized in Table 1.

Systematics

Family Termitidae Latreille, 1802

Genus *Hospitalitermes* Holmgren, 1913

Hospitalitermes nigriantennalis Syaukani & Thompson, sp. n.

<http://zoobank.org/1EEA9B9D-A871-41EB-A2F7-38055284D924>

Figs 1–15

Description. Imago. Unknown.

Soldier (Figs 1–5). Head capsule pale brown to orange with yellowish vertex and dark brown nasus; nasus paler in basal part and darker in apical part; antenna uniformly blackish, contrasting with head capsule. Pronotum in dorsal view as darker than head capsule. Abdominal tergites are gold orange to pale brown. Coxae are blackish brown; femora and tibiae pale to dark brown.

Head capsule in dorsal view strongly constricted behind antennal sockets, with anterior part excluding nasus much smaller than posterior part in size; median portion of its posterior margin nearly straight with a minute indentation in the middle; dorsal outline (including nasus) in profile weakly concave, while posterior part of head capsule fairly developed. Nasus in dorsal view more than half as long as receiving head capsule, basal part much wider than tip. Antenna with 14 segments; third segment longer than fourth, while fourth and fifth segment are nearly equal, 6th–14th gradually decreasing in length. Pronotum in dorsal view with anterior margin moderately indented in middle and posterior margin roundly convex.

Worker (Figs 6–13). Dimorphic. *Largest workers*. Head capsule dark brown to black; epicranial suture pale brown; fontanel brown to dark brown; labrum pale brown to dark brown; clypeus blackish brown to black; anteclypeus dark brown; antenna dark brown to blackish. Antenna consisting of 15 segments; third segment longer than fourth, while the fourth segment is slightly shorter than fifth, 6th–15th gradually increasing in length. Left mandible: apical tooth clearly shorter than first marginal tooth;

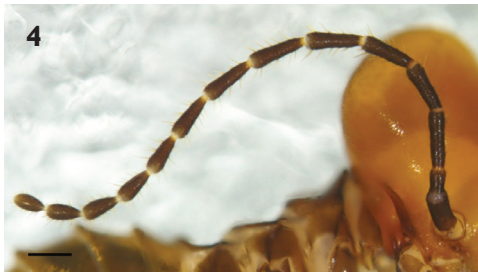
Table 1. Measurements (in mm) for n = 20 soldiers of *Hospitalitermes nigriantennalis* sp. n. from eight colonies.

Character	Holotype	Size range
Head capsule length including nasus	1.72	1.64–1.72
Head capsule length excluding nasus	1.18	1.01–1.19
Nasus length	0.65	0.63–0.65
Nasus index	0.55	0.60–0.61
Maximum head width at anterior part	0.58	0.55–0.60
Maximum head width at posterior part	1.06	1.00–1.07
Maximum height of head capsule excluding postmentum	0.82	0.75–0.82
Pronotum length	0.37	0.32–0.37
Pronotum width	0.62	0.56–0.63



Figures 1–3. Soldiers of *Hospitalitermes nigriantennalis* sp. n. Habitus in profile (1), head in profile (2), head in dorsal view (3). Scale bars: 0.5 mm (1), 0.3 mm (2, 3).

anterior edge of first marginal tooth distinctly longer than posterior edge; second marginal tooth absent, incorporated into cutting edge between first and third marginal teeth; third marginal tooth smaller than first marginal tooth, weakly protruding from



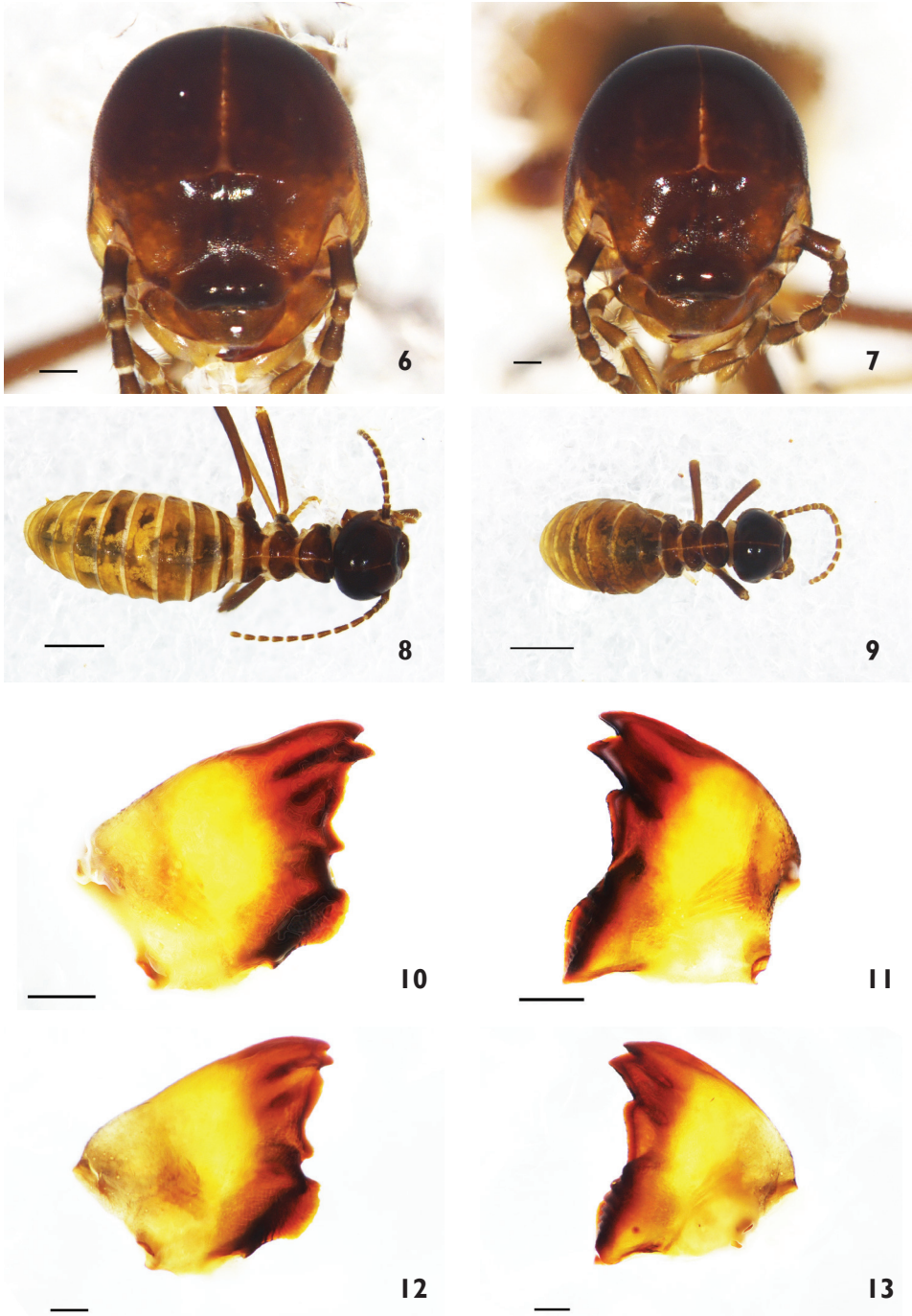
Figures 4–5. Soldier of *Hospitalitermes nigriantennalis* sp. n. Antenna (4) and pronotum (5). Scale bars: 0.3 mm (4), 0.2 mm (5).

cutting edge and separated from molar prominence by a distinct gap; fourth marginal tooth retracted, completely hidden behind molar prominence. Right mandible: first marginal tooth with anterior edge down-curved; second marginal tooth weakly recognized and separated from much larger first marginal tooth; posterior edge of second marginal tooth straight; outline of molar plate weakly visible; cockroach notch of molar plate absent.

Comparisons. *Hospitalitermes nigriantennalis* sp. n. is separated from the other species from Indo-Malayan and Austro-Malayan sub-regions by its peculiar coloration in the soldier. Specifically, *H. nigriantennalis* has prominent black antennae and palps that contrast with the pale head capsule. In other species, the head capsule is uniformly dark and does not contrast with the dark antennae. Further, by morphology *H. nigriantennalis* can be distinguished from other regional congeners *H. rufus*, *H. hospitalis*, *H. medioflavus*, *H. moluccanus* Ahmad, 1947, *H. ferrugineus* (John, 1925), *H. lividiceps*, *H. diurnus* Kemner, 1934, and *H. seikii* Syaukani, 2010 by comparing the head capsule; in dorsal view the posterior margin and the median portion of head capsule of *H. nigriantennalis* are elongated. In other species the head capsule is less elongated, rounded.

Likewise, in lateral view, the dorsal outline (including nasus) in profile weakly separate this new species from congeners (e.g., *H. umbrinus*, *H. birmanicus* (Snyder, 1934), *H. bicolor* (Haviland, 1898), *H. monoceros* (Koenig, 1779), *H. papuanus* Ahmad, 1947, *H. jepsoni* (Snyder, 1934) and *H. krishnai* Syaukani, 2011 by its elongate form.

Material examined. Holotype: soldier collected from a mass processional column on the forest floor (leaving nest to feeding sites) in an undisturbed lowland rain forest (250 m in altitude), Pararawen Nature Reserve (0°38'13"S; 114°41'10"E), North Barito, Central Kalimantan, Borneo. The nest was located in soil at the base of a dead standing tree (*Shorea* sp.), 6 m in height. Syaukani leg. 22.vi.2014. Colony code: SY-2014-Pararawen-0036. Other material from the same locality: SY-2014-Pararawen-C0045, C0051, C0052, C0059 (collected from nests at the base of standing tree), SY-2014-Pararawen-C0019, C0037, C0043 (collected from a processional column



Figures 6–13. Worker of *Hospitalitermes nigriantennalis* sp. n. Large workers (6, 8, 10–11), small worker (7, 9, 12–13). Left (10, 12) and right (11, 13) mandibles. Worker head in dorsal view (6, 7), worker habitus in dorsal (8, 9). Scale bars: 0.3 mm (6), 0.2 mm (7), 0.6 mm (8, 9), 0.1 mm (10, 11), 0.05 (12, 13).



Figure 14. Foraging party of soldiers and workers of *Hospitalitermes nigriantennalis* sp. n. on the forest floor.

en masse). The holotype is deposited at Museum Zoologicum Bogoriense (MZB), Cibinong, Indonesia. Paratypes: soldiers and workers from C0019, C0036, C0037, C0043, C0045, C0051, C0052; will be depository at MZB, the Natural History Museum, London (UK), Natural History Museum Vienna (Austria), Syiah Kuala University, Darussalam, Banda Aceh (Indonesia), the Kitakyushu Museum of Natural History and Human History (Japan), and the American Museum of Natural History, New York (USA).

Etymology. This species is named after the blackish antennae in the soldier caste.

Biological observation. With the discovery of this new species, the total number of *Hospitalitermes* species increased to eight for the island of Borneo. This species foraged above the ground and seemed to prefer leaf litter, which may afford some protection from predators. However, when huge logs or fallen trees disrupt this cover, the soldiers can be seen running in a zigzag pattern along the column edges. This observation of soldier behavior is consistent with observations by Hoare and Jones (1998) who reported this response in *Longipeditermes longipes* as a response to disturbance. The strong dimorphism in coloration between the soldier and worker castes is peculiar among the members of this genus, and distinguishes this species. Finally, *Hospitalitermes nigriantennalis* has a dimorphic worker caste.



Figure 15. Nest of *Hospitalitermes nigriantennalis* sp. n. inside a standing dead *Shorea* sp. trunk.

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Two new *Megalothorax* species of the *minimus* group (Collembola, Neelidae)

Clément Schneider¹, David Porco², Louis Deharveng¹

1 Institut de Systématique, Evolution, Biodiversité, ISYEB - UMR 7205 - CNRS, MNHN, UPMC, EPHE, Museum national d'Histoire naturelle, Sorbonne Universités, 45 rue Buffon, CP50, F-75005 Paris, France

2 Université de Rouen, Laboratoire ECODIV, Bâtiment IRESE A, Place Emile Blondel, 76821 Mont Saint Aignan Cedex, France

Corresponding author: Clément Schneider (clement.schneider@mnhn.fr)

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Abstract

Two new *Megalothorax* species, *M. potapovi* **sp. n.** from the Russian Far East and *M. sanguineus* **sp. n.** from the French Pyrénées are described. The two new species have a set of morphological characters (including a smooth mucro) that places them among the *minimus* group *sensu* Schneider and D’Haese (2013). *Megalothorax potapovi* characteristics include dorsal protuberance on forehead, peculiar chaetotaxy of antenna III and strong lanceolate chaetae on body. *Megalothorax sanguineus* characteristics include strong red pigmentation, large network of integumentary channels on head and elongated apex of the two posterodistal spines of dens. The DNA barcodes (cytochrome oxidase subunit I–COI) of the two species are also provided and analyzed among a broader sampling of the genus in order to support further their specific status. A special focus is given to the labral morphological characteristics. Pseudopores-like elements are reported for the first time in the genus. Positions of the τ -chaetae near the dorsal sensory field of thorax II are compared for several species of the genus.

Keywords

Springtails, Neelipleona, description, chaetotaxy, taxonomy, DNA barcodes, labrum

Introduction

During an expedition organized by Mikhail Potapov in Primorye (Russian Far East) in 2004, a large number of samples yielded a huge diversity of Collembola. Several of the most remarkable taxa collected have been recently described, like the new genus *Sensillonychiurus* with three new species (Pomorski and Sveenkova 2006), a genus that was subsequently retrieved in Northeastern China (Sun et al. 2013) and in other regions of northern Russia (Babenko et al. 2011). The Sino-Korean subfamily Caputaurininae was also reported for the first time for Russia (Deharveng et al. 2010) with two new species. Here, we report a morphologically remarkable new species of the genus *Megalothorax* Willem, 1900 (Neelidae, Neelipleona): *Megalothorax potapovi* sp. n. On the other end of the Palaearctic, the faunistical survey of the Pyrenean peatland of Bernadouze yielded another new species of *Megalothorax*, *M. sanguineus* sp. n. The two new species are described in the present paper, along with their barcode sequences (COI–mitochondrial cytochrome oxidase subunit I). Their genetic divergence levels with other *Megalothorax* molecular operational taxonomic units (MOTUs) are assessed and discussed. A special focus is given to the labral morphological characteristics. Pseudopores-like elements are reported for the first time in the genus. Positions of the τ -chaetae near the dorsal sensory field of Th. II are compared for several species of the genus.

Material and methods

Sampling

Megalothorax potapovi sp. n. The specimens were obtained from a 2000 cm³ sample of forest litter from Primorye, that were processed for fauna extraction in a field laboratory of Anisimovka. The litter sample was dried for 8 days on a Berlese funnel without heating.

Megalothorax sanguineus sp. n. The two sampled sites are located at medium elevation in Ariège Pyrenees (France): in very humid mossy habitats near the peat-bog of Bernadouze, and from humid litter at Osque du Couret. Samples were processed in the lab on Berlese funnels in the same conditions as above.

Morphology

Specimens were preserved in 95% ethanol then cleared in lactic acid and finally mounted on microscope slides in Marc André II medium. They were examined using a Leica DMLB compound microscope with differential phase contrast optics at magnifications ranging from 250 to 1000. Drawings were made with a drawing tube and vectorized with Inkscape. For Scanning Electronic Microscope (SEM) observations, specimens were dehydrated in 100% ethanol, before critical point drying (Emitech

K850) and gold coating (Jeol JFC-1200) and observations were performed with a SEM Jeol 840A. *Megalothorax sanguineus* sp. n. was not observed with SEM, however we were able to locate all the positions of the τ -chaetae (trichobothria) with the optical microscope.

DNA barcode

The standard DNA barcode (658bp of the COI-mitochondrial cytochrome oxidase subunit I gene, Hebert et al. 2003) was sequenced for the 2 new species (Table 4).

DNA was extracted from entire specimens in 30 μ l of lysis buffer (http://www.ccdb.ca/docs/CCDB_DNA_Extraction.pdf) and proteinase K incubated at 56 °C overnight. DNA extraction followed a standard automated protocol using 96-well glass fibre plates (Ivanova et al. 2006). Specimens were recovered after DNA extraction using a specially designed work flow allowing their morphological examination (Porco et al. 2010). The 5' region of COI used as a standard DNA barcode was amplified using M13 tailed primers LCO1490 and HCO2198 (Folmer et al. 1994). Samples that failed to generate an amplicon were subsequently amplified with a pair of internal primers combined with full length ones (C_LepFolF/C_LepFolR) (Ivanova - published on <http://www.boldsystems.org>). The standard PCR reaction protocol of the Canadian Center for DNA Barcoding was used for amplifications (<http://www.dnabarcodes2011.org/conference/preconference/CCDB-Amplification-animals.pdf>), and products were checked on a 2% E-gel 96Agarose (Invitrogen). Unpurified PCR amplicons were sequenced in both directions using M13 tailed primers, with products subsequently purified using Agencourt CleanSEQ protocol and processed using BigDye version 3.1 on an ABI 3730 DNA Analyzer (Applied Biosystems). Sequences were assembled and edited with Sequencher 4.5 (GeneCode Corporation, Ann Arbor, MI, USA). The alignment was obtained using BIOEDIT version 7.0.5.3 (Hall 1999). Sequences are publicly available on GenBank (JN298074-JN298078, JN970909-JN970929, KC900191-KC900205, KR736063-KR736070) and on BOLD at the following doi: 10.5883/DS-MEGAMIN (Table 4).

Data analyses

Forty-nine specimens of *Megalothorax* dataset representing 14 morphologically recognized species were selected, 36 from Schneider et al. 2011, Schneider and D'Haese 2013 and 13 specimens belonging to the two new species (Table 4).

Distance analyses were performed with MEGA6 (Tamura et al. 2013), utilizing a Neighbor-Joining (Saitou and Nei 1987) algorithm with the Kimura-2 parameter model (Kimura 1980) to estimate genetic distances. The robustness of nodes was evaluated through bootstrap re-analysis of 1000 pseudoreplicates. Molecular Operational Taxonomic Units (MOTUs) were defined with the software 'mothur' (Schloss et al. 2009).

Terminology

A nomenclature for the integumentary crests on the labrum is introduced (Fig. 13A–F). Crests are defined as integumentary processes with an apical line of primary grains. The longitudinal crests separating the m-row of chaetae are named *ml1–3*, when present the transversal crests in posterior position to a chaetae of the m-row are named *mt* and numbered after the chaetae position (*mt2* posterior to chaeta *m2*), the antero-median transversal crest separating the m-row from the a-row is named *amt*, and can be further separated in *amt0–2* numbered after the chaetae of m-row position. The longitudinal anterior crests separating the a-row are named *al1–3*. The transversal crest anterior to the a-row is named *at*—theoretically with the subdivisions *at0*, *at1*, *at2* though we could only observe the *at2* region in *M. minimus* Willem, 1900.

Head chaetotaxy (Fig. 14) and antenna chaetotaxy (Fig. 15) follow Schneider (in press), trunk chaetotaxy (Fig. 16) follows Schneider and D’Haese (2013). The four swollen chaetae of Ant. III sensory organ are named *S1–S4* after Deharveng (1978). We avoid to use the term ‘sensilla’ to designate some chaetae with peculiar shape and light refraction (e.g. Massoud and Ellis 1977), and use instead the following categories defined by Schneider (in press): (i) s-chaetae for the short swollen chaetae of the trunk; (ii) τ -chaetae for the long and thin chaetae of the trunk (shaped as trichobothria in *Megalothorax*); (iii) S-chaetae for the swollen chaetae of the antenna; (iv) neosminthuroid chaetae for the special chaetae of Abd. IV sternum as defined in Richards (1968), Betsch (1980) and Schneider and D’Haese (2013). Ordinary chaetae are simply referred as chaetae. Nomenclature of the claw follows Schneider (in press), based on Denis (1948) and Schneider and D’Haese (2013). The presence or absence of specific chaetae is described in reference of the chaetotaxic pattern of *M. minimus*. Reference to *M. minimus* in this work is always sensu Schneider and D’Haese (2013).

Abbreviations and symbols in text and figures

Crests on the anterior process of the labrum: *al2*, *3* = anterior longitudinal, *ml1–3* = posterior longitudinal, *amt0–2* = antero-median transversal, *mt2* = posterior transversal. **Antenna:** Ant. I–IV = antennomere I to IV, *S1–S4* = S-chaetae of Ant. III; or = Ant. IV organite; *S*, *Sx*, *Sy* = S-chaetae of Ant. IV. **Trunk:** Th. I–III = thoracic segment I to III; Abd. I–VI = abdominal segment I to VI; *av* = chaetae of anal valve; *s1*, *s2* = s-chaetae; *sm* = special chaetae of male Abd. VI sternum; τ = τ -chaetae; *wrc1–wrc8* = free wax rod secretory element 1 to 8. **Claw:** *la*, *lp*, *Ba*, *Bp* = auxiliary lamellae and crest of unguis; *Ca*, *Cp* = anterior and posterior crests of unguicula lamella. **Misc:** *dp* = dens proximal, *dd* = dens distal, *sf1–6* = sensory field 1 to 6.

Taxonomy

Megalothorax potapovi sp. n.

<http://zoobank.org/4E6BA360-2EDF-49F3-AF77-54B250A9C490>

Figs 1–7, 13A–C, 14A, B, 15, 16A

Material examined. Holotype: male on slide (MNHN-EA040223), Russia: Primorye: south of Posyet: peninsula facing to the town; 130.8034°E, 42.5709°N; alt=30 m; 28.ix.2004; Berlese extraction, forest litter; Louis Deharveng and Anne Bedos leg (RU-120) [MNHN]. Paratypes: 2 males and 5 females on slides (MNHN-EA040224–229), same data as the holotype [MNHN]; 1 specimen (sex unknown) on mount for SEM (MNHN-EA041012), same data as the holotype [MNHN].

Diagnosis. Whitish in alcohol. Presence of median integumentary protuberance in front of chaeta *a0* on forehead. Presence of chaeta *X* on Ant. IV. Labium: basomedian fields with 3 + 3 chaetae, basolateral fields with 1 + 1 chaetae. Integumentary channels as a paired tree on posterior part of the head, absent on anterior part, connection of channels with *linea ventralis* circular. Some chaetae enlarged and lanceolate, of which 5 + 5 dorsal, posterior on head and 2 + 2 on Th. II tergum. Inner chaeta of sensory field 2 slender with blunt apex, all inner chaetae of sensory fields 3–6 short flam-shaped. Dorsal abdominal s-chaetae *s2* globular, absence of dorsal abdominal s-chaetae *s3*. Abd. I to V terga with 18 + 18 ordinary chaetae. Each claw of ordinary morphology, subequal. Tenaculum with 3 + 3 teeth. Abd. IV sternum with 2 + 2 chaetae. Mucro lamellae smooth, thin.

Description. General aspect. Habitus and segmentation typical of the genus (Fig. 1A). Length from labrum to anus: ~380 µm. Specimens whitish in alcohol. Body chaetotaxy sparse including chaetae, s-chaetae, τ -chaetae as trichobothria, neosminthuroid chaetae, wax rod secretory elements and special swollen chaetae within *sf2*–6. Length of chaetae ranging from microchaetae [5–9 µm] to mesochaetae [10–14 µm] and macrochaetae [15–24 µm]. Shape of chaetae ranging from simple to lanceolate. Greatest chaetae being macrochaetae *a4* and *a7* on Th. II tergum (24 µm; Fig. 5F, G).

Integument. Secondary granulation made of the usual dorsal rough granules (e.g. Fig. 2A, B) and of smooth and flat irregular discoid granules near the ventral, postlabial chaetae of head. Integumentary channels extending laterally and dorsally in posterior part of head. Those channels as a pair of trees with five terminal branches (Figs 1A, B, 3A, B, 14A). Cephalic channels connection with *linea ventralis* circular (Figs 3B, 14B). Thoracic channels simple, restricted to ventral part.

Sensory fields and wax rods. A total of 14 + 14 wax rod secretory crypts (2 + 2 on head, 12 + 12 on body), including the ones inserted in each 6 + 6 sensory fields (Figs 3A, 4, 14A, 16A). *sf1* without inner chaeta (Figs 1B, 3A). *sf2* with one rather slender, curved inner chaeta with blunt apex (Figs 1B, 5E). Each inner chaeta of *sf3*–6 short, flam-shaped and curved (Figs 2A, B, 5F–I). *sf3* with three inner chaetae (Figs 2A, 5F). *sf4* and 5 each with two inner chaetae (Figs 2B, 5G, H). *sf6* with one inner chaeta, inner chaeta length : *sf6* diameter < 0.5 (Fig. 5I). *wrc5* adjoining *sf5* border (Figs 2B, 5H).

Labrum. Chaetae (Figs 1D, 3E, F): *a*- and *m*-row with rather slender mesochaetae, *a2* slightly thicker and longer than *m0–2*; *m0–2* apparently smooth, *a1*, 2 with one external teeth and with inward tip; *m0* almost on the same level than *m1*. Integumentary crests (Figs 1D, 13A–C): *m*-row distinctly separated from *a*-row by the antero-medial transversal crest (*amt*); longitudinal crest *ml2* projecting anteriorly, cutting the transversal integumentary crest in two part (*amt0*, *amt2*); *mt0* distinctly concave; absence of transversal crest posterior to chaetae *m2* (*pt2*); asymmetry present on at least one specimen: *ml3* strong and projecting anteriorly on one side, *ml3* feeble and not reaching *amt2* on the other side. Anterior side of the anterior process with 3 + 3 and one axial integumentary bulge (Fig. 3E). Labrum ridge with two small pikes (Fig. 3E).

Other mouth parts. Oral fold with 2 + 2 mesochaetae. Maxillary outer lobe: palp with subapical mesochaeta and apical papillate macrochaeta, edge of apical papilla with three strong integumentary lobes (Figs 3E, F); sublobal plate with one strong hair (7 µm; Fig. 3E). Basomedian fields of labium with 3 + 3 mesochaetae (Fig. 3B), basolateral fields with 1 + 1 mesochaetae on tubercle. Labial palp chaetal equipment typical of the genus, guard hairs strong in regard of papillate chaetae, hypostomal papillate chaeta flattened laterally in apical part, with subapical enlargement and acuminate apex (Figs 3G–I). Maxilla as in Figs 5A, B. Mandibula each with five apical teeth, right mandibula with a strong tooth between apex and molar plate (Figs 5C, D).

Head chaetotaxy. Trend for posterior chaetae to be longer and stronger than anterior chaetae, with 5 + 5 remarkable posterior lanceolate macrochaetae (up to 18 µm, Figs 1B, 3A). Dorsal anterior area with 11 pairs of chaetae (10 + 10 mesochaetae, 1 + 1 macrochaetae) and two axial mesochaetae (Figs 3A, 14A); with an axial integumentary protuberance in front of chaeta *a0*, devoid of secondary granules (Figs 1B, C, 3A); with 2 + 2 indistinct pseudopore-like elements between *sf1* and insertion of antenna. Lateral anterior area with 1 + 1 mesochaetae (Figs 3A, 14A). Dorsal posterior area with 11 pairs of chaetae (5 + 5 lanceolate macrochaetae, 6 + 6 thickened mesochaetae, Fig. 3A, 14A). Ventral side with three pairs of post-labial mesochaetae (Fig. 3B, 14B).

Antennal chaetotaxy. Illustrated in Figs 3C, D, pattern diagram in Fig. 15 and summarized in Table 1. Ant. I with one mesochaeta. Ant. II with four chaetae: an anterior mesochaeta and three microchaetae. Ant. III with eight chaetae (four mesochaetae, five microchaetae), two long S-chaetae (*S1*, *S4*) and two short S-chaetae (*S2*, *S3*) in a cupule. *S2* and *S3* protruding from a shallow cupule but partially covered by a strong integumentary lobe. *S1*, *S4* ornamentation unclear in light microscopy, *S2*, *S3* ornamentation feebly visible. *S4* in apical position to *S1*, on the same level than *S2*, *S3*. Tip of *S1* rising up to Ant. IV basal whorl of S-chaetae, tip of *S4* rising up to Ant. IV apical whorl of S-chaetae. Ant. IV with twelve S-chaetae (10 *S*, *Sy* and *Sx*), six microchaetae (only three chaetae in subapical group including chaeta *X*), a small organite (*Or*), two apical and subapical rods (*a*, *sa*). S-chaetae *S* with blunt apex.

Thoracic terga chaetotaxy. Th. II with 12 + 12 chaetae of variable length, 1 + 1 s-chaetae *s1* tubular and curved and 3 + 3 τ-chaetae (Figs 4, 16A). Chaetae including 3 + 3 macrochaetae (length as *a4* > *a7* > *p8*), 7 + 7 mesochaetae (*a1–3*, *p1* and *p2* thickened, *a8* and *a9* slender), 2 + 2 microchaetae (*p3*, *p4*) (Figs 4, 5F, G). Chaeta *p4* postero-lateral

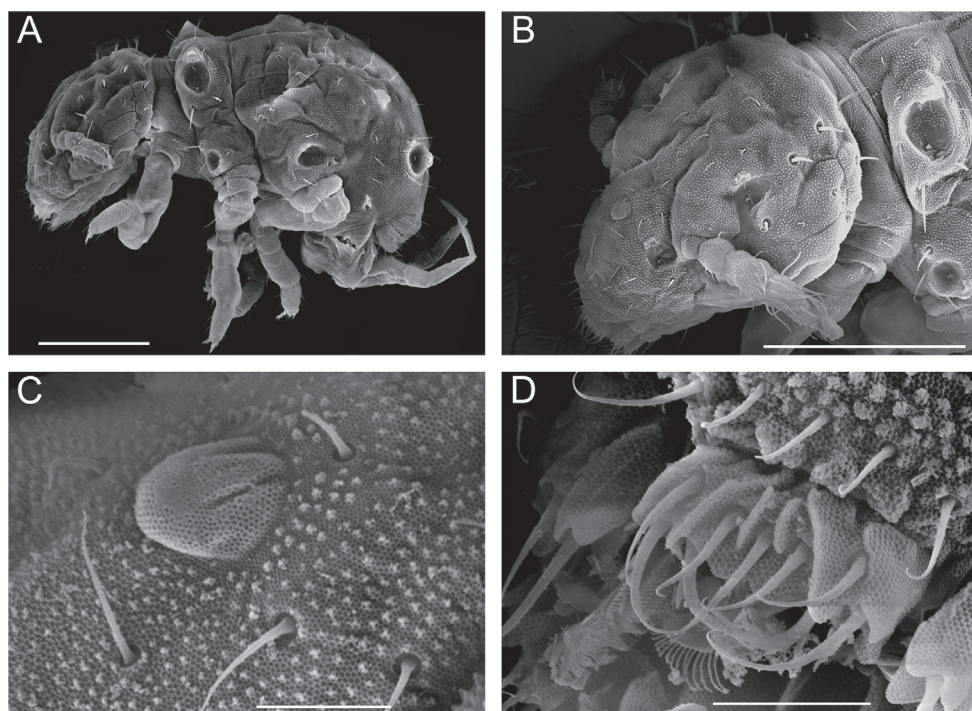


Figure 1. *Megalothorax potapovi* sp. n. **A** Whole body, lateral view **B** head, dorso-lateral view **C** integumentary protuberance on forehead, dorso-lateral view **D** labrum, dorsal view. Scale bars: 100 μm (**A**, **B**); 10 μm (**C**, **D**).

Table 1. Summary of antennal chaetotaxy.

Ant.	I	II	III		IV			
	chaetae	chaetae	chaetae	S-chaetae	chaetae	S-chaetae	Organit	Sensory rods
<i>M. potapovi</i> sp. n.	1	4	8	<i>S1–S4</i>	6 (<i>X</i> incl.)	12	<i>Or</i>	2 (<i>a</i> , <i>sa</i>)
<i>M. sanguineus</i> sp. n.			9		7 (<i>X</i> incl.)	(10 <i>S</i> , <i>Sx</i> , <i>Sy</i>)		

to $\beta 3$ (Figs 4, 5F, 16A). Two τ -chaetae in the periphery of $\beta 3$, one in posterior position and next to $p2$, one in lateral position and 10–11 granules far from $p4$ (Figs 4, 5F, 16A). Th. III with 10 + 10 chaetae, 6 + 6 free wax-rod generating crypts (*wrc1–6*) and 5 + 5 τ -chaetae (Figs 4, 16A). Chaetae including 2 + 2 macrochaetae ($a9$, $p7$), 7 + 7 mesochaetae ($a1$, $a5$, $a6$, $a8$, $p2$, $p3$, $p4$) and 1 + 1 microchaetae ($a3$) (Figs 4, 5H, J). Chaeta $p4$ moved posteriorly from *wrc2* (Figs 4, 16A). Chaeta $a6$ stronger than $a5$ (Figs 4, 5J).

Legs chaetotaxy. Legs with ordinary chaetae of variable size as in Fig. 6A–C and summarized in Table 2. Subcoxa 1 I with a mesochaeta, coxa I with a microchaeta. Subcoxa 1, 2 II each with a mesochaeta, coxa II with a macrochaeta. Subcoxa 1, 2 III and coxa III with respectively 2, 1, 1 macrochaetae. Anterior and posterior microchaetae present on each pretarsus.

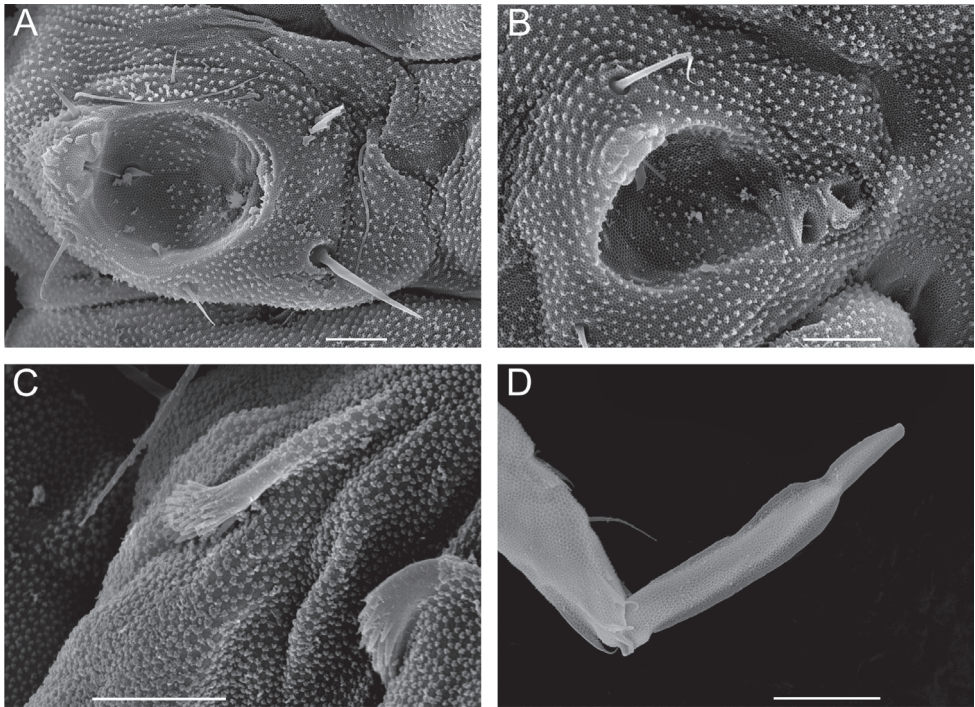


Figure 2. *Megalothorax potapovi* sp. n. **A** $s\beta 3$ on Th. II tergum, dorsal view **B** $s\beta 5$ on Th. III tergum, lateral view **C** neosminthuroid chaetae on Abd. IV sternum, lateral view **D** mucro, lateral view. Scale bars: 10 μm (**A–D**).

Claws. Ratio unguis length : pretarsus width on leg I–III respectively as 2.2, 2, 1.73, each claw with ordinary morphology, claw III bulkier than claw I and II (Fig. 6A–C). Each claw subequal in unguis length and in ratio unguiculus : unguis (~ 0.5) (Fig. 6A–C, F). Unguis basal and posterior auxiliary lamellae (la , lp and Bp) well developed, anterior crest (Ba) clear on claw II and III, weaker on claw I (Fig. 6D–F). Each unguiculus with a well developed posterior crest Cp , anterior crest Ca short and in basal position on claw I and II, more developed and not joining the internal border of the unguiculus lamella on claw III, basal tubercle posterior lobe not or feebly protruding (Figs 6D–H). Ratio unguis length : tibiotarsus length on leg I–III respectively as 0.54, 0.60, 0.65.

Abd. I–V terga chaetotaxy. With a total of 18 + 18 chaetae, 1 + 1 τ -chaetae, 2 + 2 free wax-rod generating crypts ($wrc7$, 8), 1 + 1 globular s-chaetae $s2$ (Figs 4, 16A). Chaetae including 17 + 17 mesochaetae (the longest $\varepsilon 2$, $\varepsilon 3$ and $\zeta 2$ reaching 15 μm) and 1 + 1 macrochaetae ($\eta 3$, 17–18 μm). Chaeta $a3$ close to $wrc7$, both clearly anterior to $\beta 3$ (Figs 4, 16A). Chaetae $\beta 4$ and $\varepsilon 1$ missing.

Abd. VI and genital chaetotaxy. Abd. VI: with nine dorsal mesochaetae (Fig. 7A); each anal valve with microchaeta av and several granular crests (Fig. 7A); with 9

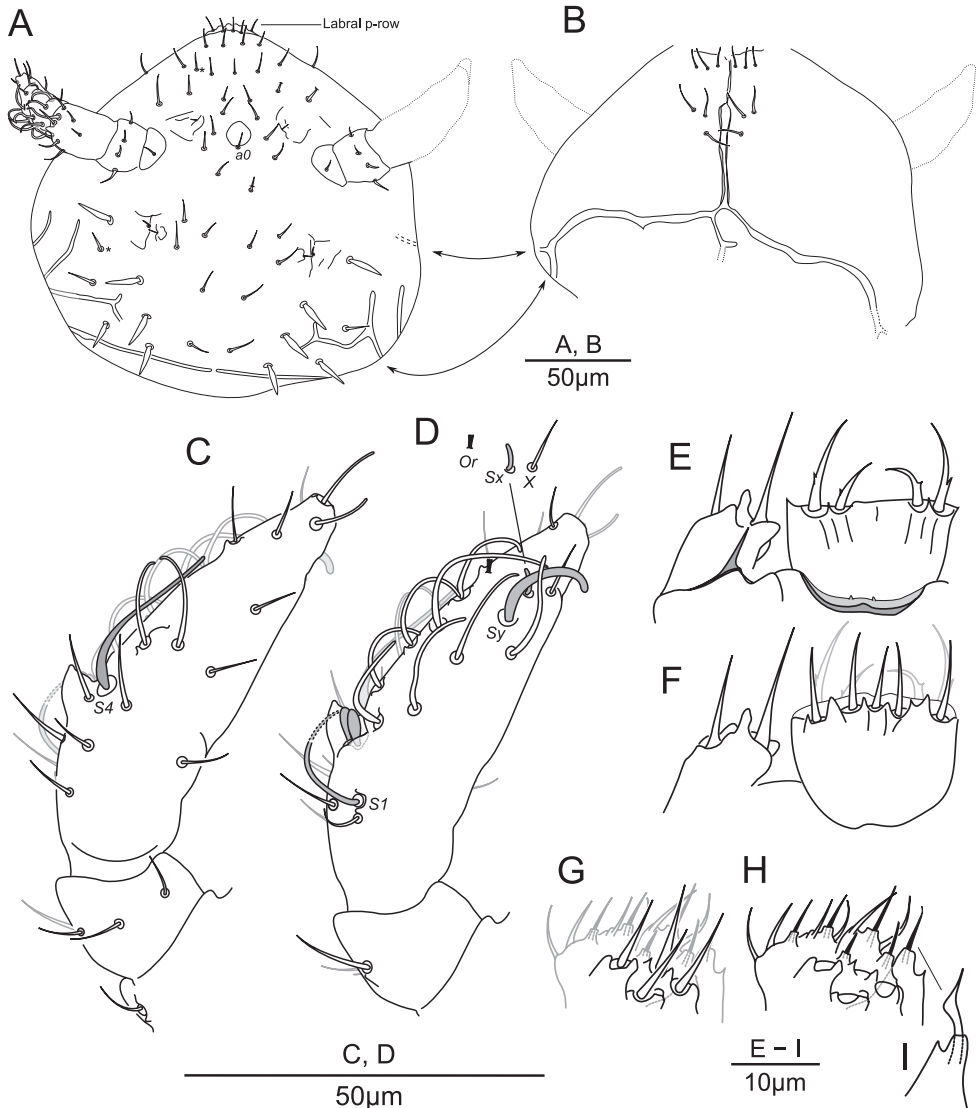


Figure 3. *Megalothorax potapovi* sp. n. Chaetotaxy of head **A** dorsal side **B** ventral side; chaetotaxy of antenna **C** anterior side **D** posterior side; labrum and maxillary outer lobe **E** anterior side **F** posterior side; palp of labium **G** focused on ventral chaetae **H** focused on distal chaetae **I** hypostomal papillate chaeta. * indicates a supplementary chaeta, absent in other specimens.

+ 9 ventral chaetae (Fig. 7A), male with 1 + 1 additional ventral cylindrical swollen chaetae *sm* (Fig. 7B, C). Genital plate: female with 2 + 2 microchaetae (Fig. 7A); male with 10 + 10 microchaetae (Fig. 7B, C).

Abd. IV sternum and furca. Abd. IV sternum with 2 + 2 neosminthuroid chaetae (Figs 2C, 7A) and 2 + 2 posterior mesochaetae (Fig. 7A). Manubrium with 2 + 2

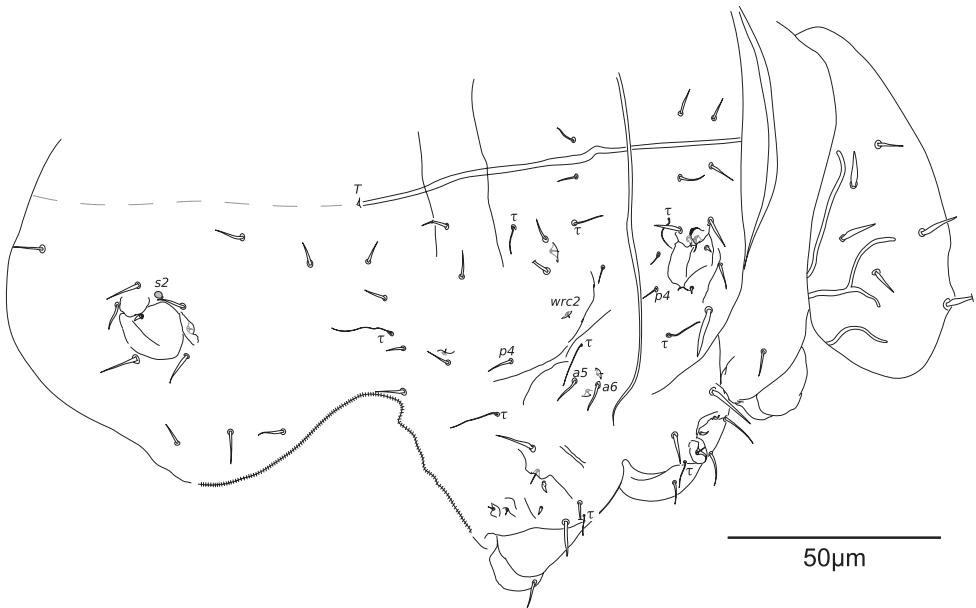


Figure 4. *Megalothorax potapovi* sp. n. Chaetotaxy of trunk, dorsal side.

posterior chaetae. Proximal subsegment of dens with one posterior chaeta (Fig. 7E); distal subsegment posteriorly with two basal spines, one median chaeta and two apical spines, anteriorly with three apical spines, spines without elongated apex (Fig. 7D, E). Mucro with a sharp narrowing in the apical 2/5, lamellae edges smooth (Figs 2D, 7D, E). Ratio $dp : dd : mucro = 0.75 : 1 : 0.88$; ratio mucro width : mucro length ~ 0.16 .

Tenaculum and ventral tube. Tenaculum with $3 + 3$ hook-like teeth (Fig. 7F). Ventral tube with two apical pairs of mesochaetae (Fig. 7G).

Affinities. *Megalothorax potapovi* sp. n. has the characteristics of the *minimus* group species (Schneider and D’Haese 2013; Papáč and Kováč 2013). Within this group, it shares with *M. sanctistephani* Christian, 1998 a median integumentary structure on forehead but differs from it by the presence of the median chaeta *a0*, the presence of the chaeta *X* on Ant. IV, the presence of strong lanceolate macrochaetae on head and thorax and the integumentary channels pattern. The absence of *a5* on Ant. III and of abdominal pair of chaetae $\varepsilon 1$ is a similitude with *M. svalbardensis* Schneider and D’Haese, 2013 and *M. tatrensis* Papáč & Kováč, 2013.

