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CHECKLIST

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Species check-list for Tintinnids of the Philippines Archipelago (Protozoa, Ciliophora)

Jane Abigail Santiago[1], Maria Carmen Lagman[1]

1 *De La Salle University, Taft Avenue, Manila*

Corresponding author: *Maria Carmen Lagman* (ma.carmen.lagman@dlsu.edu.ph)

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Abstract

Tintinnids are an essential link between nano- and macro- planktons in the food webs of the marine environment. It is also known that tintinnids are one of the major components of marine planktonic ciliates and has a cosmopolitan character. In the Philippine archipelago, which is recognized as a center of marine biodiversity, tintinnids checklist has not been done or published. Therefore, a checklist is presented in this study based on a compilation of previous tintinnids studies conducted at the Philippines waters. As a result of the studies done since 1941 up to present, a total of 114 taxa belonging to 14 families and 37 genera were listed. The Philippines coastal waters record a total of 50 species while the open seas document 72 species to date.

Keywords

Ciliates, list, Manila Bay, Philippine Sea, plankton, zooplankton

Introduction

Microzooplankton (20–200μm) constitute a major component of the marine plankton community. Previously, the significance of microzooplankton (MZP) was commonly linked with microbial loop and corresponding microbial web (Calbet and Landry 2004, Calbet et al. 2008), but recent studies have shown that they also play a key

role in the herbivorous food web (Dolan et al. 2007, Putland and Iverson 2007). MZP graze a wide variety of particles from bacteria to nano- and phytoplankton as well as other similar organisms. They have a crucial role in the first feeding of the larval fishes (Stoecker and Capuzzo 1990, Fukami et al. 1999) and thus should be valued in the aquaculture industry. The awareness of the dynamic role of MZP in marine ecosystem resulted in the increase of scientific interest in the factors affecting their abundance and distribution. Research on microzooplankton arises as one of the vital parts of biological oceanography. In order to fully understand MZP behavior in different environments, a systematic qualitative study that includes listing of the species in a region is an essential step in exploring these organisms.

One of the best-known groups of marine microzooplanktonic ciliates is tintinnid (Kato and Taniguchi 1993). The distinctive characteristic of the tintinnid is its lorica, which has been the basis of their identification and classification. The easiness in identifying tintinnids based on their morphological features made them model specimens for research on species distributions, diversity, and variations in the structure of microzooplankton communities (Dolan and Gallegos 2001). Studies about the tintinnids distribution are essential due to the fact that they have been used as bio-indicators of different water massess (Kim et al. 2012). For example, the tintinnid species named *Epiplocyloides reticulata* (Ostenfeld & Schmidt, 1901) has been acknowledged as the Kuroshio water current indicator (Lee and Kim 2010). Records of *E. reticulata* are important to know the geographic extension of the warm Kuroshio current and the possible areas it can affect. A documentation of the tintinnid distribution is recognized as one of the best method to trace the flow of the water mass in open oceans and coastal waters (Lee and Kim 2010). In an archipelagic country such as Philippines, conducting tintinnid studies can be helpful in tracing different water masses and can aid in the assessment and management of its marine environment. However, tintinnids are poorly studied in the Philippines, a place which has been recognized as the center of the center of marine shore fish biodiversity (Carpenter and Springer 2005). A species- checklist for tintinnids specific for the Philippines can be a good starting point for any researcher who wants to conduct a tintinnid survey or any type of investigation in the country.. In order to assist other possible and future tintinnids studies in the Philippines, this present work aims to present the first and current checklist of tintinnid species in the Philippines. The authors also made this list to encourage other researcher to increase tintinnid studies in the Philippines. This study is based on a compilation of the literature to date.

Materials and methods

The Philippines archipelago is bound by the Bashi Channel to the north, the Philippine Sea to the east and northeast, the Celebes Sea to the south, the Sulu Sea to the southwest, and the South China Sea to the west and northwest side.

In this study, all published literature from 1941 to 2017 was examined. Taxonomical species and author names were written according to Roxas (1941), Gómez (2007),

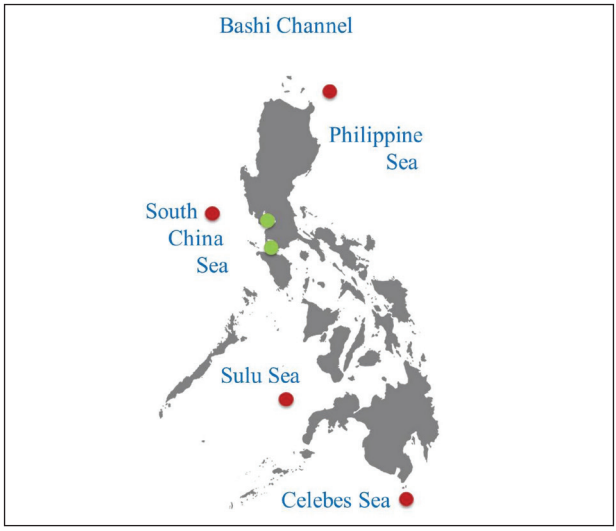

Figure 1. Map of the Philippines. Dots imdicate the sites with recorded tintinnid species. Key: green dots: coastal water; red dots: open sea.)

Kim et al. (2012) and Santiago et al. (2017).The study of Taniguchi (1977) was not included as a reference in enumerating tintinnid species since he only referred tintinnids as a group and his paper does not contain any detailed list of tintinnid species. The WoRMS (World Register of Marine Species) data system (Warren 2018) was used for classification and basis of the current species name. The species checklist in this study is alphabetically ordered.

Results

In related studies conducted in the Philippines, 114 tintinnid species belonging to 14 families and 37 genera have been recorded. The families Codonellidae (22 species, 19.30%) and Tintinnidae (21 species, 18.42%) have the highest recorded species (Table 3).
The systematic list and biogeographical distribution of the species are presented below:

Kingdom: Chromista
Subkingdom: Harosa
Phylum: Ciliophora Doflein, 1901
Class: Oligotrichea Bütschli, 1887
Subclass: Oligotrichia Bütschli, 1887
Order: Choreotrichida Small & Lynn, 1985
Family: **Ascampbelliellidae** Corliss, 1960
Genus: *Acanthostomella* Jörgensen, 1927
Acanthostomella conicoides Kofoid & Campbell, 1929
Acanthostomella minutissima Kofoid & Campbell, 1929

Genus: *Ascampbelliella* Corliss, 1960
Ascampbelliella acuta (Kofoid & Campbell, 1929)
Ascampbelliella armilla (Kofoid & Campbell, 1929)
Ascampbelliella retusa (Hada, 1935)
Ascampbelliella urceolata (Ostenfeld, 1899)
Genus: Craterella Kofoid & Campbell, 1929
Craterella aperta Marshall
Family: **Codonellidae** Kent, 1881
Genus: *Codonaria* Kofoid & Campbell, 1939
Codonaria oceanica (Brandt, 1906)
Genus: *Codonella* Haeckel, 1873
Codonella amphorella Biedermann, 1893
Genus: *Poroecus* Cleve, 1902
Poroecus annulatus Kofoid & Campbell, 1929
Poroecus apicatus Kofoid & Campbell, 1929
Genus: *Tintinnopsis* Stein, 1867
Tintinnopsis bacoornensis Roxas, 1941
Tintinnopsis beroidea Stein, 1867
Tintinnopsis buetschlii Daday, 1887
Tintinnopsis campanula Ehrenberg, 1840
Tintinnopsis chinglanensis Nie & Cheng, 1947
Tintinnopsis corniger Hada, 1964
Tintinnopsis cylindrica Daday, 1887
Tintinnopsis directa Hada, 1932
Tintinnopsis gracilis Kofoid & Campbell, 1929
Tintinnopsis loricata Brandt, 1906
Tintinnopsis major Meunier, 1910
Tintinnopsis manilensis Roxas, 1941
Tintinnopsis mortensenii Schmidt, 1902
Tintinnopsis radix (Imhof, 1886)
Tintinnopsis rotundata Kofoid & Campbell, 1929
Tintinnopsis tocantinensis Kofoid & Campbell, 1929
Tintinnopsis turgida Kofoid & Campbell, 1929
Tintinnopsis uruguayensis Balech, 1948
Family: **Codonellopsidae** Kofoid & Campbell, 1929
Genus: *Codonellopsis* Jörgensen, 1924
Codonellopsis morchella (Cleve) Jörgensen, 1924
Codonellopsis orthoceras (Haeckel, 1873) Jörgensen, 1924
Codonellopsis ostenfeldi (Schmidt, 1902) Kofoid & Campbell, 1929
Codonellopsis pusilla (Cleve) Jörgensen, 1924
Codonellopsis schabi (Brandt, 1906) Kofoid & Campbell, 1929
Family: **Cyttarocylididae** Kofoid & Campbell, 1939
Genus: *Cyttarocylis* Fol, 1881
Cyttarocylis cassis (Haeckel, 1837)

Family: **Dictyocystidae** Haeckel, 1873
- Genus: Wangiella Nie, 1934
  - *Wangiella dicollaria* Nie, 1934
- Genus: *Dictyocysta* Ehrenberg, 1854
  - *Dictyocysta elegans* Ehrenberg, 1854
  - *Dictyocysta mitra* Haeckel, 1873

Family: **Epiplocylididae** Kofoid & Campbell, 1939
- Genus: *Epiplocylis* Jörgensen, 1924
  - *Epiplocylis calyx* (Brandt, 1906)
  - *Epiplocylis exquisita* Kofoid & Campbell, 1929
  - *Epiplocylis undella* (Ostenfeld & Schmidt) Jörgensen, 1927
- Genus: *Epiplocyloides* Hada, 1938
  - *Epiplocyloides acuta* (Kofoid & Campbell,1929)
  - *Epiplocyloides ralumensis* (Brandt, 1906)
  - *Epiplocyloides reticulata* (Ostenfeld & Schmidt, 1901)

Family: **Metacylididae** Kofoid & Campbell, 1929
- Genus: *Coxliella* Brandt
  - *Coxliella longa* Kofoid & Campbell, 1929
  - *Coxliella mariana* Hada, 1938
- Genus: *Metacylis* Jörgensen, 1924
  - *Metacylis hemisphaerica* Roxas, 1941
  - *Metacylis jörgensenii* (Cleve) Kofoid & Campbell, 1929
  - *Metacylis kofoidi* Roxas, 1941
  - *Metacylis tropica* Duran, 1957
- Genus: *Helicostomella* Jörgensen, 1924
  - *Helicostomella longa* (Brandt, 1906)
- Genus: *Climacocylis* Jörgensen, 1924
  - *Climacocylis elongata* Kofoid & Campbell, 1929
  - *Climacocylis* cf. *leospiralis* Kofoid & Campbell
  - *Climacocylis scalaria* Brandt, 1906
  - *Climacocylis sipho* (Brandt, 1906) Kofoid & Campbell, 1929

Family: **Petalotrichidae** Kofoid & Campbell, 1929
- Genus: *Petalotricha* Kent, 1881
  - *Petalotricha major* Jörgensen, 1925

Family: **Ptychocylididae** Kofoid & Campbell, 1929
- Genus: *Favella* Jörgensen, 1924
  - *Favella ehrenbergii* (Claparède & Lachmann, 1858) Jörgensen, 1924
  - *Favella simplex* Roxas, 1941
  - *Favella philippinensis* Roxas, 1941
  - *Favella elongata* Roxas, 1941
  - *Favella azorica* (Cleve, 1900) Jörgensen, 1924

Family: **Rhabdonellidae** Kofoid & Campbell, 1929
- Genus: *Rhabdonella* Brandt, 1906
  - *Rhabdonella amor* (Cleve, 1900) Brandt, 1907

Rhabdonella apophysata Jörgensen, 1924
Rhabdonella brandti Kofoid & Campbell, 1929
Rhabdonella conica Kofoid & Campbell, 1929
Rhabdonella cornucopia Kofoid & Campbell, 1929
Rhabdonella elegans Jörgensen, 1924
Rhabdonella exilis Kofoid & Campbell, 1929
Rhabdonella sanyahensis Nie & Cheng, 1947
Rhabdonella fenestrata Roxas, 1941
Rhabdonella valdestriata (Brandt) Kofoid & Campbell, 1929
Rhabdonella spiralis (Fol, 1881)
Genus: *Protorhabdonella* Jörgensen, 1924
Protorhabdonella curta Cleve, 1900
Protorhabdonella simplex (Cleve) Jörgensen, 1924
Protorhabdonella striatura Kofoid & Campbell, 1929
Family: **Tintinnidae** Claparède & Lachmann, 1858
Genus: *Amphorellopsis* Kofoid & Campbell, 1929
Amphorellopsis acuta (Schmidt, 1902)
Genus: *Amphorides* Strand, 1928
Amphorides amphora (Claparède & Lachmann, 1858)
Amphorides quadrilineata (Claparède & Lachmann, 1858)
Amphorides minor Jörgensen, 1924
Genus: *Brandtiella* Kofoid & Campbell, 1929
Brandtiella palliata (Brandt, 1906) Kofoid & Campbell, 1929
Genus*: Canthariella* (Kofoid & Campbell, 1929)
Canthariella pyramidata (Jörgensen, 1924) Kofoid & Campbell, 1929
Genus: *Dadayiella* Kofoid & Campbell, 1929
Dadayiella ganymedes (Entz, 1884) Kofoid & Campbell, 1929
Dadayiella pachytoecus (Dendy, 1924)
Genus: *Eutintinnus* Kofoid & Campbell, 1939
Eutintinnus apertus Kofoid & Campbell, 1929
Eutintinnus fraknoii (Daday, 1887)
Eutintinnus lusus-undae (Entz, 1885)
Eutintinnus stramentus (Kofoid & Campbell, 1929)
Genus *Ormosella* Kofoid & Campbell, 1929
Ormosella haeckeli Kofoid & Campbell, 1929
Genus: *Salpingella* Jörgensen, 1924
Salpingella acuminata (Claparède & Lachmann, 1858) Jörgensen, 1924
Salpingella acuminatoides (Laackmann) Kofoid & Campbell, 1929
Salpingella attenuata Kofoid & Campbell, 1929
Salpingella decurtata Jörgensen, 1924
Salpingella subconica Kofoid & Campbell, 1929

Genus: *Steenstrupiella* Kofoid & Campbell, 1929
Steenstrupiella intumescens (Jörgensen, 1924) Kofoid & Campbell, 1929
Steenstrupiella steenstrupii (Claparède & Lachmann, 1858) Kofoid & Campbell, 1929
Genus: *Tintinnus* Schrank, 1803
Tintinnus perminutus Kofoid & Campbell, 1929
Family: **Tintinnidiidae** Kofoid & Campbell
Genus*: Tintinnidium* Kent, 1881
Tintinnidium primitivum Busch, 1923
Tintinnidium cylindrica Daday, 1886
Tintinnidium ampullarium Roxas, 1941
Genus*: Leprotintinnus* Jörgensen, 1899
Leprotintinnus nordqvistii (Brandt, 1906) Kofoid & Campbell, 1929
Leprotintinnus tubulosus Roxas, 1941
Family: **Undellidae** Kofoid & Campbell, 1929
Genus: *Undella* Daday, 1887
Undella claparedei (Entz) Daday, 1887
Undella clevei Jörgensen, 1924
Undella hyalina Daday, 1887
Undella subcaudata Jörgensen, 1924
Family: **Xystonellidae** Kofoid & Campbell, 1929
Genus: *Parundella* Jörgensen, 1924
Parundella aculeata (Joergensen, 1924)
Parundella caudata (Ostenfeld, 1899) Jörgensen, 1924
Parundella inflata Kofoid & Campbell, 1929
Parundella longa Joergensen, 1924
Genus: *Xystonella* Brandt, 1907
Xystonella treforti (Daday, 1887)
Genus: *Xystonellopsis* Jörgensen, 1924
Xystonellopsis brandti (Laackmann) Jörgensen, 1924
Xystonellopsis cymatica (Brandt, 1906) Jörgensen, 1924
Xystonellopsis dahli (Brandt, 1906) Kofoid & Campbell, 1929
Xystonellopsis paradoxa (Cleve, 1900) Jörgensen, 1924

The study of Roxas (1941) contained the first recorded tintinnid species in the Philippines. Roxas (1941) documented 32 tintinnid species wherein ten were newly discovered species (Table 2). *Favella simplex*, *Favella philippinensis,* and *Favella elongata* were the only accepted and registered species in the WoRMS database (Warren 2018) among the said newly discovered species. The other newly discovered species are still included in this present checklist due to the scarcity of tintinnid studies in the Philippines. The other newly discovered species were not recorded in any other studies and

we took into consideration that they might be endemic in the area where Roxas (1941) collected them. Roxas also misspelled *Leprotinntinnus nordqvistii,* which he recorded as *Leprotinntinnus nordquisti.*

Since 1941, only three other studies (Gómez 2007, Kim et al. 2012, Santiago et al. 2017) were made in the Philippines that identified tintinnids to species level. The paper of Roxas (1941) and Santiago et al. (2017) recorded a total of 50 tintinnid species from coastal waters of Manila Bay (39 species) and Puerto Galera Bay (11 species). On the other hand, Gómez (2007) and Kim et al. (2012) conducted their sample collection within the Philippines open seas, which amounted to 72 tintinnid species.

Tintinnopsis, Codonellopsis, Coxliella, Metacylis, Rhabdonella, Epiplocylis and *Eutintinus* were the genera that both appeared in coastal and open waters (Table 1). There were eight genera that were only recorded in coastal waters and a total of 24 genera were solely found in the open seas (Table 1). *Epiplocylis undella* and *Rhabdonella spiralis* were the only species common to all of four tintinnid studies in the Philippines (Table 2).

Discussion

Presently, there are only four related studies (Roxas 1941, Gómez 2007, Kim et al. 2012, Santiago et al. 2017) that contain tintinnid species in the Philippines. Roxas (1941) and Santiago et al. (2017) conducted their zooplankton collection within the Philippines coastal waters while Gómez (2007) and Kim et al. (2012) had cruises along the open seas. Table 1 and 2 showed the tintinnids distribution between open seas and coastal waters. This is an important data because some of the tintinnids were categorized into biogeographical groups (Pierce and Turner 1993). The studies (Lee and Kim 2010, Kim et al. 2012) that utilized tintinnids as indicator species used their biogeographical groups to assess water quality and mass movements. In this present study, there are species and genera that were only recorded in one area and some both appeared in open seas and coastal waters. Hence, the variation of the tintinnids distribution between open seas and coastal waters in this current work might help in further classification of tintinnid species to their biogeographical groups.

It should also be noted that each of the said four studies had a different sampling technique and effort. Roxas (1941) towed a no. 20 plankton net with 176 mesh per inch which means that it has an aperture of 0.076 mm or 76 μm. The plankton net that Santiago et al. 2017 used has 64 μm mesh size. These can indicate that the majority of the collected species of Roxas (1941) and Santiago et al. 2017 were large tintinnid species (>64 μm). Microzooplankton size range from 20 to 200 μm, thus, collecting tintinnids through plankton net with a relatively larger aperture size can result in loss of most of the smaller-sized tintinnids.

In the studies conducted in Philippines open seas, Gómez (2007) used Niskin bottles while Kim et al. (2012) towed a 20 μm mesh-plankton-net. The differences in methodologies and lack of standardization of sampling technique on tintinnids collection (Gómez 2007) can add complication on the analysis and comparison of

Table 1. Summary of the tintinnid appearance between coastal and open seas by genus.

	Coastal	Open sea	Both
	Favella	*Acanthostomella*	*Codonellopsis*
	Helicostomella	*Amphorellopsis*	*Coxliella*
	Leprotintinnus	*Amphorides*	*Epiplocylis*
	Petalotricha	*Ascampbelliella*	*Eutintinnus*
	Tintinnidium	*Brandtiella*	*Metacylis*
	Tintinnus	*Canthariella*	*Rhabdonella*
	Wangiella	*Climacocylis*	*Tintinnopsis*
		Codonaria	
		Codonella	
		Craterella	
		Cyttarocylis	
		Dadayiella	
		Dictyocysta	
		Epiplocylididae	
		Epiplocyloides	
		Ormosella	
		Parundella	
		Poroecus	
		Protorhabdonella	
		Salpingella	
		Steenstrupiella	
		Undella	
		Xystonella	
		Xystonellopsis	
Total	**7**	**24**	**7**

Table 2. Distribution of tintinnid species reported in the Philippines. The open sea has records from the southwest (**SW**) seas that include Sulu, Celebes and South China Sea (Gómez 2007). The northeast **(NE**) was based on the study of Kim et al. (2012) in the Philippine Sea. The species in the Coastal areas were from Manila bay (**MB**) (Roxas 1941, Santiago et al. 2017) and Puerto Galera Bay (**PG**) (Roxas 1941). An asterisk (*) denotes new species.

Taxon	**Open sea**		**Coastal**	
	SW	**NE**	**MB**	**PG**
1. *Acanthostomella conicoides*		+		
2.*Acanthostomella minutissima*	+			
3. *Amphorellopsis acuta*		+		
4. *Amphorides amphora*	+	+		
5. *Amphorides minor*		+		
6. *Amphorides quadrilineata*	+	+		
7. *Ascampbelliella acuta*		+		
8. *Ascampbelliella armilla*	+			
9. *Ascampbelliella retusa*	+			
10. *Ascampbelliella urceolata*		+		

Taxon	Open sea		Coastal	
	SW	NE	MB	PG
11. *Brandtiella palliata*	+	+		
12. *Canthariella pyramidata*	+	+		
13. *Climacocylis cf. leospiralis*	+			
14. *Climacocylis elongata*		+		
15. *Climacocylis scalaria*	+	+		
16. *Climacocylis sipho*		+		
17. *Codonaria oceanica*	+			
18. *Codonella amphorella*		+		
19. *Codonellopsis morchella*			+	
20. *Codonellopsis orthoceras*		+	+	
21. *Codonellopsis ostenfeldi*			+	
22. *Codonellopsis pusilla*	+			
23. *Codonellopsis schabi*	+			
24. *Coxliella longa*			+	
25. *Coxliella mariana*		+		
26. *Craterella aperta*	+			
27. *Cyttarocylis cassis*		+		
28. *Dadayiella ganymedes*	+	+		
29. *Dadayiella pachytoecus*		+		
30. *Dictyocysta elegans*	+	+		
31. *Dictyocysta mitra*		+		
32. *Epiplocylis calyx*		+		
33. *Epiplocylis exquisita*				+
34. *Epiplocylis undella*	+	+	+	+
35. *Epiplocyloides acuta*		+		
36. *Epiplocyloides ralumensis*				+
37. *Epiplocyloides reticulata*	+			
38. *Eutintinnus apertus*	+			
39. *Eutintinnus fraknoii*	+	+	+	
40. *Eutintinnus lusus-undae*	+	+	+	
41. *Eutintinnus stramentus*	+	+		
42. *Favella azorica*				+
43. *Favella ehrenbergii*			+	
44. *Favella elongate**			+	
45. *Favella philippinensis**			+	
46. *Favella simplex**			+	
47. *Helicostomella longa*			+	
48. *Leprotintinnus nordqvistii*			+	
49. *Leprotintinnus tubulosus**			+	
50. *Metacylis hemisphaerica**				+
51. *Metacylis jörgensenii*		+	+	
52. *Metacylis kofoidi**				+
53. *Metacylis tropica*			+	
54. *Ormosella haeckeli*		+		
55. *Parundella aculeata*	+			
56. *Parundella caudata*		+		

Taxon	Open sea		Coastal	
	SW	NE	MB	PG
57. *Parundella inflata*		+		
58. *Parundella longa*	+			
59. *Petalotricha major*				+
60. *Poroecus annulatus*	+			
61. *Poroecus apicatus*		+		
62. *Protorhabdonella curta*	+	+		
63. *Protorhabdonella simplex*	+	+		
64. *Protorhabdonella striatura*		+		
65. *Rhabdonella amor*	+	+		+
66. *Rhabdonella apophysata*	+	+		
67. *Rhabdonella brandti*				+
68. *Rhabdonella conica*			+	
69. *Rhabdonella cornucopia*		+		
70. *Rhabdonella elegans*	+			
71. *Rhabdonella exilis*		+		
72. *Rhabdonella fenestrata**				+
73. *Rhabdonella sanyahensis*				
74. *Rhabdonella spiralis*	+	+	+	+
75. *Rhabdonella valdestriata*		+		
76. *Salpingella acuminata*	+	+		
77. *Salpingella acuminatoides*		+		
78. *Salpingella attenuata*	+			
79. *Salpingella decurtata*	+			
80. *Salpingella subconica*		+		
81. *Steenstrupiella intumescens*		+		
82. *Steenstrupiella steenstrupii*	+	+		
83. *Tintinnidium ampullarium**			+	
84. *Tintinnidium cylindrica*			+	
85. *Tintinnidium primitivum*			+	
86. *Tintinnopsis bacoornensis**			+	
87. *Tintinnopsis beroidea*			+	
88. *Tintinnopsis buetschlii*			+	
89. *Tintinnopsis campanula*	+			
90. *Tintinnopsis chinglanensis*			+	
91. *Tintinnopsis corniger*			+	
92. *Tintinnopsis cylindrica*			+	
93. *Tintinnopsis directa*			+	
94. *Tintinnopsis gracilis*			+	
95. *Tintinnopsis loricata*			+	
96. *Tintinnopsis major*			+	
97. *Tintinnopsis manilensis**			+	
98. *Tintinnopsis mortensenii*			+	
99. *Tintinnopsis radix*			+	
100. *Tintinnopsis rotundata*			+	
101. *Tintinnopsis tocantinensis*			+	
102. *Tintinnopsis turgida*			+	

Taxon	Open sea		Coastal	
	SW	NE	MB	PG
103. *Tintinnopsis uruguayensis*			+	
104. *Tintinnus perminutus*			+	
105. *Undella claparedei*	+	+	+	
106. *Undella clevei*	+			
107. *Undella hyalina*		+		
108. *Undella subcaudata*	+			
109. *Wangiella dicollaria*			+	
110. *Xystonella treforti*	+	+		
111. *Xystonellopsis brandti*		+		
112. *Xystonellopsis cymatica*	+	+		
113. *Xystonellopsis dahli*		+		
114. *Xystonellopsis paradoxa*		+		
108. *Undella subcaudata*	+			
109. *Wangiella dicollaria*			+	
110. *Xystonella treforti*	+	+		
111. *Xystonellopsis brandti*		+		
112. *Xystonellopsis cymatica*	+	+		
113. *Xystonellopsis dahli*		+		
114. *Xystonellopsis paradoxa*		+		
108. *Undella subcaudata*	+			
109. *Wangiella dicollaria*			+	
110. *Xystonella treforti*	+	+		
111. *Xystonellopsis brandti*		+		
112. *Xystonellopsis cymatica*	+	+		
113. *Xystonellopsis dahli*		+		
114. *Xystonellopsis paradoxa*		+		

Table 3. Percentage (%) Distribution of Tintinnids families from the Philippines.

Family	Genus	Species	%
Ascampbelliellidae	3	7	6.14
Codonellidae	**4**	**22**	**19.30**
Codonellopsidae	1	5	4.39
Cyttarocylididae	1	1	0.88
Dictyocystidae	2	3	2.63
Epiplocylididae	2	6	5.26
Metacylididae	4	11	9.65
Petalotrichidae	1	1	0.88
Ptychocylididae	1	5	4.39
Rhabdonellidae	2	14	12.28
Tintinnidae	**10**	**21**	**18.42**
Tintinnidiidae	2	5	4.39
Undellidae	1	4	3.51
Xystonellidae	3	9	7.89

their biogeographical distribution. Apparently, more studies on tintinnids in the Philippines and a standard of methodology should be established. The authors executed this current work to serve as a starting point for other researchers and encourage them to conduct studies on tintinnids in a center of marine biodiversity such as the Philippines.

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RESEARCH ARTICLE

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Echinoderes pterus sp. n. showing a geographically and bathymetrically wide distribution pattern on seamounts and on the deep-sea floor in the Arctic Ocean, Atlantic Ocean, and the Mediterranean Sea (Kinorhyncha, Cyclorhagida)

Hiroshi Yamasaki[1,2], Katarzyna Grzelak[3,4], Martin V. Sørensen[5], Birger Neuhaus[1], Kai Horst George[2]

1 *Museum für Naturkunde, Leibniz Institute for Evolution and Biodiversity, Invalidenstr. 43, D-10115 Berlin, Germany* **2** *Senckenberg am Meer, Abt. Deutsches Zentrum für Marine Biodiversitätsforschung DZMB, Südstrand 44, D-26382 Wilhelmshaven, Germany* **3** *Laboratory of Polar Biology and Oceanobiology, Faculty of Biology and Environmental Protection, University of Łódź, Łódź, Poland* **4** *Polish Academy of Sciences, Institute of Oceanology, Sopot, Poland* **5** *Natural History Museum of Denmark, University of Copenhagen, Copenhagen, Denmark*

Corresponding author: *Hiroshi Yamasaki* (h.yamasaki@meiobenthos.com)

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Abstract

Kinorhynchs rarely show a wide distribution pattern, due to their putatively low dispersal capabilities and/or limited sampling efforts. In this study, a new kinorhynch species is described, *Echinoderes pterus* **sp. n.**, which shows a geographically and bathymetrically wide distribution, occurring on the Karasik Seamount and off the Svalbard Islands (Arctic Ocean), on the Sedlo Seamount (northeast Atlantic Ocean), and on the deep-sea floor off Crete and on the Anaximenes Seamount (Mediterranean Sea), at a depth range of 675–4,403 m. The new species is characterized by a combination of middorsal acicular spines on segments 4–8, laterodorsal tubes on segment 10, lateroventral tubes on segment 5, lateroventral acicular spines on segments 6–9, tufts of long hairs rising from slits in a laterodorsal position on segment 9, truncated tergal extensions on segment 11, and the absence of any type-2 gland cell outlet. The specimens belonging to the populations from the Arctic Ocean, the Sedlo Seamount, and the Mediterranean Sea show morphologi-

cal variation in the thickness and length of the spines as well as in the presence/absence of ventromedial sensory spots on segment 7. The different populations are regarded as belonging to a single species because of their overlapping variable characters.

Keywords
meiofauna, meiofauna paradox, morphological variation, taxonomy

Introduction

The meiofauna, defined as the assemblage of microscopic benthic organisms passing through a 1 mm-sieve mesh and collected on a 40–63 μm-sieve mesh, is composed of various taxonomic groups, and occurs in diverse habitats including extreme environments such as polar regions, the deep sea, and seamounts (George 2013; De Broyer et al. 2014; Zeppilli et al. 2018). While meiobenthic organisms are generally thought to have a low dispersal ability because of their low mobility as well as their lack of a planktonic larval stage, some meiofaunal species can show a wide distribution pattern. This phenomenon is referred to the "meiofauna paradox" or "everything is everywhere hypothesis" (Giere 2009; Fontaneto 2011). Such wide distribution patterns have been explained or hypothesized by the stepping stone hypothesis (George 2013; Packmor and Riedl 2016), artificial dispersal (artificial invasion) (Herranz and Leander 2016; Pardos et al. 2016; Cvitković et al. 2017), or long range dispersal using currents and/or drifting (Walters and Bell 1994; Neuhaus and Sørensen 2013; Neuhaus et al. 2014; Yamasaki et al. 2014). Some are even regarded as a pseudo-wide distribution via the detection of cryptic species (Jörger et al. 2012; Leasi et al. 2016).

Kinorhyncha is an ecdysozoan phylum which is exclusively composed of marine meiofaunal species. To date, more than 260 kinorhynchs species are known from around the world (Grzelak and Sørensen 2018a, b; Yamasaki et al. 2018). Many ecological studies on meiofauna from various regions and environments often report the presence of Kinorhyncha, but unfortunately provide only phylum-level identification (e.g., Grzelak and Kotwicki 2012; Nomaki et al. 2016; Riera et al. 2018). Most kinorhynch species have been recorded from a single or few localities within a limited region only, probably due to their low dispersal ability like other meiofaunal organisms, but most likely also because of limited sampling activities. So far, only few kinorhynch species have been recorded as geographically wide distributed species either from both shallow waters and the deep sea, e.g., *Campyloderes* cf. *vanhoeffeni* Zelinka, 1913, or from several shallow-water stations interrupted by the deep sea, e.g., *Centroderes barbanigra* Neuhaus et al., 2014, *Echinoderes ohtsukai* Yamasaki & Kajiraha, 2012, and *Echinoderes tchefouensis* Lou, 1934 (Sørensen et al. 2012b, 2016; Neuhaus et al. 2014; Herranz and Leander 2016).

In the present study, we describe a new kinorhynch species with a geographically and bathymetrically wide distribution, ranging from the Arctic Ocean to the Mediterranean Sea and from upper bathyal to lower abyssal depths. The interpopulational morphological variation of the new species is also discussed.

Materials and methods

Kinorhynchs were obtained from meiofauna samples collected from the central mount of the Karasik Seamount, Langseth Ridge in the Arctic Ocean (by the R/V *Polarstern* during the expedition PS101, Boetius and Purser (2017)), north of Svalbard in the Arctic Ocean (by the R/V *Polarstern* during the expedition PS92, Peeken (2016)), on the Sedlo Seamount in the Atlantic Ocean (by the R/V *METEOR* during the expedition M60/1, Christiansen and Wolff (2009)), in a deep-sea trench off Crete and on the adjacent deep-sea floor in the Mediterranean Sea (by the R/V *METEOR* during the expedition M71/2, Christiansen et al. (2015), and R/V *Maria S. Merian* during the expedition MSM14/1, Christiansen et al. (2012)), and on the Anaximenes Seamount in the Mediterranean Sea (by the R/V *METEOR* during the expedition M71/1, Denda and Christiansen (2011)) (Fig. 1, Table 1). All sediment samples were fixed in 4–8% formaldehyde. Subsequently, the samples were washed with tap water on a 32-µm or a 40-µm mesh sieve in the laboratory, and the meiofauna was extracted from the sediment by centrifuging with a colloidal silica polymer (H.C. Stark, Levasil 200/40%, density 1.17 g/cm^3) and Kaolin, or with a colloidal silica polymer (Ludox TS50, density 1.4 g/cm^3). After extraction, the meiofauna was rinsed with tap water, sorted under a stereomicroscope, and subsequently preserved in 75% ethanol or 4% formaldehyde solution. Specimens collected during the expeditions PS92 and MSM14/1 were stained with Rose Bengal before sorting.

Specimens for light microscopy (LM) were dehydrated in glycerol and mounted as glycerol-paraffin slides on Cobb aluminum frames or mounted in Fluoromount G™ between two cover slips attached to a plastic H-S slide. LM specimens were observed with a Zeiss Axioskop 50 microscope, or with an Olympus BX51 microscope, and a Nikon E600 microscope. All microscopes were equipped with Nomarski differential interference contrast. A camera lucida equipped with a Zeiss Axioskop 50 microscope was used to make drafts for line art illustrations. Final line art illustrations were drawn with Adobe Illustrator CS6 based on the drafts. Measurements were made through a camera lucida or with Cell^D software. Specimens were photographed with a Zeiss AxioCam MRc5 or an Olympus DP27 camera.

Five specimens from the Karasik Seamount and 23 specimens from the Mediterranean deep sea were used for scanning electron microscopy (SEM) observation. The specimens were transferred from ethanol to distilled water through a graded series of ethanol, postfixed with OsO_4 in 0.05 M phosphate buffer (pH = 7.3) with 0.3 M sodium chloride and 0.05% sodium azide for 2.5 hours, dehydrated through a graded series of ethanol, critical-point dried with a BalTec CPD 030, mounted on aluminum stubs, sputter-coated with gold-palladium with a Polaron SC 7640, and observed with a Zeiss EVO LS 10 scanning electron microscope.

The terminology follows Neuhaus and Higgins (2002), Sørensen and Pardos (2008) and Neuhaus (2013). All specimens, except those from Svalbard, have been deposited in the Museum für Naturkunde Berlin (= ZMB, former Zoological Museum Berlin), Germany, and catalogued in the collection "Vermes" in the "Generalkatalog

Table 1. Data on sampling stations.

Sampling region	Station	Cruise	Date	Depth [m]	Latitude	Longitude	Gear
Langseth Ridge, central mount on Karasik Seamount	152-1	PS101	28.09.2016	903	86°49'23"N	61°40'10"E	multicorer
North of Svalbard	31	PS92	04.06.2015	1,656	81°28'11"N	18°10'27"E	box corer
North of Svalbard	43	PS92	15.06.2015	790	82°12'19"N	7°38'4"E	box corer
Sedlo Seamount	717	M60/1	24.11.2003	2,721	40°11'00"N	26°33'6"W	box corer
Mediterranean deep sea	24	M71/2	04.01.2007	2,789	33°43'41"N	26°32'55"E	multicorer
Mediterranean deep sea	51	M71/2	07.01.2007	4,323	34°30'19"N	26°11'30"E	multicorer
Mediterranean deep sea	52	M71/2	07.01.2007	4,326	34°30'18"N	26°11'31"E	multicorer
Mediterranean deep sea	55	M71/2	07.01.2007	4,332	34°30'19"N	26°11'30"E	multicorer
Mediterranean deep sea	56	M71/2	08.01.2007	4,327	34°30'19"N	26°11'31"E	multicorer
Mediterranean deep sea	62	M71/2	08.01.2007	4,396	34°25'5"N	26°7'6"E	multicorer
Mediterranean deep sea	63	M71/2	08.01.2007	4,395	34°24'56"N	26°6'59"E	multicorer
Mediterranean deep sea	64	M71/2	08.01.2007	4,399	34°24'59"N	26°6'57"E	multicorer
Mediterranean deep sea	65	M71/2	09.01.2007	4,403	34°25'00"N	26°6'59"E	multicorer
Mediterranean deep sea	66	M71/2	09.01.2007	4,401	34°25'00"N	26°6'59"E	multicorer
Mediterranean deep sea	94	M71/2	12.01.2007	4,147	34°21'29"N	25°58'30"E	multicorer
Mediterranean deep sea	1167.1	MSM14/1	11.01.2010	4,353	34°24'36"N	26°7'31"E	multicorer
Mediterranean deep sea	1169.1	MSM14/1	12.01.2010	4,344	34°24'34"N	26°7'30"E	multicorer
Anaximenes Seamount	918	M71/1	17.12.2006	2,043	35°30'14"N	30°8'58"E	multicorer
Anaximenes Seamount	930	M71/1	19.12.2006	675	35°26'4"N	30°9'53"E	multicorer

Freilebende Würmer". Specimens from Svalbard were deposited in the Natural History Museum of Denmark (NHMD). The maps of the sampling localities are drawn by the Generic Mapping Tools (GMT, https://www.soest.hawaii.edu/gmt/) using bathymetric data from the database of the National Center for Environmental Information.

Results

Taxonomy

Class Cyclorhagida Sørensen et al., 2015
Order Echinorhagata Sørensen et al., 2015
Family Echinoderidae Zelinka, 1894
Genus *Echinoderes* Claparède, 1863

***Echinoderes pterus* sp. n.**
http://zoobank.org/7F59E70B-3B53-4168-929B-F0EDCB6CD231
Figs 2–9; Tables 2 and 3

Diagnosis. *Echinoderes* with middorsal acicular spines on segments 4–8; laterodorsal tubes on segment 10; lateroventral tubes on segment 5; lateroventral acicular spines on

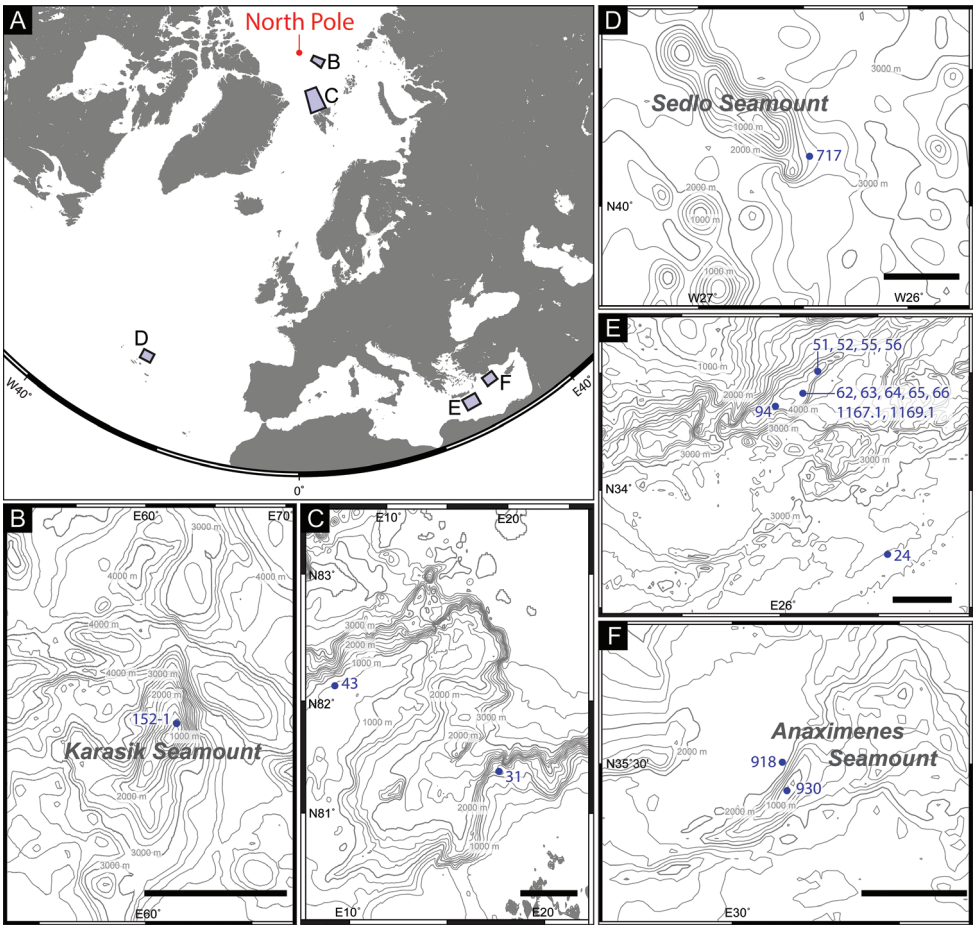


Figure 1. Map of the sampling localities. **A** map of the Northern hemisphere, including the Arctic Ocean, Atlantic Ocean, and Mediterranean Sea **B** enlarged map of the Karasik Seamount **C** enlarged map of the north of Svalbard **D** enlarged map of the Sedlo Seamount **E** enlarged map of the deep-sea canyon off Crete in the Mediterranean Sea **F** enlarged map of the Anaximenes Seamount. Scale bars: 20 km (**B**), 50 km (**C**), 30 km (**D–F**).

segments 6–9; tufts of long hairs arising from slits in a laterodorsal position on segment 9; truncated tergal extensions on segment 11; without type-2 gland cell outlet.

Etymology. The species name is derived from the Latinized Greek *pterón* (wing or feather), referring to the tufts of hairs on segment 9 which look like wings.

Material examined. Holotype: Adult male (ZMB 11608), collected at station 55 in the Mediterranean deep sea off Crete (Fig. 1A, E; Table 1), mounted as a glycerol-paraffin slide on a Cobb aluminum frame.

Paratypes: Adults, collected in the Mediterranean Sea off Crete; four males and one female, collected at station 24 (ZMB 11609–11613); one female, collected at station 51 (ZMB 11614); one female, collected at station 52 (ZMB 11615); one

male, collected at station 56 (ZMB 11616); one male and three females, collected at station 62 (ZMB 11617–11620); one female, collected at station 64 (ZMB 11621); one male, collected at station 65 (ZMB 11622); one male, collected at station 66 (ZMB 11623); one male, collected at station 94 (ZMB 11624); four males and seven females, collected at station 1167.1 (ZMB 11628–11638); one male and one female, collected at station 1169.1 (ZMB 11639–11640); one female, collected at station 918 (ZMB 11625); one male and one female, collected at station 930 (ZMB 11626–11627); (Fig. 1A, E, F; Table 1). All paratypes mounted as glycerol-paraffin slides on Cobb aluminum frames.

Additional material for LM: all adults; seven males and 12 females, collected at station 152 on Karasik Seamount, mounted as glycerol-paraffin slides on Cobb aluminum frames (ZMB 11642–11660); one male and one female, collected at station 31 north of Svalbard, mounted in Fluoromount G (NHMD-202798 and NHMD-202799); one male and one female, collected at station 43 north of Svalbard, mounted in Fluoromount G (NHMD-202800 and NHMD-202801); one male, collected at station 717 on the Sedlo Seamount, mounted as a glycerol-paraffin slide on a glass slide (ZMB 11641) (Fig. 1A–D; Table 1).

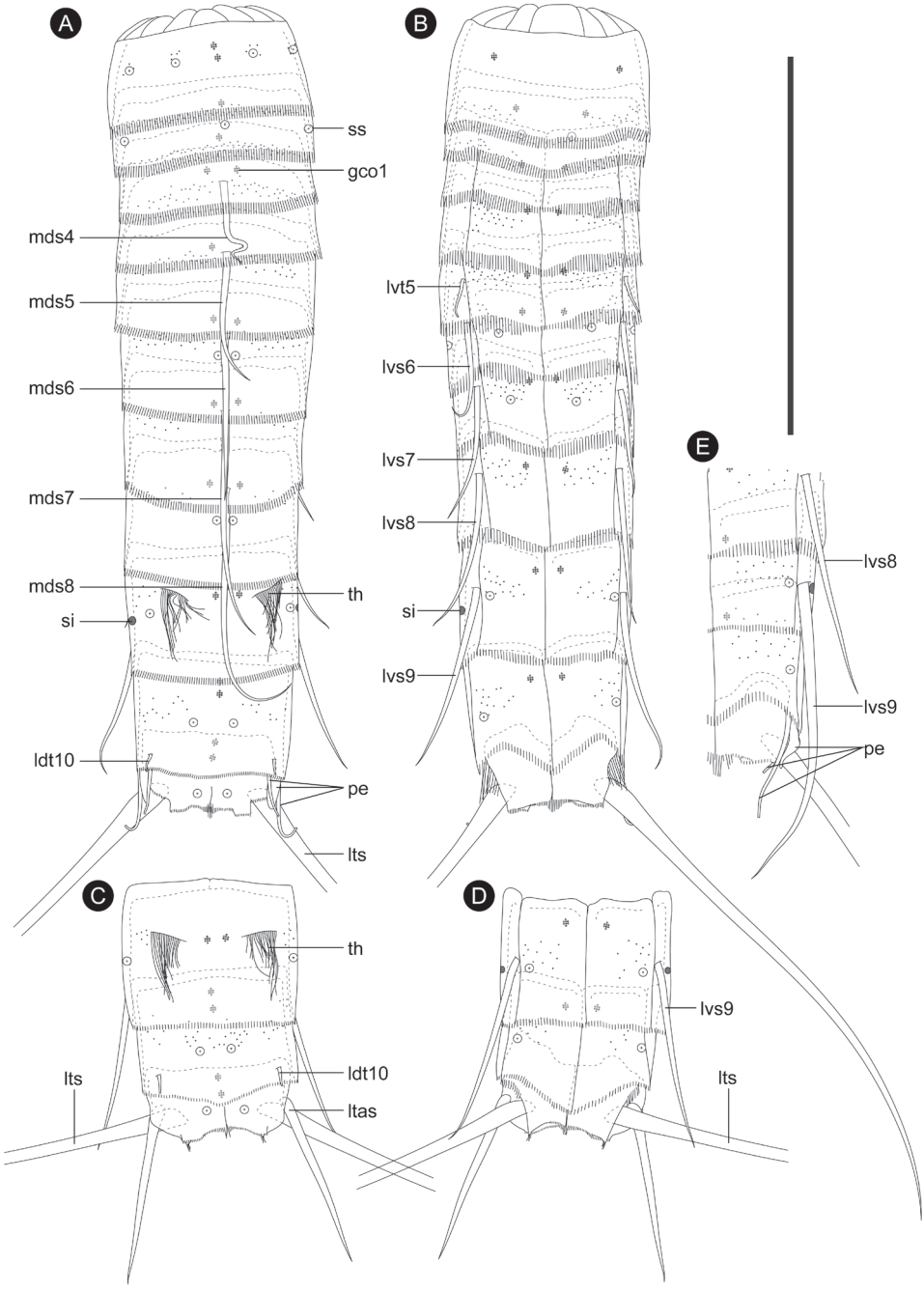
Additional material for SEM: adults, mounted on aluminum stubs; five males and nine females, collected at station 63 (ZMB 11664a–d, 11665a–d, 11666a, 11667a–d, 11668a), Mediterranean deep sea off Crete; five males and four females, collected at station 66, Mediterranean deep sea off Crete (ZMB 11661a–c, d, 11662a–c, 11663a, c); one male and four females, collected at station 152, the Karasik Seamount (ZMB 11669a, b, 11670b, d, 11671e) (Fig. 1A, B, E; Table 1).

Type locality. Deep-sea trench off Crete, Mediterranean Sea, (34°30'19"N, 26°11'30"E), 4,332 m depth (Fig. 1A, E; Table 1).

Description. Adult with head, neck, and eleven trunk segments (Figs 2A, B, 3A, 4A). See Table 2 for measurements. Table 3 indicates the positions of cuticular structures (sensory spots, gland cell outlets, spines, tubes, and sieve plates).

Head consisting of retractable mouth cone and introvert (Fig. 3B). Mouth cone with three rings of inner oral styles and nine outer oral styles (Figs 3C, 5). Pharyngeal crown shown anterior to inner oral styles in specimens with artificially protruded

Figure 2. *Echinoderes pterus* sp. n., camera lucida drawings. **A, B** Holotype, male (ZMB 11608), collected at station 55 (Mediterranean deep sea off Crete), entire animal, segments 1–11 in dorsal and ventral view, respectively **C, D** paratype, female (ZMB 11614), collected at station 51 (Mediterranean deep sea off Crete), segments 9–11, dorsal and ventral view, respectively **E** non-type, male (ZMB 11653), collected at station 152-1 (Karasik Seamount), segments 8–11, left side of ventral view. Characters drawn in gray color are overlapped by the preceding segment. Abbreviations: gco1, type-1 gland cell outlet; ldt, laterodorsal tube; ltas, lateral terminal accessory spine; lts, lateral terminal spine; lvs, lateroventral acicular spine; lvt, lateroventral tube; mds, middorsal acicular spine; pe, penile spine; si, protonephridial sieve plate; ss, sensory spot; th, tuft of long hairs. Digits after abbreviations indicate the corresponding segment number except in connection with a gland cell outlet. Scale bar: 100 μm.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lts

Table 2. Measurements of adult *Echinoderes pterus* sp. n. Measurements are given in micrometers, except for the ratios, and are summed for all specimens and listed separately for each population. Columns N and SD indicate sample size and standard deviation, respectively. Abbreviations: (f), length in females; ldt, length of laterodorsal tube; ltas, length of lateral terminal accessory spine; lts, length of lateral terminal spine; lvs, length of lateroventral spine; lvt, length of lateroventral tube; (m), length in males; mds, length of middorsal spine; msw, maximum sternal width; n.a., data not available; s, segment length; sw, standard width; tl, trunk length. Digits after abbreviation indicate segment number.

	Total				**Anaximenes Seamount**				**Mediterranean deep-sea off Crete**				**Sedlo Seamount**		**North of Svalbard**				**Karasik Seamount**			
	N	Range	Mean	SD	*N*	Range	Mean	SD	*N*	Range	Mean	SD	*N*		*N*	Range	Mean	SD	*N*	Range	Mean	SD
tl	56	186–253	219.3	15.5	3	205–234	215.4	15.9	30	186–253	217.8	16.5	0	n.a.	4	208–241	224.5	14.0	19	196–250	221.2	15.0
msw-5/6	30	42–59	50.2	4.3	2	48–48	47.9	0.3	13	42–54	48.0	3.5	1	49	4	56–59	58.0	1.4	10	46–56	50.5	2.5
msw/tl	29	19–28%	22.9%	2.2%	2	21–23%	21.9%	1.9%	13	19–26%	21.9%	1.7%	0	n.a.	4	23–28%	25.9%	2.1%	10	21–26%	23.2%	1.7%
sw-10	38	35–50	42.8	4.0	2	41–41	41.0	0.3	19	35–49	40.8	4.2	1	41	4	48–50	49.0	0.8	12	41–45	44.2	1.3
sw/tl	37	16–24%	19.7%	1.6%	2	18–20%	18.7%	1.6%	19	16–22%	19.2%	1.6%	0	n.a.	4	21–24%	21.9%	1.2%	12	18–22%	19.9%	1.3%
s1	46	25–38	31.8	2.9	2	29–31	29.9	1.0	25	25–37	31.6	3.1	1	30	4	27–29	28.3	1.0	14	31–38	33.6	1.6
s2	45	16–31	25.2	3.2	2	21–25	22.9	2.9	25	16–31	24.6	3.1	0	n.a.	4	19–23	21.3	1.7	14	23–29	27.6	1.7
s3	44	20–26	23.3	1.4	2	22–23	22.5	0.3	24	20–25	22.6	1.4	0	n.a.	4	23–26	24.5	1.3	14	23–26	24.1	1.1
s4	45	20–30	24.7	1.9	2	24–25	24.1	0.7	25	20–26	23.8	1.4	0	n.a.	4	27–30	28.0	1.4	14	24–27	25.7	1.1
s5	46	22–33	25.8	2.5	2	24–25	24.5	0.7	25	22–27	24.4	1.1	1	24	4	30–33	31.3	1.3	14	25–31	27.3	1.5
s6	46	25–36	28.7	2.5	2	25–28	26.6	2.3	25	25–32	27.4	1.7	1	27	4	32–36	33.8	1.7	14	27–32	29.9	1.4
s7	46	25–38	30.5	2.7	2	29–30	29.2	0.7	25	25–32	28.9	1.5	1	30	4	36–38	36.8	1.0	14	30–33	31.8	1.3
s8	46	29–43	33.8	3.0	2	30–34	31.9	2.6	25	29–37	32.5	2.0	1	30	4	40–43	41.3	1.3	14	32–36	34.4	1.3
s9	46	31–40	34.8	2.2	2	32–34	33.3	1.3	25	31–37	34.0	1.5	1	31	4	39–40	39.8	0.5	14	33–38	35.2	1.5
s10	46	32–50	39.3	4.8	2	32–37	34.5	2.9	25	34–39	36.4	1.4	1	36	4	36–41	38.3	2.2	14	40–50	45.8	3.1
s11	45	19–27	22.8	2.2	2	19–21	19.9	2.0	24	19–27	23.3	1.9	1	19	4	20–25	22.8	2.2	14	19–26	22.6	2.2
mds4	53	25–44	33.1	5.0	3	27–29	28.2	0.9	28	25–36	30.1	3.3	1	35	4	33–36	34.8	1.3	17	33–44	38.5	3.0
mds5	53	34–60	44.5	6.6	3	38–42	39.5	1.9	28	34–47	39.8	3.1	1	50	4	44–50	47.8	2.6	17	45–60	52.1	3.9
mds6	52	44–69	54.0	7.0	3	51–52	51.5	0.8	27	44–57	48.8	3.4	0	n.a.	4	48–60	55.0	5.6	18	56–69	62.0	3.6
mds7	53	56–92	71.4	11.5	3	60–69	63.7	4.6	29	56–69	63.0	3.4	1	68	3	75–76	75.3	0.6	17	79–92	86.6	4.4
mds8	48	71–108	88.0	11.2	2	84–85	84.5	0.3	27	71–88	79.5	4.6	1	101	4	89–99	95.5	4.7	14	95–108	101.9	4.2
ldt10	31	5–13	9.5	2.3	0	n.a.	n.a.	n.a.	12	5–9	7.2	1.3	0	n.a.	0	n.a.	n.a.	n.a.	19	8–13	10.9	1.2
lvt5	49	6–15	9.3	1.8	1	10–10	10.2	n.a.	28	6–15	9.7	2.1	0	n.a.	1	12–12	n.a.	n.a.	19	7–11	8.5	1.0
lvs6	51	22–43	31.7	5.4	3	27–32	29.6	2.3	27	22–38	28.0	3.6	1	35	4	30–35	33.5	2.4	16	32–43	37.7	3.0
lvs7	55	30–49	38.0	4.7	2	32–37	34.5	3.6	29	30–41	34.8	2.9	1	42	4	37–41	39.0	1.8	19	38–49	42.8	3.0
lvs8	56	37–65	48.4	7.0	3	42–46	43.7	2.1	29	37–50	43.9	3.7	1	45	4	47–61	54.5	7.0	19	46–65	55.0	5.2

	Total				Anaximenes Seamount				Mediterranean deep-sea off Crete				Sedlo Seamount		North of Svalbard				Karasik Seamount			
	N	Range	Mean	SD	*N*	Range	Mean	SD	*N*	Range	Mean	SD	*N*		*N*	Range	Mean	SD	*N*	Range	Mean	SD
lvs9	57	49–90	61.9	11.4	3	50–57	54.5	3.6	30	49–64	55.9	3.8	1	83	4	58–88	72.8	15.9	19	55–90	69.1	12.8
lvs9 (m)	25	50–90	66.2	14.9	1	56–56	n.a.	n.a.	15	50–62	55.5	3.1	1	83	2	85–88	86.5	2.1	7	80–90	84.9	3.9
lvs9 (f)	32	49–83	58.6	6.1	2	50–57	53.9	4.9	15	49–64	56.4	4.4	0	n.a.	2	58–60	59.0	1.4	12	55–64	59.9	3.2
lts	56	114–184	154.4	14.5	3	153–155	153.4	1.4	29	114–176	155.8	17.1	1	184	4	138–161	147.0	9.8	19	129–165	152.6	10.4
ltas	25	44–61	54.7	4.4	2	57–61	59.1	2.8	10	44–60	52.4	5.1	0	n.a.	2	51–52	51.5	0.7	11	52–61	56.7	2.5
lts/tl	55	52–86%	70.5%	7.2%	3	65–75%	71.5%	5.3%	29	57–86%	71.9%	8.2%	0	n.a.	4	63–69%	65.5%	3.1%	19	52–78%	69.3%	5.9%
ltas/tl	25	20–29%	25.2%	2.5%	2	28–29%	28.7%	1.1%	10	20–28%	23.9%	2.4%	0	n.a.	2	22–25%	23.6%	1.9%	11	22–29%	26.0%	2.1%

Table 3. Summary of locations of cuticular structures and appendages in *Echinoderes pterus* sp. n. Underlined structure was observed only in specimens from the Anaximenes Seamount and the Mediterranean deep sea off Crete. Abbreviations: ac, acicular spine; (f), female condition of sexually dimorphic character; gco1, type-1 gland cell outlet; la, lateral accessory; ld, laterodorsal; ltas, lateral terminal accessory spine; lts, lateral terminal spine; lv, lateroventral; (m), male condition of sexually dimorphic character; md, middorsal; ml, midlateral; pd, paradorsal; pe, penile spine; sd, subdorsal; si, sieve plate; sl, sublateral; ss, sensory spot; tu, tube; vl, ventrolateral; vm, ventromedial.

Position / segment	md	pd	sd	ld	ml	sl	la	lv	vl	vm
1	gco1, gco1		ss	ss				gco1		
2	gco1, ss			ss						gco1, ss
3	gco1									gco1
4	ac	gco1								gco1
5	ac	gco1						tu		gco1
6	ac	gco1, ss			ss			ac		ss, gco1
7	ac	gco1						ac		<u>ss</u>, gco1
8	ac	gco1, ss						ac		gco1
9		gco1		ss		si		ac	ss	gco1
10	gco1, gco1		ss	tu					ss	gco1
11	gco1, gco1		ss				pe×3 (m), ltas (f)	lts		

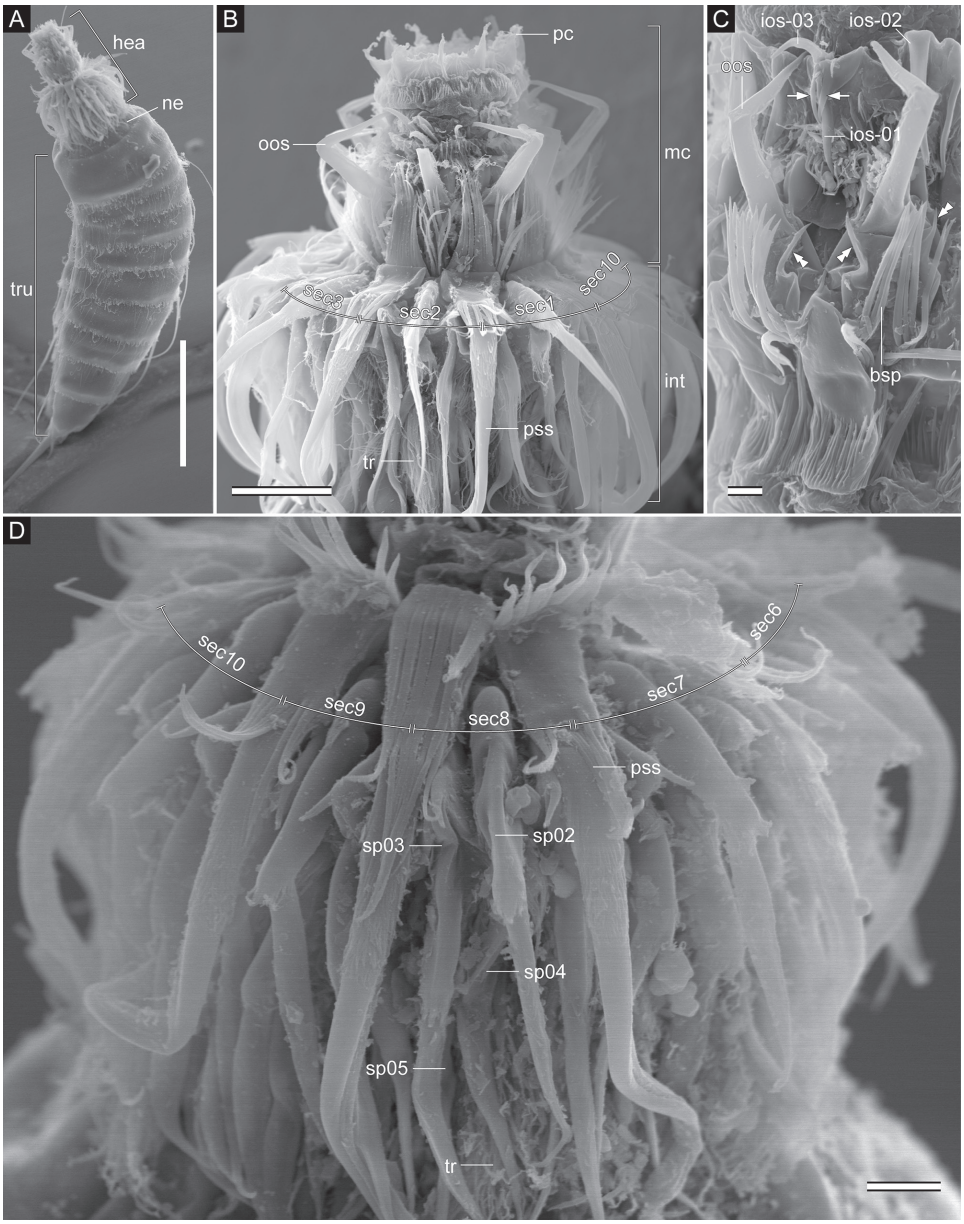


Figure 3. *Echinoderes pterus* sp. n., scanning electron micrographs. Male (**A, D** ZMB 11662c), collected at station 66 (Mediterranean deep sea off Crete) and females (**B** ZMB 11669b; **C** ZMB 11671e), collected at station 152-1 (Karasik Seamount). **A** entire animal, lateral view (left side) **B** head, ventral view **C** close-up of mouth cone, subdorsal view **D** close-up of introvert, lateral view (left side). Abbreviations: bsp, bifurcated spinose processes; hea, head; int, introvert; ios, inner oral style; mc, mouth cone; ne, neck; oos, outer oral style; pc, pharyngeal crown; pss, primary spinoscalid; sec, sector; sp, spinoscalid; tr, trichoscalid; tru, trunk. Digits after abbreviations indicate the sector or ring number. White arrows point to spinose structures at basal part of ring -01 inner oral styles. White double arrowheads indicate short spinose processes. Scale bars: 50 μm (**A**), 10 μm (**B**), 2 μm (**C**), 3 μm (**D**).

head (Fig. 3B), but located interior and posterior of inner oral styles in nature. Five thin and tube-like inner oral styles in ring 03, five thick spinose inner oral styles in ring 02, and ten spinose inner oral styles in ring 01. Two spinose structures present at basal part of ring -01 inner oral styles between sectors 2 and 3, 4 and 5, 7 and 8, and 9 and 10 (Figs 3C, 5). Each outer oral style consisting of rectangular basal part and triangular distal part, with basal part alternating in size between five larger ones in odd sectors and four smaller ones in even sectors (Figs 3B, C, 5). Each outer oral style with six long spinose processes bifurcated at their tips. One pair of additional short spinose processes originating slightly more anteriorly and laterally on either side of each outer oral style. Introvert composed of one ring of primary scalids, five rings of spinoscalids, and one ring of trichoscalids (Figs 3B, D, 5). Each primary spinoscalid consisting of basal sheath and distal end piece. Basal sheath with two layers of proximal fringes. End piece long, covered with minute hairs proximally, bluntly ending at distal tip. Each spinoscalid of rings 02–05 composed of basal sheath with fringed edge and distal long-spinose end piece. Spinoscalids in rings 02 and 03 longer than those in rings 04 and 05. Thin hair-like structures present at basal part of each spinoscalid. Trichoscalids arising from trichoscalid plates. Each trichoscalid covered with long hairs.

Neck with 16 placids (Figs. 2A, B, 4B, C). Midventral placid broadest (Fig. 4C). Remaining placids similar in size. Two trichoscalid plates present ventrally and four dorsally, each associated with ventromedial, subdorsal, and laterodorsal placid, respectively (Fig. 4B, C).

Segment 1 consisting of complete cuticular ring. Sensory spots located in subdorsal and laterodorsal position (Figs 2A, 4D, 6A, B). Few hairs flanking each sensory spot. Two type-1 gland cell outlets present in tandem in middorsal and additional single pair in lateroventral position (Figs 2A, B, 4D, 6A, C). Posterior part of this and following ten segments with primary pectinate fringe (Figs 2A, B, 4D, 6A, C). Pectinate fringe teeth of primary pectinate fringe thin and long. Segment devoid of cuticular hairs except for hairs associated with sensory spots (Figs 3A, 6A, C).

Segment 2 with complete cuticular ring as segment 1. This and following eight segments with thick pachycyclus at anterior margin of each segment (Figs 2A, B, 4A, D–F). Pachycyclus interrupted middorsally in segments 3–9 as well as at tergosternal and midsternal junctions in segments 3–10. Cuticular hairs rising from perforation sites in anterior and central area of this and following eight segments (Fig. 6A); hairs long, rather thin and flexible, and tending to curl up (Figs 6D, 7C). Sensory spots present in middorsal, laterodorsal and ventromedial position (Figs 2A, B, 6A, C). Type-1 gland cell outlets present in middorsal and ventromedial position.

Segment 3 and following eight segments consisting of one tergal and two sternal plates (Fig. 2A, B). No sensory spots present. Type-1 gland cell outlets situated in middorsal and ventromedial position.

Segment 4 with middorsal acicular spine (Figs 2A, 4D, D, 6A). No sensory spots present. Type-1 gland cell outlets present in paradorsal and ventromedial position.

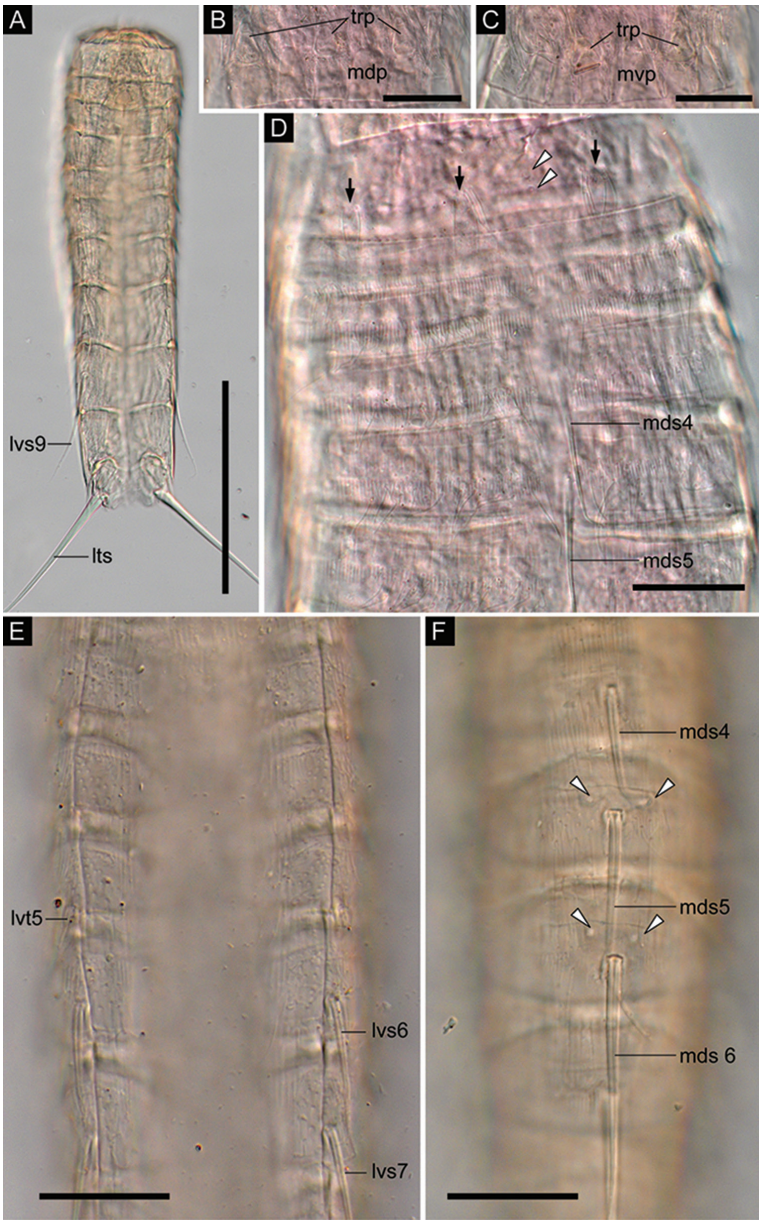
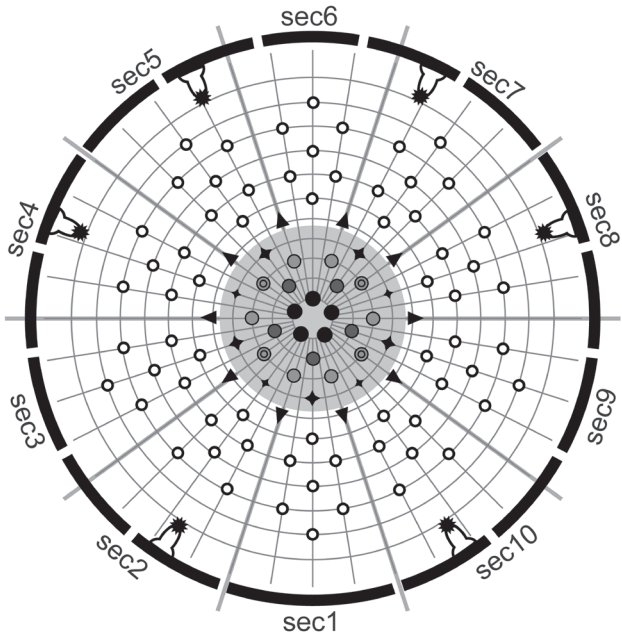


Figure 4. *Echinoderes pterus* sp. n., Nomarski photomicrographs. The holotype male (**A, F** ZMB 11608), collected at station 55 (Mediterranean deep sea off Crete), a male (**E** ZMB 11609), collected at station 24 (Mediterranean deep sea off Crete), and a female (**B–D** ZMB 11635), collected at station 1167.1 (Mediterranean deep sea of Crete). **A** entire animal, ventral view **B** neck, dorsal view **C** neck, ventral view **D** segments 1–6, dorsal view **E** segments 3–7, ventral view **F** segments 4–7, dorsal view. Abbreviations: lts, lateral terminal spine; lvs, lateroventral acicular spine; lvt, lateroventral tube; mdp, middorsal placid; mds, middorsal acicular spine; mvp, midventral placid; trp, trichoscalid plate. Digits after abbreviations indicate the corresponding segment number. Black arrows mark sensory spots; white arrowheads point to type-1 gland cell outlets. Scale bars: 100 μm (**A**), 20 μm (**B–D**).



Scalid and style arrangement

Ring	Sector 1	2	3	4	5	6	7	8	9	10	Total
-03 inner oral styles ●	0	1	0	1	0	1	0	1	0	1	5
-02 inner oral styles ●	1	0	1	0	1	0	1	0	1	0	5
-01 inner oral styles ◎●	1	1	1	1	1	1	1	1	1	1	10
00 outer oral styles ✦	1	1	1	1	1	0	1	1	1	1	9
01 primary spinoscalids ▼	1	1	1	1	1	1	1	1	1	1	10
02 spinoscalids ○	1	1	1	1	1	1	1	1	1	1	10
03 spinoscalids ○	2	2	2	2	2	2	2	2	2	2	20
04 spinoscalids ○	1	1	1	1	1	1	1	1	1	1	10
05 spinoscalids ○	2	2	2	2	2	2	2	2	2	2	20
06 spinoscalids ○	1	0	1	0	1	1	1	0	1	0	6
07 trichoscalids ✸	0	1	0	1	1	0	1	1	0	1	6

Figure 5. Polar-coordinate diagram of mouth cone, introvert, and placids in *Echinoderes pterus* sp. n. Grey area and heavy line arcs show mouth cone and placids respectively. The table lists the arrangement of styles and scalids by sector. Inner oral styles of ring 01 showing spinose processes at basal part indicated by black circle in grey outer circle. Abbreviation: sec, sector.

Segment 5 with middorsal acicular spine and lateroventral tubes (Figs 2A, B, 4D–F, 6D). Lateroventral tubes consisting of relatively thick and short basal part and long flexible distal part. Sensory spots absent. Type-1 gland cell outlets present in paradorsal and ventromedial position (Fig. 4F).

Segment 6 with middorsal and lateroventral acicular spines (Figs 2A, B, 4E, F, 6D–F, 7A, B). Sensory spots present in paradorsal, midlateral, and ventromedial po-

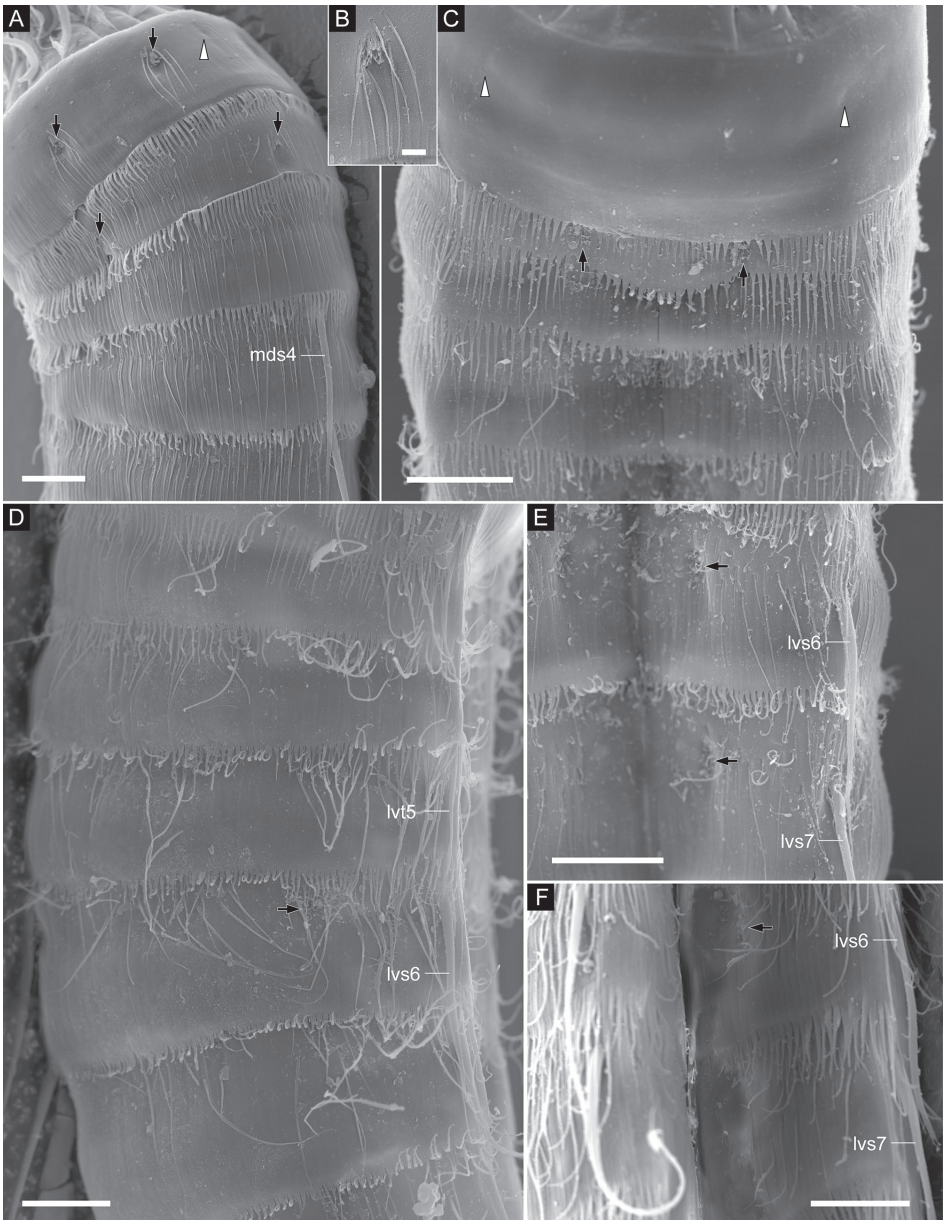


Figure 6. *Echinoderes pterus* sp. n., scanning electron micrographs. Females (**A, B** ZMB 11669a, collected at station 152-1 (Karasik Seamount) **D** ZMB 11661c, collected at station 66 (Mediterranean deep sea of Crete) **F** ZMB 11669b, collected at station 152-1 (Karasik Seamount)) and a male (**C, E** ZMB 11661a, collected at station 66 (Mediterranean deep sea off Crete)). **A** segments 1–4, laterodorsal view (left side) **B** close-up of laterodorsal sensory spot on segment 1 **C** segments 1–4, ventral view **D** segments 3–7, lateral view (right side) **E** sternal plates on segments 6 and 7 **F** sternal plates on segments 6 and 7. Abbreviations: lvs, lateroventral acicular spine; lvt, lateroventral tube; mds, middorsal acicular spine. Digits after abbreviations indicate the corresponding segment number. Black arrows point to sensory spots; white arrowheads mark type-1 gland cell outlets. Scale bars: 10 μm (**A, C–F**), 2 μm (**B**).

Figure 7. *Echinoderes pterus* sp. n., scanning electron micrographs. Females (**A** ZMB 11661b, collected at station 66 (Mediterranean deep sea off Crete) **B** ZMB 11669a, collected at station 152-1 (Karasik Seamount) **C** ZMB 11664a, collected at station 63 (Mediterranean deep sea off Crete) **D** ZMB 11665d, collected at station 63 (Mediterranean deep sea off Crete)). **A** segments 6–8, dorsal view **B** segments 6–9, lateral view (left side) **C** segments 8–11, lateral view (left side) **D** close-up of tuft of hairs on segment 9. Abbreviations: ldt, laterodorsal tube; ltas, lateral terminal accessory spine; lts, lateral terminal spine; lvs, lateroventral acicular spine; mds, middorsal acicular spine; th, tuft of long hairs. Digits after abbreviations indicate the corresponding segment number. Black arrows point to sensory spots. Scale bars: 10 µm (**A–C**), 2 µm (**D**).

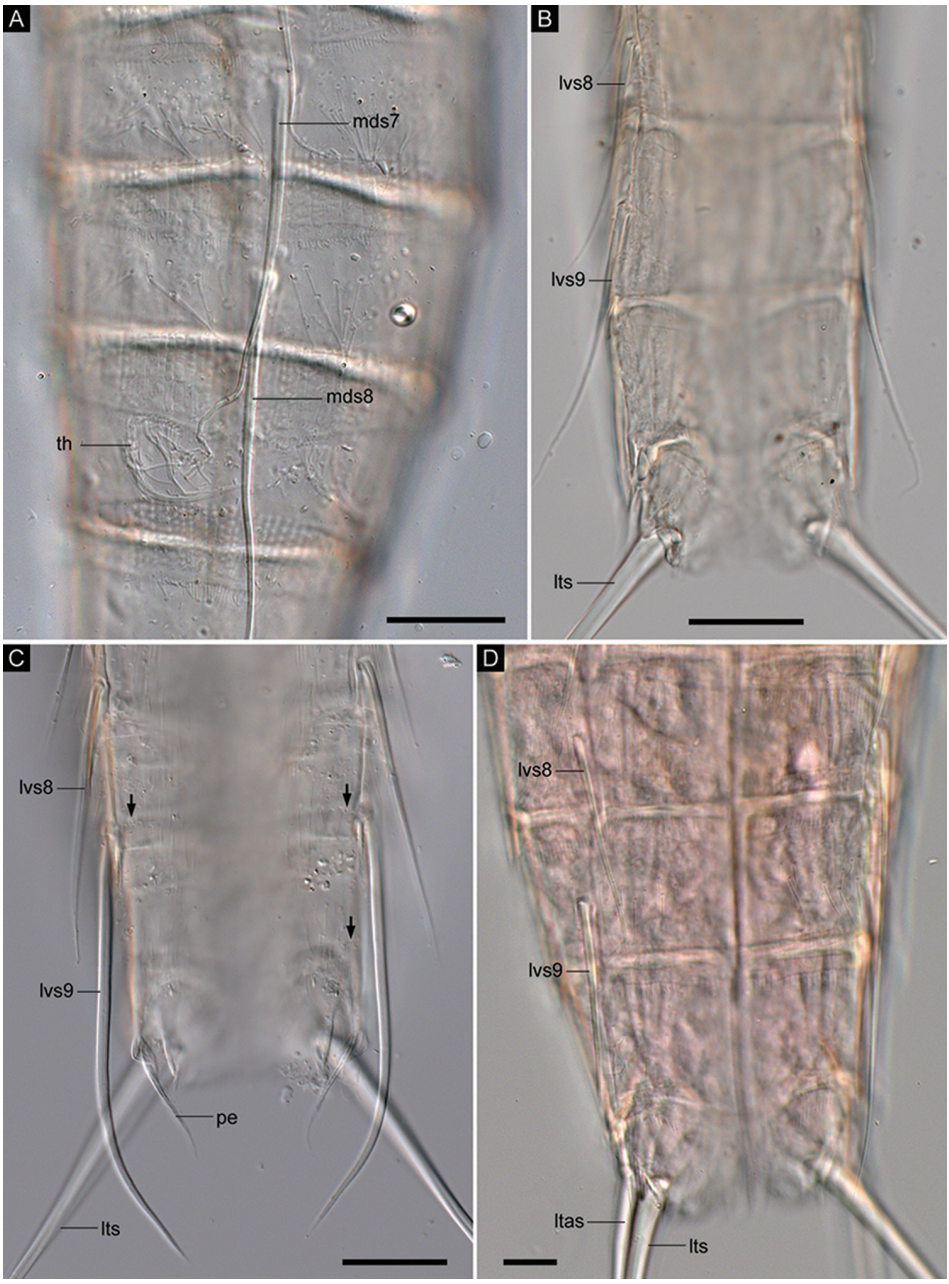


Figure 8. *Echinoderes pterus* sp. n., Nomarski photomicrographs. The holotype male (**B** ZMB 11608, collected at station 55, Mediterranean deep sea off Crete), non-type males (**A** ZMB 11641, collected at station 717, Sedlo Seamount **C** ZMB 11653, collected at station 152-1, Karasik Seamount), and a female (**D** ZMB 11635, collected at station 1167.1, Mediterranean deep sea off Crete). **A** segments 7–9, dorsal view **B** segments 8–11, ventral view **C** segments 8–11, ventral view **D** segments 8–11, ventral view. Abbreviations: ltas, lateral terminal accessory spine; lts, lateral terminal spine; lvs, lateroventral acicular spine; mds, middorsal acicular spine; pe, penile spine; th, tuft of long hairs. Digits after abbreviations indicate the corresponding segment number. Black arrows point to sensory spots. Scale bars: 20 µm (**A–C**), 10 µm (**D**).

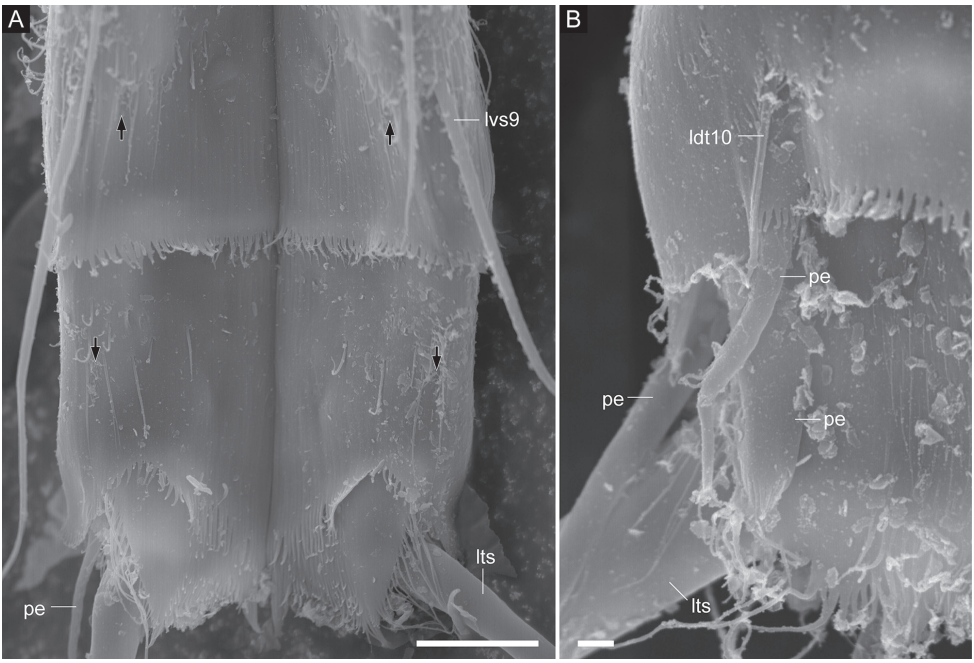


Figure 9. *Echinoderes pterus* sp. n., scanning electron micrographs. Males (**A** ZMB 11662b **B** ZMB 11662a, both collected at station 66 (Mediterranean deep sea off Crete)). **A** segments 9–11, ventral view **B** left side of sternal plates on segments 10 and 11. Abbreviations: ldt, laterodorsal tube; lts, lateral terminal spine; lvs, lateroventral acicular spine; pe, penile spine. Digits after abbreviations indicate the corresponding segment number. Black arrows point to sensory spots. Scale bars: 10 μm (**A**), 1 μm (**B**).

sition (Figs 2A, B, 6D–F, 7A, B). Type-1 gland cell outlets present paradorsally and ventromedially (Fig. 4F).

Segment 7 with middorsal and lateroventral acicular spines (Figs 2A, B, 4E, 6E, 7A, B, 8A). Sensory spots present in ventromedial position in specimens from Mediterranean deep sea off Crete and those from the Anaximenes Seamount (Fig. 6E). Sensory spots absent in specimens from the Karasik Seamount, north of Svalbard, and the Sedlo Seamount (Fig. 6F). Type-1 gland cell outlets present paradorsally and ventromedially.

Segment 8 with middorsal and lateroventral acicular spines (Figs 2A, B, E, 7A–C, 9A–D). Sensory spots present paradorsally (Fig. 7A, C). Type-1 gland cell outlets present in paradorsal and ventromedial position.

Segment 9 with lateroventral acicular spines (Figs 2B, D, E, 4A, 7B, C, 8B–D, 9A). Lateroventral acicular spines in male specimens from the Karasik Seamount, north of Svalbard, and the Sedlo Seamount conspicuously thick and long (Figs 2E, 8C), whereas thickness of spines similar to those on preceding segments in other specimens (Figs 2B, D, 4A, 7B, C, 8B, D, 9A). Tufts of hairs arising from slits in laterodorsal position (Figs 2A, C, 7B–D, 8A). Most hairs of the tufts conspicuously longer than other usual cuticular hairs. Laterodorsal and ventrolateral sensory spots present (Figs 7B, C, 8C, 9A). Type-1 gland cell outlets present in paradorsal and ventromedial position. Small rounded sieve plates present in sublateral position.

Segment 10 with laterodorsal tubes (Figs 2A, C, 7C, 9B). Subdorsal and ventrolateral sensory spots present (Figs 7C, 8C, 9A). Two type-1 gland cell outlets aligned middorsally. Additional pair of type-1 gland cell outlets present in ventromedial position.

Segment 11 with lateral terminal spines (Figs 2A–D, 4A, 7C, 8B–D). Three pairs of penile spines present in males, with two pairs being tube-like and one pair thick and cone shaped (Figs 2A, E, 8C, 9A, B). One pair of lateral terminal accessory spines present in females (Figs 2C, D, 7C, 8D). Subdorsal sensory spots present. Two type-1 gland cell outlets present middorsally. Tergal extensions very short and truncate; sternal extensions triangular, extending slightly beyond tergal ones (Figs 2A–D, 4A, 8B, D, 9A, B).

Differential diagnosis

Echinoderes pterus sp. n. can be easily distinguished from all the other congeners by the presence of the tufts of hairs on segment 9. Such a structure has never been described for any other kinorhynch, and is thus a unique character for the new species. This is also the case for the conspicuously thick and long lateroventral spines on segment 9, although this character appears to be restricted to males in the Karasik Seamount, Svalbard, and the Sedlo Seamount populations.

With respect to other characters, the spine/tube pattern of *E. pterus* sp. n., i.e., with middorsal acicular spines on segments 4–8, laterodorsal tubes on segment 10, lateroventral tubes on segment 5, and lateroventral acicular spines on segments 6–9, but without any other spine and tube is not shared with any of 109 congeners.

The head morphology of *E. pterus* sp. n. seems to be shared with only a few species of Kinorhyncha. In the new species, the ring -02 and -03 inner oral styles occur in odd and even sectors, respectively. Such an arrangement is known for *Dracoderes abei* Higgins & Shirayama, 1990 (see Sørensen et al. 2012a), whereas the position of these styles seems to be reversed in all cyclorhagid species for which the arrangement of the inner oral styles is known, i.e., *Antygomonas caeciliae* Dal Zotto, 2015, *Antygomonas incomitata* Nebelsick, 1990, *Antygomonas oreas* Bauer-Nebelsick, 1996, *Antygomonas paulae* Sørensen, 2007, *Cateria gerlachi* Higgins, 1968, *Ce. barbanigra*, *Centroderes bonnyae* Neuhaus et al., 2014, *Centroderes drakei* Neuhaus et al., 2014, *Centroderes readae* Neuhaus et al., 2014, *Cephalorhyncha liticola* Sørensen, 2008, *Semnoderes armiger* Zelinka, 1928 *Tubulideres seminoli* Sørensen et al., 2007, *Triodontoderes anulap* Sørensen & Rho, 2009 (see Bauer-Nebelsick 1996; Sørensen 2007, 2008; Sørensen et al. 2007, 2009; Sørensen and Rho 2009; Dal Zotto 2015; Neuhaus et al. 2014; Neuhaus and Kegel 2015). However in *Cat. gerlachi*, only a single specimen mounted for light microscopy had its inner oral styles everted enough to be recognizable, and the mouth cone was separated from the specimen (Neuhaus and Yamasaki, unpubl. obs.). Neuhaus and Kegel (2015, fig. 3) illustrated ring -02 and -03 inner oral styles in the position they assumed to be correct. This raises the question how accurate identification of the position was in other species by these and other authors. Since the exact arrangements and the shapes of inner oral styles have been infrequently observed in *Echinoderes*, it is not possible to conclude whether those in *E. pterus* sp. n. are unique

among the genus or not. We hope that further observations of head structures in other species of *Echinoderes* will allow a comprehensive comparison of this character in the future.

Discussion

Geographically and bathymetrically wide distribution in Kinorhyncha

Echinoderes pterus sp. n. shows a geographically and bathymetrically wide distribution, from near the North Pole to the eastern Mediterranean Sea through the northeast Atlantic Ocean, and from 675 m to 4,403 m depth (Fig. 1, Table 1). For other kinorhynchs, such a geographically and bathymetrically wide distribution is only known for *Cam. vanhoeffeni*, *Centroderes spinosus* (Reinhard, 1881), and *S. armiger*. The former one was reported worldwide at a depth ranging from 0–5,118 m from several localities in the Atlantic Ocean, Pacific Ocean, Indian Ocean, and the Antarctic Sea (Neuhaus and Sørensen 2013). The latter two were found in the Mediterranean Sea, Black Sea, northeastern Atlantic Ocean, and North Sea at depths ranging from 14 m to 444 m (*Ce. spinosus*) and from 15 m to 444 m (*S. armiger*) (Neuhaus 2013; Neuhaus et al. 2013).

There are few other kinorhynchs which have been reported to show either a geographically or a bathymetrically wide distribution. Species with a geographically wide distribution are e.g., *Ce. barbanigra* found in the Gulf of Mexico, the Caribbean Sea, Bermuda, and the Dominican Republic at a depth ranging from 2 m to 57.5 m, *E. ohtsukai* found on both the eastern and western coasts of the Pacific Ocean in the intertidal zone, and *E. tchefouensis* found in the East China Sea, South China Sea, Celebes Sea, Singapore Strait, and Mariana Islands at a depth ranging from 0 m to 140 m (Sørensen et al. 2012b, 2016; Yamasaki and Kajihara 2012; Neuhaus et al. 2014; Herranz and Leander 2016). Species from a bathymetrically wide range are e.g., *Echinoderes arlis* Higgins, 1966, *Echinoderes drogoni* Grzelak & Sørensen, 2018, *Echinoderes eximus* Higgins & Kristensen, 1988, *Echinoderes peterseni* Higgins & Kristensen, 1988, and *Echinoderes rhaegali* Grzelak & Sørensen, 2018, all found in the Arctic Ocean, at depths ranging from 236 m to 940 m (*E. arlis*), 78 m to 2,200 m (*E. drogoni*), 60 m to 940 m (*E. eximus*), 24 m to 940 m (*E. peterseni*), and 78 m to 940 m (*E. rhaegali*) (Grzelak and Sørensen 2018b). However, their distribution records are not both geographically and bathymetrically wide like those of *E. pterus* sp. n., *Cam. vanhoeffeni*, *Ce. spinosus*, and *S. armiger*.

A single or multiple species?

The morphological comparison between populations of *E. pterus* sp. n. reveals that the new species shows an inter-population variation (Fig. 10, Table 2). The most obvious difference is found between males of the Arctic populations (Karasik Seamount + Svalbard) + the Sedlo Seamount population with lateroventral acicular spines on segment 9 being

conspicuously thicker and longer than the preceding spines, as opposed to those of the Mediterranean populations (Mediterranean deep sea + Anaximenes Seamount), which have lateroventral spines on segment 9 of similar thickness to the other spines and only slightly longer than the preceding ones (compare Fig. 8B and Fig. 8C; see Fig. 10 for measurements). Such a large difference is not found between females of these populations. In addition, the length of the remaining spines is slightly longer in the Arctic populations than in the Mediterranean populations (Fig. 10). The population on the Sedlo Seamount, although it is represented by a single specimen in this study, shows similarities in spine length to the Arctic populations in the middorsal acicular spines on segments 4, 5, 8 and the lateroventral acicular spines on segments 6, 7, 9, whereas it shares a similar spine length with the Mediterranean populations in the other spines. The ventromedial sensory spots on segment 7 reveal variation insofar as they are absent in the Arctic and Sedlo Seamount populations but present in the Mediterranean populations.

Considering the geographically and bathymetrically wide distribution of *E. pterus* sp. n., the presence of inter-population variation in morphological characters, as well as the potentially low-distribution ability of kinorhynchs, it should be considered whether *E. pterus* sp. n. represents one or multiple species. In the case of the other geographically and bathymetrically wide distribution kinorhynchs, intra- and inter-populational variation of several morphological characters, e.g., body length, arrangement of gland cell outlets, and sensory spots, has been detected in *Cam. vanhoeffeni*. However, it was still regarded as a single species due to the overlapping characters between/within populations and the absence of the type material (Neuhaus and Sørensen 2013). Variation in the occurrence of sensory spots within one species has also been reported for several other kinorhynchs, e.g., *Cat. gerlachi*, *Cateria styx* Higgins, 1968, *Ce. spinosus*, *Ce. barbanigra*, and *Ce. readae* (Neuhaus et al. 2013, 2014; Neuhaus and Sørensen 2013; Neuhaus and Kegel 2015).

Echinoderes pterus sp. n. may on the one hand represent two species, e.g., one species in the Arctic Ocean and on the Sedlo Seamount and the second species in the Mediterranean, or it may even belong to three species, i.e., one in the Arctic Ocean, another on the Sedlo Seamount, and the third in the Mediterranean, with only a few morphological differences. However, there is the possibility that the different populations belong to the same species with the observed morphological variations, which gradually change from the Arctic Ocean via the Sedlo Seamount to the Mediterranean populations or *vice versa*. Although we cannot reject these possibilities, we currently regard all populations as a single species. Further investigations of the species, for instance the sampling and observation of populations in intermediate localities and/or molecular phylogeographic studies, should provide more information about the population connectivity of the species and support one of the two hypotheses.

Whichever hypothesis is correct, all populations in this study are undoubtedly closely related to each other. They have expanded their habitat range with or without speciation, however, their distribution process is open to question: did they distribute from the Arctic Ocean via the Atlantic Ocean to the Mediterranean, from the Mediterranean via the Atlantic Ocean to the Arctic Ocean, or from the Atlantic Ocean to both the Arctic Ocean and the Mediterranean? Indeed the species represents interesting

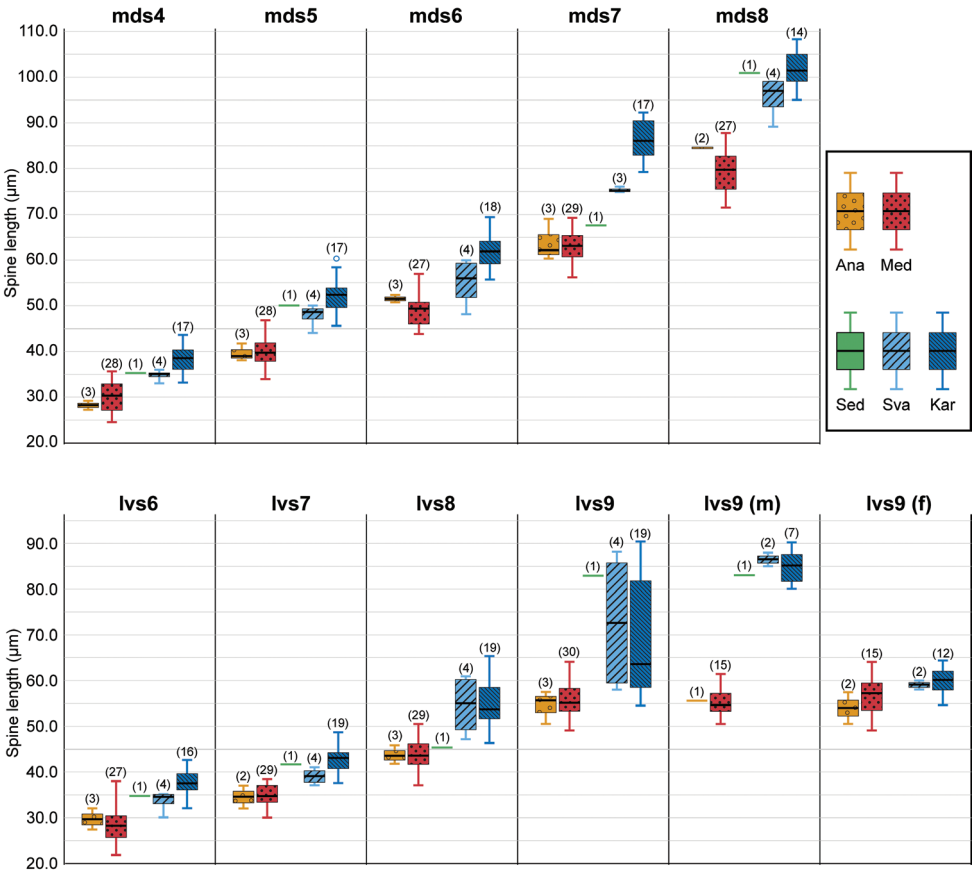


Figure 10. Box plot for the spine-lengths comparison among populations of *Echinoderes pterus* sp. n. Each color represents one population. The numbers above a box indicate the number of measured specimens for each character and population. Abbreviations: Ana, population from the Anaximenes Seamount; (f), length in females; Kar, population from the Karasik Seamount; lvs, lateroventral acicular spine; (m), length in males; Med, population in the Mediterranean deep sea off Crete; mds, middorsal acicular spine; Sed, population from the Sedlo Seamount; Sva, population north of Svalbard. Digits after mds and lvs indicate the corresponding segment number.

material for studying the "meiofauna paradox" or the "everything is everywhere hypothesis". We cannot provide a strongly-supported answer based on our current data. Further data about the species distribution range and population connectivity would also enable us to approach the question in future studies.

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RESEARCH ARTICLE

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Two new species of the genus *Trilacuna* from Chongqing, China (Araneae, Oonopidae)

Yanfeng Tong[1], Xijin Guan[1], Shuqiang Li[2]

1 *Life Science College, Shenyang Normal University, Shenyang 110034, China* **2** *Institute of Zoology, Chinese Academy of Sciences, Beijing 100101, China*

Corresponding author: *Shuqiang Li* (lisq@ioz.ac.cn)

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Abstract

Two new species of the genus *Trilacuna* Tong & Li, 2007, *T. simianshan* Tong & Li, **sp. n.** and *T. songyuae* Tong & Li, **sp. n.**, are described from Simianshan Natural Reserve, Chongqing, China.

Keywords

Asia, copulatory organs, Gamasomorphinae, spider, taxonomy

Introduction

The spider genus *Trilacuna* was established by Tong and Li in 2007 to accommodate two new species, *T. angularis* Tong & Li, 2007 and *T. rastrum* Tong & Li, 2007, from Southwest China. Subsequently, additional species have been described from Thailand, Malaysia and Sumatra (Eichenberger and Kranz-Baltensperger 2011), Vietnam (Tong and Li 2013), the Himalayan region (Grismado et al. 2014), Iran (Malek-Hosseini et al. 2015), and Korea (Seo 2017). Currently, the genus *Trilacuna* comprises 20 species known from Asia (World Spider Catalog 2018).

This genus was originally diagnosed by the enlarged male palpal femora, the very complicated embolus-conductor complex, the branched endites in males and the notched labium (Tong and Li 2007). Grismado et al. (2014) re-diagnosed *Trilacuna* by

the loss of the furrow connecting the posterior spiracles in males. However, as already discussed by Grismado et al. (2014) and Malek-Hosseini et al. (2015), some species, i.e., *T. aenobarba* (Brignoli, 1978), *T. bangla* Grismado & Ramírez, 2014, *T. hazara* Grismado & Ramírez, 2014 and *T. qarzi* Malek Hosseini & Grismado, 2015, have a shallow groove connecting the spiracles in males; *T. diabolica* Kranz-Baltensperger, 2011 and *T. werni* Eichenberger, 2011 have a well-developed furrow connecting the spiracles in males. So far, all known species of *Trilacuna* have a long postepigastric scutum in the females. This character is useful to distinguish *Trilacuna* from the other genera in the "*Dysderoides* complex" (Grismado et al. 2014; Tong and Li 2015).

In this paper two new *Trilacuna* species, *T. simianshan* Tong & Li, sp. n. and *T. songyuae* Tong & Li, sp. n., collected in the Simianshan Mountains, are described and illustrated.

Materials and methods

The specimens were examined using a Leica M205C stereomicroscope. Details were studied under an Olympus BX51 compound microscope. Photos were made with a Canon EOS 550D zoom digital camera (18 megapixels) mounted on an Olympus BX51 compound microscope. Vulvae were cleared in lactic acid. For scanning electron microscopy (SEM), specimens were air-dried and uncoated. Pictures were taken with a Hitachi TM3030. All measurements were taken using an Olympus BX51 compound microscope and are in millimeters.

The following abbreviations are used in the text and figures:

ALE	anterior lateral eyes;	**pe**	posterior extension;
apo	apodemes;	**PLE**	posterior lateral eyes;
blo	broom-like outgrowth;	**PME**	posterior median eyes;
boc	booklung covers;	**psc**	paddle-like sclerite;
cll	cluster of long line-like structure;	**psp**	posterior spiracles;
cp	circular projection;	**rlo**	ribbon-like outgrowth;
css	cone-shaped structure;	**rp**	rectangular projection;
dd	dark dot;	**sdb**	slightly distal branch;
dk	dark knob;	**slh**	small hole;
ehb	elevated hair base;	**sls**	slender line-like structure;
fo	fold;	**sp**	sperm pore;
ldi	labium deep incision;	**spr**	small projection;
mp	membranous projection;	**sps**	spear-like setae;
nls	numerous, long setae;	**sso**	sector-shaped outgrowth;
ogr1	outgrowth 1;	**ssp**	sickle-shaped protuberance;
ogr2	outgrowth 2;	**tss**	two long, strong setae.

Type material is deposited in Shenyang Normal University (**SYNU**) and the Institute of Zoology, Chinese Academy of Sciences in Beijing (**IZCAS**).

Taxonomy

Trilacuna Tong & Li, 2007

Type species. *Trilacuna rastrum* Tong & Li, 2007.

Trilacuna simianshan Tong & Li, sp. n.

http://zoobank.org/899E9966-88FD-4512-AE01-1C74A42ECB3F
Figs 1–5

Type material. Holotype ♂ (SYNU-99), China, Chongqing Municipality, Jiangjin Dist., Simianshan Natural Reserve, Dawopu, 28°35'14.628"N, 106°22'44.790"E, 1000 m, 20.X.2014, leg. Y. Tong. **Paratypes:** 1 ♂, 2 ♀ (SYNU-99), same data as holotype; 1 ♂, 2 ♀ (IZCAS Ar-25089), same data as holotype; 2 ♀ (SYNU-100), China, Chongqing Municipality, Jiangjin Dist., Simianshan Natural Reserve, Dawopu, 28°34'43.956"N, 106°21'2.424"E, 28 m, 20.X.2014, leg. Y. Tong.

Etymology. The specific name is a noun in apposition taken from the type locality.

Diagnosis. This new species is similar to *T. rastrum* and can be distinguished by two long outgrowths of the embolus system and the long cone-shaped structure in females *vs*. the embolus system with a short ribbon-like outgrowth and a rake-shaped protuberance, and a simple stick-shaped sclerite centrally on the female genitalia of *T. rastrum* (see Tong and Li 2007: figs 6–10).

Description. Male. Body yellow-brown, chelicerae and sternum lighter, legs yellow. Habitus as in Fig. 1A–C. Body length 2.21; carapace 1.13 long, 0.86 wide; abdomen 1.16 long, 0.75 wide. Carapace sides granulate; lateral margin rebordered, with a row of short, fine hairs and small blunt denticles. Six eyes, well developed, arranged in a compact group; ALE, PME subequal, larger than PLE; ALE–PLE separated by less than ALE radius, PME touching each other; posterior row recurved from above, procurved from front (Fig. 1D, G). Clypeus sinuous in frontal view, anterior lateral eyes separated from edge of carapace by about 2.0 times their diameter, with needle-like setae. Mouthparts: chelicerae straight, proximal region with one hair with elevated hair base (ehb); labium rectangular, anterior margin deeply incised (ldi) (Fig. 1E); endites slender, distally branched (sdb) (Fig. 1E). Sternum with radial furrows between coxae I–II, II–III, III–IV; surface strongly rugose on radial furrows and middle area; setae sparse, light, needle-like, evenly scattered (Fig. 1E). Abdomen: booklung covers large, ovoid, surface smooth (Fig. 2B). Dorsal scutum not fused to epigastric scutum. Apodemes present, posterior spiracles connected by a shallow groove (Fig. 2A). Leg spination (all spines longer than segment width): legs I-II: tibia: v2-2-2-2-0, metatarsus: v2-2-0. Trichobothria: tibia: each with three; metatarsus: each with one.

Genitalia. Epigastric region with sperm pore (sp) small, oval, rebordered, situated between anterior spiracles; with a small hole (slh) between the posterior spiracles

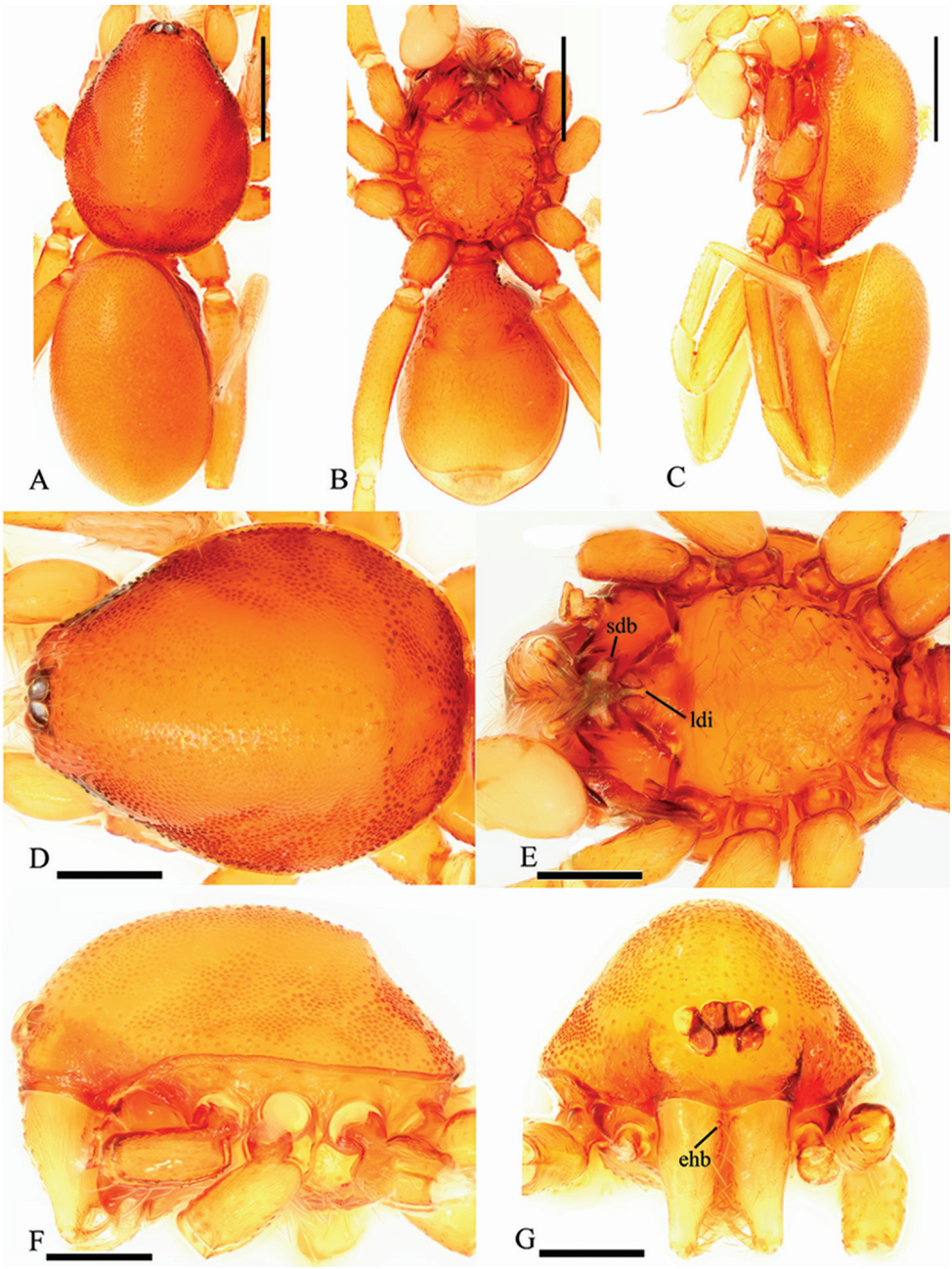

Figure 1. *Trilacuna simianshan* sp. n., male. **A** habitus, dorsal view **B** habitus, ventral view **C** habitus, lateral view **D** prosoma, dorsal view **E** prosoma, ventral view **F** prosoma, lateral view **G** prosoma, anterior view. Abbreviations: ehb = elevated hair base; ldi = labium deep incision; sdb = slightly distal branch. Scale bars: 0.2 mm (**A–C**); 0.1 mm (**D–G**).

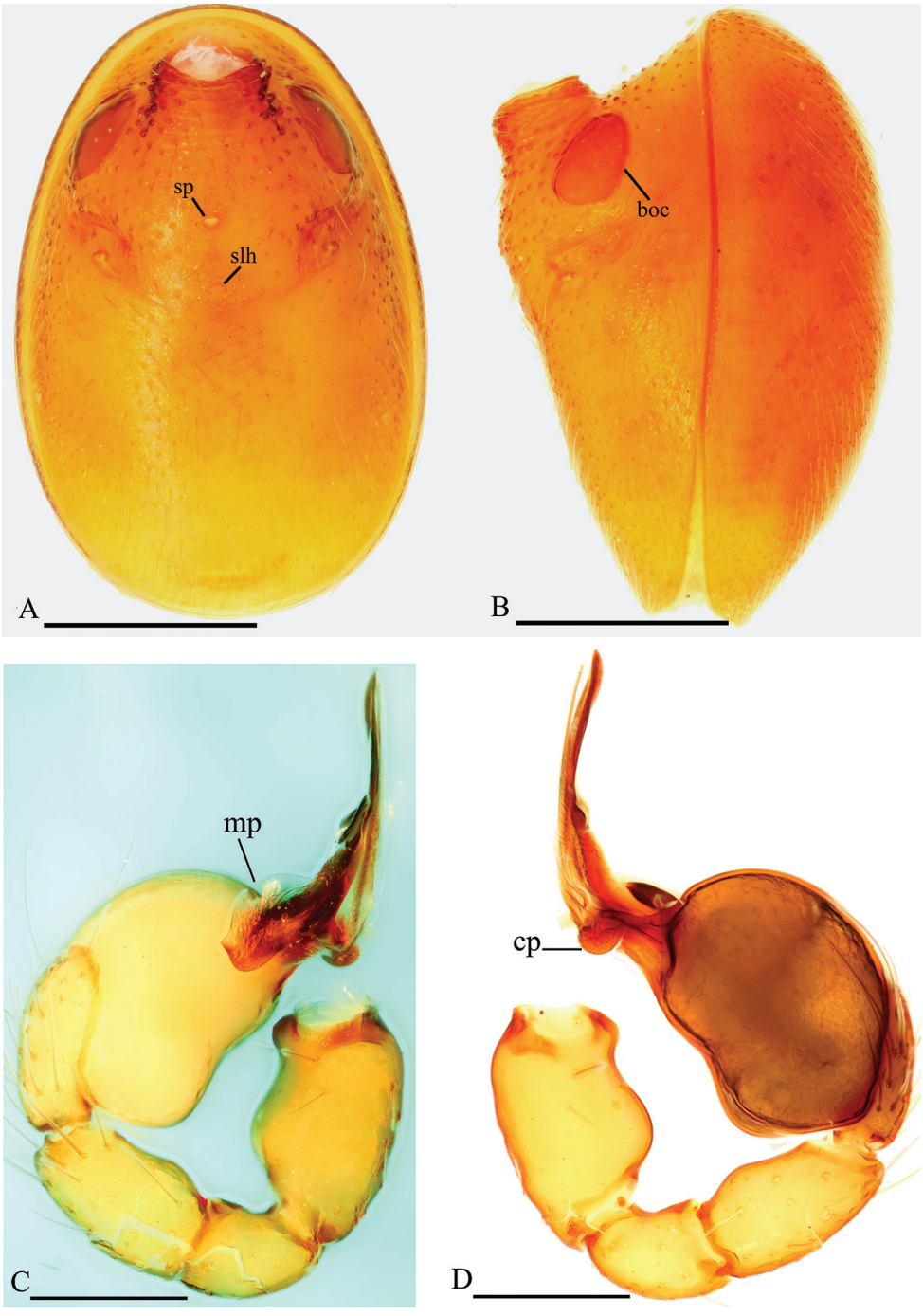

Figure 2. *Trilacuna simianshan* sp. n., male. **A** abdomen, ventral view **B** abdomen, lateral view **C** left palp, prolateral view **D** left palp, retrolateral view. Abbreviations: boc = booklung covers; cp = circular projection; mp = membranous projection; slh = small hole; sp = sperm pore. Scale bars: 0.2 mm.