The integumentary structure on forehead and the lanceolate macrochaetae clearly separate *M. potapovi* sp. n. from *M. minimus*, *M. aquaticus* Stach, 1951, *M. svalbardensis*, *M. willemi* Schneider and D’Haese, 2013, *M. tuberculatus* Deharveng and Beruete, 1993, *M. carpaticus* Papáč & Kováč, 2013 and *M. tatrensis*. Other peculiar characteristics of the species are shape of hypostomal papillate chaeta, presence of a strong lobe protecting *S2*, *S3* on Ant. III, and *S4* in apical position on Ant. III. On the basis of

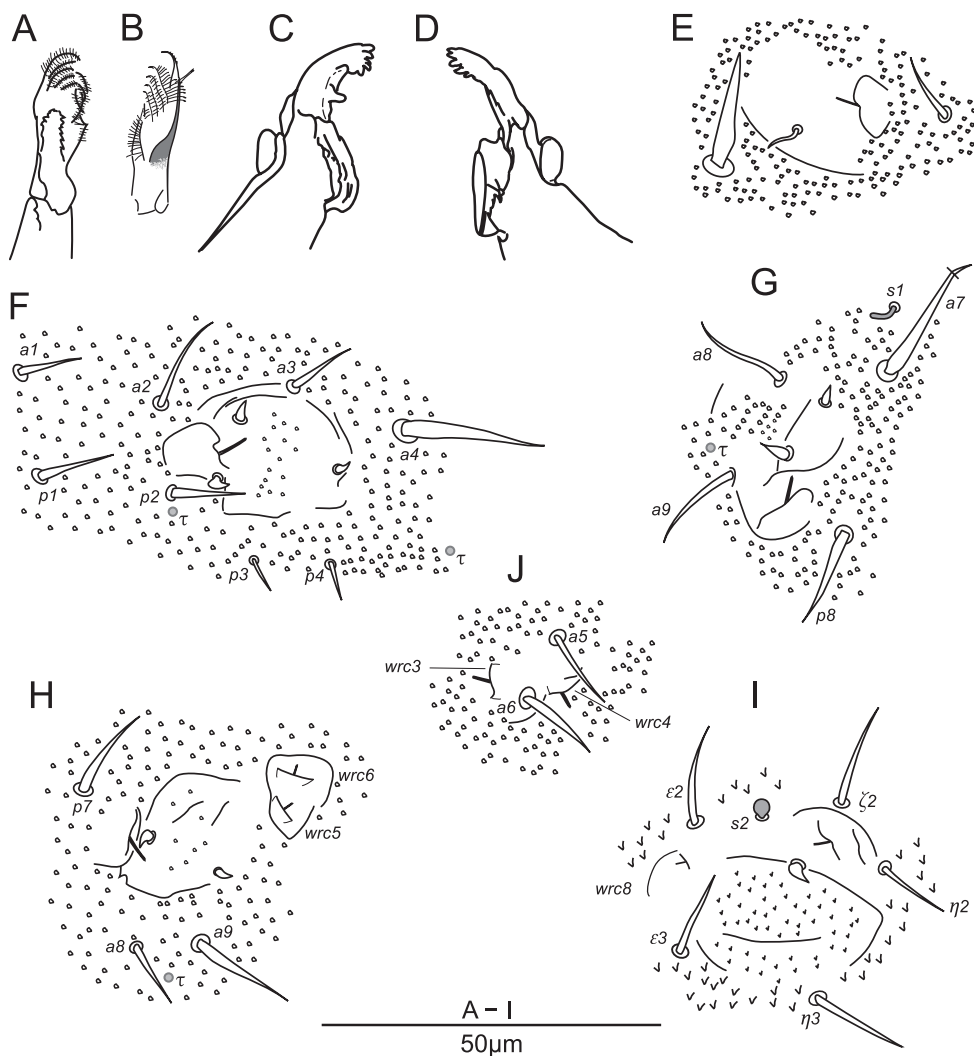


Figure 5. *Megalothorax potapovi* sp. n. Maxilla **A** dorsal side **B** ventral side; mandibula **C** right mandibula **D** left mandibula; sensory fields **E** *sf2* on head **F** *sf3* on Th. II **G** *sf4* on Th. II **H** *sf5* on Th. III **I** *sf6* on abdomen **J** *wrc3*, 4 and chaetae *a5*, 6 on Th. III.

labral features *M. minimus* (Fig. 13D–F) differs from *M. potapovi* sp. n. (Fig. 13A–C) by undivided *amt*, *ml2* not joining *amt*, presence of *mt2*. A similar asymmetry was observed in both species (*ml3* joining *amt* on one side, not joining *amt* on the other side). The morphology of the anterior crests (forming the anterior papillae) could not be comprehensively studied.

Ecology and distribution. The species was collected in lowland forest litter, and only found so far in the southern part of Primorye.

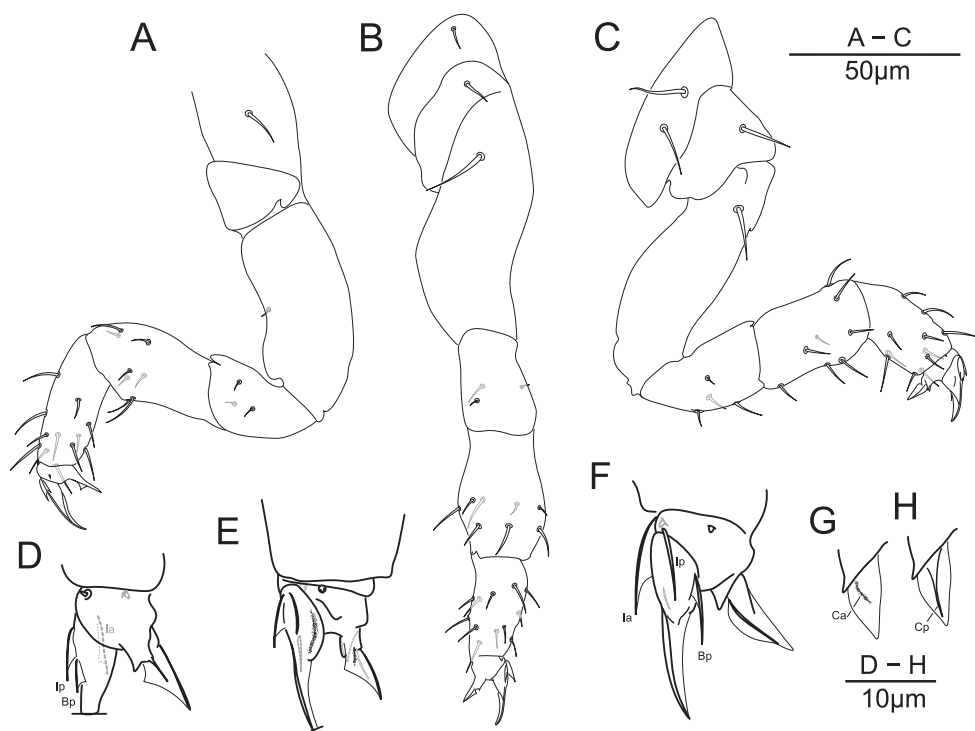


Figure 6. *Megalothorax potapovi* sp. n. Legs chaetotaxy, **A** leg I **B** leg II **C** leg III; claws **D** claw I posterior side **E** claw II anterior side **F** claw III posterior side; unguiculus III **G** anterior side **H** posterior side.

Etymology. *Megalothorax potapovi* sp. n. is dedicated to Mikhail Potapov, who led the 2004 field trip in Primorye which allowed to discover the new species.

DNA barcode. A 658bp fragment of the COI gene was amplified and sequenced from paratype (MNHN-EA040229, voucher 00620C05) and seven other specimens (type locality, specimens lost). 251 bases in 5' were not readable, thus a final sequence of 407bp is available. The sequences are identical. The sequence is deposited into the GenBank database under accession number KR736069. The base composition of the sequence is A = 26%, C = 23.1%, G = 13.5%, T = 37.4% (A + T = 63.4%).

5'-TAAGTTTTTGACTTCTTCCACCTTCTCTCACCCTTCTACTTTCAA-
GAGGTCTAGCAGAATCAGGTGCTGGAACAGGTTGAACTGTTTATCCTC-
CTTTATCTTCAAATATTTCCCATGCAGGAGCCTCTGTGCGACTTAAC-
TATTTTCAGTTTACATTTAGCTGGTATGTCATCAATTTTAGGAGCTAT-
TAATTTTATTACAACATCTTTAACATACGATCCCCAGGAATAACAT-
GAGATCAAACCTTCACTATTTATTTGATCTGTTTTAATTACATCAATTT-
TACTTCTCTTGTCTCTTCCAGTTCTAGCAGGAGCTATCACCATACTTT-
TAACCGACCGAAATTTAAATACTTCATTTTTTGACCCCGCTGGGGGTG-
GTGACCCAATTTTATACCAACACCTATTC-3'

***Megalothorax sanguineus* sp. n.**

<http://zoobank.org/DD7E3CB4-26AF-4B47-9788-65E2C11F17F4>

Figs 8–12, 14C, D, 15, 16B

Material examined. Type material. Holotype: female on slide (MNHN-EA040230), France: Midi-Pyrénées: Ariège: Suc-et-Sentenac: Vicdessos: on the edge of the Bernadouze peat-bog, mosses at a spring to the west under beech; lon=1.4220°E; lat=42.8024°N; alt=1360 m; 13.vi.2013; Berlese extraction, mosses, Lorène Marchal and Anne Bedos leg (09-BDZ1306-G03M) [MNHN]. Paratypes: 2 males and 4 females on slides (MNHN-EA040231–236), same data as the holotype [MNHN].

Other material. 4 females on slides (MNHN-EA040237–239)], France: Midi-Pyrénées: Ariège: Saint-Lary: Osque du Couret, forest litter on humid slopes; lon=0.8548; lat=42.8891; alt=1150 m; 28.vii.2010; Berlese extraction, litter, Louis Deharveng and Anne Bedos leg (09-761) [MNHN].

Diagnosis. Reddish in alcohol. Absence of median integumentary protuberance in front of chaeta *a0* on forehead. Presence of chaeta *X* on Ant. IV. Labium: basomedian fields with 3 + 3 chaetae, basolateral fields with 1 + 1 chaetae. Integumentary channels as a paired network on posterior part of the head and a simple channel on anterior part, connection of channels with *linea ventralis* circular. Chaetae on head and trunk with ordinary shape. All inner chaetae of sensory fields 2–6 short flam-shaped. Dorsal abdominal s-chaetae *s2* bean-shaped, absence of dorsal abdominal s-chaetae *s3*. Abd. I to V terga with 20 + 20 ordinary chaetae. Slightly elongated claws. Tenaculum with 3 + 3 teeth. Abd. IV sternum with 2 + 2 chaetae. Mucro lamellae smooth, moderately enlarged.

Description. General aspect. Habitus and segmentation typical of the genus. Length from labrum to anus: ~500 µm. Specimens with pale to deep red pigmentation in alcohol. Body chaetotaxy sparse including chaetae, s-chaetae, τ-chaetae as trichobothria, neosminthuroid chaetae, wax rod secretory elements and special swollen chaetae within *sf2*–6. Length of chaetae ranging from microchaetae [<6 µm] to mesochaetae [6–10 µm] and macrochaetae [11–15 µm]. Chaetae simple, without any remarkable development.

Integument. Secondary granulation made of the usual dorsal rough granules (Fig. 9) and of smooth and flat irregular discoid granules near the ventral, post-labial chaetae of head (Fig. 8C). Integumentary channels extending laterally and dorsally in anterior and posterior part of head (Fig. 8A, B). Posterior channels as a pair of well developed network. The most detailed observation allowed recognition of at least 10 cycles and 11 terminal branches with unclear tips (Fig. 8A). Anterior channel as a simple branch ending near the lateral edge of *sf1*, touching lateral chaeta of pra.a-row (Figs 8B, 14C). Cephalic channels connection with *linea ventralis* circular (Figs 8C, 14D). Thoracic channels simple, restricted to ventral part.

Sensory fields and wax rods. A total of 14 + 14 wax rod secretory crypts (2 + 2 on head, 12 + 12 on body), including the ones inserted in each 6 + 6 sensory fields (Figs 8A, B, 9, 14C, 16B). *sf1* without inner chaeta (Fig. 8B). Each inner chaeta of

*sf*2–6 flam-shaped and curved (Figs 8A, 9), the biggest in *sf*6 (Fig. 9). Inner chaeta of *sf*6 length : *sf*6 diameter < 0.5. *sf*2, 6 with one inner chaeta. *sf*3 with three inner chaetae (Fig. 9). *sf*4, 5 each with two inner chaetae (Fig. 9). *wrc*5 adjoining *sf*5 borders (Fig. 9).

Labrum. Chaetae (Fig. 8D, E): *a*1, 2 much thicker and longer than chaetae *m*0–2; *m*0–2 smooth, *a*2 with three-four external slender teeth and with inward tip, *a*1 with three feeble blunt teeth and with outward, flattened tip; *m*0 almost on the same level than *m*1. Integumentary crests: *m*-row distinctly separated from *a*-row by the antero-median transversal crest (*amt*); longitudinal crest *ml*2 apparently not projecting anteriorly. Anterior side of the anterior process with 3 + 3 clear integumentary bulges and one axial, short bulge (Fig. 8E). Anterior process of the labrum not further studied. Ridge of the labrum with three pikes (Fig. 8E).

Other mouth parts. Oral fold with 2 + 2 mesochaetae (Fig. 8C). Maxillary outer lobe: palp with subapical mesochaeta and apical papillate macrochaeta (Fig. 8F, G), edge of apical papilla with weak lobes, sublobal plate with two short hairs (Fig. 8F, G). Basomedian fields of labium with 3 + 3 mesochaetae, basolateral fields of labium with 1 + 1 mesochaetae on tubercle (Fig. 8C, H). Labial palp chaetal equipment typical of the genus, guard hairs strong in regard of papillate chaetae (Fig. 8H–J). Maxilla as in Fig. 10A, B. Left mandibula with five apical teeth (Fig. 10C), right mandibula with six apical teeth and a double tooth between apex and molar plate (Fig. 10D).

Head chaetotaxy. Dorsally and laterally with mesochaetae, posterior and anterior mesochaetae subequal with a slight trend for posterior chaetae to be stronger than anterior chaetae (Fig. 8A, B). Dorsal anterior area with 11 pairs of chaetae and two axial chaetae (Figs 8B, 14C); with 2 + 2 pseudopore-like elements as ovoid, clear rings between *sf*1 and insertion of antenna (Figs 8B, 14C). Lateral anterior area with 1 + 1 chaetae (Figs 8B, 14C). Dorsal posterior area with 11 pairs of chaetae (Figs 8A, 14C). Ventral side with three pairs of post-labial macrochaetae (Figs 8C, 14D).

Antennal chaetotaxy. Illustrated in Fig. 10E, F, pattern diagram in Fig. 15 and summarized in Table 1. Ant. I with one mesochaeta. Ant. II with four mesochaetae, anterior chaeta longer than the other. Ant. III with nine mesochaetae, two long S-chaetae (*S*1, *S*4) and two short S-chaetae (*S*2, *S*3) in a cupule. *S*2 and *S*3 clearly protruding from a shallow cupule, only weakly covered by a feeble integumentary lobe. *S*1–*S*4 ornamentation unclear in light microscopy. Tip of *S*1 rising slightly above Ant. IV basal whorl of S-chaetae, tip of *S*4 rising up to Ant. IV basal whorl of S-chaetae. Ant. IV with twelve S-chaetae (10 *S*, *S*_γ and *S*_χ), seven ordinary microchaetae, a small organite (*Or*) apically flared, two apical and subapical rods (*a*, *sa*). S-chaetae *S* with blunt apex, rather short (5–6 μm).

Thoracic terga chaetotaxy. Th. II with 12 + 12 chaetae of variable length, 1 + 1 s-chaetae *s*1 tubular and curved and 3 + 3 τ-chaetae (Figs 9, 16B). Chaetae including 5 + 5 macrochaetae (*a*4, *a*7, *a*8, *p*1, *p*8), 5 + 5 mesochaetae (*a*1, *a*2, *a*3, *a*9, *p*2) and 2 + 2 microchaetae (*p*3, *p*4) (Fig. 9). Chaeta *p*4 postero-lateral to *sf*3 (Figs 9, 16B). Two τ-chaetae in the periphery of *sf*3, one in posterior position next to *p*2, one in lateral position and 5–6 granules far from *p*4 (Figs 9, 16B). Th. III area with 10 + 10 chaetae, 5 + 5 τ-chaetae and 6 + 6 free wax-rod generating crypts (*wrc*1–6; Figs 9, 16B). Chaetae

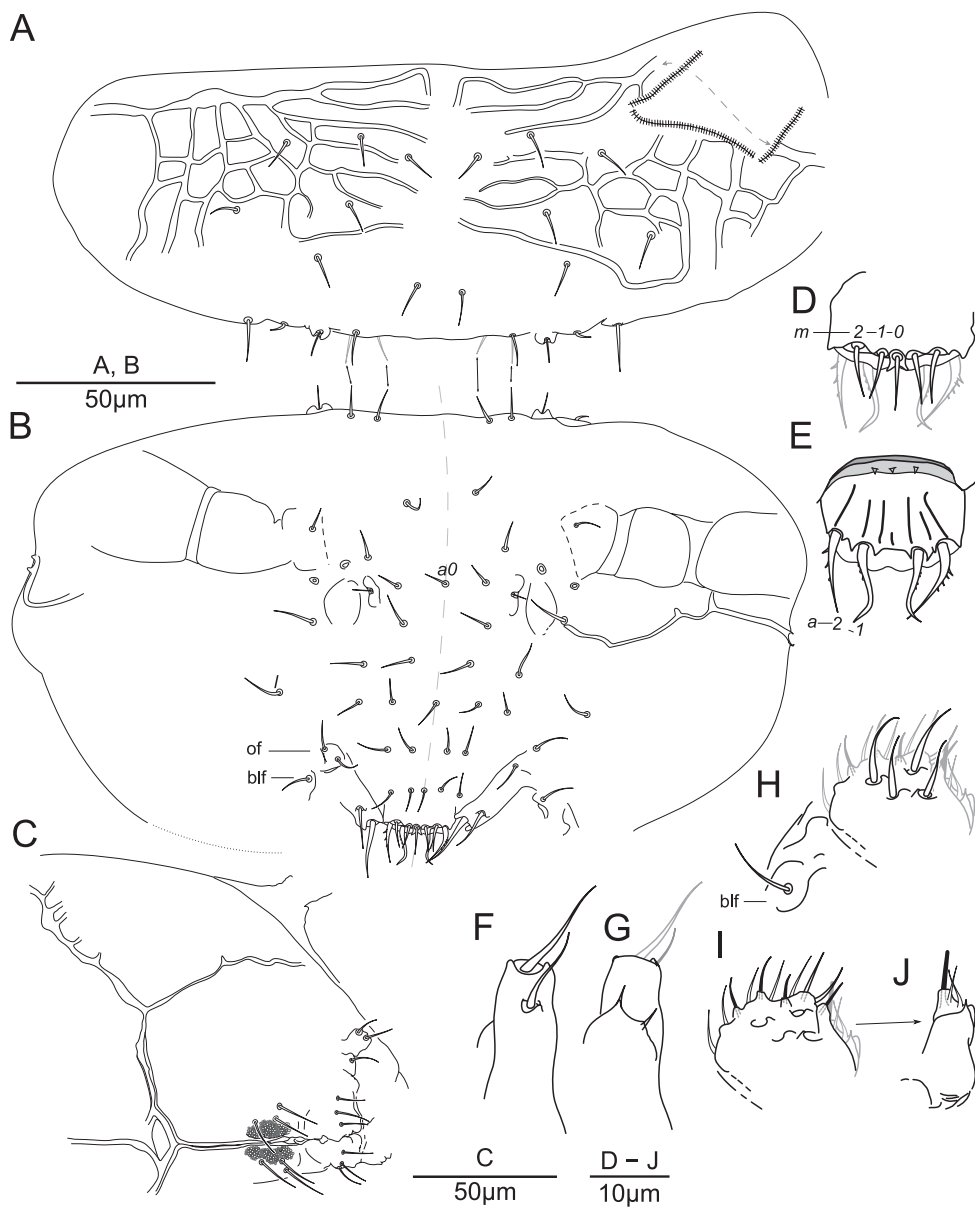


Figure 8. *Megalothorax sanguineus* sp. n. Chaetotaxy of head **A** dorso-posterior side **B** dorso-anterior side **C** ventral side; anterior process of labrum **D** posterior side **E** anterior side; maxillary outer lobe **F** dorsal side **G** ventral side; labium **H** focused on ventral chaetae and basolateral field **I** focused on distal chaetae **J** hypostomal papilla. Legend: blf = basolateral field of labium, of = oral fold.

including 4 + 4 macrochaetae (*a6*, *a8*, *a9*, *p7*), 4 + 4 mesochaetae (*a5*, *p2*, *p3*, *p4*) and 2 + 2 microchaetae (*a1*, *a3*) (Fig. 9). Chaeta *p4* moved posteriorly from *wrc2* (Figs 9, 16B). Chaeta *a6* slightly bigger than *a5* (Fig. 9).

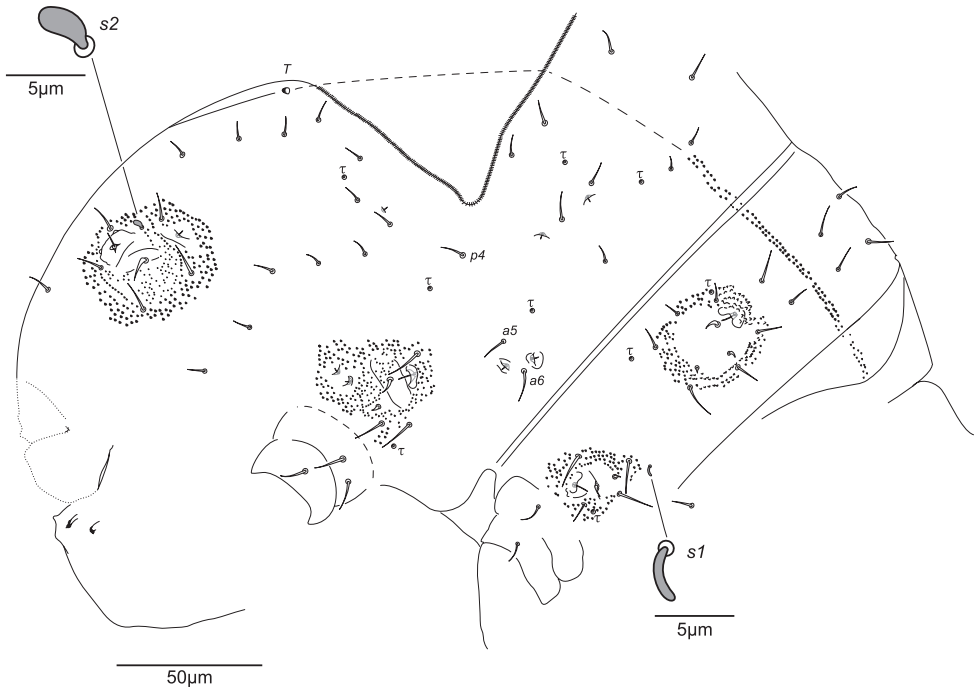


Figure 9. *Megalothorax sanguineus* sp. n. Chaetotaxy of trunk, lateral side. Representation of the granulation limited to the sensory fields area.

Legs chaetotaxy. Legs with ordinary chaetae of variable size as in Fig. 11A–C and summarized in Table 2. Subcoxa 1 I with a mesochaeta, coxa I with a microchaeta. Subcoxa 1, 2 II each with a mesochaeta, coxa II with a macrochaeta. Subcoxa 1, 2 III and coxa III with respectively 2, 1, 1 macrochaetae. Anterior and posterior microchaetae present on each pretarsus.

Claws. Ratio unguis length : pretarsus width on leg I–III respectively as 3.2, 2, 1.87, claw I with rather slender morphology, claw III bulkier than claw I and II. Claw I with longer unguis and each claw with subequal length of unguiculus, ratio unguiculus : unguis for claw I, II, III as ~ 0.43, 0.5, 0.5 (Fig. 11D–I). Unguis basal and posterior auxiliary lamellae (*la*, *lp* and *Bp*) well developed, anterior crest (*Ba*) clear on claw II and III (Fig. 11F, H), hardly perceptible on claw I. Each unguiculus with a posterior crest *Cp*, anterior crest *Ca* short and in basal position on each claw, joining the internal border of the unguiculus lamella on claw III, basal tubercle with posterior lobe not or weakly protruding (Fig. 11D–J). Ratio unguis length : tibiotarsus length on leg I–III respectively as 1.85, 1.43, 1.47.

Abd. I–V terga chaetotaxy. With a total of 20 + 20 chaetae, 1 + 1 τ -chaetae, 2 + 2 free wax-rod generating crypts (*wrc7*, 8), 1 + 1 *s*-chaetae *s2* shaped as a bean (Figs 9, 16B). Chaetae including 15 + 15 chaetae rather small and thin (5–7 μ m), 5 + 5 stronger chaetae (macrochaetae $\epsilon 2$, $\epsilon 3$ = 11–12 μ m, mesochaetae $\zeta 2$, $\eta 2$, $\eta 3$ = 9–10 μ m). Chaeta *a3* close to *wrc7*, both clearly anterior to $\beta 3$ and $\beta 4$ (Figs 9, 16B).

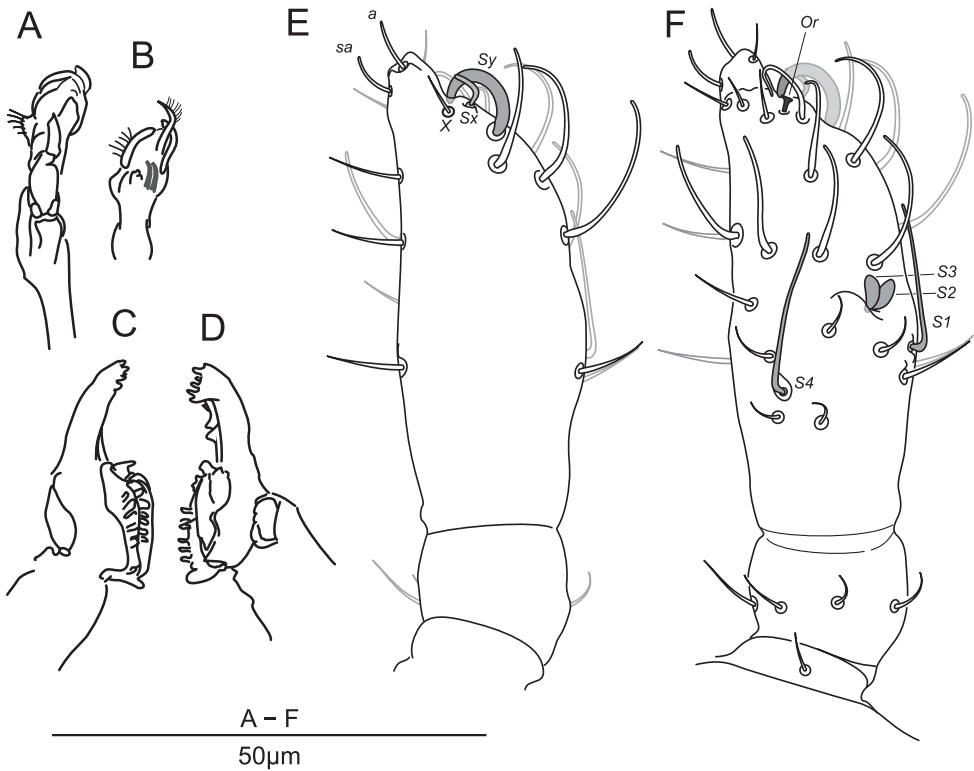


Figure 10. *Megalothorax sanguineus* sp. n. Maxilla **A** dorsal side **B** ventral side; mandibula **C** left mandibula **D** right mandibula; chaetotaxy of antenna **E** ventral side **F** dorsal side.

Abd. VI and genital chaetotaxy. Abd. VI: with nine dorsal chaetae (6–7 μm) (Fig. 12A); each anal valve with microchaeta *av* and several granular crests (four paired plus one axial on dorsal valve, four on each ventral valve); with 7 + 7 ventral chaetae (4–8 μm ; Fig. 12A), male with 1 + 1 additional ventral cylindrical swollen chaetae *sm* (Fig. 12E). Genital plate: female with 2 + 2 microchaetae; male with 9 + 9 microchaetae (Fig. 12E, F).

Abd. IV sternum and furca. Abd. IV sternum with 2 + 2 neosminthuroid chaetae and 2 + 2 posterior mesochaetae (Fig. 12A). Manubrium with 2 + 2 posterior chaetae (Fig. 12A). Proximal subsegment of dens with one posterior chaeta (Fig. 12A); distal subsegment posteriorly with two basal spines, one median chaeta and two apical spines, anteriorly with three apical spines, basal spines without elongated apex, apical spines with elongated apex (longer in posterior spines) (Fig. 12A). Mucro lamellae well developed conferring a slight elliptical shape to the mucro in lateral and dorsal view, with a gradual narrowing in the apical 1/5 (Fig. 12A). Lamellae edges smooth. Ratio $dp : dd : \text{mucro} = 0.69 : 1 : 75$; ratio mucro width : mucro length ~ 0.23 .

Tenaculum and ventral tube. Tenaculum with 3 + 3 hook-like teeth (Fig. 12B–D). Ventral tube with two apical pairs of mesochaetae (Fig. 12B).

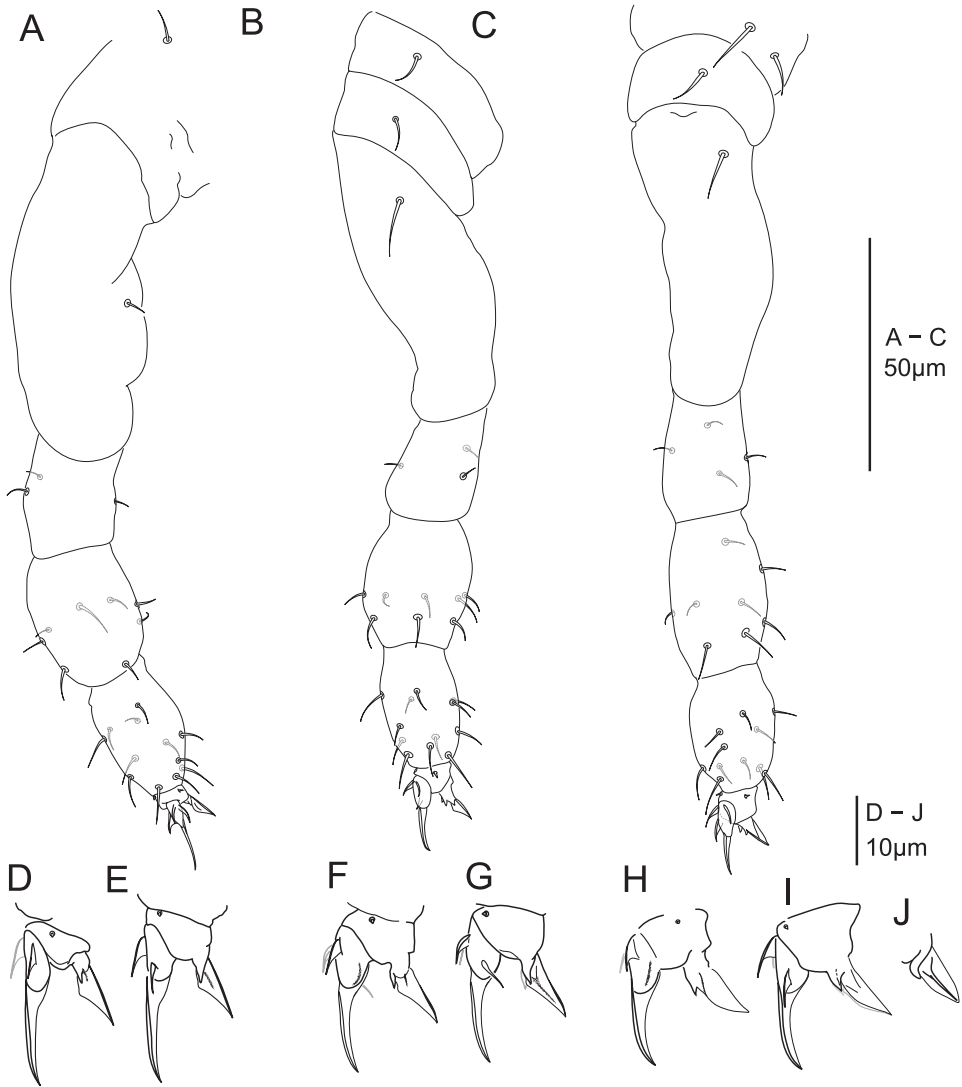


Figure 11. *Megalothorax sanguineus* sp. n. Chaetotaxy of legs **A** leg I **B** leg II **C** leg III; claws **D** claw I anterior side **E** posterior side **F** claw II anterior side **G** posterior side **H** claw III anterior side **I** claw III posterior side **J** unguiculus III interno-posterior side.

Affinities. *Megalothorax sanguineus* sp. n. has the characteristics of the *minus* group species (Schneider and D’Haese 2013; Papáč and Kováč 2013). Within this group, it differs clearly from *M. sanctistephani* and *M. potapovi* sp. n. by the absence of a median integumentary structure on forehead. *M. sanguineus* is similar to *M. minus* in terms of chaetotactic pattern on antenna, legs, and trunk terga (without differences in absence/presence of chaetae). It differs from *M. minus* by the shape of the inner

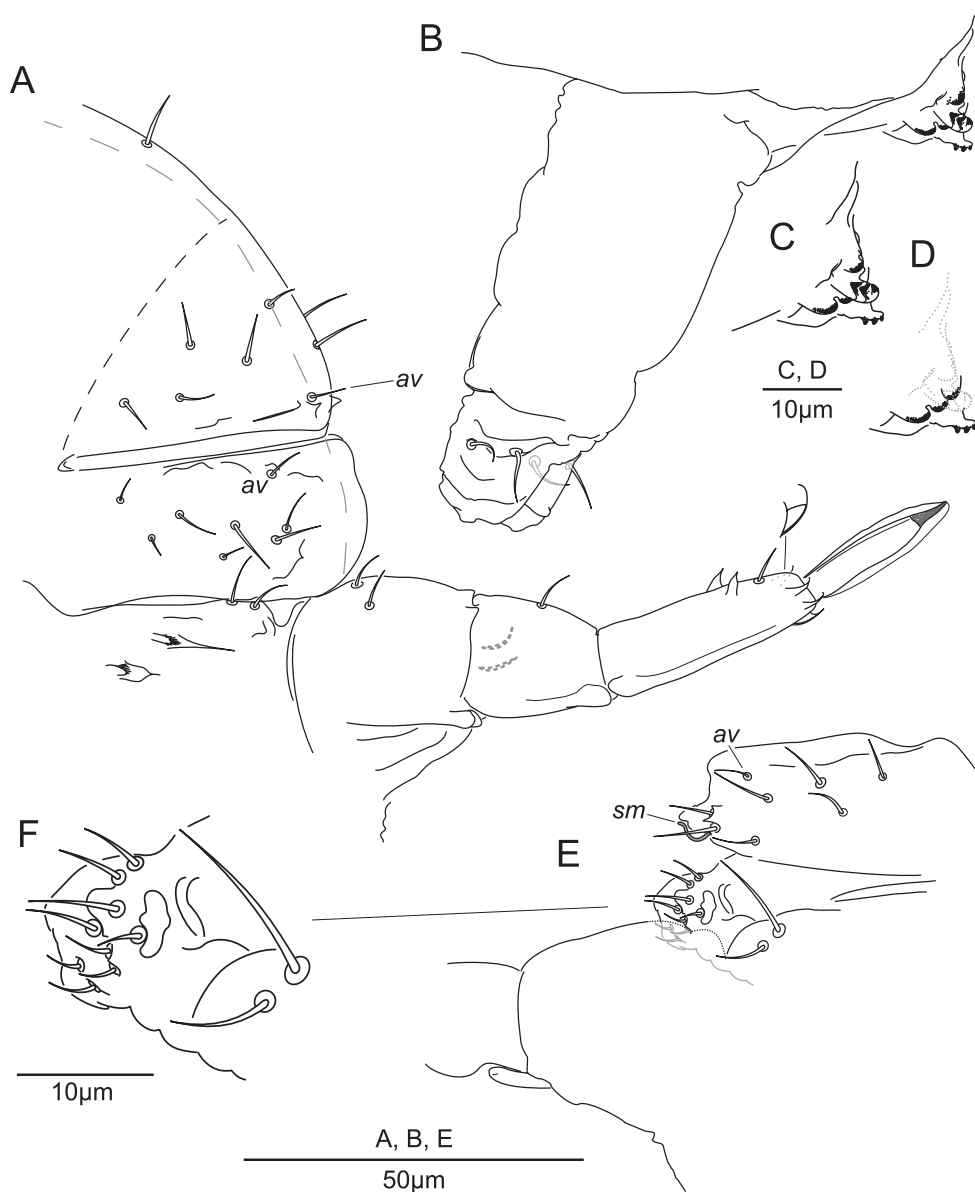


Figure 12. *Megalothorax sanguineus* sp. n. **A** Chaetotaxy of Abd. IV and Abd. VI sterna with furca, female **B** ventral tube and tenaculum, lateral side **C** focus on tenaculum **D** focus on tenaculum axial lobes **E** chaetotaxy of Abd. IV–VI sterna, male **F** focus on genital plate and Abd. IV posterior chaetae, male.

chaetae of *sf*3–7 (some T-shaped in *M. minimus*, always flam-shaped in *M. sanguineus* sp. n.), the morphology of chaetae in the dorsal posterior area of head, the integumentary pattern, the morphology of labral chaetae, claw and mucro. The deep red pigmentation of *M. sanguineus* sp. n. might be similar to that of *M. rubidus* (Salmon, 1946),

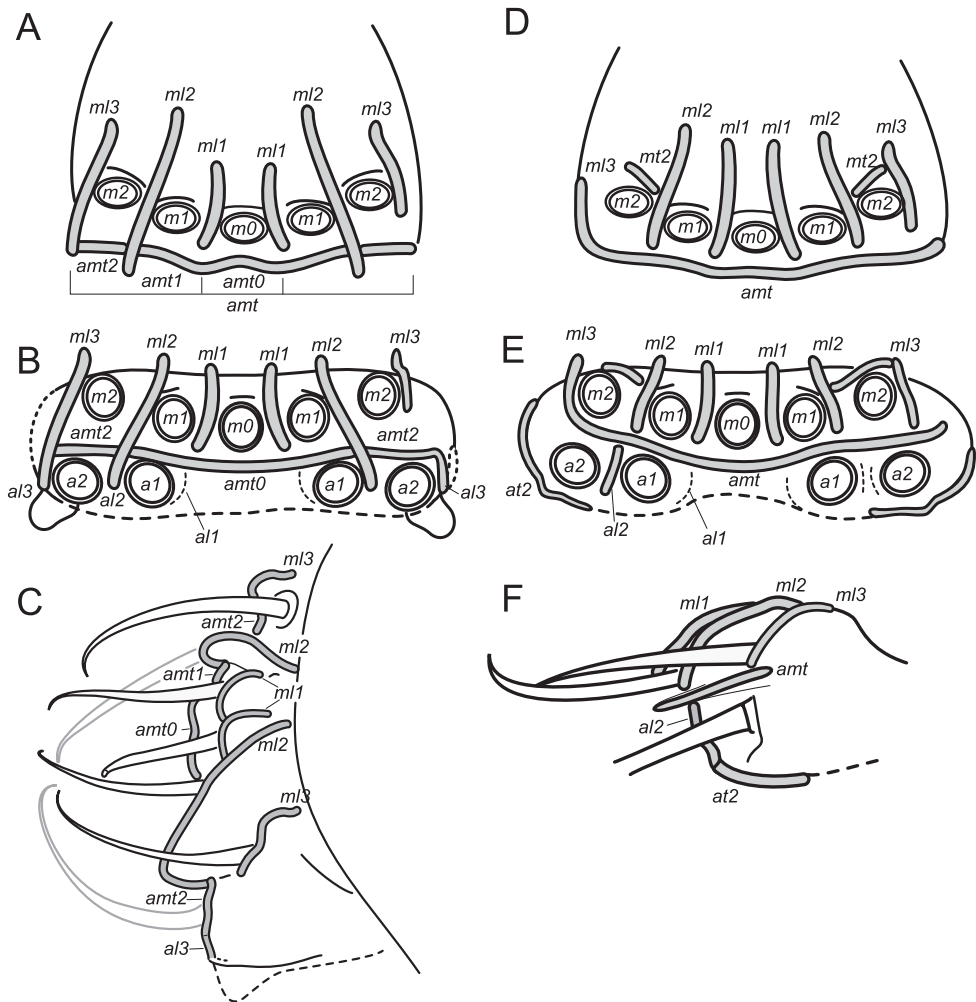
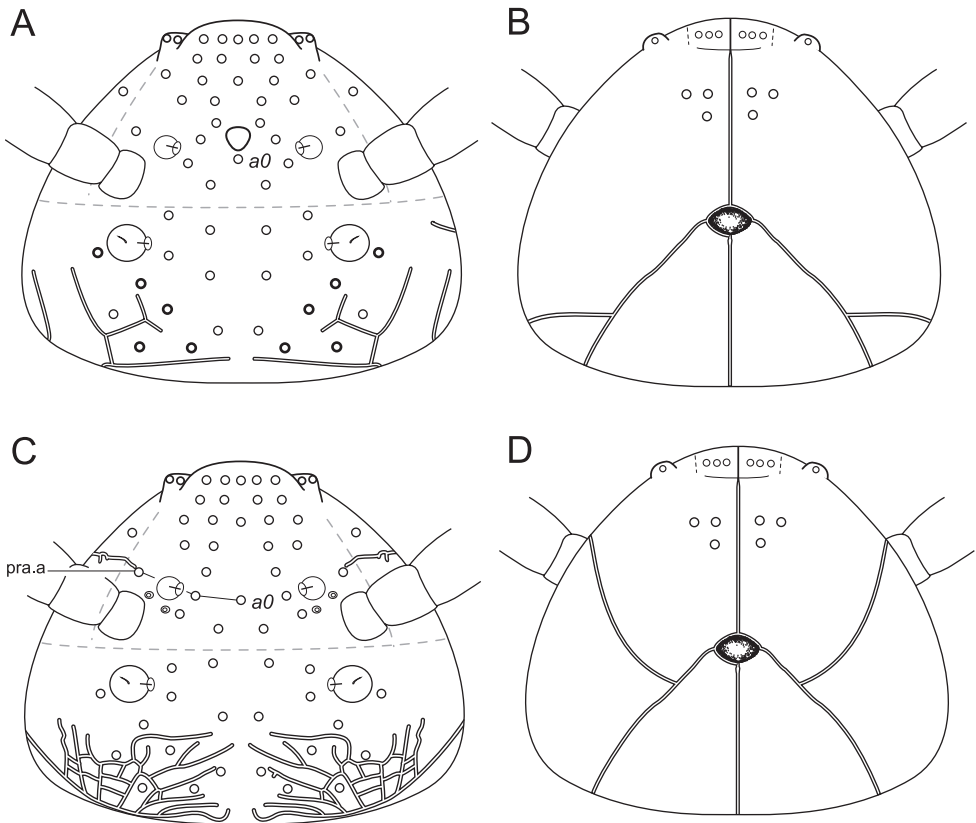


Figure 13. Diagram of the labrum anterior process. *Megalothorax potapovi* sp. n. **A** dorsal view **B** frontal view **C** dorso-lateral view; *Megalothorax minimus* **D** dorsal view **E** frontal view **F** lateral view. In gray integumentary crests, dotted lines indicate areas not clearly observed.

but the two species differ in dental spines morphology (the four posterior spines with elongated apex in *M. rubidus*). *Megalothorax sanguineus* sp. n. shares morphological trends with *M. aquaticus* and *M. granulatus* Schneider & D’Haese, 2013: enlargement of mucro lamellae, developed network of integumentary channels on head and elongation of dental spines apex (Stach 1957, Schneider and D’Haese 2013 and pers. obs.). In term of unguis I length : pretarsus I width ratio, it is surpassed by *M. aquaticus* (epigeic hygrophilous mountains) and *M. draco* Papáč & Kováč, 2013 (trogllobiontic), comparable to *M. massoudi* Deharveng, 1978 (trogllobiontic) and *M. nigropunctatus* Schneider and D’Haese, 2013 (epigeic, deadwood dwelling); it surpasses slightly *M.*

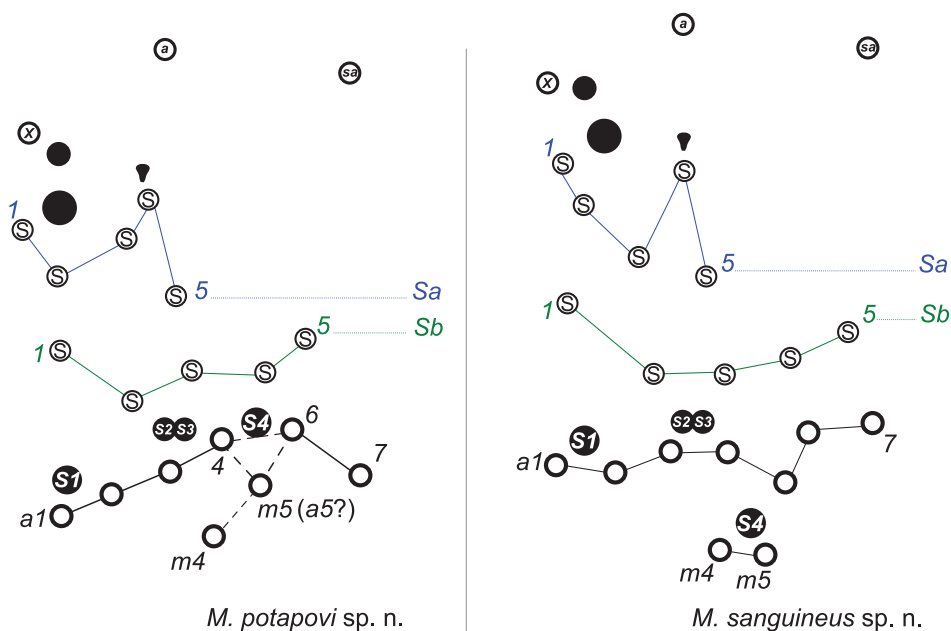


○ chaeta; ● lanceolate chaeta; ⊙ pseudopore like element; ⊖ wax rod secretory element; / integumentary channel

Figure 14. Diagram of the chaetotaxy and integumentary channels network of the head. *Megalothorax potapovi* sp. n. **A** dorsal side (pseudopores not represented) **B** ventral side; *Megalothorax sanguineus* sp. n. **C** dorsal side **D** ventral side.

granulosus (epigeic hygrophilous) and more significantly *M. tuberculatus*, *M. hipmani* Papáč and Kováč 2013 and *M. carpaticus* (troglobiontic). In term of absolute size of the unguis I, it is similar to the two later species, surpasses *M. granulosus* and is clearly surpassed by *M. nigropunctatus*, *M. tuberculatus* and *M. massoudi* sp. n.

Ecology and distribution. The species is known from humid micro-habitats in Pyrenees, though it was absent from the Bernadouze peat-bog itself. Other *Megalothorax* found in moist mosses in mountains are *M. aquaticus* (1750m in High Tatras Mountains) (Stach 1957) and *M. minimus* (up to 1500m in Pyrenees Mountains) (pers. obs.). The combination of morphological features shared with *Megalothorax aquaticus* seems to be related to hygrophilous ecology. In that regard, *M. sanguineus* sp. n. would remain less morphologically specialized than *M. aquaticus* but more than *M. minimus*. “Red” *Megalothorax* are present across the whole Pyrenean range (pers. obs.), and might be *M. sanguineus* sp. n., but identification has only been confirmed so far for Ariège and Pyrénées-Atlantique specimens.



Ant. III: ○ chaeta; **S1** **S2** **S3** **S4** **S5** S-chaetae S1–S5 of sensory organ.

Ant. IV: ⊙ S-chaeta S, ● Sy, ● Sx, ▼ subapical organite; ⊙ ⊙ apical and subapical sensory rod; ⊗ chaeta X.

Figure 15. Diagram of antennal III and IV chaetotaxy. *Megalothorax potapovi* sp. n., *Megalothorax sanguineus* sp. n. Alternative hypothesis of homology is indicated in parenthesis.

Etymology. *Megalothorax sanguineus* sp. n. is named after the deep red pigmentation of the species.

DNA barcode. A 658bp fragment of the COI gene was amplified and sequenced from five specimens from the Saint-Lary locality. Specimens were unfortunately lost, sequences identification is based on consistency between: the peculiar pigmentation of the species observed on specimens before destruction, the genetic similarity of the five specimens and the morphological identification of four other specimens with the same pigmentation from the same sample. The sequences are deposited into the GenBank database under accession numbers JN298074–JN298078.

Four sequences are identical (JN298074–JN298077, provided below), base composition is A = 29.6%, C = 17.5%, G = 15.8%, T = 37.1% (A + T = 66.7%). The fifth sequence (JN298078) differs in 11 sites (= 98.3% pairwise identity), base composition is A = 29.5%, C = 17.6%, G = 15.7%, T = 37.2% (A + T = 66.7%).

5'–AACCTTATATTTAATTTTTGGAGTATGATCTGCTATAGTTG–
GAACAGCATTTAGAGTTTTAATTCGGTTAGAATTAGGACACCCAG–
GAAGCTTAATTGGAACGATCAAATCTATAATGTAATAGTTACGGC–
CCATGCATTTGTAATAATTTTTTTATAGTAATACCAATAATAATTG–
GAGGCTTTGGTAATTGATTAGTACCTTTAATAATTGGAGCACCTGA–
TATAGCATTTCCCTCGAATAAACAAATTTAAGATTCTGACTTTTACCAC–

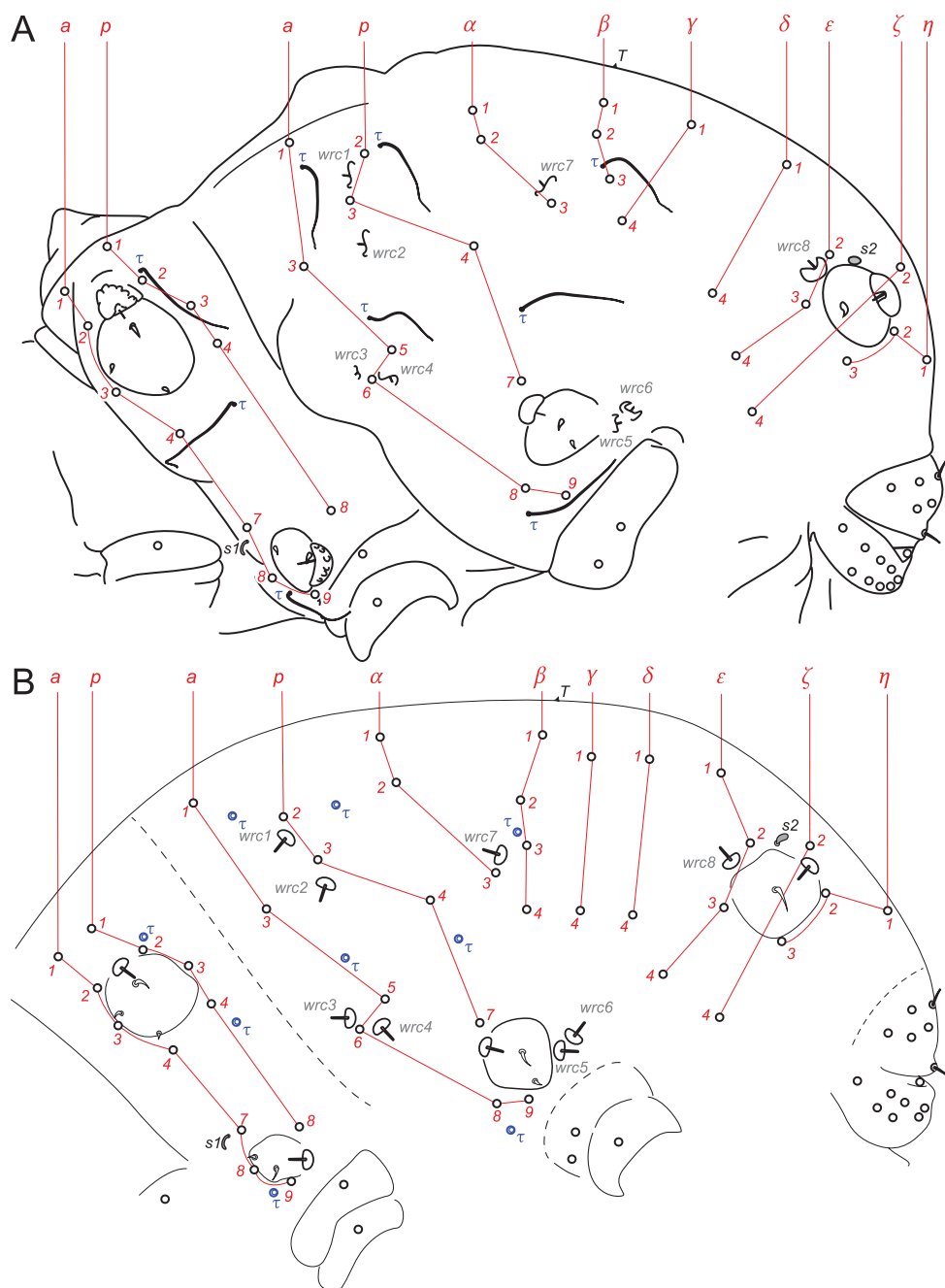


Figure 16. Diagram of the chaetotaxy of the trunk. **A** *Megalothorax potapovi* sp. n. **B** *Megalothorax sanguineus* sp. n.

Table 4. GenBank accession number.

Specimen	MOTU name	Barcode GenBank accession number
<i>Megalothorax potapovi</i> 10770C01 RU120	<i>Megalothorax potapovi</i> sp. n.	KR736064
<i>Megalothorax potapovi</i> 10770C02 RU120	<i>Megalothorax potapovi</i> sp. n.	KR736063
<i>Megalothorax potapovi</i> 00620C03 RU120	<i>Megalothorax potapovi</i> sp. n.	KR736067
<i>Megalothorax potapovi</i> 00620C04 RU120	<i>Megalothorax potapovi</i> sp. n.	KR736070
<i>Megalothorax potapovi</i> 00620C05 RU120	<i>Megalothorax potapovi</i> sp. n.	KR736069
<i>Megalothorax potapovi</i> 00620C06 RU120	<i>Megalothorax potapovi</i> sp. n.	KR736068
<i>Megalothorax potapovi</i> 00620C07 RU120	<i>Megalothorax potapovi</i> sp. n.	KR736065
<i>Megalothorax potapovi</i> 00620C08 RU120	<i>Megalothorax potapovi</i> sp. n.	KR736066
<i>Megalothorax sanguineus</i> 6139D02 09761	<i>Megalothorax sanguineus</i> sp. n.	JN298074
<i>Megalothorax sanguineus</i> 6139D03 09761	<i>Megalothorax sanguineus</i> sp. n.	JN298075
<i>Megalothorax sanguineus</i> 6139D04 09761	<i>Megalothorax sanguineus</i> sp. n.	JN298076
<i>Megalothorax sanguineus</i> 6139D05 09761	<i>Megalothorax sanguineus</i> sp. n.	JN298077
<i>Megalothorax sanguineus</i> 6139D06 09761	<i>Megalothorax sanguineus</i> sp. n.	JN298078
<i>Megalothorax</i> cf. <i>interruptus</i> GUF 1	<i>Megalothorax</i> cf. <i>interruptus</i> L1	JN970929
<i>Megalothorax</i> cf. <i>interruptus</i> GUF 2	<i>Megalothorax</i> cf. <i>interruptus</i> L1	JN970928
<i>Megalothorax</i> cf. <i>interruptus</i> GUF 3	<i>Megalothorax</i> cf. <i>interruptus</i> L2	JN970910
<i>Megalothorax granulosus</i> cs110_CHL021	<i>Megalothorax granulosus</i>	KC900204
<i>Megalothorax minimus</i> BEL 1	<i>Megalothorax minimus</i>	JN970925
<i>Megalothorax minimus</i> cs70_Be001	<i>Megalothorax minimus</i>	KC900191
<i>Megalothorax minimus</i> cs71_Be001	<i>Megalothorax minimus</i>	KC900192
<i>Megalothorax minimus</i> cs93_Fr38	<i>Megalothorax minimus</i>	KC900195
<i>Megalothorax nigropunctatus</i> cd345c	<i>Megalothorax nigropunctatus</i>	KC900196
<i>Megalothorax nigropunctatus</i> cs104_CHL102	<i>Megalothorax nigropunctatus</i>	KC900197
<i>Megalothorax nigropunctatus</i> cs118_CHL033	<i>Megalothorax nigropunctatus</i>	KC900198
<i>Megalothorax nigropunctatus</i> cs119_CHL205	<i>Megalothorax nigropunctatus</i>	KC900199
<i>Megalothorax perspicillum</i> cs121_Fr114	<i>Megalothorax perspicillum</i>	KC900200
<i>Megalothorax perspicillum</i> cs122_Fr114	<i>Megalothorax perspicillum</i>	KC900201
<i>Megalothorax perspicillum</i> cs123_Fr114	<i>Megalothorax perspicillum</i>	KC900202
<i>Megalothorax perspicillum</i> cs124_Fr114	<i>Megalothorax perspicillum</i>	KC900203
<i>Megalothorax</i> sp. ARG 1	<i>Megalothorax</i> sp2	JN970916
<i>Megalothorax</i> sp. ARG 2	<i>Megalothorax</i> sp1	JN970926
<i>Megalothorax</i> sp. CHL 1	<i>Megalothorax</i> sp1	JN970927
<i>Megalothorax</i> sp. FRA 8	<i>Megalothorax</i> sp4	JN970913
<i>Megalothorax</i> sp. USA 1	<i>Megalothorax</i> sp3	JN970909
<i>Megalothorax svalbardensis</i> cs40_sva19	<i>Megalothorax svalbardensis</i>	KC900205
<i>Megalothorax willemi</i> ARG 3	<i>Megalothorax willemi</i> L6	JN970918
<i>Megalothorax willemi</i> ARG 4	<i>Megalothorax willemi</i> L6	JN970919
<i>Megalothorax willemi</i> cs91_Be005	<i>Megalothorax willemi</i> L6	KC900193

Specimen	MOTU name	Barcode GenBank accession number
<i>Megalothorax willemi</i> cs92_Be005	<i>Megalothorax willemi</i> L4	KC900194
<i>Megalothorax willemi</i> FRA 1	<i>Megalothorax willemi</i> L5	JN970912
<i>Megalothorax willemi</i> FRA 2	<i>Megalothorax willemi</i> L6	JN970917
<i>Megalothorax willemi</i> FRA 3	<i>Megalothorax willemi</i> L1	JN970911
<i>Megalothorax willemi</i> FRA 4	<i>Megalothorax willemi</i> L3	JN970920
<i>Megalothorax willemi</i> FRA 5	<i>Megalothorax willemi</i> L3	JN970921
<i>Megalothorax willemi</i> FRA 6	<i>Megalothorax willemi</i> L3	JN970922
<i>Megalothorax willemi</i> FRA 7	<i>Megalothorax willemi</i> L4	JN970915
<i>Megalothorax willemi</i> FRA 9	<i>Megalothorax willemi</i> L2	JN970924
<i>Megalothorax willemi</i> FRA 10	<i>Megalothorax willemi</i> L2	JN970923
<i>Megalothorax willemi</i> FRA 11	<i>Megalothorax willemi</i> L7	JN970914

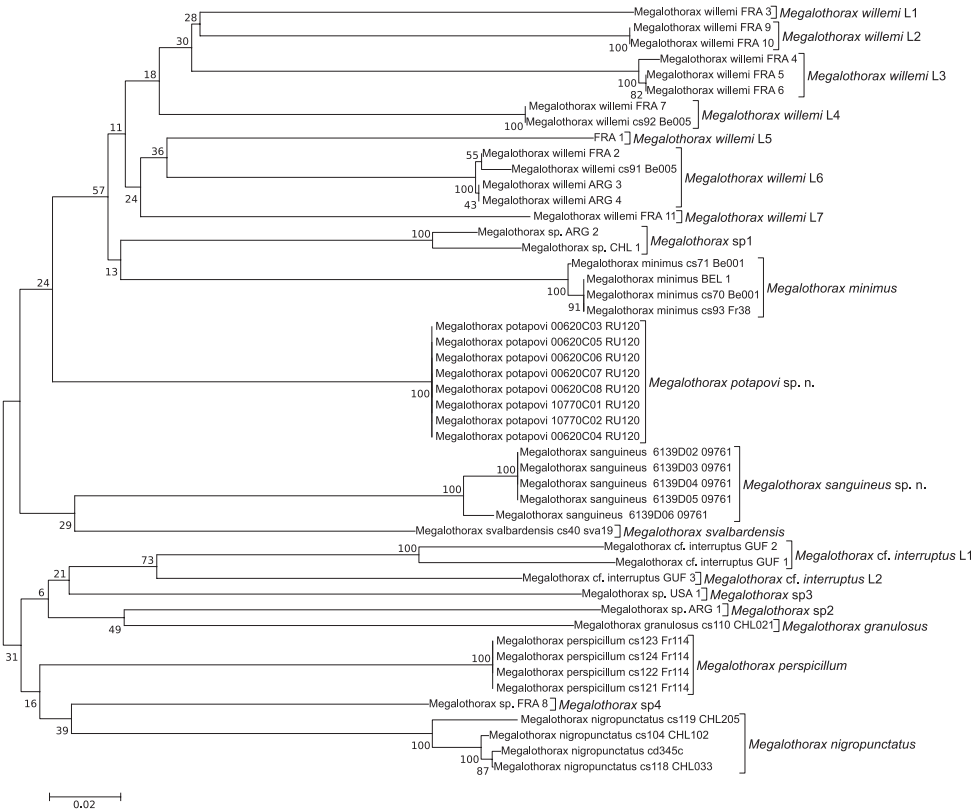


Figure 17. Tree inferred from the COI barcode by Neighbor-Joining with Kimura-2 parameter model. Robustness supports (bootstrap) are reported next to the nodes.

CATCTTTAATCTTATTACTATCCAGAGGGTTAGTTGAAACTGGTGCTG-
GCACAGGATGAACAGTATATCCCCCTCTATCGTCTAATATTTCTCATA-
GAGGAGCTTCTGTAGATTAACTATTCTTAGACTTCATTTAGCTGG-
GATATCTTCTATTCTTGGGGCAATTAATTTTATTACAACCTATTCT-
TAATATACGAATACCAGGAATAACATGAGACCAAACCTTCTTTATTT-
GTATGATCAGTTTTTATTACCTCAATTTTATTACTCCTCTCGCTTC-
CAGTGCTTGCTGGAGCAATTACTATACTTTTAACTGACCGTAACCT-
GAATACCTCATTTTTTGGATCCTGCGGGAGGAGGAGACCCTATTCTA-
TATCAACATTTATTT–3’.

DNA barcoding results

Fig. 17, Table 3.

Twenty MOTUs were delineated using a conservative 19.5% threshold based on the higher bound of the barcode gap (not shown). Over the seven species for which several specimens were sequenced, five were represented by a single MOTU (*M. nigropunctatus*, *M. perspicillum* Schneider & D’Haese, 2013, *M. minimus*, *M. potapovi* sp. n., *M. sanguineus* sp. n.) and two exhibited several discrete MOTUs each (*M. willemi*—7 MOTUs, *Megalothorax* cf. *interruptus*—2 MOTUs). Deep genetic divergences showed among the MOTUs (Fig. 17). The mean genetic divergence among the MOTUs was 28.27% (range: 19.36%–37.99%). The mean intra-MOTU divergence was 0.95% (range: 0%–10.70%). The mean observed divergences between *M. potapovi* sp. n., *M. sanguineus* sp. n. and the other MOTUs were respectively 26.09% (range: 19.36%–31.92%) and 28.52% (range: 22.00%–34.84%). These ranges of genetic divergences are comparable to those observed among *Megalothorax* MOTUs included in the dataset as well as with the interspecific variation found among MOTUs corresponding to monophyletic identified species (28.08% ; range: 19.36%–36.47%). This supports further the validity of the specific status for the two new species.

Discussion

DNA barcoding

The two new species *M. potapovi* sp. n., *M. sanguineus* sp. n. are both supported by differences in morphological and molecular characters. The sequencing of COI for a paratype for *M. potapovi* sp. n. is critical as it will prevent ambiguities if a case of cryptic diversity is discovered in this species (Porco et al. 2012). Indeed, within the genus, the striking example of *M. willemi* exhibiting a high molecular diversity in parallel with morphological stability calls for a dedicated investigation (Schneider and D’Haese 2013). A similar yet less documented diversity is observed in a new species near *Megalothorax interruptus* (Schneider et al. in prep.).

Morphology

Labrum. Schneider and D’Haese (2013) pointed out the potential of the labrum morphology for taxonomy in reporting the differences between *M. minimus* (*minimus* group) and *M. nigropunctatus* (*incertus* group). Here some differences are described between two species of the *minimus* group: *M. potapovi* sp. n. (Fig. 13A–C) and *M. minimus* (Fig. 13D–F), and introduce a nomenclature for the integumentary crests of the anterior process of the labrum. This structure remains unpractical to describe comprehensively: in light microscopy, the integumentary crests can be distinguished but their precise development and connections to each other are hard to assess. SEM allowed the description partially and also the recognition of asymmetry, but the method suffers from several flaws: (i) lack of depth, several shots from different angles would be required; (ii) part of the labrum is generally shadowed; (iii) asymmetry being evidenced, several specimens should be observed to assess intra-specific variation. Those requirements prevent use for regular taxonomic due to the cost and availability of SEM equipment, as well as the need for a significant number of specimens.

Integument. The pairs of pseudopore-like elements at the base of antenna were never reported in the *Megalothorax* genus but seem to be common features of the genus. We observed them clearly on *M. sanguineus* sp. n. and *M. carpaticus*, they are visible but faint in the following *Megalothorax* species: *potapovi* sp. n., *minimus*, *granulosus*, *nigropunctatus*, *willemi*, *svalbardensis* and also in French specimens of *M. sanctistephani*. They were observed in SEM in *M. perspicillum* and *M. aquaticus*, where the dorsal one consists of a ring of primary grain and a small integumentary duct and the lateral one of a simple ring of primary grain. At the species level, those characters do not yield evident systematics value. They could not be observed in *Neelus murinus* and *Neelides folsomi* but the presence of dermastrons could blur the observation of the integument. In the state of knowledge, it is a putative apomorphy of the genus *Megalothorax*.

τ -chaetae. Schneider and D’Haese (2013) used the position of the lateral τ -chaetae guarding *sf3* as a descriptor, separating *M. perspicillum* from *M. minimus*, *M. nigropunctatus*, *M. svalbardensis* and *M. willemi*. We now describe more precisely the position of the two τ -chaetae guarding *sf3*. Position of the most dorsal τ -chaeta: (i) between *p1* and *p2* and close to *p2* (*M. minimus*, *M. svalbardensis*, *M. willemi*, *M. tatrensis* and the two new species); (ii) between *p1* and *p2* and equidistant to them (*M. perspicillum*, *M. carpaticus*); (iii) between *p1* and *p2* and close to *p1* (*M. nigropunctatus*); (iv) between *p2* and *p3* and close to *p2* (*M. granulosus*).

Position of the most lateral τ -chaeta: (i) between *p2* and *p3* (*M. perspicillum*), (ii) in lateral position and close to *p4* with 2 or less granules between the chaetae (*M. minimus*, *M. svalbardensis*, *M. carpaticus*, *M. granulosus*), (iii) in lateral position and more or less far from *p4* with 5 or more granules between the chaetae (the two new species and *M. nigropunctatus*). *M. draco*, *M. tatrensis* and *M. hipmani* were also observed but the τ -chaetae could not be spotted at the exception of the most dorsal τ -chaeta in *M. tatrensis*.

Antenna. The homology of the chaeta directly below *S4* (*m5*) on Ant. III of *M. potapovi* is ambiguous; an alternative hypothesis is provided in Fig. 15.

Claws. The apparent elongation of the claws in *M. sanguineus* sp. n. called for a comparison with the other species of *Megalothorax*. The ratio of unguis I length : tibiotarsus I width was used by Papáč and Kováč (2013) as an indicator of troglobiontic adaptation. In practice, the tibiotarsus width is not exactly constant along its whole length and is frequently swollen in slide preparations (with dilatation of the integument). We instead estimated the ratio unguis I length : pretarsus I width and the ratio unguis I length : tibiotarsus I length.

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A new, widely distributed species of the *Exocelina ekari*-group from West Papua (Coleoptera, Dytiscidae, Copelatinae)

Helena Shaverdo¹, Rawati Panjaitan², Michael Balke³

1 Naturhistorisches Museum, Burgring 7, A-1010 Vienna, Austria **2** Department of Biology, Faculty of Sciences and Mathematics, State University of Papua (UNIPA), Jalan Gunung Salju Amban, Manokwari 98314, West Papua, Indonesia **3** Zoologische Staatssammlung München, Münchhausenstraße 21, D-81247 Munich, Germany and GeoBioCenter, Ludwig-Maximilians-University, Munich, Germany

Corresponding author: Helena Shaverdo (shaverdo@mail.ru; helena.shaverdo@nhm-wien.ac.at)

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Abstract

Exocelina manokwariensis sp. n. from West Papua is placed into the *E. ekari*-group based on the structure of its male genitalia. The new species is described, including its three subspecies, from the mainland of West Papua, Waigeo Island, Batanta and Salawati Islands, and Bomberai peninsula. An identification key to the subspecies as well as data on species distribution are provided.

Keywords

Coleoptera, Dytiscidae, *Exocelina*, new species, new subspecies, molecular phylogenetics, West Papua

Introduction

Of the 88 species of the genus *Exocelina* BROWN, 1886 described from New Guinea, only eight species are known from West Papua, and all of them belong to the *E. ekari*-group (Balke 1998, 1999, Shaverdo and Balke 2014, Shaverdo et al. 2005, 2012, 2013, 2014). Herein, a new member of that group is described, which is widely distributed across the Bird's Head of West Papua, accounting for the geographical structure observed in the morphological characters studied by erecting four subspecies.

Material and methods

The present work is based on the material from the following collections:

MZB	Museum Zoologicum Bogoriense, Cibinong, Indonesia
NHMW	Naturhistorisches Museum Wien, Vienna, Austria
ZSM	Zoologische Staatssammlung München, Munich, Germany

All specimen data are quoted as they appear on the labels attached to the specimens. Label text is cited using quotation marks. Comments in square brackets are ours. All types of the herein described specimens are provided with red labels. Female specimens, identification of which is difficult or sometimes impossible, were included in the type series only when they were collected with males of respective species and did not show external morphological differences from them. If two or more morphologically similar species were collected together (i.e., males found together), their females were not included in the type series but were instead mentioned under additional material. Species descriptions are based on the whole type series.

Measurements were taken with a Wild M10 stereomicroscope. The following abbreviations were used: TL (total body length), TL-H (total body length without head), MW (maximum body width), and hw (handwritten). Number of the ventral setae of the male protarsomere 5 is given only for one specimen of each species, which was mounted on a glass slide (see below) for drawing. This character was found to be of limited practical use for species identification since it is possible to make a general statement on the setation pattern (short/long, dense/sparse) but not to count them with certainty at the magnification of normal dissecting microscopes. The potential phylogenetic information content of this character will be studied in a further work.

Drawings were made with the aid of a camera lucida attached to a Leica DM 2500 microscope. For detailed study and drawing, antennae, protarsi, and genitalia were removed and mounted on glass slides with DMHF (dimethyl hydantoin formaldehyde) as temporary preparations. The drawings were scanned and edited, using the software Adobe Illustrator CS5.1.

The terminology to denote the orientation of the genitalia (ventral for median lobe and dorsal and external for paramere) follows Miller and Nilsson (2003). The terminology on the structure of the prosternum follows Larson et al. (2000). Administrative divisions of Indonesia follow information from Wikipedia (2015).

Systematics

Exocelina manokwariensis sp. n.

<http://zoobank.org/77D1CC24-24BC-4BE1-AC1F-CBAEA851B583>

Figs 1, 2

Type locality. Indonesia: West Papua Province: Manokwari Regency, Road Manokwari – Mokwam, 01°00.60'S; 133°53.92'E.

Type material. *Holotype*: male “Indonesia: Papua, Road Manokwari - Mokwam, 320m, 25./27.i.1990, 01.00.596S 133.53.921E, Balke (BH 01)” (MZB). *Paratypes*: **Manokwari**: 12 males, 8 females with the same label as the holotype, two males additionally with green labels “M.Balke 1267”, “M.Balke 1282” (MZB, NHMW, ZSM). 6 males, 5 females “Indonesia: Papua, Ransiki - Anggi, 1160m, 30.i.1990, 01.25.536S 134.02.456E, Balke (BH 03)”, one male additionally with a green label “M.Balke 1270” (NHMW, ZSM). 2 males, 5 females “IRIAN JAYA, Manokwari Rasiki, Mayuby – Benyas ca. 300–400m, 27.-28.IX.1990, leg. A. Riedel” (NHMW, ZSM). 121 males, 94 females “Indonesia: Papua Barat, Manokwari, Maripi, creek white pebbles, 135m, -0.907576 133.9214718 (BH039)” (MZB, NHMW, ZSM). 2 males “IN: West Papua: Manokwari Reg., on road Manokwari-Kebar, near Munbrani vill., 66 m, 8.V., 00°46'21"S, 133°22'53"E., roadside ditch (2015-WP36)” (NHMW, ZSM). 1 male “Indonesia: Papua Barat, Manokwari to Kebar, forest stream, 302m, -0.80058566 133.33216397 (BH023)”, one male additionally with a label “M.Balke 6187” (ZSM). 36 males “Indonesia: Papua Barat, Kebar to Aibogar, slow forest stream, 503m, -0,86241595 132,82993928 (BH025)”, one male additionally with a label “M.Balke 6190” (MZB, NHMW, ZSM). 2 males, 4 females “Indonesia: Papua Barat, Kebar to Aibogar, forest stream, 942m, -0,89933965 132,7221734 (BH026)”, one male additionally with a label “M.Balke 6192” (ZSM). 38 males, 26 females “Indonesia: Papua Barat, Fumato, forest stream, 820m, -0.90427148 132.71981431 (BH027)”, four males additionally with labels “M.Balke 6201”, “M.Balke 6202”, “M.Balke 6203”, “M.Balke 6204” (MZB, NHMW, ZSM). 31 males, 22 females “Indonesia: Papua Barat, Fumato to Kebar, forest stream, 674m, -0.88384738 132.73705681 (BH028)” (MZB, NHMW, ZSM). 11 males, 7 females “Indonesia: Papua Barat, Tamrau Mts. N of Kebar, forest stream, 750m, -0,783199 133,072143 (BH033)” (ZSM). 75 males, 154 females “Indonesia: Papua Barat, Tamrau Mts. N of Kebar, forest stream, puddles, 1050m, -0.774519 133.069929 (BH034)” (MZB, NHMW, ZSM). **Sorong**: 6 males, 9 females “Indonesia: Papua Barat, Sorong-Sausapor, 300m, -0.7629653 131.6177023 (BH041)” (ZSM). 18 males, 21 females “Indonesia: Papua Barat, Sausapor-Fef, 157m, -0.6975004 132.072253 (BH044)” (MZB, NHMW, ZSM).

Additional material. 1 female “Indonesia: Papua Barat, Tamrau Mts. N of Kebar, sandy sunny riverbank”, “758m, -0,78387424 133,07218533 (BH032)” (ZSM). 78 females “Indonesia: Papua Barat, Kebar to Aibogar, slow forest stream, 503m, -0,86241595 132,82993928 (BH025)”, the females are a mixture of *E. manokwariensis* sp. n. and *E. polita* (Sharp, 1882) (MZB, NHMW, ZSM).



Figure 1. Habitus and coloration of *Exocelina manokwariensis* sp. n.

Diagnosis. Beetle small, brown to blackish brown, usually with paler clypeus and pronotal sides or head and pronotum, shiny, with almost invisible dorsal punctation; pronotum with distinct lateral bead; male antennomeres 3–4 strongly enlarged and triangular (3 distinctly larger than 4), 5 distinctly enlarged, 6–8 somewhat enlarged; male

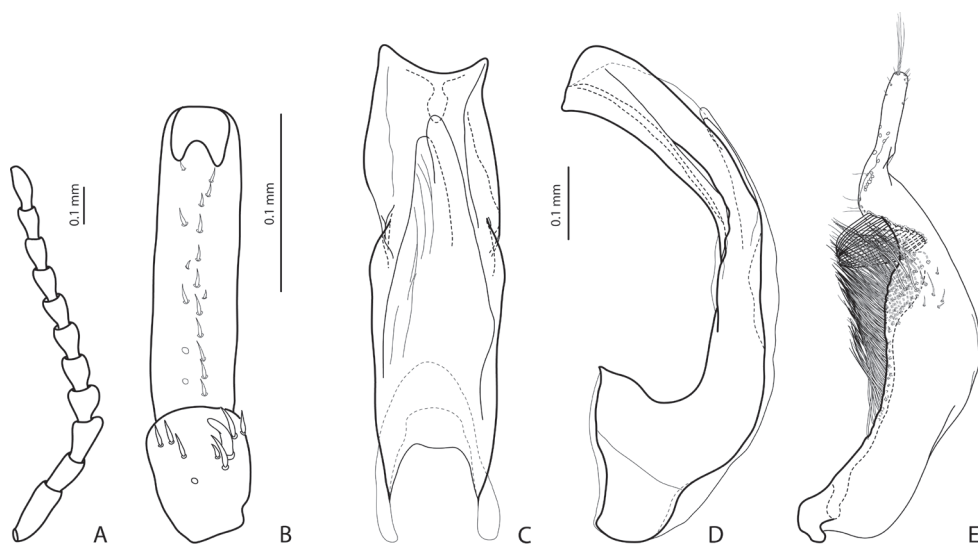


Figure 2. *Exocelina manokwariensis* sp. n. **A** male antenna **B** male protarsomeres 4–5 in ventral view **C** median lobe in ventral view **D** median lobe in lateral view **E** paramere in external view.

protarsomere 4 with medium-sized, slender, evidently curved anterolateral hook-like seta; median lobe with strong submedian constriction in ventral view, apex of median lobe truncate; paramere with notch on dorsal side and subdistal part short and small, with relatively short, thick, and flattened setae.

Description. *Size and shape:* Beetle small (TL-H 3.2–3.75 mm, TL 3.45–4.15 mm, MW 1.7–2.05 mm; *holotype:* TL-H 3.3 mm, TL 3.7 mm, MW 1.75 mm), with oblong-oval habitus, broadest at elytral middle.

Coloration: Head reddish brown to blackish brown, paler on clypeus and vertex; pronotum reddish brown to blackish brown, with paler sides and darker disc; elytra brown to blackish brown, sometimes with brown sutural lines; head appendages and legs yellowish to yellowish red, legs darker distally (Fig. 1). Teneral specimens paler.

Surface sculpture: Head with relatively dense punctation (spaces between punctures 1–3 times size of punctures), evidently finer and sparser anteriorly; diameter of punctures smaller than diameter of cells of microreticulation. Pronotum with extremely sparse and fine punctation, almost invisible. Elytra with punctation finer than on pronotum, indistinct. Pronotum and elytra with weakly impressed microreticulation, dorsal surface shiny. Head with microreticulation stronger. Metaventrite and metacoxa distinctly microreticulate, metacoxal plates with longitudinal striae and transverse wrinkles. Abdominal ventrites with distinct microreticulation, striae, and extremely fine, sparse punctation, almost invisible, only slightly coarser and denser on two last abdominal ventrites.

Structures: Pronotum with distinct lateral bead. Base of prosternum and neck of prosternal process with distinct ridge, less rounded and smooth anteriorly, without

anterolateral extensions. Blade of prosternal process lanceolate, relatively elongate, convex, with distinct lateral bead and few setae; neck and blade of prosternal process evenly jointed. Abdominal ventrite 6 broadly rounded or slightly truncate apically.

Male: Antennomeres 3–4 strongly enlarged and triangular (3 distinctly larger than 4), 5 distinctly enlarged, 6–8 somewhat enlarged (Fig. 2A); antennomeres 3–7 rugose ventrally. Protarsomere 4 with medium-sized, slender, evidently curved anterolateral hook-like seta. Protarsomere 5 ventrally with anterior row of 12 and posterior row 6 short setae (Fig. 2B). Abdominal ventrite 6 with 8–16 lateral striae on each side, slightly truncate apically. Median lobe with strong submedian constriction in ventral view, apex of median lobe truncate, with relatively short tip in lateral view and relatively asymmetric in ventral view (Fig. 2C, D). Paramere with notch on dorsal side and subdistal part short and small, with numerous, relatively short, thick, and flattened setae (Fig. 2E).

Female: Antennae simple, abdominal ventrite 6 broadly rounded apically, without striae.

Variability. The species has three subspecies, which are isolated geographically, occurring in restricted regions (Fig. 9). They are very similar morphologically and show (at least on material we have) no much variability in their morphology. Comparisons are given as separate notes after the descriptions.

Here, we discuss the variability of the nominative subspecies, which is more widely distributed (Fig. 9). This subspecies demonstrates variability mainly in shape of the apex of median lobe and setation of the subdistal part of the paramere. The truncate margin of the median lobe apex varies from almost straight (especially specimens from Manokwari) to slightly concave (especially specimens from Kedar, Fumato, Sorong) in lateral view. This variability is observed within and among the populations. Also, number of the subdistal flattened setae of the paramere varies though it is not possible to estimate that quantitatively, since they are numerous and densely attached. The specimens from western populations have less numerous subdistal flattened setae than specimens from Manokwari.

Comparative notes. In the *E. ekari*-group, the new species is similar to the species of the *E. polita*-complex: *E. polita* (Sharp, 1882), *E. alexanderi* Shaverdo, Hendrich & Balke, 2012, *E. anggiensis* Shaverdo, Hendrich & Balke, 2012, and *E. arfakensis* Shaverdo, Hendrich & Balke, 2012; see descriptions and illustrations in Shaverdo et al. 2012. From all these species, *E. manokwariensis* sp. n. can be distinguished by its smaller size (TL-H: 3.1–3.85 mm, MW: 1.65–2.1 mm; for *E. polita*-complex: TL-H: 3.7–4.3 mm, MW: 2.05–2.3 mm) and apex of the median lobe almost truncate in lateral view (elongate for *E. polita*-complex, if slightly truncate (in *E. alexanderi*), then antennomeres 3 and 4 of almost equal size). With its very fine dorsal punctation, the new species particularly resembles *E. alexanderi*, which also has a slightly truncate apex of the median lobe in lateral view, but differs from it by the smaller size and distinctly different shape of the male antennomeres 3 and 4. *Exocelina polita* also has fine dorsal punctation and it was found together with the new species in two localities. From *E. polita*, *E. manokwariensis* sp. n. can be separated by its smaller size, truncate apex of the median lobe in lateral view, and slightly different shape of the male antennomeres 3 and 4.

The nominative subspecies can be distinguished from all the other subspecies by more numerous flattened setae on the subdistal part of the paramere, the slightly shorter median lobe, and the prosternal ridge being less rounded anteriorly. From *E. m. batanta* ssp. n. and *E. m. nokensis* ssp. n., it can be also separated by slightly darker coloration and the stronger dorsal microreticulation. From *E. m. batanta* ssp. n. and *E. m. hendrichi* ssp. n., by the more asymmetric apex of the median lobe in ventral view and the smaller subdistal part of the paramere.

Distribution. Indonesia: West Papua Province: Sorong and Manokwari Regencies (Fig. 9).

Etymology. The species is named after Manokwari Regency where it is occur. The name is an adjective in the nominative singular.

Ecology. The species was collected in localities BH 023 and BH 025 together with *E. polita* in ratios 1:4 and 1:1, respectively.

***Exocelina manokwariensis batanta* ssp. n.**

<http://zoobank.org/047A24B7-0ED0-491E-BF10-B69C103B2236>

Figs 3, 4

Exocelina undescribed sp. MB1277: Toussaint et al. 2014: Supplementary figs 1–4, tab. 2.

Type locality. Indonesia: West Papua Province: Raja Ampat Regency, Batana Utara, approximately 00°50.13'S; 130°42.86'E.

Type material. *Holotype*: male “Indonesia: Papua, Batanta Utara, 180m, above 00.50.125S 130.42.856E (BH 13)” (MZB). *Paratype*: 16 males, 14 females with the same label as the holotype, two males additionally with green labels “M.Balke 1277”, “M.Balke 1278” (MZB, NHMW, ZSM). 3 males, 4 females “Indonesia: Papua, Batanta Selatan, Wailebet, 280m, inland 00.53.957S 130.39.951E, (BH 16)”, one male additionally with a green label “M.Balke 1280” (NHMW, ZSM). 2 males, 2 females “Indonesia: Papua, Salawatti Utara, 100-250m, inland 00.57.954S 130.40.531E (BH 18)”, one male additionally with a green label “M.Balke 1281” (NHMW, ZSM).

Description. As nominative subspecies, except for the following characters.

Size: TL-H 3.2–3.6 mm, TL 3.65–3.95 mm, MW 1.75–1.9 mm; *holotype*: TL-H 3.5 mm, TL 3.85 mm, MW 1.85 mm.

Coloration: Head reddish brown to dark brown, paler on clypeus and vertex; pronotum reddish brown to dark brown, with paler sides and darker disc; elytra brown to blackish brown, usually with reddish brown sutural lines (Fig. 3).

Surface sculpture: Dorsal microreticulation, especially on head and pronotum, slightly weaker.

Structures: Base of prosternum and neck of prosternal process with distinct ridge, rounded and smooth anteriorly, with few transverse lines.



Figure 3. Habitus and coloration of *Exocelina manokwariensis batanta* ssp. n.

Male: Antennomeres 3–4 strongly enlarged and triangular (3 distinctly larger than 4), 5–6 distinctly enlarged, 7–8 somewhat enlarged (Fig. A). Protarsomere 5 ventrally with anterior row of 11 and posterior row 5 short setae (Fig. 4B). Abdominal ventrite 6 with 6–8 lateral striae on each side. Median lobe larger. Its apex strongly concave and symmetric in ventral view and with truncate margin more strongly curved in lateral

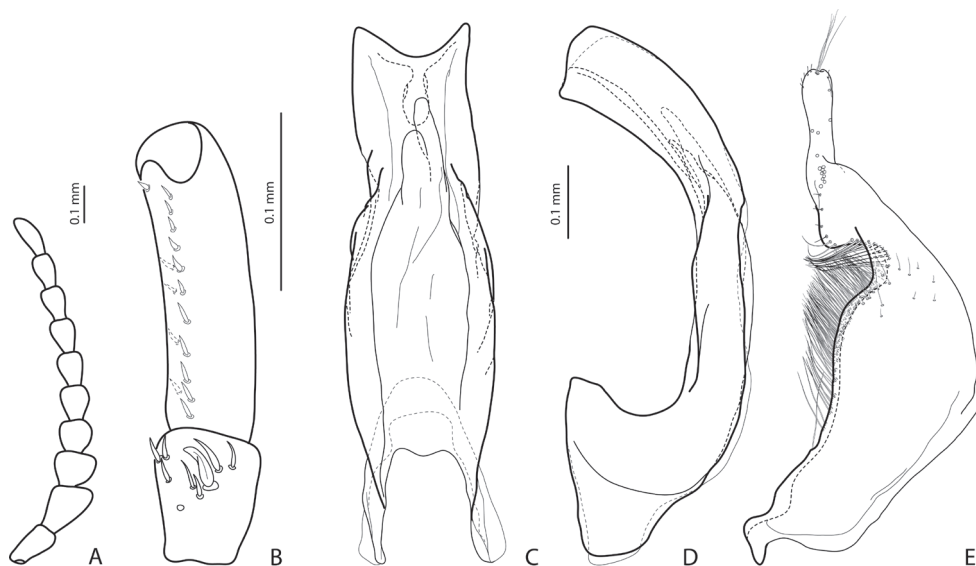


Figure 4. *Exocelina manokwariensis batanta* ssp. n. **A** male antenna (antennomere 1 not shown) **B** male protarsomeres 4–5 in ventral view **C** median lobe in ventral view **D** median lobe in lateral view **E** paramere in external view.

view (Fig. 4C, D). Subdistal part of paramere larger, with flattened setae thinner and less numerous (Fig. 4E).

Female. Antennae simple, abdominal ventrite 6 broadly rounded apically, without striae.

Comparison with the other subspecies. *Exocelina m. batanta* ssp. n. can be separated from all other subspecies by its less numerous and thinner flattened setae of the subdistal part of the paramere and the apex of the median lobe being strongly concave and symmetric in ventral view.

Distribution. Indonesia: West Papua Province: Raja Ampat Regency, Batanta Island and the northern part of Salawati Island (misspelled as Salawatti on labels) (Fig. 9). *Exocelina m. batanta* ssp. n. is the only known *Exocelina* species in these islands.

Etymology. The species is named for the Batanta Island, where it was discovered. The name is a noun in the nominative singular standing in apposition.

***Exocelina manokwariensis hendrichi* ssp. n.**

<http://zoobank.org/4EC8EF55-8ED9-40CC-A6C4-DBC1CDA45F8E>

Figs 5, 6

Exocelina undescribed sp. MB1321: Toussaint et al. 2014: Supplementary figs 1–4, tab. 2.

Type locality. Indonesia: West Papua Province: Fak-Fak Regency, Kalimati, 4 km N Fak-Fak, approximately 02°53.76'S; 132°18.07'E.



Figure 5. Habitus and coloration of *Exocelina manokwariensis hendrichi* ssp. n.