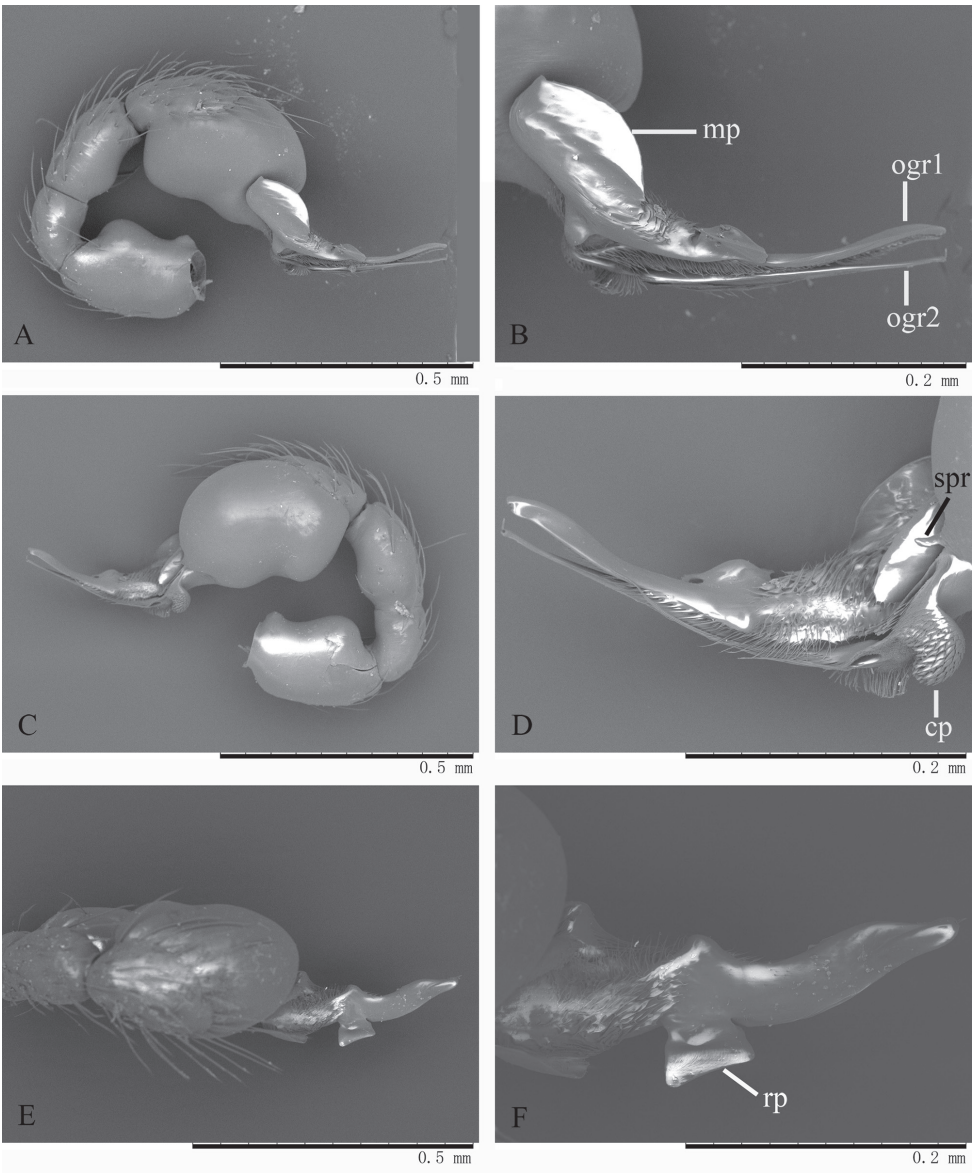

Figure 3. *Trilacuna simianshan* sp. n., male, SEM. **A** left palp, prolateral view **B** embolus system, prolateral view **C** left palp, retrolateral view **D** embolus system, retrolateral view **E** left palp, dorsal view **F** embolus system, dorsal view. Abbreviations: cp = circular projection; mp = membranous projection; ogr1 = outgrowth 1; ogr2 = outgrowth 2; rp = rectangular projection; spr = small projection.

(Fig. 2A). Palp (Figs 2C, D, 3): orange. 0.46 long (0.15, 0.08, 0.11, 0.12). Femur strongly swollen (width/length = 0.09/0.15) (Fig. 2C, D). Bulb oval, stout, tapering apically. Embolus system (Fig. 3B, D, F) complex, with two long, strongly curved outgrowths (ogr1 and ogr2); the surface of the embolus system bearing numerous

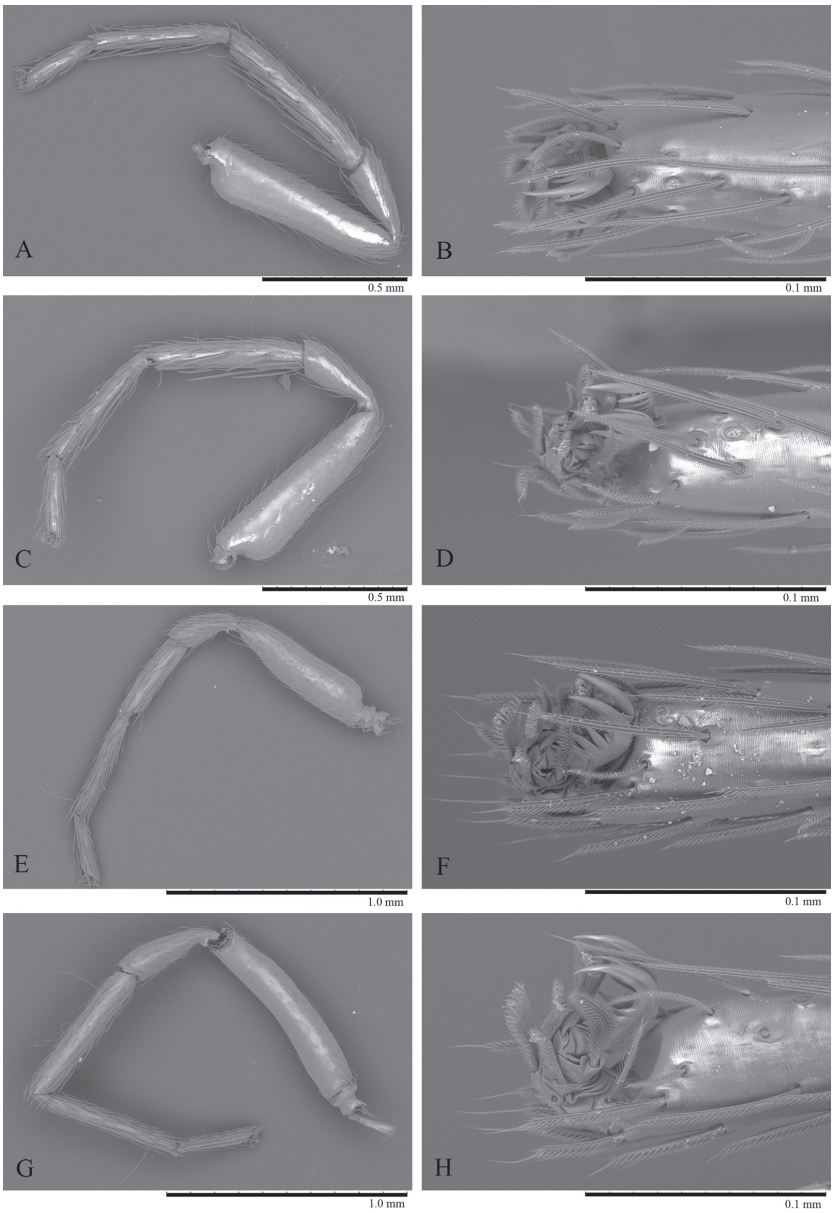

Figure 4. *Trilacuna simianshan* sp. n., female, right legs, SEM. **A** leg I, prolateral view **B** tarsus I, dorsal view **C** leg II, prolateral view **D** tarsus II, dorsal view **E** leg III, prolateral view **F** tarsus III, dorsal view **G** leg IV, prolateral view **H** tarsus IV, prolateral view.

small "papillae". The base of the embolus system with a wing-like, membranous projection (mp) in prolateral view and a circular projection (cp) covered with scales in retrolateral view; middle part of the embolus system with a rectangular projection (rp) in dorsal view.

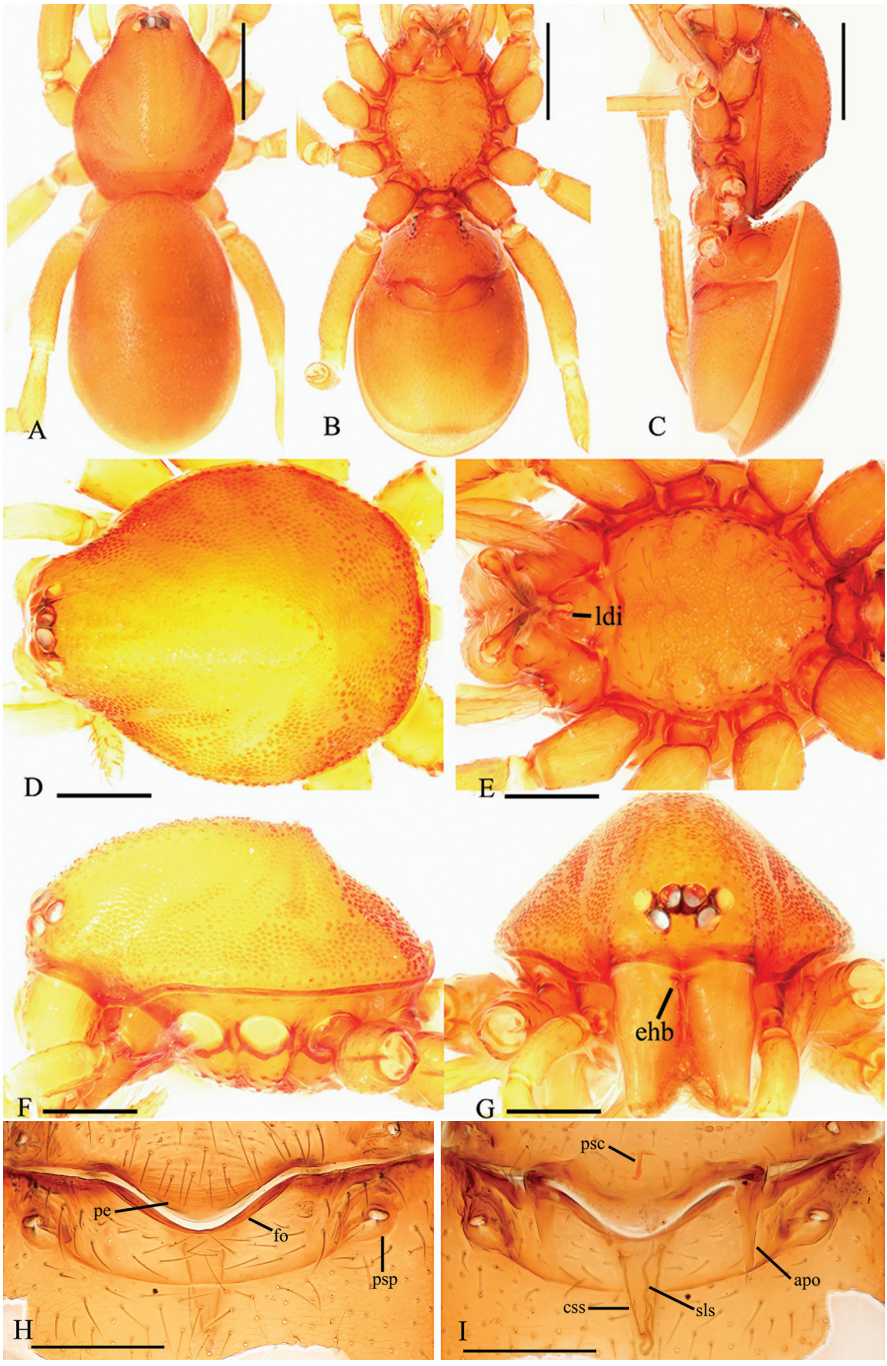

Figure 5. *Trilacuna simianshan* sp. n., female. **A, B, C** habitus, dorsal, ventral and lateral views **D, E, F, G** prosoma, dorsal, ventral, lateral and anterior views **H, I** genitalia, ventral and dorsal views. Abbreviations: apo = apodemes; css = cone-shaped structure; ehb = elevated hair base; fo = fold; ldi = labium deep incision; pe = posterior extension; psc = paddle-like sclerite; psp = posterior spiracles; sls = slender line-like structure. Scale bars: 0.2 mm (**A–C**); 0.1 mm (**D–I**).

Female. As in male except as noted. Slightly larger than male. Body length 2.28; carapace 0.99 long, 0.85 wide; abdomen 1.36 long, 0.89 wide. Postepigastric scutum long. Posterior spiracles connected by groove (Fig. 5B).

Female genitalia. Ventral view (Fig. 5H): Middle part of posterior margin of epigastric scutum much extended posteriorly (pe); surface without external features. Dorsal view (Fig. 5I): with a very long, nearly cone-shaped structure (css), at the posterior end of the cone-shaped structure is a slender line-like structure (sls) originating and extending anteriorly. Transverse bars with two relatively long, lateral apodemes.

Distribution. China (Chongqing).

Trilacuna songyuae **Tong & Li, sp. n.**
http://zoobank.org/737A9BE2-8B18-4FA6-AB7E-D31F25495E0F
Figs 6–10

Type material. Holotype ♂, (SYNU-101), China, Chongqing Municipality, Jiangjin Dist., Simianshan Natural Reserve, Dawopu, 28°34'43.956"N, 106°21'2.424"E, 28 m, 20.X.2014, leg. S. Lyu and Y. Tong. **Paratypes:** 2 ♂, 2 ♀ (SYNU-101), same data as holotype; 5 ♂, 4 ♀ (SYNU-102), same data as holotype; 7 ♂, 5 ♀ (IZCAS Ar-25088), China, Chongqing Municipality, Jiangjin Dist., Simianshan Natural Reserve, Dawopu, 28°35'14.628"N, 106°22'44.790"E, 1000 m, 20.X.2014, leg. S. Lyu and Y. Tong.

Other material studied. 7 ♂, 1 ♀ (SYNU-103), same data as holotype; 8 ♂, 2 ♀ (SYNU-105), China, Chongqing Municipality, Jiangjin Dist., Simianshan Natural Reserve, Dawopu, 28°35'14.628"N, 106°21'44.790"E, 1000 m, 20. X. 2014, leg. S. Lyu and Y. Tong.

Etymology. The specific name is after Miss Songyu Lyu (吕松宇), one of the collectors of this species.

Diagnosis. The new species is similar to *T. hansanensis* Seo, 2017. Both species have an elevated ridge on the posterior part of the male sternum, but can be distinguished by the long oval bulb, the very long setae (nls) on the prolateral surface of the male palpal tibiae and the two small, spear-like setae (sps) on the basal part of the prolateral surface of male palpal cymbium. *Trilacuna hansanensis* has a pear-shaped bulbus, and there are no special setae on the male palpal tibia or cymbium (see Seo 2017: figs 1A–K).

Description. Male. Body yellow-brown, chelicerae and sternum lighter, legs yellow. Habitus as in Fig. 6A–C. Body length 1.87; carapace 0.86 long, 0.73 wide; abdomen 0.97 long, 0.71 wide. Carapace sides granulate; lateral margin rebordered, with a row of short, fine hairs and small, blunt denticles. Eyes six, well developed, arranged in a compact group; ALE largest, PLE smallest; ALE–PLE separated by less than ALE radius, PME touching each other; posterior row recurved from above, procurved from front (Fig. 6D, G). Clypeus sinuous in frontal view, anterior lateral eyes separated from edge of carapace by about 2.0 times their diameter, with needle-like setae. Mouth-

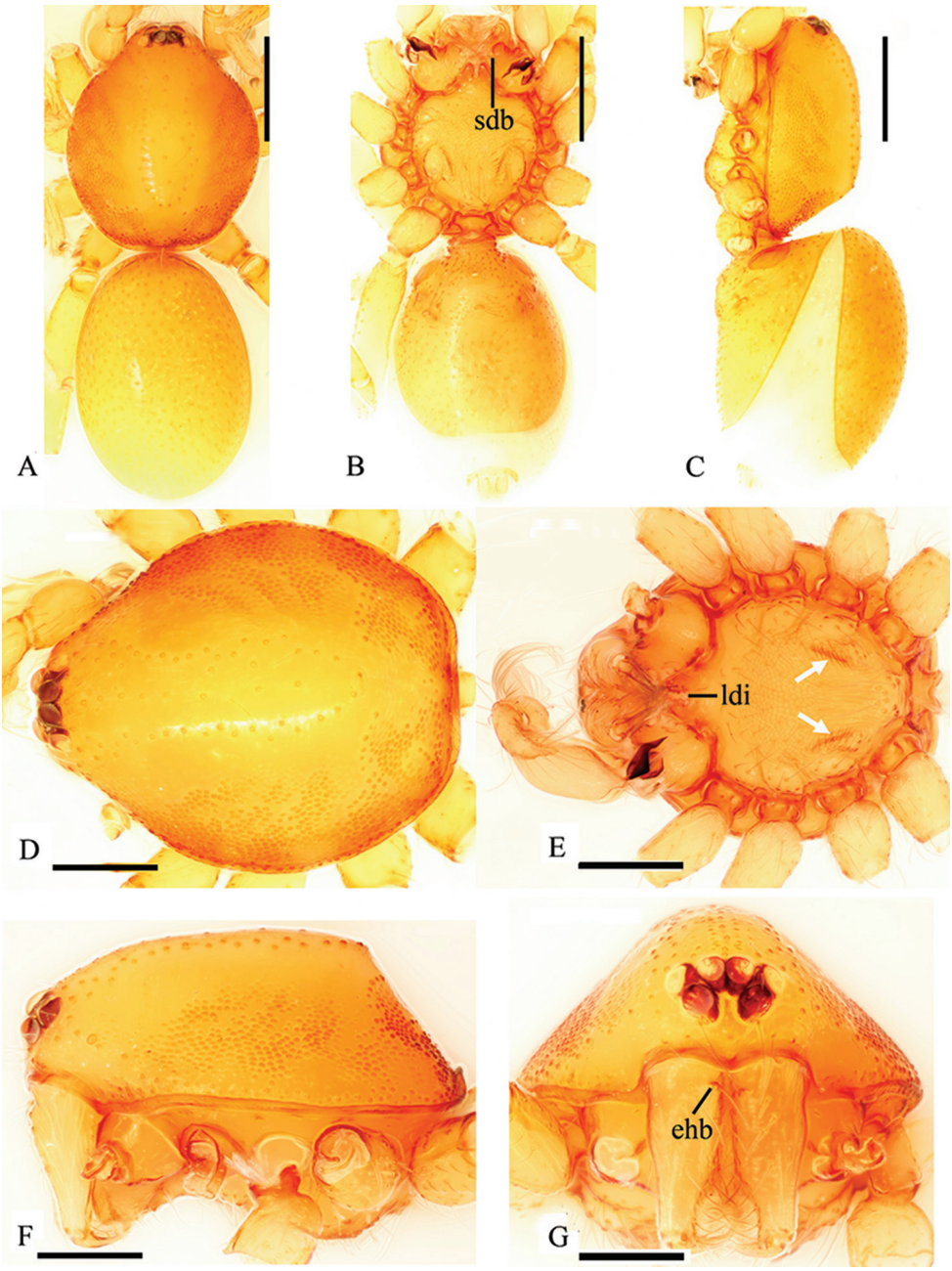

Figure 6. *Trilacuna songyuae* sp. n., male. **A** habitus, dorsal view **B** habitus, ventral view **C** habitus, lateral view **D** prosoma, dorsal view **E** prosoma, ventral view, white arrow shows the ridges, with a row of setae **F** prosoma, lateral view **G** prosoma, anterior view. Abbreviations: ehb = elevated hair base; ldi = labium deep incision; sdb = slightly distal branch. Scale bars: 0.2 mm (**A–C**); 0.1 mm (**D–G**).

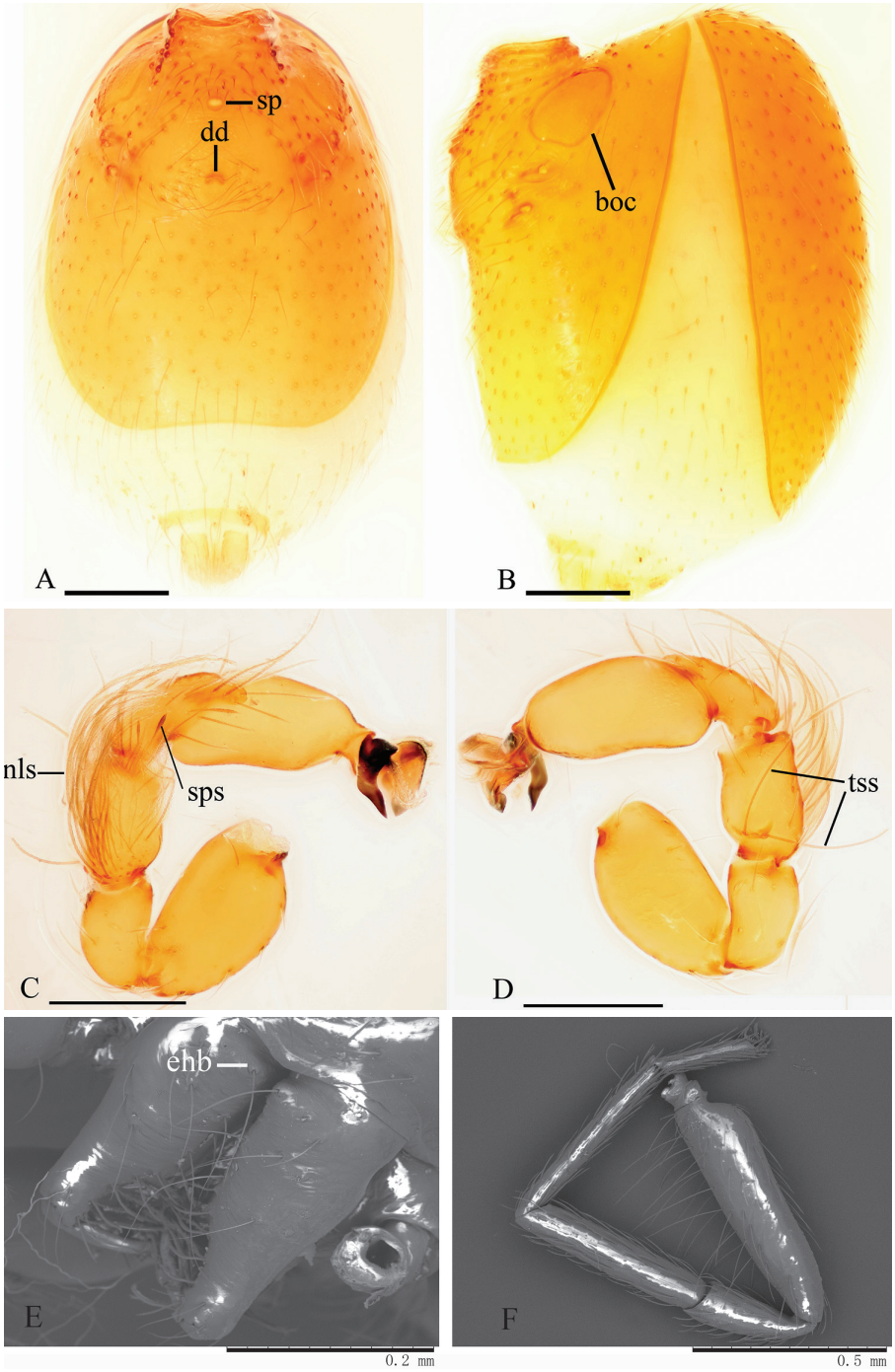

Figure 7. *Trilacuna songyuae* sp. n., male. **A** abdomen, ventral view **B** abdomen, lateral view **C** left palp, prolateral view **D** left palp, retrolateral view **E** chelicerae, oblique, anterior view **F** left leg IV, prolateral view. Abbreviations: boc = booklung covers; dd = dark dot; ehb = elevated hair base; nls = numerous, long setae; sp = sperm pore; sps = spear-like setae; tss = two long, strong setae. Scale bars: 0.1 mm (**A–D**).

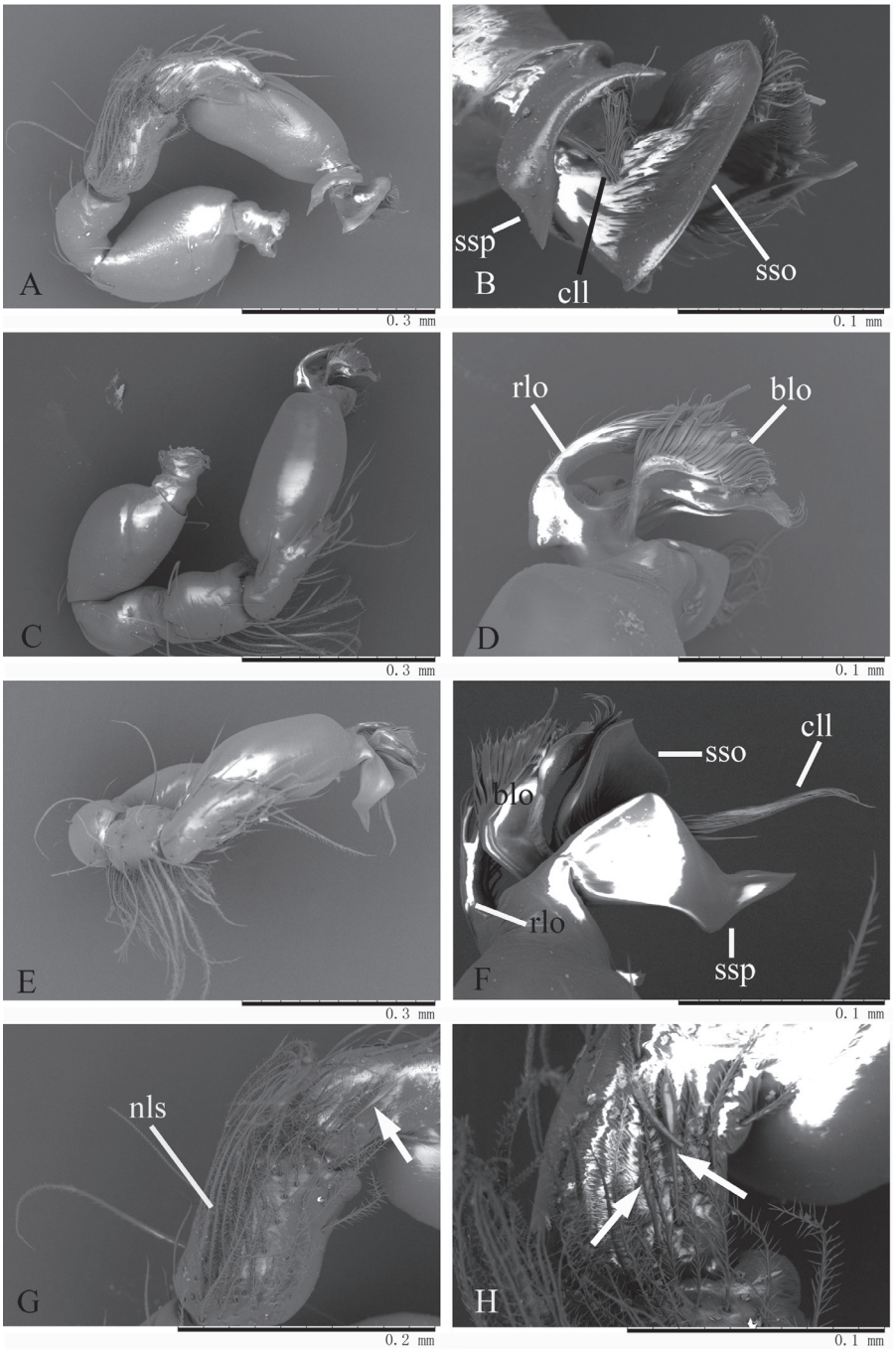

Figure 8. *Trilacuna songyuae* sp. n., male, SEM. **A** left palp, prolateral view **B** embolus system, prolateral view **C** left palp, retrolateral view **D** embolus system, retrolateral view **E** left palp, dorsal view **F** embolus system, dorsal view **G** tibia and cymbium, prolateral view **H** same, details, white arrow shows the spear-like setae. Abbreviations: blo = broom-like outgrowth; cll = cluster of long line-like structure; nls = numerous, long setae; rlo = ribbon-like outgrowth; sso = sector-shaped outgrowth; ssp = sickle-shaped protuberance.

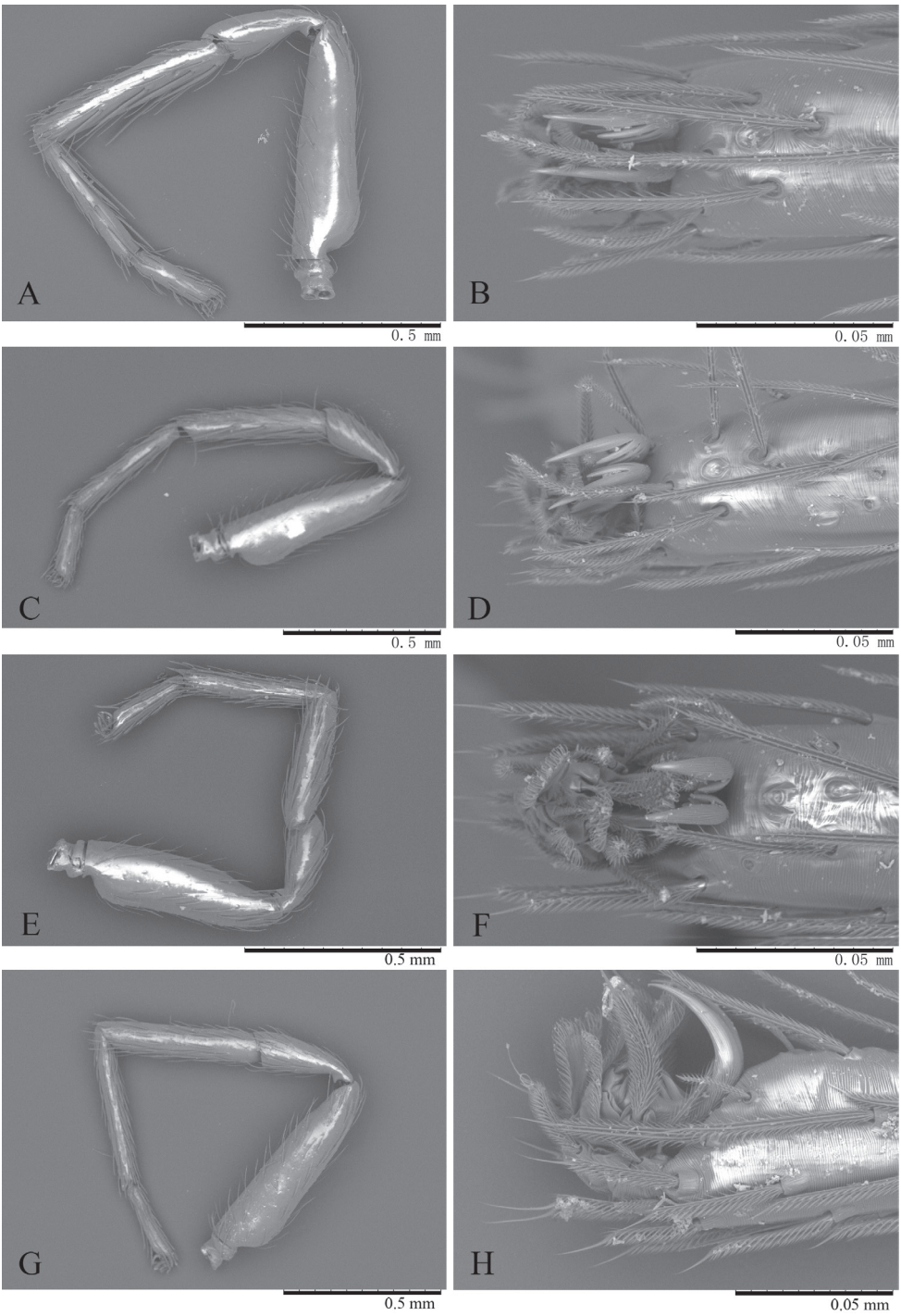

Figure 9. *Trilacuna songyuae* sp. n., female, right legs, SEM. **A** leg I, prolateral view **B** tarsus I, dorsal view **C** leg II, prolateral view **D** tarsus II, dorsal view **E** leg III, prolateral view **F** tarsus III, dorsal view **G** leg IV, prolateral view **H** tarsus IV, prolateral view.

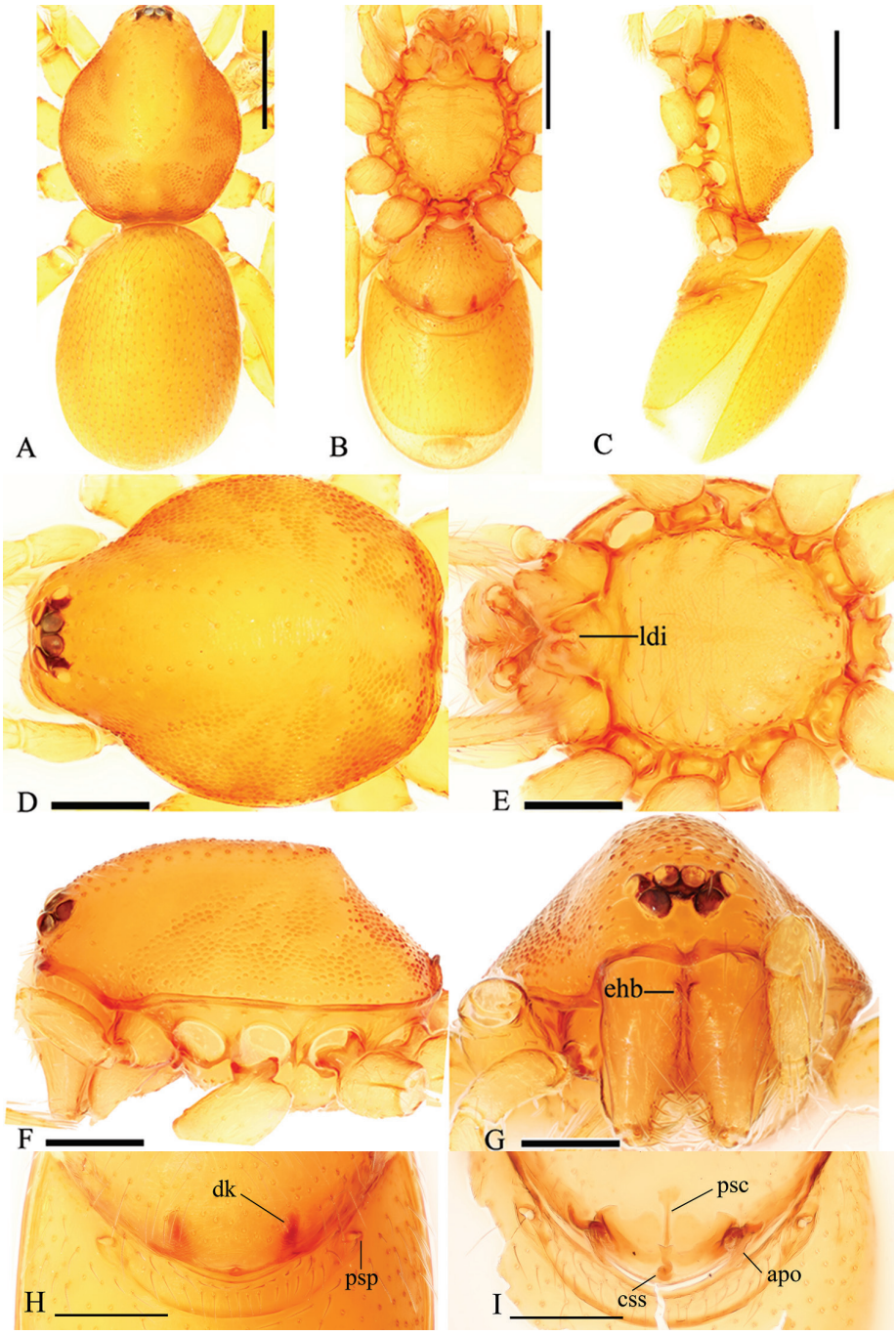

Figure 10. *Trilacuna songyuae* sp. n., female. **A, B, C** habitus, dorsal, ventral and lateral views **D, E, F, G** prosoma, dorsal, ventral, lateral and anterior views **H, I** genitalia, ventral and dorsal views. Abbreviations: apo = apodemes; css = cone-shaped structure; dk = dark knob; ehb = elevated hair base; ldi = labium deep incision; psc = paddle-like sclerite; psp = posterior spiracles. Scale bars: 0.2 mm (**A–C**); 0.1 mm (**D–I**).

parts: chelicerae straight, proximal region with one hair with elevated hair base (ehb); labium rectangular, anterior margin deeply incised (ldi) (Fig. 6E); endites slender, distally slightly branched (sdb) (Fig. 6B). Sternum with radial furrows between coxae I–II, II–III, III–IV; lateral margin smooth, middle area reticulate, posterior part with two slightly elevated ridges, each covered with a row of short, strong setae, the region between the two ridges strongly wrinkled (Fig. 6E). Abdomen: booklung covers (boc) large, ovoid, surface smooth (Fig. 7B). Dorsal scutum not fused to epigastric scutum. Apodemes present, posterior spiracles not connected by groove (Fig. 7A). Leg spination (all spines longer than segment width): legs I–II: tibiae: v2-2-2-2-0, metatarsi: v2-2-0, leg IV: femur with very long hairs ventrally (Fig. 7F). Trichobothria: tibia: each with 3; metatarsus: each with 1.

Genitalia. Epigastric region (Fig. 7A) with sperm pore small, oval, rebordered, situated before anterior spiracles; with a small dark dot (dd) between the posterior spiracles, a cluster of long hairs around the dark dot. Palp (Figs 7C, D, 8): orange. 0.42 long (0.14, 0.07, 0.10, 0.11). Femur strongly swollen (width/length = 0.08/0.14) (Fig. 7C, D). Tibia with numerous, very long, penniform setae (nls) on prolateral surface and two long, strong setae (tss) on retrolateral surface (Fig. 7C, D). Cymbium with two small, spear-like setae (sps) on basal part of prolateral surface (Figs 7C, 8G, H). Bulb long, oval, stout, tapering apically. Embolus system (Fig. 8B, D, F) complex, bearing numerous small "papillae"; with a strongly sclerotized, sickle-shaped protuberance (ssp) and a fan-shaped outgrowth (sso) prolaterally; between the two outgrowths is a cluster of long, line-like structures (cll); with a ribbon-like, nearly transparent outgrowth (rlo) and a broom-like outgrowth (blo) retrolaterally.

Female. As in male except as noted. Slightly larger than male. Body length 1.91; carapace 0.89 long, 0.75 wide; abdomen 1.02 long, 0.78 wide. Postepigastric scutum long. Posterior spiracles connected by groove (Fig. 10B).

Genitalia. Ventral view (Fig. 10H): surface without external features, a dark knob-like marking (dk) can be seen through the cuticle. Dorsal view (Fig. 10I): with a very small, cone-shaped structure (css). Transverse bars with two relatively long, lateral apodemes.

Distribution. China (Chongqing).

Acknowledgements

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ZooKeys 771: 57–71 (2018)
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RESEARCH ARTICLE

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Comments on the genus *Diplura* C. L. Koch, 1850, with description of two new species (Araneae, Mygalomorphae, Dipluridae)

Denis Rafael Pedroso[1], Alessandro Ponce De Leão Giupponi[2], Renner Luiz Cerqueira Baptista[3]

1 *Museu Nacional / Universidade do Brasil (UFRJ). Quinta da Boa Vista, São Cristóvão, 20.940-040, Rio de Janeiro, RJ, Brazil* **2** *Laboratório Referência Nacional em Vetores das Riquetsioses – LIRN/IOC; Coleção de Artrópodes Vetores Ápteros de Importância em Saúde das Comunidades, CAVAISC-IOC. Pav. Lauro Travassos, Anexo Posterior, sala 10. Av. Brasil, 4365, Manguinhos, Rio de Janeiro, RJ, Brazil* **3** *Laboratório de Diversidade de Aracnídeos, Instituto de Biologia, Universidade do Brasil (UFRJ), Avenida Carlos Chagas Filho, 373, Ilha do Fundão, 21941-902, Rio de Janeiro, RJ, Brazil*

Corresponding author: *Alessandro Ponce De Leão Giupponi* (agiupponi@gmail.com)

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Abstract

Two new species of *Diplura* C. L. Koch 1850 are described from Brazil: *Diplura mapinguari* **sp. n.,** from the state of Rondônia in southeastern Amazonia, northern Brazil, and *Diplura rodrigoi* **sp. n.,** known from southeastern and central west regions of Brazil. *Diplura rodrigoi* **sp. n.** is morphologically similar to *D. lineata* (Lucas, 1857), *D. sanguinea* (F. O. Pickard-Cambridge, 1896), and *D. mapinguari* **sp. n.** Comments on diagnostic characters of *Diplura* are included. The synonymy of *D. maculata* (Mello-Leitão, 1927) with *D. catharinensis* (Mello-Leitão, 1923) is corroborated. A classification of color pattern of the dorsum of the abdomen is given.

Keywords

Amazonia, Atlantic Forest, biodiversity, Diplurinae, Neotropical

Introduction

Diplura C. L. Koch, 1850 is a Neotropical mygalomorph genus currently including 17 species distributed from Panama to Argentina (Pedroso et al. 2016; World Spider Catalog 2018). Most species were described from southeastern and southern Brazil, with additional records from Panamá and numerous South American countries: Argentina, Bolivia, Colombia, Ecuador, Paraguay, and Venezuela (Pedroso et al. 2016). Recently, we have examined many specimens of several species from Peru. The genus is currently recognized by the following combination of characters (Pedroso et al. 2016): simple lyra, formed by a single series of strong and thickened setae, with tip spatulate and not curved (Maréchal and Marty 1998, Drolshagen and Bäckstam 2011, Pedroso and Baptista 2014), legs with thin and restricted scopula (Drolshagen and Bäckstam 2011, Pedroso and Baptista 2014), tarsi with only a few cracks (Drolshagen and Bäckstam 2011, Pedroso and Baptista 2014) and males with short and thickened palp tibia (Pedroso and Baptista 2014).

Herein we describe two new species of *Diplura*, one from the state of Rondônia, southeastern Amazonia, northern Brazil, and the other from southeastern and central west Brazil, both based on male and female specimens.

Materials and methods

The description of color pattern is based on specimens preserved in 75% ethanol. Information and photos of living animals were included, when available. Observations, photographs and measurements were made with a Leica DFC295 camera attached to a Leica M205C stereoscopic microscope. All photos were edited in the Photoshop CS5 software and plates were prepared with CorelDraw X7 software. Measurements are given in millimeters, unless otherwise noted. Scale bars represent 1 mm, unless otherwise noted. Body length was measured from the anterior margin of the chelicerae to the posterior border of the abdomen, without spinnerets. Carapace length was measured from anterior margin of the clypeus to the posterior border. Each article of the pedipalp and legs was measured in retrolateral view, from the basal condylus to the distal one. The receptaculum seminis (spermathecae) was examined through dissection of the genital region of the females, cleaned, and immersed in clove oil for clearing. Geographical coordinates were obtained from Geonames (2018). The distribution map was created using ESRI ARCGIS 10 software.

Abbreviations. Institutions (and curators):

CAVAISC Coleção de Artrópodes Vetores Ápteros de Importância em Saúde das Comunidades, Instituto Oswaldo Cruz, Rio de Janeiro, Brazil (M. Amorim);
IBSP Instituto Butantan, São Paulo, Brazil (A. Brescovit);
MCN Museu de Ciências Naturais, Fundação Zoobotânica, Porto Alegre, Rio Grande do Sul, Brazil (R. Ott);
MCTP Museu de Ciências e Tecnologia, Pontifícia Universidade Católica, Porto Alegre, Rio Grande do Sul, Brazil (R. Teixeira);

MNRJ Museu Nacional, Universidade do Brasil/Universidade Federal do Rio de Janeiro, Brazil (A. Kury);
MZSP Museu de Zoologia da Universidade de São Paulo (R. Pinto-da-Rocha), Brazil;
UFRJ Laboratório de Diversidade de Aracnídeos, Instituto de Biologia, Universidade do Brasil/Universidade Federal do Rio de Janeiro, Brazil (R. Baptista);
UNB Universidade de Brasília, Distrito Federal, Brazil (P. Mota).

Structures:
ALE anterior lateral eyes;
AME anterior median eyes;
ITC inferior (unpaired) tarsal claws;
PLE posterior lateral eyes;
PLS posterior lateral spinnerets;
PME posterior median eyes;
PMS posterior median spinnerets;
STC superior (paired) tarsal claws.

Macrosetae:
ap apical;
p prolateral;
pld prolaterodorsal;
plv prolateroventral;
r retrolateral;
rld retrolaterodorsal;
rlv retrolateroventral;
v ventral.

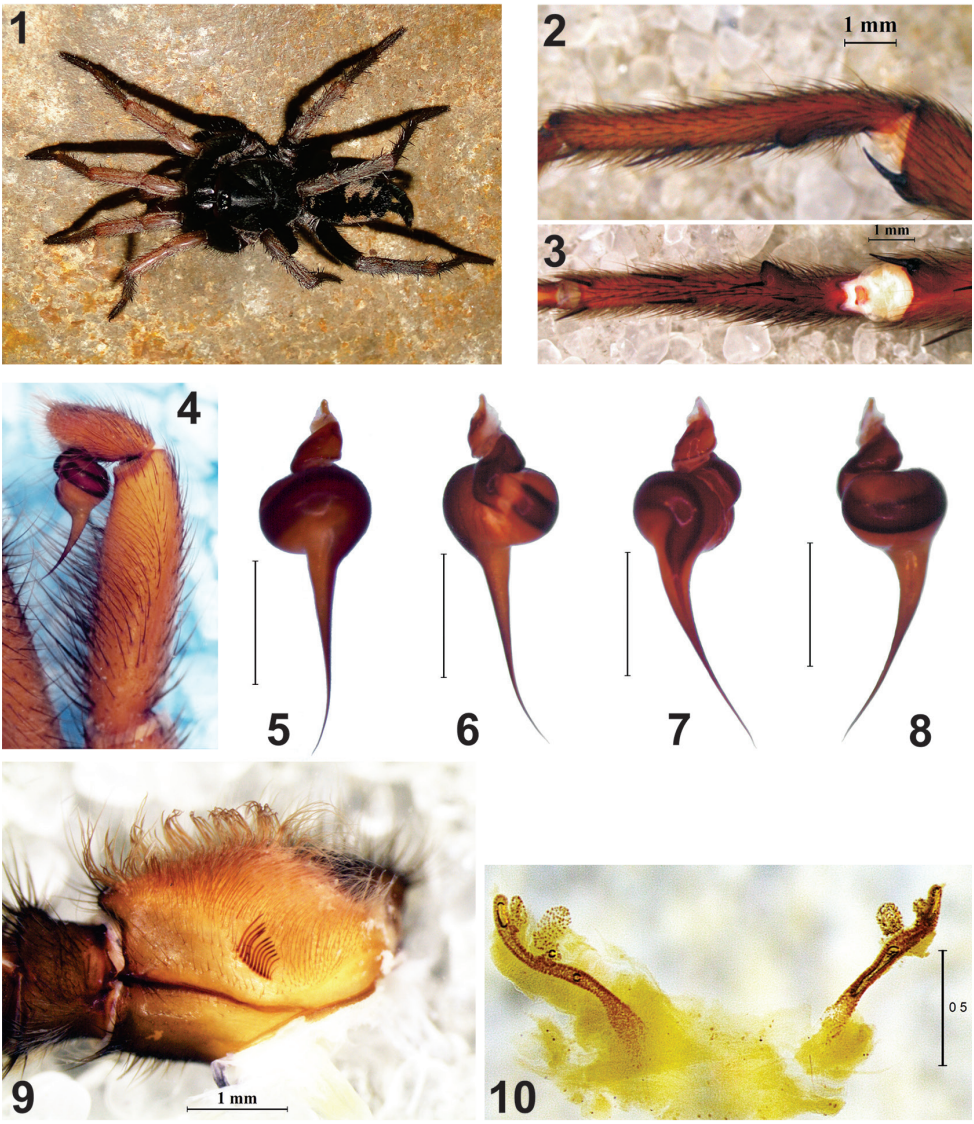
Results

Taxonomy

Family DIPLURIDAE Simon, 1889
Genus *Diplura* C. L. Koch, 1850

***Diplura mapinguari* sp. n.**
http://zoobank.org/FA9C778F-DABA-4E52-B454-8DDAB58A3FCC
Figures 1–10, 28, 29

Type material. Holotype: **BRAZIL**: RONDÔNIA: *Porto Velho*, Parque Natural Municipal de Porto Velho, [no date], [no collector] (♂, MNRJ 04414). **Paratypes**: **BRAZIL**: RONDÔNIA: *Guajará-Mirim*, 18.i.2001, Eq. Butantan (♀, IBSP 12336); *Porto*



Figures 1–10. *Diplura mapinguari* sp. n. Juvenile: **1** habitus dorsal (Porto Velho-RO, photo R. Indicatti). Male: left leg I **2** tibial spur, retrolateral **3** tibial spur and metatarsal clasper, ventral **4** left palp, retrolateral; left bulb **5** retrolateral **6** prolateral **7** ventral **8** dorsal **9** maxilla with lyra. Female: **10** receptaculum seminis (dorsal).

Velho: Mutum, transecto 5, parcela 400m, 18.xi.2011, Candiani, D. (juvenile, MZSP 44043); Mutum, transecto 7, parcela 650m, 18.iv.2012, Indicatti, R. (juvenile, MZSP 47085); UHE Samuel, Reserva, 17–21.viii.1992, Pontes, G. (juvenile, MCTP 02217).

Etymology: The specific name is taken from the folklore of Amazonian Indian tribes. "Mapinguari" is a magical creature, a huge long-haired animal, with long arms and large claws.

Diagnosis. *Diplura mapinguari* sp. n. shares the same oblique continuous light stripes on the dorsum of the abdomen with other species (*D. lineata*, *D. sanguinea*, and *D. rodrigoi* sp. n.), but differs by having the stripes unequally spaced. The three median stripes of *D. mapinguari* sp. n are wider, almost touching each other near the middle and merging with the ventral light background (Fig. 1). The male of *D. mapinguari* sp. n. has the longest embolus in *Diplura*, 2.5× longer than the bulb (Fig. 5). Females also have an elongated *receptaculum seminis*, with a thin stalk, and only three lobes: the internal lobe is lateral and larger; the other two are a pair at the apex (Fig. 10).

Description. Male (holotype, MNRJ 04414): **Measurements**: Body length 18.2; carapace length 8.8, carapace width 7.6; abdomen length 7.5, abdomen width 3.7. Leg formula 4123, total length: I 36.2, II 31.0, III 30.2, IV 38.7. **Carapace**: Clypeus tiny, with anterior margin bearing five thick setae, elongated and turned forward. Eye tubercle without thick setae at anterior margin, but with two thick setal insertions and many thin, common setae between the posterior eyes. AME separated from each other by 1/2 their diameter and almost as large as ALE. ALE much longer than wide, just a bit longer than AME. PME oval, around 1/2 the diameter of the AME. PLE longer than wide, a bit smaller than AME. PME and PLE contiguous. Anterior and posterior eye rows slightly recurved and with similar width. Chelicera with eleven promarginal teeth. Plectrum with seven thick and elongated setae. Sigillae ellyptical. Maxillae with 17–25 digitiform cuspules. Lyra (Fig. 9) formed by eleven elongated setae, clearly curved at their middle and slightly spatulated, the basalmost seta thinner and shorter than the others, which increase regularly in length up to the distal seta. **Legs:** Leg I (Figs. 2, 3). Tibia I with a retrolateral distal spur, slightly curved, with thick end which bears a megaseta. In ventral view, spur placed transversally to the long axis of tibia, with its apex directed retrolaterally (Fig. 3). Megaseta (or megaspine) elongated, regularly curved and acute, directed retrolaterally. In ventral view, it is placed obliquely in relation to its base and is nearly as long as the spur. Metatarsus I relatively long and straight, with its basal third bearing a large retrolateral tubercle, elongated and pointed, slightly turned towards the distal portion of the article. There is a short cluster of many spiniform setae (clasper) between the two macrosetae at the mid-basal portion of the prolateral face of the article. **Macrosetae**: Leg I: femur d2-3-3-3 left, d2-2-1-2-3 right; patella d1 left; tibia p1-1-1, v1-1-1ap (apophysis) left; v1-2-1ap (apophysis) right; metatarsus p1-1-0, v1-1-1-2ap left, v1-1-2-2ap right; leg II: femur d1-2-3-3-2 left, d1-1-3-3-2 right, p0-1-1-1; patella p1-1; tibia p1-1, r1, v2-2-2ap; metatarsus p1-1-1, v1-1-2-1ap left, v1-1-2-2ap right; leg III: femur d3-3-2-2; patella p1-1, r1; tibia d1-1-1, p1-1-1, r1-1-1, v2-2-2ap; metatarsus d1-1-2-2, p1-1-1, r1-1-0; v2-2-1-2ap left, v2-1-1-1-2ap right; leg IV: femur d1-3-3-1-2 left, d1-3-2-3-1-2 right; patella p1-1, r1; tibia d0-1-0, p1-1, r1-1-1, v2-1-1-2ap; metatarsus d1-1-1-1-2, p1-1-1-0, r1-1-1-0, v2-2-2-2ap left v2-2-2-3ap right. **Genitalia: Palpus** (Fig. 4) not as short and incrassate as usual, approx. 3.6× longer than wide and 2.6× longer than the cymbium. Bulb (Figs 5–8) globose, wider than long, with thin and elongated embolus, approx. 2.5× longer than the bulb. Embolus with relatively thin base, forming a 90° angle with the dorsal face of bulb,

in retrolateral and prolateral views, tapering regularly towards the apex, with its distal third much thinner, curved and slightly twisted. In ventral and dorsal views (Figs. 7, 8), there is a clear oblique placement of the embolus axis in relation to the bulb axis. In ventral view, sperm duct is wide at the beginning, with strong diminution of diameter at the base of the embolus, and then regularly tapering toward the apex (Fig. 7).

Female (paratype, IBSP 12336). Measurements: Body length 28.1; carapace length 11.3, carapace 9.2; abdomen length 12.3, abdomen width 8.7. Leg formula 4123, total length: I 37.3, II 34.7, III 35.2, IV 44.8. Females resemble males, except by the following characteristics. **Carapace**: Clypeus length around 1/2 the diameter of AME, with anterior margin bearing four thick setae, elongated, and turned forward. Eye tubercle with three elongated setae at anterior margin and five setae between the posterior eyes. Chelicerae with 12 promarginal teeth. Maxilae with 26 cuspules. Lyra with 13 elongated setae, slightly curved medially. Genitalia: ***Receptaculum seminis*** (Fig. 10) paired, elongated, separated by a little less than its height, with thin and elongated stalk, bearing one large and elongated internal lobe and two distal lobes that are not as large as the basal one.