Type material. *Holotype*: male “IRIAN JAYA: Fak-Fak Kalimati, 4 km N Fak-Fak 260 m, 8–9.8.1991 Balke & Hendrich (IR 27)” (MZB). *Paratype*: 26 males, 22 females with the same label as the holotype, one female additionally with a green label “M.Balke 3261” (MZB, NHMW, ZSM). 6 males “IR 27-W.New Guinea, Fak-Fak, Kali Mati 4km

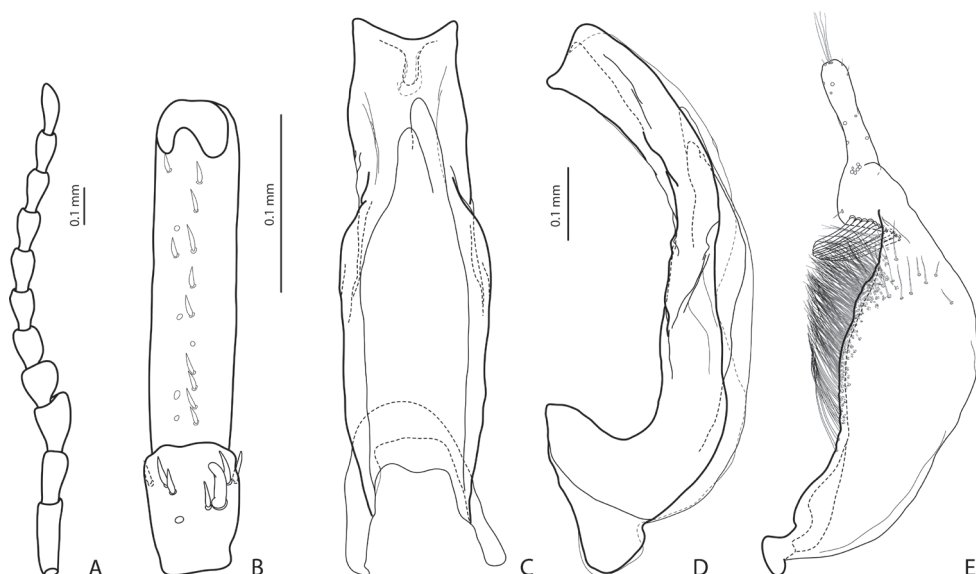


Figure 6. *Exocelina manokwariensis hendrichi* ssp. n. **A** male antenna **B** male protarsomeres 4–5 in ventral view **C** median lobe in ventral view **D** median lobe in lateral view **E** paramere in external view.

N F.-F., 260 m, 8.-9.viii.1991 Balke & Hendrich leg.” (NHMW, ZSM). 44 males, 31 females “West New Guinea/Fak-Fak/IR27 Kali Mati, 4 km N of Fak-Fak 260 m, 8. & 9.8.1991 leg: Balke & Hendrich” (NHMW, ZSM). 2 males, 1 female “Indonesia: Irian Jaya Barat, Fak Fak, 310m, 23.ii.2006, Tindige”, with green labels “M.Balke 1321”, “M.Balke 4190”, “M.Balke 4191” respectively (ZSM). 1 female “Indonesia: Irian Jaya Barat, Fak Fak, 310m, 23.ii.2006, 2 53.756S 132 18.07E, Tindige (Fak-Fak)” (ZSM).

Description. As nominative subspecies, except for the following characters.

Size: TL-H 3.3–3.85 mm, TL 3.75–4.45 mm, MW 1.75–2.1 mm; **holotype:** TL-H 3.75 mm, TL 4.3 mm, MW 2 mm.

Coloration: Dorsal surface more or less uniform reddish brown to dark brown, paler on clypeus, pronotal sides, along elytral suture, and sometimes on vertex (Fig. 5).

Structures: Base of prosternum and neck of prosternal process with distinct ridge, rounded and smooth anteriorly.

Male: Antennomeres 3–4 strongly enlarged and triangular (3 distinctly larger than 4), 5 distinctly enlarged, 6–7 somewhat enlarged (Fig. 6A). Protarsomere 5 ventrally with anterior row of 10 and posterior row 6 short setae (Fig. 6B). Abdominal ventrite 6 with 7–9 lateral striae on each side, slightly truncate apically. Median lobe larger. Its apex slightly asymmetric in ventral view and concave, with relatively long tip in lateral view (Fig. 6C, D). Subdistal part of paramere larger, with more or less numerous, thick flattened setae (Fig. 6E).

Female: Antennae simple, abdominal ventrite 6 broadly rounded apically, without striae.

Comparison with the other subspecies. *Exocelina m. hendrichi* ssp. n. can be separated from all other subspecies by the shape of the apex of its median lobe: slightly asymmetric in ventral view and concave, with relatively long tip in lateral view.

Distribution. Indonesia: West Papua Province: Fak-Fak Regency (Fig. 9). *Exocelina m. hendrichi* ssp. n. is the only known *Exocelina* species in this region.

Etymology. The species is named for our colleague and friend Lars Hendrich who collected this species. The species name is a noun in the genitive case.

***Exocelina manokwariensis nokensis* ssp. n.**

<http://zoobank.org/9F65FAC4-58E8-4667-9C12-236CB7F46016>

Figs 7, 8

Exocelina undescribed sp. MB1275: Toussaint et al. 2014: Supplementary figs 1–4, tab. 2.

Type locality. Indonesia: West Papua Province: Raja Ampat Regency, Waigeo Island, Waifo, Mountain Nok, 00°05.08'S; 130°44.59'E.

Type material. *Holotype*: male “Indonesia: Papua, Waigeo, Waifo, Mt. Nok, 500m, 00.05.076S 130.44.586E (BH 11)” (MZB). *Paratypes*: 25 males, 39 females with the same labels as the holotype, one male additionally with a green label “M.Balke 1275” (MZB, NHMW, ZSM). 1 male “Indonesia: Papua, Waigeo, Waifo, <50m, 00.06.088S 130.42.855E, Balke (BH 10)”, “M.Balke 1274” [green] (ZSM). 23 males “N.DUTCH NEW GUINEA: Waigeu. Camp Nok. 2,500 ft. iv.1938. L.E.Cheesman. B.M.1938-593.”, one of them additionally with labels “collection 28”, “measured J.Parkin 78” (BMNH). 5 males “N.DUTCH NEW GUINEA: Waigeu. Camp 1.Mt. Nok. 2,500 ft. v.1938. L.E.Cheesman. B.M.1938-593.” (BMNH).

Additional material. 27 females “N.DUTCH NEW GUINEA: Waigeu. Camp Nok. 2,500 ft. iv.1938. L.E.Cheesman. B.M.1938-593.”, one of them additionally with labels “collection 27”, “measured J.Parkin 76” (BMNH). 6 females “N.DUTCH NEW GUINEA: Waigeu. Camp 1.Mt.Nok. 2,500 ft. v.1938. L.E.Cheesman. B.M.1938-593.” (BMNH). These females might belong to two species: *E. m. nokensis* ssp. n. and *E. waigeoensis* Shaverdo, Hendrich & Balke, 2012.

Description. As nominative subspecies, except for the following characters.

Size: TL-H 3.1–3.6 mm, TL 3.45–4.0 mm, MW 1.65–1.9 mm; *holotype*: TL-H 3.4 mm, TL 3.75 mm, MW 1.8 mm (Fig. 7).

Surface sculpture: Dorsal microreticulation, especially on head and pronotum, slightly weaker.

Structures: Base of prosternum and neck of prosternal process with distinct ridge, less rounded, smooth or with few transverse lines anteriorly.

Male: Protarsomere 5 ventrally with anterior row of 9 and posterior row 4 short setae (Fig. 8B). Abdominal ventrite 6 with 3–6 lateral striae on each side. Median lobe slightly larger and somehow more slender. Its apex with relatively short tip and truncate margin almost straight in lateral view and asymmetric in ventral view (Fig. 8C, D). Subdistal part of paramere with less numerous, thick flattened setae (Fig. 8E).

Female: Antennae simple, abdominal ventrite 6 broadly rounded apically, without striae.



Figure 7. Habitus and coloration of *Exocelina manokwariensis nokensis* ssp. n.

Comparison with the other subspecies and co-inhabiting species. Although widely separated geographically, *E. m. nokensis* ssp. n. is very similar to the nominative subspecies, from which can be separated by the larger and somehow more slender median lobe, less numerous flattened setae on the paramere, and its finer dorsal

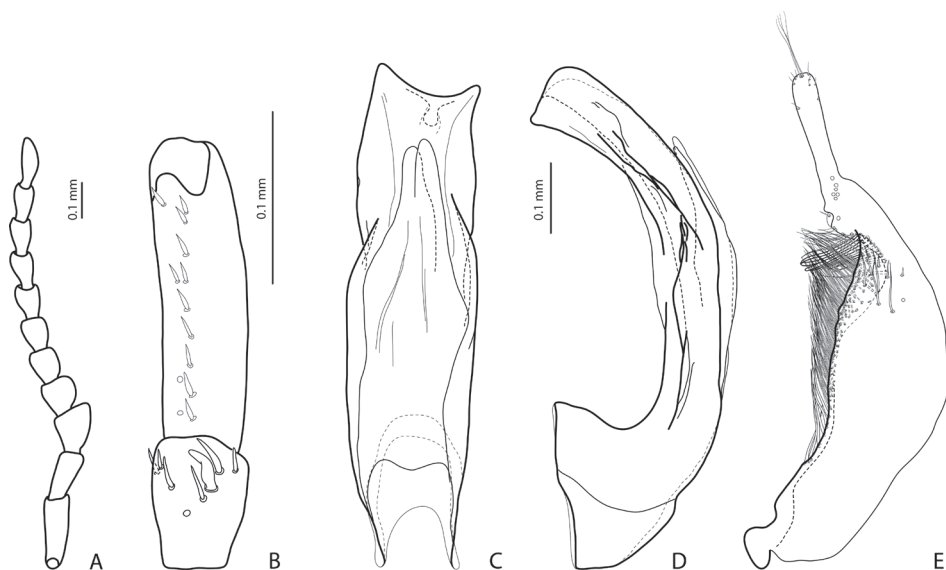


Figure 8. *Exocelina manokwariensis nokensis* ssp. n. **A** male antenna **B** male protarsomeres 4–5 in ventral view **C** median lobe in ventral view **D** median lobe in lateral view **E** paramere in external view.



Figure 9. Map of the western part of New Guinea showing distribution of subspecies of *Exocelina manokwariensis* sp. n. and co-occurring species.

microreticulation. This subspecies was collected together with two other species of the *E. ekari*-group: *E. evelyncheesmanae* Shaverdo, Hendrich & Balke, 2012 and *E. waigeoensis* Shaverdo, Hendrich & Balke, 2012; see descriptions and illustrations in Shaverdo et al. 2012. From the former (both males and females), it can be easily separated by its smaller size and distinctly modified male antennae (TL-H: 3.75–4.1 mm, MW: 1.9–2.2 mm and slightly modified male antennae: antennomeres 3–7 very slightly enlarged, antennomere 3 slightly more triangular than other antennomeres, in *E. evelyncheesmanae*). From the latter, males can be distinguished by their distinctly modified antennae and the shapes of the median lobes (slightly modified antennae and apex of the median lobe elongate in lateral view in *E. waigeoensis*).

Distribution. Indonesia: West Papua Province: Raja Ampat Regency, Waigeo Island (Fig. 9).

Etymology. The species is named after Nok Mountain, the type locality of the species. The name is an adjective in the nominative singular.

Ecology. The species was collected in two localities on Nok Mountain together with *E. evelyncheesmanae* and *E. waigeoensis* and in one locality together with *E. evelyncheesmanae* in ration ca. 1:1.

Key to subspecies of the *Exocelina manokwariensis* sp. n.

This key is a modified part of the key to species of the *E. ekari*-group from Shaverdo et al. (2014). It is based mostly on male characters. In many cases, females cannot be assigned to species due to similarity of their external and internal structures (for female genitalia, see figs 17a and 17b in Shaverdo et al. (2005) and fig. 7C in Shaverdo et al. (2013)).

- 27 Male antennomere 3 much larger than other antennomeres, triangular; beetle larger, TL-H: 3.8–4.8 mm, MW: 2.0–2.55 mm; male protarsomere 4 with anterolateral hook very small (smaller than more laterally situated large seta), thin, and slightly curved; paramere distinctly longer than median lobe, without notch on dorsal side, with dense, thin setae subdistally and sparse, thin setae and spines proximally **28**
- Male antennomeres 3 and 4 much larger than other antennomeres, triangular; beetle smaller, TL-H: 3.1–4.3 mm, MW: 1.65–2.3 mm; male protarsomere 4 with anterolateral hook thin or thick, slightly curved but larger than more laterally situated large seta; paramere equal or shorter than median lobe, with notch on dorsal side, setae of subdistal part thick and flattened, proximally setae dense and thinner, no spines **29A**
- 29A Beetle larger, TL-H: 3.7–4.3 mm, MW: 2.05–2.3 mm; dorsal punctuation very fine to dense and coarse; apex of median lobe elongate in lateral view (figs 9–11 in Shaverdo et al. (2012)); if almost truncate, *E. alexanderi*, antennomeres 3 and 4 larger, triangular but elongated due to external margin strongly expanded (figs 8A, D in Shaverdo et al. (2012)) **30**

- Beetle smaller, TL-H: 3.1–3.85 mm, MW: 1.65–2.1 mm; dorsal punctation very fine; apex of median lobe almost truncate in lateral view (Figs 2D, 4D, 6D, 8D); male antennomeres 3 and 4 evidently smaller, more distinctly triangular, not elongated due to external margin only slightly expanded (Figs 2A, 4A, 6A, 8A)..... ***manokwariensis* sp. n. 32A**
- 32A Apex of median lobe more strongly concave, with tip distinctly longer in lateral view (Fig. 6A, D)..... ***m. hendrichi* ssp. n.**
- Apex of median lobe not concave or slightly concave, with tip shorter in lateral view (Figs 2A, 4A, 8A) **32B**
- 32B Apex of median lobe with truncate margin more strongly curved in lateral view and symmetrical in ventral view; subdistal part of paramere larger, with flattened setae less numerous and thinner (Fig. 4C–E)..... ***m. batanta* ssp. n.**
- Apex of median lobe with truncate margin almost straight in lateral view and asymmetrical in ventral view; subdistal part of paramere smaller, with flattened setae more numerous and thicker **32C**
- 32C Median lobe longer, somehow more slender, subdistal part of paramere with less numerous flattened setae (Fig. 8C–E)..... ***m. nokensis* ssp. n.**
- Median lobe shorter and more robust, subdistal part of paramere with more numerous flattened setae (Fig. 2C–E) ***m. manokwariensis* ssp. n.**

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We are grateful Dr. H. Schillhammer (Vienna) for the habitus photos and Prof. D. Bilton (Plymouth) for a linguistic review of the manuscript.

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A new genus and nine new species of Eugnomini (Coleoptera, Curculionidae) from New Caledonia

Miłosz A. Mazur¹

¹ Center for Biodiversity Studies, Department of Biosystematics, Opole University, Oleska 22; 45–052 Opole, Poland

Corresponding author: Miłosz A. Mazur (milosz@uni.opole.pl)

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Abstract

The genus *Rasilinus* **gen. n.** is described (type species *Rasilinus tchambicus* sp. n.). Nine new species: *Rasilinus bicolor* **sp. n.**, *R. bifurcatus* **sp. n.**, *R. bimaculatus* **sp. n.**, *R. grandidens* **sp. n.**, *R. longulus* **sp. n.**, *R. subgemellus* **sp. n.**, *R. subnodulus* **sp. n.**, *R. tchambicus* **sp. n.**, *R. virgatus* **sp. n.** are described from New Caledonia. Illustrations of the external morphology, male and female terminalia, dorsal habitus colour photographs of the adults, key to species and distribution map of the new genus *Rasilinus* are provided.

Keywords

Coleoptera, Curculionidae, Curculioninae, Eugnomini, *Rasilinus*, new genus, new species, New Caledonia, distribution, key to species

Introduction

The Eugnomini is a small, poorly studied tribe of the speciose family Curculionidae. The classification, biogeography, and biology of most species are poorly known. Currently, Eugnomini comprises about 200 known species included in 28 genera and is primarily an Old World group occurring in New Zealand (19 genera), Australia (five), New Caledonia (three) and New Guinea (one) (Zimmerman 1994; Alonso-Zarazaga and Lyal 1999; Macfarlane et al. 2011; Kuschel 2014; Mazur 2014a, b). In the

New World the tribe is represented by four genera known from South America; only one genus, *Rhopalomerus* Blanchard, occurs both in the New and Old Worlds (Alonso-Zarazaga and Lyal 1999). More detailed study about the tribe with general diagnosis and systematic background were presented last time by Cawthra (1966). The newest checklist of all known genera, data on their distribution and comments on the current classification of the Eugnomini were presented by Mazur (2014b). Detailed summary history of New Caledonian fauna with zoogeographic and evolutionary implications, based on apionid weevils (Coleoptera: Curculionoidea: Apionidae), were presented by Wanat (2001).

This paper presents descriptions of a new genus and nine species of Eugnomini from New Caledonia along with a key to all new species.

Materials and methods

This study is based on 37 specimens. Holotypes are deposited in the Muséum National d'Histoire Naturelle, Paris (MNHN). Paratypes are deposited in institutions abbreviated below. Abbreviations are used throughout the paper:

DBUO	Department of Biosystematics, Opole University, Poland
MNHW	Museum of Natural History, University of Wrocław, Poland
NZAC	New Zealand Arthropod Collection, Lincoln, New Zealand
QM	Queensland Museum, Australia
USMB	Natural History Department of Upper Silesian Museum, Bytom, Poland

Measurements were taken using a calibrated stereomicroscopic grid eyepiece (C–W10xB/22) and stereomicroscope NIKON SMZ–800. Genitalia preparations were made according to the standard method of macerating the separated abdomen for 5–10 minutes in a hot KOH solution. Photographs were taken using the camera a CANON Power Shot A640 camera connected with the stereomicroscope and processed using the Helicon Focus v. 4.50 and PhotoFiltre v. 6.1 software programmes.

The nomenclature of the male terminalia and abbreviations of particular measurements (partly modified) follows Wanat (2001) (alphabetical order):

apw	pronotum width at anterior margin;
arw	width of rostrum apex;
bew	width of elytral base (measured through the middle of humeral calli);
bpw	pronotum width at the base;
el	elytra length, measured in top view in a position when the base and apex of elytra are at the same level;
eyl	eye length, measured in top view, when the head is positioned horizontally;
frw	minimum frons width;
hl	head length;

hw	head width, measured across the middle of the eyes;
lb	length of body exclusive of rostrum;
mew	maximum elytra width;
mith	minimum height of tooth on hind femur, measured from basal part of femur (shorter edge);
mpw	maximum pronotal width;
pl	pronotum length;
ptbl	protibia length;
ptbmw	maximum width of fore tibia;
mth	maximum height of tooth on hind femur; measurement from apex of femur (longer edge);
rl	rostrum length, measured in top of view, when base and apex of rostrum are in the same level;
scl	antennal scape length.

The nomenclature of antennal parts follows Lyal (<http://weevil.info/glossary-weevil-characters>).

All dimensions are given in millimetres.

Taxonomic treatment

Rasilinus gen. n.

<http://zoobank.org/E5E03CF2-1CB8-4854-9455-72E4E80B3C62>

Type species. *Rasilinus tchambicus* sp. n. Gender masculine.

Diagnosis. Body massive; elytra narrowed, smooth, without any tubercles or spines, not covered with adjacent scales, sculpture of elytra clearly visible; hind femora stout, strongly clavate with large tooth, their basal part stout.

Description. Size 2.5–3.6 mm. Body stout, distinctly convex transversally. Rostrum dorsoventrally flattened, as long as head or slightly longer; dorsal surface covered with white, more or less protruding, elongate scales, sometimes mixed with additional white scales which are suboval and adjoining. Antennae inserted on apical part of rostrum; funicle with seven antennomeres; scape reaching posterior margin of eye. Scrobe deep in lateral view with sharp edges; partly visible in dorsal view of rostrum; not passing along ventral part and not reaching front margin of eyes. Eyes weakly to strongly convex. Frons narrower than base of rostrum. Pronotum subquadrate. Elytra widest at basal half, distinctly and regularly narrowed to apex; apically truncate or rounded; humeral calli weakly or strongly prominent, posterior calli absent. Surface of elytra glabrous, more or less shining; intervals wider than striae with single line of short, protruding, inclined backward setae; entire surface in some species covered with extremely small, hardly visible, piliform setae. Second pair of wings well developed. Front coxae contiguous. Trochanters small, fusiform. Posterior margin of metaventrite

with distinct line of dense, closely adjoining, white scales. All femora covered with sparse, elongate scales. Outer margin of tibiae covered with white, elongate scales. Hind femora broadened, clavate with enlarged tooth; dorsal surface with contrasting, transverse stripe of white scales (except *R. subnodulus* sp. n.); posterior margin of tooth on hind femora with two types of piliform setae: one short and straight and other elongate and hooked apically. Hind tibiae strongly curved. Segments of front and middle tarsi similar in length; first tarsal segment of hind tarsi elongate, as long as 2+3 or longer. Male pygidium (tergite VIII) with two narrow processes on ventral side. Tegmen with elongate or very short parameres. Penis well sclerotised, most species with fully sclerotised base of pedon (here, basal part of pedon is the anterior ventral margin of the penis body between the apodemes) and variable, well visible structures in internal sac.

Etymology. The generic name is derived from the Latin adjective *rasilis* (smooth) and refers to the elytral sculpture. Gender masculine.

Distribution. New Caledonia (main island), only *R. subgemellus* sp. n. is known from Lifou Island (Map 1).

Biology. Detailed biology unknown. Other members of Eugnomini have been reared from dead wood, subcortical tissues, live stems, galls, leaves or fruits of many species of plants in different families (e.g. May 1987).

***Rasilinus tchambicus* sp. n.**

<http://zoobank.org/27621B98-059F-4457-B97D-A2221039B182>

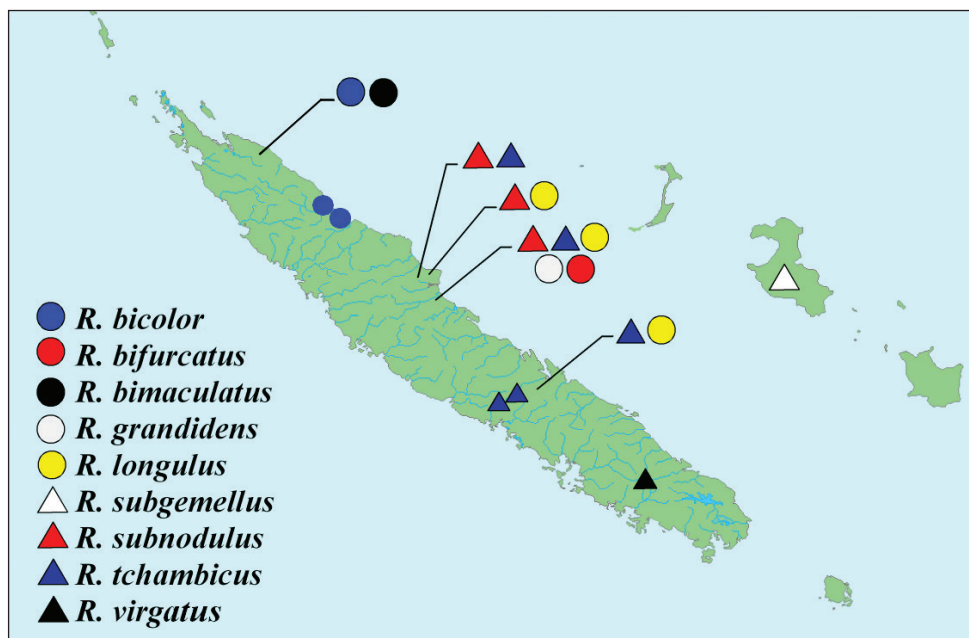
Figs 8, 17, 26, 35, 44, 70–73, 84, 91, 98, 105, 112, 119, 125, 130, 135

Diagnosis. One of the smallest members of new genus. The following combination of characters allows this species to be distinguished from its congeners: rostrum short and relatively thin with compare to its congeners, almost as long as head; pronotum wider than long; elytra weakly narrowed; minute tooth on fore and middle femora; apodemes much longer than aedegal pedon; tegmen with completely separated parameroid lobes.

Description. Body length (lb) *ca.* 2.50 mm.

Body colour and vestiture (Fig. 8). Colour of body variable, from uniformly light brown to almost black. Elytra, pronotum and head usually dark brown, except for lighter rostrum and legs. Legs with three possible types of coloration: i) dark femora with lighter tibiae, ii) light femora (sometimes with darkening base) with darker tibiae (sometimes only apical part darkening), iii) femora and tibiae with the same colour. Rostrum and frons covered with two kinds of white scales: one suboval and recumbent and other elongate, protruding. Outer margin of tibiae with white, elongate, protruding scales. Elytral intervals with single line of protruding, elongate scales with variable colour, from dark on basal to bright on apical part of elytra. Entire surface of elytra covered with additional minute, hardly visible, short, piliform, recumbent scales.

Head, rostrum and antennae (Figs 26, 35, 44). Head elongate (hw/hl 1.30–1.45). Forehead flat. Eyes distinctly convex laterally; protruding above margin of head in



Map I. Distribution of species from genus *Rasilius* gen. n. in New Caledonia.

lateral view; longer than half length of head (eyl/hl 0.63–0.70). Lateral margin of head narrowed from its base to hind margin of eyes. Vertex strongly scabrous, matt. Rostrum longer than width at apex (rl/arw 1.20–1.40), almost straight. Funicle much shorter than scape; first desmomer as long as 2 and 3 combined; desmomeres 4–7 subcircular, wider than long. Club *ca.* 2 × as long as its wide, longer than desmomeres 2–7.

Pronotum (Figs 17, 26). Wider than long (mpw/pl 1.15–1.27). Laterally slightly narrowed near base; strongly narrowed subapically. Apical margin straight; base slightly bisinuate. Surface distinctly rough, matt.

Elytra (Figs 17, 26). Elongate (el/mew 1.35–1.45), widest across humeral calli, weakly narrowed to apex. Striae with suboval, distinct punctures, at apical part of elytra punctures evanescent, forming indistinct line. Intervals glabrous, shining, weakly convex.

Legs (Figs 70–73, 84). Front and middle femora robust, with small teeth beyond middle; tibiae robust, front slightly sinuate, middle straight. Hind femora slightly narrowed beyond base; tibiae regularly curved, narrowed subapically. Claws regularly curved, distinctly broadened basally.

Abdomen (Fig. 91). Short, 1.08 × longer than wide. First suture obsolete at middle of length. Sutures between ventrites 2–5 distinct, depressed. Last ventrite trapezoidal, almost 2 × as wide as long, apical margin almost straight. Pygidium of male subquadrate; apical margin almost straight with numerous, elongate setae; lobed middle part small with single setae.

Male terminalia (Figs 105, 112, 119). Aedegal pedon shorter than apodemes; basal part sclerotised, slightly extended; lateral margins equilateral at basal half, from middle to apex distinctly narrowed; apex widely rounded. From lateral view distinctly, regularly curved with upturned apex. Endophallus not projecting outside pedon, internal structure not visible. Parameroid lobes of tegmen strongly elongate, thin, completely separated, of similar length to tegminal apodeme. Sternite VIII with bifurcate basal part; laterally flattened, apodeme slightly curved apically with thin apical keel; hemisternites on sternite IX subtriangular, clearly visible.

Female (Figs 98, 125, 130, 135). Similar to male in body shape but slightly larger. Elytra stout, widest beyond humeral calli, near middle. Apodeme of sternite VIII elongate, base bifurcate, irregular. Gonocoxite thin, elongate, more than $4 \times$ as long as its wide; stylus minute with few setae. Spermatheca stout, distinctive curved. Abdominal tergite VIII more than $2 \times$ wider than long; widely rounded apically; basally with slightly narrowed angles; surface with sparse punctation and few setae on apical margin.

Measurements. Holotype, ♂: apw 0.45; arw 0.25; bew 1.10; bpw 0.60; el 1.50; eyl 0.25; frw 0.15; hl 0.35; hw 0.45; lb 2.45; mew 1.10; mith 0.15; mpw 0.60; mth 0.30; pl 0.50; ptbl 0.55; ptbmw 0.10; rl 0.35; scl 0.45.

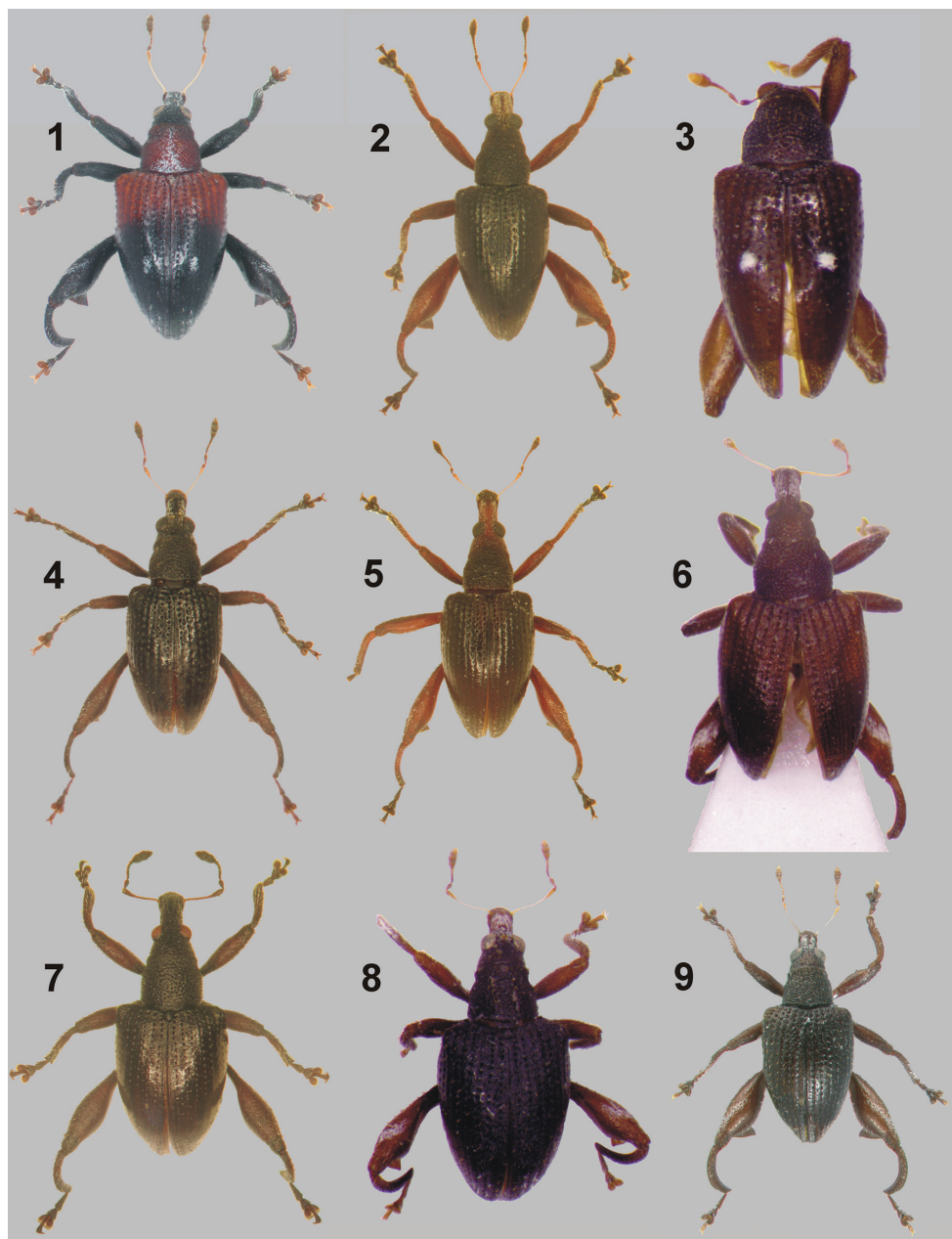
Paratypes, ♂/♀: apw 0.45–0.50/0.55; arw 0.25–0.30/0.30; bew 1.10–1.25/1.30–1.35; bpw 0.60–0.70/0.70–0.75; el 1.50–1.80/1.90–2.00; eyl 0.25/0.25; frw 0.15/0.15; hl 0.35–0.40/0.35; hw 0.35–0.45/0.45–0.50; lb 2.45–2.80/2.75–2.90; mew 1.10–1.25/1.35–1.45; mith 0.15–0.20/0.20; mpw 0.60–0.70/0.70–0.75; mth 0.30–0.40/0.35; pl 0.50–0.55/0.60–0.65; ptbl 0.55–0.70/0.65; ptbmw 0.10–0.15/0.15; rl 0.35/0.40; scl 0.45–0.55/0.55.

Type material. Holotype, ♂ – 21.58536/165.79319, Col d'Amieu 500m (3,0 km to gate), 16.11.2008, leg. M. Wanat (MNHN).

Paratypes: 1♂–21037.632'S 165045.830'E, Farino env. Les Grandes Fougères, rainforest, netting, biting, 12.03.2008 467m, leg. R. Dobosz & T. Blaik; 5915/11630 (BMNH); 1♂, 1♀–21.61176/165.75406, Farino, Parc des Grandes Fougères, 400m Camp de la Houe, 13.11.2008, leg. M. Wanat (MNHW); 1♀–21035.1'S 16504', Col d'Amieu 490m (3,5 km from gate), 6–7.01.2007 (loc 3), leg. M. Wanat (MNHW); 1♂–21.58536/165.79319, Col d'Amieu 500m, (3,0 km to gate), 16.11.2008, leg. M. Wanat (MNHW); 1♀–Col d'Amieu, Forestry Station, 18–21 Oct 1978, J.S. Dougdale; malaise trap; N.Z. Arthropod Collection NZAC, Private Bag 92170, Auckland, New Zealand (NZAC); 1♀–21011'S 165016'E, Aoupinié 950–1000m, meteo st.–summit, 8.02.2004, leg. M. Wanat (MNHW); 1♀–Tchamba (Wão Uni), at day, rainforest, 1.04.2008, leg. T. Blaik (DBUO); 1♂–21000.2'S/16504.6'E, Tchamba (Wão Uni), 16.01.2007 500–530m, forest, old northern road, leg. M. Wanat (MNHW); 1♂–Mt. Rembai, 700m, 18 Oct 1978, J.C. Watt; beating logging area at night; N.Z. Arthropod Collection NZAC, Private Bag 92170, Auckland, New Zealand (NZAC).

Etymology. A toponymical adjective, after Tchamba, where some of the paratypes were collected.

Distribution. New Caledonia (main island, north and south provinces).



Figures 1–9. Dorsal habitus colour photographs of New Caledonian species from the genus *Rasilinus* gen. n. **1** *Rasilinus bicolor* sp. n., paratype, ♀, Mandjélia (MNHW) **2** *R. bifurcatus* sp. n., holotype, ♂, Auopinié, (MNHN) **3** *R. bimaculatus* sp. n., holotype, ♂, Mandjélia (MNHN) **4** *R. grandidens* sp. n., holotype, ♂, Auopinié (MNHN) **5** *R. longulus* sp. n., paratype, ♀, Pic d’Amoa (QM) **6** *R. subgemellus* sp. n. holotype, ♂, Lifou Is. (MNHN) **7** *R. subnodulus* sp. n., holotype, ♂, Auopinié (MNHN) **8** *R. tchambicus* sp. n., paratype, ♀, Tchamba (DBUO) **9** *R. virgatus* sp. n., holotype, ♂, Dzumac Mts. (MNHN).

***Rasilinus bicolor* sp. n.**

<http://zoobank.org/3100327F-A4EC-49E3-8D7D-7A0BEAAAED40>

Figs 1, 10, 19, 28, 37, 49–51, 77, 86, 89, 94, 100, 107, 114, 121, 126, 131

Diagnosis. Distinguished by the bicolored body with pronotum and basal part of elytra reddish and remaining parts of body black. Pronotal disc with subtriangular mark composed of white scales. Humeral calli strongly prominent.

Description. Body length (lb) 2.55–2.90 mm.

Body colour and vestiture (Fig. 1). Head and rostrum dark brown to black covered with white, suboval (adjoining) and elongate (protruding) scales. Scape orange, darkening to apex; funicle and club darker. Pronotum reddish with subtriangular spot composed of white scales. Elytra bicolored, anterior half reddish, posterior half dark brown to black; intervals with single, protruding, elongate, dark (lighter-colored at apical part) scales. Elytra medially with two small spots on third interval composed of white suboval scales (sometimes hardly visible). Legs dark brown; fore and middle femora with single, white, protruding scales, hind femora with transverse stripe of small, suboval, white scales. Front and middle tibiae with elongate, protruding scales, these are brown on basal part and white on apical two thirds. Tarsi orange.

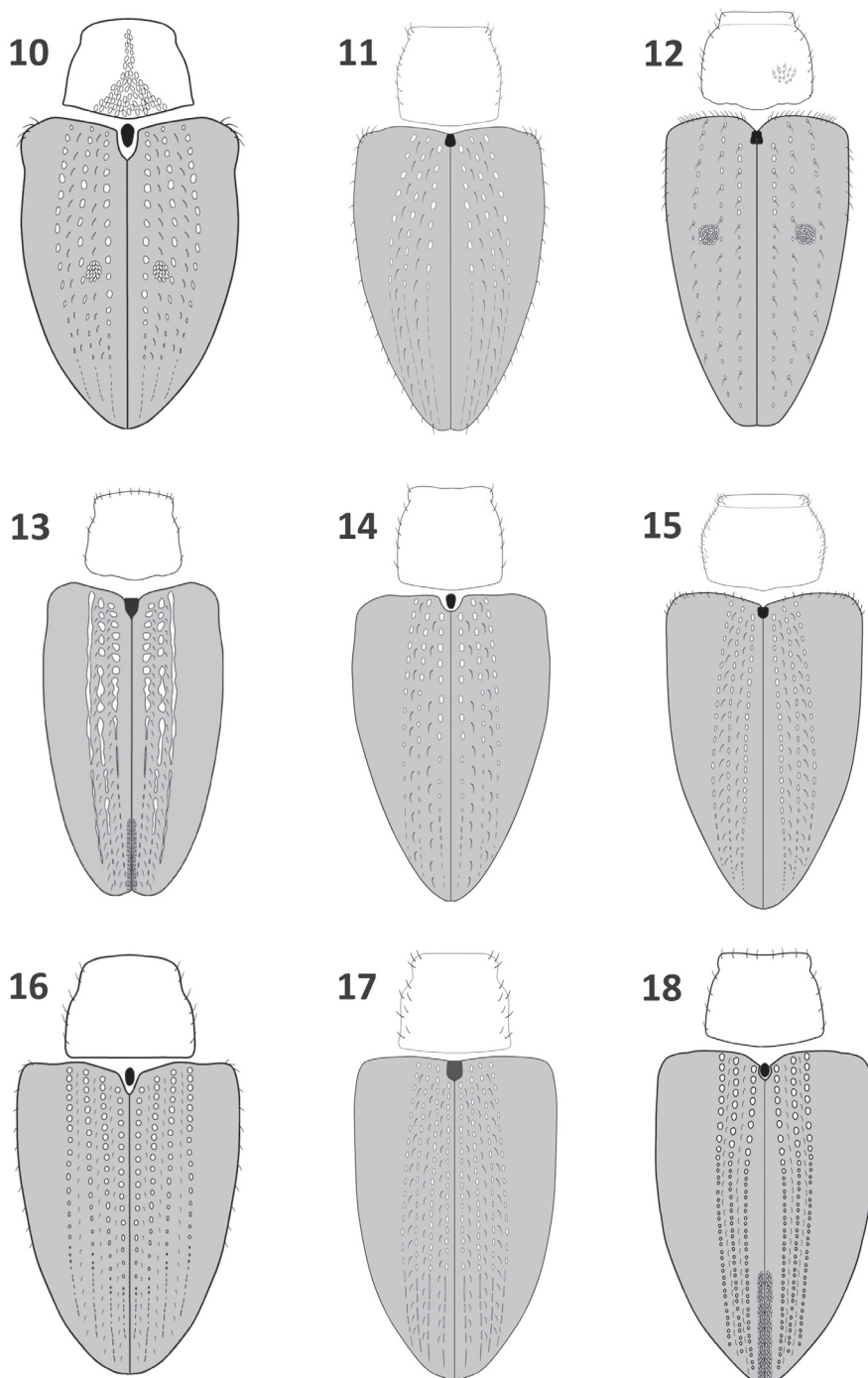
Head, rostrum and antennae (Figs 19, 28, 37). Head capsule transverse (hw/hl *ca.* 1.30). Forehead between eyes flat; eye protruding in dorsal view. Vertex distinctly convex, strongly rough. Eyes rounded, convex, slightly protruding beyond the head outline; longer than half length of head (eyl/hl *ca.* 0.70). Rostrum weakly curved, much longer than wide at apex (rl/arw *ca.* 1.60). Funicle shorter than scape; desmomer 1 elongate, as long as 2+3; 2 elongate, almost as long as 3+4; desmomeres 3–7 slightly longer than wide. Club elongate, *ca.* 2 × longer than wide, as long as last five desmomeres of funicle, compact.

Pronotum (Figs 10, 19). Campaniform with weakly rounded apical margin, basal margin slightly medially extended onto scutellum, widely rounded. Widest at base, bpw/pl *ca.* 1.20. Pronotal disc flat in lateral view, with fine depression near apex. Surface with dense punctation, rough; space between punctures matt.

Elytra (Figs 10, 19). Widest across humeral calli (el/mew *ca.* 1.50); distinctly narrowed behind humerus, slightly broadened medially, strongly narrowed to apex. Dorsal surface glabrous, shining. Striae with subcircular, well isolated punctures, these becoming less numerous towards apex. Intervals flat, glabrous, with single line of short, protruding scales in two colours: brown on basal four fifths and white on apical fifth.

Legs (Figs 49–51). Front and middle legs robust; tibiae bisinuate, short and wide (ptbl/ptbmw *ca.* 4.00); hind tibiae with arched inner margin, distinctly narrowed before apex. Femora with rough surface and distinct, transverse corrugation. Front and middle femora stout with small ventral tooth, surface between tooth and apex with semicircular, deep cavity. Base of hind femora distinctly compressed, slightly twisted. Corrugation on flattened, basal part of legs deeper and parallel horizontally. Claws toothed.

Abdomen (Fig. 86). Weakly narrowed, almost as long as maximal width at base. Suture between ventrites 1 and 2 depressed laterally; medially not depressed, only as thin



Figures 10–18. Elytra and pronotum, dorsal view: **10** *Rasilinus bicolor* sp. n. **11** *R. bifurcatus* sp. n. **12** *R. bimaculatus* sp. n. **13** *R. grandidens* sp. n. **14** *R. longulus* sp. n. **15** *R. subgemellus* sp. n. **16** *R. subnodulus* sp. n. **17** *R. tchambicus* sp. n. **18** *R. virgatus* sp. n.

line; sutures between ventrites 2–5 wide, strongly depressed. Last ventrite with widely rounded posterior margin; $2 \times$ as wide as long. Entirely covered with deep punctation and piliform, white setae; surface glabrous, shining. Pygidium of male subquadrate, dorsal surface with sparse punctures. Ventral processes elongate with single, short setae.

Male terminalia (Figs 100, 107, 114). Tegminal apodeme short and narrowed. Pedon slightly, regularly tapering toward rounded apex; base fully sclerotized; in lateral view distinctly curved with upturned apex. Basal part of sternite VIII apodeme extended into pair of elongate, slightly curved and tapering processes; Sternite IX with two small, subtriangular sclerites situated at apical part of divided appendices. Tegmen with parameres fused over basal third of length, without intervening membrane.

Female (Figs 94, 121, 126, 131). Similar to male in measurements and proportion of body, but slightly larger. Subtriangular white mark on pronotum smaller; two white spots at the middle of elytra absent. Fore tibiae more slender than those of male; subapical part of femora less concave; tooth on fore and middle femora minute. Abdominal tergite VIII subcircular with small punctures at lateral margin; apically with elongate setae some of which are slightly broadened basally. Gonocoxite as in Fig. 121, elongate, slightly constricted medially. Spermatheca stout, short, weakly concave. Apodeme of sternite VIII long, base split into pair of short, acute processes; apical lobe irregular, furnished with elongate setae at anterior angle.

Measurements. Holotype, ♂/paratype, ♀: apw 0.50/0.55; arw 0.25/0.30; bew 1.15/1.35; bpw 0.65/0.75; el 1.75/2.00; eyl 0.25/0.30; frw 0.15/0.15; hl 0.35/0.40; hw 0.25/0.30; lb 2.55/2.90; mew 1.15/1.35; mith 0.20/0.25; mpw 0.65/0.75; mth 0.30/0.35; pl 0.55/0.60; ptbl 0.60/0.70; ptbmw 0.15/0.15; rl 0.40/0.45; scl 0.55/0.55.

Type material. Holotype, ♂–20°33'S/164°48'E, 20–50 m., Cascade de Tao, humid forest along stream, 01.02. 2004, leg. M. Wanat (MNHN).

Paratypes: 1♀– 20°23.9'S/164°31.9'E, Mandjélia (summit), 12.01.2007, 750–780 m, beating, montane forest, leg. M. Wanat & R. Dobosz (MNHW); 1♀– 20°33'S/164°46'E, Mt. Panié, 500–1000 m, E track, humid forest, 03.02.2004, leg. M. Wanat (MNHW).

Etymology. This specific epithet is derived from the Latin prefix *bi-* (two), and noun *color* (color, pigment) and refers to the bicolored body. A noun in apposition.