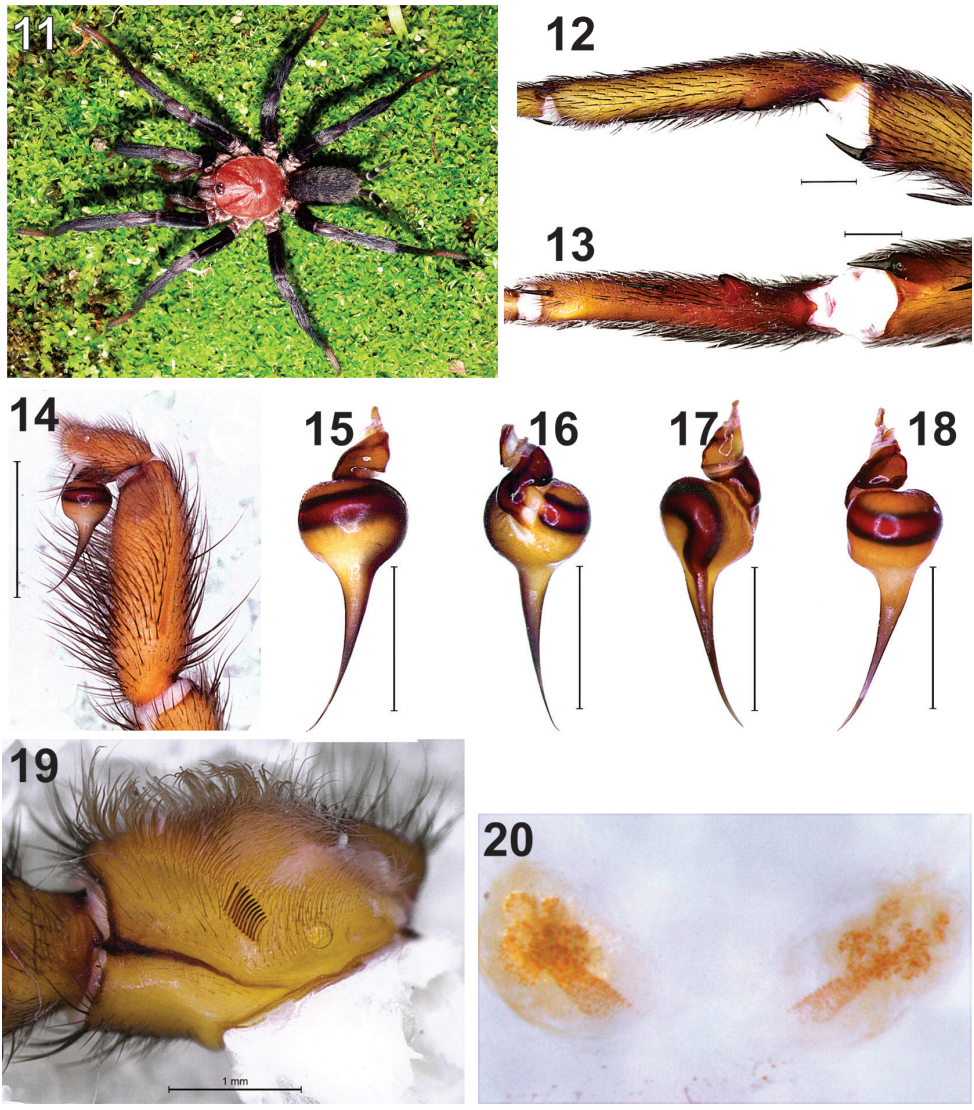
Color pattern. Carapace reddish brown, with thoracic sulci a bit darker. Eye region black. In live juveniles, the carapace presents an almost black color and the colors of all body parts are more vivid (Fig. 1). Chelicerae, labium, sternum and coxae reddish brown. Legs mostly reddish brown, with darker femurs. Abdomen black, dorsum with five light transverse stripes, of different sizes and shapes (Fig. 1). First and last stripes shorter and thinner (disappearing in some specimens). Three median stripes wider and shorter, widest at their middle region, where they almost touch one another. Compared to the last median stripe, the two first median stripes are wider, longer and are connected to the venter. The carapace is covered with abundant light brown setae.

Distribution. Known only from Porto Velho and Guajará-Mirim, Rondônia state, Amazon area, northern Brazil (Fig. 29).

Diplura rodrigoi sp. n.

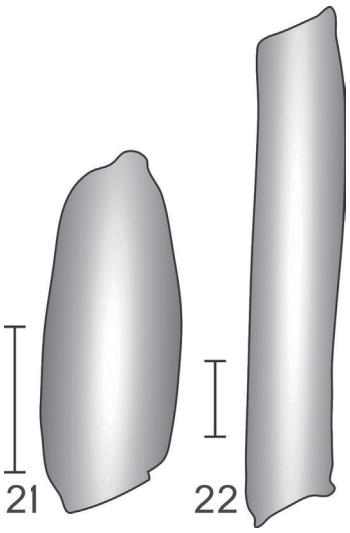
http://zoobank.org/8CDC2C3B-6A50-496E-B447-4820C19F50AF
Figures 11–20, 25, 29

Type-material. Holotype: BRAZIL: RIO DE JANEIRO: *Casimiro de Abreu*: BR-101, xii.2010, Equipe Herpetologia(♂, MNRJ 7620, ex. UFRJ 0920). **Paratypes: BRAZIL**: RIO DE JANEIRO: *Campos dos Goytacazes*: Mata do Mergulhão, 10.iii-05.iv.2004, Teixeira, C. L. (8♂, MCN/FZBRS 43436); Mata do Mergulhão, 10.iii-05.iv.2004, Teixeira, C. L. (8♂, MCN/FZBRS 43437); *Casimiro de Abreu*: BR-101, xii.2010, Equipe Herpetologia (♂, UFRJ 0920); Barra de São João, Morro de São João, 21–24.iii.2003, Exp. Arachné (♂, MNRJ 4344); *Macaé*: Terminal Cabiúnas, 25–30.iii.2010, Baptista, R. et al. (♂, MNRJ 4539); 21–26.ii.2013, Pedroso, D. R. and Miranda, G. (♂, UFRJ MAC 3617); 19–24.ii.2016, Pedroso, D. R. and Villar-



Figures 11–20. *Diplura rodrigoi* sp. n. Juvenile: **11** habitus dorsal (Porto Velho-RO, photo R. Indicatti). Male: left leg I **12** tibial spur, retrolateral **13** tibial spur and metatarsal clasper, ventral **14** left palp, retrolateral; left bulb **15** retrolateral **16** prolateral **17** ventral **18** dorsal **19** maxilla with lyra. Female: **20** receptaculum seminis (dorsal).

real, O. (♂, CAVAISC, ex. UFRJ); 19–24.ii.2016, Pedroso, D. R. and Villarreal, O. (♂, CAVAISC, ex. UFRJ); *Mendes*: Colégio Marista São João das Paineiras, v.2008, Baptista, R. (♀, UFRJ 0102); *Rio de Janeiro*: Parque Nacional da Tijuca, Bom Retiro, v.2016, Pedroso, D. R. and Baptista, R. L. C. (♂, UFRJ 1360); vi.2016, Pedroso, D. R. and Baptista, R. L. C. (♂, MNRJ 7620, ex. UFRJ 1361).

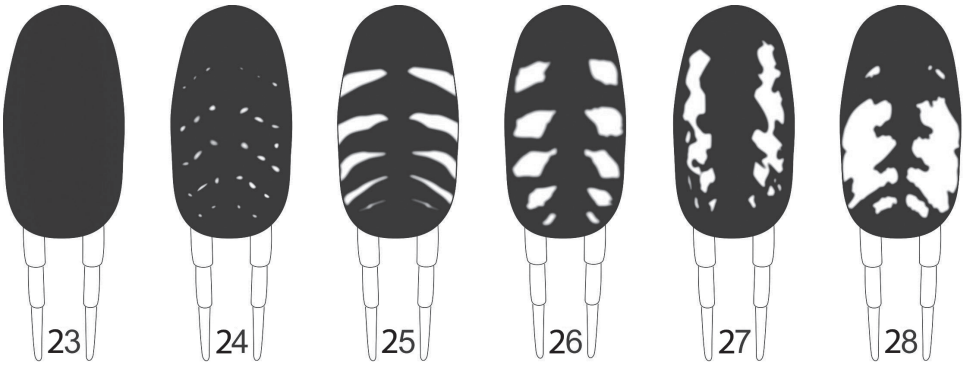


Figures 21–22. Pedipalp tibia drawings of male Diplurinae (what view): **21** *Diplura* sp. **22** *Harmonicon* sp.

Etymology. This species is named after the biologist, Rodrigo de Cerqueira da Costa, who first directed Denis Pedroso and Alessandro Giupponi in their studies of zoology.

Diagnosis. *Diplura rodrigoi* sp. n. differs from other species displaying several oblique continuous light stripes on the dorsum of the abdomen (*D. lineata*, *D. sanguinea*, and *Diplura mapinguari* sp. n.) by its very characteristic stripe pattern. Its elongated oblique stripes are very thin near the median line of the dorsum but continuously widening and approaching each other towards the venter, where they merge in the light background (Fig. 25). The three median stripes are longer and not as wide and confluent at their middle portion as in *Diplura mapinguari* sp. n. In contrast to *D. lineata* and *D. sanguinea*, the light stripes are longer and clearly delimited, with well-defined borders. Males of *D. rodrigoi* sp. n. are the only Diplurinae with a prolateroventral swelling at the distal portion of metatarsus I, which is glabrous and lighter than the surrounding areas (Fig. 13). As in *D. sanguinea*, males of *Diplura rodrigoi* sp. n. bear a relatively wide sperm duct from the base of the embolus towards the apex (Fig. 17), in contrast to *Diplura mapinguari* sp. n. and *D. lineata*, where the sperm duct is strongly constricted and becomes almost filiform towards the apex. *Diplura rodrigoi* sp. n. males differ from *D. sanguinea* by having the megaseta of tibial spur of leg I a bit shorter than the basal portion of the spur (Fig. 12) and 10–11 setae in the lyra (Fig. 19), in contrast with megaseta longer than the spur and seven setae at the lyra in the latter species.

Description. Male (Holotype, **MNRJ 7620)**: **Measurements**: Body length 20.0; carapace length 8.7, width 7.2. Abdomen length 8.3, width 4.8. Leg formula 4123, length: I 33.3, II 30.6, III 27.4, IV 35.0. **Carapace**: Clypeus about 40% the diameter of AME, partially covered by eye tubercle; frontal margin bearing five thick setae, which are elongated and turned forward. Eye tubercle with four thick setae at ante-



Figures 23–28. Drawings of color pattern types of the dorsum of the abdomen in *Diplura* species: **23** Type I **24** Type II **25** Type III **26** Type IV **27** Type V **28** Type VI.

rior margin and two setae between posterior eyes. AME separated from each other by 1/3 their diameter, and a little larger than ALE. ALE longer than wide. PME almost spherical, with around 1/2 the AME diameter. PLE longer than wide, a little shorter than AME diameter. PME and PLE contiguous. Anterior eye row a little recurved, posterior row recurved. Anterior and posterior rows of similar width. Chelicera with 12 promarginal teeth. Plectrum with six thick and elongated setae. Sigillae ellyptical. Maxillae with 12–15 elongated cuspules. Lyra (Fig. 19) formed by eleven setae almost straight or just a bit curved, of similar size, with apex slightly spatulate, the basalmost seta much thinner than the others. **Legs:** Leg I (Figs 12–13). Tibia I with distal retrolateral spur slightly curved, not acutely pointed, bearing an apical megaseta, much longer than wide. Spur megaseta short and slightly curved, a little shorter than the spur. Metatarsus I relatively long and slightly sinuous in ventral view, bearing a retrolateral tubercle conical, pointed and turned in apical direction, placed at the basal third of the article. Cluster of spiniform setae (clasper) placed from the base to the level of the third megaseta at the mid-basal region of the prolateral face of the article. Swelling placed near the prolateral distal margin, glabrous and lighter than the surrounding areas. **Megasetae**: leg I: femur d1-2-1-3-3 left, d1-1-1-1-2 right; patella p1 left; tibia p1-1, v1-1-1ap (apophysis); metatarsus p0-1-1 left, p1-1-1 right, v0-1-1ap; leg II: femur d2-3-2-2-1 left, d2-3-3-2 right; patella p1; tibia p1-1, v1-2-2ap; metatarsus p1-1-1, v1-2-2ap; leg III: femur d2-3-2-2 left, d1-3-2-3-2 right; patella p1 left, p1-1 right, r1; tibia d1-1, p1-1, r1-1, v2-1-1-2ap; metatarsus d1-1-2, p1-1-1, r1-1-1-1 left, r1-1-1-0 right; v1-1-1-1-3ap; leg IV: femur d1-1-2-3-2-2 left, d1-1-2-2-3-2 right; patella p1 left, p1-1 right, r1; tibia d1-1, p1-1, r1-1, v2-1-1-2ap; metatarsus d1-1-0-2 left, d1-1-1-2 right, p1-1-0 left, p1-1-1 right, r1-1-1, v1-1-1-2-3ap left v2-1-1-2-3ap right. Genitalia: Palpus (Fig. 14) short and incrassate, around 3× longer than wide and 2.6× longer than the cymbium. Bulb (Figs 15–18) almost piriform, a little wider than long, with embolus moderately long and thin, around 2× longer than bulb. Embolus with base relatively thick in relation to the bulb. In ventral view, sperm duct wide at

the beginning, with a moderate diminution of diameter at the base of the embolus, and then tapering toward the apex, with distal third much thinner (Fig. 17). Embolus regularly and slightly curved, especially at the distal region.

Female (Paratype, UFRJ 0102): **Measurements:** Body length 26.4; carapace length 9.6, carapace width 8.2; abdomen length 12.3; abdomen width 7.6. Leg formula 4123, length: I 30.4, II 24.8, III 23.7, IV 30.6. Females resemble males, except by the following characteristics. **Carapace**: Clypeus length similar to AME diameter, with anterior margin bearing five thick setae, elongated and turned forward. Eye tubercle with three thick and long setae and ten smaller setae, of variable size, at anterior margin. Area between posterior eyes with single long and thick setae. AME separated from each other by 80% of their diameter. Chelicera with 12–13 promarginal teeth. Plectrum with five thick and elongated setae. Maxillae with 15–17 cuspules. Lyra (Fig. 19) formed by 11–12 subequal setae, except for the first one, which is shorter and thinner. Setae slightly spatulated, with a thin and pointed apex. **Genitalia**: *Receptaculum seminis* (Fig. 20) paired, separated by a distance similar to its own height. Stalk relatively wide, its diameter a little smaller at the distal third, near the five or six apical large lobes, with all of them being similar in size.

Color pattern. Carapace reddish, with thoracic sulci a little darker. Eye region darkened. Chelicerae reddish brown. Labium, sternum and coxae orange brown. Sigillae slightly darker than sternum. Legs light brown. Dorsum of abdomen dark brown with five elongated pale brown transverse stripes, with their width diminishing posteriorly. Stripes continuous, with well-defined borders, thin and far from each other near the midline of the dorsum, but growing wide and closer toward the venter, where they blend into the pale background. When alive, they bear a vivid red carapace and dark brown legs and abdomen.

Natural history. The female paratype from Mendes (UFRJ 0102) was collected in a short tunnel, with a small silk lined opening, on the slope of an old road through second-growth Atlantic Forest. Other specimens have been collected under rocks and logs on forest floor. Most specimens were caught by pitfall traps in forested areas.

Records. BRAZIL: DISTRITO FEDERAL: *Brasília*: Reserva Ecológica do IBGE/RECOR: alt. 1077m, -15.939653° -47.879984°, 14–16.v.2015, Kury, A., Pinto, A. and Carvalho, R. (♂, MNRJ 6859); IBGE, mata de galeria, 23.iv.2001, Diniz, D. (2♂, UNB 1142); 01.v.2000, Milhomem, M. (2♂, UNB 3998); ESPÍRITO SANTO: *Santa Teresa*: ESFA leg. (♂, MNRJ 4339); *Sooretama:* Reserva Biológica de Sooretama, Porteira Quirinão, 20.iv.2006, Exp. Arachné (♂, MNRJ 4341); GOIÁS: *Morrinhos*: Parque Ecológico Jatobá, XII.2006-VIII.2007, Santana, R. (♂, IBSP 140891); MINAS GERAIS: *Belo Horizonte*, Estação Ecológica da UFMG, iii.2001, Maria, M. et al. (♂, IBSP 10739); UFMG, campus Pampulha, 2000, Álvares, E. (♂, IBSP 13824); *Itacarambi*: Gruta Olhos d´água, 26.vi.2001, Giupponi, A. and Baptista, R. (♂, MNRJ 3518); *Juiz de Fora*: ix.2008-iv.2009, Gomide, S. (♂, ♀, IBSP 144024; ♂, IBSP 144025); *Viçosa*: Mata do Paraíso, 21–24.iii.2001, Azevedo, L. P. (♂, MNRJ 4320); RIO DE JANEIRO: *Macaé*: Ilha de Santana, 27.vi.2009, Baptista, R. L. C. (j, UFRJ MAC 2166; j, UFRJ MAC 2246); Parque Municipal do Atalaia, 26.vi.2009, Baptista, R. L. C. et al.

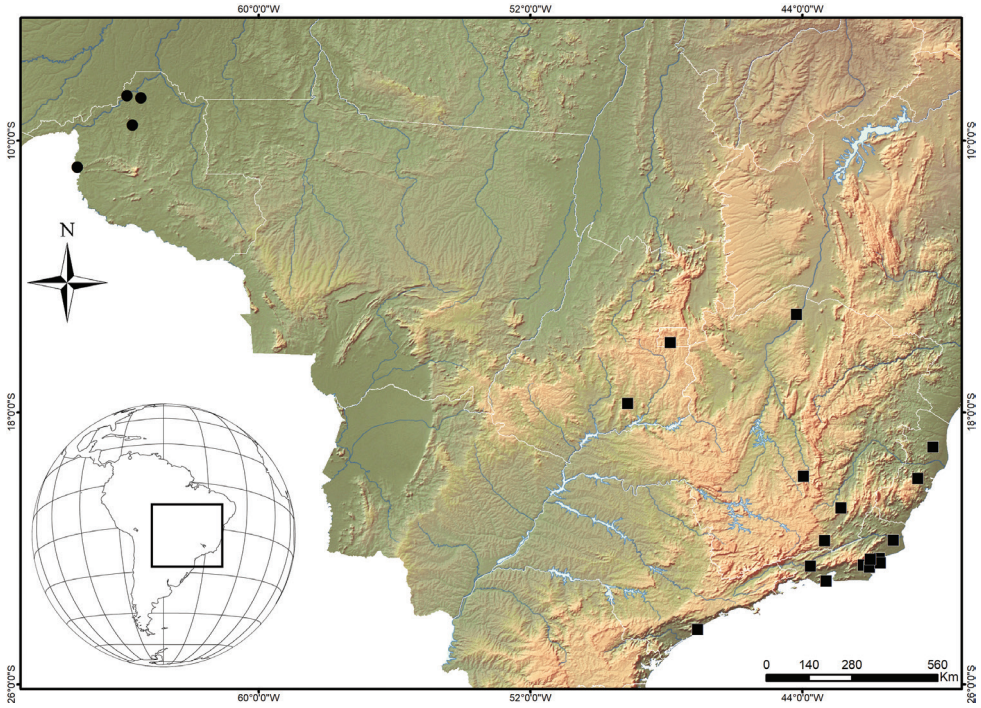


Figure 29. Geographical distribution of the two new species of *Diplura*. Key: black circles *Diplura mapinguari* sp. n., black squares *Diplura rodrigoi* sp. n.

(2 j, UFRJ MAC 2174); Terminal Cabiúnas, Mata da Odebei, 11–16.v.2015, Pedroso, D. R. and Castanheira, P., pitfall (♂, UFRJ MAC 10265); *idem*, 18–22.ii.2014, Pedroso, D. R. and Castanheira, P., pitfall (♂, UFRJ MAC 7191); SÃO PAULO: *Peruíbe*: Estação Ecologica Juréia-Itatins, III.1997, Brescovit, A. et al. (♂, IBSP 11577).

Distribution: Widespread and common in a wide area of southeastern and midwestern Brazil, from north Espírito Santo state and central-south Minas Gerais state, reaching west to the Distrito Federal and south, down to southeastern São Paulo state (Fig. 29). It is sympatric with *D. lineata* (Lucas, 1957), a similar species, in the municipalities of Casimiro de Abreu and Rio de Janeiro, both in Rio de Janeiro state, Brazil (see Pedroso et al. 2016).

Discussion

Notes on the diagnosis and composition of *Diplura*

The diagnosis of *Diplura* in relation to other Diplurinae needs some comments and amendments. The presence of a lyra in the inner face of the palp maxilla is a key character that allows for separation between lyrate (*Diplura* C. L. Koch, 1850, *Harmonicon*

F. O. Pickard-Cambridge, 1896 and *Trechona* C. L. Koch, 1850) and alyrate Diplurinae (*Linothele* Karsch, 1879). The single line of stiff setae found in lyra of *Diplura* and *Harmonicon* is quite different from the plate-like lyra, with several series of setae, in *Trechona* (Pedroso et al., 2008). In *Harmonicon*, the lyra is formed by four to seven setae in adult specimens, with a flattened and curved tip (Drolshagen and Bäckstam 2011, Pedroso and Baptista 2014). In *Diplura*, the number of setae in the lyra is quite variable. The described species of *Diplura* have stiff setae in the lyra ranging from four to seven in *Diplura taunayi* (Mello-Leitão, 1923) to 15 in *Diplura studiosa* (Mello-Leitão, 1920). However, we found specimens of *Diplura* from southern Brazil with up to 18 setae. On the other hand, specimens from southeastern and northeastern Brazil may have only one to three stiff setae in the lyra. One specimen we examined had only one seta in one maxilla, but the other maxilla was devoid of stiff setae. Those findings show that the number of setae in the lyra may increase or decrease in different species, and even the complete absence of the lyra may happen in some specimens. Therefore, as pointed out by Drolshagen and Bäckstam (2011) and Pedroso and Baptista (2014), the number of stiff setae in the lyra is not diagnostic for the genera.

The shape of the stiff setae of the lyra is much more variable than previously pointed out in the literature. In many described species of *Harmonicon*, including the type-species *Harmonicon rufescens* F. P.-Cambridge, 1896, the setae in the lyra are strongly hook-shaped, with a strong distal curvature and an acute and not widened tip (F. P.-Cambridge, 1896: pl. 35, fig. 3, Maréchal and Marty 1998: fig. 2, Pedroso and Baptista 2014: fig. 6). However, the lyra of *Harmonicon oiapoqueae* Drolshagen & Bäckstam, 2011 does not display a clear hook, with the tip less curved and a little widened (Drolshagen and Bäckstam 2011: fig. 6), similar to some undescribed species we have examined from Brazil. The lyra of one of those undescribed species has a very wide and clearly spatulated tip. On the other hand, there are species of *Diplura* with curved stiff setae (ex. *D. mapinguari* sp. n., Fig. 9) and the tip not clearly spatulated (see *D. lineata*, Pedroso et al. 2016: fig. 22–24, and *D. rodrigoi* sp. n., Fig. 19). Therefore, we consider that the variation found on the shape of the stiff setae of the lyra in both *Diplura* and *Harmonicon* are too wide and clearly overlapping.

Besides the lyra, there are also other diagnostic characters in the maxilla. On its ventral face, there is a transversal suture just below the lyra. In *Diplura*, the area just below the basal portion of the maxillar suture is either glabrous or has just some small thin setae (Figs. 9, 19). On the other hand, there is a field of spiniform setae in that area in *Harmonicon* (Pedroso and Baptista 2014: fig. 6) and *Trechona* (Guadanucci et al. 2016: fig. 1g). Additionally, there is also a dense fringe of long and thin setae between the lyra and the basal portion of the suture in *Trechona* (Guadanucci et al. 2016: fig. 1g).

Specimens of *Diplura* have relatively short and thin scopula, sometimes almost absent in the metatarsus and tarsus of the legs. Scopulae in the other lyrate Diplurinae are formed by long numerous setae and cover most of the distal articles of the legs. In *Diplura*, the tarsi of the legs are not pseudosegmented and not very flexible, lacking large and numerous cracks; they have only a few ventral, thin cracks, that allow just a limited bending of the article (Drolshagen and Bäckstam 2011, Pedroso and Baptista 2014).

An easy way to separate males of *Diplura* from other Diplurinae is by the short and incrassate pedipalp tibia (Fig. 21), which contrasts strongly with the elongated and thin tibia of other Diplurinae (Fig. 22). The ratio length/width of the pedipalp tibia reaches 3.6× in *Diplura* and is at least 5× in the other Diplurinae. This character was already pointed out by Pedroso and Baptista (2014) and Pedroso et al. (2016).

The *receptaculum seminis* of most *Diplura* species is formed by a short and relatively wide stalk topped by a cluster of many globular to ovoid lobes (*fundus*), of variable sizes (Fig. 20, Pedroso et al. 2016: fig. 13, 25). In *D. mapinguari* sp. n., the stalk is elongated and thinner and the lobes are separated in two groups (Fig. 10). In *Harmonicon* (Drolshagen and Bäckstam 2011: fig. 5) and *Trechona* (Pedroso and Baptista 2004: fig. 1, Pedroso et al. 2008: fig. 4), there are usually two branches: the first one simple and at the inner side of the stalk, and the second one distal and topped by one large fundus, sometimes with lateral flaps. However, there are no clear multiple lobes as in *Diplura.*

Currently, 17 species of *Diplura* are considered as valid, distributed from Panama to Argentina (Pedroso et al. 2016; World Spider, Catalog 2018). However, *Diplura maculata* (Mello-Leitão, 1937) has been already synonymized with *Diplura catharinensis* (Mello-Leitão, 1927) by Bücherl (1962: 261). Although this synonymy had been completely overlooked in the literature and catalogs, we agree with Bücherl after examining the types and additional material from the type-localities or nearby areas in Santa Catarina state, southern Brazil. As a result, *Diplura* now includes 18 species, taking into consideration the synonymy referred to above and the two new Brazilian species herein described.

Most Diplurinae species have a pattern of light stripes or dots over the dark dorsum of the abdomen. The exceptions are *Harmonicon*, and some species of *Diplura*, whose abdomen are uniformly dark, without a contrasting light pattern. The light pattern of most Diplurinae may be present only at the sides of the dorsum, but usually extend either to the middle area of the dorsum or to the venter, even merging with the background color in that area. The species of *Diplura* may be grouped below in six color pattern types following the different markings on the dorsum of abdomen, numbered from I to VI (Figs 23–28). These pattern types are an easy way to group species and also allows a clear distinction between these groups or isolated species.

Type I (Fig. 23): Uniform dark color, sometimes with sparse and inconspicuous light dots randomly spread: *D. annectens* (Bertkau, 1880), *D. macrura* (C. L. Koch, 1841), *D. paraguayensis* (Gerschman & Schiapelli, 1940), *D. riveti* (Simon, 1903), *D. studiosa* (Mello-Leitão, 1923).

Type II (Fig. 24): Pattern with many light dots randomly distributed on the dorsum or with a variable number (2–6) of "pseudostripes", where many dots are aligned but not fused: *D. argentina* (Canals, 1931), *D. catharinensis* (Mello-Leitão, 1927), *D. erlandi* (Tullgren, 1905), *D. nigra* (F. O. Pickard-Cambridge, 1896), *D. paralella* (Mello-Leitão, 1923), *D. taunayi* (Mello-Leitão, 1923).

Type III (Fig. 25): Pattern formed by continuous and well-defined transversal stripes, with thin tips near the middle area of dorsum, but increasing in width towards the venter, each stripe with a more or less triangular profile: *D. rodrigoi* sp. n.

Type IV (Fig. 26): Pattern formed by elongated transverse light blotches, sometimes more or less restricted to the sides of the dorsum: *D. garbei* (Mello-Leitão, 1923), *D. petrunkevitchi* (Caporiacco, 1955), *D. sanguinea* (F. O. Pickard-Cambridge, 1896).

Type V (Fig. 27): Pattern formed by irregular large light spots, with most of them connected to one another, forming an irregular longitudinal stripe on the sides of the dorsum: *D. lineata* (Lucas, 1857).

Type VI (Fig. 28): Pattern formed by three irregular very wide light spots, widest at their middle region, where they almost touch one another: *D. mapinguari* sp. n.

The only described species of *Diplura* not listed above is *D. garleppi* (Simon, 1892), from San Mateo, Bolivia. As its holotype has not been found in the Museum national d´Histoire naturelle, Paris (E. Leguin, pers. comm.), the short description does not give enough detail on the color pattern and we have not examined any specimen ascribable to *D. garleppi*, we were not able to include it in any of the proposed color pattern types.

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RESEARCH ARTICLE

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The Dromiusina Bonelli, 1810 of southwestern Saudi Arabia with description of a new species (Coleoptera, Carabidae, Lebiini)

Iftekhar Rasool[1], Mahmoud S. Abdel-Dayem[1,2], Ron F.F.L. Felix[3], Hathal M. Aldhafer[1]

1 *King Saud University Museum of Arthropods (KSMA), Plant Protection Department, College of Food and Agriculture Sciences, King Saud University, P.O. Box 2460 Riyadh 11451, Saudi Arabia* **2** *Entomology Department, Faculty of Science, Cairo University, Giza 12613, Egypt* **3** *Naturalis Biodiversity Center Leiden, The Netherlands*

Corresponding author: *Iftekhar Rasool* (irasool@ksu.edu.sa)

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Abstract

In this paper, species of the subtribe Dromiusina Bonelli, 1810 from southwestern Saudi Arabia are revised. Eleven species in six genera (*Calodromius*, *Dromius*, *Mesolestes*, *Metadromius*, *Microlestes*, and *Zolotarevskyella*) are recognized. *Dromius saudiarabicus* Rasool, Abdel-Dayem and Felix, **sp. n.** is newly described species from Rayda Nature Reserve Asir province. The presence of *Metadromius ephippiatus* in Saudi Arabia is doubtful. A key is also provided to genera and species level for Dromiusina of Saudi Arabia.

Keywords

Dromius saudiarabicus sp. n., Dromiusina, revision, Saudi Arabia, taxonomy

Introduction

The Dromiusina Bonelli, 1810 is the third largest subtribe in the tribe Lebiini of the subfamily Lebiinae, encompassing approximately 735 described species (Lorenz 2005). Its members can be recognized by the fused mentum and prementum. Other important characters of these ground beetles are epipleurae incomplete, not passing the

apical angles of elytra; last labial palpomeres pointed; claws smooth or sparsely dentate; base of pronotum weakly incised or straight (Ball and Hilchie 1983, Basilewsky 1984).

Dromiusina are distributed worldwide and are currently classified in 48 genera (Lorenz 2005). Jeannel (1949) placed this subtribe in the tribe Dromiines under subfamily Dromiitae (Lebiidae) and omitted *Apristus* Chaudoir, 1846. Habu (1967) changed Jeannel's classification and ranked Dromiines as a subtribe of the Lebiini, as did Ball and Hilchie (1983). Kabak (2003) enlisted *Apristus* Chaudoir, 1846, *Eremolestes* Maindron, 1905, *Syntomus* Hope, 1838, and *Tilius* Chaudoir, 1876 under Lionychina Jeannel, 1948 in the Palearctic realm. In the recent Catalogue of Palaearctic Coleoptera, Kabak (2017) followed the classification of Bousquet (2012) and listed genera of Lionychina and Singilina under Dromiusina. Macrosystematic issues are very complex and need further investigation at molecular level.

The Dromiusina fauna of the Arabian Peninsula is not completely studied and only 18 species are reported. Five species were listed from United Arab Emirates (Felix 2009), 18 from Saudi Arabia (Britton 1948, Mateu 1979, 1986, 1990, Kabak 2003, Felix 2009), and six from Yemen (Kabak 2003, Felix 2009). Not a single species of Dromiusina has been reported from Kuwait, Oman, or Qatar until now. This subtribe has also been poorly studied in Saudi. The first list of species was given within the Carabiade of southwest Arabia by Britton (1948) who included three species: *Microlests vittatus* Mostschulsky, 1859, *M. micromys* Alluaud, 1918, and *M. discoidalis* Fairmaire, 1892 from Hejaz (Saudi Arabia). Mateu (1979) presented the first synopsis of subfamily Lebiinae that included a list of eight Dromiusina species of Saudi Arabia and the description of one species *Metadromius arabicus*. Mateu (1986) published a list of Lebiinae and Brachininae of Saudi Arabia with four additional species. Mateu (1990) described *Dromius buettikeri* as a new species from Makkah, Harithi, which is thought to be endemic to Saudi Arabia.

The present study is the third in a series of papers revising the southwestern Saudi Arabian Lebiini (Rasool et al. 2017, 2018). A total of eleven species is recognized and treated in subtribe Dromiusina, including one new species. The study includes a key to species of Dromiusina in Saudi Arabia and illustrations of the most important characters.

Materials and methods

This review is based on extensive surveys (during 2012–2016) in southwestern Saudi Arabia (Al Baha, Asir, and Jizan provinces) and preserved collections at King Saud University Museum of Arthropods, Saudi Arabia (KSMA) (comprising 2253 specimens). Additional materials, including holotypes and paratypes, were also borrowed for examination from the following museums: British Museum of Natural History, London, UK (**BMNH**), Natural History Museum Basel, Switzerland (**NHMB**) and Naturalis Biodiversity Centre, Leiden Netherlands (**RMNH**). The newly collected materials were deposited in KSMA. Other acronyms of the holotype depositories mentioned in the

text are the National Museum of Natural History, Paris, France (**MNHN**) and the Museum of Natural History, Hungary (**MNH**).

For collection of species, light trap (LT), hand Picking (HP), pit fall trap (PT) and sticky trap (ST) were used. Male specimens of freshly collected species were dissected for aedeagus, which is boiled in 70 % KOH for 1–2 minutes to eliminate additional tissues and kept in clove oil for 24 hours. The aedeagus were glued on cards or preserved inside a glycerin vial pinned under specimen.

All the species and aedeagus were photographed by Q–imaging Micro Publisher 5.0 RTV camera, attached with a trinocular stereomicroscope (LEICA MZ125). Taken images were joined by software Zerene Staker 1.04. FEI Inspect S50 model (Scanning Electron Microscope) was used to take scanned images.

Total body length (**TBL**) was measured from the anterior margin of labrum to terminating margin of abdomen along midline; head length (**HL**) was taken from anterior margin of labrum to anterior margin of pronotum along middle line, while pronotum length (**PL**) and elytra length (**EL**) was taken from anterior to posterior margin along the middle line of pronotum and elytra respectively; head width including eyes (**HW**), pronotum width (**PW**) and elytra width (**EW**) were measured at their widest points. Aedeagus length (AL) was measured along its body mass. All the measurements were taken with an ocular micrometer in a stereo-binocular microscope (МБС-9).

Verbatim label data cited for the type specimens of the newly described species have label breaks indicated by a slash ("/"). The chorotypes of species were designated by following the classification of Taglianti et al. (1999). For synonymy and species distribution, Kabak (2003, 2017), Bousquet (2012), Anichtchenko (2017) (http://carabidae.org), and available literature are followed.

Systematics

Key to genera and species of Dromiusina of southwestern Saudi Arabia

1 Antennomeres II shorter than III (Fig. 1)..... **2**

– Antennomeres II as long as III (Figs 2, 3, 4) **7**

2 Pubescence starts from antennomeres III (Fig. 1); elytra parallel sided; tarsomeres I of hind legs longer than last (Fig. 5) ..... ***Microlestes*, 3**

– Pubescence starts from antennomeres IV (Fig. 3); elytra parallel sided or broadened posteriorly; tarsomeres I of hind legs as long as last (Fig. 6) **5**

3 Antennae short and stout, crossing the base of pronotum with two antennomeres; eyes small, tempora long, head with microlines (Fig. 18) .... ***Microlestes infuscatus fragilis***

– Antennae long and slender, crossing the base of pronotum by three and half antennomeres; eyes large,tempora short, head without microlines (Figs 16, 17)..... **4**

4 Whole of the body black (Fig. 30); elytra with strong transverse microlines; aedeagus in lateral view straight in middle from ventral side, endophallus armature of aedeagus broad and flattened (Fig. 43) ..... ***Microlestes glabrellus***

– Elytra dark brown, with large elongate and pale testaceous discal spots (Fig. 29), abdomen–dark brown, elytra with suppressed transverse microlines, aedeagus in lateral view strongly curved throughout, endophallus armature of aedeagus elongate (Fig. 42) ..... ***Microlestes discoidalis***

5 Base of pronotum weakly incised towards hind angles (Fig. 11); elytra broadened posteriorly; apex of elytra transversely truncated; elytra pale testaceous with transverse black band in the middle, not reaching to the lateral margins (Fig. 22) ..... ***Calodromius mayeti***

– Base of pronotum straight (Figs 12, 13); elytra parallel sided, apex of elytra slightly obliquely truncates, elytra usually with pale macula (Figs 23, 24) .... ***Dromius***, **6**

6 Head wider than long; pronotum strongly transverse, sides of pronotum almost straight posteriorly, hind angles almost right; labrum transverse, tempora short, frons with few transverse wrinkles (Fig. 13) ..... ***Dromius buettikeri***

– Head longer than wide; pronotum not strongly transverse, narrowed and sinuate posteriorly before angles, hind angles obtusangular; labrum as long as wide, tempora long, frons smooth (Fig. 12)..... ***Dromius saudiarabicus* sp. n.**

7 Head and pronotum black with longitudinal furrows (Fig. 21); elytra parallel sided, apex transversely truncated; whole of the body glossy (Fig. 36) .... ***Zolotarevskyella rhytidera***

– Head and pronotum with microsculptures (Figs. 14, 15); elytra broadened posteriorly (Figs 25–28, 33–35), apex of elytra obliquely or transversely truncated **8**

8 Mentum with medium tooth (Fig. 10); pubescence of antennae starts from antennomeres IV (Fig. 3); apex of elytra obliquely truncate; base of pronotum lobate in the middle (Fig. 14, 15, 28) ..... ***Metadromius***, **9**

– Mentum without median tooth (Fig. 9); pubescence of antennae starts from antennomeres II (Fig. 4); apex of elytra transversely truncate; base of pronotum straight in the middle ..... ***Pseudomesolestes***, **11**

9 Male with 4 setae at apical margin of last abdominal sternum; head and pronotum densely and coarsely punctate with isodiametric mesh pattern (Figs. 7, 15); apical lamina of aedeagus broadly ended (Fig. 41)..... ***Metadromius brittoni***

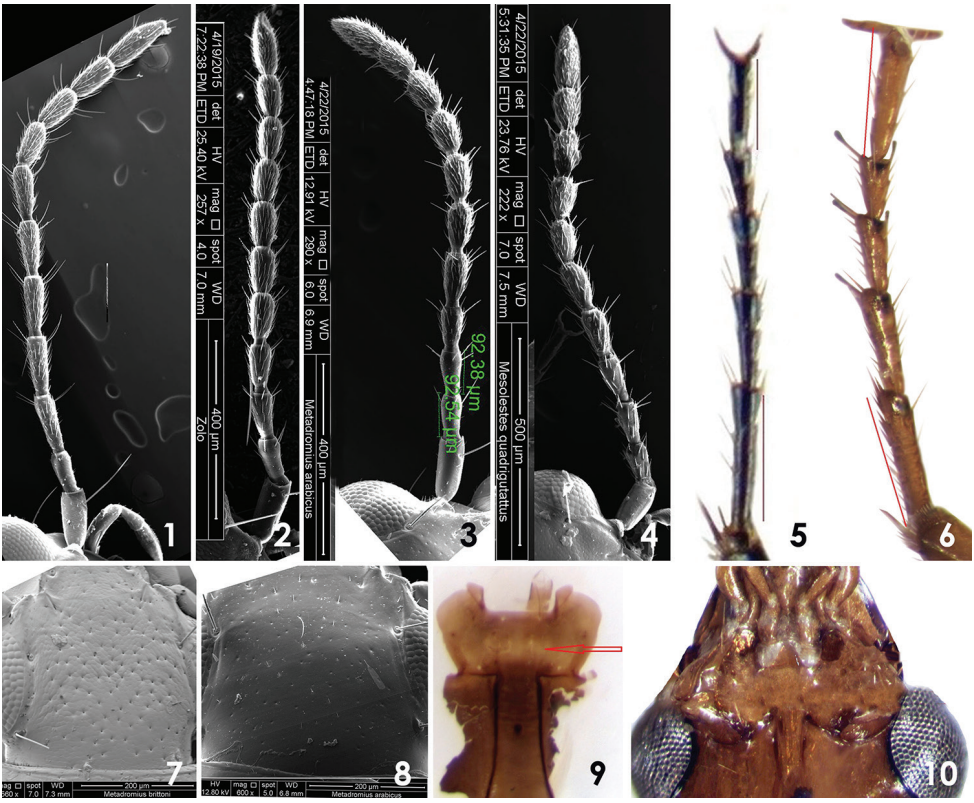
– Male with 2 setae at apical margin of last sternum; head and pronotum finely and sparsely punctate, pronotum and elytra without isodiametric mesh pattern (Figs. 8, 14); apical lamina of aedeagus elongate and narrowed (Figs. 40) **10**

10 Pronotum testaceous; head without microsculptures; elytra with sparse pubescence, disc of elytra with transverse dark brown pattern (Figs. 25, 26) .... ***Metadromius arabicus***

– Pronotum dark brown; head with microsculptures; elytra with dense and short pubescence, disc of elytra with round dark brown pattern (Fig. 28) .... ***Metadromius* spec.**

11 Head, pronotum and elytra with granulated microsculptures; pronotum with few wrinkles along the medial impression (Fig. 19); femora, maxillary and labial palpi dark brown; apical lamina of aedeagus short. (Fig. 45) .... ***Pseudomesolestes brittoni***

– Head, pronotum and elytra with isodiametric mesh pattern; pronotum without wrinkles along the medial impression (Fig. 20); femora, maxillary and labial palpi pale testaceous; apical lamina of aedeagus elongate (Fig. 46) .... ***Pseudomesolestes quadriguttatus***



Figures 1–10. Different characters used in key: 1, 5 Antennae and legs of *Microlestes discoidalis* (Fairmaire, 1892) **2** Antennae of *Zolotarevskyella rhytidera* (Chaudoir, 1876) **3, 8, 10** Antennae, dorsal view of head and mentum of *Metadromius arabicus* Mateu, 1979 **4, 9** Antennae and mentum of *Pseudomesolestes quadriguttatus* Mateu, 1979 **6** Leg of *Dromius saudiarabicus* sp. n. **7** Dorsal view of head of *Metadromius brittoni* (Basilewsky, 1948).

Calodromius Reitter, 1905

Type species. *Carabus quadrinotatus* Panzer, 1799 (= *Carabus spilotus* Illiger, 1798).

Calodromius is poor in species among the subtribe Dromiusina, with only eight species in the world (Anichtchenko 2017), seven species of which are from the Palae-

arctic realm (Kabak 2003). The genus *Calodromius* can be identified among its related genera by combination of characters: antennomeres II shorter than III; pubescence starts from antennomeres IV; base of pronotum weakly incised towards hind angles; elytra broadened posteriorly; tarsomeres I of hind legs as long as last. *Calodromius mayeti* (Bedel 1907) is the only representative of the genus from Arabian Peninsula, recorded from Madina, Saudi Arabia (Mateu 1986).

***Calodromius mayeti* (Bedel, 1907)**
Figures 11, 22, 37, 49

Dromius mayeti Bedel, 1907: 272.

Type locality. Tunisia.

Type depository. Holotype male in MNHN: Paratype in NHMB

Material examined. Total 21 specimens: 1♀ "[yellow label]" / "Saudi Arabia, W. Buttiker" / Butayn, 21.IV.1981"/ "*Philorhizus mayeti*, J. Mateu det. 1983". **[NHMB]**. Al Baha: 1♀, "KSA, Al Makhwa, Shada Al Aala, 19°52.598'N 41°18.672'E Alt. 892 m, 26.I.2015, (HP on light), I. Rasool". 2♂, "16.II.2014, (LT), M.S. Abdel-Dayem & I. Rasool". 1♂, 2♀, "19°51.066'N 41°18.037'E Alt. 1325 m, 02.III.2015, (LT)., 1♀, "19°51.066'N 41°18.037'E Alt. 1325 m, 17.X.2014, (LT)., 1♀, "19°50.710'N 41°18.267'E Alt. 1474 m, (LT), H. Al Dhafer, M.S. Abdel-Dayem, H. H. Fadl & I. Rasool". 1♂, 2♀, "19°52.717'N 41°18.712'E Alt. 825 m, 15.XI.2015, (LT)., 1♂, 1♀, "13.XI.2015, (LT)., 2♀, " 19°52.598'N 41°18.672'E Alt. 892 m, 13.XI.2015, (LT)., 1♂, 1♀, "19°51.762'N 41°18.089'E Alt. 1225, 12.XI.2015, (LT)., 1♀, "19°52.685'N 41°18.663'E Alt. 851 m, 15.XI.2015, (LT)., 1♂, "19°51.066'N 41°18.037'E Alt. 1325 m, 14.XI.2015, (LT), H. Al Dhafer, M.S. Abdel-Dayem, H. H. Fadl,A. Elgarbawy, El Turkey and Soliman, A." Asir: 1♂, "Asir, Abha, Rayda, 18°12.315'N 42°24.607'E Alt. 2578 m, 18.XI.2015, (LT), H. Al Dhafer, M.S. Abdel-Dayem, H. H. Fadl, A. Elgarbawy, El Turkey and Soliman" **[KSMA].**

Description. Body form (Fig. 22), small species 3.60–3.90 mm. *Color*: Dorsum and ventrum of pronotum and abdomen, epipleurae, antennae, mouthparts and legs testaceous; head slightly darker than others; elytra pale testaceous with transverse black band in the middle, not reaching to the lateral margins, black band prolonged to the base along the suture, shortly extended towards the apex. *Microsculpture*: head, labrum, pronotum and elytra with isodiametric mesh pattern; sternite with transverse microlines. *Head*: almost as long as wide, HL 0.72–0.82 mm and HW 0.70–0.79 mm (Fig. 11). *Pronotum*: transverse, wider than long, PW 0.71–0.78 mm, and PL 0.56–0.64; sinuate posteriorly, base almost straight with acute angles (Fig. 11). *Elytra*: broadened posteriorly, EL 1.87–2.06 mm and EW 1.42–1.49 mm; apical margins transversely truncate; striae and intervals finely punctuate, provided with short brown pubescence. Claws smooth. *Abdomen*: All visible sternite with short pubescence, apical margin of last sternum rounded and 4–setose in both sexes. *Aedeagus*: Small and thick aedeagus (Fig. 37), 0.78 mm; basal side of aedeagus narrowed; very broad and depressed at apical lamina; apical end short and with tooth like tip.

Ecological notes. This species was collected in the natural habitat of mountains and valleys covered with variety of vegetation, sand, and stones. Species was distributed in elevation ranging from 892–1611 m (Fig. 49). Adult beetles were attracted to UV–light. In winters this species appears in low elevation while in summers it appears in high elevation.

Geographical distribution. This species is recorded from Iran, Libya, Morocco, Saudi Arabia, Tunisia, UAE (Kabak 2003, 2017, Felix 2009). In current study it is collected from Al Baha and Asir regions of Saudi Arabia. It is a Mediterranean species that exemplifies Mediterranean-Sindian chorotype.

Dromius Bonelli, 1810

Type species. *Carabus quadrimaculatus* Linné, 1758.

The genus *Dromius* is type genus of subtribe Dromiusina, representing 105 species in the world (Lorenz 2005) distributed in four subgenera (Anichtchenko 2017). These species are distributed in almost all zoogeographical regions, Nearctic, Neotropical, Australian, Oriental, Afrotropical, and Palaearctic regions. In the Palaearctic it is represented by 53 species (Bousquet 2012). This genus can be differentiated from other genera in the subtribe Dromiusina by elongate and parallel sided elytra; head small and with constricted neck; labrum semirounded, mentum without tooth; antennae long and cylindrical, pubescence starts from antennomeres IV; base of pronotum straightly truncate, and pronotum sometimes slightly sinuate posteriorly; tarsomeres I–III dilated in fore legs, basal tarsomere of hind legs as long as last, claws dentate; elytra usually with pale macula, apical margins of elytra obliquely truncate (Lindroth 1974, Bousquet 2010). Only *D. buettikeri* Mateu, 1990 is described from Saudi Arabia and *D. (Dromius) saudiarabicus* sp. n. is described in the present work from Asir Province.

Dromius saudiarabicus, Rasool, Abdel-Dayem & Felix, sp. n.

http://zoobank.org/47D2FBB7-38D4-4199-8A8E-09A2777F0552
Figures 6, 12, 23, 38, 48, 50

Type material. 23 specimens: HOLOTYPE, male in KSMA, point-mounted, labeled: "KSA, Asir, Abha, Rayda, 18°11.695'N 42°23.818'E Alt. 1897 m, 21.X.2014, (LT), H. Al Dhafer, M.S. Abdel-Dayem, H.H. Fadl, A. El Turkey & A. Elgarbawy" / "Holotype [red label] *Dromius saudiarabicus* sp. n." [printed label]. Paratypes: Total 22 specimens, sex and label data as follows. "4♀, same as holotype". 1♀, same as holotype except, 18.XI.2015, H. Al Dhafer, M.S. Abdel-Dayem, H.H. Fadl, A. El Turkey, A. Elgarbawy & Soliman, A". 1♂, 1♀, same as holotype except, "18°12.315'N 42°24.607'E Alt. 2761 m, 30.II.2014., "1♀, same as holotype except "18°11.766'N 42°24.315'E Alt. 2285 m, 20.X.2014., 2♀, same as holotype except "18°11.884'N 42°24.435'E Alt. 2387 m, 20.X.2014., 1♂, 1♀, same as holotype except "18°12.315'N 42°24.607'E

Alt. 2761 m, 20.X.2014., 2♂, same as holotype except "18°12.095'N 42°24.536'E Alt. 2578 m, 20.X.2014., 1♂, 1♀ same as holotype except, "18°12.095'N 42°24.536'E Alt. 2578 m, 18.XI.2015, H. Al Dhafer, M.S. Abdel-Dayem, H.H. Fadl, A. El Turkey, A. Elgarbawy & Soliman, A". 2♂, 2♀ same as holotype except, "18°11.766'N 42°24.315'E Alt. 2285 m, 18.XI.2015, H. Al Dhafer, M.S. Abdel-Dayem, H.H. Fadl, A. El Turkey, A. Elgarbawy & Soliman, A" **[KSMA]**. 1♀ same as holotype except, "18°12.315'N 42°24.607'E Alt. 2761 m, 20. X.2014., 1♂, same as holotype except, "18°11.884'N 42°24.435'E Alt. 2387 m, 20.X.2014" **[RMNH]**. All paratypes with second label reading "Paratype *Dromius saudiarabicus* sp. n." [yellow label]

Type locality. Rayda Nature Reserve (18°12'N, 42°24'E), 20 km northwest the city of Abha, Asir Province, southwestern Saudi Arabia.

Specific epithet. The specific epithet is a Latinized adjective in the masculine form based on country Saudi Arabia, from which the new species is described.

Diagnosis. Adults of *Dromius saudiarabicus* sp. n. have all the features of other members of subgenus *Dromius* Bonelli, 1810 and can be distinguished from them by the following combination of external features: dorsum of head and pronotum rufous to rufo-testaceous, Elytra dark brown, with testaceous maculae, antennae, mandibles, palpi, and legs; head without microlines, but with mesh pattern isodiametric on the vertex, frons smooth; head longer than wide; tempora long with strongly constricted neck; pronotum not strongly transverse, narrowed and sinuate posteriorly before angles.

Description. *Habitus*: Body form (Fig. 21) elongate subparallel sized species, TBL Holotype 6.90 mm, male 6.80–7.30 mm, female 7.00–8.00 mm. *Color*: Dorsum of head and pronotum rufous to rufo–testaceous; antennae, mandibles, palpi and legs testaceous. Elytra dark brown, with testaceous macula suture below scutellum with different expending range, but never reaching middle or lateral border of elytra; epipleurae testaceous anteriorly and dark brown posteriorly; ventrum of thorax testaceous, abdominal sternites dark brown laterally and testaceous medially, sometimes sternites III–V completely dark brown. *Microsculpture*: Head without microlines, but with mesh pattern isodiametric on the vertex, frons smooth; pronotum with distinct transverse wrinkles medially along the median longitudinal impression, smooth laterally; elytra with mesh pattern isodiametric, microlines absent; thoracic ventrum smooth; abdomen with microlines. *Luster*: Head, pronotum and ventrum glossy, elytra moderately dull. *Head*: Small and obtuse (Fig. 12), Holotype HL 1.36 mm and HW 1.16 mm; tempora long with strongly constricted neck; surface smooth with two pairs of supraorbital setae; clypeus smooth, larger than labrum, with a pair of setae; labrum almost as long as wide, rounded laterally, with anterior margins slightly convex; last segments of maxillary and labial palpi pointed; mentum without median tooth; antennae long filiform, extending beyond base of pronotum by three antennomeres; antennomeres I, III and IV equal in length and longer than the rest; antennomeres II shortest; antennomeres V–IX subequal; pubescence starts from antennomere IV. *Pronotum*: more or less transverse, (Fig. 12) Holotype PL 1.05 mm and PW 1.24 mm; median longitudinal impression deep; narrowed posteriorly, slightly sinuate before basal angles; provided with two pairs of lateral setae; anterior margins of pronotum concave

with rounded angles and basal margins straight with almost right angles. *Elytra*: subparallel sided, Holotype WL 4.10 mm and EW 2.50 mm, broadened in the posterior third; humeri broadly rounded; striae clear; apices of elytra slightly obliquely truncate; epipleurae ends before apical angles of elytra. *Legs*: Long and slender; protarsomeres I–III dilated in male; tarsomeres I shorter than V in fore legs, tarsomeres I as long as V in median and hind legs; claws with 2–3 tooth in the middle. *Abdomen*: abdominal sternite smooth, laterally pubescent; suture between III and IV sternite not complete; margins of last two sternite with lateral setae, last sternum emarginated medially in males and rounded in females; males and females with 8 anal setiferous punctures at the apical margin of the last sternum, 4 inner setiferous punctures shorter than outer in females. *Aedeagus*: Shape of aedeagus (Fig. 38), AL of Holotype 1.50 mm; in lateral view it is narrowed at both ends, broad in the middle, curved dorsally; apical lamina long, narrowed and depressed, rounded apically; basal side rounded and cylindrical.

Affinities. Externally, *Dromius saudiarabicus* sp. n. is similar to *D. buettikeri* Mateu, 1990 and *D. meridionalis* Dejean, 1825, but it can be differentiated from both species by its dull surface, constricted neck, and shape and internal sac of aedeagus. It can also be separated from *D. buettikeri* by its comparatively less transverse pronotum, sinuate lateral margin of pronotum and tempora long. It is also separated from *D. meridionalis* by its slightly sinuate lateral margin of pronotum and absence of two ridges near eyes.

Ecological notes. This species was collected at elevation of 1897–2761 m (Fig. 50) in Rayda Nature Reserve. Fully winged beetles were collected by UV–light traps from steep slopes covered in woodlands dominated by juniper *Juniperus procera* Hochst. Ex Endl. (Cupressaceae) (Fig. 48) and wild olive trees, *Oleae europaea cuspidata* (Wall. ex G. Don) Cif. (Oleaceae). Adults are collected only during October.

Geographical distribution. This species is only known from the type locality in the Rayda Nature Reserve, Abha, on the southwestern edge of Al Souda Mountain, in the Asir Highlands of the southwestern of Saudi Arabia (Fig. 50).

***Dromius buettikeri* Mateu, 1990: 40**
Figures 13, 24, 39, 50

Dromius buettikeri Mateu, 1990: 40.

Type locality. Saudi Arabia, Makkah, Harithi.

Type depository. Holotype male and paratypes one male and one female in NHMB.

Material examined. Total 22 specimens: Al Baha: 1♀, "KSA, Al Baha, Al Makhwa, Shada Al Aala, 19°50.710'N E41°18.267'E Alt. 1474 m, 27.I.2014, (LT)., 1♀, "19°50.575'N 41°18.691'E Alt. 1666 m, 27.I.2015, (LT)., 1♀, "19°50.411'N 41°18.686'E Alt. 1611 m, 27.I.2015, (LT)., 1♂, "19°50.329'N 41°18.604'E Alt. 1563 m, 27.I.2015, (LT)., 1♀, "19°51.066'N 41°18.037'E Alt. 1325 m, (LT)., 1♂, 1♀,

"19°50.710'N 41°18.267'E Alt. 1474 m, 15.II.2014, (LT), H. Al Dhafer, M.S. Abdel-Dayem, H. H. Fadl, A. El Turkey, A. Elgarbaway & I. Rasool". 1♂, "19°52.717'N 41°18.712'E Alt. 825 m, 15.XI.2015, (LT)., 1♀, "13.XI.2015, (LT)., 1♀, "19°52.685'N 41°18.663'E Alt. 851 m, 15.XI.2015, (LT)., 1♂, 1♀, "19°52.598'N 41°18.672'E Alt. 892 m, 12.XI.2015, (LT)., 1♀, "19°51.066'N 41°18.037'E Alt. 1325 m, 15.XI.2015, (LT)., 1♂, 2♀, "14.XI.2015, (LT)., 1♂, "19°50.710'N 41°18.267'E Alt. 1474 m, 14.XI.2015, (LT), H. Al Dhafer, M.S. Abdel-Dayem, H. H. Fadl, A. El Turkey, A. Elgarbaway & Soliman, A". 1♂, "19°50.710'N 41°18.267'E Alt. 1474 m, 08.XII.2014, (LT), H. Al Dhafer, M.S. Abdel-Dayem, H.H. Fadl, A. El Turkey, A. Elgarbaway & I. Rasool". Asir: 1♀, "KSA, Abha, Wadi Rayda, 18°11.749'N 42°23.345'E Alt. 1614 m, 24.II.2014, (LT), I. Rasool." 1♂, "17.XI.2015, (LT)., 1♀, "18°11.749'N 42°23.345'E Alt. 1614 m, 11.XII.2014, (LT)., 1♂, "18°11.679'N 42°23.691'E Alt. 1851 m, 11.XII.2014, (LT), H. Al Dhafer, M.S. Abdel-Dayem, H.H. Fadl, A. El Turkey, A. Elgarbaway & I. Rasool" **[KSMA].** 1♂, "KSA, Abha, Wadi Rayda, 18°11.749'N 42°23.345'E Alt. 1614 m, 24.II.2014, (LT), I. Rasool" **[RMNH].**

Description. Elongate and parallel sized species (Fig. 24), 5.50–6.30 mm. *Color*: Head, pronotum and basal four sternite light brown in the middle; mouth parts, antennae, legs, anterior 3/4 of epipleurae testaceous; humeri with pale or testaceous macula may extend to middle of elytra; rest of elytra, apical fourth of epipleurae and lateral boarders of elytra, last two abdominal sternite dark brown. *Microsculpture*: Head, pronotum, elytra with isodiametric mesh pattern; abdomen with depressed microlines. *Head*: Wider than long, HL 0.92–1.06 mm, HW 1.05–1.12 mm, narrower than pronotum; tempora short and curved (Fig 13). *Pronotum*: Broad, transverse, PL 0.99–0.92 mm, PW 1.23–1.34 mm, lateral margins almost straight, basal angles right with straight base (Fig. 13). *Elytra*: Elongate and parallel sized, WL 3.25–3.75 mm, EW 1.87–2.12 mm. Claws with 2–3 teeth in the middle. *Abdomen*: last two sternite with 8 setiferous setae in females and 4 in males; lateral margins with fine scattered pubescence. *Aedeagus:* narrowed at both ends, AL 1.09 mm. In lateral view, it is incised in the middle from ventral sides and hump like from dorsal sides, broad in the middle. Tip of apical lamina short and rounded, weakly incised near dorsal margin of apical lamella (Fig. 39).