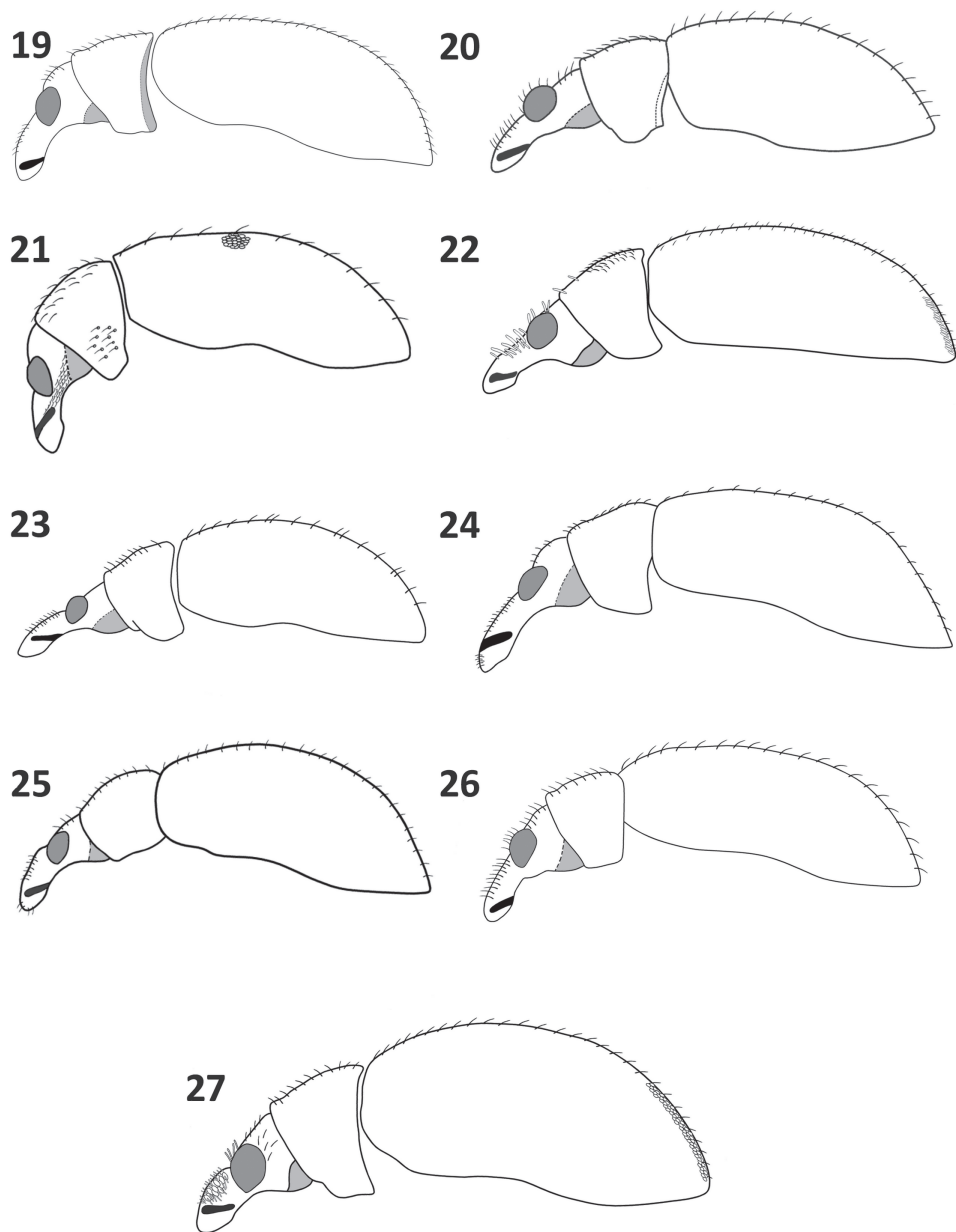
Distribution. New Caledonia (main island, north province).

***Rasilinus bifurcatus* sp. n.**

<http://zoobank.org/B42F2DD0-A97C-4E1E-B773-CCB252CC9B7B>

Figs 2, 11, 20, 29, 38, 52–54, 78, 87, 99, 101, 108, 115

Diagnosis. The species can be distinguished from other species by the following combination of features: rostrum short and wide; eyes strongly convex laterally; lateral line of temples longer than length of eyes, distinctly divergent. Last abdominal ventrite apically with two shallow grooves bearing elongate setae. Parameroid lobes of tegmen separate to base. Internal sac of aedeagus with two, elongate, sclerites. Most similar to



Figures 19–27. General habitus, lateral view: **19** *Rasilinus bicolor* sp. n. **20** *R. bifurcatus* sp. n. **21** *R. bimaculatus* sp. n. **22** *R. grandidens* sp. n. **23** *R. longulus* sp. n. **24** *R. subgemellus* sp. n. **25** *R. subnodulus* sp. n. **26** *R. tchambicus* sp. n. **27** *R. virgatus* sp. n.

R. longulus sp. n. but can be easily distinguished by toothed tarsal claw (unarmed in *R. longulus* sp. n.), stronger convex eyes— $hw/hl = 1.00$ (*R. longulus* sp. n.— $hw/hl = ca. 1.20$) and shorter rostrum— $rl/arw = 1.50$ (*R. longulus* sp. n.— $rl/arw = 1.70$).

Description. Body length (lb) *ca.* 3.20 mm.

Body colour and vestiture (Fig. 2). Head, pronotum and elytra dark brown to black; rostrum and legs reddish, apex dark; apical part of tibiae darkening. Antennal scape orange; funicle and club darker. Dorsal surface of rostrum covered with suboval, white scales, middle of rostrum with asetose line. Ventral side of rostrum at base and prosternum covered densely with suboval, white scales. Legs with mixed dark and white elongate scales; hind femora with indistinct transverse stripe composed of small, sub-oval, white scales.

Head, rostrum and antennae (Figs 20, 29, 38). Head capsule subquadrate (hw/hl *ca.* 1.00). Forehead flat. Eyes convex, strongly protruding dorsally, shorter than half length of head (eyl/hl *ca.* 0.45). Rostrum weakly curved; longer than wide at apex (rl/arw *ca.* 1.50). Funicle shorter than scape; desmomer 1 strongly broadened, *ca.* 2 × as long as maximal width, as long as 2+3; 2 elongate, longer than 3; 3 longer than wide; 4–7 subquadrate. Club elongate, more than 2 × longer than wide, almost as long as desmomer 2–7; compact.

Pronotum (Figs 11, 20). Shorter than wide (mpw/pl *ca.* 1.20); apical margin straight; base weakly rounded. Widest at middle; anterior half narrower than base. Pronotal disc, when viewed laterally, more sloping towards head than elytra. Surface strongly rough with dense punctation, space between punctures with microsculpture, matt.

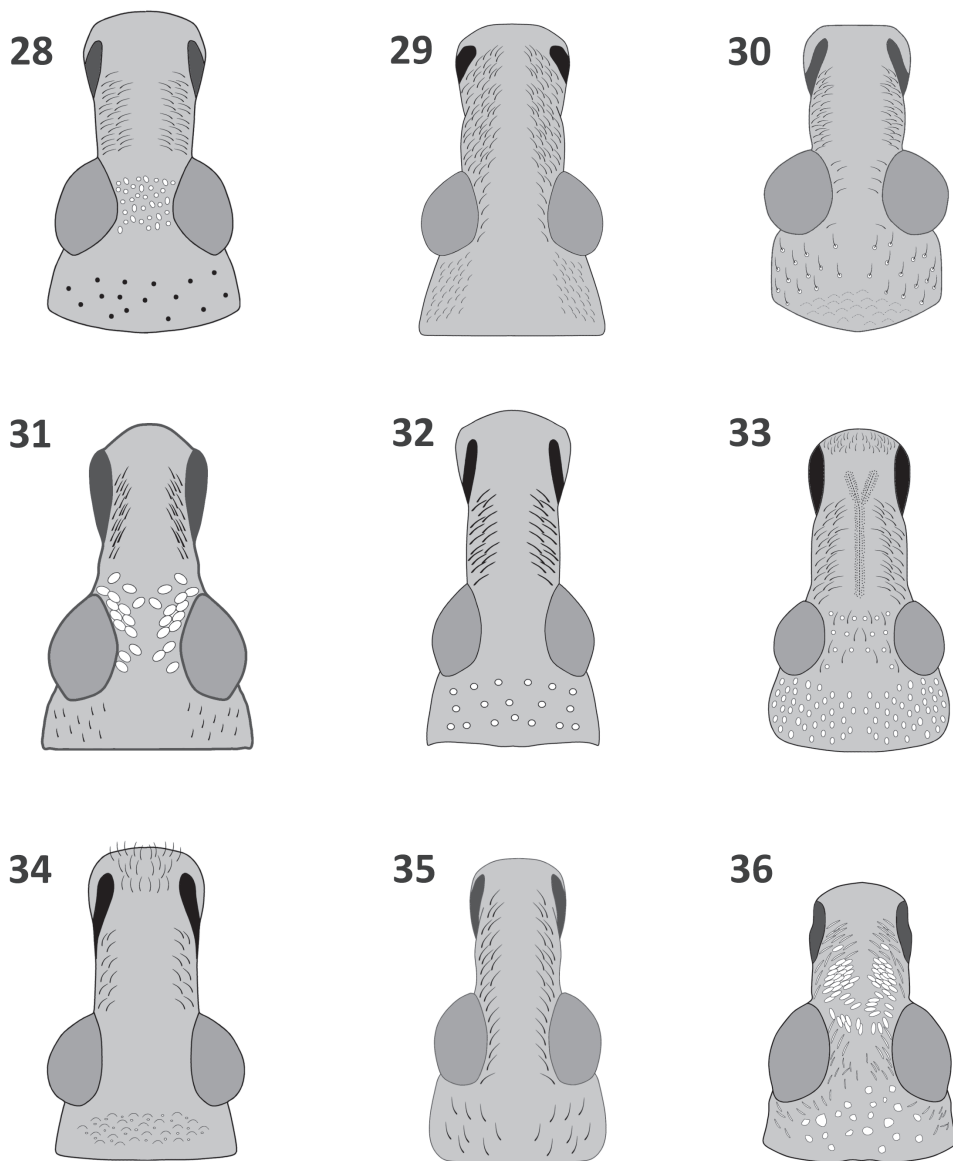
Elytra (Figs 11, 20). Widest behind humeral calli, elongate (el/mew *ca.* 1.60), from middle of length strongly narrowed to apex. Dorsal surface slightly shining. Striae with suboval, well isolated punctures, in distal two-thirds of length becoming less numerous towards apex. Intervals weakly convex across whole length.

Legs (Figs 52–54, 78). Front and middle legs elongate; tibiae straight, slender (ptbl/ptbmw *ca.* 5.30). Hind tibiae slender, regularly curved. Front femora glabrous, without tooth; middle femora with small tooth. Claws with obtuse teeth.

Abdomen (Fig. 87, 99). Weakly narrowed, slightly longer than wide at base. Sutures between ventrites 2–5 wide and strongly depressed. Last ventrite almost 2 × wider than long; surface with sparse punctures and elongate setae; lateral margin along two-thirds of length with distinctive, sharp edges, apically with two shallow grooves, each bearing few elongate setae; apical margin widely rounded. Pygidium of male subquadrate, dorsal surface with single, sparse punctures. Ventral processes broad, stout, subquadrate with concentration of elongate setae in the middle and on apical margin.

Male terminalia (Figs 101, 108, 115). Aedegal pedon almost as long as apodemes; regularly narrowed, strongly constricted apically with rounded apex; basal part of pedon completely sclerotised. In lateral view regularly curved with slightly upturned apex. Internal sac with irregular transfer apparatus and two elongate, acute processes. Tegmen with parameroid lobes shorter than apodeme; parameroid lobes completely bilobed, entirely surrounded by membrane; apical part of membrane with distinct, elongate setae. Sternite VIII with elongate, stout apodeme; basal part of apodeme enlarged. Sternite IX with two highly visible, irregular sclerites.

Female. Unknown



Figures 28–36. Head and rostrum, dorsal view: **28** *Rasilinus bicolor* sp. n. **29** *R. bifurcatus* sp. n. **30** *R. bimaculatus* sp. n. **31** *R. grandidens* sp. n. **32** *R. longulus* sp. n. **33** *R. subgemellus* sp. n. **34** *R. subnodulus* sp. n. **35** *R. tchambicus* sp. n. **36** *R. virgatus* sp. n.

Measurements. Holotype, ♂: apw 0.60; arw 0.30; bew 1.30; bpw 0.75; el 2.15; eyl 0.25; frw 0.20; hl 0.55; hw 0.55; lb 3.20; mew 1.35; mith 0.25; mpw 0.80; mth 0.50; pl 0.65; ptbl 0.80; ptbmw 0.15; rl 0.45; scl 0.60.

Type material. Holotype, ♂ – 22°11.0'S/165°17.6'E, Auopinié, 850–900 m., 18.01.2007, forest, leg. M. Wanat & R. Dobosz (MNHN).

Etymology. From the Latin prefix *bi-* (two), and noun *furca* (fork, two-pronged), refers to the two characteristic, elongate sclerites in the internal sac of aedeagus. An adjective.

Distribution. New Caledonia (main island, north province).

***Rasilinus bimaculatus* sp. n.**

<http://zoobank.org/1C320791-3DE2-4EA7-89F1-58FACEC1E9B3>

Figs 3, 12, 21, 30, 39, 46, 55–57, 79, 88, 102, 109, 116

Diagnosis. It differs from other members of the new genus in having two characteristic spots in the middle of elytra. Body elongate; head behind eyes wide and stout with parallel lateral margin of vertex, eyes hardly concave; claws strongly curved with prominent, acute basal tooth.

Description. Body length (lb) *ca.* 3.30 mm.

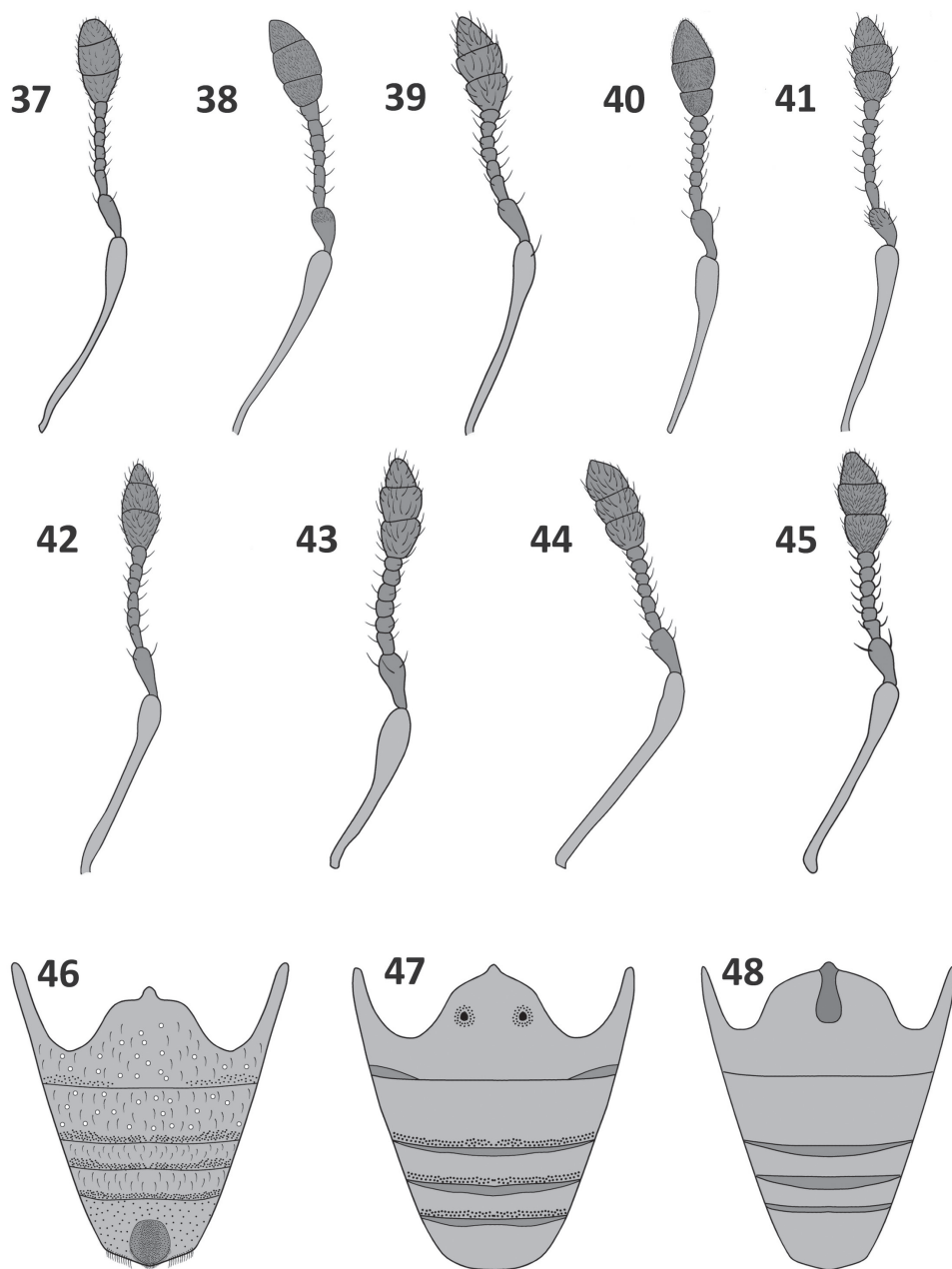
Body colour and vestiture (Fig. 3). Pronotum and elytra dark brown; dorsal surface of rostrum covered with suboval, white scales, middle of rostrum with asetose line; underside of rostrum with white, elongate scales. Pair of white spots at the middle of elytra (at third intervals) composed of small, strongly imbricate, suboval, white scales; intervals with line of protruding, elongate, dark and white scales. Femora brown with darker base; tibiae and tarsi dark orange. Antennae uniformly brown with brighter club. Hind femora with distinct transverse stripe composed of small, suboval, white scales.

Head, rostrum and antennae (Figs 21, 30, 39). Head capsule subquadrate (hw/hl *ca.* 1.00). Forehead flat. Eyes strongly convex, distinctly protruding above margin of head in dorsal and lateral views; half as long as head (ey/hl *ca.* 0.50). Vertex with distinctly, well isolated punctures. Rostrum short (rl/arw *ca.* 1.30), weakly curved. Funicle shorter than scape; desmomer 1 elongate, almost as long as 2–4; 2 slightly longer than 3; 3 subquadrate; 4–7 wider than long. Club more than 2 × longer than wide; as long as desmomer 2–7.

Pronotum (Figs 12, 21). Slightly shorter than wide (mpw/pl *ca.* 1.15); sides parallel, apically strongly narrowed; base bisinuate. Pronotal disc, when viewed laterally, more sloping towards head than elytra. Surface strongly rough with dense punctation, space between punctures with microsculpture, matt.

Elytra (Figs 12, 21). Widest across weakly protruding humeral calli, distinctly elongate (el/mew *ca.* 1.75), apical two thirds regularly tapering to apex. Dorsal surface glabrous, shining. Striae with suboval, well-isolated punctures, from one third of length becoming less numerous towards apex. Intervals flat across entire length.

Legs (Figs 55–57, 79). Front and middle femora stout, weakly narrowed basally; fore femora with very small, middle with distinct tooth on ventral margin. Tooth on hind femora sharp and narrow. Front tibiae bisinuate, broadened apically; middle tibiae elongate, weakly bisinuate, not broadened apically; hind tibiae regular curved, slightly narrowed apically. Claws strongly curved with prominent, acute, basal tooth.



Figures 37–48. Antennae (37–45) and abdominal sternites (46–48): 37 *Rasilinus bicolor* sp. n. 38 *R. bifurcatus* sp. n. 39 *R. bimaculatus* sp. n. 40 *R. grandidens* sp. n. 41 *R. longulus* sp. n. 42 *R. subgemellus* sp. n. 43 *R. subnodulus* sp. n. 44 *R. tchambicus* sp. n. 45 *R. virgatus* sp. n. 46 *R. bimaculatus* sp. n. 47 *R. subgemellus* sp. n. 48 *R. subnodulus* sp. n.

Abdomen (Fig. 46, 88). Weakly longer than maximal width, strongly narrowed to apex. First suture obsolete medially; sutures between ventrites 2–5 wide and strongly depressed. Last ventrite almost 2 × as wide as long with distinct, suboval cavity at middle; margin of cavity at anterior half with strongly elongate, bright setae, similar setae (but more sparse) on whole apical margin of last ventrite. Pygidium of male longer than wide, dorsal surface with sparse punctation; apical margin with elongate setae; ventral processes suboval with elongate setae at basal part and apical margin.

Male terminalia (Figs 102, 109, 116). Aedegal pedon shorter than apodemes, basally fully sclerotised and broadened, medially slightly narrowed; apex truncate, widely rounded. From lateral view distinctly broadened medially. Internal sac with single kidney shaped sclerite. Apodeme of sternite VIII strongly broadened and curved apically in lateral view, basal part arrow shaped; sternite IX with pair of clearly visible, subtriangular sclerites. Apodeme of tegmen broadened apically, longer than parameroid lobe, which is not completely divided.

Female. Unknown

Measurements. Holotype, ♂: apw 0.60; arw 0.35; bew 1.35; bpw 0.85; el 2.30; eyl 0.25; frw 0.20; hl 0.50; hw 0.55; lb 3.35; mew 1.35; mith 0.25; mpw 0.80; mth 0.45; pl 0.70; ptbl 0.75; ptbmw 0.15; rl 0.45; scl 0.60.

Type material. Holotype, ♂—No. 1194, 22°24.0'S × 164°31'E, 580 m., Mandje-lia, lower creek, 12–13 Dec 2004, rainforest, leg. G.B. Monteith, beating (MNHN).

Etymology. From the Latin prefix *bi-* (two), and noun *macula* (spot), refers to the two characteristic spots in the middle of the elytra. An adjective.

Distribution. New Caledonia (main island, north province).

***Rasilinus grandidens* sp. n.**

<http://zoobank.org/60A7AAB7-49DD-4195-B585-E09B08AF96E5>

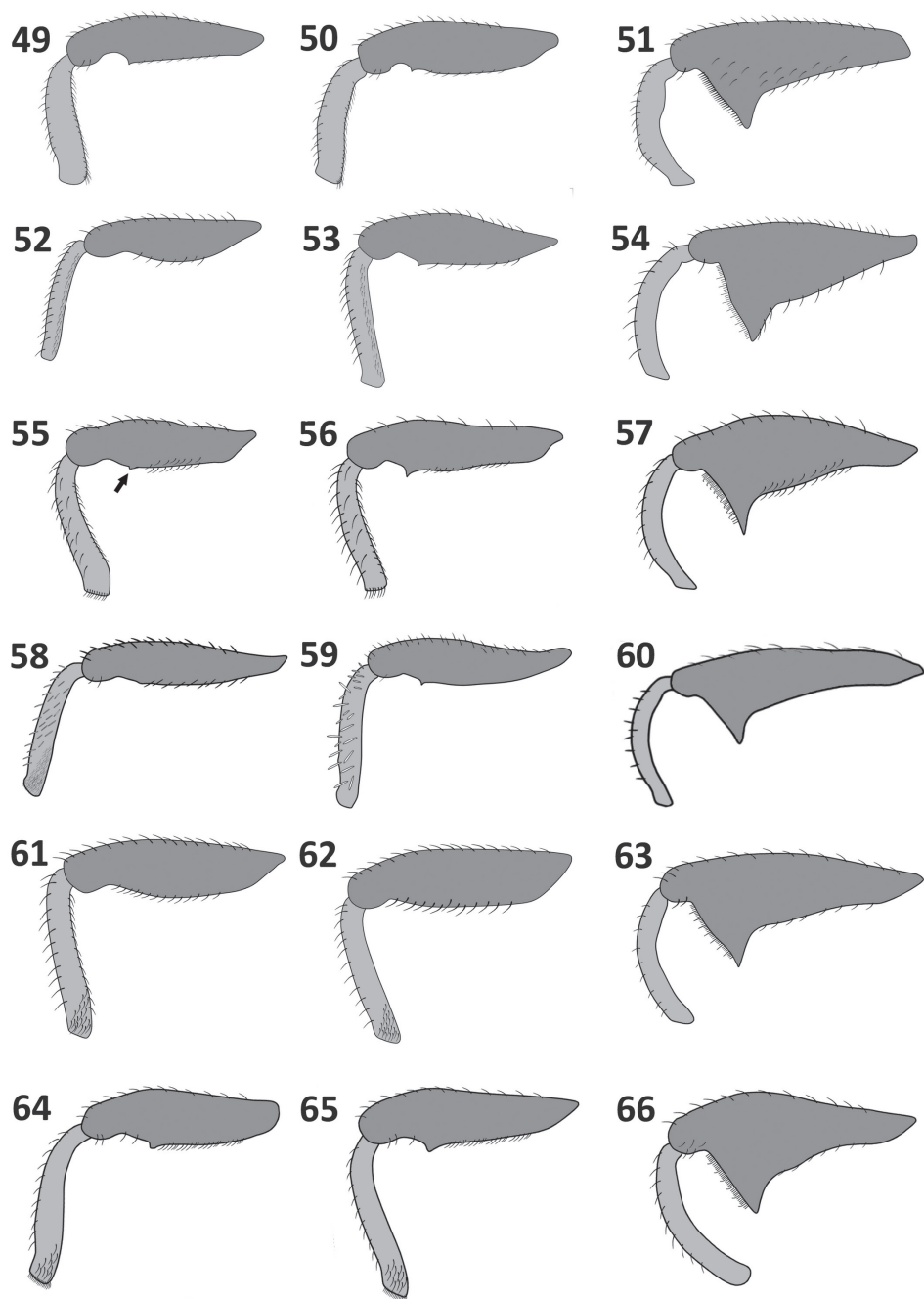
Figs 4, 13, 22, 31, 40, 57–60, 80, 93, 95, 117, 122, 127, 132

Diagnosis. This species is unique among members of the genus in having a blunt, large tooth on the basal part of the tarsal claws. Forehead and basal part of rostrum with suboval, white scales. Elytral striae composed of irregular punctures, from third striae outwards punctures fused into irregular line. Apical part of suture with stripe composed of fine, pale scales.

Description. Body length (lb) *ca.* 2.60 mm.

Body colour and vestiture (Fig. 4). Body generally blackish; legs dark brown; antennal scape orange, darkening toward apex; funicle and club dark brown. Elytral intervals with line of protruding, elongate, dark scales. First interval apically with indistinct line composed of white, minute, suboval scales. Hind femora with distinct transverse stripe composed of small, suboval, white scales.

Head, rostrum and antennae (Figs 22, 31, 40). Head transverse (hw/hl *ca.* 1.50). Forehead flat. Eyes convex, weakly protruding above margin of head in lateral and dorsal views, longer than half total length of head (eyl/hl *ca.* 0.80). Vertex without punc-



Figures 49–66. Legs: *Rasilinus bicolor* sp. n.: **49** front leg **50** middle leg **51** hind leg *R. bifurcatus* sp. n.: **52** front leg **53**–middle leg **54** hind leg *R. bimaculatus* sp. n.: **55** front leg (minute tooth marked by arrow) **56** middle leg **57** hind leg *R. grandidens* sp. n.: **58** front leg **59** middle leg **60** hind leg *R. longulus* sp. n.: **61** front leg **62** middle leg **63** hind leg *R. subgemellus* sp. n.: **64** front leg **65**–middle leg **66** hind leg.

tures, rough, matt. Rostrum less than twice its apical width (rl/arw *ca.* 1.60), weakly curved; dorsal part with two types of scales: one short and adjacent and other elongate, strongly protruding. Funicle shorter than scape; desmommere 1 enlarged, elongate, as long as 2–4; 2 longer than 3; 3–5 subquadrate; 6–7 wider than long. Club 2 × as long as wide, as long as desmomeres 2–7.

Pronotum (Figs 13, 22). Subisodiametric (mpw/pl *ca.* 1.10); slightly broadened to base, apically distinctly narrowed; base slightly bisinuate. Surface distinctly rough, matt, with short scales directed forwards.

Elytra (Figs 13, 22). Elongate (el/mew *ca.* 1.70), widest at about one-third of length, slightly tapering toward apex. Striae with subcircular, distinctive punctures, those of striae 1–2 fused into irregular line on their apical two thirds; striae 3–10 without distinctive punctures formed by shallow line. Intervals convex.

Legs (Figs 57–60, 80). Femora slender, fore unarmed, middle with small tooth, hind with relatively small and narrowed tooth. Tibiae elongate, slender, fore and middle straight, hind tibiae distinctive curved and slender, narrowed subapically. Claws strongly curved with broadened, acute basal tooth.

Abdomen (Fig. 93). Elongate, 1.30 × longer than wide. First suture obsolete along entire length, visible as thin line. Sutures between ventrites 2–5 distinctive, visible as strongly depressed line. Last ventrite subtriangular, widely rounded apically. Pygidium of female subtriangular, rounded apically; surface asetose with sparse punctures.

Female terminalia (Figs 95, 122, 127, 132). Sternite VIII with bifurcate base and pair of subquadrate lobes; apodeme strongly elongate. Abdominal tergite VIII subquadrate with parallel lateral margin. Apical margin widely rounded with very long, acute setae. Surface with sparse punctures. Ovipositor as in Fig. 122. Spermatheca as in Fig. 127.

Male. Unknown.

Measurements. Holotype, ♀: apw 0.50; arw 0.25; bew 1.05; bpw 0.60; el 1.75; eyl 0.25; frw 0.15; hl 0.30; hw 0.45; lb 2.60; mew 1.05; mith 0.20; mpw 0.60; mth 0.25; pl 0.55; ptbl 0.60; ptbmw 0.10; rl 0.40; scl 0.45.

Type material. Holotype, ♀– 22°11'S/165°17'E, Aoupinie, 900–950 m., gate-meteo st., 8.02.2004, leg. M. Wanat (MNHN).

Etymology. The specific epithet derived from the Latin adjective *grandis* (big, large) and the noun *dens* (a tooth) and refers to the distinctly toothed claws. A noun in apposition.

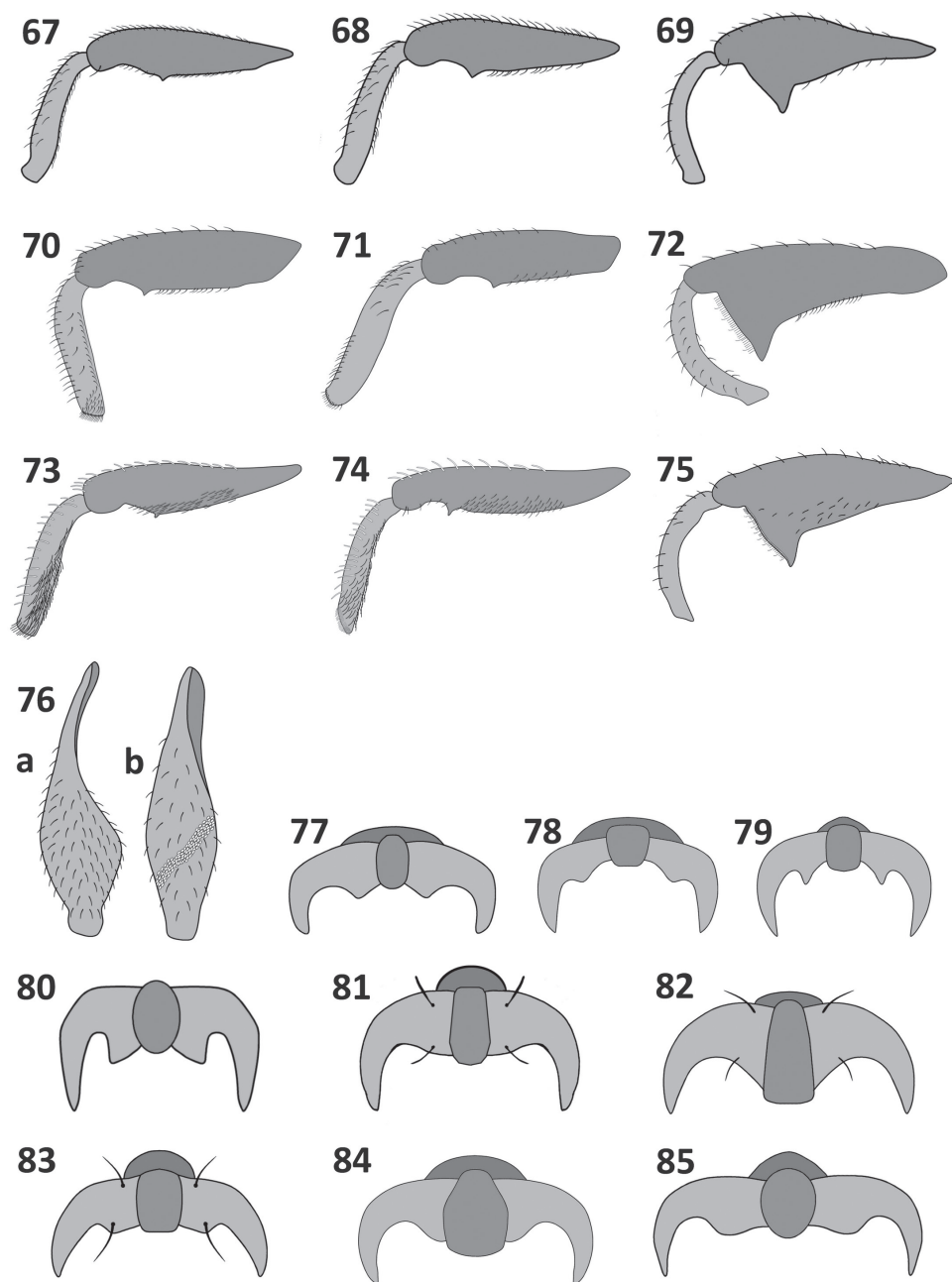
Distribution. New Caledonia (main island, north province).

Rasilinus longulus sp. n.

<http://zoobank.org/A456689F-20D7-4475-968F-274CE3101AE9>

Figs 5, 14, 23, 32, 41, 61–63, 81, 96, 123, 128, 133

Diagnosis. The following combination of characters allows this species to be distinguished from its congeners: rostrum elongate, distinctly curved laterally; ventral margin



Figures 67–85. Legs (67–75) and tarsal claws (77–85): *Rasilinus subnodulus* sp. n.: **67** front leg **68** middle leg **69** hind leg *R. tchambicus* sp. n.: **70** front leg **71** middle leg **72** hind leg *R. virgatus* sp. n.: **73** front leg **74** middle leg **75** hind leg **76** hind femora, dorsal view of: a –*Pactola* (Pasc.) and b –*Rasilinus* gen. n. **77** *R. bicolor* sp. n. **78** *R. bifurcatus* sp. n. **79** *R. bimaculatus* sp. n. **80** *R. grandidens* sp. n. **81** *R. longulus* sp. n. **82** *R. subgemellus* sp. n. **83** *R. subnodulus* sp. n. **84** *R. tchambicus* sp. n. **85** *R. virgatus* sp. n.

of fore and middle femora glabrous, without teeth; tarsal claws untoothed; base of sternite VIII in female as enlarged plate with distinctive, deep recess.

Description. Body length (lb) *ca.* 3.50 mm.

Body colour and vestiture (Fig. 5). Pronotum and elytra dark brown to blackish; head, rostrum and legs brighter; scape yellowish, funicle and club darker, brown. Dorsal surface of rostrum and outer margin of fore and middle tibiae with elongate, white scales. Hind femora with distinct transverse stripe composed of small, suboval, white scales. Pronotum entirely covered with short, indistinct, brown scales. Elytral intervals with line of protruding, elongate, dark scales.

Head, rostrum and antennae (Figs 23, 32, 41). Head subquadrate (hw/hl 0.90–1.00). Forehead flat. Eyes weakly convex laterally; protruding above margin of head in lateral view; half as long as head (eyl/hl; *ca.* 0.50); lateral margin of head strongly narrowed from base to hind margin of eyes. Vertex with sparse punctation, space between punctures rough, matt. Rostrum with length nearly 2 × its apical width (rl/arw *ca.* 1.70), curved laterally; dorsal part with two types of scale: one short and adjacent and other elongate, strongly protruding; middle of rostrum with asetose longitudinal line. Funicle shorter than scape; desmomer 1 *ca.* 1.50 × as long as 2; 2 almost 2 × longer than 3; 3–7 slightly longer than wide. Club 2 × as long as it is wide, as long as desmomeres 3–7.

Pronotum (Figs 14, 23). Slightly longer than wide (mpw/pl *ca.* 1.15); side almost parallel, subapically distinctly narrowed; base and apical margin straight. Surface distinctly rough, matt.

Elytra (Figs 14, 23). Elongate (el/mew *ca.* 1.65), widest at about one-third of length; distinctly narrowed to apex. Striae with small, elongate punctures; apically with punctures disappearing, forming indistinct line. Intervals rugose, flat.

Legs (Figs 61–63, 81). Femora robust; front and middle with ventral margin glabrous, without tooth. Tibiae elongate, slender; fore and middle straight, hind regularly curved. Claws untoothed, only broadened basally.

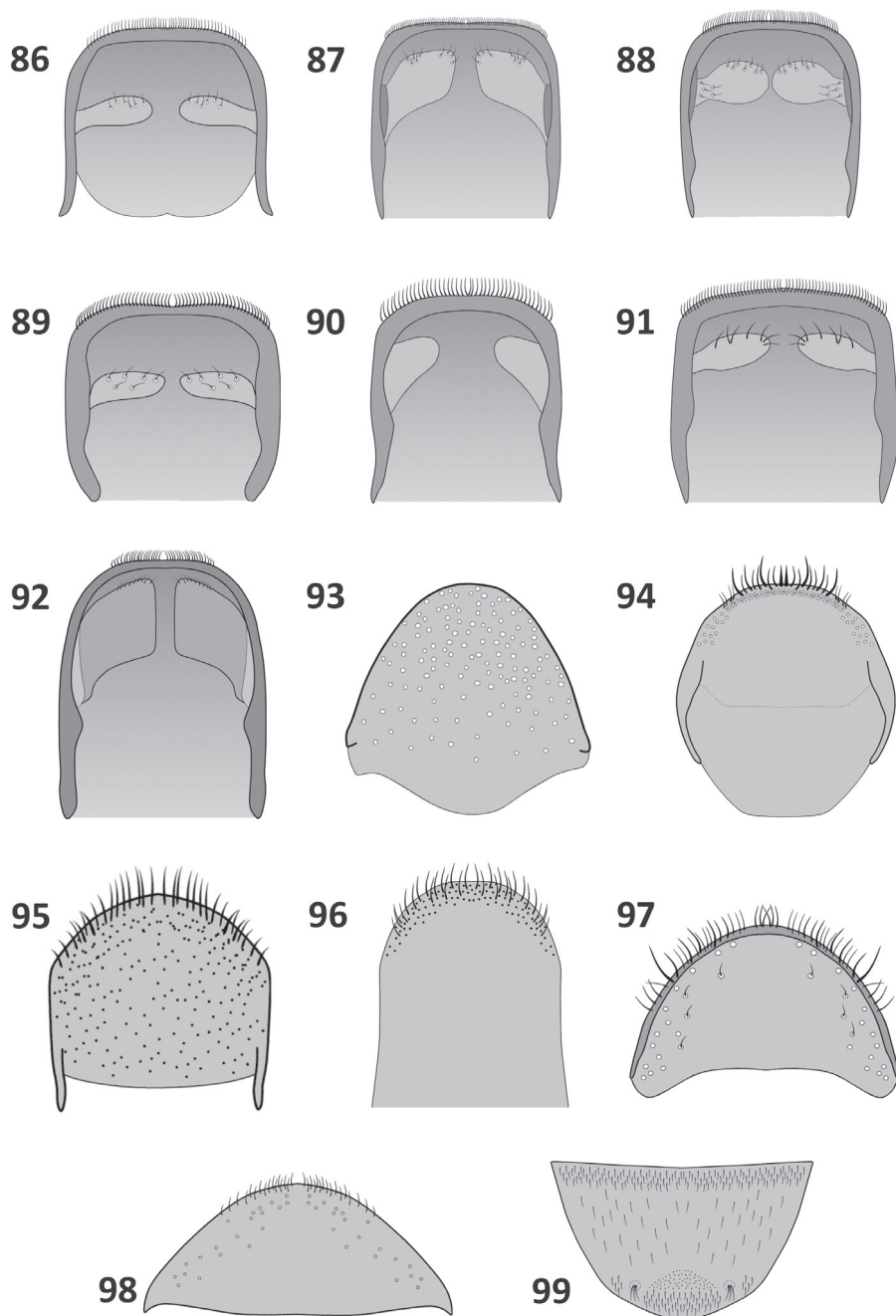
Abdomen. Elongate, *ca.* 1.20 × longer than wide. First suture obsolete along whole length. Sutures between ventrites 2–5 strongly depressed medially. Last ventrite subtriangular, widely rounded apically.

Female terminalia (Figs 96, 123, 128, 133). Abdominal tergite VIII massive, distinctly longer than wide; apex widely rounded, covered with long setae. Ovipositor slender, almost straight. Spermatheca L-shaped. Sternite VIII with long, thin apodeme; base with enlarged, suboval plate, deeply recessed medially.

Male. Unknown.

Measurements. Holotype, ♀/paratypes, ♀: apw 0.65/0.60–0.65; arw 0.35/0.30–0.35; bew 1.50/1.45–1.50; bpw 0.85/0.80–0.85; el 2.40/2.30–2.35; eyl 0.25/0.25; frw 0.15/0.15; hl 0.50/0.50–0.55; hw 0.50/0.45–0.50; lb 3.50/3.55–3.60; mew 1.50/1.45–1.50; mith 0.25/0.25; mpw 0.85/0.80–0.85; mth 0.45/0.45; pl 0.75/0.75; ptbl 0.80/0.80; ptbmw 0.10/0.10; rl 0.60/0.60; scl 0.65/0.60–0.65.

Type material. Holotype, ♀– 21°11'S/165°17'E, Aoupinie, 850–900 m., 18.01.2007, forest, leg. M. Wanat & R. Dobosz (MNHN).



Figures 86–99. Terminalia. Male pygidium, ventral view (86–92), female pygidium, dorsal view (93), female abdominal tergite VIII, dorsal view (94–98) and last ventrite of male (99): 86 *Rasilinus bicolor* sp. n. 87 *R. bifurcatus* sp. n. 88 *R. bimaculatus* sp. n. 89 *R. subgemellus* sp. n. 90 *R. subnodulus* sp. n. 91 *R. tchambicus* sp. n. 92 *R. virgatus* sp. n. 93 *R. grandidens* sp. n. 94 *R. bicolor* sp. n. 95 *R. grandidens* sp. n. 96 *R. longulus* sp. n. 97 *R. subnodulus* sp. n. 98 *R. tchambicus* sp. n. 99 *R. bifurcatus* sp. n.

Paratype: 1♀, No. 8683, 20°58'S × 165°17'E, 500 m, Pic d'Amoa, N slopes, 10–24 Nov. 2001, leg C. Burwell & G. Monteith, malaise trap (QM); 1♀, No. 12003, 21°35'S × 165°51'E, 780 m, Mt. Rembai, top junction, 19 Dec 2004, leg. G. Monteith, beating, rainforest (QM).

Etymology. The specific epithet is derived from the Latin adjective *longus* (long) and diminutive ending *-ulus* and refers to the elongate rostrum.

Distribution. New Caledonia (main island, north and south provinces).

***Rasilinus subgemellus* sp. n.**

<http://zoobank.org/F4F6F30A-9F12-4744-ADA4-FB99D222770B>

Figs 6, 15, 24, 33, 42, 47, 64–66, 82, 89, 103, 110, 117

Diagnosis. The species is unique within the genus in having a pair of small nodules at the middle of the first ventrite of male; rostrum with distinct median keel; regularly rounded lateral margin of pronotum and parameroid lobes of tegmen with a pair of very short, sclerotised processes.

Description. Body length (lb) *ca.* 3.60 mm.