Ecological notes. Adult beetles were collected by UV–light from elevation ranges from 1474–1851 m on steep sloop mountains (Fig. 50), characterized by surface vegetation, stones, gravels and small shrubs and trees, this species was collected in December to February in winter season.

Geographical distribution. Endemic to the Saudi Arabia and only found in nature reserve of Rayda mountains in Abha, Asir (Mateu 1990, Kabak 2017).

Metadromius Bedel, 1907

Type species. *Dromius myrmidon* Fairmaire, 1859

Metadromius is a complex genus that comprises about 30 species that are distributed in Afrotropical and Palaearctic regions (Anichtchenko 2017). A revision

of the genus in the Middle East is in preparation, with some new species. Fifteen species inhabit Palaearctic region, three are mentioned from within the territories of Arabian Peninsula (Mateu 1979, Kabak 2003, 2017 Anichtchenko 2017). The genus can be differentiated from other genera in the subtribe Dromiusina by: small body size range from 2–3 mm; mentum with median tooth; antennae stout, antennomere II as long as III, pubescence starts from antennomere IV; anterior margin of labrum slightly rounded; pronotum transverse, base of pronotum weakly incised, sinuate posteriorly with sharp angles; apex of elytra obliquely truncate; tarsomeres I longer than V in hind legs, claws dentate. In Saudi Arabia, *M. arabicus* Mateu, 1979; *M. ephippiatus* Fairmaire, 1884; and *M. brittoni* Basilewsky, 1948 are mentioned up to now (Mateu 1979, 1986, Kabak 2003). However, the record of *M. ephippiatus* is a doubtful one. Its occurrence is based on a probably false identification by Mateu (1979).

***Metadromius arabicus* Mateu, 1979**
Figures 3, 8, 10, 14

Metadromius arabicus Mateu, 1979: 151.

Type locality. Saudi Arabia, Riyadh, Wadi Mazbil.

Type depository. Holotype male in NHMB.

Material examined. Holotype. Total 654 specimens: Male labeled "HOLOTYPE [red label]" / "Saudi Arabien, W. Büttiker" / "Wadi Mizbil, 13.4.1977" / "*Metadromius arabicus* n.sp. J. Mateu det. 1977". [**NHMB**] (Fig. 26). Al Baha: 1♂, "KSA, Al Makhwa, Shada Al Aala, 19°50.411'N 41°18.686'E Alt. 1611 m, 27.I.2015, (LT)., 1♀, "19°51.066'N 41°18.037'E Alt. 1325 m, 27.I.2015, (LT)., 1♂, 2♀, "19°50.710'N 41°18.267'E Alt. 1474 m, 15.II.2014, (LT)., 3♂, 5♀, "19°50.575'N 41°18.691'E Alt. 1666 m, 02.III.2015, (LT)., 1♂, "19°51.066'N 41°18.037'E Alt.1325 m, 02.III.2015, (LT)., 1♂, 1♀, "19°51.762'N 41°18.089'E Alt. 1225 m, 02.III.2015, (LT), H. Al Dhafer, M.S. Abdel-Dayem, H. H. Fadl, A. El Turkey, A. Elgarbway & I. Rasool". 1♀, "KSA, Al Baha, Wadi Turaba, 20°14.369'N 41°15.234'E Alt. 1757 m, 9.III.2012, (LT), M.S. Abdel-Dayem". 51♂, 71♀ "19°50.329'N 41°18.604'E Alt. 1563 m, 02.IX.2015, (LT)., 2♂, ♀, "19°51.066'N 41°18.037'E Alt. 1325 m, 02.IX.2015, (LT)., 14♂, 22♀, "19°50.575'N 41°18.691'E Alt. 1666 m, 02.IX.2015, (LT)., 37♂, 51♀, "19°50.710'N 41°18.267'E Alt. 1474 m, 02.IX.2015, (LT)., 2♀, "19°51.762'N 41°18.089'E Alt. 1225 m, 02.IX.2015, (LT)., 88♂, 96♀, "19°50.411'N 41°18.686'E Alt. 1611 m, 02.IX.2015, (LT)., Al Dafer H., M.S. Abdel Dayem., H. H. Fadl., El Gharbawy., El Turkey & Soliman, A". 3♂, 6♀, "19°50.329'N 41°18.604'E Alt. 1563 m, 17.X.2014, (LT)., 1♂, 2♀, "19°51.762'N 41°18.089'E Alt. 1225 m, 17.X.2014, (LT)., 3♂, 2♀, "19°50.710N' 41°18.267'E Alt. 1474 m, 17.X.2014, (LT)., 1♂, 1♀, "19°51.066'N 41°18.037'E Alt. 1325 m, 17.X.2014, (LT)., 4♂, 2♀, "19°50.411'N 41°18.686'E Alt. 1611 m, 17.X.2014, (LT), H. Al Dhafer, M.S. Abdel-

Dayem, H. H. Fadl, A. El Turkey, A. Elgarbway & I. Rasool". 1♀, "19°52.598'N 41°18.672'E Alt. 892 m, 17. X.2014, (LT)., 1♀, "19°50.391'N 41°18.634'E Alt. 1562 m, 03.XI.2013, (HP), I. Rasool". 1♂, "19°52.685'N 41°18.663'E Alt. 851 m, 14.XI.2015, (LT)., 2♂, 2♀, "15.XI.2015, (LT)., 2♀, "19°50.329'N 41°18.604'E Alt. 1563 m, 18.XI.2015, (LT)., 1♂, 1♀, "19°52.598'N 41°18.672'E Alt. 892 m, 15.XI.2015, (LT)., 3♂, 5♀, "19°51.066'N 41°18.037'E Alt. 1325 m, 14.XI.2015, (LT)., 2♂, "19°50.329'N 41°18.604'E Alt. 1563 m, 14.XI.2015, (LT)., 5♂, 3♀, "19°52.717'N 41°18.712'E Alt. 825 m, 15.XI.2015, (LT)., 2♂, 4♀, "13.XI.2015, (LT), Al Dafer H., M.S. Abdel Dayem., H. H. Fadl., El Gharbawy., El Turkey & Soliman, A". 1♀, "KSA, Wadi Saad Dam, 20°07.605'N 41°21.459'E (HP), I. Rasool". Asir: 4♀, **"**KSA, Abha, Rayda, 18°11.749'N 42°23.345'E Alt.1614 m, 21.II.2014, (LT)., 2♂, 4♀, "18°11.679'N 42°23.691'E Alt. 1851 m, 21.II.2014, (LT)., 5♂, 5♀, "18°11.618'N 42°23.42'E Alt. 1772 m, 21.II.2014, (LT), H. Al Dhafer, M.S. Abdel-Dayem, H. H. Fadl, A. El Turkey, A. Elgarbway & I. Rasool". 1♂, 2♀, "Wadi Maraba, 18°19.79'N 42°40.952'E Alt. 1467 m, 23.II.2014, (HP), Rasool, I". 3♂, 7♀, "Wadi Rayda, 18°11.749'N 42°23.345'E Alt.1614 m, 24.II.2014, (LT), Rasool, I". 6♂, 9♀, "18°11.749'N 42°23.345'E Alt. 1614 m, 24.III.2014, (LT), S. Soonbati". 1♂, 1♀, "18°11.884'N 42°24.435'E Alt. 2387 m, 04.III.2015, (LT)., 1♀, "18°11.766'N 42°24.315'E Alt. 2285 m, 04.III.2015, (LT)., 2♂, "18°11.695'N 42°23.818'E Alt. 1897 m, 04.III.2015, (LT)., 5♂, 7♀, "18°11.679'N 18°11.679'E Alt. 1851 m, 04.2015, (LT)., 3♂, 1♀, "18°11.618'N 42°23.42'E Alt. 1772 m, 04.III.2015, (LT), Al Dafer H., M.S. Abdel Dayem., H. H. Fadl., El Gharbawy., El Turkey & Soliman, A". 1♂, 2♀, "18°11.695'N 42°23.818'E Alt. 1897 m, 26.IV.2014, (LT)., 1♂, "18°11.679'N 42°23.691'E Alt. 1851 m, 06.VI.2014, (LT)., 3♂, 6♀, "18°11.618'N 42°23.42'E Alt. 1772 m, 26.VIII.2014, (LT)., 1♀, "18°11.695'N 42°23.818'E Alt. 1897 m, 26.VIII.2014, (LT)., 3♀, "18°11.618'N 42°23.42'E Alt. 1772 m, 20.X.2014, (LT)., 1♂, 1♀, "18°11.679'N 18°11.679'E Alt. 1851 m, (LT)., 2♂, "18°11.749'N 42°23.345'E Alt. 1614 m, (LT)., 1♂, 3♀, "18°11.695'N 42°23.818'E Alt. 1897 m, (LT)., 2♂, 1♀, "18°11.766'N 42°24.315'E Alt. 2285 m, (LT)., 4♂, 2♀, "18°11.884'N 42°24.435'E Alt. 2387 m, (LT), H. Al Dhafer, M.S. Abdel-Dayem, H. H. Fadl, A. El Turkey, A. Elgarbway & I. Rasool". 1♂, "Al Magardah, Wadi Yabah, 19°14.911'N 41°47.255'E Alt. 402 m, 11. X.2013, (HP), I. Rasool, M. Al Harbi, S. Soonbati & S. Khan". 1♀, "18°11.749'N 42°23.345'E Alt. 1614 m, 17.XI.2015, (LT)., 1♂, "17. XI.2015, (HP)., 1♀, "18°12.315'N 42°24.607'E Alt. 2578 m, 18.XI.2015, (LT)., 1♂, 3♀, "18°11.679'N 18°11.679'E Alt. 1851, 18.XI.2015, (LT)., 2♂, 2♀, "18°11.618'N 42°23.42'E Alt. 1772 m, 18.XI.2015, (LT)., 1♂, "18°11.884'N 42°24.435'E Alt. 2387 m, 18.XI.2015, (LT)., 1♂, 1♀, "18°11.695'N 42°23.818'E Alt. 1897 m, 18.XI.2015, (LT), Al Dafer H., M.S. Abdel Dayem., H. H. Fadl., El Gharbawy., El Turkey & Soliman, A". 1♂, "18°11.766'N 42°24.315'E Alt. 2285 m, 12.XII.2014, (LT)., 2♂, "18°11.695'N 42°23.818'E Alt. 1897 m, (LT)., 1♂, 3♀, "18°11.679'N 18°11.679'E Alt. 1851 m, (LT)". 1♂, 2♀, "18°11.749'N 42°23.345'E Alt. 1614 m, (LT)., 1♀, "18°11.618'N 42°23.42'E Alt. 1772 m, (LT), H. Al Dhafer, M.S. Abdel-Dayem, H. H. Fadl, A. El Turkey, A. Elgarbway & I. Rasool" **[KSMA].**

Description. Small beetles (Fig. 25) TBL 2.43–3.00 mm. *Color*: Frons and vertex dark brown or rufo-testaceous; neck, mouthparts, antennae, pronotum, elytra, epipleurae and legs testaceous; antennae, mouthparts and legs sometimes pale testaceous; abdomen pale testaceous; elytra with dark brown transverse band at middle, not reaching to lateral margin and apex, prolonged along suture to the base of elytra. *Microsculpture*: Labrum with isodiametric transverse pattern; head without microsculpture; last sternum of abdomen sometimes with depressed microlines. *Head*: as long as wide HL 0.52–0.66 mm and HW 0.56–0.63 mm, narrower than pronotum; dorsum finely and sparsely punctuated (Fig. 14). *Pronotum*: Transverse, PW 0.61–0.66 mm PL 0.42–0.49 mm, narrowed posteriorly with sharp basal angles, base incised near the angles (Fig. 14); dorsum finely punctuated. *Elytra*: Subparallel, EL 1.42–1.73 mm, EW 0.99–1.20 mm; widest behind the middle; apex obliquely truncate. Claws weakly dentate. *Abdomen*: All sternites smooth, except last sternum with short and fine pubescence; apical margins of last sternum rounded and tetra–setose in females, slightly incised in middle and bi–setose in males. *Aedeagus*: Elongate (Fig. 40), AL 0.53 mm; in lateral view it is curved dorsally, narrowed at both ends, thick and broad before apical lamina; apical lamina elongate, rounded at the end; endophallus armature almost rounded

Affinities. This species is very close to *Metadromius* spec. (see below) in general appearance, body form, shape of head, pronotum, and elytra, but can be easily distinguished by its testaceous pronotum, smooth head, transverse band on elytra, and short apical lamina of aedeagus, with an elongate endophallus armature.

Ecological notes. It is collected from low lands to high lands in diverse habitats within 402–2387 m range of altitude (Fig. 51). It is found under stones among vegetation and in sandy ranges, which are influenced by rain water. The species was collected during all months of the year except July.

Geographical distribution. This species is described from Saudi Arabia (Mateu 1979) and distributed in southwest Saudi Arabia, also reported from Iran and United Arab Emirates (Felix 2009, Kabak 2017). It is W–Palaearctic element that exemplifies SW–Asiatic chorotype.

***Metadromius brittoni* (Basilewsky, 1948)**
Figures 7, 15, 27, 41, 51

Philorhizus brittoni Basilewsky, 1948: 129.

Type locality. Yemen, Dahla

Type depository. Holotype in BMNH

Material examined. Total 1,362 specimens: Al Baha: 1♂, "KSA, Al Makhwa, Shada Al Aala, 19°51.762'N 41°18.089'E Alt. 1225 m, 27. I.2015, (LT)., 1♀, "19°52.598'N 41°18.672'E Alt. 892 m, 16.II.2014, (LT), M.S. Abdel-Dayem & I. Rasool". 1♂, 1♀, "19°50.329N' 41°18.604'E Alt. 1563 m, 21.IV.2014, (LT)., 2♂, 3♀, "19°51.066'N 41°18.037'E Alt. 1325 m, 21.IV.2014, (LT)., 17♂, 9♀,

"19°51.762'N 41°18.089'E Alt. 1225 m, 21.IV.2014, (LT)., 1♀, "19°50.710'N 41°18.267'E Alt. 1474 m, 21.IV.2014, (LT)., 12♂, 8♀ "19°52.598'N 41°18.672'E Alt. 892 m, 23.IV.2014, (LT)., 21♂, 16♀, "19°51.762'N 41°18.089'E Alt. 1225 m, 03.VI.2014, (LT)., 8♂, 5♀, "19°51.762'N 41°18.089'E Alt. 1225 m, 23.VIII.2014, (LT)., 13♂, 9♀, 19°51.066'N 41°18.037'E Alt. 1325 m, 23.VIII.2014, (LT)., 1♂, 19°50.710'N 41°18.267'E Alt. 1474 m, 23.VIII.2014, (LT)., 1♂,, "19°50.411'N 41°18.686'E Alt. 1611 m 23.VIII.2014, (Sucking), H. Al Dhafer, M.S. Abdel-Dayem, H. H. Fadl, A. El Turkey, A. Elgrbaway & I. Rasool". 2♂, 4♀, "19°51.066'N 41°18.037'E Alt. 1325 m, 16.X.2014, (LT), I. Rasool". 24♂, 14♀, "19°52.598'N 41°18.672'E Alt. 892 m 17.X.2014, (LT), I. Rasool & M. Al Harbi". 3♀, "19°51.762'N 41°18.089'E Alt. 1225 m, 17. X.2014, (LT)., 1♀, "19°51.762'N 41°18.089'E Alt. 1225 m, 18. X.2014, (PT)., 2♂, 5♀, "19°51.066'N 41°18.037'E Alt. 1325 m, 17. X.2014, (LT)., 1♂, "19°50.710'N 41°18.267'E Alt. 1474 m, (LT)., "19°50.411'N 41°18.686'E Alt. 1611 m, (LT)., 1♀, "19°50.411'N 41°18.686'E Alt. 1611 m, 18. X.2014, (PT)., 1♂, "19°50.391'N 41°18.634'E Alt. 1562 m, 03.XI.2013, (HP), I. Rasool". 1♀, "Wadi Neera, 19°44.870'N 41°20.008'E Alt. 471 m, 10.XII.2014, (LT), H. Al Dhafer, M.S. Abdel-Dayem, H. H. Fadl, A. El Turkey, A. Elgarbway & I. Rasool". 1♀, "Al Mandaq, Wadi Turbah, 20°12.937'N 41°17.176'E Alt. 1793 m, 10.V.2011, (HP), M.R. Sharaf". 4♂, 2♀, Wadi Saad, 20°07.605'N 41°21.459'E 17.X.2014, (HP), I. Rasool". Asir: 2♂, 2♀, "KSA, Abha, Wadi Maraba, 18°19.79'N 42°40.952'E Alt. 1467 m, 23.II.2014, (HP)., 1♂, "Wadi Rida, 18°11.749'N 42°23.345'E Alt. 1614 m, 24.II.2014, (LT), I. Rasool". 6♂, 21♀, "Wadi Rida, 18°11.749'N 42°23.345'E Alt. 1614 m, 24.III.2014, (LT), S. A. El-Sonbati". 2♂, "Rayda, 18°11.766'N 42°24.315'E Alt. 2285 m, 26.IV.2014, (LT)., 26♂, 28♀, "18°11.749'N 42°23.345'E Alt. 1614 m, 26.IV.2014, (LT)., 1♀, "18°11.679'N 18°11.679'E Alt. 1851 m, (LT)., 1♂, 2♀, "18°11.695'N 42°23.818'E Alt. 1897 m, 26.IV.2014, (LT)., 1♀, "18°11.618'N 42°23.42'E Alt. 1772 m, 26.VIII.2014, (LT)., 1♂, 2♀, "18°11.749'N 42°23.345'E Alt.1614 m, 20.X.2014, (LT)., 1♂, "18°11.679'N 42°23.691'E Alt. 1851 m, 06.VI.2014, (LT), H. Al Dhafer, M.S. Abdel-Dayem, H. H. Fadl, A. El Turkey, A. Elgarbway & I. Rasool". 509♂ 455♀, "Al Hubail, Wadi Reem, 18°06.981'N 42°13.939'E Alt. 451 m, 20.X.2014, (LT), I. Rasool & M. Al Harbi". 20♂, 14♀, "Al Magardha, Wadi Yabah, 19°14.911'N 41°47.255'E Alt. 402 m, 11. X.2013, (LT), I. Rasool, M. Al Harbi, S. Soonbati & S. Khan". 5♂, 3♀, "Rayda 18°11.766'N 42°24.315'E Alt. 2285 m, 11.XII.2014, (LT), H. Al Dhafer, M.S. Abdel-Dayem, H. H. Fadl, A. El Turkey, A. Elgarbway & I. Rasool". Jazan: 1♀, "KSA, Fifa, Al Absia, 17°15.831'N 43°60.498'E Alt. 1770 m, 20.III.2014, (LT), 30♂, 12♀ "17°15.831'N 43°60.498'E Alt. 1770 m, 23.III.2014, (LT)., 2♀, "Jazan Road, 17°20.223'N 43°07.539'E 1770 m, 21.III.2014, (LT)., 1♀, "Fifa, Agricultural research station, 17°28.671'N 43°14.39'E Alt. 879 m, 06.IV.2013, (HP), M.R. Sharaf" **[KSMA].**

Description. Small beetle (Fig. 27) TBL 2.13–2.75 mm. *Color*: Head, lateral margin of abdominal sternite and posterior half of epipleurae dark brown; pronotum,

elytra, anterior half of epipleurea and antennae testaceous; legs, ventrum of thorax and abdominal sternite pale testaceous; elytra with dark brown pattern covering the posterior half of elytra, leaving the testaceous round spots near apex and suture, suture dark brown throughout. *Microsculpture*: head, clypeus, labrum, pronotum, and elytra with mesh isodiametric pattern; last abdominal sternum with transverse microlines, rest of the sternites with depressed microlines. *Head*: As long as wide, narrower than pronotum; HL 0.45–0.52 mm and HW 0.46–0.52 mm; dorsum densely and coarsely punctate (Fig. 15). *Pronotum*: Transverse, PW 0.55–0.58 mm and PL 0.40–0.44 mm, pronotum narrowed posteriorly with sharp basal angles, base lobate at middle, incised near the angles; dorsum of pronotum densely and coarsely punctate (Fig. 15). *Elytra*: Subparallel, slightly widened posteriorly, EL 1.34 mm EW 0.95 mm apical margin obliquely truncate, sparsely punctuate, claws dentate. *Abdomen*: All visible sternite sparsely and finely punctate; last sternum Tetra–setose, incised in males and rounded in females. *Aedeagus*: It is elongate (Fig. 41), AL 0.45 mm; in lateral view flat throughout, very thin and equally broadened from base to apical end; apical lamina broadened, end strongly rounded.

Affinities. This species is similar to *M. arabicus* and *M. ephippiatus* in general from but it can be differentiated by: densely punctated head and pronotum, presence of microsculptures on whole body, Tetra–setose apical margin of abdominal sternum in male, and apical lamina of aedeagus broad.

Ecological notes. This species is attracted to UV–light. Living from low to high elevated areas from 402–2761 m (Fig. 51). It is collected from various kind of habitats, sand dunes covered with light vegetation, near the water streams and under the shade of small shrubs where it lives with variety of arthropods (Hemipetra, Collembola, Staphylinidae, and spiders), while in valleys of mountains, it is hidden under leaves and stones.

Geographical distribution. It was described from Yemen (Basilewsky 1948), then recorded from Jordan and Saudi Arabia (Mateu 1979, Kabak 2003, 2017, Anichtchenko 2017). *Metadromius brittoni* is Arabian element that exemplifies Arabian chorotype.

***Metadromius* spec.**
Figures 28, 51

Material examined. Total seven specimens: One female labeled as, "Saudi Arabien, W. Büttiker" / "W. Shuqub Turabah, 1250 m, 21.IV.1980"/ "*Metadromius ephippiatus*, Fairm., J. Mateu, det. 1983" **[NHMB].** Al Baha: 1♂, "KSA, Al Baha, Al Makhwa, Wadi Neera, 19°44.870'N 41°20.008'E Alt. 471 m, 3.III.2015, (LT)., 1♀, Shada Al Aala "19°51.066'N 41°18.037'E Alt. 1325 m, 2.III.2015, (LT), H. Al Dhafer, M.S. Abdel-Dayem, H. H. Fadl, A. El Turkey, A. Elgarbway & I. Rasool". Asir: 2♂, 2♀, "KSA, Al Magardah, Wadi Yabah, 19°14.911'N 41°47.255'E Alt. 402 m, 11.X.2013, (LT), I. Rasool, M. Al Harbi, S. Soonbati & S. Khan" **[KSMA].**

Notes. These specimens (Figs. 28) are similar to specimens identified by Mateu (1986) from Saudi Arabia as *M. ephippiatus* (Fairmaire, 1884). However, the specimens of *M. ephippiatus* known from Algeria are quite different and identification of Mateu, 1986 is doubtful. Most probably the specimens from Saudi Arabia are a new species. As *Metadromius* in the Middle East is under revision, a species name is not designated here.

Microlestes Schmidt-Gobel, 1846

Type species. *Microlestes inconspicuus* Schmidt-Göbel, 1846

The genus *Microlestes* is the largest genus of Dromiusina encompass about 130 species all over the world (Lorenz 2005, Anichtchenko 2017), distributed in Palaearctic (Middle East and Asia), Nearctic, Afrotropical, Oriental and Neotropical regions (Mateu 1971, Bousquet 2012). Kabak (2003, 2017) in his catalogue, mentioned 63 *Microlestes* species from Palaearctic region. The members of *Microlestes* can be distinguished from other related genera in Dromiusina by the combination of the characters: small sized beetle ranges from 2.30–3.40 mm; labrum truncate at anterior margins; mentum without median tooth; pubescence of antennae starts from antennomeres III; lateral margins of pronotum sinuated posteriorly, base of pronotum weakly incised and curved towards hind angles and rounded in the middle; basal tarsomere of hind legs distinctly longer than last, claws sparsely dentate; elytra parallel sided and transversally truncated at apex (Lindroth 1974, Bousquet 2010). So far eight species have been known from Saudi Arabia (Mateu 1979, 1986, Kabak 2003, 2017). Only two species *Microlestes infuscatus fragilis* Mateu, 1956 and *Microlestes glabrellus* (Reitter 1901) are occuring in the southwestern part of the country (Mateu 1986). In the present study, *Microlestes discoidalis* (Fairmaire 1892) is also newly recorded from the southwest of Saudi Arabia.

Microlestes discoidalis (Fairmaire, 1892)

Figures 16, 29, 42, 52

Blechrus discoidalis Fairmaire, 1892: 83.
Microlestes schmiedeknechti Pic, 1900: 91.

Type locality. Djibouti, Obock

Type depository. Holotype in MHNP.

Material examined. 51 specimens: Al Baha: 2♂, 1♀, "KSA, Al Makhwa, Shada Al Aala, 19°52.598'N 41°18.672'E Alt. 892 m, 26. I.2015, (LT)., 3♂, 8♀, "19°52.598'N 41°18.672'E Alt. 892 m, 15-16. II.2014, (LT), I. Rasool, 1♂ "19°50.329'N 41°18.604'E Alt. 1563 m, 21. IV.2014, (LT)., 1♂, "19°52.598'N 41°18.672'E Alt.

892 m, 23.IV.2014, (LT), H. Al Dhafer, M.S. Abdel-Dayem & H. H. Fadl, I. Rasool". 1♂, 1♀, "19°52.685'N 41°18.663'E Alt. 851 m, 15.XI.2015, (LT)., 1♀, "19°52.717'N 41°18.712'E Alt. 825 m, 13.XI.2015, (LT), Al Dafer H., M.S. Abdel-Dayem., H. H. Fadl., El Gharbawy., El Turkey & Soliman, A". Asir: 1♀, "KSA, Abha, Rayda, 18°11.749'N 42°23.345'E Alt. 1614 m, 24.II.2014, (LT), I. Rasool". 1♂, "Wadi Rayda, 18°11.749'N 42°23.345'E Alt. 1614 m, 24.III.2014, (LT), S. A. El-Sonmbati". 1♀, "18°11.749'N 42°23.345'E Alt. 1614 m, 30. I.2015, (LT), H. Al Dhafer, M.S. Abdel-Dayem, H. H. Fadl, A. El Turkey, A. Elgarbway & I. Rasool". 2♀, "Al Manznar, Wadi Baqrah, 18°47.476'N 41°56.310'E Alt. 331 m, 13.III.2012, (LT), H. AL Dhafer, M. S Abdel-Dayem & H. H. Fadl". 1♂, "Wadi Quonunah, 19°25.457'N 41°36.141'E Alt. 353 m, 12.V.2011, (LT), M.R. Sharaf". 1♀, "Al Magardah, Wadi Yabah, 18°47.977'N 42°01.375'E Alt. 411 m, 2.VI.2012, (LT), H. Al Dhafer & A. Al Ansi". 2♀, "19°14.911'N 41°47.255'E Alt. 402 m, 11.X.2013, (LT)., 5♀, 1♂, "Al Hubail, Wadi Reem, 20.X.2014, 18°06.981'N 42°13.939'E Alt. 451 m, (LT), I. Rasool & M. Al Harbi". Jazan: 6♂, 7♀, "KSA Adrab, Wadi Baiz, 17°37.562'N 42°22.242'E Alt. 75 m, 24.II.2015, (HP), I. Rasool".1♂, 2♀, "Fifa, Al Absia, 17°15.831'N 43°60.498'E Alt. 1770 m, 23.III.2014, (LT)., 1♂, "17°15.831'N 43°60.498'E Alt. 1770 m 20.III.2014, (LT), S. A. El-Sonmbati" **[KSMA].**

Description. Small beetles (Fig. 29), TBL 2.25–3.47 mm. *Color*: Dorsum and ventrum of head and pronotum black; femora, tarsomeres, mouthparts and epipleurae dark brown; antennae, abdomen, lateral margins, suture, base and apex of elytra -dark brown, elytra with two large pale testaceous macula. *Microsculpture*: Head, clypeus and labrum with isodiametric mesh pattern; pronotum with irregular and ventrum of head, thorax and abdomen with regular transverse microlines; elytra with transverse microlines on base, apex and lateral margins. *Head*: as long as wide, as wide as width of pronotum, HL and HW 0.52–0.70 mm; eyes large and prominent, tempora short (Fig. 16) *Pronotum*: Slightly wider than long, PL 0.38–0.56 mm and PW 0.49–0.69 mm; pronotum narrowed and sinuate posteriorly, basal angles very weak, base of pronotum lobate in middle (Fig. 16). *Elytra*: Elytra parallel sized; EL 1.07–1.77 mm, EW 0.78–1.27 mm. *Abdomen*: Apical margin of last sternum bi–setose in both males and females, rounded in males, slightly incised in females. *Aedeagus*: Shape of aedeagus (Fig. 42), AL 0.58 mm; in lateral view, aedeagus strongly curved dorsally and ventrally, blunt base, broadened in the middle, narrowed apically; apical lamina elongated and with blunt end; endophallus armature of aedeagus elongate and slender with pointed end.

Affinities. This species is very similar to *M. glabrellus* (Reitter 1901) in body size, shape of pronotum, large eyes, and short tempora, but can be differentiated by the two large and elongated pale testaceous discal maculae on the elytra and suppressed transverse microlines on the elytra. Endophallus armature of aedeagus elongate and slender.

Ecological notes. The species was attracted to UV–light at low elevated areas to high mountainous areas at 75–1770 m range of altitude (Fig. 52). In day time, it remains hidden under gravels and leaf litter below the shade of small shrubs and vegetation; and can be easily collected by aspirator.

Geographical distribution. This species was described from Djibouti (Fairmaire 1892) and is now widely distributed in Afghanistan, Chad, Eritrea, Iran, Israel, Kenya, Mauritania, Niger, Oman, Saudi Arabia, Somalia, Sudan, Turkey, Yemen, United Arab Emirates (Felix 2009, Kabak 2003, 2017, Anichtchenko 2017). It exemplifies Afrotropico–Indo–Mediterranean chorotype.

***Microlestes glabrellus* (Reitter, 1901)**
Figures 17, 30, 43, 52

Blechrus glabrellus Reitter, 1901: 380.
Microlestes arabicus Mateu, 1956.
Microlestes flavipes Holdhaus, 1912.

Type locality. Egypt.

Type depository. Holotype in MNH.

Material Examined. Total 7 specimens: Asir: 1♀, "KSA, Abha, Rayda, "18°11.749'N 42°23.345'E Alt. 1614 m, 30. I.2015, (LT)., 1♀, "4.III.2015, (LT)., 1♀, "18°11.695'N 42°23.818'E Alt. 1897 m, 31.VII.2014, (LT)., 1♂, "18°11.749'N 42°23.345'E Alt. 1614 m, 26. VIII.2014, (LT)., 1♂ "18°11.618'N 42°23.42'E Alt. 1772 m, 26.VIII.2014, (LT), H. Al Dhafer, M.S. Abdel-Dayem, H. H. Fadl, A. El Turkey, A. Elgarbway & I. Rasool". 1♂, 1♀, "18 10.293'N 42 22.195'E Alt. 1150 m, 16.IV.2016, (LT), H. Al Dhafer, M.S. Abdel-Dayem, B. Daniele, A. Al Ansi, A. Soliman & I. Rasool" **[KSMA]**.

Description. Subparallel sized beetle (Fig. 30), TBL 3.12–3.60 mm. *Color*: Overall black, dorsum and ventrum of head, pronotum and abdomen, mouthparts and femora black; antennae, epipleurae, tibiae and tarsomeres -dark brown; coxae dark brown; elytra bronze to black. *Microsculpture*: Head along with clypeus and labrum with isodiametric mesh pattern; elytra, epipleurae, ventrum of thorax and abdominal sternite with transverse microlines. *Head*: As long as wide, almost as wide as pronotum, HL and HW 0.65–0.71 mm; eyes large, tempora short (Fig. 17). *Pronotum*: wider than long, PL 0.49–0.56 mm, PW 0.68–0.75 mm; pronotum narrowed posteriorly with weak basal angles; base of pronotum lobed (Fig. 17). *Elytra*: Subparallel sized, EL 1.61–1.77 mm EW 1.15–1.21 mm; apex of elytra transversally truncates; claws weakly dentate. *Abdomen*: apex of last abdominal sternum bi–setose and rounded in both males and females; *Aedeagus*: Shape of aedeagus (Fig. 43), AL 0.56 mm, in lateral view, aedeagus curved dorsally, straight in the middle ventrally, broad from the base to apical lamina; apical plat long narrowed with elongate and blunt end; internal sac broad and flat.

Affinities. This species is similar to *M. discoidalis* in general appearance, elongate and slender, antennae, eyes large with short temples, but can be distinguished by black color of whole body (except tibiae and tarsomeres), strong transverse microlines on elytra, and endophallus armature of aedeagus broad and flat.

Ecological notes. Members of this species were found in steep slopes in Rayda Nature Reserve (Asir Provence). They were collected from 1614–1897 m of elevation (Fig. 52), adult beetles were fly to UV-light. The adults were collected from places covered by different vegetation that dominated by Cactus shrubs *Opuntia-ficus indica.*

Geographical distribution. This species was described from Egypt (Reitter 1901), and then reported from Chad, Ethiopia, Mauritania, Niger, Senegal, Saudi Arabia, and Yemen (Mateu 1986, Kabak 2003, 2017, Anichtchenko 2017). Its geographical range exemplifies Saharo – Sahelo – Arabian Chorotype.

***Microlestes infuscatus fragilis* Mateu, 1956**
Figures 18, 31, 32, 44, 52

Type locality. Saudi Arabia, Hejaz.

Type depository. Holotype in BMNH.

Material examined. Total 55 specimens: HOLOTYPE**:** Male labeled "Hedjaz, Millingen, 1915-38" / "Holotype [red square label]" / "*Microlestes fragilis*, J. Mateu, det." / "Holotype [red round label]". **[BMNH]** (Fig. 32). Al Baha: 1♂, 2♀, "KSA, Al Makhwa, Shada Al Aala, 19°52.598'N 41°18.672'E Alt. 892 m, 26.I.2015, (LT), I. Rasool". 3♂, 5♀, "Thee Ain Village, 19°55.774'N 41°26.574'E Alt. 754 m, 10.III.2012, (HP), M.S. Abdel-Dayem". 2♂, 3♀, "19°55.465'N 41°26.343'E Alt. 744 m, 07.IV.2013, (HP), M.R. Sharaf". 7♂, 9♀, "19°52.598'N 41°18.672'E Alt. 892 m, 23.IV.2014, (LT), H. Al Dhafer, M.S. Abdel-Dayem, H. H. Fadl, A. El Turkey, A. Elgarbway & I. Rasool". 2♀, "19°55.459'N 41°26.302'E Alt. 741 m, 11.V.2013, (HP), M.R. Sharaf". 2♂, 3♀, "Al Mandaq, Wadi Turba, 20°12.937'N 41°17.176'E Alt. 1793 m, 14.V.2011, (HP)., 2♂, "Wad Elzaraeb, 20°04.243'N 41°23.123'E Alt. 2086, (HP), M.R. Sharaf". 1♂, "19°51.066'N 41°18.037'E Alt. 1325 m, 23.VIII.2014 (LT), H. Al Dhafer, M.S. Abdel-Dayem, H. H. Fadl, A. El Turkey, A. Elgarbway & I. Rasool". 1♀, "19°50.710'N 41°18.267'E Alt. 1474 m, 02.IX.2015, (LT)., 1♂, "19°50.575'N 41°18.691'E Alt. 1666 m, 02.XI.2015, (LT), H. Al Dhafer, M.S. Abdel-Dayem, H. H. Fadl, A. El Turkey, A. Elgarbway & I. Rasool". 1♀, "19°50.575'N 41°18.691'E Alt. 1666 m, 15.XI.2015, (LT), H. Al Dhafer, M.S. Abdel-Dayem, H. H. Fadl, A. El Turkey, A. Elgarbway & A. Soliman". Asir: 1♂, "KSA, Abha, Rayda, "18°11.695'N 42°23.818'E Alt. 1897 m, 26.IV.2014, (LT)., 2♀, "18°11.766'N 42°24.315'E Alt. 2285 m, 8.VI.2014, (PT), H. Al Dhafer, M.S. Abdel-Dayem, H. H. Fadl, A. El Turkey, A. Elgarbway & I. Rasool". 2♂, 1♀, "Al Magardah, Wadi Yabah, 19°14.911'N 41°47.255'E Alt. 402 m, 11.X.2013, (LT)., 1♂, 1♀, "Wadi Talalea, 19°2.74'N 41°46.333'E Alt. 259 m, 12.X.2013, (LT), I. Rasool, M. A. Al Mushairi, S. Sonmbaati, S. Khan". Jazan: 2♂, 2♀, "Fayfa, Dayer Beni, 17°28.797'N 43°.14.434'E Alt. 871 m, 4.IV.2013, (HP), M. R. Sharaf" **[KSMA]**.

Description. Small beetle (Fig. 31), TBL 2.27–2.55 mm. *Color*: Head and pronotum black, pronotum sometimes–dark brown; sub scutellum, apical forth of elytra,

epipleurae, femora, thoracic and abdominal ventrum, antennae, mouthparts and labrum–dark brown; rest of the elytra, tibiae and tarsomeres ferruginous. *Microsculpture*: Head with longitudinal microlines; clypeus with isodiametric mesh pattern; labrum, pronotum, elytra, thoracic and abdominal ventrum with transverse microlines; irregular on abdominal sternite. *Head*: As long as wide, HL 0.48–0.56 mm, HW 0.44–0.51 mm; eyes small with long tempora (Fig. 18). *Pronotum*: Transverse, almost as wide as head, PL 0.34–0.38 mm and PW 0.52–0.58 mm; pronotum narrowed posteriorly, sinuate before basal angles, base of pronotum lobate in the middle. *Elytra*: Parallel sized; EL 1.13–1.20 mm, EW 0.79–0.85 mm; apex transversally truncates, claws weakly dentate in the middle. *Abdomen*: apical margin of last sternum rounded in males and slightly incised in females. *Aedeagus*: small (Fig. 44), AL 0.38 mm; in lateral view, strongly curved; basal part up to apical lamina thick, widened in the middle, apical margin and lamina narrow and long; apical end small rounded; internal sacs leaf-like.

Affinities. This species is very close to *Microlestes vittipennis* J.R Sahlberg, 1908 in general appearance, color, body size and pattern of elytra, but it can be distinguished by: antennomere II as long as III, eyes small with large temples, strongly curved, apical margin and lamina narrow and long; apical end small rounded; internal sacs leaf-like.

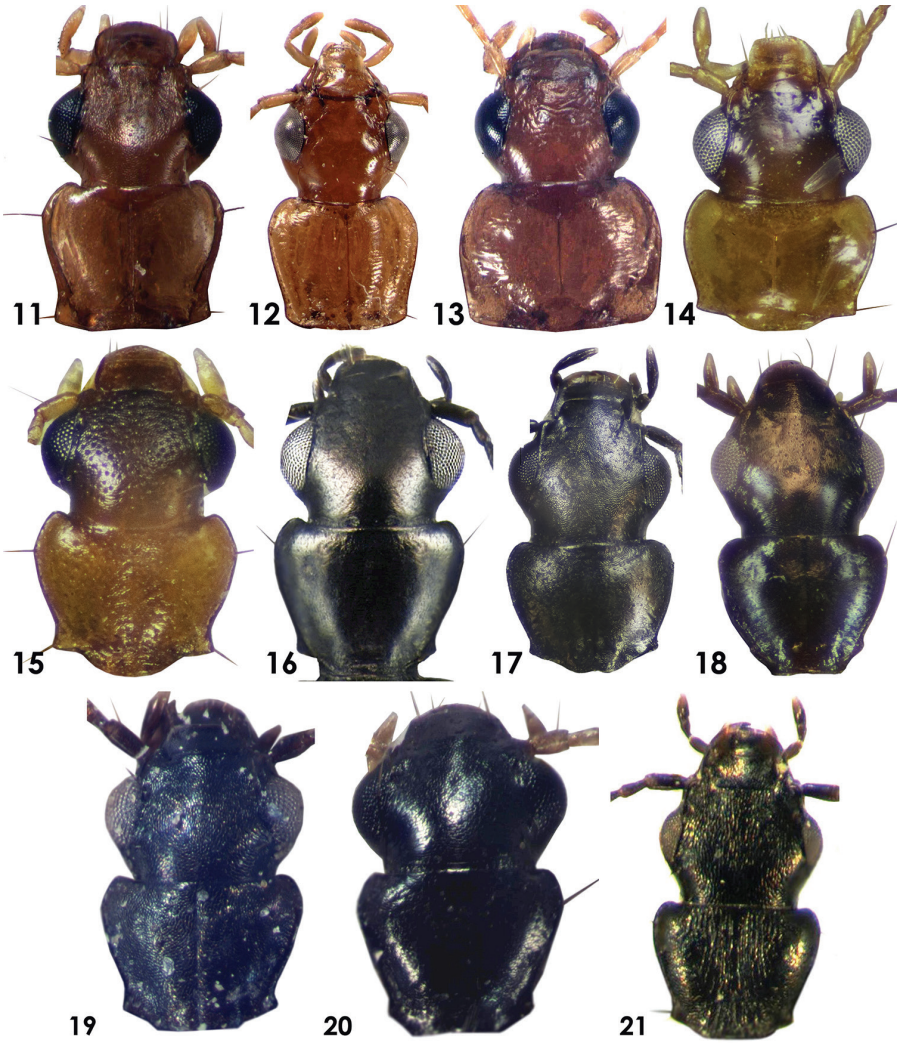
Ecological notes. The species was collected from low lands and mountainous areas with 648–2285 m elevation range (Fig. 52). Adults were found under gravels and leaf litter in humid and moist places among mixed vegetation and shrubs. Also, they are attracted to UV–light.

Geographical distribution. This species was described by Matue (1956) from southwestern Saudi Arabia and also reported from Afghanistan and Yemen (Mateu 1979, Kabak 2003). This range exemplifies Afrotropico–Indo–Mediterranean.

Pseudomesolestes Mateu, 1956

Type species. *Mesolestes brittoni* Mateu, 1956

The genus *Pseudomesolestes* is a small genus that contains only seven species, distributed in Palaearctic, Oriental, and Afrotropical regions (Anichtchenko 2017). Three species have been recorded from Palaearctic region, two of which are documented from Arabian Peninsula (Kabak 2003, 2017). This genus can be distinguished from other genera in subtribe Dromiusina by the following combination of characters: antennae stout, antennomeres II as long as III; pubescence starts from antennomeres II; mentum without median tooth; labrum rounded at anterior margins; maxillary palpi fusiform; pronotum constricted and sinuate posteriorly, base of pronotum straight in the middle, making 45° angle to hind angles; elytra broadened posteriorly, apex of elytra transversally truncates; basal boarder of elytra is complete up to scutellum (Mateu 1956, 1984). In Arabian Peninsula, this genus is represented by two species *P. brittoni* Mateu, 1956 described from Yemen and also recorded from Saudi Arabia, and *P. quadriguttatus* Matue, 1979 is endemic to Saudi Arabia only.



Figures 11–21. Dorsal view of head and pronotum of Dromiusina species: **11** *Calodromius mayeti* (Bedel, 1907) **12** *Dromius saudiarabicus* sp. n. **13** *D. buettikeri* Mateu, 1990 **14** *Metadromius arabicus* Mateu, 1979 **15** *M. brittoni* (Basilewsky, 1948) **16** *Microlestes discoidalis* (Fairmaire, 1892) **17** *M. glabrellus* (Reitter, 1901) **18** *M. infuscatus fragilis* Mateu, 1956 **19** *Pseudomesolestes brittoni* Mateu, 1956 **20** *P. quadriguttatus* Mateu, 1979 **21** *Zolotarevskyella rhytidera* (Chaudoir, 1876).

***Pseudomesolestes brittoni* Mateu, 1956**

Figures 19, 33, 45, 53

Mesolestes brittoni Mateu, 1956: 66.

Type locality. Yemen, Kamaran Island.

Type depository. Male in BMNH.

Material examined. Holotype: Male labeled "Holotype [red label]" / "stones" / "S. Arabia: Kamaran. I. 27-11-1903, Dr. M. Cameron. B.M. 1928-109" / "*Mesolestes* (*Pseudomesolestes*) *brittoni*, J. Mateu det." / "Holotype [rounded label, red boarder]" **[BMNH]** (Fig. 33 in this work)**.**

Description. Small beetle (Fig. 33) 2.55 mm. *Color*: frons and vertex black; clypeus, labrum, dorsum and ventrum of head and thorax, mouthparts, elytra, antennomeres I and femora -dark brown; rest of the antennomeres dark brown; elytra with two pale testaceous elongate spots, one after humeri covering intervals IV–VI and second round small spot near apex of elytra, covering intervals IV and V; tibiae and tarsomeres pale testaceous. *Microsculpture*: Head, pronotum and elytra with granulated microsculptures, clypeus and labrum with transverse lines. *Head*: as long as wide HL 0.56 mm and HW 0.58 mm as wide as pronotum; tempora short (Fig. 19). *Pronotum*: Transverse, PL 0.42 mm and PW 0.58 mm, narrowed posteriorly, sinuate before the basal angles, base straight in the middle with weak angles (Fig. 19). *Elytra*: Widened posteriorly, apical margins transversally truncate; striae II with fine punctures. Claws smooth. *Aedeagus*: Small (Fig. 45) AL 0.61 mm, in lateral view, aedeagus slightly curved dorsally and ventrally; thick from base to apical lamina; apical lamina narrowed, short and slightly curved before end with a small tooth dorsally; base of aedeagus also with a small tooth.

Affinities. *Pseudomesolestes quadriguttatus* is the only other specie recorded from Saudi Arabia which is close to *P. brittoni* in shape of head and pronotum, but can be distinguished by granulated microsculptures on head, pronotum and elytra, wrinkles on dorsum of pronotum along the medial impression; shape of testaceous spots; dark brown femora, aedeagus with single elongate endophallus armature and short apical lamina.

Geographical distribution. This species was originally described from Yemen (Mateu 1956) and also recorded from Saudi Arabia (Mateu 1979, Kabak 2017). It is confined to Arabian Peninsula and exemplifies Arabian chorotype.

Pseudomesolestes quadriguttatus **Mateu, 1979**

Figures 4, 9, 20, 34, 35, 46, 53

Pseudomesolestes quadriguttatus Matue, 1979: 148.

Type locality. Saudi Arabia, Riyadh, Wadi Mizibl.

Type depository. Holotype male in NHMB.**Material examined**. Total 18 specimens: **Holotype** (Fig. 35)**:** Male labeled "Type [red label]" / "Saudi Arabien, W. Büttiker" / "Wadi Mizbil, 13.4.1977" / "*Pseudomesolestes quadriguttatus* n. sp J. Mateu det. 1977". [**NHMB**]. Al Baha: 1♀, "KSA, Al Baha, Al Makhwa, Shada Al Aala, 19°52.598'N 41°18.672'E Alt. 892 m, 26.I.2015, (LT), I. Rasool". 1♂, 19°51.066'N 41°18.037'E Alt. 1325 m, 2.III.2015, (LT), H. Al Dhafer, M.S. Abdel-Dayem, H.

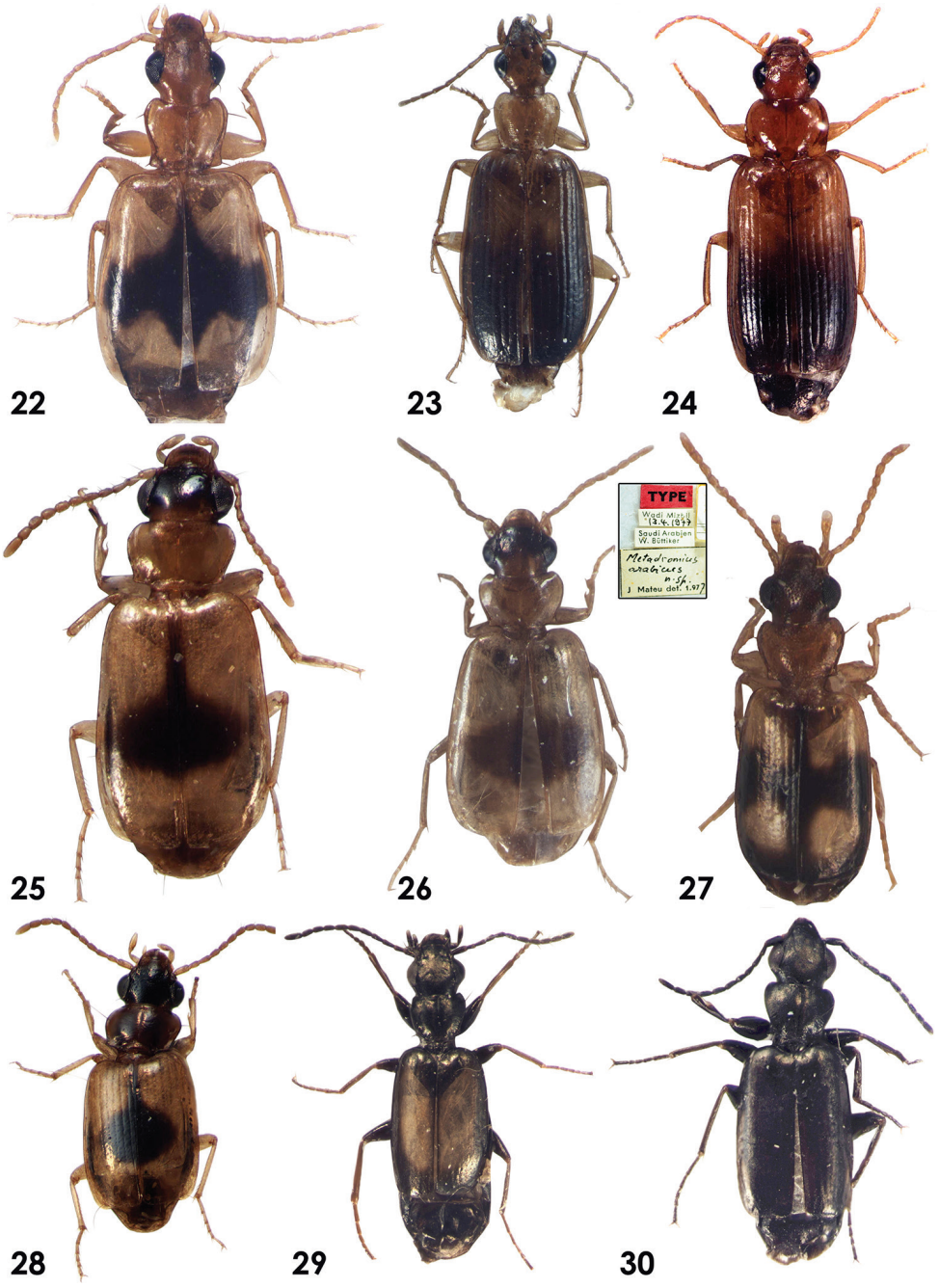
H. Fadl, A. El Turkey, A. Elgarbway, A. Al Ansi & I. Rasool". 1♂, 2♀, "19°52.598'N 41°18.672'E Alt. 892 m, 18.X.2014, (LT), I. Rasool". 1♀, 17.X.2014, (LT)., I. Rasool and M. Al Harbi". 1♀, "19°50.329'N 41°18.604'E Alt. 1663 m, 17.X.2014, (LT), H. Al Dhafer, M.S. Abdel-Dayem, H. H. Fadl, A. El Turkey, A. Elgarbway & I. Rasool". 2♀, "Raghadan, Wadi Saad dam, 20°07.605'N 41°21.459'E 17.X.2014 (LT)., 1♂, "Wadi Turaba 20°10.430'N 41°19.365'E 17.X.2014, (HP), I. Rasool". 1♂, 1♀, "19°52.685'N 41°18.663'E Alt. 851 m, 15.XI.2015, (LT), H. Al Dhafer, M.S. Abdel-Dayem, H. H. Fadl, A. El Turkey, A. Elgarbway & A. Soliman". Asir: 1♀ "KSA, Abha, Wadi Rayda, 18°11.749'N 42°23.345'E Alt. 1614 m, 24.II.2014, (LT), I. Rasool". 1♂, "18°12.315'N 42°24.607'E Alt. 2761 m, 11.XII.2014, (LT), H. Al Dhafer, M.S. Abdel-Dayem, H. H. Fadl, A. El Turkey, A. Elgarbway & I. Rasool" **[KSMA].** 1♂, "KSA, Al Baha, Al Makhwa, Shada Al Aala, 19°52.598'N 41°18.672'E Alt. 892 m, 18.X.2014, I. Rasool" **[RMNH].**

Description. Small beetles (Fig. 34), TBL 2.75–3.30 mm. *Color*: Frons and vertex black; clypeus, labrum, thorax, posterior half of epipleurae and dorsum and ventrum of head dark brown; elytra -dark brown with pale testaceous inverted comma shaped spot at humeri and oval shaped after half of elytra, not reaching the lateral and apical margins; legs, mouthparts, antennae, ventrum of abdomen and anterior half of epipleurae pale testaceous. *Microsculpture*: Head, clypeus, labrum, pronotum and elytra with irregular isodiametric pattern, neck with suppressed microlines; ventrum of head, thorax, and abdomen with microlines. *Head*: Almost as long as wide HL 0.58–0.71 mm and HW 0.59–0.67 mm, as wide as pronotum, tempora short (Fig. 20). *Pronotum*: Transverse, PW 0.56–0.64 mm PL 0.47–0.53 mm, narrowed posteriorly, sinuate before basal angles, base of pronotum straight in the middle with weak angles (Fig. 20). *Elytra*: Broadened posteriorly, EL 1.56–1.77 mm, EW 1.06–1.35 mm; intervals II with few scattered fine punctures, claws smooth. *Abdomen*: apical margin of last sternum in both males and females notched in the middle. *Aedeagus*: Shape of aedeagus (Fig. 46), AL 0.58 mm; in lateral view, aedeagus slightly curved dorsally, straight ventrally, broad from base to apical lamina; apical lamina narrowed, elongate and slightly curved before end with a small tooth dorsally; base of aedeagus also with a small tooth; internal sacs finger-like.

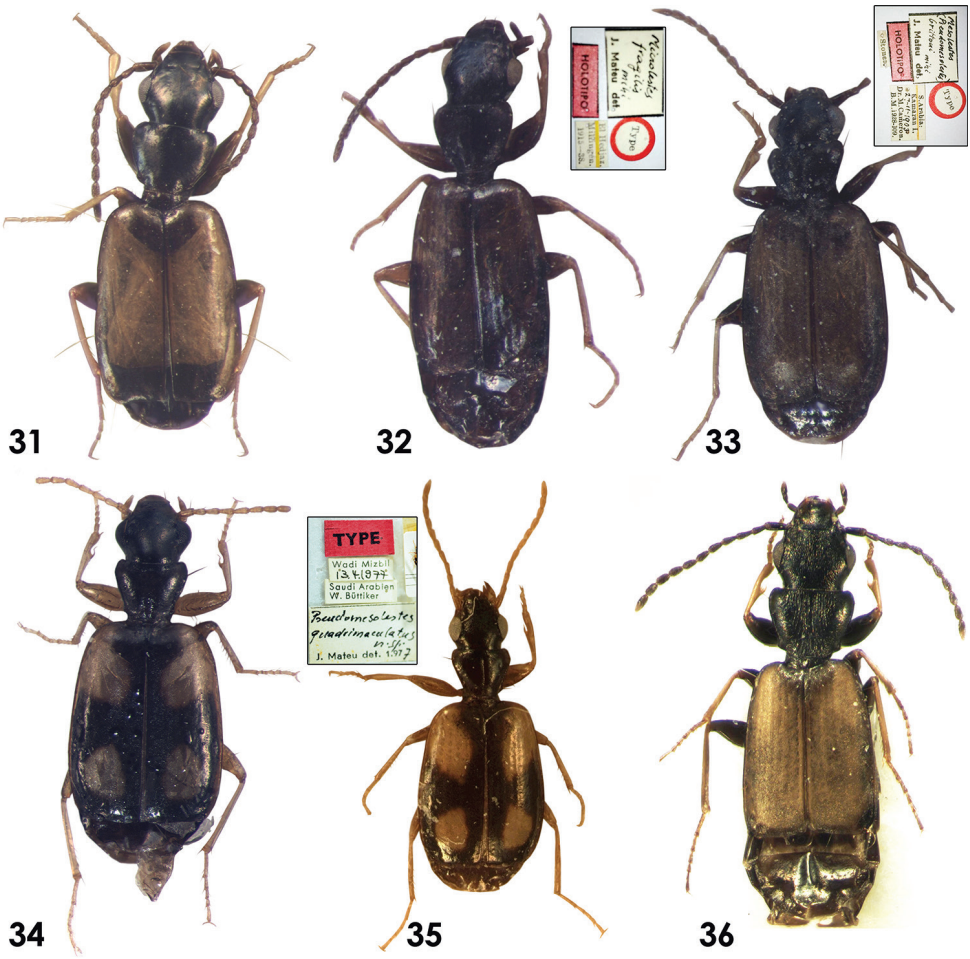
Affinities. *Pseudomesolestes brittoni* is the only other species recorded from Saudi Arabia and is close to *P. quadriguttatus* in shape of head and pronotum, but can be distinguished by elytra of *P. quadriguttatus* considerably widened posteriorly with pale testaceous inverted spot at humeri and round spot after middle, legs completely pale testaceous, aedeagus with three elongate endophallus armatures.

Ecological notes. This species was collected from hilly and mountainous zones of 892–2761 m elevation range (Fig. 53). It was collected during day time from root zones of superficial vegetation and small shrubs, while during night it fly to UV–light. The species was collected during January, February, March, September, and December.

Geographical distribution. It is endemic to Saudi Arabia (Mateu 1990, Kabak 2017).



Figures 22–30. Habitus of Dromiusina species**: 22** *Calodromius mayeti* (Bedel, 1907) **23** *Dromius saudiarabicus* sp. n. **24** *Dromius buettikeri* Mateu, 1990 (**25, 26)** *Metadromius arabicus* Mateu, 1979 **27** *Metadromius brittoni* (Basilewsky, 1948) **28** *Metadromius* spec. **29** *Microlestes discoidalis* (Fairmaire, 1892) **30** *Microlestes glabrellus* (Reitter, 1901).

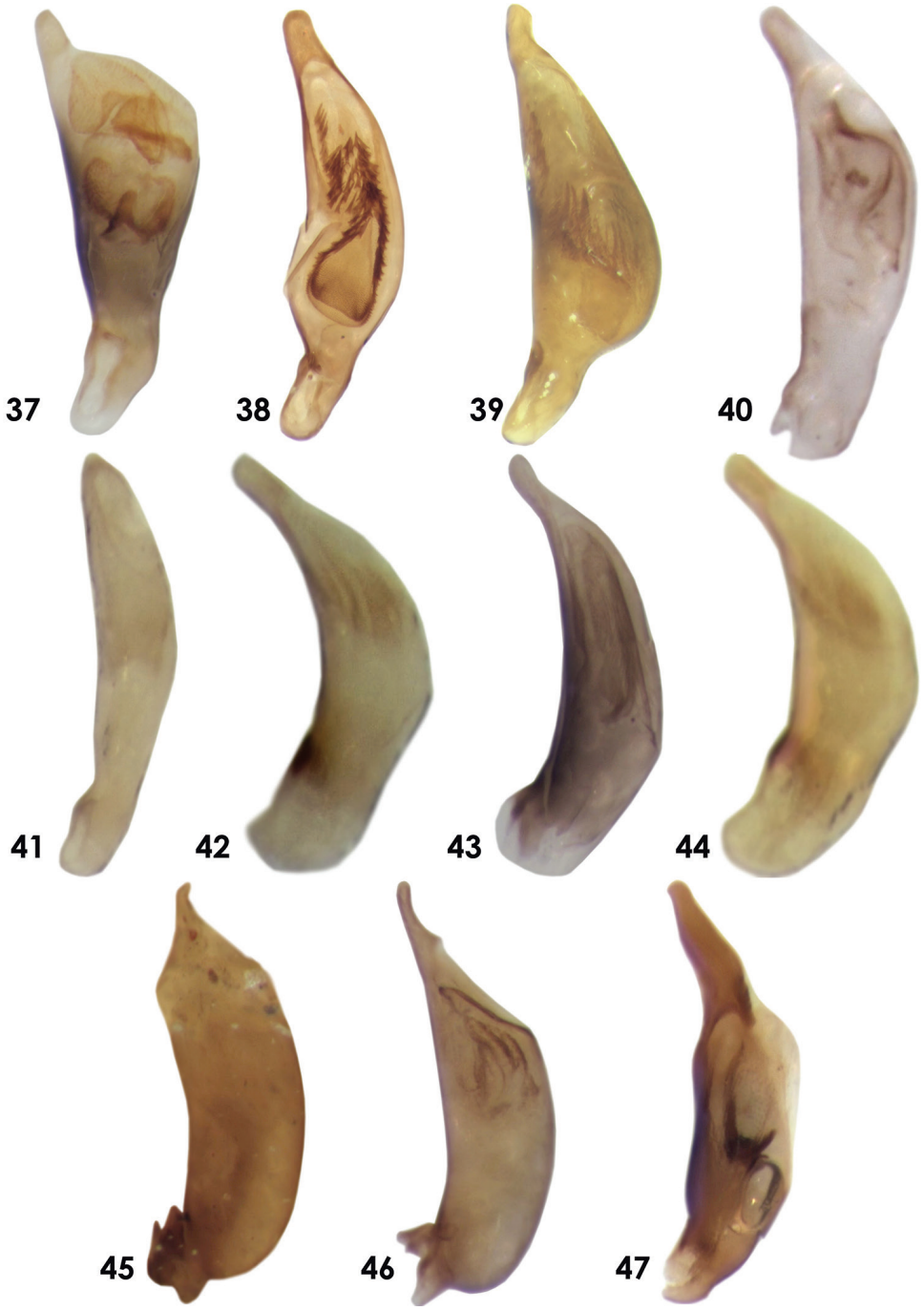


Figures 31–36. Habitus of Dromiusina species: **31, 32** *Miceolestes infuscatus fragilis* Mateu, 1956 **33** *Pseudomesolestes brittoni* Mateu, 1956 **34, 35** *P. quadriguttatus* Matue, 1979 **36** *Zolotarevskyella rhytidera* (Chaudoir, 1876).

Zolotarevskyella Mateu, 1953

Type species. *Blechrus rhytiderus* Chaudoir, 1876.

This genus represents the subtribe Dromiusina by only three species (Anichtchenko 2017), two species *Z. afghan* Mateu, 1976 and *Z. rhytidera* (Chaudoir 1876) have been reported from Palaearctic region (Kabak 2003). This genus can be differentiated from other genera in the subtribe by combination of following characters: labrum transverse anteriorly; mentum without median tooth; last labial and maxillary palpomeres fusiform; antennomeres II as long as III, pubescence starts from the antennomeres III; eyes large, temples long; pronotum with longitudinal furrows in the middle; pronotum narrowed posteriorly and weakly sinuate; base of pronotum lobate, weakly



Figures 37–47. Aedeagus of Dromiusina species: **37** *Calodromius mayeti* (Bedel, 1907) **38** *Dromius saudiarabicus* sp. n. **39** *D. buettikeri* Mateu, 1990 **40** *Metadromius arabicus* Mateu, 1979 **41** *Metadromius brittoni* (Basilewsky, 1948) **42** *Microlestes discoidalis* (Fairmaire, 1892) **43** *Microlestes glabrellus* (Reitter, 1901) **44** *Microlestes infuscatus fragilis* Mateu, 1956 **45** *Pseudomesolestes Brittoni* (Mateu, 1956) **46** *Pseudomesolestes quadriguttatus* Mateu, 1979 **47** *Zolotarevskyella rhytidera* (Chaudoir, 1876).

Figure 48. Photograph of the type locality for *Dromius saudiarabicus* sp. n. at Rayda Nature Reserve, Abha, Asir Province, southwestern Saudi Arabia at an elevation of 1897 m.

incised towards hind angles; apex of elytra transversally truncates; tarsomeres I longer than V in hind legs. *Zolotarevskyella rhytidera* was described from Egypt (Chaudoir 1876) and then was reported from Saudi Arabia (Mateu 1986).

***Zolotarevskyella rhytidera* (Chaudoir, 1876)**
Figures 2, 21, 36, 47, 54

Blechrus rhytidera Chaudoir, 1876: 374.

Type locality. Egypt, Upper Egypt.**Type depository**. Holotype in MNHN.

Material examined. Total 32 specimens: Al Baha: 1♀, "KSA, Al Makhwa, Wadi Aleep, 20°10.695'N 40°68.556'E Alt. 455 m, 16.X.2014, (HP), I. Rasool". 1♀, "Shada Al Aala, 19°50.710'N 41°18.267'E Alt. 1474 m, 18.X.2014, (PT), H. Al Dhafer, M.S. Abdel-Dayem, H. H. Fadl & I. Rasool". 1♀, "19°50.391'N 41°18.634'E Alt. 1562 m, 3.XI.2013, (HP), I. Rasool". Asir: 1♂, 1♀, "Saloos Al Manzar, Wadi Baqrah, 18°47.977'N 42°01.375'E Alt. 425 m, (HP), Al Dhafer H". 1♂, "Al Magardah, Wadi Wabah, 19°14.911'N 41°47.255'E Alt. 402 m, 11.X.2013, (LT), I. Rasool, M. Al Harbi, S. Soonbati & S. Khan". 1♀, "Al Hubail, Wadi Reem, 17°52.475'N

42°16.533'E Alt. 156 m, 20.X.2014, (HP)., 3♂, 4♀, "18°03.284'N 42°13.407'E Alt. 354 m, (HP)., 2♂, 1♀, "18°06.981'N 42°13.939'E Alt. 451 m, (HP), I. Rasool". 1♂, 1♀ "18°06.981'N 42°13.939'E Alt. 451 m (LT), I. Rasool & M. Al Harbi". Jazan: 1♂, "Adarab, Wadi Samar, 17°34.103'N 42°24.593'E Alt. 64 m, 24.II.2015, (HP)., 1♀ "Saybia, Saybia-Abu Areessh Road, 17°04.252'N 42°47.052'E Alt. -5 m, 24.II.2015, (HP), I. Rasool". 1♀, "KSA, Fayfa, Al Abasia, 17°15.831'N 43°60.498'E Alt. 1770 m, 20.III.2014, (LT), S. A. El Sonbati". 1♂, "Agricultural Research Station, 17°28.671'N 43°14.39'E Alt. 879 m, 6.IV.2013, (HP)., 1♀, "Wadi Jora, 17°22.856'N 43°06.169'E Alt. 419 m, (HP), M.R. Sharaf" **[KSMA].** 1♀, "19°50.391'N 41°18.634'E Alt. 1562 m, 3.XI.2013, (HP), I. Rasool". 1♀, "18°03.284'N 42°13.407'E Alt. 354 m, (HP)" **[RMNH].**

Description. Small parallel sized beetle, whole the body glossy (Fig. 36), TBL 2.38–2.90 mm. *Color*: Head and pronotum black; mouthparts, antennae, femora, anterior, lateral, apical margins of elytra and whole the ventrum of the bodydark brown; rest of elytra ferruginous; tibiae and tarsomeres pale testaceous. *Microsculpture*: Labrum, with irregular micro cells, clypeus and elytra with isodiametric mesh pattern, pronotum with isodiametric mesh pattern laterally; whole the ventrum of body with transverse microlines. *Head*: Almost as long as wide, HL 0.58–0.66 mm, HW 0.56–0.61 mm; dorsum of vertex and frons with longitudinal irregular longitudinal ridges; eyes moderate with short temples (Fig. 21). *Pronotum*: Slightly transverse, as wide as head, PW 0.57–0.62 mm, PL 0.46–0.50 mm, pronotum narrowed posteriorly; base of pronotum almost rounded with small basal angles; dorsum with longitudinal furrows at the middle (Fig. 21). *Elytra*: Parallel sized, EL 1.28–1.35 mm, EW 0.75–0.81 mm; apex transversally truncate, claws smooth. *Abdomen*: apical margin of last sternum bi–setose in both males and females, rounded in females slightly incised in males. *Aedeagus*: small, (Fig. 47) AL 0.72 mm; in lateral view it is curved dorsally and ventrally; narrowed at both ends, broad in the middle; ventral margin wavy; apical lamina in the middle, elongate apically; endophallus armature with a large hook.

Ecological notes. It was recorded from various range elevation from 156–1770 m (Fig. 54). It is found among small vegetation and weeds and under the gravels near water streams associated with collembolans, spiders, Hemipteran, *Microlestes*, *Eremolestes*, *Tilius*, and *Apristus* species.

Geographical distribution. This species was described from Egypt (Chaudoir 1876) and also known from Saudi Arabia, Senegal and Yemen (Mateu 1986, Kabak 2003, 2017). This range exemplifies Saharo – Sahelo – Arabian chorotype.

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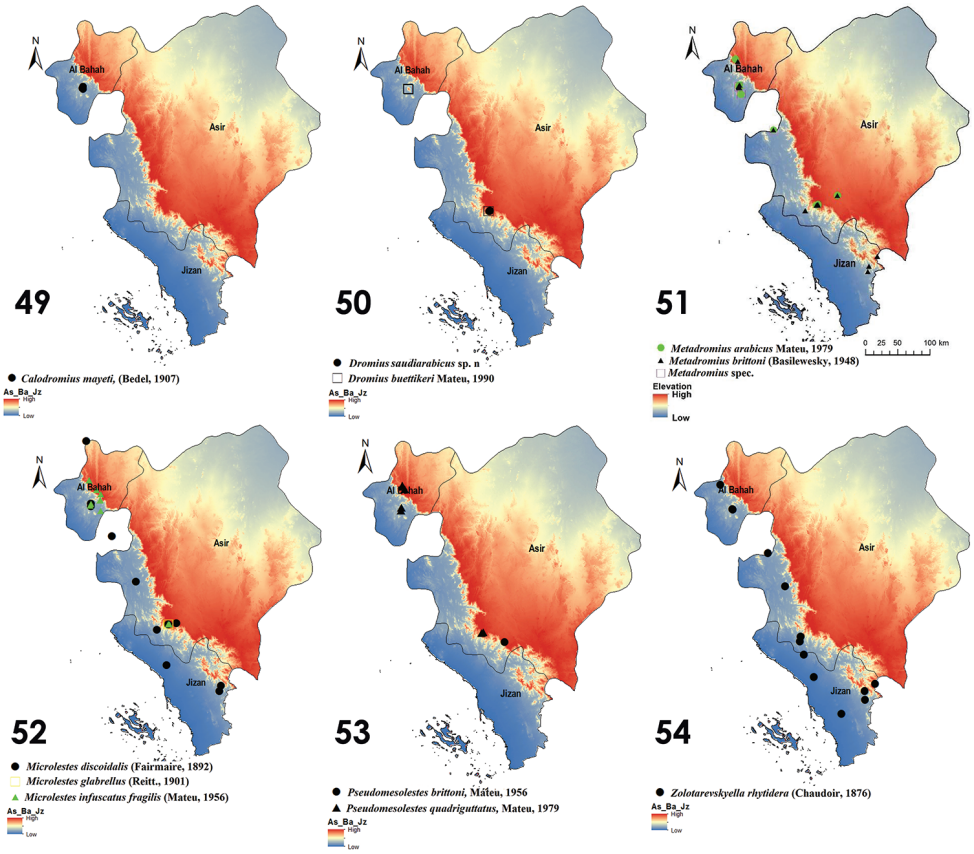

Figures 49–54. Distribution of Dromiusina species in Southwestern Saudi Arabia **49** *Calodromius mayeti* (Bedel, 1907) **50** *Dromius saudiarabicus* sp.n. and *D. buettikeri* Mateu, 1990 **51** *Metadromius arabicus*, Mateu, 1979, *Metadromius brittoni*, (Basilewesky, 1948) and *Metadromius* spec. **52** *Microlestes discoidalis*, (Fairmaire, 1892), *Microlestes glabrellus*, (Reitt. 1901) and *Microlestes infuscatus fragilis*, Mateu, 1956 **53** *Pseudomesolestes brittoni*, Mateu, 1956 and *Pseudomesolestes quadriguttatus*, Mateu, 1979 **54** *Zolotarevskyella rhytidera*, (Chaudoir, 1876).

Museum Basel, Switzerland) for lending us the holotype of *Metadromius arabicus*, *Pseudomesolestes quadriguttatus*, and several other identified species. Thanks also due to Beulah Garner, Senior Curator Coleoptera (British Museum of Natural History, London, UK) for lending us the holotypes of *Pseudomesolestes brittoni* and *Microlestes infuscatus fragilis*. We are grateful to Prince Bandar Bin Saud Al Saud, the Head of the Saudi National Commission for Wildlife Conservation and Development, for permitting collection in Shada Al Aala and Rayda nature reserves. The Deanship of Scientific Research at King Saud University provided funding for this research group NO (RGP-1438–082).

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Revision of the Palaearctic species of the *Merodon desuturinus* group (Diptera, Syrphidae)

Ante Vujić[1], Snežana Radenković[1], Laura Likov[1]

1 *Department of Biology and Ecology, University of Novi Sad, Trg Dositeja Obradovića 2, 21000 Novi Sad, Serbia*

Corresponding author: *Laura Likov* (llikov@yahoo.com)

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Abstract

This revision of material belonging to the *Merodon desuturinus* group from the Palaearctic Region resulted in the delimitation of four species: *Merodon cabanerensis* Marcos-García, Vujić & Mengual, 2007; *Merodon desuturinus* Vujić, Šimić & Radenković, 1995; *Merodon neolydicus* Vujić, **nom. n.**; and *Merodon murorum* Fabricius, 1794. *Merodon murorum* is redescribed. A neotype for *Merodon auripilus* Meigen, 1830 is designated, which is a new junior synonym of *Merodon murorum*. The related Afrotropical species *Merodon cuthbertsoni* Curran, 1939 is re-evaluated and compared to its sibling Palaearctic taxon *Merodon desuturinus*. An identification key for the *Merodon desuturinus* group is provided.

Keywords

Merodon auripilus, *Merodon cuthbertsoni*, *Merodon murorum*, *Merodon neolydicus* nom. n.

Introduction

The genus *Merodon* Meigen, 1803 (Diptera, Syrphidae) comprises more than 160 species distributed across the Palaearctic and Afrotropical Regions (Ståhls et al. 2009). The Mediterranean Basin hosts the highest diversity with more than 110 species, most probably due to high variety of bulb plants that are larval hosts of this phytophagous genus (Ricarte et al. 2008, Andrić et al. 2014).

Hurkmans (1993) conducted the first published revision of part of this genus, analysing 61 species (only those with tapering abdomens) classified into eleven groups.

In the last decade, a number of papers have been published on particular species groups, such as *aureus*, *melanocerus*, *nanus*, *natans*, *nigritarsis*, *ruficornis* (Milankov et al. 2008a, Francuski et al. 2009, 2011, Vujić et al. 2012, 2013, 2015, Šašić et al. 2016, Radenković et al., 2018). The Mediterranean fauna has been frequently studied (Mengual et al. 2006, Marcos-García et al. 2007, 2011, Petanidou et al. 2011, Radenković et al. 2011, Ricarte et al. 2012, Ståhls et al. 2009, 2016, Vujić et al. 2007, 2011), whereas the Afrotropical Region with less than ten recognised species (Pape and Thompson 2013), has received less attention (Radenković et al. 2018).

Initial research on the phylogeny of the *Merodon* genus was conducted by Mengual et al. (2006). Based on analysis of COI sequences of the Iberian species, they defined four well-supported groups: *desuturinus*, *albifrons*, *nigritarsis*, and *aureus*.

One in particular, the so-called "*desuturinus* group" of range-restricted species, is of special conservation interest as it has members in both the Palaearctic and Afrotropical Regions. Vujić et al. (1995) described an endemic species, *Merodon desuturinus*, from the high mountains of the Balkan Peninsula. Later, Marcos-García et al. (2007) discovered a related species, *M. cabanerensis*, from central Spain. Another species was recognized by Hurkmans (unpublished manuscript, cited in Milankov et al., 2008b) as *M. lydicus* Hurkmans, which was recorded in the Eastern Mediterranean. This latter species is formally described here as *M. neolydicus* Vujić, nom. n. One additional taxon belonging to the *desuturinus* group, *M. murorum* Fabricius, 1794, was uncovered and we redescribed it here.

Milankov et al. (2008b) detected low genetic variability in a population of *M. desuturinus* and demonstrated that this taxon represents an evolutionarily independent lineage among *Merodon* taxa.

Radenković et al. (2018) found new members of the *desuturinus* group in South Africa, which are related to *Merodon melanocerus* Bezzi, 1915. Those records represent the first detailed characterisation of *Merodon* species in the Afrotropical Region using morphological and molecular data.

The aim of this paper is to present a revision of the Palaearctic species of the *Merodon desuturinus* group in order to clarify its taxonomy with the support of morphological characters, and to present an identification key for the adults of the species within this group.

Materials and methods

This study is based on the examination of all available material of the *Merodon desuturinus* species group (published and unpublished data), which has been deposited in the museums, universities and private collections listed below. The following acronyms for museums and entomological collections are used in the text:

AEU	University of the Aegean, Mytilene, Greece
AMNH	American Museum of Natural History, New York
BMNH	Natural History Museum, London
CEUA	Colección Entomológica Universidad de Alicante, Spain
FSUNS	Faculty of Science, University of Novi Sad
KBIN	Royal Belgian Institute for the Natural Sciences, Brussels, Belgium
MNHN	Musee National d'Histoire Naturelle, Paris, France
MNMS	Museo Nacional de Ciencias Naturales, Madrid, Spain
MZH	Finnish Museum of Natural History, University of Helsinki, Finland
NHMB	Prirodnjački Muzej Beograd, Serbia
NHMW	Naturhistorisches Museum Wien, Austria
NMNL	National Museum of Natural History Naturalis, Leiden, Netherlands
TAU	Tel Aviv University, Israel
ZMHB	Zoologisches Museum of the Humboldt University, Berlin, Deutschland
ZMUC	Zoological Museum, University of Copenhagen, Denmark
WML	World Museum Liverpool, UK
coll. C. Palmer	Private collection of Chris Palmer, United Kingdom
coll. E. Gilasian	Private collection of Ebrahim Gilasian, Iran
coll. M. Taylor	Private collection of Mike Taylor, United Kingdom
coll. V. Weyer	Private collection of Guy Van de Weyer, Belgium

The characters used in the key, descriptions, and drawings follow the terminology established by Thompson (1999), except for the term "pleuron", which follows McAlpine (1981), and those relating to male genitalia are according to Marcos-García et al. (2007). Colour characters are described from dry-mounted specimens. Male genitalia were stored in microvials containing glycerol after clearing in warm 10% potassium hydroxide (KOH) for a few minutes and neutralising in acetic acid for 5–10 seconds.

The following abbreviations are used: **f** = female, **m** = male.

All information on the specimens (locality, collector, coordinates, etc.) is presented under the description of the respective examined material. The capture locations (geographical coordinates) were entered into the GenGIS (v2.5.1) software to generate the distribution map (Parks et al. 2013).

Diagnoses of species were made according to unique characters attributable to the group, complex, and species considered here, and also to combinations of characters that enabled taxa to be distinguished and recognised. The type material of the included species was examined by Ante Vujić. Drawings were made with an FSA 25 PE drawing tube and digital photographs were taken with a Leica DFC 320 digital camera, both of which were attached to a Leica MZ16 binocular microscope.

Results

Diagnostic characters and diversity of the *Merodon desuturinus* species group

The *M. desuturinus* species group sensu Mengual et al. (2006) is characterised by the following adult morphological characters: posterior side of mesocoxa with pile; anterior surstyle lobe with a curved distal prolongation (dp in Figs 1B, 9B, 11B, 12B, 14B); the specific shape of the lateral sclerite of the aedeagus (gradually tapered, with the tip curved downwards) is the main synapomorphic character that connects all species from the group (s in Figs 1C, D, 9C, 11C, 12D, 14C, 16) (Vujić et al. 1995, Milankov et al. 2008b). The *M. desuturinus* species group is closely related to the *albifrons* group (Mengual et al. 2006), which has been designated as an *albifrons*+*desuturinus* clade in Radenković et al. (2018).

The *M. desuturinus* group consists of two clearly separate lineages, Palaearctic and Afrotropical based on both adult morphological and molecular data (Radenković et al. 2018). The main morphological diagnostic character that distinguishes these two lineages is the presence of a strong dense yellow to red brush of pile on the metatrochanter of Afrotropical species, which Palaearctic taxa lack. Besides the taxon *M. desuturinus*, the Palaearctic lineage of this species group includes three additional species, one western Mediterranean endemic (*M. cabanerensis*) and two species presented here.

The Afrotropical lineage of the *M. desuturinus* group (Radenković et al. 2018) comprises nine taxa arising from a revision of the *M. melanocerus* subgroup (*Merodon capensis* Hurkmans, 2018; *Merodon commutabilis* Radenković & Vujić, 2018; *Merodon drakonis* Vujić & Radenković, 2018; *Merodon flavocerus* Hurkmans, 2018; and *Merodon melanocerus* Bezzi, 1915) and the *Merodon planifacies* subgroup (*M. planifacies* Bezzi, 1915, *Merodon stevensoni* Curran, 1939 and one undescribed species so far) with a reduced oral margin covered by microtrichia as a clear apomorphic character (Fig. 2A). The other Afrotropical species of the group, *Merodon cuthbertsoni* Curran, 1939, which is morphologically related to *M. desuturinus*, is redefined here.

General description of the *Merodon desuturinus* species group

Male. *Head* (Figs 2, 3, 4): Antenna (Fig. 4) usually dark brown; basoflagellomere generally short, as long as broad (except in *M. flavocerus* where it is light brown and longer), concave dorsally, with acute apex; arista light brown to dark brown, thickened basally, 1.5-2 times longer than basoflagellomere, covered with dense brown microtrichia. Face covered with long whitish yellow pile, except on median bare vitta that occupies 1/4 width of face. Frons black, often with bronze film and indistinct microtrichia that, at face level, follow a narrow line along the eye margin. Vertical triangle isosceles (Fig. 3), black (brown-red in *M. flavocerus*) and shiny (except at anterior end covered with microtrichia), predominantly covered with long, black, thick pile, except at posterior end with light yellow pile. Eye pile dense, as long as scape, often pale, but can be

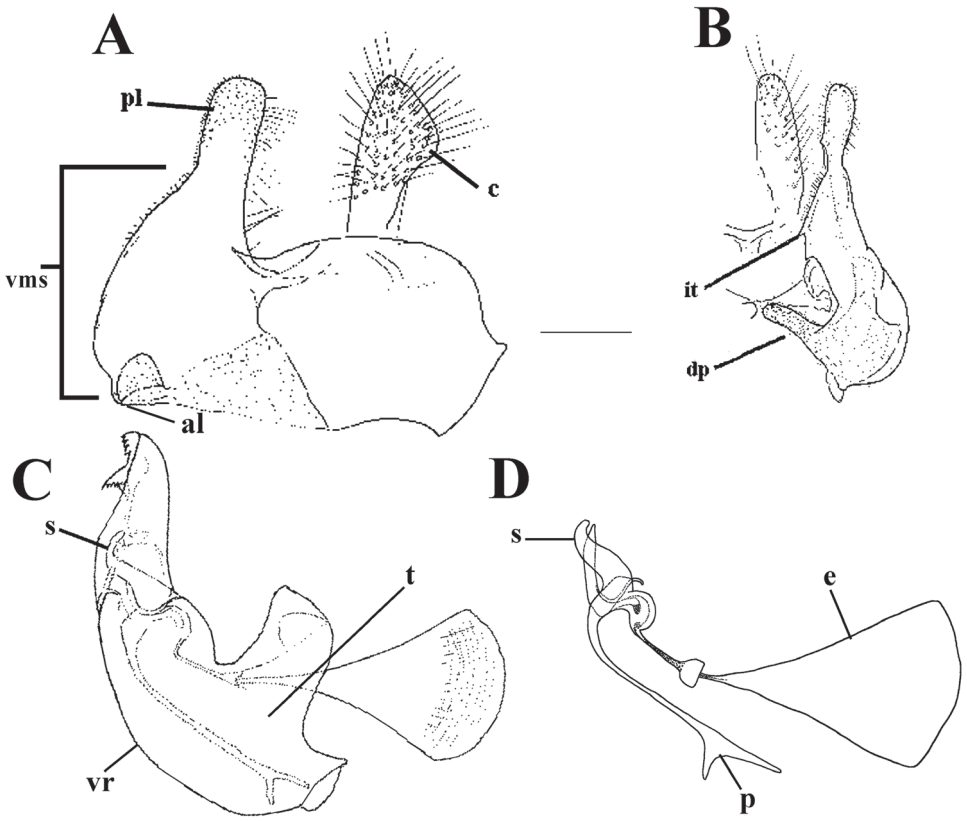

Figure 1. *Merodon neolydicus* Vujić, nom. n. male genitalia. **A** Epandrium, lateral view **B** Epandrium, ventral view **C** Hypandrium, lateral view **D** Aedeagous. Abbreviations: **al**-anterior surstyle lobe, **pl**-posterior surstyle lobe, **c**-cercus, **e**-ejaculatory apodeme, **p**-phallapodeme, **s**-lateral sclerite of aedeagus, **it**-inner thorn on medial part of surstylus, **dp**-distal prolongation on anterior surstyle lobe, **vms**-ventral margin of surstylus, **vr**-ventral ridge of theca, **t**-theca. Scale bar: 0.2 mm.

darker dorsally. Occiput covered with whitish yellow pile, dorsally with metallic, bluish or bronze lustre; white microtrichia from upper eye corner as a narrow line dorsally, becoming dense and wide laterally and ventrally, occupying the lower 2/3 of occiput.

Thorax (Fig. 5): Scutum and scutellum black with bronze lustre (in *M. flavocerus* postpronotum and posterior rim of scutellum pale yellow), covered with relatively long (as long as or a little longer than basoflagellomere), dense, erect, more or less branched and usually yellow pile (in *M. capensis* and *M. commutabilis* mixed with black pile); presence of microtrichia variable (from well-developed in *M. drakonis* to absent in *M. capensis*). Pleuron often covered with grey-green microtrichia (lacking in *M. flavocerus*) and the following parts with long yellow pile: posterior part of anterior anepisternum, posterior anepisternum (except anteroventral part), anepimeron, metasternum, and anterior, posterodorsal and posteroventral parts of katepisternum; katatergum with dense, erect, short, yellowish or light brown pile. Wing hyaline, with dense microtri-

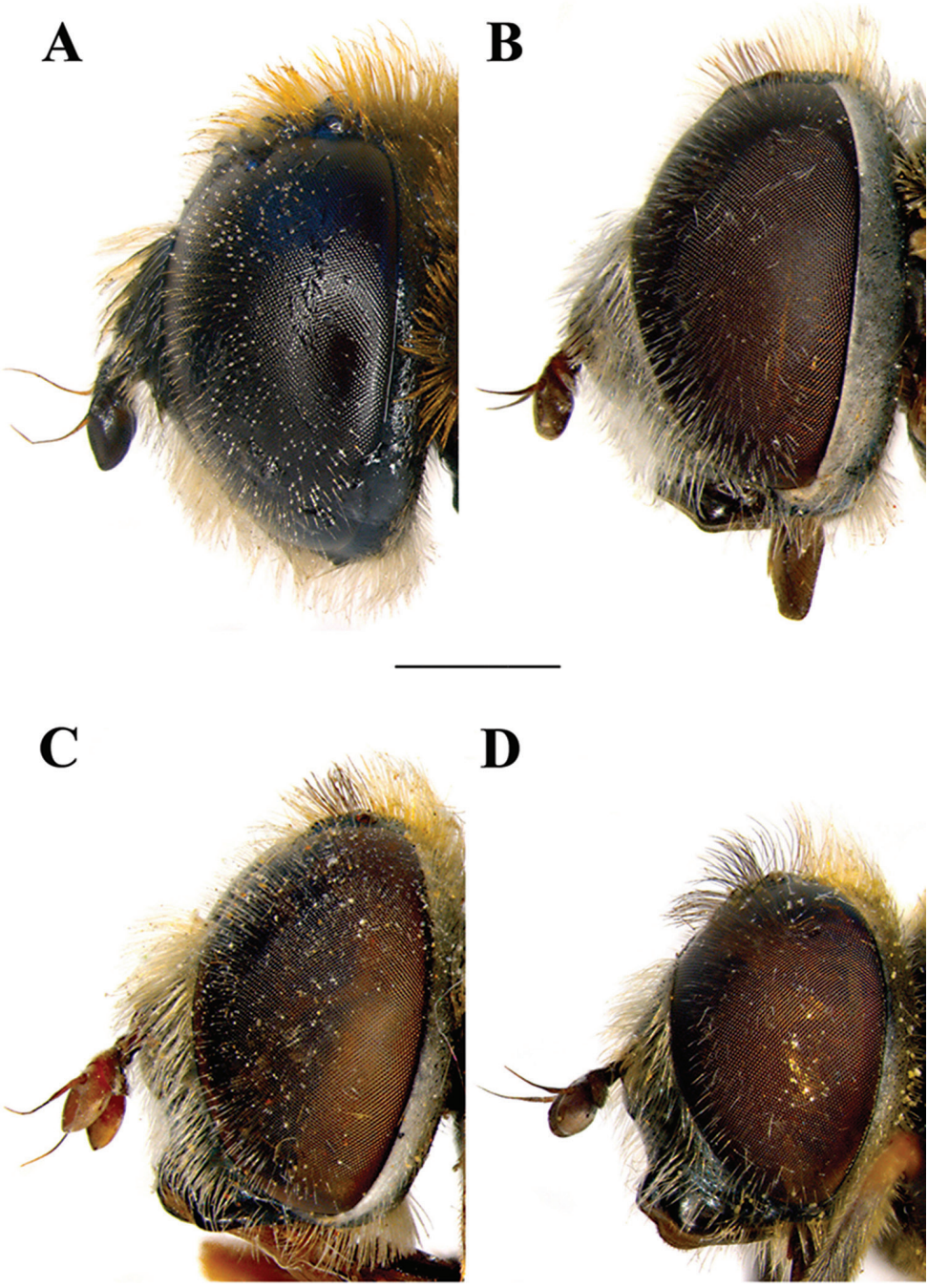

Figure 2. Male head, lateral view. **A** *Merodon planifacies* **B** *Merodon neolydicus* Vujić, nom. n. **C** *Merodon murorum* **D** *Merodon desuturinus*. Scale bar: 2 mm.

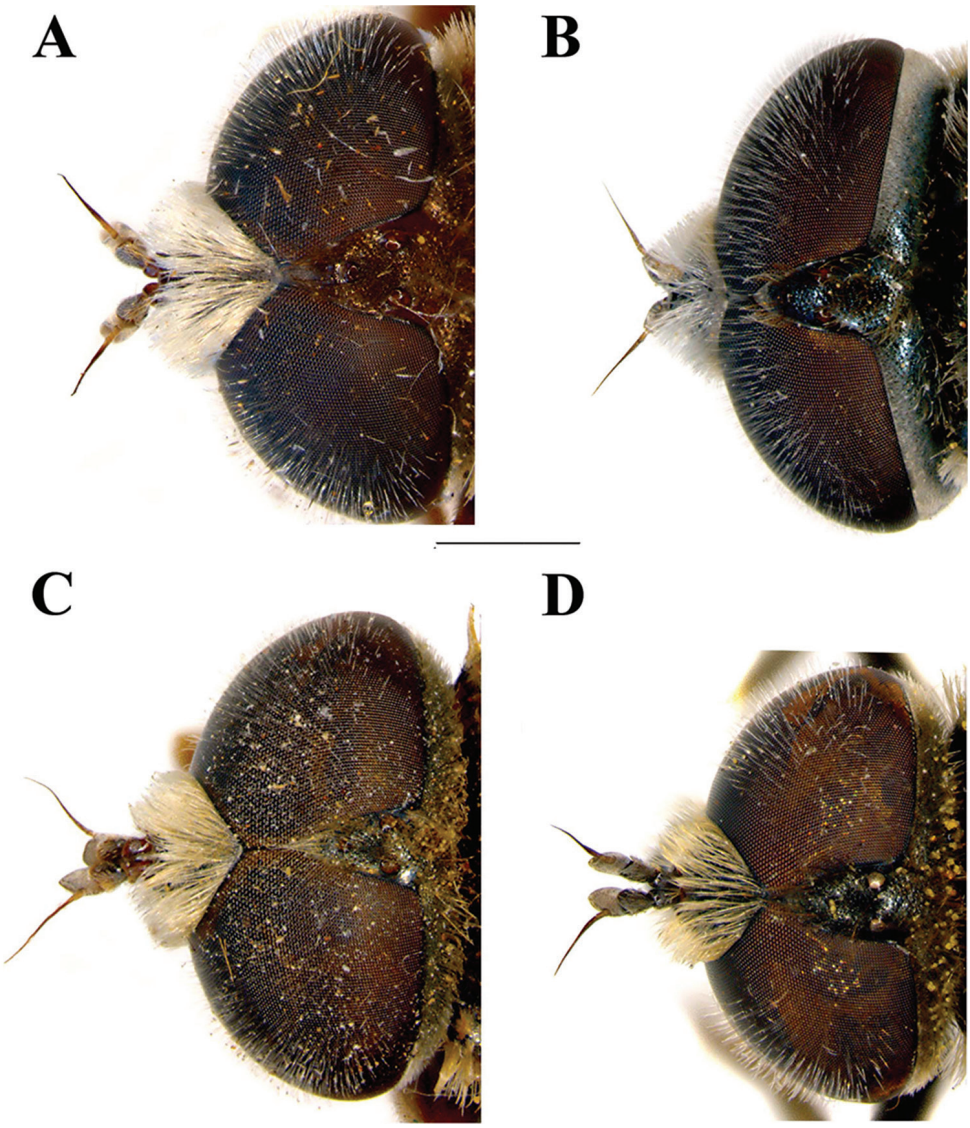

Figure 3. Male head, dorsal view. **A** *Merodon flavocerus* **B** *Merodon neolydicus* Vujić, nom. n. **C** *Merodon murorum* **D** *Merodon desuturinus*. Scale bar: 2 mm.

chia and light brown to dark brown veins. Calypter yellow. Haltere with brown pedicel and yellow to brown capitulum. Legs usually dark brown-black (light brown in *M. flavocerus* and *M. murorum*), except in some cases for paler knees and paler bases and apexes of tibiae; colour of tarsi varies. Metatrochanter lacks processes, covered with yellow to orange pile. Metafemur moderately thickened and straight or slightly curved (Fig. 5). Metatibia with inconspicuous apical, anteroventral spur and indications of a

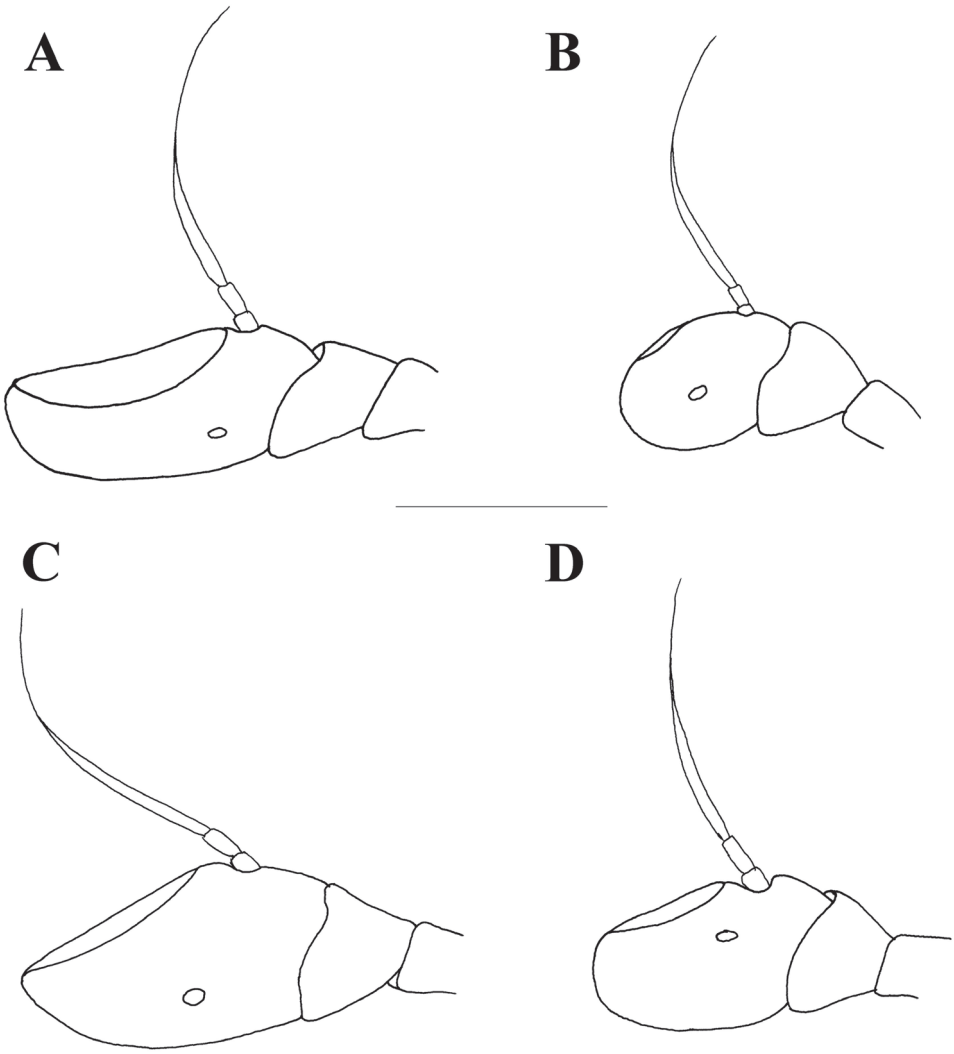

Figure 4. Male antennae, lateral view. **A** *Merodon flavocerus* **B** *Merodon desuturinus* **C** *Merodon murorum* **D** *Merodon neolydicus* Vujić, nom. n. Scale bar: 1 mm.

posteroventral spur. Pile on legs predominantly yellow, except for some short black pile on tarsi dorsally.

Abdomen (Fig. 6): Black with bronze reflections, slightly tapering, as long as mesonotum. Terga 2-4 black with more or less distinct transverse fasciae of white microtrichia interrupted in the middle (can be connected on tergum 4); tergum 2 in some taxa with pair of antero-lateral orange maculae (lacking in *M. capensis*, *M. cuthbertsoni*, *M. commutabilis*, *M. cabanerensis*, and *M. desuturinus*, all of which have dark terga), or areas covered with long, dense, erect, yellow pile; pilosity on lateral sides of terga long, erect and whitish, adpressed on central parts, and white on mictrotichose transversal

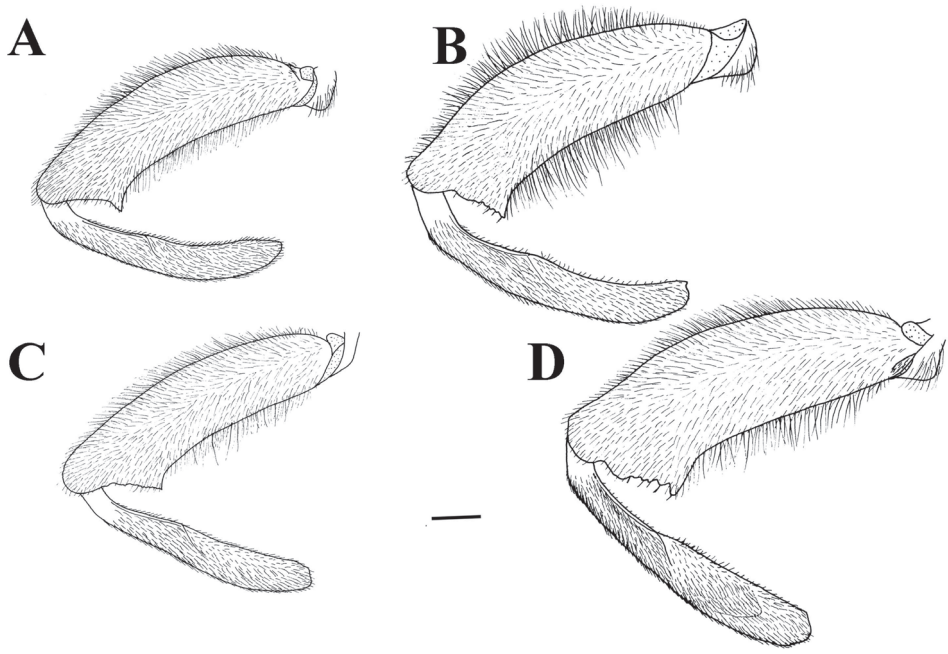

Figure 5. Metaleg, lateral view. **A** *Merodon neolydicus* Vujić, nom. n., male **B** *Merodon murorum*, male **C** *Merodon neolydicus* Vujić, nom. n., female **D** *Merodon murorum*, female. Scale bar: 1 mm.

fasciae, posterior 2/3 of tergum 4 and also on the posterior margin of terga 2-3 of most of the species (otherwise black). Sternum dark brown (except in *M. flavocerus* in which it is yellow) and shiny, covered with very long, pale yellow pile.

Male genitalia: Posterior surstyle lobe triangular, usually pointed apically (pl in Figs 11A, 12A, 14A, 15); ventral margin of surstylus straight (vms in Fig. 1A) or convex (vms in Fig. 14A); anterior surstyle lobe bent inwards; median part of surstylus with one or two inner thorns (it in Figs 1B, 9B, 11B, 12B, 14B, 15D); cercus elongated (c in Figs 1A, 9A, 11A, 12A, 14A). Hypandrium with broad theca (as in Figs 9C, 12D: t). Lateral sclerite of aedeagus narrow, gradually tapered, with the tip curved downwards (s in Figs 1C, 9C, 12D, 14C, 16A).

Female: Similar to the male except for typical sexual dimorphism (Figs 5C, D, 7, 8).

Length: medium-sized species, body 10–13 mm, wing 6–9 mm.

Species of the Palaearctic lineage of the *Merodon desuturinus* species group

Merodon cabanerensis Marcos-García, Vujić & Mengual, 2007

Figs 6D, 9, 10

Diagnosis. Small (8–11 mm) dark species with narrow abdomen, oral margin notched, evident, basoflagellomere small, 1-1.1 times as long as broad, legs dark. Terga mostly

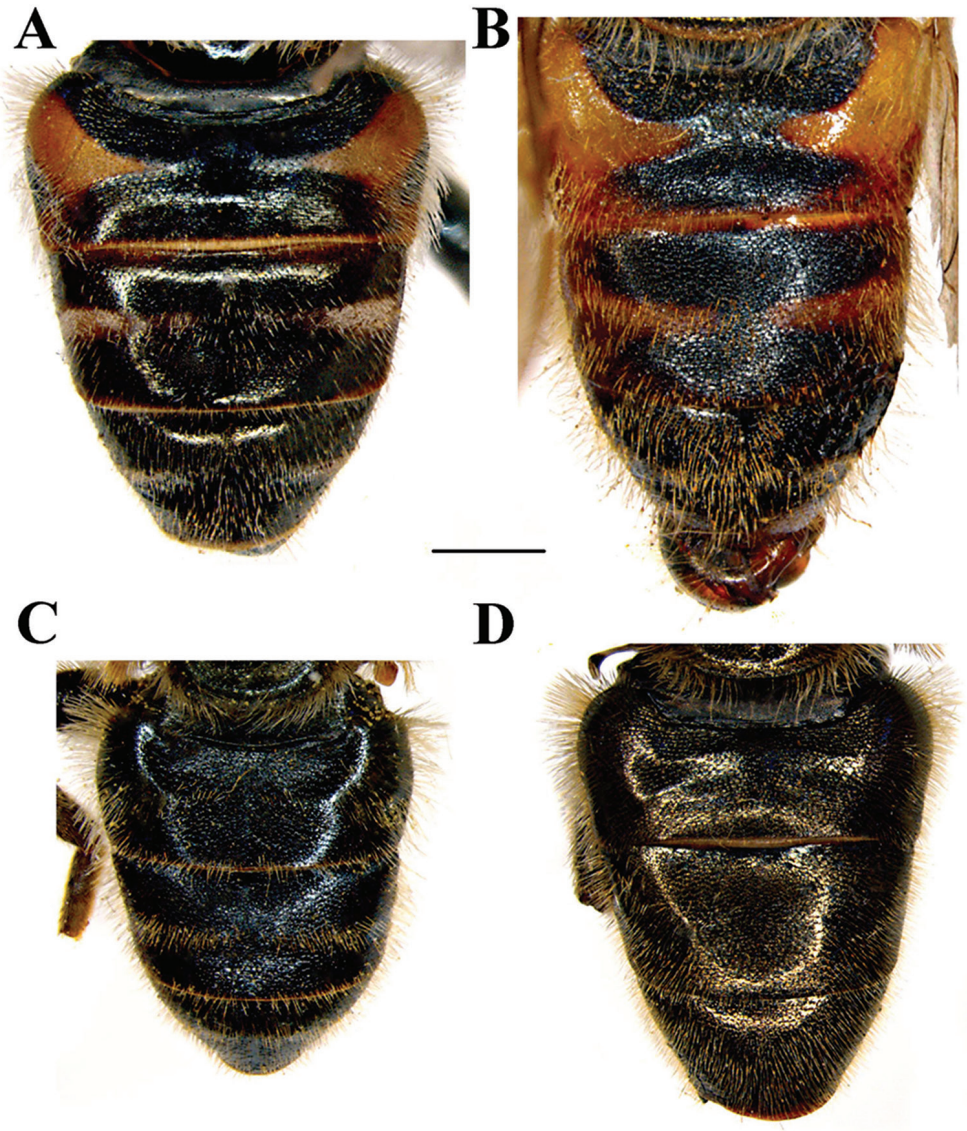

Figure 6. Male abdomen, dorsal view. **A** *Merodon neolydicus* Vujić, nom. n. **B** *Merodon murorum* **C** *Merodon desuturinus* **D** *Merodon cabanerensis*. Scale bar: 2 mm.

black, terga 2–4 with or without only a trace of transverse pair of microtrichose fasciae. Males: eye contiguity 8–10 facets long. Male genitalia with smooth thecal ridge, posterior surstyle lobe very narrow in apical half with parallel margins (Fig. 9). Similar to *M. neolydicus* nom. n., from which it differs by its smaller size (10–13 mm in *M. neolydicus* nom. n.), the shape of the male genitalia (Figs 1, 9), and its distribution (*M. cabanerensis* is found in the Western Mediterranean and *M. neolydicus* nom. n. occurs in the Eastern Mediterranean).

Examined material. Type material. Holotype: male, pinned, in CEUA. Original label: "Spain, Ciudad Real, Canalejas, P. N. de Cabañeros, 39°24'17.03"N, 4°30'35.73"W, 19.iii.2004, leg. A. Ricarte".

Paratypes: **Spain**: 1m+1f, Ciudad Real, Canalejas, P. N. de Cabañeros, 39°24'17.03"N, 4°30'35.73"W, 19.iii.2004, leg. A. Ricarte (CEUA); 1m, Ciudad Real, Canalejas, P. N. de Cabañeros, 39°24'17.03"N, 4°30'35.73"W, 19.iii.2004, leg. A. Ricarte (MNMS); 1m, Ciudad Real, Canalejas, P. N. de Cabañeros, 39°24'17.03"N, 4°30'35.73"W, 19.iii.2004, leg. A. Ricarte (FSUNS).

Additional material. Morocco: 1m, Azilal, Ait Mhamed, 31°52'19.39"N, 6°29'6.72"W, 1700m, 26.iii.2013, leg. J. Dils, J. Faes (V.Weyer coll.).

Distribution. Iberian Peninsula and Morocco (Fig. 10).

Merodon desuturinus Vujić, Šimić & Radenković, 1995

Figs 2D, 3D, 4B, 6C, 7C, 8B, 10, 11, 13B

Diagnosis. Small (8–11 mm) dark species with dark legs; small and short basoflagellomere, 1–1.1 times as long as broad (Fig. 4B); oral margin notched, evident; narrow abdomen. Terga 2–4 with or without pair of narrow transversal microtrichose fasciae (Fig. 6C). Males: eyes almost touching (approaching) (Figs 3D, 13B). Male genitalia: hypandrium with smooth thecal ridge (Fig. 11C), posterior surstyle lobe elongated and triangular (Fig. 11A). Unique Palaearctic species with eyes almost touching (Fig. 3D). Female similar to *M. cabanerensis*, from which it can be separated by its distribution (*M. desuturinus* occurs in the Balkan Peninsula, whereas *M. cabanerensis* is distributed in the Iberian Peninsula).

Examined material. Type material. Holotype: male, pinned, in NHMB. Original label: "Srbija, Kopaonik, Čukara-Jablanova ravan, 43°12'15.00"N, 20°50'13"E, 22.v.1993, leg. Vujić".

Paratypes: **Serbia**: 18m+3f, Kopaonik, Čukara-Jablanova ravan, 43°12'15.00"N, 20°50'13"E, 1300-1400m, 22.v.1993, leg. Vujić (FSUNS), 1m+1f, leg. Radenković (NHMB); 11m+14f, Kopaonik, Čukara, 43°12'14.96"N, 20°50'12.95"E, 1400m, 23.v.1993, leg. Vujić (FSUNS); 1m+5f, Kopaonik, Jasle-Čukara, 43°16'36.91"N, 20°46'37.09"E, 1400-1500m, 20.v.1986, leg. Radnović, Vujić (FSUNS); 12m+4f, Kopaonik, Jasle-Čukara, 43°16'36.91"N, 20°46'37.09"E, 1400-1500m, 23.v.1993, leg. Vujić (FSUNS); 1m+1f, Kopaonik, Velika reka, 43°15'39.23"N, 20°50'5.64"E, 1300m, 23.v.1986, leg. Radnović, Vujić (FSUNS).

Additional material. Serbia: 1f, Kopaonik, Jasle-Čukara, 43°16'36.91"N, 20°46'37.09"E, 8.vi.1998, leg. Vujić (FSUNS); 1f, Kopaonik, Jasle-Čukara, 43°16'36.91"N, 20°46'37.09"E, 20.vi.1996 (FSUNS); 3m+1f, Kopaonik, 43°15'N 20°49'59.98"E, 7.vi.1998 (FSUNS); 3f, Kopaonik, Jasle-Čukara, 43°16'36.91"N, 20°46'37.09"E, 16.vi.2012, leg. Vujić (FSUNS); 1m+1f, Stara planina, Dojkinci 2, 43°15'0.07"N, 22°46'36.07"E, 01.v.2017, leg. Vujić (FSUNS); **Montenegro**: 1f, Orjen, Vratlo, 42°30'33.06"N, 18°33'25.53"E, 1.vi.2011, leg. Vujić (FSUNS); 1m, Dur-

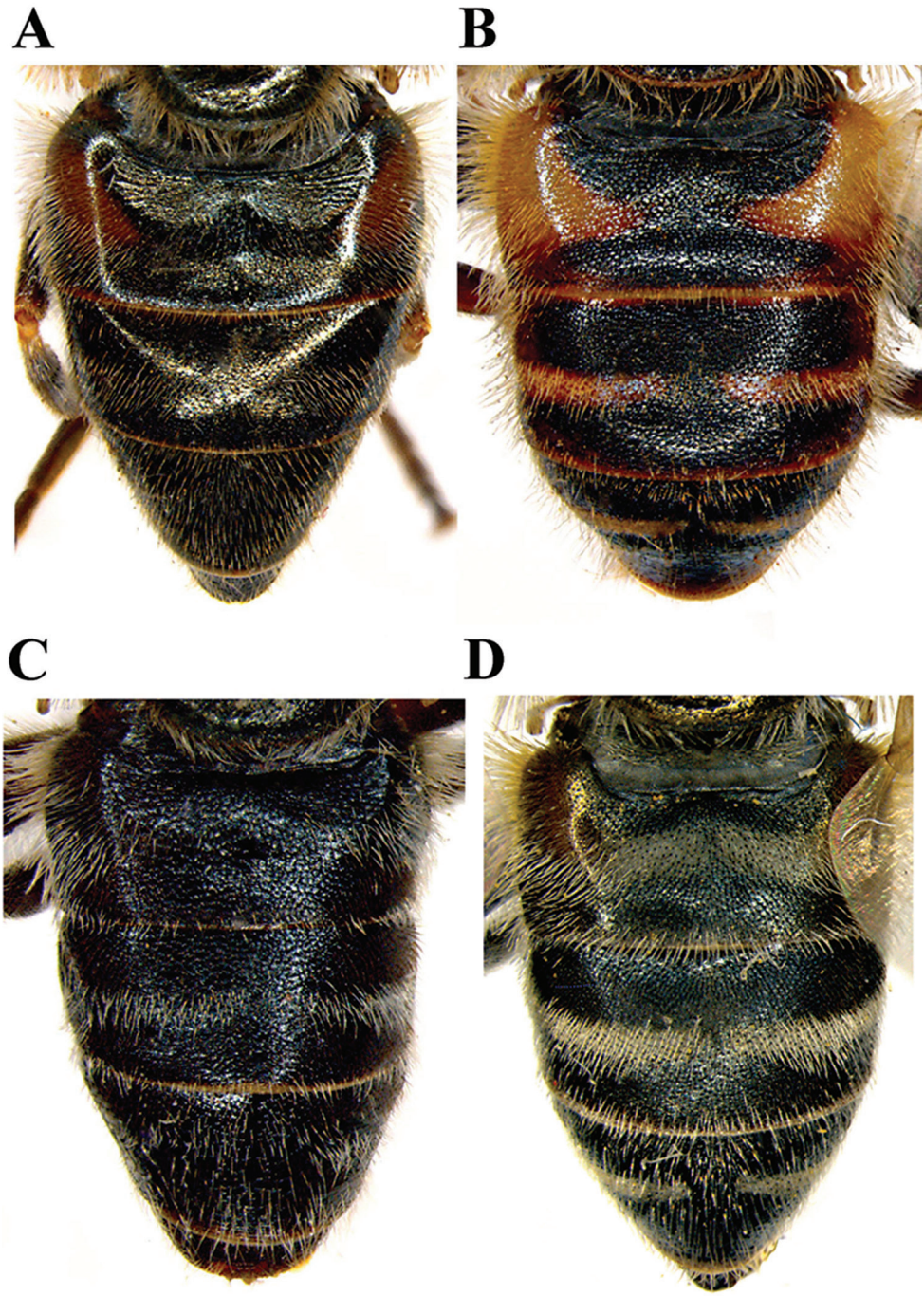

Figure 7. Female abdomen, dorsal view. **A** *Merodon neolydicus* Vujić, nom. n. **B** *Merodon murorum* **C** *Merodon desuturinus* **D** *Merodon commutabilis*. Scale bar: 2 mm.

mitor, kanjon Sušice, 43°9'29.68"N, 18°59'39.22"E, 21.vi.1998 (FSUNS); 8f, Durmitor, Aluge, 43°8'51"N, 19°15'20.00"E, 5.vi.2016, leg. Vujić, Veličković (FSUNS); 1m, Durmitor, Krecmani, 43°8'26.08"N, 18°59'53.00"E, 22.vi.1998 (FSUNS); 1m, Durmitor, jezerska površ, 43°8'46.00"N, 19°5'33.00"E, 21.v.1998 (FSUNS); 1m, Durmitor, kanjon Komarnice, 43°0'13.00"N, 18°57'3.99"E, 21.v.1998 (FSUNS); 1m, Durmitor, Luke, 42°42'55.02"N, 19°70"E, 1.vi.1994 (FSUNS).