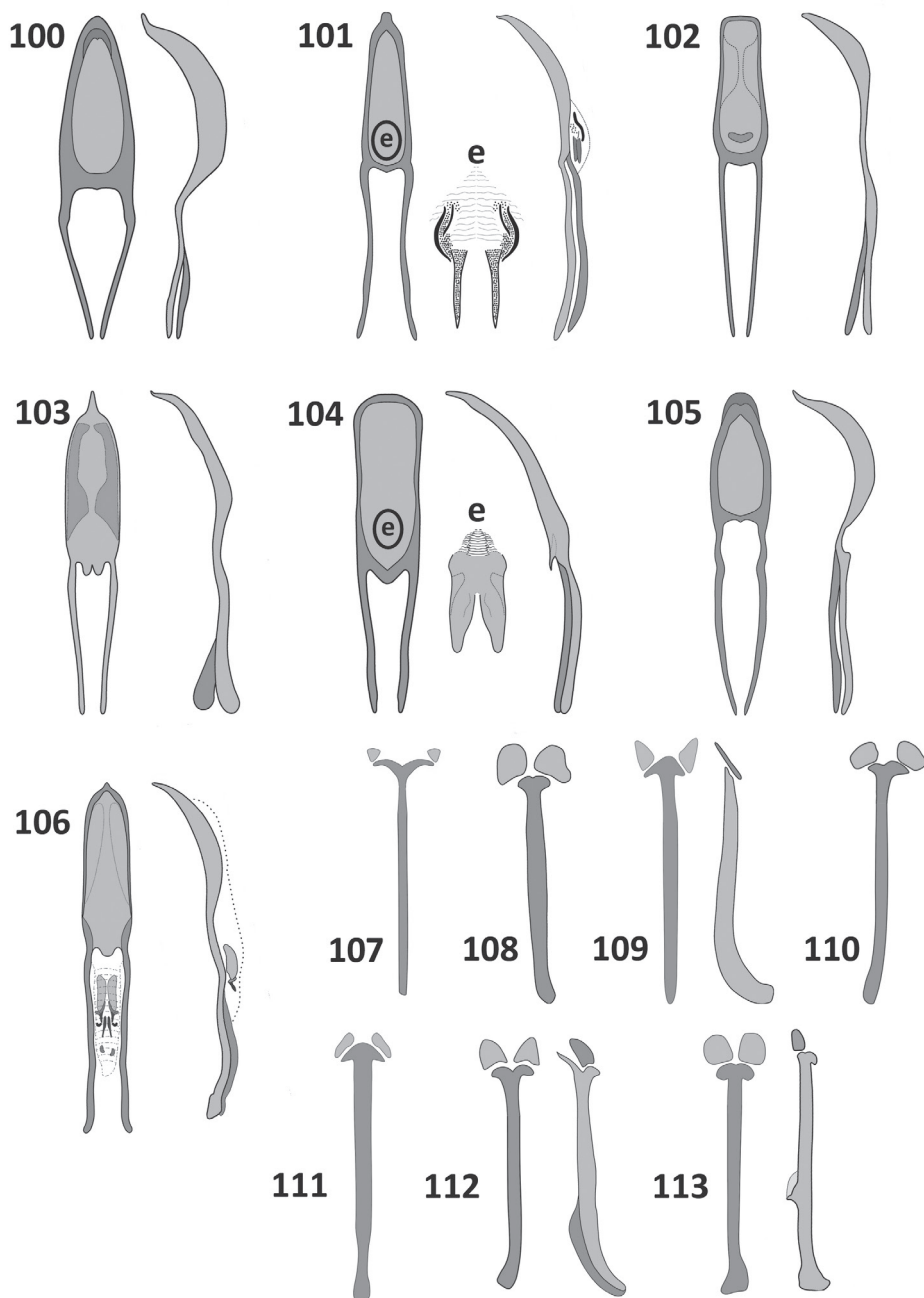
Body colour and vestiture (Fig. 6). Pronotum, elytra and tibiae dark brown to blackish; femora brown with darker base and apex. Scape of antennae orange, funicle and club darker. Dorsal part of rostrum covered with white, suboval scales. Tarsus with strongly elongated, white scales, sometimes much longer than length of tarsomeres. Hind femora with distinct, transverse, wide stripe composed of small, suboval, white scales. Intervals with line of elongate, strongly protruding, dark scales. Abdomen dark orange, apical margins of ventrites and pair of nodules much darker.

Head, rostrum and antennae (Figs 24, 33, 42). Head subquadrate (hw/hl *ca.* 1.10). Forehead slightly concave. Eyes relatively small, weakly convex laterally; slightly protruding above margin of head in lateral view; approximately as long as half-length of head (eyl/hl *ca.* 0.40). Vertex distinctly convex, with irregular, dense punctation, strongly scabrous; lateral margin broadened, widely rounded near base. Rostrum almost as long as it is double width at apex (rl/arw *ca.* 1.85), as long as head, weakly curved laterally; medially with distinct, protruding keel. Funicle shorter than scape; desmomer 1 strongly elongate, as long as 2–4 taken together; 2 slightly longer than 3; 3–7 slightly longer than wide. Club 2 × than wide, as long as desmomeres 3–7.

Pronotum (Figs 15, 24). Distinctly wider than long (mpw/pl *ca.* 1.25); laterally regularly rounded, narrowed subapically. Surface strongly rough, matt.

Elytra (Figs 15, 24). Elongate (el/mew *ca.* 1.55), widest across humeral calli, weakly narrowed to middle of length, strongest apically. Striae narrow, composed of small punctures, slightly concave only at apical part. Intervals wide, flat, strongly rugose, shining.

Legs (Figs 64–66, 82). Fore and middle legs elongate, slender; femora with tooth at ventral side; tibiae slightly bisinuate, narrowed subapically. Hind tibiae regularly curved. Claws untoothed, basally distinctly, regularly broadened.



Figures 100–113. Male terminalia. Aedeagus, dorsal and lateral view (**100–106**) spiculum gastrale, dorsal view (**107, 108, 110, 111**) spiculum gastrale, dorsal and lateral view (**109, 112, 113**): **100** *Rasilinus bicolor* sp. n. **101** *R. bifurcatus* sp. n. (e—endophallus with characteristic sclerites) **102** *R. bimaculatus* sp. n. **103** *R. subgemellus* sp. n. **104** *R. subnodulus* sp. n. **105** *R. tchambicus* sp. n. **106** *R. virgatus* sp. n. **107** *R. bicolor* sp. n. **108** *R. bifurcatus* sp. n. **109** *R. bimaculatus* sp. n. **110** *R. subgemellus* sp. n. **111** *R. subnodulus* sp. n. **112** *R. tchambicus* sp. n. **113** *R. virgatus* sp. n.

Abdomen (Fig. 47, 89). Slightly longer than wide. First ventrite with two distinct nodules; suture distinct laterally, medially obsolete. Sutures between ventrites 2–5 strongly depressed. Last ventrite wider than long; apical margin straight. Pygidium of male subquadrate, dorsal surface with sparse punctation. Apical margin with elongate setae. Ventral processes relatively small; with few, sparse setae.

Male terminalia (Figs 103, 110, 117). Aedegal pedon longer than apodemes, basal part unsclerotised, extended into pair of processes; apex strongly narrowed, acuminate. From lateral view curved irregularly with slightly upturned apex. Tegmen with subcircular tegminal ring; tegminal apodeme thin and short; parameroid lobes indistinct, composed of two fully separated, short processes, each surrounded by thin membrane. Basal part of sternite VIII irregularly bifurcate; hemisternites on sternite IX irregular, well visible.

Female. Unknown.

Measurements. Holotype, ♂: apw 0.70; arw 0.35; bew 1.60; bpw 0.95; el 2.50; eyl 0.30; frw 0.20; hl 0.65; hw 0.60; lb 3.60; mew 1.60; mith 0.25; mpw 1.00; mth 0.35; pl 0.80; ptbl 0.85; ptbmw 0.15; rl 0.65; scl 0.70.

Type material. Holotype, ♂– Loyalty Is., Lifu, nr. We(Oue), 2–35m, 26–28. III.1968; T.C. Maa, Collector, Bishop; N.Z. Arthropod Collection, private bag 92170, Auckland, New Zealand (MNHN).

Etymology. The specific epithet is derived from the Latin prefix *sub*– (on the lower side, beneath) and Latin adjective *gemellus* (paired, double) and refers to the pair of nodules situated on the first segment of the male abdomen.

Distribution. New Caledonia (Lifou Island).

***Rasilinus subnodulus* sp. n.**

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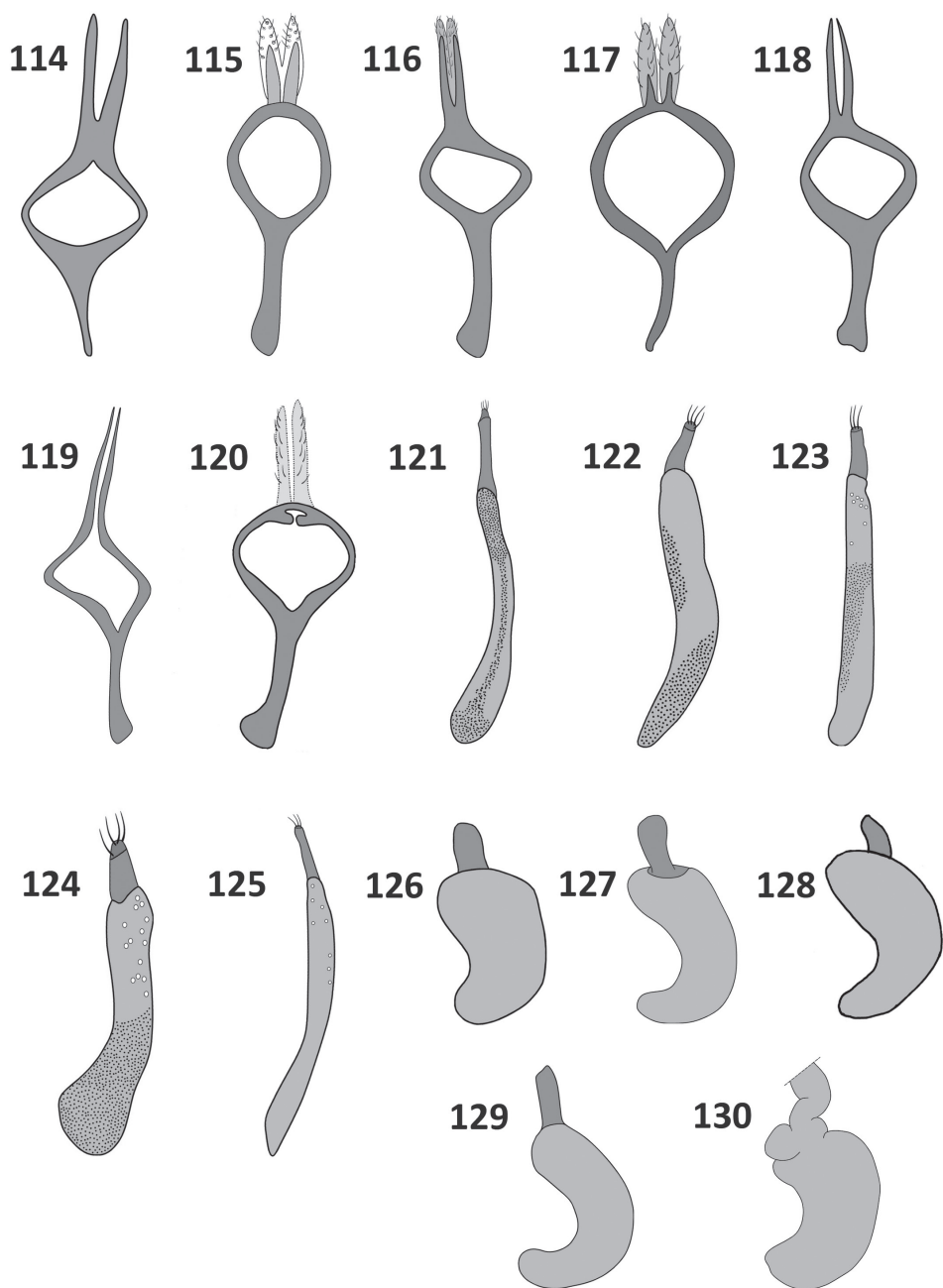
Figs 7, 16, 25, 34, 43, 48, 67–69, 83, 90, 97, 104, 111, 118, 124, 129, 134

Diagnosis. The species is unique within the genus in having a strongly convex pronotum and elytral disc; large tubercle in the middle of first ventrite in male; internal sac with characteristic sclerite with two elongate lobes; tegmen with parameroid lobes completely divided into two, thin parameres. Spermatheca of female slender and strongly curved; apex of sternite VIII T-shaped with well-developed, split almost to base, hemisternites.

Description. Body length (lb) 3.20–3.60 mm.

Body colour and vestiture (Fig. 7). Head, pronotum and elytra dark brown to blackish ventrally and dorsally. Legs varying from uniformly reddish to blackish with lighter medial part of femora or blackish basal part. Scape of antennae orange, funicle and club darker. Tarsi same colour as tibiae, sometimes last tarsomere lighter.

Head, rostrum and antennae (Figs 25, 34, 43). Head subquadrate (hw/hl ca 1.10). Forehead flat, wide (frw/hw ca. 0.45). Eyes distinctly convex laterally; length approximately half length of head (eyl/hl ca. 0.45). Vertex with distinctive, deep punctation, surface rough. Rostrum as long as head or longer (rl/hl 1.00–1.20), distinctly curved,



Figures 114–130. Terminalia. Male tegmen (114–120), female ovipositor (121–125) and spermatheca (126–130) : 114 *Rasilinus bicolor* sp. n. 115 *R. bifurcatus* sp. n. 116 *R. bimaculatus* sp. n. 117 *R. subgemellus* sp. n. 118 *R. subnodulus* sp. n. 119 *R. tchambicus* sp. n. 120 *R. virgatus* sp. n. 121 *R. bicolor* sp. n. 122 *R. grandidens* sp. n. 123 *R. longulus* sp. n. 124 *R. subnodulus* sp. n. 125 *R. tchambicus* sp. n. 126 *R. bicolor* sp. n. 127 *R. grandidens* sp. n. 128 *R. longulus* sp. n. 129 *R. subnodulus* sp. n. 130 *R. tchambicus* sp. n.

punctures only laterally, glabrous medially and matt on apical third. Funicle as long as scape; desmommere 1 as long as 1–2 taken together; 2 longer than 3; 3–7 subquadrate. Club $2 \times$ than wide, as long as desmomeres 3–7.

Pronotum (Figs 16, 25). Subquadrate ($mpw/pl = 1.00\text{--}1.07$); dorsally equilateral at base, strongly narrowed at apical half. Disc distinctly convex. Surface distinctly rough, densely punctate, matt.

Elytra (Figs 16, 25). Elongate ($el/mew = 1.40\text{--}1.58$), widest across humeral calli, regularly narrowed from base to apex. In lateral view distinctly convex. Striae narrow, composed of small punctures, becoming evidently smaller to obsolescent from middle of disc towards apex. Intervals wide, flat, glabrous, slightly shining.

Legs (Figs 67–69, 83). Fore tibiae distinctly narrowed apically; femora with minute tooth near midlength. Mid legs similar, tibiae weakly narrowed apically; femora with distinct tooth beyond midlength. Hind tibiae regularly curved. Claws weakly curved, basally with broadly rounded tooth and two pairs of elongate setae: one on bottom and second on upper side of the claw.

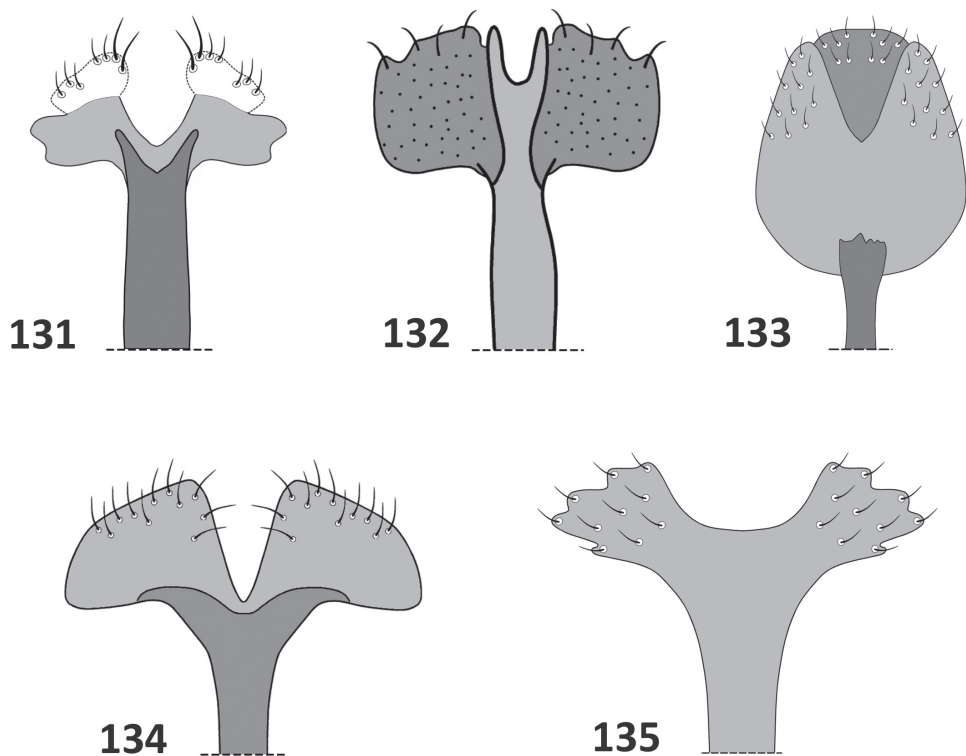
Abdomen (Figs 48, 90). Elongate, *ca.* $1.20 \times$ as long as maximum width at base. First ventrite with one distinct median nodule. Sutures between ventrites 2–5 strongly depressed. Last ventrite wider than long, slightly narrowed apically. Pygidium of male longer than wide, apical margin straight with elongate setae; inner folds distinct, asetose.

Male terminalia (Figs 104, 111, 118). Aedegal pedon longer than apodemes; lateral margins parallel with weak concavity at middle of length; apex widely rounded. In lateral view nearly straight basally, curved more strongly distally, slightly narrowed apically; basal part sclerotised, narrowed, extended into prominent, acute process. Endophallus with well visible transfer apparatus with pair of prominent process. Tegmen well sclerotised, incised to the base parameroid lobes; tegminal apodeme stout, broadened apically, as long as diameter of tegminal ring. Basal part of sternite VIII arrow-shaped, hemisternites on sternite IX elongate, well visible.

Female (Figs 97, 124, 129, 134). Similar to male body shape but slightly larger. Rostrum more elongate than in male (rl/arw $1.50\text{--}1.70$, in male *ca.* 1.40). First ventrite of abdomen without nodule, glabrous; last ventrite widely rounded. Abdominal tergite VIII wider than long with incrassate outer margin and elongate setae; surface sparsely punctate and with isolated short setae; apical margin rounded. Spermatheca strongly curved. Gonocoxite stout, conical. Apodeme of sternite VIII split into pair of short, acute processes connected with well-developed hemisternites.

Measurements. Holotype, ♂: apw 0.65; arw 0.35; bew 1.45; bpw 0.80; el 2.20; eyl 0.25; frw 0.25; hl 0.50; hw 0.55; lb 3.50; mew 1.45; mth 0.25; mpw 0.80; mth 0.40; pl 0.75; $ptbl$ 0.90; $ptbmw$ 0.15; rl 0.50; scl 0.60.

Paratypes, ♂/♀: apw 0.65–0.70/0.75; arw 0.35/0.35–0.40; bew 1.45–1.60/1.60–1.65; bpw 0.80–0.90/0.90–1.00; el 2.20–2.40/2.25–2.60; eyl 0.25/0.25–0.30; frw 0.25/0.20–0.25; hl 0.40–0.55/0.50–0.60; hw 0.55–0.60/0.55–0.60; lb 3.25–3.50/3.50–3.60; mew 1.45–1.60/1.60–1.65; mth 0.25/0.25; mpw 0.80–0.90/0.90–1.00; mth 0.40–0.45/0.40–0.45; pl 0.75–0.90/0.75–0.80; $ptbl$ 0.80–1.00/0.95–1.00; $ptbmw$ 0.150.20/0.15–0.20; rl 0.45–0.50/0.60–0.65; scl 0.55–0.65/0.65–0.70.



Figures 131–135. Terminalia. Female, apex of sternite VIII: **131** *Rasilinus bicolor* sp. n. **132** *R. grandidens* sp. n. **133** *R. longulus* sp. n. **134** *R. subnodulus* sp. n. **135** *R. tchambicus* sp. n.

Type material. Holotype, ♂– 21°11.0'S 165°17.6'E; Aoupinié, 700–900 m.; 18.01.2007, forest; leg. R. Dobosz & M. Wanat (MNHN).

Paratypes: 1♀–No. 11975; 20°58'S×165°17'E, 480m.; Pic d'Amoa, north slope; 3 Jan 2005, rainforest; G. Monteith, beating (QM); 1♀–No. 11986; 21°09'S×165°19'E, 500m.; Aoupinié, lower east road; 17Dec2004; G. Monteith, beating, rainforest (QM); 1♀–No. 11984; 21°09'S×165°19'E, 500m.; Aoupinié, sawmill; 2 Jan 2005; G. Monteith, beating, rainforest (QM); 1♀–No. 11981; 21°09'S×165°19'E, 500m.; Aoupinié, sawmill; 17 Dec 2004; G. Monteith, MV light, rainforest (QM); 1♀–450–550 m., 5.2.63, Kuschel leg.; Col. d.Rousseltes (NZAC); 2♀♀–21°00.3'S 165°14.9'E; Tchamba (Wão Uni); 15.01.2007, refuge, 400 m.; night coll. (lamp & beating) leg. M. Wanat & R. Dobosz (MNHW); 1♀–21°10.8'S 165°18.1'E; Aoupinié, 650 m.; 18.01.2007, night beating; leg. M. Wanat (MNHW); 3♂♂–21°11.0'S 165°17.6'E; Aoupinié, 700–900 m.; 18.01.2007, forest; leg. R. Dobosz & M. Wanat (MNHW); 1♀–21.14890/165.32348; Aoupinié (refuge), 400 m.; beating rainforest; 29.11.2008; leg. M. Wanat (MNHW); 1♀–20.95280/165.29135; Pic d'Amoa (Povila), 400 m., rainforest; 22.11.2008; leg. M. Wanat (MNHW); 1♂–21°00.3'S 165°14.9'E; Tchamba (Wão Uni); 1.04.2008, day, rainforest; leg. T. Blaik (DBUO).

Etymology. The specific epithet is derived from the Latin prefix *sub-* (on the lower side, beneath) and Latin noun *nodulus* (knob, tubercle) and refers to the distinct nodule situated on the first segment of the male abdomen. A noun in apposition.

Distribution. New Caledonia (main island, north province).

***Rasilinus virgatus* sp. n.**

<http://zoobank.org/37FD7535-D457-46C2-8508-4DB6070BFF02>

Figs 9, 18, 27, 36, 45, 73–75, 85, 92, 106, 113, 120

Diagnosis. The following combination of characters allows this species to be distinguished from its congeners: head capsule almost quadrate; rostrum small, shorter than head capsule; elytra with stripe composed of pale scales at apical part of suture; tegmen with membranous parameroid lobes and dorsal part of tegminal ring bearing a pair of short, broadly rounded sclerotised lobes; aedeagus with complex transfer apparatus in endophallus; male pygidium with enlarged ventral lobes, occupying almost half area of inner part of pygidium.

Description. Body length (lb) *ca.* 3.00 mm.

Body colour and vestiture (Fig. 9). Pronotum and elytra dark brown to blackish, head and rostrum lighter in colour. Legs uniformly brown with brighter tarsal claws. Rostrum covered with pale, suboval scales. Antennae with light brown scape and darkening funicle and club. Elytra with single line of erect, elongate, dark scale on each interval, additional surface entirely covered with minute, hardly visible, short, piliform, recumbent scales.

Head, rostrum and antennae (Figs 27, 36, 45). Head almost subquadrate (hw/hl *ca.* 1.10). Forehead flat. Eyes distinctly protruding above margin of head in lateral view; more than half as long as head (eyl/hl 0.67). Lateral margin of head slightly broadened to base. Vertex rough dorsally, with distinct punctation laterally. Rostrum short and robust, slightly shorter than head capsule (rl/hl *ca.* 0.90), *ca.* 1.60 × longer than maximum width (rl/arw), distinctly curved. Scape almost as long as funicle and club combined; first desmommere elongate, as long as 2–4; desmommere 2 broadened apically, longer than 3; desmomeres 3–7 subcircular, wider than long. Club *ca.* 2.0 × as long as its wide, longer than last six desmomeres.

Pronotum (Figs 18, 27). Wider than long (mpw/pl *ca.* 1.35). Strongly narrowed subapically, lateral margin almost entirely distinctly narrowed, broadened only on apical part. Basal margin weakly rounded, apical margin almost straight. Surface with irregular, deep punctures, rough, matt.

Elytra (Figs 18, 27). Elongate (el/mew *ca.* 1.55), widest in basal half; humerus not projecting; lateral margins in basal half subparallel, curving and converging apically, apices separate. Striae with suboval, distinct punctures in basal half, apical half with punctures much smaller. Intervals flat, shining, with minute nodules, each bearing elongate, erected seta.

Legs (Figs 73–75, 85). Front and middle legs slender; front femora with minute teeth beyond middle, middle femora with tooth more elongate, and hind femora with

enlarged tooth with sharp edge; hind femora regularly tapering toward base, fusiform. Front and middle tibiae almost straight, slightly narrowed subapically; hind tibiae regularly curved, narrowed near base. Claws regularly curved, distinctly broadened near base; tooth not developed.

Abdomen (Fig. 92). Short, almost as long as its maximum width at base. First suture clearly visible along entire length; sutures 2–4 depressed. Middle area at basal part of first ventrite distinctly depressed. Surface glabrous, shining. Last ventrite subtriangular, almost $2 \times$ wider than long; apical margin regularly rounded. Pygidium of male elongate, *ca.* $1.30 \times$ longer than wide; apical margin straight with numerous elongate setae; ventral lobes enlarged, subquadrate with few, short setae only at apical angles.

Male terminalia (Figs 106, 113, 120). Aedeagal pedon as long as apodemes; basal part unsclerotised, extended; lateral margins slightly narrowed; apex with short, prominent process, in lateral view regularly curved. Endophallus with complex apparatus and few free sclerites. Tegminal apodeme broadened apically; dorsal part of tegminal ring with pair of short, broadly rounded processes between the parameroid lobes; parameroid lobes shorter than tegminal apodeme, weakly sclerotised with few, sparse setae. Basal part of sternite VIII with pair of broad, short processes; apodeme elongate, laterally flattened with broadened apex and acute, short teeth beyond middle of length connected with short membrane; hemisternites clearly visible, subcircular.

Female. Unknown.

Measurements. Holotype, male: apw 0.55; arw 0.25; bew 1.30; bpw 0.75; el 2.00; eyl 0.30; frw 0.15; hl 0.45; hw 0.50; lb 3.00; mew 1.30; mith 0.20; mpw 0.75; mth 0.50; pl 0.55; ptbl 0.70; ptbmw 0.15; rl 0.40; scl 0.50.

Type material. Holotype, ♂ – 22.03188/166.46738, Dzumac Mts 900m, Mt Ouin road junction, night beating, 29.10.2008, leg. M. Wanat (MNHN).

Etymology. The specific epithet is the Latin adjective *virgatus* (striped) and refers to the stripe of pale scales at the apical part of the suture.

Distribution. New Caledonia (main island, south province).

Key to species

The known species of the new genus *Rasilinus* can be separated as follows:

- 1 Body bicoloured, apical part of elytra, legs and head dark brown to black; base of elytra and pronotum reddish (Fig. 1) ***R. bicolor***
- Elytra and pronotum uniformly brown to almost black (Figs 2–9) **2**
- 2 Elytra with pair of white spots medially (Figs 3, 12, 21) ***R. bimaculatus***
- Elytra without any spots **3**
- 3 Apical part of elytral suture with a stripe composed of fine, white scales differing from those on elytral disc (Figs 13, 18) **4**
- Apical part of elytral suture without distinctive scales forming a stripe **5**

- 4 Elytra *ca.* 1.70 × as long as wide; tarsal claws strongly curved with broadened, stout, basal tooth (Fig. 80) ***R. grandidens***
- Elytra *ca.* 1.50 × as long as wide; tarsal claws weakly curved, distinctly broadened near base, without tooth (Fig. 85) ***R. virgatus***
- 5 Ventral margin of front femora with tooth **6**
- Ventral margin of front femora unarmed **8**
- 6 Rostrum elongate (rl/arw *ca.* 1.85); median keel on rostrum present (Fig. 33); first abdominal ventrite of male with pair of small, median tubercles (Fig. 47)..... ***R. subgemellus***
- Rostrum shorter (rl/arw = 1.20–1.60); median keel on rostrum absent (Figs 34, 35); first abdominal ventrite of male without median tubercles or with a single large one **7**
- 7 Larger species (lb = 3.25–3.60); pronotum subquadrate (mpw/pl = 1.00–1.07); first abdominal ventrite of male with a large median tubercle (Fig. 48) ***R. subnodulus***
- Smaller species (lb = 2.45–2.90); pronotum transverse (mpw/pl = 1.15–1.27); first abdominal ventrite of male without median tubercle ***R. tchambicus***
- 8 Middle femora with small tooth (Fig. 53); eyes strongly convex; rostrum stout, shorter than 2 × its maximum wide (Fig. 29); claws with obtuse tooth (Fig. 78)..... ***R. bifurcatus***
- Middle femora unarmed (Fig. 62); eyes weakly convex; rostrum elongate, longer than 2 × its maximum width (Fig. 32); claws only enlarged at base (Fig. 81)..... ***R. longulus***

Discussion

The new genus *Rasilinus* is superficially similar to the genus *Koghicola* Mazur, 2014 but can be easily distinguished by the absence of the prominent processes at the apex of the elytra and normal (not enlarged) trochanters (see Fig. 4 in Mazur 2014b). The new genus, together with genus *Pactola* Pascoe, 1876 and *Koghicola*, has a very characteristic form of the hind legs with strongly broadened femora and curved tibiae. However, the new genus can be easily distinguished from both other genera by the distinctive shape of the femora (clearly visible in dorsal view) (Fig. 76). In *Pactola* the hind femora have a very thin and strongly curved basal half (see Figs 17a–20c in Mazur 2014a), whereas *Koghicola* and *Rasilinus* gen. n. display a weakly curved and more massive base of the hind femora (see Figs 10–12 in Mazur 2014b). Additionally, in *Rasilinus* gen. n. the basal part of the hind femora at its inner side is clearly compressed.

Most known species from the tribe Eugnomini that have been described so far come from New Zealand. From New Caledonia only two genera have been known for many years—the monotypic genus *Callistomorphus* Perroud, 1865 and three species from the genus *Pactola* Pascoe, 1876 (describe at the time as *Macropoda* Montrouzier, 1861, see Mazur 2014a).

Fauna of New Caledonian Eugnomini have not been investigated in greater detail so far. Until now three more species of *Pactola* and one monotypic genus *Koghicola* Mazur, 2014b have been described (Mazur 2014a, b; Mazur and Jezuita 2015), while many others are in preparation (Mazur in prep. and Mazur unpublished data).

A wide distribution of the tribe (from South America to Australian region) with many endemic genera and extremely intra- and interspecies variability causes many problems with redefinition of the tribe. Furthermore, many genera have not been described so far, so phylogeny, zoogeography and origin of the tribe still require further research.

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Taxonomic review of the genus *Teliphasa* Moore, 1888 from China, with descriptions of four new species (Lepidoptera, Pyralidae, Epipaschiinae)

Linjie Liu¹, Yiping Wang¹, Houhun Li¹

¹ College of Life Sciences, Nankai University, Tianjin 300071, P. R. China

Corresponding author: Houhun Li (lihohun@nankai.edu.cn)

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Abstract

The genus *Teliphasa* Moore, 1888 from China is reviewed. Nine species are treated, including descriptions of four new species: *Teliphasa spinosa* Li, **sp. n.**, *T. similalbifusa* Li, **sp. n.**, *T. erythrina* Li, **sp. n.**, and *T. hamata* Li, **sp. n.** Photographs of adults, wing venation, and both male and female genitalia are provided, along with a key for the identification of all the Chinese species.

Keywords

Lepidoptera, Pyralidae, Epipaschiinae, *Teliphasa*, taxonomy, new species, China

Introduction

The genus *Teliphasa* was erected by Moore (1888) to accommodate the two species, *T. orbiculifer* and *T. nubilosa* from India, with *T. orbiculifer* as the type. *Teliphasa* is closely allied to *Macalla* Walker, 1859, in which several *Teliphasa* species were once included. Janse (1931) recombined *Stericta picta* Warren, 1895 from *Macalla* to *Teliphasa*, which was later placed in the genus *Orthaga* by Shaffer et al. (1996). Mutuura (1957) transferred *T. elegans* (Butler, 1881) and *T. amica* (Butler, 1879) from *Macalla*

to *Teliphasa*. Ghesquière (1942) reported *T. dibelana* from Congo and Zaire, and Viette (1960) described *T. andrianalis* from Madagascar. Inoue and Yamanaka (1975) made a revision of the *Teliphasa* species in Japan, in which they transferred *T. albifusa* (Hampson, 1896) from *Macalla* to the present genus and described a new species *T. sakishimensis*. Solis (1992) provided a list of the Old World Epipaschiinae, in which six species of *Teliphasa* were included. Koçak (1987) proposed a new genus *Sultania* with *Macalla lophotalis* Hampson, 1900 as the type. But currently *Sultania* is considered as a synonym of *Teliphasa* (Nuss et al. 2003–2015).

Teliphasa comprises nine species worldwide, occurring in the Oriental, Palaearctic and Ethiopian regions. Five species were recorded in China prior to this study. The aim of the present paper is to review nine species of *Teliphasa* recognized in China, including descriptions of four new species.

Materials and methods

The present study is based on the examinations of the specimens collected by light traps. Adults were examined using an Olympus SZX9 stereomicroscope. Permanent mounting methods of genitalia and venation follow the techniques introduced by Li (2002). Images of adults and genitalia were taken by using a Leica M205A stereo microscope and a Leica DM750 microscope.

All the studied specimens, including the types of the new species, are deposited in the Insect Collection of College of Life Sciences, Nankai University (NKUM), Tianjin, China.

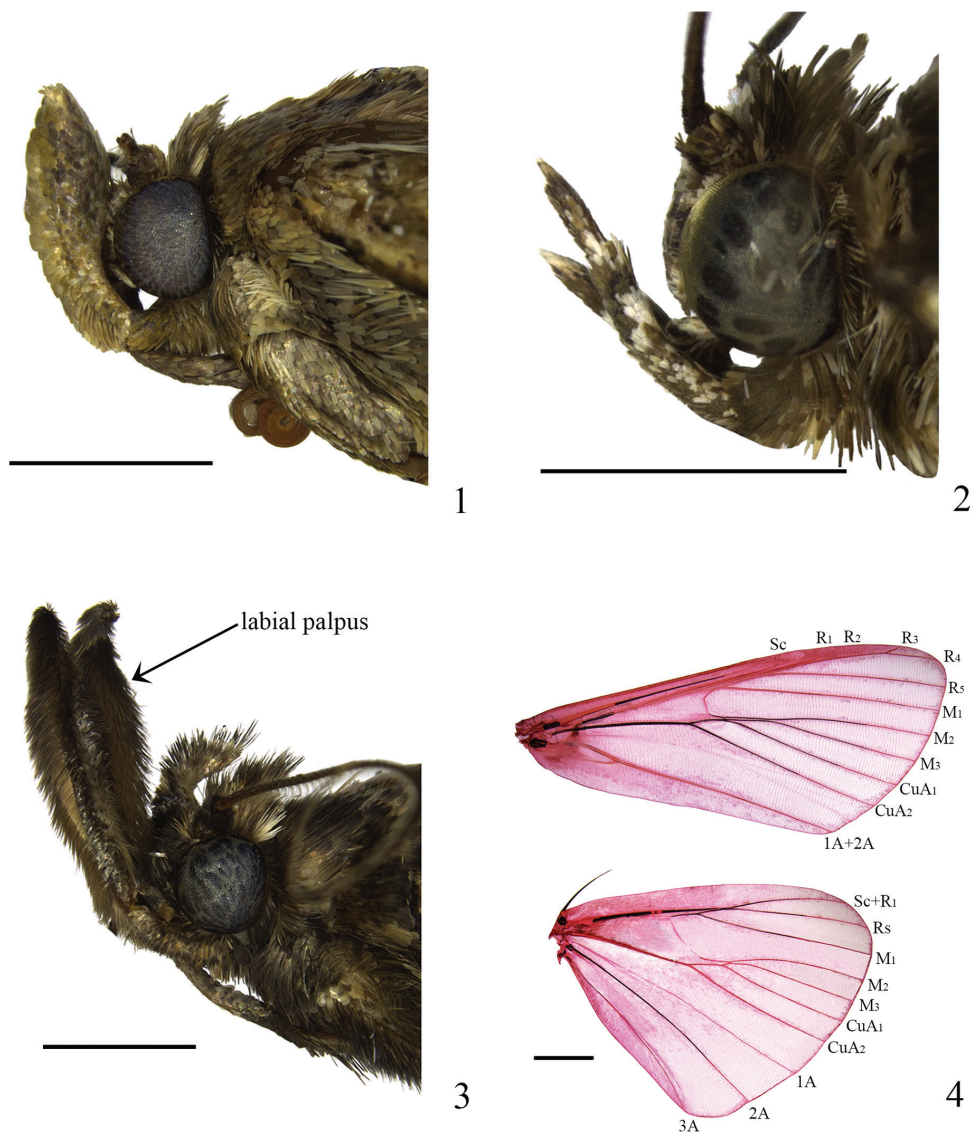
Taxonomy

Genus *Teliphasa* Moore, 1888

Teliphasa Moore, 1888: 200. Type species: *Teliphasa orbiculifer* Moore, 1888.

Sultania Koçak, 1987: 119. Type species: *Macalla lophotalis* Hampson, 1900.

Generic characters. Adult (Figs 1–4): Large sized. Head with thick chaetosema. Labial palpus in male (Fig. 1) often stronger than in female (Fig. 2), with diameter of second segment longer than three times length of female, upturned far above vertex of head, even extending back to thorax (Fig. 3), third segment thin, very short, hidden in scales of second; in some species, both male and female labial palpus slender, upturned beyond vertex of head, second segment slightly stronger than third, third segment slender. Antenna thicker in male than in female, male with a row of short cilia along anterior margin. Forewing broad; discal and discocellular spots conspicuous, bearing scale tufts; scale tuft usually set below lower margin of cell near base; antemedian line narrow; postmedian line relatively broad, usually curved outward to form an angle medially; subrectangular spots uniformly placed along inner side of terminal line, in-



Figures 1–4. Morphology of *Teliphasa* spp. **1–3** Head **1** *T. albifusa*, male **2** *T. nubilosa*, female **3** *T. nubilosa*, male **4** Venation of *T. albifusa*, slide No. LLJ15186W. Scale bars: 2.0 mm.

errupted by pale color at veins; hindwing broad triangular, with discocellular spot. Venations (Fig. 4): Forewing with Sc to 2/3 of costa, R₁ and R₂ stalked, R₃ and R₄ long stalked, R₅ stalked with R₃₊₄, M₁ from upper angle of cell, M₂ and M₃ from lower angle of cell and adjacent in basal 1/4, CuA₁, CuA₂ and M₃ parallel, CuP degenerated, 1A+2A furcated basally; hindwing with Sc+R₁ and R₅ connected at middle of Sc+R₁, M₂, M₃ and CuA₁ from lower angle of cell, CuA₂ nearly parallel to CuA₁.

Male genitalia. Uncus various in shape. Gnathos separated, being paired long processes, lateral arms slender. Scaphium columnar, usually narrowed gradually from

base to apex. Valva extremely broad, roundly expanded, with numerous long setae. Costa well-developed, varied in shape. Transtilla banded, extending backward to base of uncus, joined medially. Saccus narrowly banded, sometimes ill-defined. Saccus separated, broad, inverted triangular, or complete, only protruding in short triangle, or ill-defined. Phallus stout, with one or two complicated cornuti.

Female genitalia. Apophyses anteriores about same length as apophyses posteriores, occasionally longer than apophyses posteriores. Antrum usually strongly sclerotized. Ductus bursae shorter than or as long as corpus bursae. Corpus bursae pyriform or elliptical; signum paired, often ridged medially.

Diagnosis. This genus is much similar to *Termioptycha* Meyrick, 1889 superficially by having both discal and discocellular spots with scale tufts, the postmedian line relatively broad and curved outward to form an angle medially, and the subrectangular spots set uniformly along the inner side of the terminal line. *Teliphasa* can be easily separated from *Termioptycha* by the costa of forewing without a stigma in the median area, and the hindwing with a discocellular spot; in *Termioptycha*, the costa of forewing has a distinct stigma in the median area, and the hindwing lacks the discocellular spot.

Remarks. Differences within a species exist in *Teliphasa*, including the variations of the wing color and the degree of scale density. For example, *T. elegans* is divided into a blackish form and a whitish form due to such variations (Inoue and Yamanaka 1975).

Key to Chinese species of *Teliphasa* based on male genitalia

- | | | |
|---|--|--------------------------------|
| 1 | Saccus separate; juxta not bilobed | 2 |
| – | Saccus complete; juxta bilobed..... | 7 |
| 2 | Phallus with two cornuti, one protruding out from before apex of phallus.. | 3 |
| – | Phallus with one cornutus..... | 5 |
| 3 | Gnathos hooked apically (Fig. 14) | <i>T. similalbifusa</i> sp. n. |
| – | Gnathos rounded apically | 4 |
| 4 | Cornutus protruding out from phallus hooked, longer than 1/2 length of phallus (Fig. 16) | <i>T. hamata</i> sp. n. |
| – | Cornutus protruding out from phallus horned, slightly longer than 1/3 length of phallus | <i>T. sakishimensis</i> |
| 5 | Juxta with clustered spines (Fig. 13) | <i>T. spinosa</i> sp. n. |
| – | Juxta without spines..... | 6 |
| 6 | Uncus trapezoidal; costa with a subtriangular process ventrally (Fig. 18) | <i>T. albifusa</i> |
| – | Uncus subovate; costa without process ventrally (Fig. 19)..... | <i>T. elegans</i> |
| 7 | Uncus triangular (Fig. 15) | <i>T. erythrina</i> sp. n. |
| – | Uncus semicircular or irregular in shape | 8 |
| 8 | Uncus semicircular; juxta laterally protruding outward semicircularly at base (Fig. 20)..... | <i>T. amica</i> |
| – | Uncus irregular in shape; juxta dilated globosely at base (Fig. 17)... | <i>T. nubilosa</i> |

***Teliphasa spinosa* Li, sp. n.**

<http://zoobank.org/FCB51905-4D1D-4C16-9841-C1CE835CA26F>

Figs 5, 13, 21

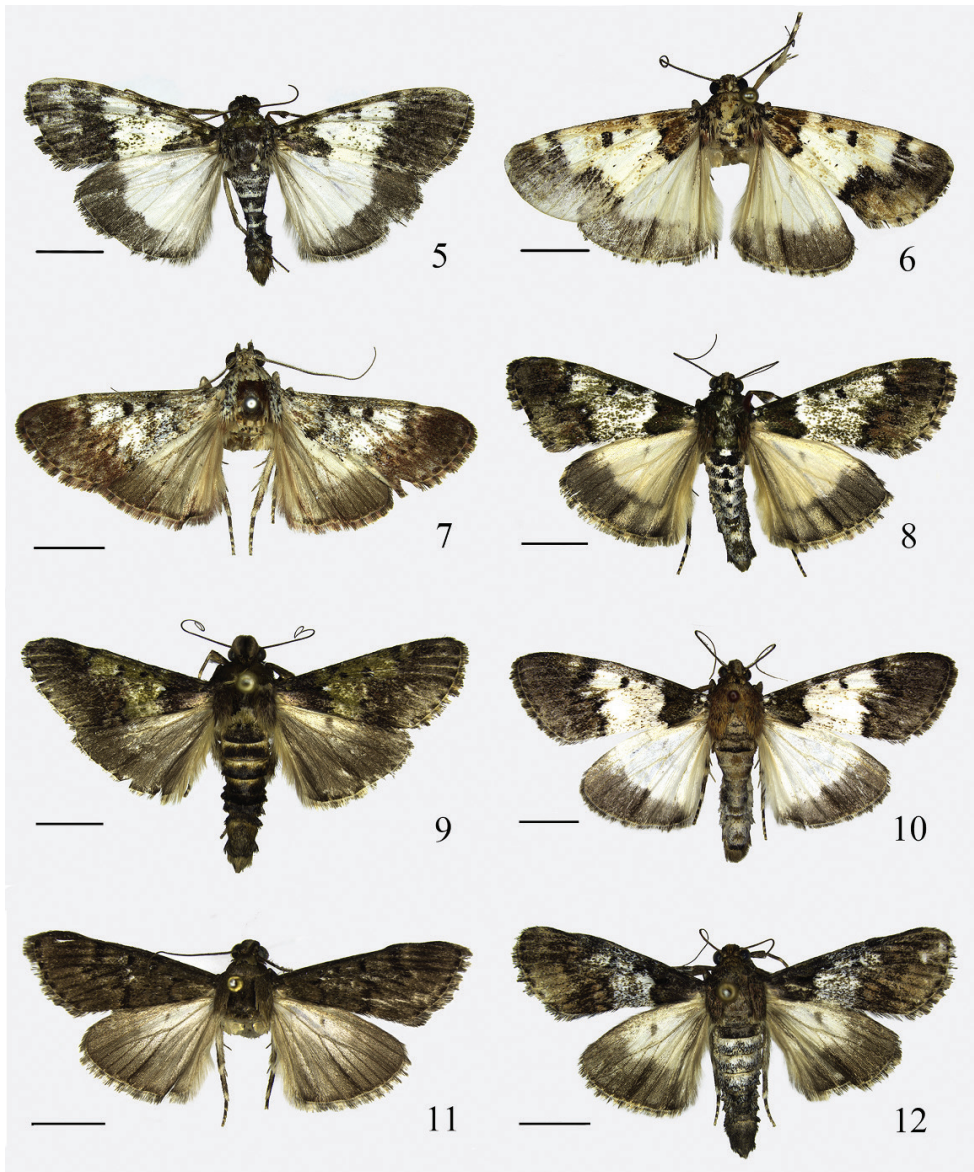
Type material. Holotype ♂ – **CHINA**, Tengchong County (25.29°N, 98.70°E), Yunnan Province, 2144 m, 15.viii.2014, leg. Kaijian Teng, Shurong Liu and Hua Rong, genitalia slide No. LLJ15172.