Distribution. High mountains of the Balkan Peninsula (Fig. 10).

Merodon neolydicus Vujić, nom. n.

Figs 1, 2B, 3B, 4D, 5A, 5C, 6A, 7A, 8D, 10, 19A

Note. New name for *M. lydicus* Hurkmans in an unpublished manuscript, cited in Milankov et al. (2008b) and Miličić et al. (2018); *M. lydicus* is here designated a nom. nud.

Diagnosis. Dark species with broad abdomen. Oral margin only slightly notched (Fig. 2B). Basoflagellomere small, 1–1.2 times as long as broad (Figs 4D, 8D). Legs usually dark, except for pale knees. Metafemur with less developed apical triangular processes, only the apical thorn is distinct (Fig. 5A, C). Terga mostly black, terga 2 and 3 each can have small reddish lateral fasciae or maculae; transverse pair of distinct narrow microtrichose fasciate maculae on terga 2–4, approx. 1/8 of tergal length, which in some specimens can be absent from all terga (Figs 6A, 7A). Males: eye contiguity 9-12 facets long (Fig. 3B). Male genitalia with smooth thecal ridge, posterior surstyle lobe with parallel margins (Figure 1). Similar to *M. cabanerensis*, from which it differs by its larger size (10-13 mm for *M. neolydicus* nom. n. and 8-11 mm for *M. cabanerensis*), the shape of the male genitalia (Figs 1 and 9), and its distribution (*M. cabanerensis* is found in the Western Mediterranean and *M. neolydicus* nom. n. occurs in the Eastern Mediterranean).

Examined material. Type locality: Greece: Chios, Kato Fana, 38°12'27.72"N, 25°55'37.2"E.

Type material. Holotype: male, pinned, in WML. Original label: Chios, Kato Fana, 38°12'30.01"N, 25°55'43.81"E, 3.iv.2010, leg. M. J. Taylor.

Paratypes: **Israel**: 2 specimens, Jerusalem, Bet Hakerem, 31°46'31.72"N, 35°10'0.44"E, 17.iii.1951, leg. O. Theodor (NMNL); 1 specimen, Jerusalem, Wadi Ruaz, Bet Hakerem, 31°46'31.72"N, 35°10'0.44"E, 24.iii.1951, leg. O. Theodor (NMNL); 1 specimen, Jerusalem, Wadi Ruaz, Bet Hakerem, 31°46'31.72"N, 35°10'0.44"E, 10.iii.1957, leg. O. Theodor (NMNL); 2 specimens, Jerusalem, 21.iii.1929, leg. Y. Tapukin, det. *Lampetia hirsuta* by Sack (BMNH); 1 specimen, Jerusalem, Mountain Scopus, 15.vii.1930 (NMNL); 1m, Monfort, 33°2'35.15"N, 35°11'5.40"E, 10.iii.1981, leg, Frieidberg (TAU); 1f, Haifa, Har Carmel, 32°45'59.60"N, 35°1'19.027"E, 23.ii.1995, leg. J. A. W. Lucas (NMNL); 1m, Haifa, Har Carmel, 32°45'59.60"N, 35°1'19.027"E, 27.ii.1995, leg. J. A. W. Lucas (NMNL); 1f, Haifa, 32°45'59.60"N, 35°1'19.027"E, 26.ii.1977, leg. A. Freidberg, det. *Merodon hirsutus* by Hurkmans (TAU); **Greece**: 1m, Chios, Armolia, 38°16'20.28"N, 26°2'40.2"E, 3.iv.2012, leg. M. Taylor (AEU); 1f, Chios, Ag. Pateres, 38°22'19.92"N, 26°3'2.52"E, 24.iv.2002, leg. M. J. Taylor (M. Taylor coll.); 1f, Chios, Kato Fana, 38°12'27.72"N, 25°55'37.2"E, 30.iii.1998,

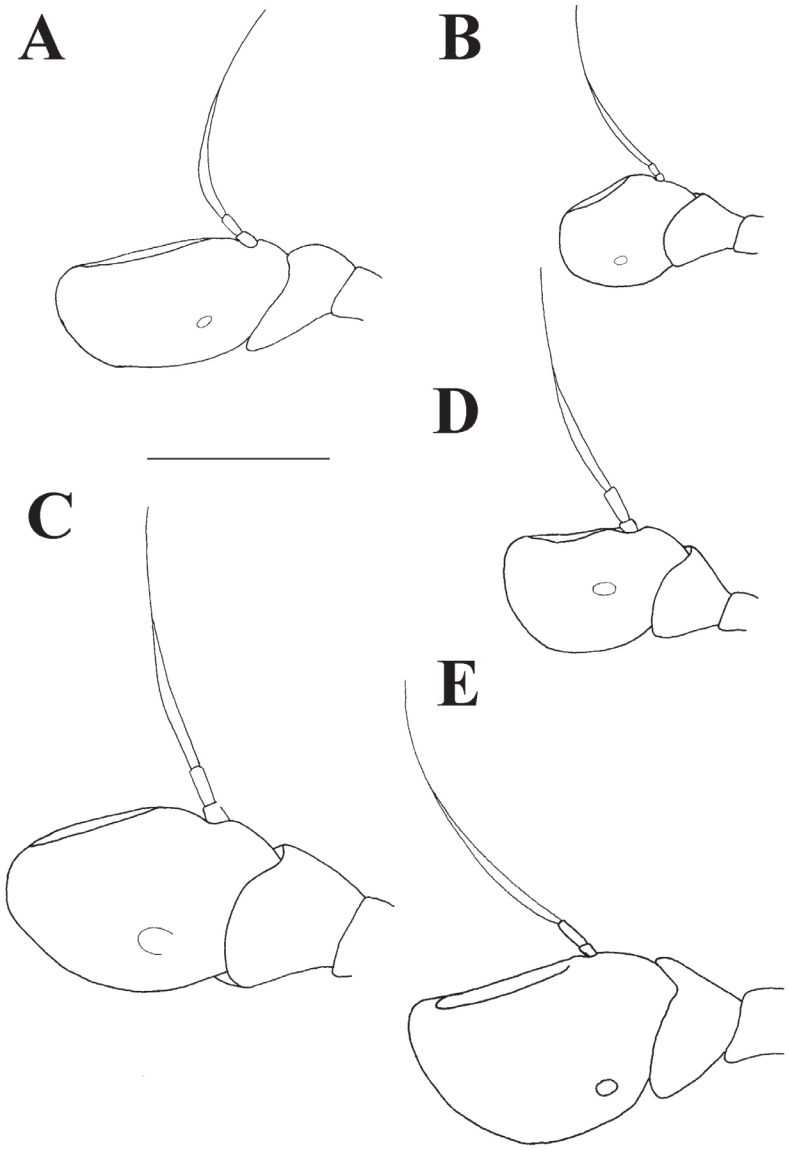

Figure 8. Female antennae, lateral view. **A** *Merodon flavocerus* **B** *Merodon desuturinus* **C** *Merodon murorum* **D** *Merodon neolydicus* Vujić, nom. n. **E** *Merodon commutabilis*. Scale bar: 1 mm.

leg. M. J. Taylor, det. *Merodon species 2* by C. Palmer (C. Palmer coll.); 6m, Chios, Kato Fana, 38°12'30.01"N, 25°55'43.81"E, 28.iii.2010, leg. M. J. Taylor (WML); 2m, Chios, Kato Fana, 38°12'30.01"N, 25°55'43.81"E, 26.iii.2010, leg. M. J. Taylor (WML); **Iran**: 1m, Yasug-Kakan, 30°35'58.99"N, 51°49'3"E, 2100m, 1-2.v.1996, leg. M. Hradsky (FSUNS); 1m, Esfahan, Semirom, Dolat Gharin, 31°32'5"N, 51°36'20"E, 2710m, 11.v.2007, leg. E. Gilasian (E. Gilasian coll.); 1m, Dascht Arajan, 38°30'29.99"N, 46°35'11"E, 20.iii.1965,

leg. Saf. (FSUNS); **Syria**: 1m+1f (other information missing) (NHMW); **Turkey**: 1m, Antalya, Finike, 36°23'52.11"N, 30°6'57.87"E, 50-100m, 7.iv.1964, leg. Guichard, Harvey (BMNH); 1m, Demirkazik, Kayseri, 37°49'0"N, 35°10'0"E, 12-13.vi.1993, leg. M. Hull (C. Palmer coll.); Amanus, 1914, leg. Tölg (NHMW); **Lebanon**: 1m, Hammana, Lebanon Mountains, 33°49'45.03"N, 35°42'54.81"E, 15.v.1953, leg. G. A. Mavromoustakis (KBIN); 1m, Hammana, Lebanon Mountains, 33°49'45.03"N, 35°42'54.81"E, 16.v.1953, leg. G. A. Mavromoustakis (KBIN); 1f, Beyrouth, 19.v.1953, leg. G. A. Mavromoustakis (KBIN).

Additional material. Turkey: 1f, Afyon, Suhut, 38°31'52"N, 30°32'45"E, 1000m, 9.v.1995 (FSUNS); 1m, Mardin Province, Mardin, 37°18'2"N, 40°45'32"E, 22.iv.2000 (NMNL); 1m, Nigde, 37°49'59.99"N, 34°45'0"E, 16.v.1961, det. *Merodon tricinctus* by Hurkmans (NMNL); **Israel**: 1f, Zova, 31°46'35.49"N, 35°7'7.205"E, 31.iii.1974, leg. M. Kaplan, det. *Merodon hirsutus* by Hurkmans (TAU); 1m, Beit Guvrim, 31°36'11.09"N, 34°54'3.94"E, 29.iii.1992, leg. A. Freidberg (TAU); 1m, Jerusalem, Wadi Ruaz Bet Hakerem, 31°46'31.72"N, 35°10'0.44"E, 29.iii.1952, leg. O. Theodor, det. *Lampetia hirsuta* by P. H. van Doesburg (NMNL); 1m, Lahav, 31°21'51.90"N, 34°51'17.96"E, 27.ii.1974, leg. A. Freidberg (TAU); 1m, Meged coastal plain, 32°1'46.87"N, 34°57'52.58"E, 27.i.1956, leg. O. Theodor, det. *L. annulata* by Doesburg (TAU); 2m, Meged, 32°1'46.87"N, 34°57'52.58"E, 27.i.1951, leg. O. Theodor (TAU); 1m+1f, Meged coastal plain, 32°1'46.87"N, 34°57'52.58"E, 27.i.1951, leg. O. Theodor, det. *L. annulata* by Doesburg (TAU); 1f, Lahav, 31°21'51.90"N, 34°51'17.96"E, 26.iii.1978, leg. A. Freidberg, det. *Merodon alexei* by Hurkmans (TAU); 1m, HaDarom, Beersheba, 31°6'0"N, 34°38'60"E, 24.iii.1954, leg. O. Theodor, det. *Lampetia hirsuta* by P. H. Doesburg (NMNL); 1m+1f, Haifa, Mount Carmel, 32°43'43"N, 35°2'48"E, 24.ii.1995 (NMNL); 21m+2f, Haifa, Mount Carmel, 32°43'43"N, 35°2'48"E, 22-27.ii.1995 (NMNL); 1m, Mount Hermon, 32°43'34.10"N, 35°18'57.14"E, 1450m, 22.iv.1973, leg. D. Furth (TAU); 1m, Hazafon, Nahal Bezet, 33°4'59.9"N, 35°6'0"E, 22.iii.1974 (NMNL); 1m, N. Bezet, 33°4'59.9"N, 35°6'0"E, 22.iii.1974, leg. D. Furth (TAU); 1f, Jerusalem, Wadi Ruaz, Bet Hakerem, 31°46'31.72"N, 35°10'0.44"E, 22.iii.1952, leg. O Theodor, det. *Merodon natans* by Hurkmans (TAU); 1m, Jerusalem, Wadi Ruaz, Bet Hakerem, 31°46'31.72"N, 35°10'0.44"E, 22.iii.1952, leg. O. Theodor (TAU); 3m, Jerusalem, Wadi Ruaz, Bet Hakerem, 31°46'31.72"N, 35°10'0.44"E, 22.iii.1952, leg. O. Theodor, det. *Lampetia hirsuta* by P. H. van Doesburg (NMNL); 2m, Jerusalem, Bet Hakerem, 31°46'31.72"N, 35°10'0.44"E, 21.ii.1953, leg. O. Theodor, det. *Merodon natans* by Hurkmans (TAU); 3m, Jerusalem, Wadi Ruaz, Bet Hakerem, 31°46'31.72"N, 35°10'0.44"E, 21.ii.1953, leg. O. Theodore, 2 m det. *Lampetia hirsuta* by P. H. Doesburg (NMNL); 1m, Jerusalem, Meged, 32°1'46.87"N, 34°57'52.58"E, 21.i.1951, leg. O. Theodor (TAU); 1m, Mount Hermon, 32°42'34.10"N, 35°18'57.14"E, 1700m, 17.v.2009, leg. A. Freidberg (TAU); 5m, Hai Tanu, 15.iii.1975, leg. M. Kaplan, A. Freidberg (TAU); 4m, Tanuri, 15.iii.1975, leg. F. Kaplan (TAU); 1m, W. Faria, 15.ii.1979, leg. D. Furth (TAU); 1m, Hazafon, Montfort, 33°2'60"N, 35°13'60"E, 14.iii.1985 (NMNL); 1m, Montfort, 33°2'60"N, 35°13'60"E, 14.iii.1985, leg. A. Freidberg (TAU); 1m, Kefar Menahem, 31°43'46.45"N, 34°50'57.54"E, 11.iii.1993, leg. A. Freidberg (TAU); 1f, Hazafon, Montfort, 33°2'35.15"N, 35°11'5.40"E, 10.iii.1981 (NMNL); 8m+2f, Montfort, 33°2'35.15"N, 35°11'5.40"E, 10.iii.1981, leg.

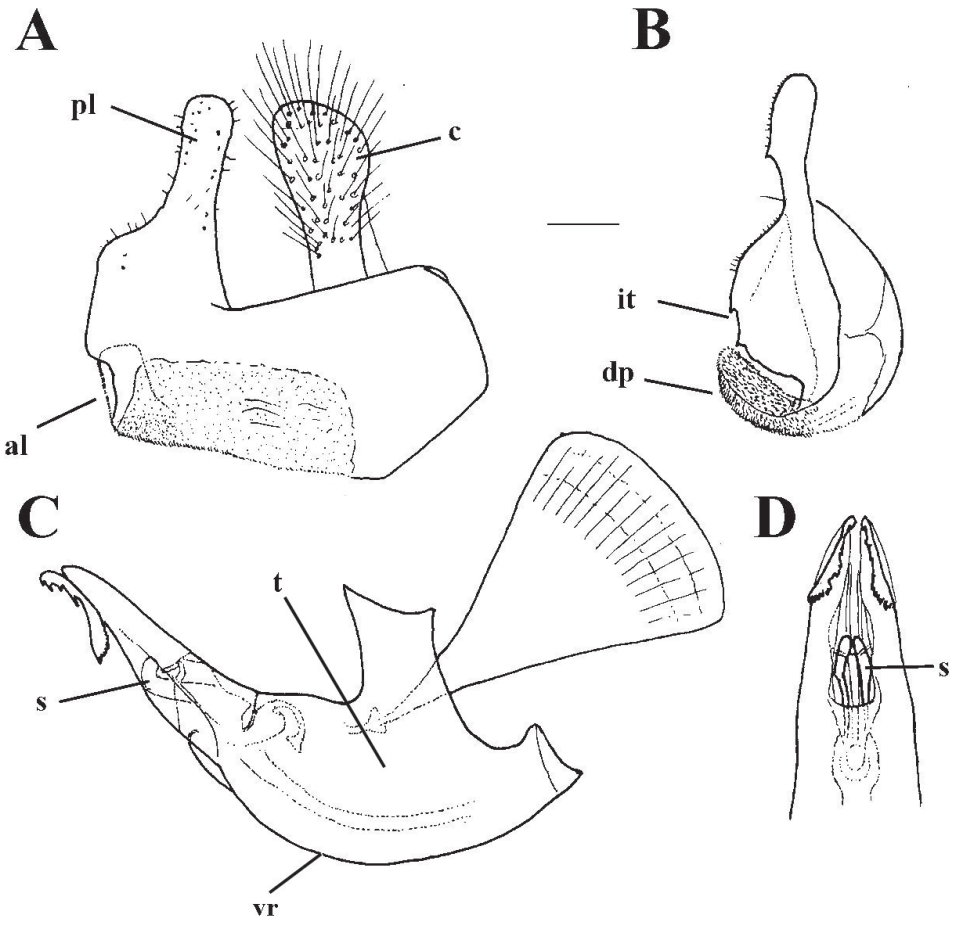

Figure 9. *Merodon cabanerensis* male genitalia. **A** Epandrium, lateral view **B** Epandrium, ventral view **C** Hypandrium, lateral view **D** Part of hypandrium, ventral view. Abbreviations: **al**-anterior surstyle lobe, **pl**-posterior surstyle lobe, **c**-cercus, **s**-lateral sclerite of aedeagus, **it**-inner thorn on medial part of surstylus, **dp**-distal prolongation on anterior surstyle lobe, **t**-theca, **vr**-ventral ridge of theca. Scale bar: 0.2 mm.

A. Freidberg, F. Kaplan (TAU); 1f, Carmel, 32°43'43"N, 35°2'48"E, 10.iii.1979, leg. R. King, det. *Merodon aeneus* by Hurkmans (TAU); 1m, Jerusalem, Wadi Ruaz, Bet Hakerem, 31°46'31.72"N, 35°10'0.44"E, 10.iii.195? (last digit of the year is unreadable in the specimen record) leg. O. Theodor, det. *Merodon natans* by Hurkmans (TAU); 1m, 8.iii.1975, det. *Merodon hirsutus* by Hurkmans (TAU); 1m, Montfort, 33°2'35.15"N, 35°11'5.40"E, 6.iii.2000, leg. A. Freidberg (TAU); 1m+1f, Nahal-kziv, 33°1'59.98"N, 35°13'35.99"E, 5.iii.2008, leg. L. Friedman, A. Fridberg (TAU); 1m, W. Faria, 5.iii.1973, leg. M. Kaplan (TAU); 1m, Montfort, 33°2'35.15"N, 35°11'5.40"E, 4.iii.1993, leg. A. Freidberg (TAU); 1f, N. Oren, 31°56'31.79"N, 34°58'17.26"E, 4.iii.1975, leg. F. Kaplan, det. *Merodon natans* by Hurkmans (TAU); 2m, N. Oren, 31°56'31.79"N, 34°58'17.26"E, 4.iii.1975, leg. F. Kaplan, M. Kaplan (TAU); 1f, Jerusalem, Bet Hakerem, Curum 10 km Bouch-

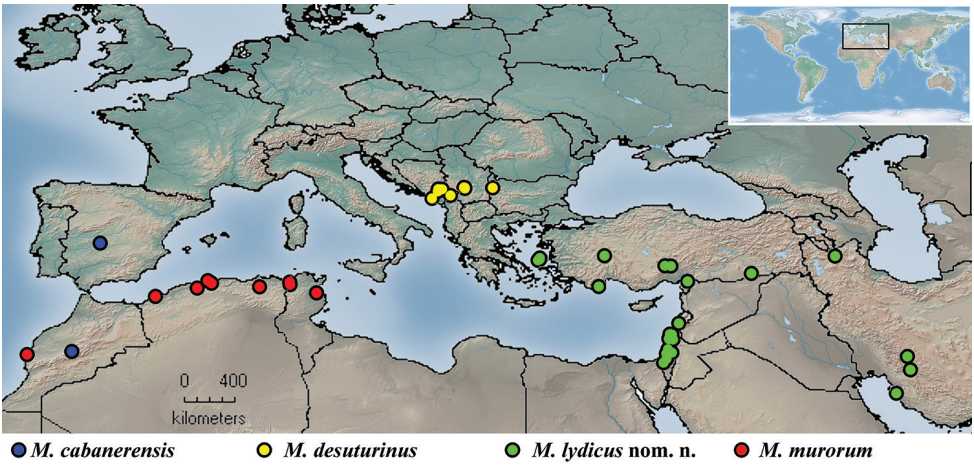

Figure 10. Distribution map of *Merodon cabanerensis*, *Merodon desuturinus*, *Merodon neolydicus* Vujić, nom. n., and *Merodon murorum*.

ir, 28°58'30"N, 50°50'17"E, 3.iii.1951 (NMNL); 2m, Bet Hakerem, 31°46'31.72"N, 35°10'0.44"E, 3.iii.1951, leg. O. Theodor, 1m det. *Merodon natans* by Hurkmans (TAU); 1m, Wadi Ruaz, Bet Hakerem, 31°46'31.72"N, 35°10'0.44"E, 3.iii.1951, leg. O. Theodor, det. *Lampetia annulata* by P. H. Doesburg (NMNL); 4m, Jerusalem, Wadi Ruaz, Bet Hakerem, 31°46'31.72"N, 35°10'0.44"E, 1.iv.1953, leg. O. Theodor, 3m det. *Merodon natans* by Hurkmans (TAU); 1m+1f, Jerusalem, Wadi Ruaz, Bet Hakerem, 31°46'31.72"N, 35°10'0.44"E, 1.iv.1953, leg. O. Theodor, det. *Lampetia hirsuta* by P. H. Doesburg (NMNL); 1m, Jerusalem, 1.iv.1953, det. *Lampetia* by P. H. Doesburg (NMNL); **Iran**: 1f, Curum, 10 km from Bouchir, 28°58'30"N, 50°50'17"E, 24.ii.1995, det. *Merodon tricinctus* by Hurkmans (NMNL); 1m, Fars, Kakan, Yasug, 30°35'58.99"N, 51°49'3"E, 2.v.1996 (NMNL); 1m, 1.iv.1936, det. *Merodon murina* (MZH); **unknown country**: 1f, 21.v.1904, leg. Aihalad (MZH).

Description. ***Male.*** *Head* (Figs 2B, 3B): Antenna (Figure 4D) brown to black, basoflagellomere 1.1–1.2 times as long as wide; arista dark brown. Vertical triangle isosceles, 2.2 times longer than eye contiguity. Vertex and face covered with whitish microtrichia, except for shiny oral margin. Ocellar triangle equilateral, black pilose. Frons with pale yellow pile. Eye contiguity approx. 9–12 facets long. Eye pile mostly pale.

Thorax: Scutum and scutellum black with bronze lustre, covered with dense, erect grayish or yellow pile. Scutum with barely visible 2 longitudinal microtrichose vittae. Wing hyaline with dark-brown veins, and densely covered with microtrichia, except basal edges of cells BM and CuP. Femora and tibiae brown-black, except for paler knees and base of tibiae; tarsi dark brown dorsally (except for usually paler tarsal segments on pro- and mesolegs), light brown ventrally. Pile on legs yellow. Metafemur (Figure 5A) slightly curved.

Abdomen: Terga 2 and 3 can have small reddish lateral triangular fasciae or maculae; terga 2-4 each with more or less distinct white transverse fascia of microtrichia interrupted in the middle (lacking in some specimens); pile on terga erect and whitish

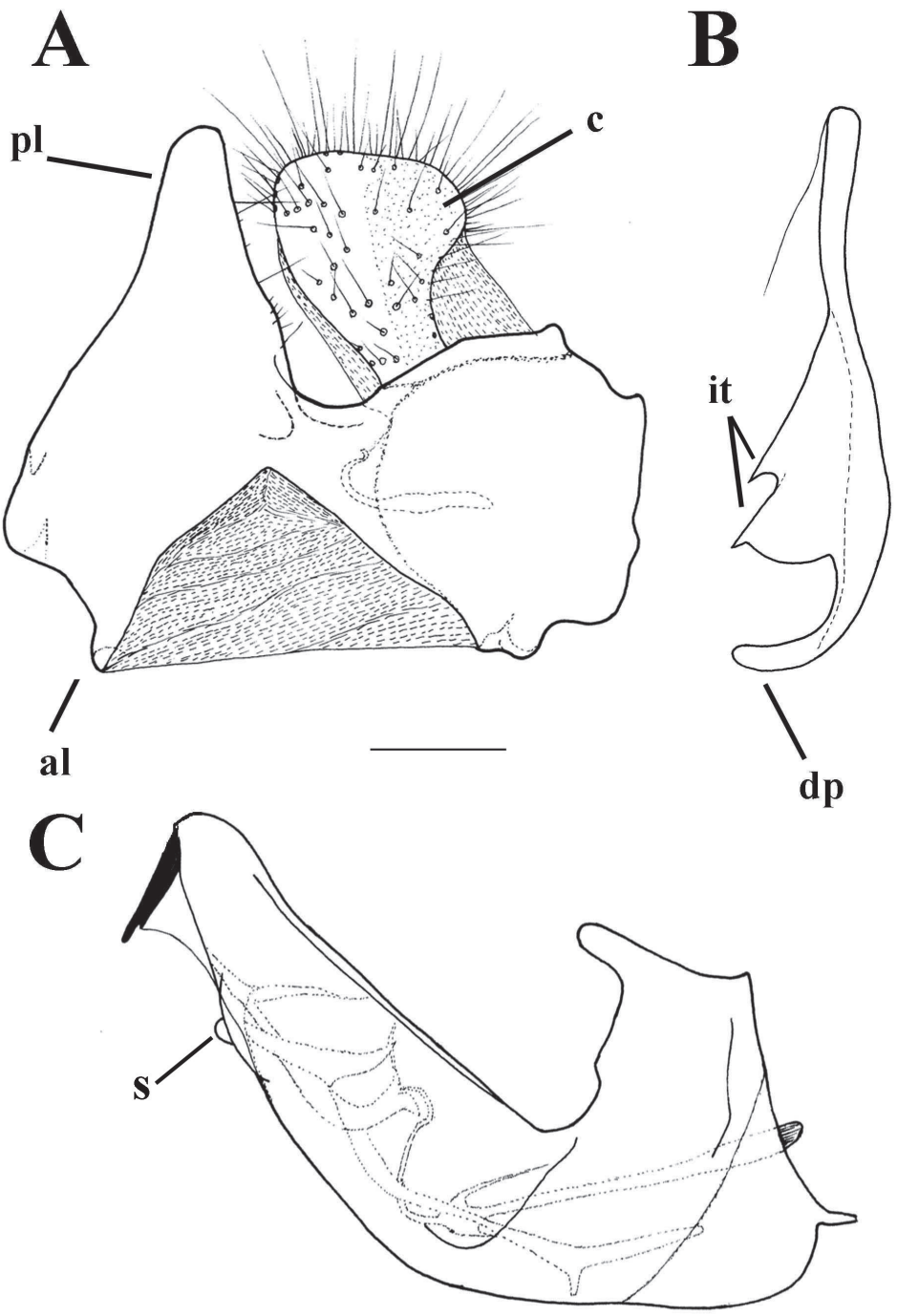

Figure 11. *Merodon desuturinus* male genitalia. **A** Epandrium, lateral view **B** Epandrium, ventral view **C** Hypandrium, lateral view. Abbreviations: **al**-anterior surstyle lobe, **pl**-posterior surstyle lobe, **c**-cercus, **it**-inner thorn on medial part of surstylus, **dp**-distal prolongation on anterior surstyle lobe, **s**-lateral sclerite of aedeagus. Scale bar: 0.2 mm.

yellow on lateral sides, but terga 2 and 3 medially with adpressed black pile, except for white pile on microtrichose bands (Figure 6A).

Male genitalia (Figure 1): Anterior surstyle lobe bent inwards (Figure 1B), with ventral margin slightly convex (Figure 1A); median parts of surstylus with one inner thorn (Figure 1B); posterior surstyle lobe wide and triangular, pointed apically (Figure 1A). Hypandrium wide, with smooth thecal ridge (Figure 1C).

Female (Figs 5C, 7A, 8D). Similar to the male except for typical sexual dimorphism and shiny frons with narrow line of microtrichia along eye margin, mostly covered with black pile. Postalar callus and postpronotum can be yellow-red or brown.

Etymology. The epithet *lydicus* is Latin, meaning "from Lydia", and refers to the region of origin of the holotype, viz. western Turkey, which once was included in the Kingdom of Lydia and *neo* refers to the new name for this species known from unpublished manuscript. It is to be treated as an adjective.

Distribution. Species distributed in the Eastern Mediterranean and Iran (Figure 10).

***Merodon murorum* (Fabricius, 1794)**
Figs 2C, 3C, 4C, 5B, 5D, 6B, 7B, 8C, 10, 12, 18B

Merodon auripilus Meigen, 1830: 354 **(syn. n.)**
Merodon murorum is redescribed and a neotype for *M. auripilus* is designated. Moreover, *M. auripilus* is considered a junior synonym of *M. murorum*.
Syrphus murorum Fabricius, 1794:

Type locality of *M. murorum*. North-West Africa [as "Barbaria"], historically a region that included Morocco, Algeria, Tunisia, and Libya.

Type material of *M. murorum*. Holotype: male, pinned, in ZMUC. Original label: "*S. murorum*".

Type locality of *M. auripilus*. Morocco, Essaouira [as "Mogador"].

Type material of *M. auripilus*. Holotype: Type presumably lost. Neotype: designated here, identified by Sack as *M. auripilus*: **Algeria**: 1m, Foret de Baïnen, 36°47'56.06"N, 2°58'20.11"E, 17.vi.1910, leg. Dr. J. Bequaert, det. *M. auripilus* by Sack (MNHN).

Examined material. Additional material. Algeria: 1m, Santa Cruz, Oran, 35°42'24.71"N, 0°39'46.35"W, leg. Dr. J. Bequaert, det. *M. auripilus* by Vujić 2008 (MNHN); 1f, Saint-Charles, 35°42'8.10"N, 0°40'37.27"W, 1902, leg. A. Thery, det. *M. auripilus* by Vujić 2008 (MNHN); 1m, Foret de Baïnen, 36°47'56.06"N, 2°58'20.11"E, 17.vi.1910, leg. Dr. J. Bequaert, det. *M. auripilus* by Vujić 2008 (MNHN); 1f, det. *M. algirus=albifrons* by Sack (ZMHB); 1m, 9.x.1893, leg. A. E. Eaton (NMNL); 1f, Maison Carreé, 36°41'0.40"N, 3°8'26.50"E, leg. Dr. J. Bequaert (MNHN); 1f, 9.x.1893, leg. A. E. Eaton, det. *M. auripilus* by Hurkmans 1990 and by Vujić 2005 (NMNL); 1f, iv.1908, leg. W. Rothschild, det. *M. auripilus* by Hurkmans (BMNH); 1f, Rivet, 36°37'9.99"N, 3°13'31.00"E, 10.v.1951, leg. K. M. Guichard, det. *M. rufus* by Hurkmans (BMNH); 1f, 12.iv.1898, leg. G. Ricardo, det. *Merodon rufus*

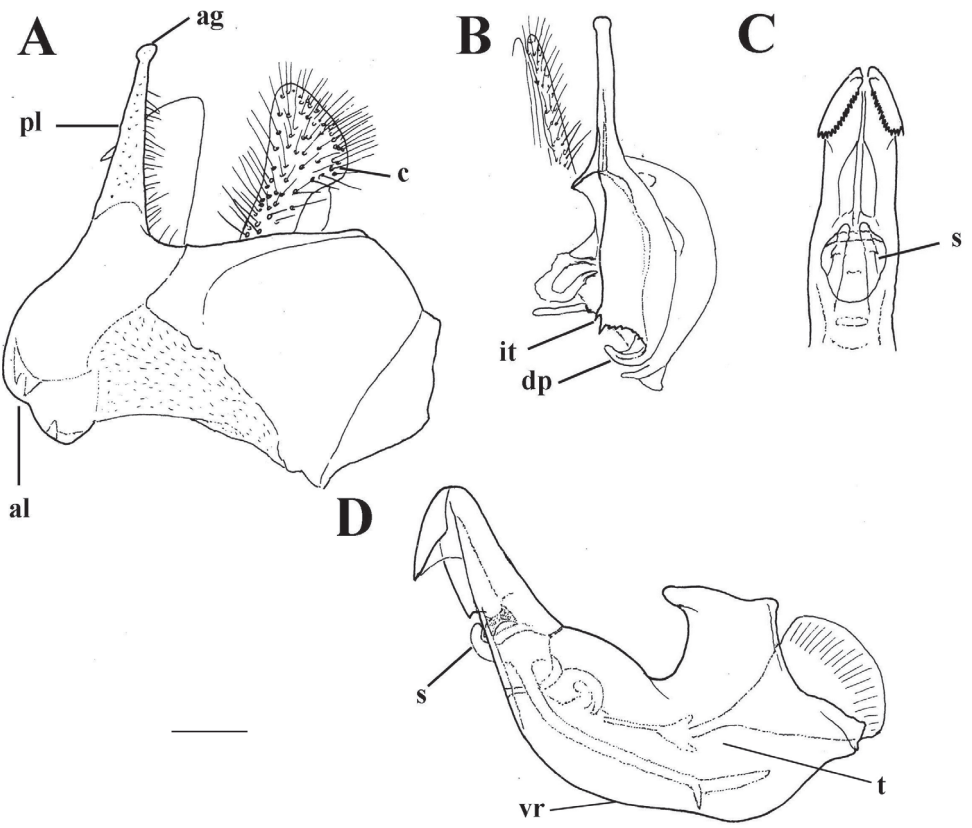

Figure 12. *Merodon murorum* male genitalia. **A** Epandrium, lateral view **B** Epandrium, ventral view **C** Part of hypandrium, ventral view **D** Hypandrium, lateral view, lateral view; **ag**-apical globule, **al**-anterior surstyle lobe, **pl**-posterior surstyle lobe, **c**-cercus, **s**-lateral sclerite of aedeagus, **it**-inner thorn on medial part of surstylus, **dp**-distal prolongation on anterior surstyle lobe, **vr**-ventral ridge of surstylus, **t**-theca. Scale bar: 0.2 mm.

by Hurkmans (BMNH); 1m, W. Tlemcen, Khemis, Rhar el Khal, 36°17'12.59"N, 2°13'42.39"E, 10.iv.1981 (NMNL); 1m, Constantine, Constantine, 36°22'9.87"N, 6°33'45.33"E, 9.vi.1895 (NMNL); **Tunisia**: 1m, (ZMHB); m, det. *Lampetia auripila* (MNHN); 1f, Jundubah, 25 km SE Ain Draham, 36°41'50.22"N, 8°39'47.39"E, 10-16.v.1988, det. *M. auripilus* by Vujić 2008 (ZMUC); 1m, Jundubah, 40 km from Jendouba, 36°31'14.09"N, 8°41'30.32"E, 17.v.1988 (ZMUC); 1m, Hergla, salt lake south of Hergla, 35°56'57.84"N, 10°31'38.20"E, 8.iv.1988, leg. R. Schouten, det. *Merodon auripilus* by Hurkmans (NMNL); **country unknown**: 1m, det. *M. auripilus* by Vujić 2008 (MNHN).

Diagnosis. Reddish species with long pale pile on the lateral sides of terga (Figs 6B, 7B). Terga 2 and 3 each with reddish triangular transverse maculae (Figs 6B, 7B). Basoflagellomere orange-brown (Figure 2C). Metafemur with strong apical triangular process (Figure 5B). Males: eye contiguity approx. 12 facets long (Figure 3C). Male

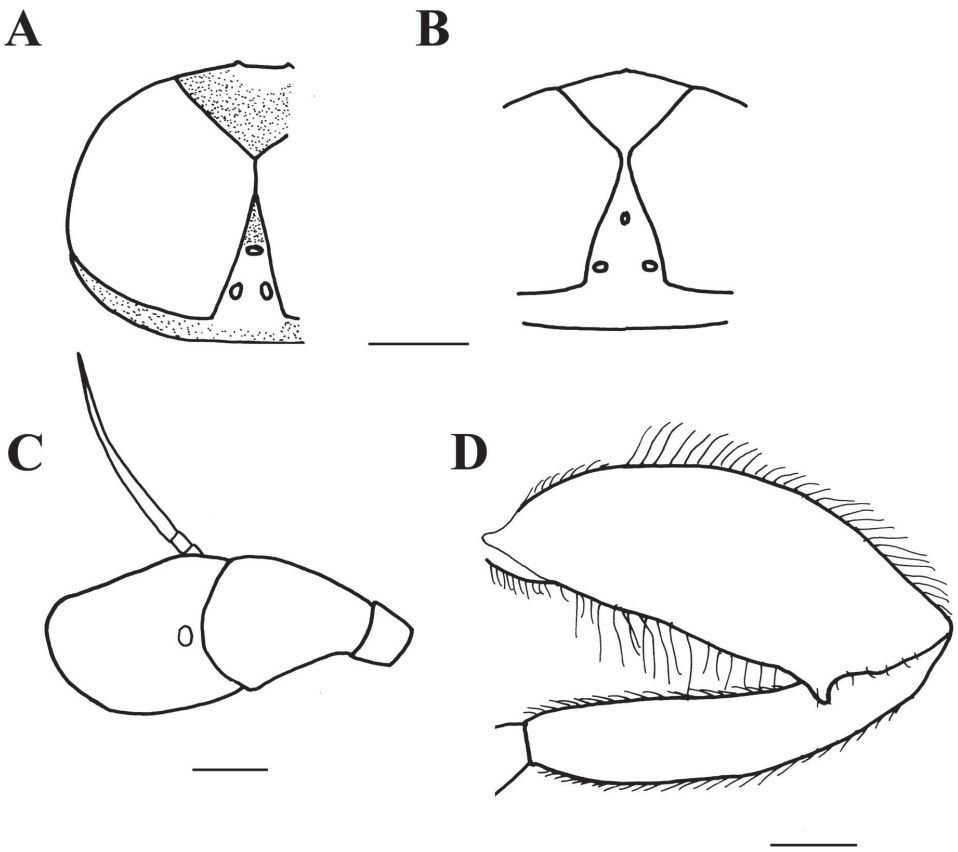

Figure 13. *Merodon cuthbertsoni*, holotype, male. (**A, C–D**) *Merodon desuturinus*, male (**B**): **A, B** head, dorsal view **C** antenna **D** metaleg. Scale bars: 1 mm (**A**, **B**), 0.2 mm (**C**), 1 mm (**D**).

genitalia: posterior surstyle lobe narrow and very long, with small apical globule (Figure 12). Differs from other species of the Palaearctic line by the reddish colour of the terga and the long pile along the lateral sides of terga.

Redescription. ***Male.*** *Head* (Figs 2C, 3C): Antenna (Figure 4C) yellow to brown, basoflagellomere 1.3–1.5 times as long as wide; arista brown. Vertical triangle isosceles, twice as long as eye contiguity. Vertex covered with dense whitish microtrichia. Face with sparse microtrichia, except for shiny oral margin. Ocellar triangle equilateral, black pilose. Frons with pale pile. Eye contiguity approx. 12 facets long. Eye pile pale.

Thorax: Scutum and scutellum black with bronze lustre, covered with dense, erect yellow or whitish pile. Wing hyaline with dark-brown veins, and dense microtrichia. Femora brown-black, knees and most of tibiae (or at least both ends) yellow-red; tarsi usually yellow dorsally and light brown ventrally (in some specimens all tarsi can be brown). Pile on legs yellow. Metafemur thick, slightly curved (Figure 5B) and covered with long pile.

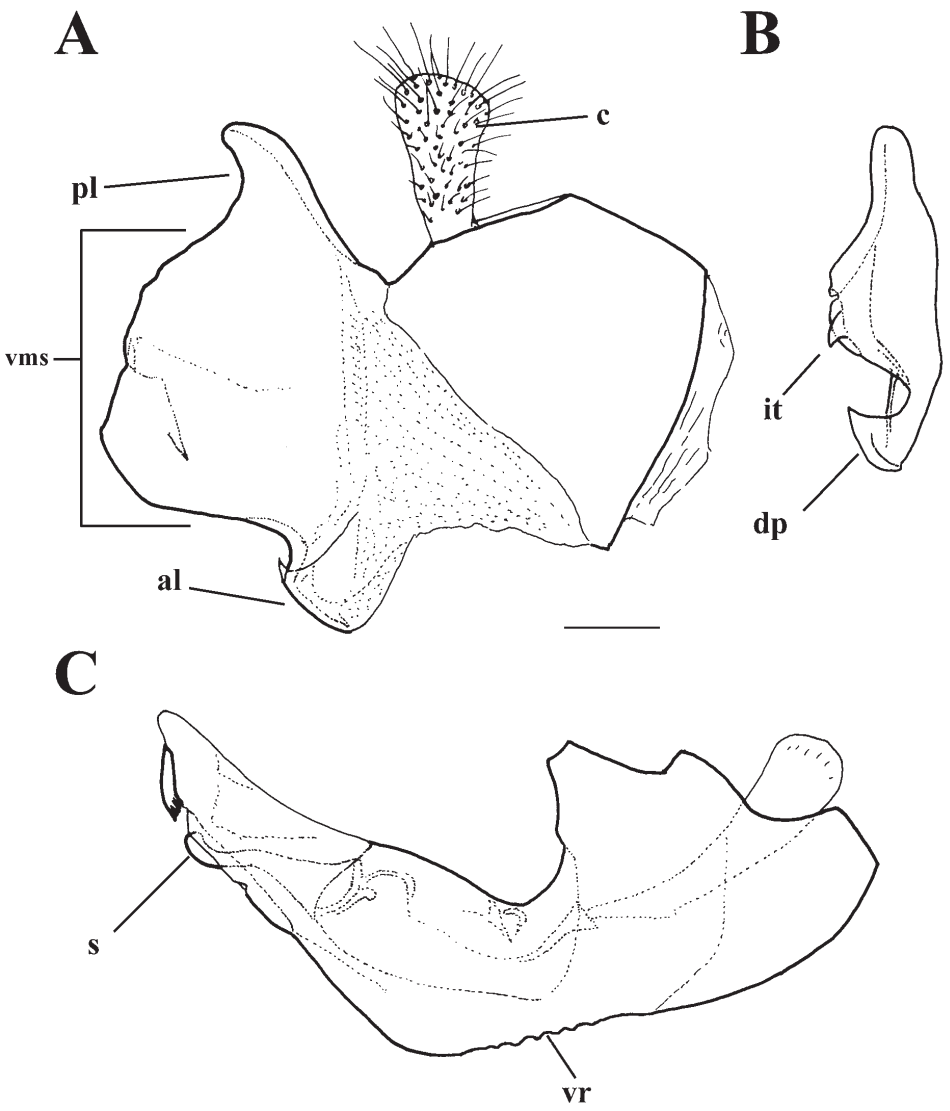

Figure 14. *Merodon cuthbertsoni*, holotype, male genitalia. **A** Epandrium, lateral view **B** Epandrium, ventral view **C** Hypandrium, lateral view. Abbreviations: **al**-anterior surstyle lobe, **pl**-posterior surstyle lobe, **c**-cercus, **s**-lateral sclerite of aedeagus, **it**-inner thorn on medial part of surstylus, **dp**-distal prolongation on anterior surstyle lobe, **vms**-ventral margin of surstylus, **vr**-ventral ridge of theca. Scale bar: 0.2 mm.

Abdomen: Lateral sides red-orange to red-brown, medially black; terga 2 and 3 can have reddish triangular vittae or maculae; terga 2–4 each with more or less distinct white transverse fascia of microtrichia interrupted in the middle (lacking in some specimens) (Figure 6B); pile on terga erect, whitish yellow and very long on lateral sides; terga 2-4 medially with adpressed pile, variable in colour (from all black except for white pile on microtrichose fasciae to predominantly pale).

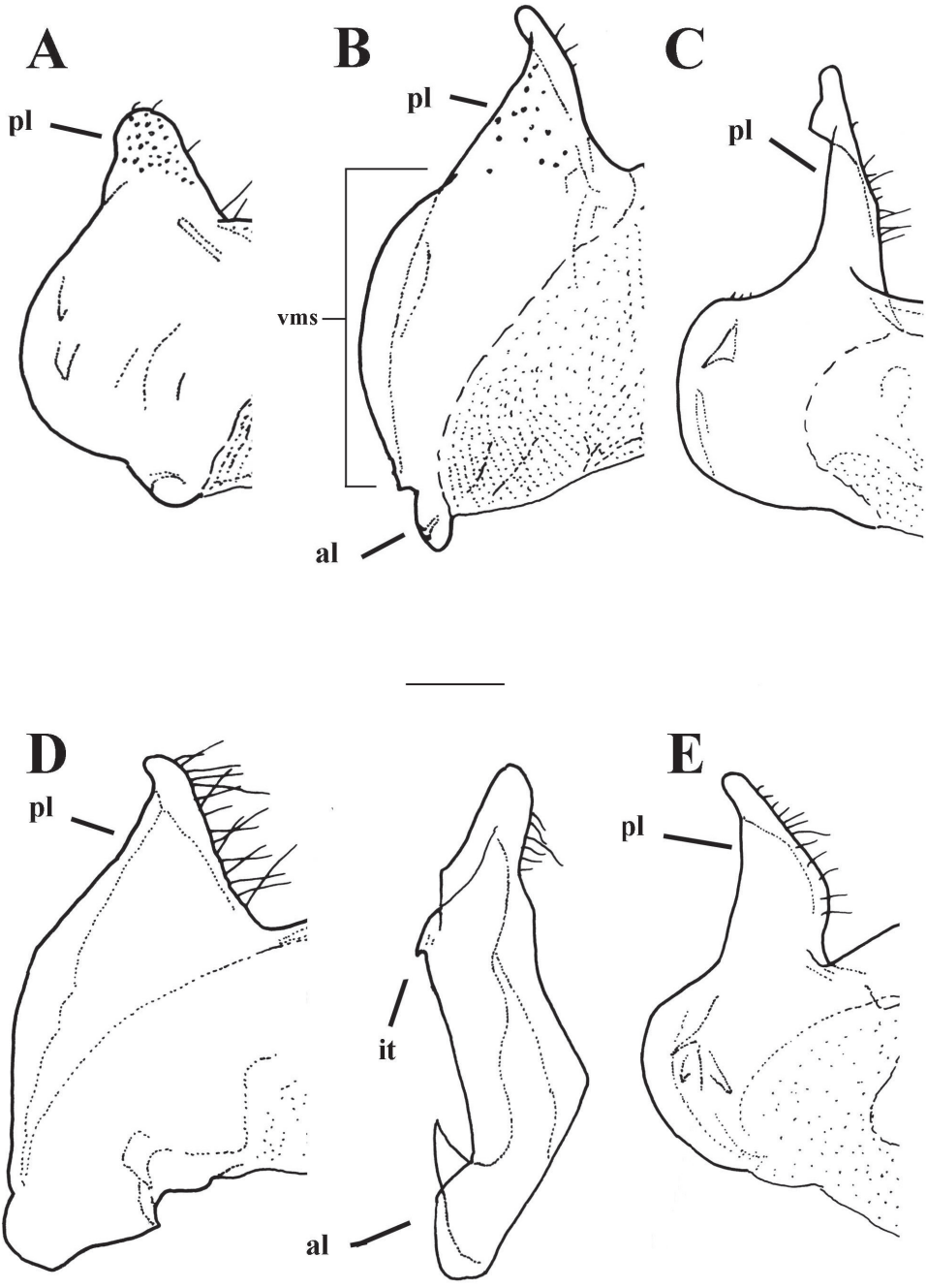

Figure 15. Surstylus, lateral view. **A** *Merodon flavocerus* **B** *Merodon capensis* **C** *Merodon drakonis* **D** *Merodon melanocerus* (lateral and ventral view) **E** *Merodon commutabilis*. Abbreviations: **al**- anterior surstyle lobe, **pl**-posterior surstyle lobe, **it**-inner thorn on medial part of surstylus, **vms**-ventral margin of surstylus. Scale bar: 0.2 mm.

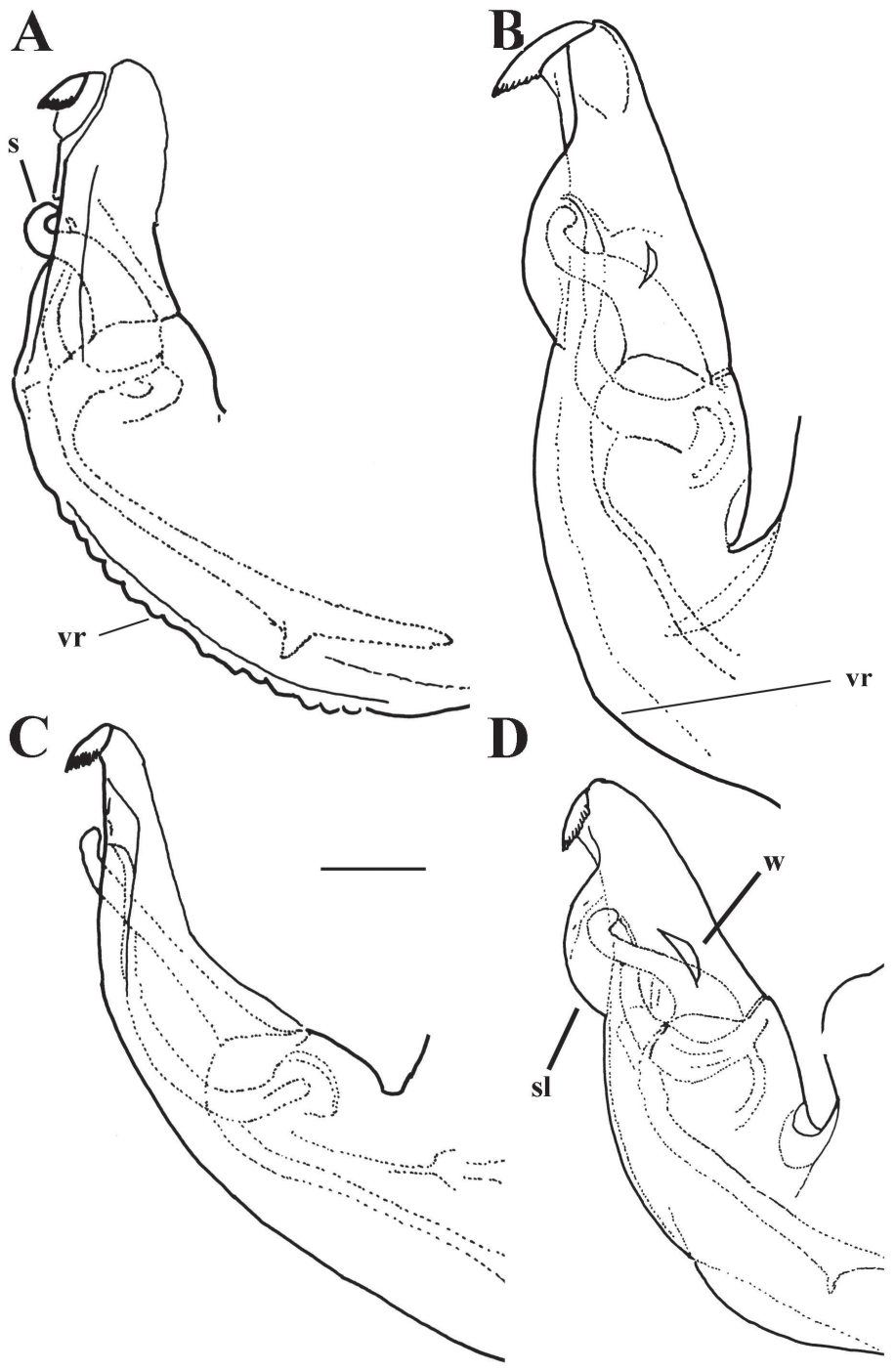

Figure 16. Part of hypandrium. **A** *Merodon capensis* **B** *Merodon drakonis* **C** *Merodon melanocerus* **D** *Merodon commutabilis*. Abbreviations: **w**-ventral wing of theca, **vr**-ventral ridge of theca, **sl**-subapical lamella of theca, **s**-lateral sclerite of aedeagus. Scale bar: 0.2 mm.

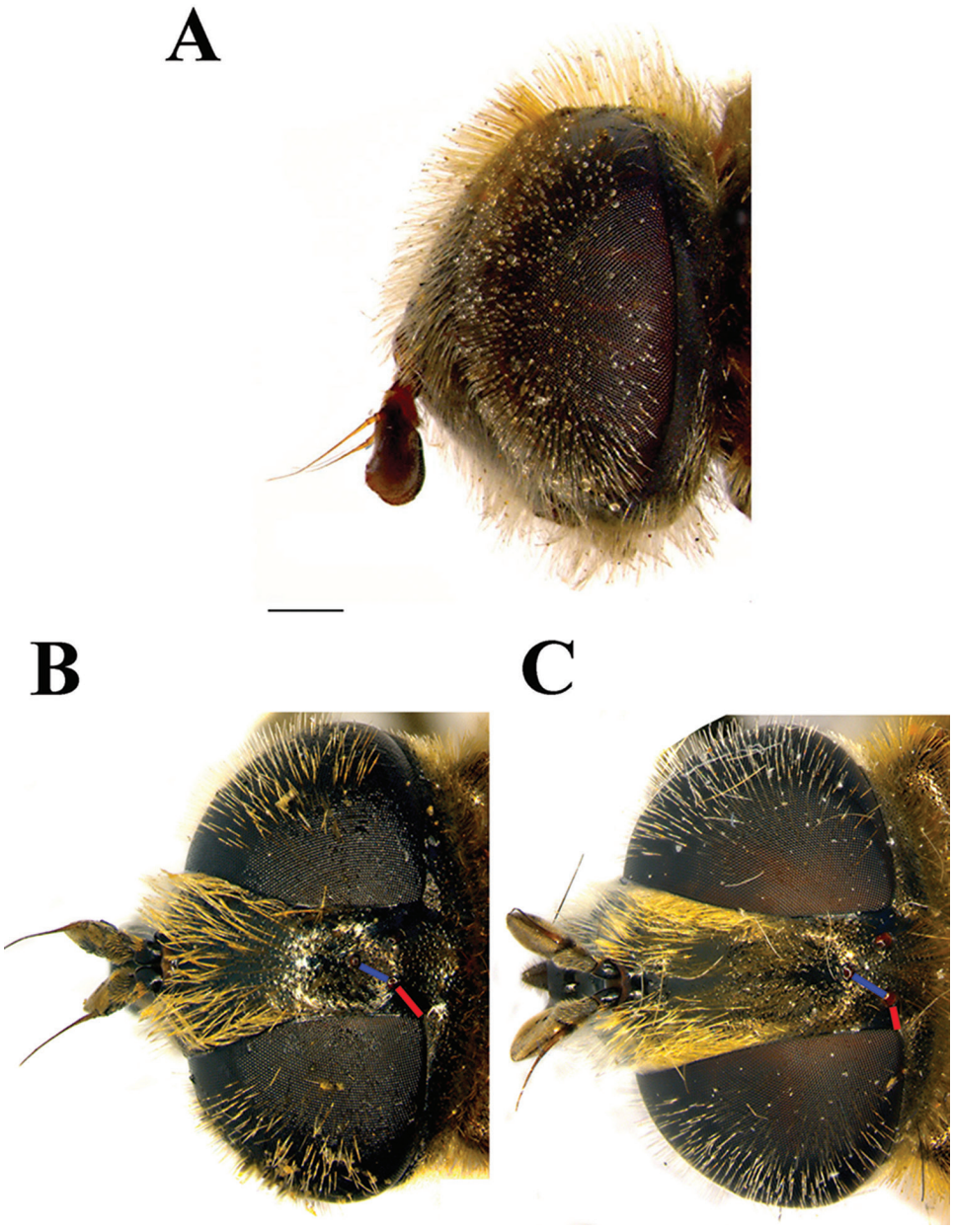

Figure 17. Head, female. **A** *Merodon planifacies* **B** *Merodon melanocerus* **C** *Merodon drakonis*. **A** lateral view **B–C** dorsal view. Scale bar: 1 mm.

Male genitalia (Figure 12): Anterior surstyle lobe bent inwards (Figure 12B), with ventral margin slightly convex (Figure 12A); median parts of surstylus with one inner thorn (Figure 12B); posterior surstyle lobe wide and triangular, pointed apically (Figure 12A). Hypandrium wide, with smooth thecal ridge (Figure 12D).

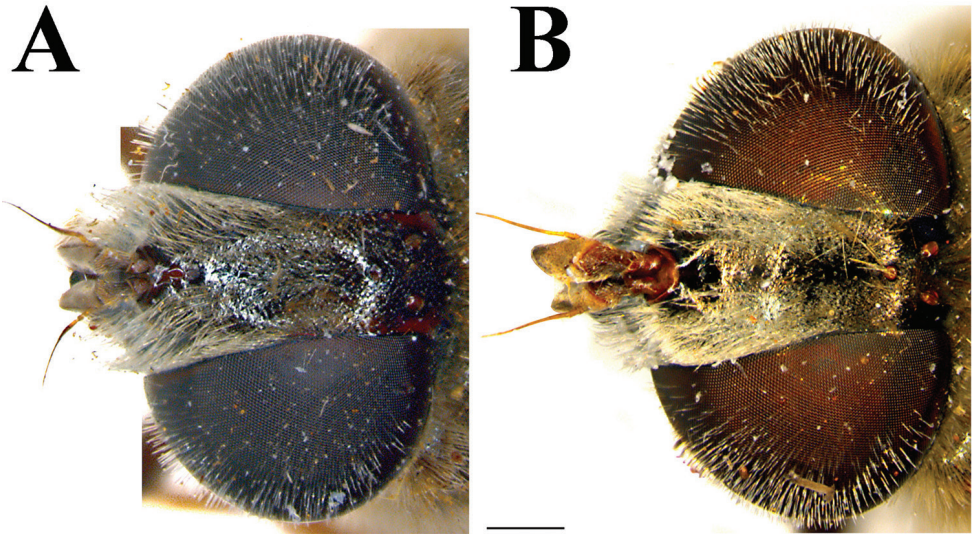

Figure 18. Head, female. **A** *Merodon flavocerus* **B** *Merodon murorum*. Scale bar: 1mm.

Female (Figs 5D, 7B, 8C). Similar to the male except for typical sexual dimorphism; face shiny, almost lacking microtrichia; frons shiny, with distinct line of microtrichia along eye margin. Scutum usually with two lateral and three medial longitudinal microtrichose vittae.

Distribution. Species distributed in North Africa (Figure 10).

Below, we redescribe an Afrotropical species of the *Merodon desuturinus* species group that is morphologically closely related to *M. desuturinus*.

Merodon cuthbertsoni Curran, 1939

Figs 13A, C, D, 14

Type material. Holotype: male, in AMNH. Original label: Zimbabwe, Sanyati Valley S. Rhodesia, 9–10.1925, leg. R. H. R. Stevenson, det. Curran.

Diagnosis. Face covered with microtrichia; black terga without lateral orange maculae, and terga 3 and 4 each with very narrow microtrichose fascia, approx. 1/10 of tergal length. Morphologically related to the species *M. desuturinus* from which it can be distinguished by the following features: eye contiguity is approx. 8 facets long (Figure 13A) (the eyes are separated in *M. desuturinus*, Figure 13B); tarsi entirely pale (dark brown dorsally in *M. desuturinus*); male genitalia: posterior surstyle lobe with narrow apex pointed upwards (Figure 14A) (triangular in *M. desuturinus*, Figure 11A); hypandrium with ventral margin of theca angled and folded (Figure 14C) (rounded and unfolded in *M. desuturinus*, Figure 11C). *M. cuthbertsoni* is known only from Zimbabwe (Sanyati Valley in southern Zimbabwe), whereas *M. desuturinus* is endemic to just a few high Balkan mountains (Europe).

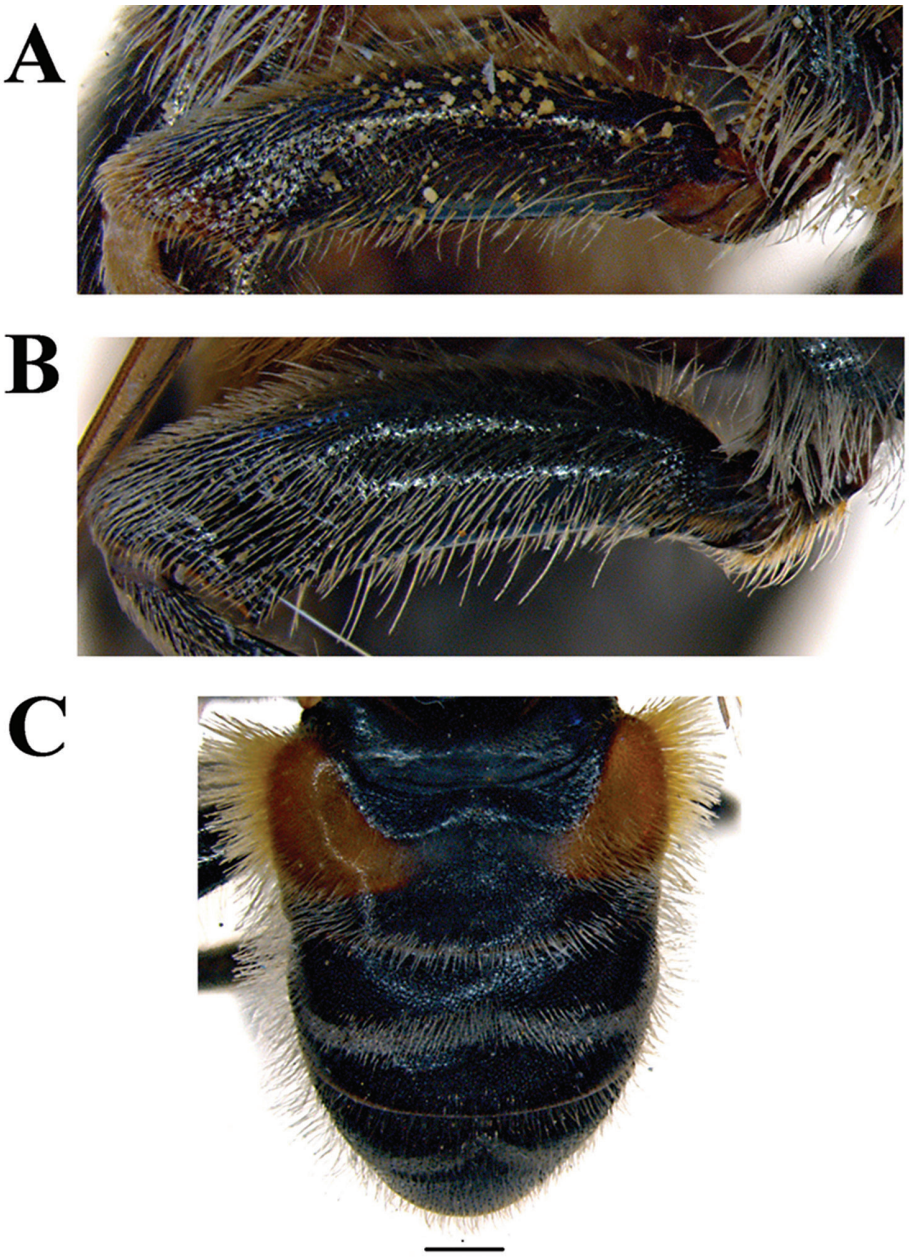

Figura 19.A *Merodon neolydicus* Vujić, nom. n. **B** *Merodon drakonis* **C** *Merodon melanocerus*. **A, B** metatrochanter, female, **C** abdomen, female. Scale bar: 1 mm.

Redescription. ***Male.*** *Head* (Figure 13A, C): Antenna (Figure 13C) brown, basoflagellomere 1.1 times as long as wide; arista brown and thickened basally and dark brown apically, 1.3 times longer than basoflagellomere, covered with short, dense mi-

crotrichia. Face and frons black, covered with long whitish yellow pile and sparse silver microtrichia. Oral margin shiny black, slightly protruded. Vertical triangle isosceles (Figure 13A), three times longer than eye contiguity, shiny black except in front of anterior ocellus that has white microtrichia, covered with long whitish yellow pile. Ocellar triangle slightly isosceles. Eye contiguity approx. 8 facets long. Eye pile as long as scape, pale. Occiput with whitish yellow pile, along the eye margin with dense white microtrichia and posteriorly with metallic bluish greenish lustre.

Thorax: Scutum and scutellum black with bronze lustre, covered with dense, erect yellow pile. Pleuron covered with grey-green microtrichia and the following parts with long yellow pile: posterior part of anterior anepisternum, posterior anepisternum (except anteroventral part), anepimeron, metasternum, and anterior, posterodorsal and posteroventral parts of katepisternum; katatergum with short, dense, erect, light-brown pile. Wing hyaline, with dense, brown microtrichia. Calypter pale yellow. Haltere with light brown pedicel and yellow capitulum. Femora dark brown-black, except for usually paler apex; tibiae dark brown with pale basal and apical parts; all tarsi yellow. Metatrochanter without processes. Metafemur (Figure 13D) thickened and slightly curved.

Abdomen: Black with bronze reflections, as long as mesonotum. Terga 2-4 each black with more or less distinct white transverse fascia of microtrichia, interrupted in the middle; pile on terga erect and yellow, except for central parts of terga 2-4 that are covered with adpressed black pile. Sterna blackish brown, covered with long pale yellow pile.

Male genitalia (Figure 14): Posterior surstyle lobe narrow, pointed upwards (Figure 14A); ventral margin of surstylus convex (Figure 14A); anterior surstyle lobe bent inwards (Figure 14B); median part of surstylus with one inner thorn (Figure 14B); cercus elongated (Figure 14A). Hypandrium with folded thecal ridge (Figure 14C: vr) and angular ventral margin (Figure 14C). Lateral sclerite of aedeagus narrow, gradually tapering, with the tip curved downwards (Figure 14C).

Female. Unknown.

Distribution. Species endemic to Zimbabwe.

Identification key for species of the *Merodon desuturinus* group

Males

1 Eyes connected (Fig. 3C) **3**

– Eyes separated or almost touching (Figs 3A, D, 13B) **2**

2 Basoflagellomere elongated, 1.5 times as long as wide (Fig. 4A); male genitalia: posterior surstyle lobe very short, broad and triangular (Fig. 15A) (Republic of South Africa) ..... ***Merodon flavocerus*** **Hurkmans**

– Basoflagellomere shorter, 1.1 times as long as wide (Fig. 4B); male genitalia: posterior surstyle lobe elongated and triangular (Fig. 11A) (Balkan Peninsula) ..... ***Merodon desuturinus*** **Vujić, Šimić & Radenković, 1995**

3 Oral margin reduced, covered by microtrichia (Fig. 2A) (central and southern Africa)..... ***Merodon planifacies*** **subgroup**

– Oral margin notched, slightly produced forward..... **4**

4 Male genitalia: hypandrium with folded thecal ridge (Figs 16A, 14C) **5**

– Male genitalia: hypandrium with smooth thecal ridge (Fig. 12D) **6**

5 Scutum with fascia of black pile between wing bases; male genitalia: ventral margin of surstylus (Figs 15B) and hypandrium convex (Republic of South Africa)..... ***Merodon capensis*** **Hurkmans**

– Scutum entirely with pale pile; male genitalia: ventral margin of surstylus and hypandrium angular (Fig. 14C) (Zimbabwe) ..... ***Merodon cuthbertsoni*** **Curran, 1939**

6 Male genitalia: posterior surstyle lobe with parallel margins (Figs 1A, 9A) **7**

– Male genitalia: posterior surstyle lobe triangular or with hook-like apex (Figs 12A, 15C, D, E) **8**

7 Small species (8-11 mm) with narrow abdomen (Fig. 6D); male genitalia: ventral margin of anterior surstyle lobe angular (Fig. 9A), distal prolongation on anterior surstyle lobe broad (Fig. 9B); apical part of hypandrium narrow (Fig. 9C) (Western Mediterranean) ..... ***Merodon cabanerensis*** **Marcos-García, Vujić & Mengual, 2007**

– Large species (10-13 mm) with broad abdomen (Fig. 6A); male genitalia: ventral margin of anterior surstyle lobe rounded (Fig. 1A), distal prolongation on anterior surstyle lobe narrow and opened towards central line of symmetry (Fig. 1B), apical part of hypandrium broad (Fig. 1C) (Eastern Mediterranean) ..... ***Merodon neolydicus*** **Vujić, nom. n**.

8 Male genitalia: posterior surstyle lobe long and narrow (Figs 12A, 15C) **9**

– Male genitalia: posterior surstyle lobe broad and triangular (Fig. 15D, E).... **10**

9 Male genitalia: posterior surstyle lobe with small apical ridge (Fig. 15C); anterior surstyle lobe evident, strongly produced forward; theca in apical fourth broad with oval lateral lamellae and small lateral wings (Fig. 16B) (Republic of South Africa) ..... ***Merodon drakonis*** **Vujić & Radenković**

– Male genitalia: posterior surstyle lobe without apical globule (Fig. 12A); anterior surstyle lobe less evident (Fig. 12A); theca without lateral lamellae or lateral wings (Fig. 12D) (North Africa) ..... ***Merodon murorum*** **Fabricius, 1794**

10 Tergum 2 with orange lateral maculae; male genitalia: anterior surstyle lobe with almost straight ventral margin (Fig. 15D) and large inner thorn (Fig. 15D); theca narrow in apical quarter (Fig. 16C) (Republic of South Africa) ..... ***Merodon melanocerus*** **Bezzi, 1915**

– Tergum 2 usually black; male genitalia: anterior surstyle lobe with convex ventral margin (Fig. 15E); theca in apical quarter broad with oval lateral lamellae and small lateral wings (Fig. 16D) (Republic of South Africa)..... ***Merodon commutabilis*** **Radenković & Vujić**

Females

(Note: female of *Merodon cuthbertsoni* is unknown, but most probably keys with *M. capensis*).

1 Oral margin reduced, covered by microtrichia (Fig. 17A) (central and southern Africa)..... ***Merodon planifacies* subgroup**

– Oral margin evident, notched, shiny..... **2**

2 Tergum 2 black or at least lateral sides dark (Fig. 7C, D) **3**

– Tergum 2 with orange lateral maculae extending along lateral sides (Fig. 7A, B)..... **6**

3 Legs partly pale, at least at both ends of tibiae pro- and mesolegs, and the basal tarsomeres 1–2 of pro- and mesolegs; scutum with fascia of black pile between wing bases (Republic of South Africa) ..... ***Merodon capensis* Hurkmans**

– Legs black, exceptionally tarsi of metalegs brown dorsally; pilosity of scutum variable, can be covered with pale or mixed black and pale pile..... **4**

4 Basoflagellomere elongated, 1.3 times as long as wide (Fig. 8E); terga 2-4 each with clear microtrichose fasciate maculae (Fig. 7D) (Republic of South Africa)..... ***Merodon commutabilis* Radenković & Vujić**

– Basoflagellomere shorter, 1.1 times as long as wide (Fig. 8B); terga 2-4 each with or without very narrow microtrichose fasciate maculae **5**

5 Distribution: Balkan Peninsula ..... ***Merodon desuturinus* Vujić, Šimić et Radenković, 1995**

– Distribution: Western Mediterranean ..... ***Merodon cabanerensis* Marcos-García, Vujić & Mengual, 2007**

6 Basoflagellomere elongated, more than 1.5 times as long as wide (Fig. 8A, C)..... **7**

– Basoflagellomere shorter, 1.1 times as long as wide (Fig. 8D)..... **8**

7 Frons with very narrow microtrichose vittae along eye margins (Fig. 18A) (Republic of South Africa) ..... ***Merodon flavocerus* Hurkmans**

– Frons with broad lateral microtrichose vittae (Fig. 18B) (North Africa) ..... ***Merodon murorum* Fabricius, 1794**

8 Body pile very short (Fig. 7A); metatrochanter with sparse pale pile (Fig. 19A) (Eastern Mediterranean) ..... ***Merodon neolydicus* Vujić, nom. n.**

– Body pile long (as on Fig 19C); metatrochanter with patch of dense yellow pile (Fig. 19B); distribution: Republic of South Africa..... **9**

9 Frons shiny, almost without microtrichia; distance between posterior ocelli and upper eye corner larger than distance between posterior and anterior ocellus (Fig. 17B) (Republic of South Africa)..... ***Merodon melanocerus* Bezzi, 1915**

– Frons with broad lateral microtrichose vittae along eye margins; distance between posterior ocelli and upper eye corner less than distance between posterior and anterior ocellus (Fig. 17C) (Republic of South Africa)..... ***Merodon drakonis* Vujić & Radenković**

Discussion

The *Merodon desuturinus* clade was first mentioned by Mengual et al. (2006), and Milankov et al. (2008b) showed that this group represents an evolutionarily independent lineage among *Merodon* taxa. However, each of this study included only one species of the group (*M. cabanerensis* and *M. desuturinus,* respectively) in their analyses. Radenković et al. (2018) recently confirmed the monophyly of the *M. desuturinus* group in their analysis that examined an additional eight species of the group in relation to 27 other *Merodon* taxa, as well as its close relationship to the *albifrons* group. Based on adult morphological, molecular, and distributional data, Radenković et al. (2018) found that the *M. desuturinus* species group consists of two clearly separate lineages and represents an important link between the Palaearctic and Afrotropical faunas. They proposed that diversification in the *M. desuturinus* group most likely occurred during fundamental shifts in African climate. During the Pliocene-Pleistocene epoch, favourable conditions for *Merodon* species (increased aridity and open grasslands) in Africa most probably allowed faunal transitions from the Eastern Mediterranean (including SW Asia), with one lineage migrating to South Africa and another to the western Palaearctic.

The main morphological diagnostic character that separates these two lineages is the presence of a dense and strong yellow-to-red brush of pile on the metatrochanter in Afrotropical species, which is lacking in Palaearctic taxa. The Afrotropical lineage comprises the *M. melanocerus* subgroup of five taxa (Radenković et al. 2018), the *M. planifacies* subgroup, and the species *M. cuthbertsoni* that is morphologically related to the Palaearctic taxon *M. desuturinus*. The *M. planifacies* subgroup is characterised by a distinct apomorphic character, i.e., a reduced oral margin covered by microtrichia. *M. cuthbertsoni* is endemic to Zimbabwe, but its systematic position remains unclear. Currently, there is no genetic data on *M. cuthbertsoni* since only old museum material exists.

Our revision of the Palaearctic species from the *M. desuturinus* group has resulted in the delimitation of four species. This lineage consists of closely related yet clearly morphologically distinct species. The most distinctive species is *M. murorum,* based on the shape of the male genitalia and its reddish abdomen.

Two of these Palaearctic taxa are endemo-relicts; *M. cabanerensis* is known only from a restricted area in central Spain and Morocco and *M. desuturinus* is found only on four high mountains of the Balkan Peninsula, of which two are in Montenegro (Durmitor and Orijen) and two are in Serbia (Kopaonik and Stara planina). *Merodon neolydicus* Vujić, nom. n. is present in several countries of the Eastern Mediterranean (Greece, Turkey, Syria, Lebanon, Israel) and Iran, while *M. murorum* is distributed in North-West Africa (Algeria, Morocco, Tunisia) (Fig. 10).

Based on the distributions of the Palaearctic lineage of the *M. desuturinus* species group on high mountains of North Africa, in the Eastern Mediterranean and on the Iberian and Balkan peninsulas, they can be considered as oromediterranean relicts (Fig. 10).

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A review of the Japanese *Cryptochironomus* Kieffer, 1918 (Diptera, Chironomidae)

Chuncai Yan[1], Ting Liu[1], Wei Cao[1], Guangjun Zhao[1], Wenbin Liu[1]

1 *Tianjin Key Laboratory of Animal and Plant Resistance, Tianjin Normal University, Tianjin, 300387, PR China*

Corresponding author: *Wenbin Liu* (skyliuwenbin@163.com)

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Abstract

The genus *Cryptochironomus* Kieffer, 1918 from Japan is reviewed based on material composed of male adults. New combinations of three species are established and they are re-described based on male adult of: *C. misumaiprimus* (Sasa & Suzuki, 1998), **comb. n.**, *C. tokaraefeus* (Sasa & Suzuki, 1995), **comb. n.** and *C. tonewabeus* (Sasa & Tanaka, 2002), **comb. n.** Additional taxonomic notes are also provided: *C. albofasciatus* (Staeger, 1839), which is a senior synonym of *Parachironomus inafegeus* Sasa, Kitami & Suzuki, 2001 and *C. rostratus* (Kieffer, 1921) as the senior synonym of *Paracladopelma inaheia* Sasa, Kitami & Suzuki, 2001. A key to the known adult males of the genus from Japan is given.

Keywords

Cryptochironomus, Japan, key, new combination, synonymy, taxonomy

Introduction

Cryptochironomus is a diverse genus and widely distributed worldwide. Kieffer (1918) erected this genus based on *Chironomus* (*Cryptochironomus*) *chlorolobus* Kieffer, 1918 as type species. Subsequently, the genus in all its life stages was studied by a number of authors (Townes 1945; Roback 1957; Curry 1958; Shilova 1966; Beck and Beck 1969;

Sæther 1977, 2009; Sasa and Kikuchi 1995; Sasa 1998; Zorina 2000; Makarchenko et al. 2005; Silva et al. 2010; Yan et al. 2016).

Eight *Cryptochironomus* species were reported from Japan by Sasa (1998), Sasa and Kikuchi (1995) and Sasa and Ogata (1999): *C. albofasciatus* (Staeger), *C. hentonensis* Hasegawa & Sasa, *C. javae* Kieffer, *C. sauteri* (Kieffer), *C. tamaichimori* Sasa, *C. tamayoroi* Sasa & Ichimori, *C. tokaracedeus* Sasa & Suzuki and *C. jokaprimus* Sasa & Ogata. *Cryptochironomus sauteri* (Kieffer) was transferred to *Parachironomus* Lenz by Sublette& Sublette (1973). After re-examining the material of *Cryptochironomus* Kieffer, *Parachironomus* Lenz, and *Paracladopelma* Harnisch from Sasa's collection, and comparing the generic characters as defined by Cranston et al. (1989), *Parachironomus misumaiprima* Sasa & Suzuki, 1998, *Parachironomus tokaraefea* Sasa & Suzuki, 1995, and *Parachironomus tonewabea* Sasa & Tanaka, 2001 are assigned to the genus *Cryptochironomus* based on the following characters: inferior volsella with strong setae and completely covered by the superior volsella, lacking microtrichia; gonocoxite and gonostylus are fused; gonostylus short and wide. Moreover, *Parachironomus inafegeus* Sasa, Kitami & Suzuki is a junior synonym of *Cryptochironomus albofasciatus* (Staeger, 1839), and *Paracladopelma inaheia* Sasa, Kitami & Suzuki is a junior synonym of *Cryptochironomus rostratus* (Kieffer, 1921). Thus, eleven valid species of the genus *Cryptochironomus* are currently recorded in Japan: *C. albofasciatus*, *C. hentonensis*, *C. javae*, *C. jokaprimus*, *C. misumaiprimus*, *C. rostratus*, *C. tamaichimori*, *C. tamayoroi*, *C. tokaracedeus*, *C. tokaraefeus*, and *C. tonewabeus*.

In this paper, the genus *Cryptochironomus* is reviewed from Japan. Three new combinations and two synonyms are established and re-described. A key to the known adult males of the genus from Japan is presented.

Materials and methods

A large amount of material composed of adult males belonging to the genus *Cryptochironomus* was examined based on slide-mounted following the procedures outlined by Sæther (1969). Morphology and terminology follow Sæther (1980). All of the examined specimens are deposited in the Department of Zoology, National Science Museum, Tokyo, Japan.

Abbreviations used in text as follows:

AR antennal ratio = length of ultimate fagellomere: combined lengths of fagellomeres one to penultimate;
fe femur;
HR hypopygium ratio = gonocoxite length: gonostylus length;
HV hypopygium value = body length: gonostylus length × 10;
LR leg ratio: tarsomere length: tibia length;
LR_1 tarsomere I length: tibia length;
p1–3 Legs (1–fore, 2–mid, 3–hind);

R Radius; R_1, Radius 1; R_{4+5}, Radius four and five;
Ta1–5 tarsomeres 1–5;
Ti tibia;
VR ratio of length of Cu: length of M.

Taxonomy

Cryptochironomus albofasciatus (Staeger, 1839)

Chironomus albofasciatus Staeger 1839: 566.
Chironomus (*Cryptochironomus*) *albofasciatus* Staeger. Goetghebuer 1937–1954: 38.
Cryptochironomus albofasciatus (Staeger). Reiss 1968: 195; Pinder 1978: 116; Sasa and Kawai 1987: 16; Sasa 1988: 56; 1989: 76; 1990: 31; 1991: 84; Sasa and Okazawa 1991: 53; Sasa, Kitami and Suzuki 1999: 7; 2001: 5; Makarchenko et al. 2005: 408; Yan et al. 2016: 486-487.
Parachironomus inafegeus Sasa, Kitami & Suzuki, 2001: 6 **(syn. n.**).

Material examined. China. ♂ (No. 05227) Fujian Province, Longyan City, Shanghang county, 3.v.1993, light trap, X. Wang. The type specimen of *Parachironomus inafegeus* Sasa, Kitami & Suzuki. Holotype, ♂ (No. 398: 65), on the shore of lake Inawashiro, insect net, 8.vi.2000.

Diagnostic characters. Thorax yellowish brown with white stripes; anal point parallel-sided, slender; anal tergite bands "V"-shaped, not fused in the middle; superior volsella crescent-like; inferior volsella tuberculate with two small protuberances, bearing two strong apical setae, free of microtrichia.

Distribution. China (Fujian Province); Russian Far East; Japan; Europe.

Remarks. The holotype specimen of *Parachironomus inafegeus* Sasa, Kitami & Suzuki, 2001 mainly agrees with the description of *Cryptochironomus albofasciatus* (Staeger, 1839) by Goetghebuer (1937–195: 38, fig. 116), especially the characters of anal point, superior and inferior volsella, and gonostylus. Consequently, it must be considered a junior synonym of *Cryptochironomus albofasciatus* (Staeger, 1839). See also the species illustration in Yan et al. (2016: 487, fig 1.).

Cryptochironomus hentonensis Hasegawa & Sasa, 1987

Cryptochironomus hentonensis Hasegawa & Sasa, 1987: 290; Sasa and Kawai 1987: 63; Sasa and Kikuchi 1995: 99; Sasa 1998: 28; Makarchenko et al. 2005: 409.

Material examined. Japan. The type specimen of *Cryptochironomus hentonensis* Hasegawa & Sasa. Holotype, ♂ (No. 64: 91), on the bank of Eel pond at Hentona, Okinawa, in the Ryukyu Islands, southern Japan. 2.xii.1982.

Diagnostic characters. AR 3.03; frontal tubercles present; anal point long and tapering, lateral setae and microtrichia absent; superior volsella thumb-like, inferior volsella finger-shaped.

Distribution. Japan; Russian Far East.

Cryptochironomus javae Kieffer, 1924

Cryptochironomus javae Kieffer, 1924: 264; Sublette and Sublette 1973: 403; Sasa and Hasegawa 1983: 323; Sasa and Kawai 1987: 61.

Diagnostic characters. According to Sasa and Hasegawa (1983: 323, Fig. 3K). Total length 4.84 mm, wing length 2.22 mm. AR 2.44, LR_1 1. 89, frontal tubercles present. Mid and hind with two tibial spurs. Anal point short and wide. Superior volsella pad-like, bearing two setae at apex; inferior volsella tuberculate, covered by superior volsella completely, bearing two setae at apex, free microtrichia. Gonostylus wide and short, with almost straight inner margin, rounded apically.

Distribution. Japan; Indonesia.

Cryptochironomus jokaprimus Sasa & Ogata, 1999

Cryptochironomus jokaprimus Sasa & Ogata, 1999: 86; Sasa and Suzuki 2001: 2.

Material examined. Japan. Holotype, ♂ (No. 321: 37), at the side of a stream discharging water (the Kurobe Municipal Sewage Treatment Plant (Kurobe Joka Center)), in urban areas of Japan, 27.viii.1996, light trap.

Diagnostic characters. Frontal tubercles prominent, roughly conical. Tergite IX rounded at the posterior margin. Anal point concave in its median portion, and parallel-sided to the apex, apically rounded. Superior volsella narrow at base and strongly expanded distally, bearing five strong setae, inferior volsella semicircular, gonostylus with small protrusion at apex.

Distribution. Japan.

Cryptochironomus misumaiprimus (Sasa & Suzuki, 1998), comb. n.

Figure 1

Paracladopelma misumaiprima Sasa & Suzuki, 1998: 18.

Material examined. Japan. Holotype, ♂ (No. 348: 30), at Misumai, Hokkaido, 6. ix. 1997, sweep net.

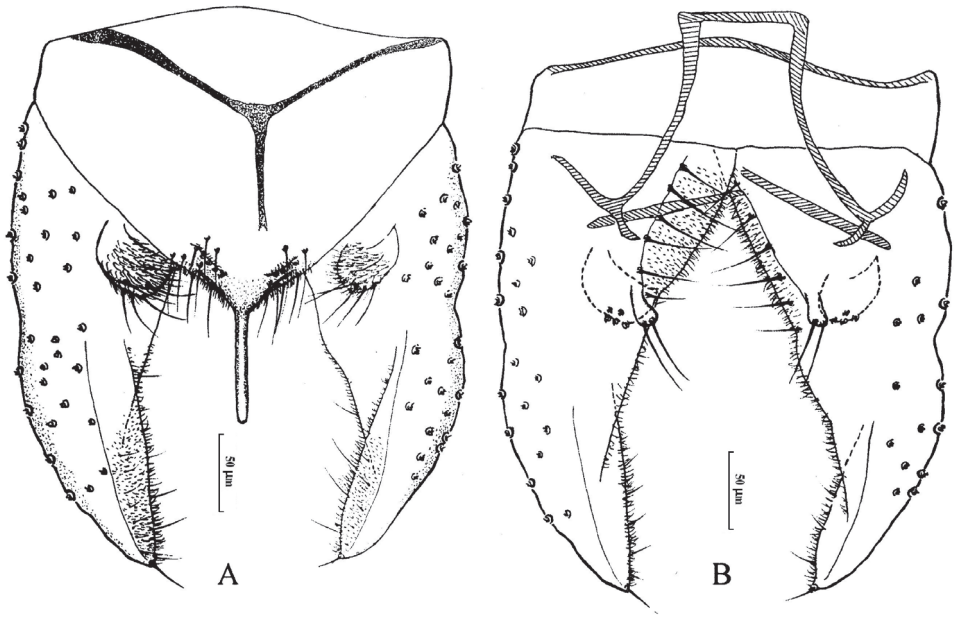

Figure 1. Male adult of *Cryptochironomus misumaiprimus* (Sasa & Suzuki, 1998), comb. n., male. **A** hypopygium (dorsal view) **B** hypopygium (ventral view).

Diagnostic characters. AR 2.84. LR_1 1.48. Anal point linear and distinctly parallel-sided, slender. Anal tergite bands "wide Y"-shaped. Superior volsella broadly semicircular; inferior volsella finger-shaped, slender at base, swelling at apex, bearing two setae, free microtrichia. Gonostylus tapering to the apex.

Description. Male imago (n = 1).

Total length 5.45 mm; wing length 2.60 mm; total length / wing length 2.10; wing length / length of profemur 2.08.

Coloration. Thorax yellow-white, with yellow-brown spots. Femora of front legs yellow-brown, tibia and tarsi dark brown; femora, tibiae and tarsi I of mid and hind legs yellow-brown, tarsi II–V dark brown. Abdomen yellow-brown, hypopygium dark brown.

Head. AR: 2.84. Ultimate flagellomere 1080 µm; frontal tubercles present but unclear. Temporal setae 24, including ten inner verticals, six outer verticals, and eight postorbitals. Clypeus with 16 setae; palpomere lengths (µm): 48; 63; 245; 208; 260. Palp segment $5^{th}/3^{rd}$: 1.06.

Thorax. Antepronotals unclear; acrostichals nine; dorsocentrals 16; prealars six. Scutellum with 24 setae.

Wing. VR: 1.10. R with 22 setae. R_1 with 21 setae. R_{4+5} with 37 setae. Brachiolum with three setae. Squama with nine setae.

Legs. Front tibia with three subapical setae, 185 µm and 188 µm, the other lost. Mid legs with two spurs, 30 mm and 33 mm; tibial comb with 52 teeth, 14 mm long. Spurs of hind tibia 30 mm and 33 mm long, tibial comb with 62 teeth, 15 mm long.

Table 1. Male adult of *Cryptochironomus misumaiprimus* (Sasa & Suzuki, 1998), comb. n. Length (μm) and proportions of legs.

	fe	ti	ta_1	ta_2	ta_3	ta_4	ta_5	LR
p_1	1250	1000	1475	710 0	630	540	230	1. 48
p_2	1150	1025	700	310	250	140	100	0. 68
p_3	1250	1375	920	460	370	220	120	0. 67

The sensilla chaetica of tarsus I of mid leg and metapedes were not distinguishable. Lengths (in μm) and proportions of thoracic legs as in Table 1.

Hypopygium (Fig. 1). Tergite IX with 11-13 setae placed dorsally and ventrally on each side of the base of anal point. Laterosternite IX with three lateral setae. Anal point parallel-sided, slender, lateral setae and microtrichia absent. Anal tergite bands "Y"-shaped. Phallapodeme 125 mm long. Transverse sternapodeme 80 mm long. Superior volsella semicircular, bearing five strong setae at apex, covered with microtrichia. Inferior volsella finger-shaped, swelling at apex, bearing two setae at apex, free microtrichia. Gonocoxite 140 mm long, bearing six strong setae along inner margin. Gonostylus 175 mm long, widest at base, curved slightly at 1/3 distance from base, tapered to the apex, bearing seven short setae along inner margin and one seta at apex. HR: 0.89; HV: 3.11.

Distribution. Japan.

Remarks. The characters of frontal tubercles, superior and inferior volsella, and gonostylus of this species followed the generic character of the genus *Cryptochironomus* emended by Cranston et al. (1989). The small frontal tubercles and "Y"-shaped anal tergite bands separate this species from other members of the genus.

Cryptochironomus rostratus (Kieffer, 1921)

Figure 2

Chironomus rostratus Kieffer, 1921: 67.

Chironomus (*Chironomus*) *rostratus*: Edwards 1929: 390.
Chironomus (*Cryptochironomus*) *rostratus*: Goetghebuer 1928: 84; Kruseman 1933: 187.
Cryptochironomus rostratus: Pinder 1978: 116; Ree and Kim 1981: 143; Cranston and Judd 1989: 252; Chaudhuri and Chattopadhyay 1990: 157; Dutta et al. 1996: 269; Wang 2000: 643.
Paracladopelma inaheia Sasa, Kitami & Suzuki, 2001: 7 (**syn. n.**).

Material examined. Japan: the type specimen of *Paracladopelma inaheia* Sasa, Kitami & Suzuki, Holotype, ♂ (No. 402: 17), shore of Lake Inawashiro, Japan, 21.viii.2000, light trap.

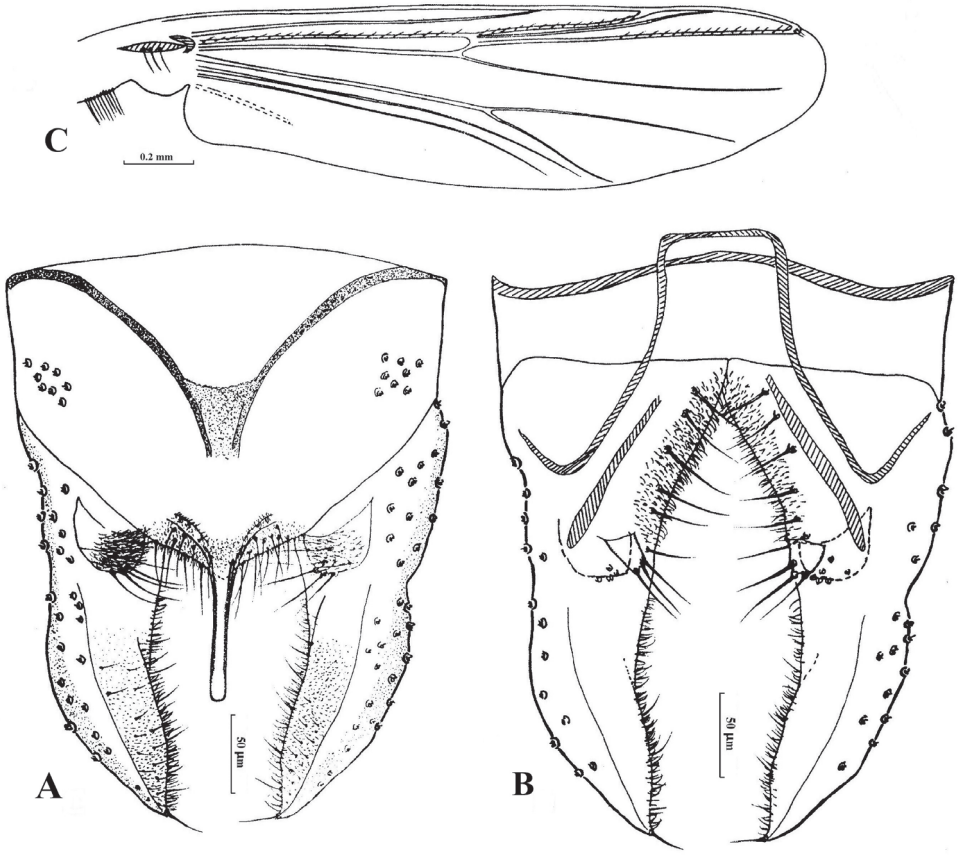

Figure 2. Male adult of *Cryptochironomus rostratus* (Kieffer, 1921) (holotype specimen of *Paracladopelma inaheia* Sasa, Kitami & Suzuki) male. **A**. hypopygium (dorsal view) **B**. hypopygium (ventral view) **C** Wing.

Diagnostic characters. Thorax with dark brown spots; the posterior margin of tergite IX shoulder-like or slightly cone-like; anal point slender, tapering distally or parallel-sided. Superior volsella crescent-like; inferior volsella tuberculate, bearing 1-3 stout setae, free microtrichia. Anal tergite bands "V" shaped, the junction of gonostylus and gonocoxite distinctly concaved, curved at 1/3 distance from base, apex with a small protrusion, bent inwards and bearing one seta.

Description. Male imago (n = 1).

Total length 5.45 mm; wing length 2.30 mm, total length/wing length 2.37; wing length / length of profemur 2.17.

Coloration. Thorax yellow-white, with yellow-brown spots. Femora of front legs yellow-brown, tibiae and tarsomeres dark brown; femora and tibiae of mid and hind legs yellow-brown, tarsi I yellow-brown except for dark yellow-brown at ends, tarsi II–V dark yellow brown. Abdomen yellow-brown, hypopygium dark brown.

Table 2. Male adult of *Cryptochironomus rostratus* (Kieffer, 1921). Lengths (μm) and proportions of legs.

	fe	ti	ta_1	ta_2	ta_3	ta^4	ta_5	LR
p_1	1060	825	1500	650 0	540	440	200	1.82
p_2	1020	910	630	300	220	120	100	0.69
p_3	1110	1200	860	450	350	190	120	0.72

Head. AR: 2.89. Ultimate flagellomere 1010 μm; little and semi-circular frontal tubercles, diameter 7 μm. Temporal setae 25, including six inner verticals, 12 outer verticals, and seven postorbitals. Clypeus with 17 setae. Palpomere lengths (μm): 45; 65; 220; 212; 230. Palp segment $5^{th}/3^{rd}$. 1.05.

Thorax. Antepronotals bare; acrostichals ten; dorsocentrals 14; prealars eight. Scutellum with 32 setae.

Wing. VR: 1.12. R with 24 microtrichia. R_1 with 23. R_{4+5} with 22 setae. Brachiolum with three strong setae. Squama with 17 fringed setae.

Legs. Front tibia with three subapical setae, 165μm and 168μm, the other lost. Mid legs with two spurs, 30 mm and 35 mm, tibial comb with 44 teeth, 15 mm long. Spurs of hind tibia 35 mm and 37 mm long, tibial comb with 60 teeth, 15 mm long. Tarsus I of mid leg with nine sensilla chaetica, Tarsus I of metapedes leg with six sensilla chaetica. Lengths (in μm) and proportions of thoracic legs as in Table 2.

Hypopygium (Fig. 2). Tergite IX broad with cone-like posterior margin, bearing approximately 30 setae located dorsally and ventrally near the base of anal point. Laterosternite IX with six lateral setae. Anal point 88 mm long, slightly wider at base, almost parallel-sided, apically rounded, lateral setae and microtrichia absent. Anal tergite bands "V"-shaped. Phallapodeme 135 mm long. Transverse sternapodeme 75 mm long. Superior volsella spherical to bulb-like, covered with microtrichia, bearing six strong setae at apex. Inferior volsella tuberculate, bearing three setae at apex, free microtrichia. Gonocoxite 138 mm long, with six stout setae placed along inner margin. Gonostylus 170 mm long, base widest, slightly curved in the middle, tapered to the apex, bearing seven short setae along inner margin and one stronger seta at apex. HR: 0.81; HV: 3.21.

Distribution. China (Zhejiang, Fujian, Jiangxi, Guangxi, Hainan, Sichuan, Guizhou, Tibet, Taiwan); South Korea; Japan; India; Bangladesh; Lebanon; Turkey; Europe (Germany, UK, Holland, Belgium).

Remarks. The holotype of *Paracladopelma inaheia* belongs to the well-known European *Cryptochironomus rostratus* based on morphological characters of the hypopygium and metric measurements (Kieffer 1921; Pinder 1978: fig. 147B). Populations of *C. rostratus* from both Japan and other European areas key close together despite some minor morphological differences mainly related to geographical variation, especially the general shape of tergite IX, anal point, superior volsella, inferior volsella, and gonostylus. Thus, *Paracladopelma inaheia* can be considered as a junior synonym of *Cryptochironomus rostratus* (Kieffer, 1921).

Cryptochironomus tamaichimori Sasa in Sasa & Kawai, 1987

Cryptochironomus sp. "*hentona*" Sasa & Ichimori, 1983: 103.
Cryptochironomus tamaichimori Sasa in Sasa & Kawai 1987: 61; Sasa 1993: 55; Makarchenko et al. 2005: 409.

Diagnostic characters. Frontal tubercles and the posterior margin of tergite IX are highly variable in this species. The main distinguishing features are as follows: superior volsella bulbous to globular, both sides of the inferior volsella stretching upward at base, formed into flank-shaped, free microtrichia, bearing two long apical setae at apex. The junction of gonostylus and gonocoxite concaved obviously, gonostylus abruptly narrowed near apex and apically pointed, bearing one seta at apex.

Distribution. China (Hebei, Zhejiang, Fujian, Hubei, Guangdong, Hainan, Sichuan); Japan; Russian Far East.

Cryptochironomus tamayoroi Sasa & Ichimori, 1983

Cryptochironomus tamayoroi Sasa & Ichimori, 1983: 102; Sasa and Kawai 1987: 61

Material examined. Japan. Holotype, ♂ (No. 74: 01), Tama River, at the Yoroi Bridge, at Yoroi-bashi, Japan. 11. iii. 1982.

Diagnostic characters. AR 2.56. Frontal tubercles present; tergite IX bearing three setae, posterior margin tapering. Anal point parallel-sided. Anal tergite bands "V"-shaped. Superior volsella about twice as long as wide, with four long setae; inferior volsella extending well beyond posterior margin of superior volsella. Gonostylus wider at base and tapering towards apex, with one single apical seta.

Distribution. Japan.

Cryptochironomus tamayoroi Sasa & Suzuki, 1995

Cryptochironomus tokaracedeus Sasa & Suzuki, 1995: 260.

Material examined. Japan. ♂ (No. 286: 21), edge of rice paddies, Tokara Islands, Kagoshima, Japan. 18–19. v. 1994, sweep net, Coll. H. Suzuki.

Diagnostic characters. Frontal tubercles present. The tibia of front leg with one subapical seta. The posterior margin of tergite IX shoulder-like. Anal point tapering to the apex, lateral setae and microtrichia absent. Anal tergite bands "H"-shaped. Superior volsella small, thumb-like, almost entirely covered by microtrichia; inferior volsella bearing three apical setae at apex, free microtrichia.

Distribution. Japan.

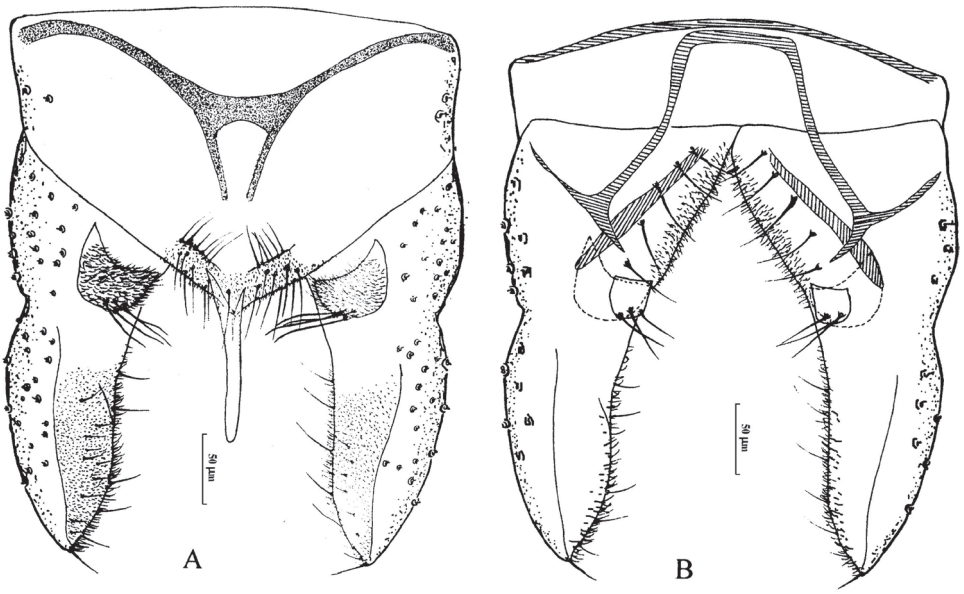

Figure 3. Male adult of *Cryptochironomus tokaraefeus* (Sasa & Suzuki, 1995), comb. n., male. **A** hypopygium (dorsal view) **B** hypopygium (ventral view)

***Cryptochironomus tokaraefeus* (Sasa & Suzuki, 1995), comb. n.**
Figure 3

Paracladopelma tokaraefea Sasa & Suzuki, 1995: 262.

Material examined. Japan. Holotype specimen of *Paracladopelma tokaraefea* Sasa & Suzuki, 1995. ♂ (No. 287: 19), at the edge of a rice paddy, on Kuchinoshima Island, on the Tokara Islands Kagoshima, Japan. 19.v.1994, insect net, Coll. H. Suzuki.

Diagnostic characters. Anal point almost parallel-sided. Anal tergite bands H-shaped. Superior volsella bulbous to spherical; inferior volsella square-shaped, and width is equal to half of superior volsella, bearing three long setae at apex, free microtrichia.

Male imago (n = 1). Total length 5.23 mm; wing length 2.20 mm; total length / wing length 2.38; wing length / length of profemur 2.26.

Coloration. Thorax yellow-white, with yellow-brown spots; femora, tibiae and tarsi I of mid and hind legs yellow-brown; tarsi II-V dark yellow-brown. Abdomen yellow brown; hypopygium dark brown.

Head. Antenna damaged; frontal tubercles unrecognizable. Temporal area damaged. Clypeus with 15 setae. Palpomere lengths (μm): 48; 52; 200; 180; 228. Palp segment $5^{th}/3^{rd}$: 1.14.

Thorax. Antepronotals bare; acrostichals eight; dorsocentrals 13; prealars five. Scutellum with 28 setae.

Wing. VR: 1.08. R with 24 microtrichia. R_1 with 19. R_{4+5} with 28 setae. Brachiolum with three strong setae. Squama with at least ten fringed setae.

Table 3. Male adult of *Cryptochironomus tokaraefeus* (Sasa & Suzuki, 1995), comb. n**.** Length (μm) and proportions of legs.

	fe	ti	ta_1	ta_2	ta_3	ta_4	ta_5	LR
p_1	975	800	1325	550 0	500	400	180	1.66
p_2	960	890	560	270	200	120	100	0.63
p_3	1050	1115	810	400	300	270	120	0.73

Legs. Front tibia with two subapical setae, 150 μm and 155 μm. Mid legs with two spurs, 13 mm and 22 mm, tibial comb with 50 teeth, 10 mm long. Spurs of hind tibia 14 mm and 25 mm long, tibial comb with 66 teeth, 10 mm long. Tarsus I of mid and hind leg were not distinguishable. Lengths (in μm) and proportions of thoracic legs as in Table 3.

Hypopygium (Fig. 3). Tergite IX bearing 14 setae. Laterosternite IX with two lateral setae. Anal point 100 mm long, straight, wider base, almost parallel-sided, narrower at apex, lateral setae and microtrichia absent. Anal tergite bands H-shaped. Phallapodeme 120 mm long. Transverse sternapodeme 85 mm long. Superior volsella semicircular, covered with microtrichia, bearing four strong setae along inner margin. Inferior volsella square-shaped, width and length are almost equal, bearing two long setae at apex, free microtrichia. Gonocoxite 138 mm long, bearing five strong setae along inner margin. Gonostylus 170 mm long, widest at basal 1/3, tapering to the apex. HR: 0.81; HV: 3.08.

Distribution. Japan.

Remarks. The characters of frontal tubercles, superior volsella and inferior volsella, and gonostylus followed the generic character of the genus *Cryptochironomus* by Cranston et al. (1989). The character of "H"-shaped anal tergite is similar to *Cryptochironomus tokaracedeus* Sasa & Suzuki, 1995, but *tokaraefeus* can be separated by the semicircular superior volsella, square-shaped inferior volsella and some metric characteristics.

Cryptochironomus tonewabeus (Sasa & Tanaka, 2002), comb. n.

Figure 4

Paracladopelma tonewabea Sasa & Tanaka, 2002: 30.

Material examined. Japan. Holotype specimen of *Paracladopelma tonewabea* Sasa & Tanaka, 2002. ♂ (No. 405: 51), Tone River at Taisho Bridge, Gunma Prefecture, Japan. 19. xii. 2000, reared from bottom sample, coll. N. Tanaka.

Diagnostic characters. AR 2.53, frontal tubercles cylindrical. Tergite IX broadly semi-circular, with 16 setae (eight on each side of base of anal point). Anal point wide at base, parallel-sided medially and distally, rounded apically. Anal tergite bands "wide V"-shaped, not fused in the middle, and abruptly interrupted at the end. Superior vol-

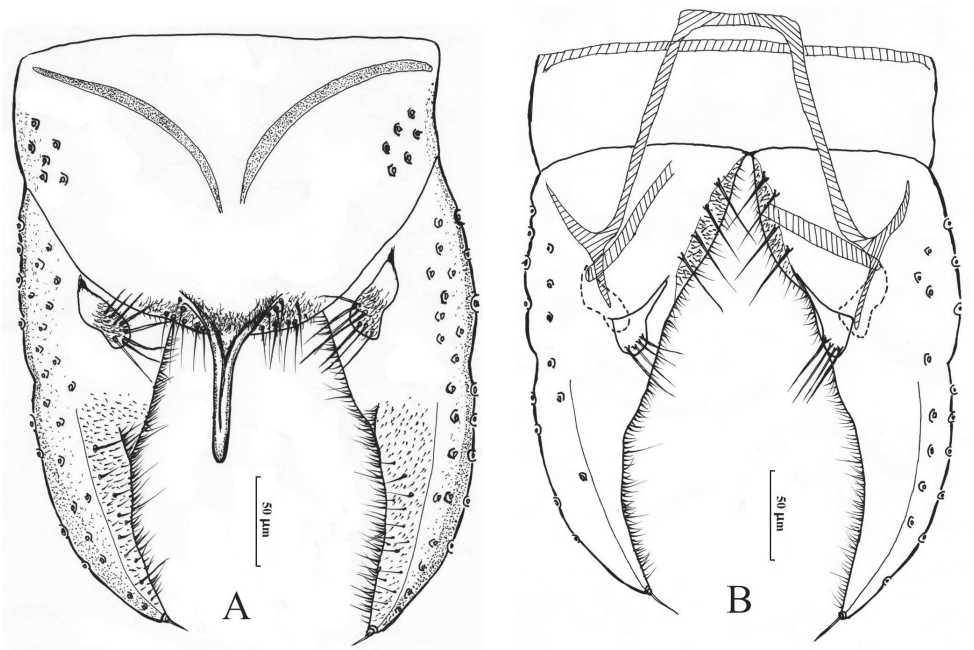

Figure 4. Male adult of *Cryptochironomus tonewabeus* (Sasa & Tanaka, 2002) comb. n., male. **A** hypopygium (dorsal view) **B** hypopygium (ventral view).

sella peanut-like, concave midially. Inferior volsella thumb-like, with slender extension at the base. Gonostylus and gonocoxite fused completely. Gonostylus wider at base, tapering to the apex.

Coloration. Thorax light yellow-brown, with yellow-brown spots, Femora of front legs yellow-brown, tibia and tarsomeres dark brown; femora, tibiae and tarsi I of mid and hind legs brown; tarsi II-V dark yellow-brown, hypopygium dark brown.

Head. AR: 2.53, Ultimate flagellomere 1010 μm; frontal tubercles tapering, 20 μm high, 13 μm width at base. Temporal setae 23, including seven inner verticals, nine outer verticals, and seven postorbitals. Clypeus with 20 setae. Palpomere lengths (μm): 60; 75; 290; 120; 330. Palp segment $5^{th}/3^{rd}$: 1.14.

Thorax. Antepronotals bare; acrostichals ten; dorsocentrals ten; prealars six. Scutellum with 25 setae.

Wing. VR: 1.15. R with 22 microtrichia. R_1 with 19. R_{4+5} with 28 setae. Brachiolum and squama were broken.

Legs. Front tibia with three subapical setae, 175 μm, 180 μm, 193 μm. Mid legs with three spurs, 28 μm, 30 μm; tibial comb with 48 teeth, 12 μm long. Spurs of hind tibia 30 μm and 37 μm long, tibial comb with 64 teeth, 13 μm long. Tarsus I of mid leg with three sensilla chaetica; tarsus I of metapedes leg with two sensilla chaetica. Lengths (in μm) and proportions of thoracic legs as in Table 4.

Hypopygium (Fig. 4A–B). Tergite IX shoulder-shaped at the posterior margin, bearing 16 setae. Laterosternite IX with six lateral setae. Anal point 77 μm long, wider

Table 4. Male adult of *Cryptochironomus tonewabeus* (Sasa & Tanaka, 2002), comb. n. Length (μm) and proportions of legs.

	fe	ti	ta_1	ta_2	ta_3	ta_4	ta_5	LR
p_1	1300	950	1700	780 0	650	600	225	1. 79
p_2	1125	1030	690	320	240	140	100	0. 67
p_3	1275	1330	920	450	380	210	110	0. 69

at base, parallel-sided with rounded apex, lacking dorsal and lateral setae, microtrichia absent. Anal tergite bands "V"-shaped, not fused in the middle. Phallapodeme 90 μm long. Transverse sternapodeme 80 μm long. Superior volsella peanut-like, concave medially, bearing six strong setae. Inferior volsella thumb-like, with slender extension at the base, bearing four long setae at apex, free microtrichia. Gonocoxite 158 μm long, bearing eight strong setae along inner margin; Gonostylus 164 μm long, with seven short inner setae and one single seta. HR: 0.78; HV: 3. 25.

Distribution. Japan.

Remarks. Frontal tubercles cylindrical, superior volsella peanut-like, and concave medially combined with a thumb-like inferior volsella, bearing four long setae at apex, and free microtrichia followed the generic characters of Cranston et al. (1989). The "V" shaped anal tergite bands, not fused medially, are similar to *Cryptochironomus albofasciatus* (Staeger, 1839), but *C. tonewabeus* can be differentiated by the frontal tubercles, superior volsella and inferior volsella.

Key to known male adults of *Cryptochironomus* from Japan

1 Superior volsella spherical to bulbous.....**2**
– Superior volsella not as above.....7
2 Junction of gonostylus and gonocoxite distinctly compacted **3**
– Junction of gonostylus and gonocoxite compacted slightly or not at all.....**6**
3 Inferior volsella with microtrichia ..... ***C. tamayoroi* Sasa & Ichimori, 1983**
– Inferior volsella bare.....**4**
4 Anal point tapering to the apex.....**5**
– Anal point nearly parallel-sided..... ***C. rostratus* (Kieffer, 1921)**
5 Tibia and tarsi of front legs dark brown, tibia with 3 subapical setae.....
..... ***C. tamaichimori* Sasa & Kawai, 1987**
– Tibia and tarsi of front legs light brown, tibia with 1 subapical seta .....
.....***C. tokaracedeus* Sasa & Suzuki, 1995**
6 Anal tergite bands "wide Y"-shaped .....
..... ***C. misumaiprimus* (Sasa & Suzuki, 1998), comb. n.**
– Anal tergite bands "H"-shaped.....
..... ***C. tokaraefeus* (Sasa & Suzuki, 1995), comb. n.**

7 The posterior margin of tergite IX tapered **8**
– The posterior margin of tergite IX arced **9**
8 Frontal tubercles low and broad, width is at least two times longer than height ..... ***C. albofasciatus*** **(Staeger, 1839)**
– Frontal tubercles tapering, width nearly equal to height ..... ***C. hentonensis*** **Hasegawa & Sasa, 1987**
9 Anal point wide and short, gonostylus blunt and rounded apex ..... ***C. javae*** **Kieffer, 1924**
– Anal point slender and short, gonostylus tapering to the apex **10**
10 Superior volsella spherical, slightly compacted at base ..... ***C. jokaprimus*** **Sasa & Ogata, 1999**
– Superior volsella peanut-like, distinctly compacted at distal 1/3 ..... ***C. tonewabeus*** **(Sasa & Tanaka, 2002), comb. n.**

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