Paratypes – 2♂, 2♀, Nankang, Baoshan, Yunnan Province, 2009 m, 8–10.vii.2014, other same date as holotype.

Diagnosis. This species is different from its congeners by the valva triangularly protruding dorso- and ventro-apically and the juxta with clustered spines in the male genitalia. This species is similar to *T. hamata* sp. n. superficially, but can be differentiated by the subrhombic uncus, the approximately fan-shaped valva, and the phallus with one cornutus in the male genitalia. In *T. hamata* sp. n., the uncus is trapeziform, the valva is subrhombic, and the phallus has two cornuti in the male genitalia.

Description. Adult (Fig. 5): Wingspan 34.0–38.0 mm. Head brown, tinged with white scales. Labial palpus blackish brown mixed with white, white at apices of second and third segments; third segment slender, about 1/3 length of second. Maxillary palpus blackish brown, with a few white scales, short, slightly upturned. Antenna with scape brown mottled black, or blackish brown mixed with white; flagellum alternately yellowish brown and deep brown. Thorax and tegula blackish brown, with white scales. Forewing tinged with pale olive-green luster; basal area blackish brown, mixed with black and white scales, with two subrounded white spots near base; median area white, with scattered pale brown and blackish brown scales, with dense brown and blackish brown scales from costa diffused to above cell, forming a narrow elongate dark streak; distal area deep brown, with black scales; costa with a white spot at outside of postmedian line, spreading to R_5 , mixed with pale brown; antemedian line black, extending from costal 1/4 obliquely inward to scale tuft near base, then obliquely outward to 1/3 on dorsum; postmedian line black, extending from costal 2/3 slightly oblique outward to R_5 , then running slightly oblique inward to dorsal 2/3, its inner margin more or less serrated; discal spot almost circular, smaller than discocellular spot; discocellular spot nearly trapeziform; terminal line white, with ill-defined subrectangular black spots uniformly placed along its inner side, interrupted by grayish white mixed with blackish brown or brown scales at veins; cilia yellowish brown to brown, blackish brown along extension of veins. Hindwing with basal 3/4 white, distal 1/4 deep brown; discocellular spot pale grayish brown; cilia yellowish brown or brown. Legs brownish yellow, mixed with white, brown and black scales; tarsi with each tarsomere white apically, except black at apex of last tarsomere. Abdomen blackish brown with white, intersegment white.

Male genitalia (Fig. 13). Uncus transversally subrhombic. Gnathos slightly dilated in basal 1/3, then gradually narrowed to gently hooked apex; about 1/3 length of scaphium. Valva approximately fan-shaped, triangularly protruding dorso- and ventro-apically. Costa narrow, elongate triangular, reaching valva apically. Sacculus narrowly banded, wide basally, narrowed distally, reaching ventral 4/5 length of valva.



Figures 5–12. Adults of *Teliphasa* spp. **5** *T. spinosa* sp. n., paratype, male **6** *T. similalbifusa* sp. n., holotype, male **7** *T. erythrina* sp. n., holotype, male **8** *T. hamata* sp. n., paratype, male **9** *T. nubilosa*, male **10** *T. albifusa*, male **11** *T. elegans*, male **12** *T. amica*, male. Scale bars: 5.0 mm.

Transtilla joined medially in a knot. Juxta nearly circular, heavily sclerotized, with clustered spines. Saccus separated. Phallus curved at middle; cornutus a long plate, narrow basally, serrated along dorsal margin of distal half and on apex.

Female genitalia (Fig. 21). Papillae anales subrectangular, densely setose. Eighth tergite weakly sclerotized at middle posteriorly, with setae, anterior margin wavy, obvi-

ously concave medially; eighth sternite produced to paired triangular plates, separated medially, strongly sclerotized. Apophyses anteriores about same length as apophyses posteriores, dilated basally, gradually thinned distally, thicker than apophyses posteriores. Antrum subquadrate, slightly thicker than ductus bursae. Ductus bursae stout, strongly sclerotized, with clustered granules on inner surface; about $2/5$ length of corpus bursae. Corpus bursae pyriform; signum semicircular, strongly sclerotized, with dense spines.

Distribution. China (Yunnan).

Etymology. The specific name is derived from the Latin *spinosus* (with many spines), in reference to the juxta with clustered spines in the male genitalia.

Remarks. The labial palpus of this species is not sexual dimorphic. The shape and pattern of wing is consistent with the diagnostic characters of *Teliphasa*, and the male genitalia resemble other congeners in having a paired gnathos, the roundly expanded valva, and the separated inverted triangular saccus. Therefore, we regard this species as a new species of *Teliphasa* and describe it here.

***Teliphasa similalbifusa* Li, sp. n.**

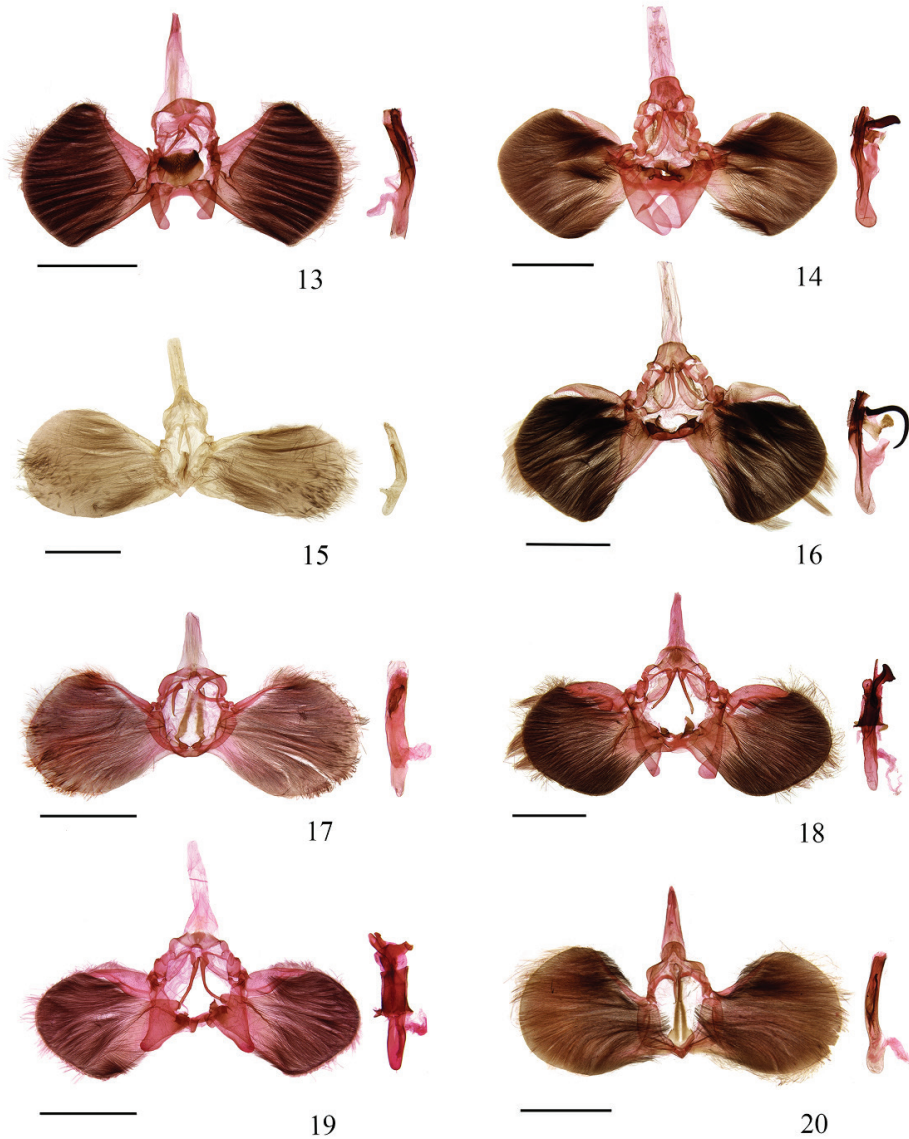
<http://zoobank.org/2BC387B1-E606-4E4C-989F-7487507242CF>

Figs 6, 14

Type material. Holotype ♂ – CHINA, Mt. Daming (23.40°N, 108.48°E), Guangxi Zhuang Autonomous Region, 1250 m, 20.v.2011, leg. Linlin Yang and Yinghui Mou, genitalia slide No. LLJ13039.

Diagnosis. This species is similar to *T. albifusa* superficially, but can be separated from the latter by the gnathos about $3/5$ the length of the scaphium, the costa without process near base on the ventral margin, and the phallus with two cornuti in the male genitalia. In *T. albifusa*, the gnathos is about $3/4$ the length of the scaphium, the costa is protruding subtriangularly near base on the ventral margin, and the phallus has a single cornutus in the male genitalia. In addition, *T. similalbifusa* sp. n., *T. hamata* sp. n. and *T. sakishimensis* are much similar in the male genitalia by the subtrapeziform uncus, the approximately rhombic valva, the broadly banded transtilla, the irregularly shaped juxta, the separated saccus, and one of the paired cornuti stretching out from before the apex of the phallus. However, the gnathos is hooked apically, and the stretching out cornutus is stout and shorter than $1/3$ the length of the phallus in *T. similalbifusa* sp. n.; the gnathos is obtuse apically, and the stretching out cornutus is slender and longer than $1/2$ the length of the phallus in *T. hamata* sp. n.; the gnathos is also obtuse apically, but the stretching out cornutus is horned and slightly longer than $1/3$ the length of the phallus in *T. sakishimensis*.

Description. Adult (Fig. 6): Wingspan 34.0 mm. Head white, mixed with yellowish brown and black scales. Male labial palpus white mixed with dense yellowish brown; second segment strong; third segment short, apex pointed. Antenna with scape white, mixed with yellowish brown and black scales; flagellum alternate-



Figures 13–20. Male genitalia of *Teliphasa* spp. **13** *T. spinosa* sp. n., holotype, slide No. LLJ15172 **14** *T. similalbifusa* sp. n., holotype, slide No. LLJ13039 **15** *T. erythrina* sp. n., holotype, slide No. WYP05198 **16** *T. hamata* sp. n., holotype, slide No. LLJ15167 **17** *T. nubilosa*, slide No. LLJ15173 **18** *T. albifusa*, slide No. LLJ15175 **19** *T. elegans*, slide No. LLJ13044 **20** *T. amica*, slide No. LLJ15178. Scale bars: 2.0 mm.

ly pale yellowish brown and deep brown. Thorax white, with scattered black and brown scales. Tegula blackish brown, mixed with white scales, with long brown scales distally. Forewing with basal area pale ochreous brown, mixed with black

and white scales; median area white mixed with pale yellow and yellowish brown scales, with dense yellowish brown scales from costa scattered to above cell; distal area yellowish brown, mixed with black scales; antemedian line black, ill-defined anteriorly, extending distinctly from black scale tuft near base obliquely outward to below 1A+2A, then straightly reaching dorsal 1/3; postmedian line black, extending from costal 3/4 obliquely outward to M_2 , then arched and extending inward along CuA_1 , forming a blunt angle, finally straight to dorsal 2/3, its inner margin serrated; costa with a blackish brown spot at basal 1/3 diffused to above cell, with a white spot at outside of postmedian line spreading to R_5 ; discal spot small, black surrounded by pale yellowish brown, with raised white scales on its outer margin; discocellular spot nearly rectangular, relatively large, surrounded by pale yellowish brown scales; terminal line yellowish white, spots ill-defined along its inner side; cilia yellowish white mixed with pale brown, blackish brown along extension of veins. Hindwing with basal 3/4 white mixed with pale yellow; distal 1/4 grayish brown, deepening from costa to dorsum; discocellular spot pale grayish brown; cilia yellowish white, blackish brown along extension of veins, with a brown line near base. Legs yellowish white, mixed with blackish brown and grayish white scales; tarsi blackish brown, white at apex of each tarsomere except black at apex of last tarsomere.

Male genitalia (Fig. 14). Uncus nearly trapeziform, rounded on posterior margin. Gnathos slightly dilated at base, gradually narrowed to hooked apex; about 3/5 length of scaphium. Valva approximately rhombic. Costa narrow, elongate triangular, smoothly arched dorsally, reaching before apex of valva. Sacculus narrowly banded, not reaching apex of valva. Transtilla joined in a semicircular protrusion. Juxta irregular in shape, heavily sclerotized. Saccus separated. Phallus dilated in basal 1/5, protruding at dorsal 1/2, relatively narrow distally; two cornuti present: one a long plate, serrated along dorsal margin distally; another stout, heavily sclerotized, stretching out of phallus from before apex, shorter than 1/3 length of phallus, narrow basally, broad distally, hooked apically.

Female unknown.

Distribution. China (Guangxi).

Etymology. The specific name is derived from the Latin *simil-* (similar), and the specific name of another species *albifusa*, in reference to the similarity of the two species in the superficial morphology.

***Teliphasa erythrina* Li, sp. n.**

<http://zoobank.org/B721CC89-7816-44E0-9FFC-C0CFC9CF208B>

Figs 7, 15

Type material. Holotype ♂ – **CHINA**, Bubang, Mengla County (21.60°N, 101.59°E), Yunnan Province, 650 m, 23.viii.2005, leg. Yingdang Ren, genitalia slide No. WYP05198.

Diagnosis. This species is obviously different from its congeners by the forewing reddish brown and the hindwing deep gray tinged with pale reddish brown in the distal area. In addition, this species is distinguishable by the subtriangular uncus and the relatively narrow valva with length obviously longer than the maximum width in the male genitalia. In other *Teliphasa* species, the uncus is not subtriangular, and the relatively broad valva is shorter than or equal to the maximum width.

Description. Adult (Fig. 7): Wingspan 36.0 mm. Head white, mixed with pale yellow and blackish brown scales. Male labial palpus grayish white, with scattered brown scales; second segment dilated near base; third segment shorter than 1/10 length of second. Antenna with scape white, mixed with brown; flagellum alternately yellowish brown and brown. Thorax and tegula white, mixed with brownish yellow and black scales; tegula with brown long scales distally. Forewing white in basal 2/3, suffused with pale yellowish, pale brown and brownish black scales, with blackish brown scale tuft near base, mottled white; costa with brownish black scales from basal 1/3 to 2/3, diffused to above cell, with a white spot at outside of postmedian line, spreading to R_5 ; distal 1/3 reddish brown, tinged with white scales; antemedian line black wavy, extending from costal 1/3 obliquely outward to below cell, then obliquely inward to scale tuft near base, thereafter obliquely outward to $1A+2A$, finally straight to dorsal 1/3; postmedian line black, extending from costal 2/3 obliquely outward to M_3 , then running obliquely inward to dorsal 2/3, its inner margin serrated; discal and discocellular spots brownish black, the former circular, the latter subrectangular; terminal line grayish white, with subrectangular blackish brown spots uniformly placed along its inner side, interrupted by pale brown at veins. Hindwing with basal 2/3 white mixed with grayish scales; distal 1/3 deep gray tinged with pale reddish brown, gradually paler from costa to dorsum; discocellular spot pale brown; cilia of fore- and hind-wings brownish yellow, blackish brown along extension of veins. Legs yellowish white, mixed with blackish brown and pale brown scales; tarsi blackish brown, white at apex of each tarsomere.

Male genitalia (Fig. 15). Uncus triangular, concave medially on anterior margin. Gnathos gradually narrowed to gently hooked apex; about 3/5 length of scaphium. Valva relatively narrow, length about three times width at base. Costa narrowly banded, reaching valva apically. Transtilla joined medially in a small knot. Sacculus narrowly banded, reaching 1/2 length of valva on ventral margin. Juxta bilobed, each lobe gradually narrowed distally, inner side strongly sclerotized. Saccus not separated, protruding triangularly, acute apically. Phallus slender, slightly curved at basal 1/3; cornutus broad basally, slightly curved medially, dilated distally, protruding to a stout hook laterally.

Female unknown.

Distribution. China (Yunnan).

Etymology. The specific name is derived from the Latin *erythrinus* (red), in reference to the forewing reddish brown in the distal area.

***Teliphasa hamata* Li, sp. n.**

<http://zoobank.org/CCF9D60B-7574-46FC-8012-1EA281C2EA54>

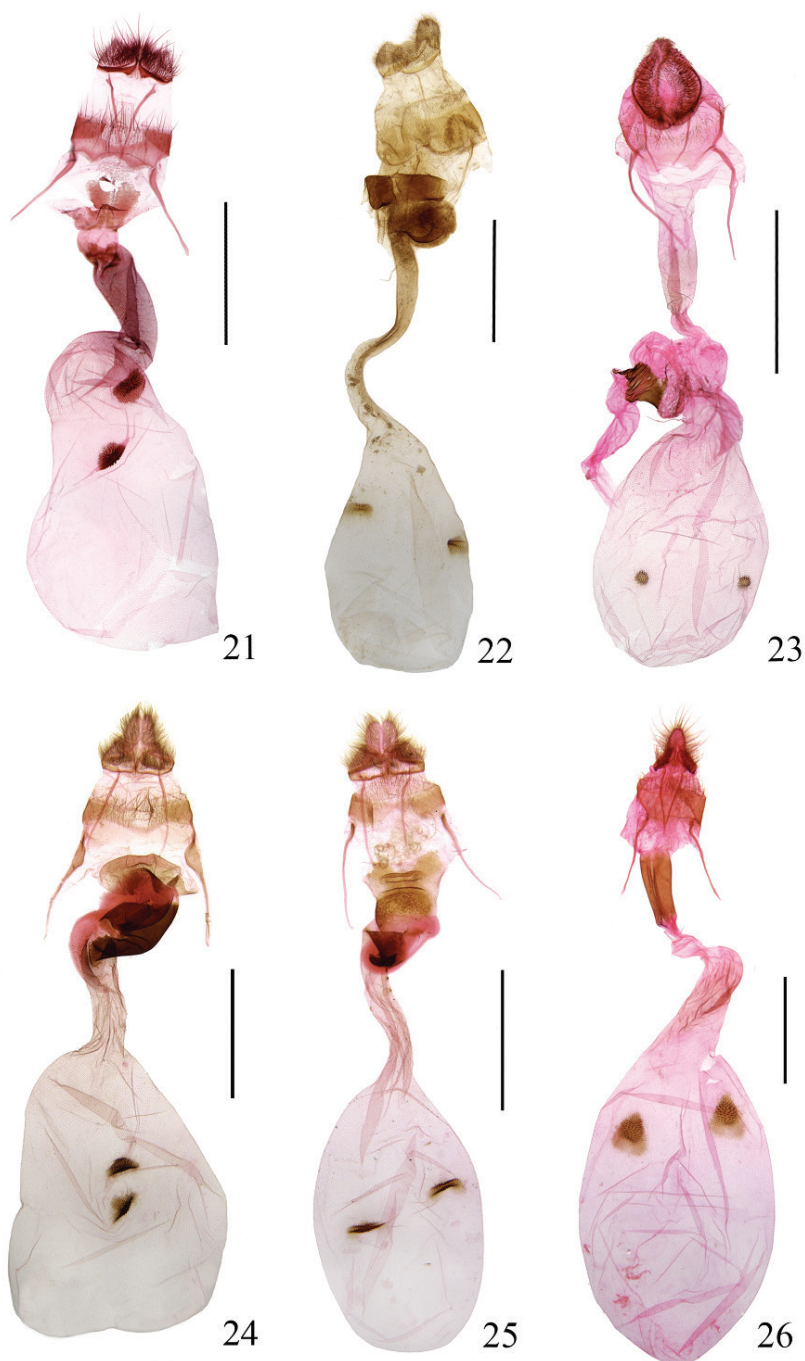
Figs 8, 16, 22

Type material. Holotype ♂ – **CHINA**, Tengchong County (25.29°N, 98.70°E), Yunnan Province, 2144 m, 16.viii.2014, leg. Kaijian Teng, Shurong Liu and Hua Rong, genitalia slide No. LLJ15172.

Paratypes: 2♂, same data as holotype; 1♂, 2♀, Wenshan County, 1105 m, xi.2003, leg. Shengxian Lu; 2♂, Kunming, Yunnan Province, 1900 m, 29.viii.2005, leg. Yingdang Ren; 1♂, Mt. Jizu, Dali, Yunnan Province, 2228 m, 27.vii.2014, leg. Kaijian Teng et al.; 1♂, Xianfengling, Mt. Wuyi, Fujian Province, 1000 m, 26.v.2004, leg. Haili Yu; 1♂, 1♀, Huaping, Leyie County, Guangxi Zhuang Autonomous Region, 1300 m, 6, 8.viii.2006, leg. Weichun Li; 3♂, 3♀, Mt. Yuanbao, Guangxi Zhuang Autonomous Region, 700 m, 11.viii.2006, leg. Weichun Li.

Diagnosis. This species is similar to *T. albifusa* superficially in the forewing color, but can be distinguished by the gnathos about $2/3$ the length of the scaphium and the phallus with two cornuti in the male genitalia. In *T. albifusa*, the gnathos is about $3/4$ the length of the scaphium, and the phallus has a single cornutus in the male genitalia. Moreover, *T. hamata* sp. n., *T. similalbifusa* sp. n., and *T. sakishimensis* are extremely similar in the male genitalia, and differences between them are stated under *T. similalbifusa* sp. n.

Description. Adult (Fig. 8): Wingspan 32.0–36.0 mm. Head white, suffused with black and pale brown scales. Male labial palpus pale yellow to brownish yellow, suffused with white and black scales; second segment slightly dilated in distal $2/3$; third segment short, pointed at apex; female labial palpus with second segment white, mixed with yellowish brown scales on dorsal surface; third segment slender, yellowish brown with black, about $1/5$ length of second. Antenna with scape white mottled blackish brown; flagellum alternately grayish brown and blackish brown. Thorax white, with brown scales. Tegula deep brown, with black and a few white scales. Forewing with basal area dark brown, mixed with black scales; median area white, with scattered brown scales; distal area ochreous brown, mixed with black and white scales; costa brown from basal $1/3$ to $2/3$, mixed with black scales, diffused to above cell, with a white spot near base and raised black scales at its outside, with a second white spot at outside of postmedian line, spreading to below R_5 ; antemedian line black, extending from costal $1/4$ obliquely inward to scale tuft near base, then obliquely outward to below $1A+2A$, finally obliquely inward to dorsal $1/3$; postmedian line black, extending from costal $2/3$ obliquely outward to M_2 , then curved and extending inward along CuA_1 , forming an angle, finally straight to dorsal $2/3$, its inner margin serrated; discal and discocellular spots black, the latter relatively large; terminal line pale yellow, with subrectangular brown or blackish brown spots uniformly placed along its inner side, interrupted by white mixed with brown at veins. Hindwing with basal $2/3$ yellowish white, distal $1/3$ grayish brown, becoming paler from costa to dorsum; discocellular spot pale grayish brown; cilia of fore- and hind-wings pale yellow, grayish brown to brownish yellow



Figures 21–26. Female genitalia of *Teliphasa* spp. **21** *T. spinosa* sp. n., paratype, slide No. RH15180 **22** *T. hamata* sp. n., paratype, slide No. WYP06011 **23** *T. nubilosa*, slide No. LLJ15182 **24** *T. albifusa*, slide No. LLJ15174 **25** *T. elegans*, slide No. LLJ13038 **26** *T. amica*, slide No. LLJ13017. Scale bars: 2.0 mm.

along extension of veins. Legs yellowish brown to blackish brown, mixed with black, brown and a few white scales; tarsi blackish brown, white at apex of each tarsomere. Abdomen white mottled black scales except first segment black.

Male genitalia (Fig. 16). Uncus broad, nearly trapeziform, rounded on posterior margin. Gnathos slender, basal half thicker than distal half, apex obtuse; about 2/3 length of scaphium. Valva subrhombic, with relatively dense setae near costa. Costa elongate triangular, broad basally, gradually narrowed distally, reaching before apex of valva; distal 1/4 obviously thinned, slightly curved inward in a hook. Sacculus narrowly banded, reaching valva apically. Transtilla knotted medially as a semi-elliptical expansion. Juxta irregular in shape, heavily sclerotized. Saccus separated. Phallus protruding near dorsal 1/2; with two cornuti, one a long plate, serrated along dorsal margin of distal part, another slender, heavily sclerotized, protruding out from phallus near apex, longer than 1/2 length of phallus, curved medially and forming a large hook.

Female genitalia (Fig. 22). Papillae anales subtriangular, densely setose. Eighth tergite nearly rectangular, with sparse setae posteriorly; eighth sternite paired triangular plates. Apophyses anteriores about same length as apophyses posteriores; thicker than apophyses posteriores. Antrum rectangular, heavily sclerotized. Ductus bursae thin, slightly longer than corpus bursae, weakly sclerotized posteriorly, with one horned plate basally. Corpus bursae pyriform; signum nearly rectangular, with clustered spines.

Distribution. China (Fujian, Guangxi, Yunnan).

Etymology. The specific name is derived from the Latin *hamatus* (hooked), referring to the slender hooked cornutus protruding out from the phallus in the male genitalia.

***Teliphasa nubilosa* Moore, 1888**

Figs 9, 17, 23

Teliphasa nubilosa Moore, 1888: 201. Type Locality: India (Darjiling).

Macalla formisibia Strand, 1919: 50.

Material examined. CHINA: Fujian Province: 9♂, Xianfengling, Mt. Wuyi, 1000 m, 26.v.2004, leg. Haili Yu; **Guangxi Zhuang Autonomous Region:** 10♂, 2♀, Huaping, Leyie County, 1300 m, 1, 8.viii.2006, leg. Weichun Li; 2♂, Mt. Yuanbao, 700 m, 12.viii.2006, leg. Weichun Li; 5♂, 6♀, Mt. Mao'er, Guilin, 1016 m, 23–24.vii.2015, leg. Mujie Qi and Shengnan Zhao; 4♂, Huanjiang County, Hechi, 1180 m, 23–26.vii.2015, leg. Meiqing Yang and Ga-Eun Lee; **Guizhou Province:** 1♂, Liming-guan, Libo County, 720 m, 19.vii.2015, leg. Meiqing Yang and Ga-Eun Lee; **Hainan Province:** 3♂, Mt. Wuzhi, 700 m, 19.v.2007, leg. Zhiwei Zhang and Weichun Li; 2♂, Mt. Diaoluo, 940 m, 31.v.2007, leg. Zhiwei Zhang and Weichun Li; 2♂, Yinggeling, Qiongzong County, 508 m, 27.vii.2014, leg. Peixin Cong, Linjie Liu and Sha Hu; 2♀, Yuanmenxiang, Baisha County, 460 m, 29–30.vi.2014, leg. Peixin Cong,

Linjie Liu and Sha Hu; 1♂, Jianfengling, Ledong County, 770 m, 14.vii.2014, leg. Peixin Cong, Linjie Liu and Sha Hu; 5♂, Mt. Limu, 607 m, 25, 27.vii.2014, leg. Peixin Cong, Linjie Liu and Sha Hu; 5♂, Mt. Wuzhi, 742 m, 20.V.2015, leg. Peixin Cong, Wei Guan and Sha Hu; **Henan Province:** 2♂, 3♀, Lushi County, 1560 m, 19, 21.vii.2001, leg. Dandan Zhang; 1♂, 2♀, Mt. Baiyun, Luoyang County, 1560 m, 22–24.vii.2001, leg. Dandan Zhang; 157♂, 40♀, Mt. Yuntai, Jiaozuo, 1028 m, 5–12. viii.2014, leg. Peixin Cong, Linjie Liu and Sha Hu; **Hubei Province:** 1♀, Pingbaying, Xianfeng, 1280 m, 22.vii.1999, leg. Houhun Li; **Jiangxi Province:** 3♂, Mt. Jiulian, 20–21.vii.2006, leg. Weichun Li; **Sichuan Province:** 1♂, Qingyinge, Mt. Emei, 900 m, 30.iv.1957, leg. Leyi Zheng and Hanhua Cheng; 3♀, Mabian County, 900 m, 21.vii.2004, leg. Yingdang Ren; 2♂, Wenchuan County, 1557 m, 9.vii.2014, leg. Kaijian Teng et al.; 1♂, Wanniansi, Mt. Emei, 830 m, 14.vii.2014, leg. Kaijian Teng et al.; **Yunnan Province:** 1♂, Bubang, Mengla County, 650 m, 23.viii.2005, leg. Yingdang Ren; 1♂, Taiyanghe, Pu'er, 1626 m, 8.vii.2013, leg. Shurong Liu, Yuqi Wang and Kaijian Teng; 1♂, Mt. Jizu, Dali, 2228 m, 27.vii.2014, leg. Kaijian Teng et al.; 10♂, Mt. Weibao, Dali, 2205 m, 30.vii.2014, leg. Kaijian Teng et al.; 1♂, Xiaodifang, Tengcong County, 2116 m, 11.viii.2014, leg. Kaijian Teng, Shurong Liu and Hua Rong; 1♂, Linjiapu, Tengcong County, 2144 m, 16.viii.2014, leg. Kaijian Teng, Shurong Liu and Hua Rong; **Zhejiang Province:** 5♂, Xianrending, Mt. Tianmu, 1500 m, 25.vii.2011, leg. Xicui Du and Xiaobing Fu; 1♂, Laoan, Mt. Tianmu, 555 m, 3.vii.2014, leg. Aihui Yin, Xuemei Hu and Qingyun Wang; 16♂, Sanmuping, Mt. Tianmu, 789 m, 13–15. vii.2014, leg. Aihui Yin, Xuemei Hu and Qingyun Wang; 2♂, Xiguan, Mt. Tianmu, 566 m, 16, 18.vii.2014, leg. Aihui Yin, Xuemei Hu and Qingyun Wang; 9♂, Mt. Longxu, 754 m, 20–22.vii.2014, leg. Aihui Yin, Xuemei Hu and Qingyun Wang; 2♂, Qingliangfeng, 1059 m, 28.vii.2014, leg. Aihui Yin, Xuemei Hu and Qingyun Wang; 5♂, 20♀, Sanmuping, Mt. Tianmu, 789 m, 16–17.vii.2015, leg. Aihui Yin, Kang Lou and Tao Wang.

Diagnosis. This species is different from its congeners by the forewing suffused with olive-green scales in the median area, the rather thick male labial palpus extending to thorax, and the dorsal side of the labial palpus with long brownish yellow hairs in the distal 3/4. In addition, this species is similar to *T. amica* in the male genitalia (Fig. 17) by the valva nearly circular, the costa narrowly banded, and the juxta with lobes. It can be distinguished by the narrow uncus irregular in shape, the juxta dilated globosely at base, the saccus ill-defined, and the cornutus about 1/4 the length of the phallus in the male genitalia; the signum set at anterior 1/3 of the corpus bursae in the female genitalia (Fig. 23). In *T. amica*, the uncus is semicircular, the juxta is protruding semicircularly at base laterally, the distinct saccus produced in a short triangle, the cornutus is about 1/2 the length of the phallus in the male genitalia; the signum is located at posterior 1/4 of the corpus bursae in the female genitalia.

Description. Adult (Fig. 9): Wingspan 26.0–38.0 mm.

Distribution. China (Fujian, Guangxi, Guizhou, Hainan, Henan, Hubei, Jiangxi, Sichuan, Yunnan, Zhejiang, Taiwan), India.

***Teliphasa albifusa* (Hampson, 1896)**

Figs 10, 18, 24

Macalla albifusa Hampson, 1896: 113. Type Locality: Sikkim, Nagas.*Teliphasa albifusa* (Hampson): Inoue and Yamanaka 1975: 99.

Material examined. CHINA: Guangxi Zhuang Autonomous Region: 1♂, 2♀, Mt. Mao'er, Guilin, 1016 m, 23.vii.2015, leg. Mujie Qi and Shengnan Zhao; 2♂, 1♀, Huanjiang County, Hechi, 1180 m, 25.vii.2015, leg. Meiqing Yang and Ga-Eun Lee; 2♂, Rongshui County, Liuzhou, 1240 m, 27.vii.2015, leg. Meiqing Yang and Ga-Eun Lee; **Hebei Province:** 10♂, 3♀, Xinglong County, 800 m, 16–29.vii.2011, leg. Houhun Li and Yanpeng Cai; **Henan Province:** 1♀, Mt. Baiyun, Luoyang, 1560 m, 22.vii.2001, leg. Dandan Zhang; 14♂, 8♀, Linzhou, 550 m, 21, 23.vii.2006, leg. Hui Zhen and Denghui Kuang; 1♂, Mt. Guan, Hui County, 550 m, 26.vii.2006, leg. Hui Zhen and Denghui Kuang; 3♂, 1♀, Mt. Wangwu, Jiyuan, 800 m, 28–29.vii.2006, leg. Hui Zhen and Denghui Kuang; 15♂, 4♀, Mt. Yuntai, Jiaozuo, 1028 m, 5–10.viii.2014, leg. Peixin Cong, Linjie Liu and Sha Hu; **Hubei Province:** 3♂, 3♀, Shennongjia, 15.vii.1977, leg. Leyi Zheng; 5♂, 1♀, Pingbaying, Xianfeng, 1280 m, 21–22.vii.1999, leg. Houhun Li et al.; 1♂, Lichuan, 700 m, 28.vii.1999, leg. Houhun Li et al.; **Sichuan Province:** 2♂, Baoxing County, 900 m, 1.viii.2004, leg. Yingdang Ren; 3♂, 2♀, Wenchuan County, 1557 m, 11.vii.2014, leg. Kaijian Teng et al.; 1♀, Wanniansi, Mt. Emei, 830 m, 14.vii.2014, leg. Kaijian Teng et al.; **Shanxi Province:** 3♂, Manghe, Yangcheng County, 594 m, 13, 16.vii.2012, leg. Wei Guan and Xiuchun Wang; **Tianjin:** 1♂, Mt. Baxian, 550 m, 23.vi.2001, leg. Houhun Li et al.; 9♂, 3♀, Mt. Baxian, 560 m, 14, 16.vii.2005, leg. Houhun Li et al.; 2♂, Mt. Baxian, 550 m, 24.vii.2015, leg. Houhun Li and Peixin Cong; **Yunnan Province:** 1♂, Bubang, Mengla County, 650 m, 22.viii.2005, leg. Yingdang Ren; 1♂, Yexianggu, Xishuangbannan, 762 m, 19.vii.2014, leg. Kaijian Teng et al.; **Zhejiang Province:** 1♂, Wuyanling, Taisun, 680 m, 31.vii.2005, leg. Yunli Xiao; 27♂, 2♀, Laoan, Mt. Tianmu, 555 m, 3–6.vii.2014, leg. Aihui Yin, Xuemei Hu and Qingyun Wang; 2♂, 1♀, Qianjiangyuan, Mt. Tianmu, 866 m, 7, 10.vii.2014, leg. Aihui Yin, Xuemei Hu and Qingyun Wang; 11♂, Xiguan, Mt. Tianmu, 566 m, 16–20.vii.2014, leg. Aihui Yin, Xuemei Hu and Qingyun Wang; 4♂, Mt. Longxu, 754 m, 20–22.vii.2014, leg. Aihui Yin, Xuemei Hu and Qingyun Wang; 3♂, Mt. Longtang, 520 m, 28, 30.vii.2014, leg. Aihui Yin, Xuemei Hu and Qingyun Wang; 9♂, Sanmuping, Mt. Tianmu, 789 m, 30.viii.2014, leg. Aihui Yin, Xuemei Hu and Qingyun Wang; 20♂, 16♀, Sanmuping, Mt. Tianmu, 789 m, 16–17.vii.2015, leg. Aihui Yin, Kang Lou and Tao Wang.

Diagnosis. This species is characterized by the subtrapeziform uncus, the gnathos about 3/4 the length of the scaphium, the transtilla joined medially in a semicircular knot, the juxta irregular in shape, the phallus ventrally with a short slender process distally and with a row of spines internally in the male genitalia (Fig. 18); the ductus bursae with two irregular sclerotized plates posteriorly, and the triangular signum in

the female genitalia (Fig. 24). *Teliphasa albifusa* is similar to *T. similalbifusa* sp. n. and the whitish form of *T. elegans* superficially, and the differences between them are stated under *T. similalbifusa* sp. n. and *T. elegans*.

Description. Adult (Fig. 10): Wingspan 34.0–38.0 mm.

Distribution. China (Fujian, Guangxi, Hebei, Henan, Hubei, Hunan, Shanxi, Sichuan, Tianjin, Yunnan, Zhejiang, Taiwan), Japan, Korea, Sikkim, Nagas.

Teliphasa elegans (Butler, 1881)

Figs 11, 19, 25

Locastra elegans Butler, 1881: 581. Type Locality: Japan (Yokohama).

Macallia elegans (Butler): Rebel 1901: 258.

Teliphasa elegans (Butler): Mutuura 1957: 105.

Material examined. CHINA: **Guizhou Province:** 2♂, Suoluo, Chishui, 390 m, 27–28.V.2000, leg. Yanli Du; **Hebei Province:** 4♂, Xinglong County, 800 m, 20.vii.2011, leg. Houhun Li and Yanpeng Cai; **Heilongjiang Province:** 2♀, Mt. Mao'er, 18.vii.2009, leg. Weichun Li and Jiayu Liu; **Henan Province:** 1♀, Mt. Jigong, Xinyang, 700 m, 13.vii.2001, leg. Dandan Zhang; 1♀, Shiziping, Lushi County, 1200 m, 21.vii.2001, leg. Dandan Zhang; 1♂, Baligou, Huixian, 780 m, 12.vii.2002, leg. Xinpu Wang; **Hubei Province:** 1♂, Shennongjia, 15.vii.1977, leg. Leyi Zheng; **Tianjin:** 3♂, Mt. Baxian, 560 m, 13–14.vii.2005, leg. Houhun Li et al.; 1♀, Mt. Jiulong, 10.vii.2009, leg. Weichun Li.

Diagnosis. This species has two forms: the blackish form and the whitish form. The blackish form can be differentiated by the forewing and the distal 2/3 of hindwing blackish brown. The whitish form is similar to *T. albifusa* superficially, but can be separated from the latter by the uncus subovate, the costa without process ventrally, and the phallus ventrally with two short digitiform distal processes that lack spines internally in the male genitalia (Fig. 19); the ductus bursae with one sclerotized subtriangular plate posteriorly, and the signum narrow rectangular in the female genitalia (Fig. 25). Whereas in *T. albifusa*, the uncus is trapezoidal, the costa has a subtriangular process ventrally, and the phallus ventrally with a short slender distal process that has a row of spines internally in the male genitalia; the ductus bursae with two irregular sclerotized plates posteriorly, and the signum is subtriangular in the female genitalia.

Description. Adult (Fig. 11): Wingspan 34.0–38.0 mm.

Host plants. *Glycine max* (Linn.) Merr. (Song and He 1977), *Cornus macrophylla* Wall. (Hayashi 2006).

Distribution. China (Fujian, Guangxi, Guizhou, Hebei, Heilongjiang, Henan, Hubei, Hunan, Shaanxi, Tianjin), Korea, Japan, Ussuri.

***Teliphasa amica* (Butler, 1879)**

Figs 12, 20, 26

Locastra amica Butler, 1879: 447. Type Locality: Japan.*Macalla amica* (Butler): Hampson 1896: 454.*Teliphasa amica* (Butler): Mutuura 1957: 105.

Material examined. CHINA: Guangxi Zhuang Autonomous Region: 1♀, Huaping, Leyie County, 950 m, 8.viii.2006, leg. Weichun Li; 1♂, 1♀, Mt. Yuanbao, 700 m, 11.viii.2006, leg. Weichun Li; **Hebei Province:** 4♂, 1♀, Xinglong County, 800 m, 20.vii.2011, leg. Houhun Li and Yanpeng Cai; **Henan Province:** 1♂, 1♀, Mt. Jigong, Xinyang, 700 m, 13.vii.2001, leg. Dandan Zhang; 1♀, Mt. Tongbai, Tongbai County, 300 m, 16.vii.2001, leg. Dandan Zhang; 35♂, 9♀, Linzhou, 550 m, 21, 23.vii.2006, leg. Hui Zhen and Denghui Kuang; 4♂, Mt. Guan, Hui County, 550 m, 26.vii.2006, leg. Hui Zhen and Denghui Kuang; 31♂, 14♀, Mt. Wangwu, Jiyuan, 800 m, 28–30.vii.2006, leg. Hui Zhen and Denghui Kuang; 4♂, Mt. Yuntai, Jiaozuo, 1028 m, 10.viii.2014, leg. Peixin Cong, Linjie Liu and Sha Hu; **Hubei Province:** 1♂, 1♀, Shennongjia, 1977, leg. Huangang Zou; **Jiangxi Province:** 1♀, Mt. Jiulong, 10.vii.2009, leg. Weichun Li; 1♀, Mt. Jiulian, 21.vii.2006, leg. Weichun Li; **Sichuan Province:** 1♂, Qingyinge, Mt. Emei, 900 m, 30.iv.1957, leg. Leyi Zheng and Hanhua Cheng; **Tianjin:** 4♂, Mt. Baxian, 550 m, 23–24.vi.2001, leg. Houhun Li et al.; 1♂, 1♀, Mt. Pan, Ji County, 170 m, 20.vii.2004, leg. Houhun Li et al.; 19♂, 6♀, Mt. Baxian, 560 m, 13, 16.vii.2005, leg. Houhun Li et al.; 3♂, 1♀, Mt. Baxian, 550 m, 23–24.vii.2015, leg. Houhun Li and Peixin Cong; **Zhejiang Province:** 2♂, Qingliangfeng, Linan, 900 m, 10, 12.viii.2005, leg. Yunli Xiao; 1♂, Xiguan, Mt. Tianmu, 566 m, 17.vii.2014, leg. Aihui Yin, Xuemei Hu and Qingyun Wang; 1♂, Yulingguan, Qingliangfeng, 220 m, 24.vii.2014, leg. Aihui Yin, Xuemei Hu and Qingyun Wang; 1♂, Mt. Longtang, 520 m, 26.vii.2014, leg. Aihui Yin, Xuemei Hu and Qingyun Wang; 2♂, Qianqingtang, Qingliangfeng, 1059 m, 28.vii.2014, leg. Aihui Yin, Xuemei Hu and Qingyun Wang; 2♂, Sanmuping, Mt. Tianmu, 789 m, 8.viii.2014, leg. Aihui Yin, Qingyun Wang and Suran Li.

Diagnosis. This species is characterized by having a semicircular uncus, the gnathos about 1/2 the length of the scaphium, the transtilla medially produced to a rectangular extension, the bilobed juxta in the male genitalia (Fig. 20); the elongate rectangular antrum and the triangular signum in the female genitalia (Fig. 26). *Teliphasa amica* is similar to *T. hamata* sp. n. superficially, but distinguishable in the male genitalia by the saccus completed and the single cornutus. But in *T. hamata* sp. n., the saccus is separated and the phallus has two cornuti. In addition, *T. amica* and *T. nubilosa* are also much alike in the male genitalia, and the differences between them are stated under *T. nubilosa*.

Description. Adult (Fig. 12): Wingspan 36.0–40.0 mm.

Distribution. China (Fujian, Guangxi, Hebei, Henan, Hubei, Jiangxi, Sichuan, Shandong, Tianjin, Yunnan, Zhejiang, Taiwan), Korea, Japan.

***Teliphasa sakishimensis* Inoue & Yamanaka, 1975**

Teliphasa sakishimensis Inoue & Yamanaka, 1975: 100. Type Locality: Japan (Mt. Banna).

Distribution. China (Hubei, Sichuan, Taiwan), Japan.

Remarks. Inoue and Yamanaka (1975) described this species from Taiwan in detail. Song and He (1977) reported this species occurring in Hubei and Sichuan provinces from Chinese Mainland. We are unable to check this species in our study, but *T. sakishimensis* can be easily separated by having a clear thorn-like projection from the juxta (Inoue and Yamanaka, 1975).

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Annotated checklist of marine fishes from the Sanctuary of Bahía Chamela, Mexico with occurrence and biogeographic data

Cristian Moisés Galván-Villa¹, Eduardo Ríos-Jara¹, Dafne Bastida-Izaguirre¹, Philip A. Hastings², Eduardo F. Balart³

1 Laboratorio de Ecosistemas Marinos y Acuicultura, Departamento de Ecología, Centro Universitario de Ciencias Biológicas y Agropecuarias, Universidad de Guadalajara. Zapopan, Jalisco, Mexico. 45110 **2** Marine Biology Research Division, Scripps Institution of Oceanography, University of California. San Diego, La Jolla, CA. 92093-0208 **3** Laboratorio de Necton y Ecología de Arrecifes, Centro de Investigaciones Biológicas del Noroeste, S.C. La Paz, Baja California Sur, Mexico. 23096

Corresponding author: Cristian Moisés Galván-Villa (gvc07765@cucba.udg.mx)

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Abstract

An annotated checklist of marine fishes of the Sanctuary of Islands and Islets of Bahía Chamela in the central Mexican Pacific is presented. Records of fish species were obtained by different methods including visual census, sampling with anesthetics, fisherman-nets, and trawling with a biological dredge. Additional records were obtained from natural history collections and publications. The list comprises 196 species in 64 families and 141 genera. The Carangidae is the most speciose family with 11 species, followed by the Labridae with 10 and the Pomacentridae with nine. Fourteen species are endemic in Mexican Pacific waters, but none is restricted to Bahía Chamela. The most dominant species recorded during underwater surveys were *Epinephelus labriformis*, *Stegastes flavilatus*, and *Halichoeres dispilus*. Most species are of tropical affinities distributed throughout the tropical eastern Pacific (123), eastern Pacific (23), and Mexican Pacific (14). Other species are known from the eastern and Indo-Pacific regions (18), eastern Pacific and western Atlantic oceans (2), and some are circumtropical (9). A new record of the Gulf Brotula *Ogilbia ventralis* is provided for the Bahía Chamela and its geographical distribution is extended to Mexican central Pacific.

Keywords

Species richness, Ichthyofauna, eastern Pacific, systematic list, biogeographic affinity

Introduction

The study of fish diversity along the Mexican Pacific coasts started two centuries ago by naturalists and scientists who studied rich collections from some now-memorable expeditions (Gilbert 1890, Jordan et al. 1895, Breder 1926, 1927, 1928, 1936, Fowler 1944). Today the estimated number of recorded marine species along these coasts is 1,121, with the Gulf of California exhibiting the highest species richness (van der Heiden and Findley 1988, Hastings et al. 2010, Espinosa-Pérez 2014). However, there are still many areas and habitats (bays, estuaries, mangroves, reefs, littoral zones, deep-water realm) in the Mexican tropical Pacific where proper fish inventories are missing.

Fishes are an important marine group from an ecological and economic point of view. The destruction and pollution of many habitats and the overexploitation of fishes have affected marine ecosystems with the consequent loss of environmental services. For this reason, the implementation of Marine Protected Areas (MPAs) has begun to be a common practice in conservation and a useful fisheries management tool (Roberts et al. 2001, Edgar 2011). However, the design of an effective MPA requires information about the diversity of species inhabiting an area and its connectivity with other areas (Halpern and Warner 2003, Costello et al. 2010).

In the Mexican Pacific, there are some well-inventoried MPAs. For instance, there are well-documented checklists of fishes inhabiting Isla Guadalupe Biosphere Reserve (Reyes-Bonilla et al. 2010), an important area for the reproduction of the white shark off the Baja California peninsula. MPAs inside the Gulf of California include the Bahía de Los Ángeles Biosphere Reserve (Viesca-Lobatón et al. 2008, Mascareñas-Osorio et al. 2011), a seasonal sanctuary for the whale shark; Loreto Marine Park (Campos-Dávila et al. 2005, Rife et al. 2013); National Park Archipelago of Espíritu Santo (Aburto-Oropeza and Balart 2001, Arreola-Robles and Elorduy-Garay 2002, Rodríguez-Romero et al. 2005); Gulf of California Islands (Del Moral-Flores et al. 2013); Cabo Pulmo National Park (Alvarez-Filip et al. 2006), where sound management has restored the fish biomass (Aburto-Oropeza et al. 2011); Isla Isabel National Park (Galván-Villa et al. 2010); and Islas Marias Biosphere Reserve (Erisman et al. 2011). Others include the Archipelago de Revillagigedo Biosphere Reserve (Jordan and McGregor 1899, Castro-Aguirre and Balart 2002, Chávez-Comparán et al. 2010), Islas Marietas National Park (Solís-Gil and Jiménez-Quiroz 2004, García-Hernández et al. 2014), and Bahías de Huatulco National Park (Ramírez-Gutiérrez et al. 2007, López-Pérez et al. 2010, Juárez-Hernández et al. 2013) in the central and southern Mexican Pacific. However, many of the MPAs from the Mexican central Pacific are lacking inventories of marine fishes. One of these is the Sanctuary of Bahía Chamela located along the coast of Jalisco; it comprises eight islands and four islets dispersed along the bay.

The Sanctuary of Bahía Chamela was the first marine sanctuary in Mexico and has been protected since 2002 (Miranda et al. 2011). This sanctuary is home to species of restricted distribution and endemic fauna and flora. However, scarce information about fish diversity of the sanctuary is available. Only two previous lists of fishes of this bay are found reporting 59 and 80 species for the mainland coastline and for the

two largest islands in the bay, respectively (Espinosa-Pérez et al. 2002, Galván-Villa 2015). In the current study, a comprehensive checklist of fish species from the Sanctuary of Bahía Chamela Islands has been compiled based on sampling work from 2007 to 2014, review of material from ichthyological collections, and critical analysis of selected references. A biogeographic and occurrence characterization of all species is also provided.

Material and methods

Study area. The Bahía Chamela is located in the middle coastline area of Jalisco state on the central Mexican Pacific (19°32'N; 105°06'W) (Figure 1). The bay is located between two major oceanic systems: the Gulf of Tehuantepec and the Gulf of California. The extent of the bay is 28 km from Punta Chamela to Punta Rivas (south to north). The sanctuary includes eight islands called as Pajarera, Cocinas, Mamut, Colorada, San Pedro, San Agustín, San Andrés, and La Negra, and four islets as Los Anegados, El Novillo, La Mosca, and Submarino (CONANP 2008). All of these islands and islets are included in the Marine Priority Region No. 38 of sites for conservation of the National Commission for Knowledge and Use of Biodiversity of Mexico (CONABIO). The continental coast of the bay presents sandy beaches to the northern side and shallow plains and rocky beaches to the south. The islands and islets are of continental origin with similar age and composition throughout the region (possibly from the Cretaceous) (Schaaf 2002). The two larger islands have rocky and sandy beaches, while the smaller islands and the islets have rocky intertidal zones sometimes with vertical steep slopes. The depth of the bay varies between 10 and 25 m, decreasing dramatically in the proximity of the coastline and the islands.

Sampling effort and data analysis. Records of fish species were made by visual census and obtained from analyses of collection reports and materials and available publications. Records *in situ* were made using underwater visual census from 2007 to 2012 according to the technique described by English et al. (1994). Each transect covered an area of 100 m² (50 m × 2 m) and was conducted by a single diver. Cryptic fishes and other specimens were collected from 2007 to 2015 with a 10% anaesthetic solution of clove oil diluted in ethanol, with a fisherman-net, and with a biological dredge. All collected specimens were deposited in the fish collection of the Laboratory of Marine Ecosystems and Aquaculture (LEMA-CPE), Centro Universitario de Ciencias Biológicas y Agropecuarias, Universidad de Guadalajara (Zapopan, Mexico), except specimen of *Chaenopsis* sp. that was deposited in the Marine Vertebrate Collection (SIO), Scripps Institution of Oceanography, University of California (San Diego, USA). Records obtained from publications included only those that were identified to species level and excluded any questionable records that we could not confirm as species known to occur in the Mexican Pacific.

The nomenclature for species level, family designations, and systematic were updated following Eschmeyer (2015). Distributions and biogeographic affinities for species are

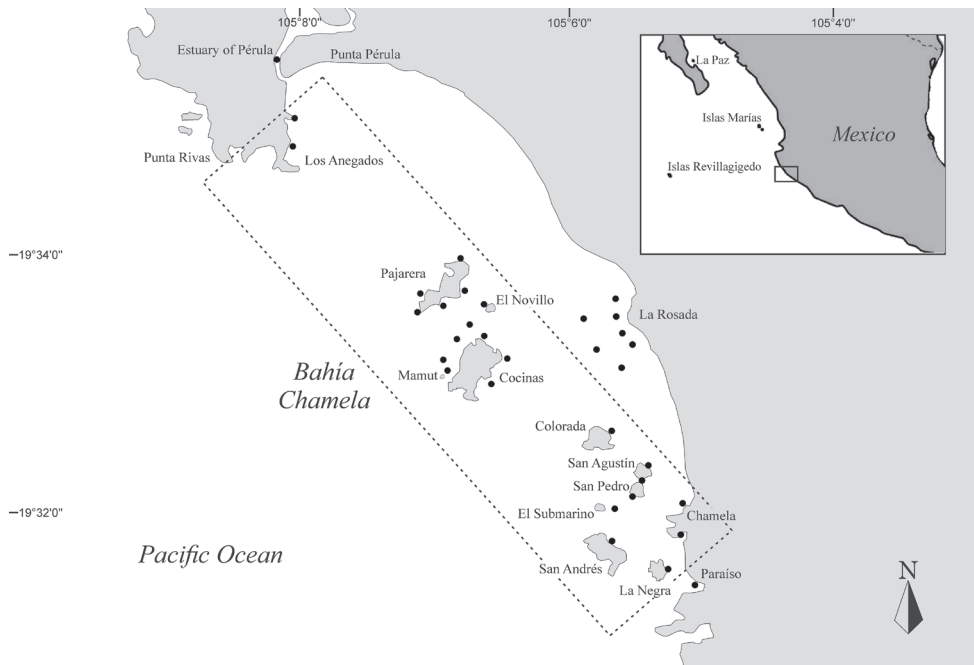


Figure 1. Location of Bahía Chamela, Jalisco, Mexico. Black dots show the location of the sampling sites in the bay. The dotted line indicates the limits of the Marine Protected Area.

based on Thomson et al. (2000), Hastings and Springer (2009), Erisman et al. (2011), Mascareñas-Ororio et al. (2011), and Robertson and Allen (2015), using the following categories: CT = Circumtropical (distributed throughout the tropics of the world), EP = eastern Pacific (including tropical and temperate regions), EP+ATL = eastern Pacific and western Atlantic oceans (occurs in both oceans), EP+IP = eastern Pacific and Indo-Pacific regions (occurs in both regions), MEX = Mexican waters of the Pacific (including the Gulf of California and outer coast of Baja California), and TEP = tropical eastern Pacific (extends from south of Magdalena Bay, Baja California to Cabo Blanco in northern Peru, includes the Gulf of California and offshore islands as Revillagigedo, Clipperton, Cocos, Malpelo, and the Galápagos). For a description of the structure of fish assemblages, the species recorded between 2007 and 2012 through visual census were classified in five categories using the frequency of occurrence: D = Dominant (> 80% of census), A = Abundant (61–80%), C = Common (41–60%), U = Uncommon (21–40%), and R = Rare (< 21%).

Results and discussion

Species richness. A list of 196 species, 141 genera, and 64 families of marine fishes from the Bahía Chamela is presented (Table 1). In comparison with previous studies

Table 1. Checklist of fishes from the Sanctuary of Bahía Chamela, Mexico. The list is arranged systematically by class, orders, and families according to Eschmeyer (2015). Record designation: V = visual record (2007–2009); C = collected specimen (2007–2015); SIO = records of the Scripps Institution of Oceanography; R1 = Espinoza-Pérez et al. (2002); R2 = Galván-Villa (2015). Frequency of occurrence: D = dominant; A = abundant; C = common; U = uncommon; R = rare. Biogeographical affinity: CT = Circumtropical; EP = Eastern Pacific; EP+ATL = Eastern Pacific and Atlantic oceans; EP+IP = Eastern Pacific and Indo-Pacific; MEX = Mexican waters of the Pacific; TEP = Tropical Eastern Pacific. IUCN Categories: EN = Endangered; VU = Vulnerable; DD = Data deficient; NT = Near threatened; LC = Least concern; NE = Not evaluated. - = No data.

CLASS/Order/Family	Species	Record designation	Catalog number of collected specimens	Frequency of occurrence	Bio-geographical affinity	IUCN Categories
CHONDRICHTHYES						
Carcharhiniformes						
Sphyrnidae	<i>Sphyrna lewini</i> (Griffith & Smith, 1834)	R1	-	-	CT	EN
Rajiformes						
Narcinidae	<i>Diplabatis ommata</i> (Jordan & Gilbert, 1890)	V	-	R	TEP	VU
	<i>Rhinobatos glaucostigma</i> Jordan & Gilbert, 1883	SIO, R1	SIO 70-238	-	TEP	DD
Rhinobatidae	<i>Rhinobatos leucorhynchus</i> Günther, 1867	V		R	TEP	NT
	<i>Zapteryx xyster</i> Jordan & Evermann, 1896	V, SIO	SIO 70-237	R	TEP	DD
Myliobatiformes						
Gymnuridae	<i>Gymnura marmorata</i> (Cooper, 1864)	R1	-	-	TEP	LC
Myliobatidae	<i>Aetobatus narinari</i> (Euphrasen, 1790)	V, R2	-	R	CT	NT
	<i>Urobatis concentricus</i> Osburn & Nichols, 1916	V, R2	-	R	MEX	DD
	<i>Urobatis halleri</i> (Cooper, 1863)	SIO, R1	SIO 70-237	-	TEP	LC
	<i>Urotrygon munda</i> Gill, 1863	R1		-	TEP	DD
Urotrygonidae	<i>Urotrygon rogersi</i> (Jordan & Starks, 1895)	SIO	SIO 70-238	-	TEP	DD
ACTINOPTERYGII						
Albuliformes						
Albulidae	<i>Albula pacifica</i> (Beebe, 1942)†	R1	-	-	EP	NE
Anguilliformes						
	<i>Ariosoma gilberti</i> (Ogilby, 1898)	SIO	SIO 70-237	-	TEP	LC
Congridae	<i>Paraconger californiensis</i> Kanazawa, 1961	V, SIO	SIO 70-235	R	TEP	LC

CLASS/Order/Family	Species	Record designation	Catalog number of collected specimens	Frequency of occurrence	Bio-geographical affinity	IUCN Categories
Muraenidae	<i>Gymnomuraena zebra</i> (Shaw, 1797)	V, R2	-	R	EP+IP	NE
	<i>Gymnothorax castaneus</i> (Jordan & Gilbert, 1883)	V	-	R	TEP	LC
	<i>Muraena lentiginosa</i> Jenyns, 1842	V, R2	-	R	TEP	LC
Ophichthidae	<i>Apterichthys equatorialis</i> (Myers & Wade, 1941)	C	LEMA-PE138	-	TEP	LC
	<i>Myrichthys tigrinus</i> Girard, 1859	V, R1, R2	-	R	TEP	LC
	<i>Ophichthys triserialis</i> (Kaup, 1856)	R1	-	-	TEP	LC
	<i>Quassiremus nothochir</i> (Gilbert, 1890)	V	-	R	TEP	LC
Clupeiformes						
Clupeidae	<i>Harengula ibrisina</i> (Jordan & Gilbert, 1882)	C, R1	LEMA-PE92	-	EP	LC
	<i>Lile stolidera</i> (Jordan & Gilbert, 1882)	R1	-	-	TEP	LC
Pristigasteridae	<i>Pliostostoma lutipinnis</i> (Jordan & Gilbert, 1882)	R1	-	-	TEP	LC
Engraulidae	<i>Anchoa ischana</i> (Jordan & Gilbert, 1882)	R1	-	-	TEP	LC
	<i>Anchoa sciofieldi</i> (Jordan & Culver, 1895)	R1	-	-	TEP	LC
Aulopiformes						
Synodontidae	<i>Synodus evermanni</i> Jordan & Bollman, 1890	SIO	SIO 70-237	-	TEP	LC
	<i>Synodus lacertinus</i> Gilbert, 1890	V, C, R1	LEMA-PE97	R	EP	LC
	<i>Synodus scintilleps</i> Jordan & Gilbert, 1882	SIO, R1	SIO 70-237	-	TEP	LC
	<i>Synodus seburnae</i> Hildebrand, 1946	SIO	SIO 70-237	-	TEP	LC
Gadiformes						
Bregmaceroidae	<i>Bregmaceros bathymaster</i> Jordan & Bollman, 1890	SIO	SIO 70-168	-	TEP	LC
Ophidiiformes						
Byrthitidae	<i>Ogilbia boydualkeri</i> Møller, Schwarzhans & Nielsen, 2005	SIO	SIO 70-165	-	TEP	LC
	<i>Ogilbia ventralis</i> (Gill, 1863)	C	LEMA-PE135	-	MEX	LC
Batrachoidiformes						
Batrachoididae	<i>Porichthys ephippiatus</i> Walker & Rosenblatt, 1988	SIO	SIO 70-168, 235, 237, 238	-	TEP	LC
Lophiiformes						
Antennariidae	<i>Antennatus coccineus</i> (Lesson, 1831)	C	LEMA-PE70, 71	-	EP+IP	NE
	<i>Antennatus sanguineus</i> (Gill, 1863)	C, SIO	LEMA-PE50, 51 SIO 70-167	-	TEP	LC

CLASS/Order/Family	Species	Record designation	Catalog number of collected specimens	Frequency of occurrence	Bio-geographical affinity	IUCN Categories
Gobiesociformes						
Gobiesocidae	<i>Arocs erythrops</i> (Jordan & Gilbert, 1882)	C, SIO	LEMA-PE74 SIO 70-167	-	MEX	LC
	<i>Gobiesox adustus</i> Jordan & Gilbert, 1882	SIO	SIO 70-167	-	TEP	LC
	<i>Gobiesox papillifer</i> Gilbert, 1890	C	LEMA-PE95	-	TEP	LC
Atheriniformes						
Atherinopsidae	<i>Atherinella eriarcha</i> Jordan & Gilbert, 1882	SIO, R1	SIO 70-167	-	TEP	LC
Beloniformes						
Belontiidae	<i>Ablennes hians</i> (Valenciennes, 1846)	C, SIO	LEMA-PE60 SIO 70-166	-	CT	NE
	<i>Platybelone argalus</i> (Lesueur, 1821)	R1	-	-	CT	LC
	<i>Tylosurus fodiator</i> Jordan & Gilbert, 1882	R1	-	-	CT	LC
Beryciformes						
Holocentridae	<i>Myripristis leignathus</i> Valenciennes, 1846	V, SIO, R2	SIO 70-167	R	TEP	LC
	<i>Sargocentron suborbitale</i> (Gill, 1863)	V, R2	-	U	TEP	LC
Syngnathiformes						
Fistulariidae	<i>Fistularia commersonii</i> Rüppel, 1838	V, SIO, R2	SIO 70-167	R	EP+IP	NE
Syngnathidae	<i>Hippocampus ingens</i> Girard, 1858	C	LEMA-PE99	-	EP	VU
Scorpaeniformes						
Scorpaenidae	<i>Pontinus</i> sp. 1‡	C	LEMA-PE132	-	-	-
	<i>Pontinus</i> sp. 2‡	C	LEMA-PE136	-	-	-
	<i>Scorpaena mystes</i> Jordan & Starks, 1895	V, C, R2	LEMA-PE102	R	EP	LC
	<i>Scorpaena sonora</i> Jenkins & Evermann, 1889	SIO	SIO 70-238	-	MEX	LC
	<i>Scorpaenodes xyris</i> (Jordan & Gilbert, 1882)	C, SIO	LEMA-PE112, 114, 115 SIO 70-167	-	EP	LC
Triglidae	<i>Prionotus stephanophrys</i> Lockington, 1881	SIO	SIO 70-168	-	TEP	LC
Perciformes						
Epinephelidae	<i>Alphistes immaculatus</i> Breder, 1936	V, R2	-	U	TEP	LC
	<i>Cephalopholis panamensis</i> (Steindachner, 1877)	V, R2	-	C	TEP	LC
	<i>Dermatolepis dermatolepis</i> (Boulenger, 1895)	V	-	R	EP	LC

CLASS/Order/Family	Species	Record designation	Catalog number of collected specimens	Frequency of occurrence	Bio-geographical affinity	IUCN Categories
	<i>Epinephelus labriformis</i> (Jenyns, 1840)	V, SIO, R2	SIO 70-167	D	EP	LC
	<i>Panathius colonus</i> (Valenciennes, 1846)	V	-	R	TEP	LC
	<i>Rypticus bicolor</i> Valenciennes, 1846	V, SIO	SIO 70-167	R	TEP	LC
	<i>Rypticus nigripinnis</i> Gill, 1861	V	-	R	TEP	LC
Serranidae	<i>Serranus psittacinus</i> Valenciennes, 1846	V, SIO, R2	SIO 70-167	U	TEP	LC
Apogonidae	<i>Apogon pacificus</i> (Herre, 1935)	V, SIO	SIO 70-167	R	EP	LC
	<i>Apogon retrosella</i> (Gill, 1862)	V, SIO, R2	SIO 70-167	R	TEP	LC
	<i>Caranx caballus</i> Günther, 1868	V, R2	-	R	EP	LC
	<i>Caranx sexfasciatus</i> Quoy & Gaimard, 1825	V, R1	-	R	EP+IP	LC
	<i>Canangoides orynter</i> (Jordan & Gilbert, 1883)	C	LEMA-PE56	-	EP	LC
	<i>Carangoides vinctus</i> (Jordan & Gilbert, 1882)	R1	-	-	TEP	LC
	<i>Chloroscombrus orqueta</i> Jordan & Gilbert, 1883	R1	-	-	EP	LC
Carangidae	<i>Gnathanodon speciosus</i> (Forsskal, 1775)	V, R1	-	R	EP+IP	NE
	<i>Hemicaranx leucurus</i> (Günther, 1864)	R1	-	-	TEP	LC
	<i>Oligoplites saurus</i> (Bloch & Schneider, 1801)	R1	-	-	TEP	NE
	<i>Selene brevirostris</i> (Gill, 1863)	C	LEMA-PE103	-	EP	LC
	<i>Trachinotus patiensis</i> Cuvier, 1832	R1	-	-	TEP	LC
	<i>Trachinotus rhodopus</i> Gill, 1863	C, R1	LEMA-PE108, 113	-	EP	LC
	<i>Hoplopagrus guentherii</i> Gill, 1862	V, R1	-	R	TEP	LC
	<i>Luijanus argentiventris</i> (Peters, 1869)	V, R1, R2	-	U	TEP	LC
	<i>Luijanus colorado</i> Jordan & Gilbert, 1882	R1	-	-	TEP	LC
Luijanidae	<i>Luijanus guttatus</i> (Steindachner, 1869)	V, R1, R2	-	R	EP	LC
	<i>Luijanus inermis</i> (Peters, 1869)	V	-	R	TEP	LC
	<i>Luijanus novemfasciatus</i> Gill, 1862	V, C, R1, R2	LEMA-PE119, 120	R	TEP	LC
	<i>Luijanus viridis</i> (Valenciennes, 1846)	V, R2	-	R	TEP	LC
	<i>Diapterus peruvianus</i> (Cuvier, 1830)	R1	-	-	TEP	LC
Gerreidae	<i>Eucinostomus dowii</i> (Gill, 1863)	SIO	SIO 70-237	-	TEP	LC
	<i>Eucinostomus gracilis</i> (Gill, 1862)	SIO, R1	SIO 70-237	-	TEP	LC
	<i>Gerres simillimus</i> Regan, 1907	V, R1	-	-	TEP	LC

CLASS/Order/Family	Species	Record designation	Catalog number of collected specimens	Frequency of occurrence	Bio-geographical affinity	IUCN Categories
Haemulidae	<i>Anisotremus taeniatus</i> Gill, 1861	SIO	SIO 70-167	-	TEP	LC
	<i>Haemulon flaviguttatum</i> Gill, 1862	V, SIO, R1, R2	SIO 70-167	U	EP	LC
	<i>Haemulon maculicauda</i> (Gill, 1862)	V, SIO, R2	SIO 70-167	U	TEP	LC
	<i>Haemulon sexfasciatum</i> Gill, 1862	V, R2	-	R	TEP	LC
	<i>Haemulon scudderi</i> Gill, 1862	R1	-	-	TEP	LC
	<i>Haemulon steindachneri</i> (Jordan & Gilbert, 1882)	V, R1, R2	-	U	TEP	LC
	<i>Microlepidotus brevipinnis</i> (Steindachner, 1869)	V, SIO, R2	SIO 70-167	R	TEP	LC
	<i>Pomadasys macracanthus</i> (Günther, 1864)	R1	-	-	TEP	LC
	<i>Pomadasys panamensis</i> (Steindachner, 1876)	R1	-	-	TEP	LC
	<i>Cynoscion nannus</i> Castro-Aguirre & Arvizu-Martínez, 1976	SIO	SIO 70-168	-	TEP	LC
Sciaenidae	<i>Pareques fuscovittatus</i> (Kendall & Raddcliffe, 1912)	V, SIO	SIO 70-167	R	MEX	LC
Polynemidae	<i>Umbrina xanti</i> Gill, 1862	R1	-	-	TEP	LC
	<i>Polydactylus approximans</i> (Lay & Bennett, 1839)	R1	-	-	TEP	LC
Mullidae	<i>Mulloidichthys dentatus</i> (Gill, 1862)	V, R2	-	C	TEP	LC
	<i>Pseudupeneus grandisquamis</i> (Gill, 1863)	V, R1	-	R	TEP	LC
Kyphosidae	<i>Kyphosus vaigiensis</i> (Quoy & Gaimard, 1825)	V, R2	-	R	EP	NE
	<i>Kyphosus elegans</i> (Peters, 1869)	V, R1, R2	-	R	TEP	LC
Chaetodontidae	<i>Chaetodon humeralis</i> Günther, 1860	V, R1, R2	-	A	EP	LC
	<i>Johnmandallia nigrirostris</i> Gill, 1862	V, SIO, R2	SIO 70-167	U	TEP	LC
Pomacanthidae	<i>Holocanthus passer</i> Valenciennes, 1846	V, SIO, R2	SIO 70-167	C	TEP	LC
	<i>Pomacanthus zonipectus</i> (Gill, 1862)	V, R2	-	R	TEP	LC
	<i>Abudefduf declivifrons</i> (Gill, 1862)	V	-	R	TEP	LC
	<i>Abudefduf troschelii</i> (Gill, 1862)	V, R2	-	U	TEP	LC
Pomacentridae	<i>Chromis atrilobata</i> Gill, 1862	V, SIO, R2	SIO 70-167	U	TEP	LC
	<i>Microspathodon bairdii</i> (Gill, 1862)	V, R2	-	R	TEP	LC
	<i>Microspathodon dorsalis</i> (Gill, 1862)	V, SIO, R2	SIO 70-167	A	TEP	LC
	<i>Stegastes acapulcoensis</i> (Fowler, 1944)	V, R2	-	A	TEP	LC
	<i>Stegastes flavilatus</i> (Gill, 1862)	V, SIO, R2	SIO 70-167	D	TEP	LC

CLASS/Order/Family	Species	Record designation	Catalog number of collected specimens	Frequency of occurrence	Bio-geographical affinity	IUCN Categories
Cirrhitidae	<i>Stegastes leucornis</i> (Gilbert, 1892)	V, R2	-	R	MEX	VU
	<i>Stegastes rectifraenum</i> (Gill, 1862)	V, R2	-	R	TEP	LC
	<i>Cirrhitichthys oxycephalus</i> (Bleeker, 1855)	V	-	R	TEP	NE
	<i>Cirrhitus rivulatus</i> Valenciennes, 1846	V	-	C	TEP	LC
Mugilidae	<i>Mugil curema</i> Valenciennes, 1836	V, R1, R2	-	R	EP+ATL	NE
	<i>Chaenomugil proboscideus</i> (Günther, 1861)	R1	-	-	TEP	LC
	<i>Bodianus diplotaenia</i> (Gill, 1862)	V, SIO, R2	SIO 70-167	C	TEP	LC
	<i>Halichoeres chierchiae</i> Di Caporiacco, 1948	V, R1, R2	-	C	TEP	LC
Labridae	<i>Halichoeres dispilus</i> (Günther, 1864)	V, C, SIO, R2	LEMA-PE93, 127, 128 SIO 70-167	D	TEP	LC
	<i>Halichoeres melanotis</i> (Gilbert, 1890)	V, R2	-	R	TEP	LC
	<i>Halichoeres nicholsi</i> (Jordan & Gilbert, 1882)	V, SIO, R2	SIO 70-167	A	TEP	LC
	<i>Halichoeres notospilus</i> (Günther, 1864)	V, R2	-	U	TEP	LC
	<i>Iniistius pavo</i> (Valenciennes, 1840)	C	LEMA-PE133	-	EP+IP	LC
	<i>Novaculichthys taenionurus</i> (Lacepède, 1801)	V, R2	-	R	EP+IP	LC
	<i>Thalassoma grammaticum</i> Gilbert, 1890	V, R2	-	R	EP+IP	LC
	<i>Thalassoma lucasanum</i> (Gill, 1862)	V, R2	-	C	TEP	LC
	<i>Nicholsina denticulata</i> (Evermann & Radcliffe, 1917)	V, R2	-	R	EP	LC
	<i>Scarus ghobban</i> Forsskal, 1775	V, R2	-	R	EP+IP	LC
Scaridae	<i>Scarus perrico</i> Jordan & Gilbert, 1882	V, R2	-	R	TEP	LC
	<i>Axoclinus storeyae</i> (Brock, 1940)	V, C	-	R	MEX	LC
Tripterygiidae	<i>Enneanectes carminalis</i> (Jordan & Gilbert, 1882)	C, SIO	LEMA-PE121 SIO 70-167	-	TEP	LC
	<i>Enneanectes glendae</i> Rosenblatt, Miller & Hastings, 2013	V, SIO	SIO 70-167	R	MEX	NE
	<i>Enneanectes macrops</i> Rosenblatt, Miller & Hastings, 2013	SIO	SIO 70-167	-	MEX	NE
	<i>Dactyloscopus annis</i> Miller & Briggs, 1962	C	LEMA-PE78	-	TEP	LC
Dactyloscopidae	<i>Gillellus arenicola</i> Gilbert, 1890	C	LEMA-PE117	-	TEP	LC
	<i>Labrisomus xanti</i> (Gill, 1860)	V	-	R	MEX	LC
Labrisomidae	<i>Malacoctenus ebisui</i> Springer, 1959	V, C, SIO, R2	LEMA-PE100, 107 SIO 70-167	R	TEP	LC

CLASS/Order/Family	Species	Record designation	Catalog number of collected specimens	Frequency of occurrence	Bio-geographical affinity	IUCN Categories
Chaenopsidae	<i>Malacotenus mexicanus</i> Springer, 1959	C, SIO	LEMA-PE98 SIO 70-167	-	TEP	LC
	<i>Malacotenus polyporus</i> Springer, 1959	V, C	LEMA-PE110	R	TEP	LC
	<i>Malacotenus tetranemus</i> (Cope, 1877)	C, SIO	LEMA-PE96, 109 SIO 70-167	-	TEP	LC
	<i>Paraclinus tanygnathus</i> Rosenblatt & Parr, 1969	C	LEMA-PE101, 106, 111	-	MEX	LC
	<i>Starksia spinipenis</i> (Al-Uthman, 1960)	V, C, SIO	LEMA-PE118 SIO 70-167	R	MEX	LC
	<i>Acanthemblemaria macrospilus</i> Brock, 1940	V, C, R2	LEMA-PE87, 134	R	MEX	LC
	<i>Chaenopsis</i> sp. §	SIO	SIO 14-41	-	-	-
	<i>Coralliozetus boehlkei</i> Stephens, 1963	C	LEMA-PE84, 85	-	TEP	LC
	<i>Ekemblemuraria myersi</i> Stephens, 1963	C, SIO	LEMA-PE80, 86, 104 SIO 70-167	-	TEP	LC
	<i>Emblemaria piratica</i> Ginsburg, 1942	C	LEMA-PE81	-	TEP	LC
Blenniidae	<i>Protemblemaria bicirrus</i> (Hildebrand, 1946)	C	LEMA-PE90, 105	-	TEP	LC
	<i>Entomacrodus chiosictus</i> (Jordan & Gilbert, 1882)	C	LEMA-PE137	-	TEP	LC
	<i>Hypsoblennius brevipinnis</i> (Günther, 1861)	C	LEMA-PE89	-	TEP	LC
	<i>Ophioblennius steindachneri</i> Jordan & Evermann, 1898	V, SIO, R2	SIO 70-167	U	TEP	LC
	<i>Plagionemus azaleus</i> (Jordan & Bollman, 1890)	V, SIO, R2	SIO 70-167	R	EP	LC
	<i>Eleotris picta</i> Kner, 1863	R1	-	-	TEP	LC
	<i>Gobiomorus maculatus</i> (Günther, 1859)	R1	-	-	TEP	LC
Gobiidae	<i>Coryphopterus urosipilus</i> Ginsburg, 1938	V, SIO, R2	LEMA-PE94 SIO 70-167	R	TEP	LC
	<i>Ctenogobius sagittula</i> (Günther, 1862)	C	LEMA-PE62	-	EP	LC
	<i>Elacatinus puncticulatus</i> (Ginsburg, 1938)	V, C, SIO, R2	LEMA-PE88, 116 SIO 70-167	R	TEP	LC
	<i>Gymnleotris seminuda</i> (Günther, 1864)	V	-	R	TEP	LC
Microdesmidae	<i>Tigriogobius digueti</i> (Pelleggrin, 1901)	C, SIO	LEMA-PE69, 83 SIO 70-167	R	MEX	NE
	<i>Microdesmus dipus</i> Günther, 1864	C	LEMA-PE66	-	TEP	DD
	<i>Microdesmus dorsipunctatus</i> Dawson, 1968	C	LEMA-PE67, 82	-	TEP	DD

CLASS/Order/Family	Species	Record designation	Catalog number of collected specimens	Frequency of occurrence	Bio-geographical affinity	IUCN Categories
Ephippidae	<i>Chaetodipterus zonatus</i> (Girard, 1858)	R1	-	-	EP	LC
Zanclidae	<i>Zanclus cornutus</i> (Linnaeus, 1758)	V, R2	-	R	EP+IP	NE
Acanthuridae	<i>Acanthurus xantopherus</i> Valenciennes, 1835	V, R1	-	R	EP+IP	LC
	<i>Prionurus punctatus</i> Gill, 1862	V, R2	-	R	TEP	LC
Sphyrnidae	<i>Sphyrna ensis</i> Jordan & Gilbert, 1882	C, R1	LEMA-PE129	-	TEP	LC
Scombridae	<i>Euthynnus lineatus</i> Kishinouye, 1920	V	-	R	EP+IP	LC
Pleuronectiformes						
	<i>Cyclosetta</i> sp.‡	C	LEMA-PE130	-	-	-
	<i>Etopus crossotus</i> Jordan & Gilbert, 1882	R1	-	-	EP+ATL	NE
	<i>Etopus</i> sp.‡	C	LEMA-PE123a	-	-	-
Paralichthyidae	<i>Syacium latifrons</i> (Jordan & Gilbert, 1882)	SIO	SIO 70-238	-	TEP	LC
	<i>Syacium ovale</i> (Günther, 1864)	SIO	SIO 70-237	-	TEP	LC
	<i>Syacium</i> sp.‡	C	LEMA-PE124	-	-	-
	<i>Bothus constellatus</i> (Jordan, 1889)	SIO	SIO 70-237, 238	-	EP+IP	NE
Bothidae	<i>Monolene dubiosa</i> Garman, 1899	SIO	SIO 70-168	-	TEP	LC
	<i>Symphurus atramentatus</i> Jordan & Bollman, 1890	SIO	SIO 70-237	-	TEP	LC
	<i>Symphurus leei</i> Jordan & Bollman, 1890	C, SIO	LEMA-PE122 SIO 70-235	-	TEP	LC
Cynoglossidae	<i>Symphurus melanurus</i> Clark, 1936	C	LEMA-PE131	-	TEP	LC
	<i>Symphurus</i> sp.‡	C	LEMA-PE123b, 125, 126	-	-	-
Tetraodontiformes						
	<i>Balistes polyplepis</i> Steindachner, 1876	V, R2	-	R	EP+IP	LC
Balistidae	<i>Pseudobalistes naufagium</i> (Jordan & Starks, 1895)	V, R2	-	R	TEP	LC
	<i>Sufflamen verres</i> (Gilbert & Starks, 1904)	V, R2	-	C	TEP	LC
Monacanthidae	<i>Aluterus scripius</i> (Osbeck, 1765)	V, R2	-	R	CT	NE
	<i>Cantherhines dumerilii</i> (Hollard, 1854)	V	-	R	EP+IP	NE
Ostraciidae	<i>Ostracion meleagris</i> Shaw, 1796	V, R2	-	R	EP+IP	NE

CLASS/Order/Family	Species	Record designation	Catalog number of collected specimens	Frequency of occurrence	Bio-geographical affinity	IUCN Categories
Tetraodontidae	<i>Arothron hispidus</i> (Linnaeus, 1758)	V	-	R	EP+IP	NE
	<i>Arothron meleagris</i> (Anonymous, 1798)	V, R1, R2	-	U	EP+IP	NE
	<i>Canthigaster punctatissima</i> (Günther, 1870)	V, R2	-	R	TEP	LC
	<i>Sphaeroides annulatus</i> (Jenyns, 1842)	V, SIO, R1, R2	SIO 70-238	R	EP	LC
	<i>Sphaeroides lobatus</i> (Steindachner, 1870)	V, SIO, R2	SIO 70-237, 238	R	TEP	LC
Diodontidae	<i>Chilomycterus reticulatus</i> Linnaeus, 1758	V, R2	-	R	CT	NE
	<i>Diodon holocanthus</i> Linnaeus, 1758	V, SIO, R2	SIO 70-167	C	CT	NE
	<i>Diodon hystrix</i> Linnaeus, 1758	V, R1, R2	-	R	CT	NE

† Considered as *Albula nemoptera* by Espinoza-Pérez et al. (2002), designated as *Albula pacifica* by Pfeiler (2008).

‡ These individuals represent juveniles too small to be accurately identified.

§ This individual is an undescribed species previously found in Costa Rica.

(Espinoza-Pérez et al. 2002, Galván-Villa 2015), the richness of the bay increased in this study by more than 240% (by 117 species). The jacks (Carangidae) represent the most diverse family, with 11 species and 8 genera, followed by the wrasses (Labridae) with 10 species and 5 genera, and damselfishes (Pomacentridae) and grunts (Haemulidae) each with 9 species and 4 genera. Eighteen families are represented by only one species. No endemic species for Bahía Chamela were found but 14 endemic species for the Mexican Pacific are recorded here.

The fish species richness of Bahía Chamela (196 species) is greater than in other surveyed MPAs of the Mexican Pacific, including Bahía de Los Ángeles (93 species), Bahía Loreto (66), Cabo Pulmo (62), and Isla Isabel (118) in the Gulf of California (Campos-Dávila et al. 2005, Alvarez-Filip et al. 2006, Galván-Villa et al. 2010, Viesca-Lobaton et al. 2008, Mascareñas-Osorio et al. 2011); Islas Marietas (46) (Solís-Gil and Jiménez-Quiroz 2004) in the central Mexican Pacific; and Bahías de Huatulco (112) in the southern Mexican Pacific (López-Pérez et al. 2010). Only three species (*Hippocampus ingens*, *Holocanthus passer*, *Pomacanthus zonipectus*) occurring in the bay have been designated with special protection category by the Mexican Official Norm 059-ECOL-2010. Furthermore, in the red list of the International Union for Conservation of Nature (IUCN 2015) three species are assessed as vulnerable (*Diplobatis ommata*, *H. ingens*, *Stegastes leucurus*) and one as endangered (*Sphyrna lewini*) (Table 1).

Fifty-four percent of the species was recorded using visual census. The composition of the fish assemblage of the bay is characterized mainly by rare species (72%). Three species are categorized as dominant: *Epinephelus labriformis*, *Stegastes flavilatus*, and *Halichoeres dispilus*; these species are widely distributed along the Mexican Pacific and are recognized as important in the reef-fish assemblage structure for this bay and other MPAs of the Mexican Pacific because of their high abundance and biomass (Galván-Villa 2015). Another four species are categorized as abundant: *Chaetodon humeralis*, *Microspathodon dorsalis*, *Stegastes acapulcoensis*, and *Halichoeres nicholsi*; nine as common, and 13 as uncommon. The number of species inhabiting the bay may increase after checking additional details of some of the collected specimens and published records. Additions may include undescribed species, juvenile stages from different species, or records from publications with erroneous determinations. For example, a single female individual of chaenopsid pike-blenny (*Chaenopsis* sp.) that was collected from sandy bottom of the bay corresponds to an undescribed species distributed from Mexico to Costa Rica (Hastings *pers obs*). Also three individuals of *Pontinus* (sp. 1 and sp. 2) were collected, but due to their small size (< 2 cm), the identification of species was not possible. They probably correspond to *P. furcirhinus* or *P. sierra*, as both species have been recorded in the area (Robertson and Allen 2015). Another five juvenile individuals of flounders (Paralichthyidae) and eight tonguefishes (Cynoglossidae) collected by the biological dredge from sandy bottoms were not identified to species level. Future careful taxonomic work on these and other specimens would increase the number of species recorded from the bay.

Biogeographic affinity. Most fish species recorded in Bahía Chamela are widely distributed in the tropical eastern Pacific (123 spp = 66%) (Figure 2). Twenty-three

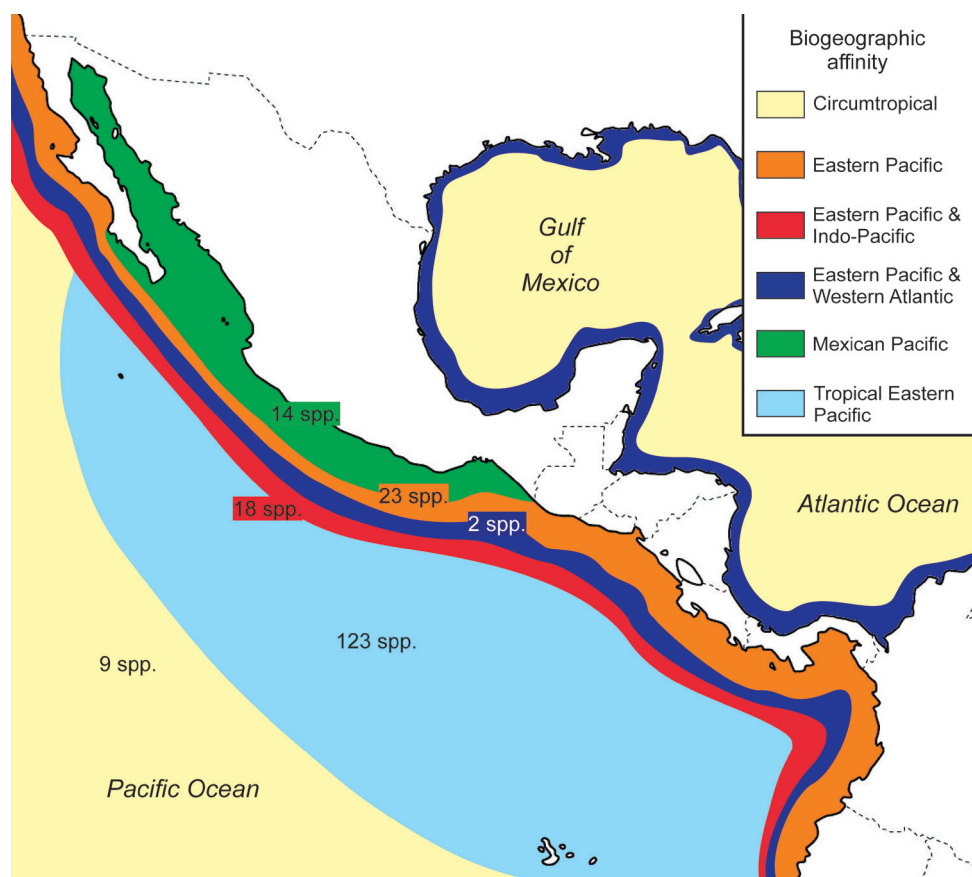


Figure 2. Map showing the number of fish species recorded in Bahía Chamela and their biogeographic affinities.

species occur in the eastern Pacific, and 18 occur in both eastern and Indo-Pacific waters. Fourteen species are endemic in Mexican waters of the Pacific. One specimen of the Gulf Brotula, *Ogilbia ventralis*, was collected with clove oil anesthetic from under rocks, depth 6 m at the islet Novillos (Figure 3). This record represents a southern range extension for this species, known previously from the Gulf of California and southern part of the outer Baja peninsula. Bahía Chamela is the type locality for a second *Ogilbia* species, *O. boydwalkeri* (Møller et al. 2005). The festive drum fish, *Pareques fuscovittatus*, is the only endemic species in the Mexican Province (Robertson and Allen 2015). Nine species are circumtropical, and another two (*Mugil curema* and *Etropus crossotus*) occur in both the eastern Pacific and western Atlantic regions. Seven undetermined or non-described species were excluded from the analysis of biogeographic affinity.

Previous studies considered *Haemulon steindachneri* (Haemulidae) to occur in both eastern Pacific and western Atlantic oceans, although recently molecular analysis found that these two populations belong to different species, so the valid distribution



Figure 3. *Ogilbia ventralis*. LEMA-PE135, ♂, 56 mm SL, Pacific Mexico, Bahía Chamela. Scale 10 mm. Photo by CMGV.

of this nominal species is the TEP (Rocha et al. 2008). Future review of other species that reportedly occur in both oceans is important to define valid distributions. Finally, according to Robertson and Cramer (2009), the fish richness of Bahía Chamela is most similar to that of the Panama biogeographic province, but there is an important contribution of species from the Gulf of California and outer Baja peninsula and a few species from other oceans.

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