RESEARCH ARTICLE



Redescription and molecular characterization of *Placobdella cryptobranchii* (Johnson & Klemm, 1977) (Glossiphoniidae, Hirudinida)

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Abstract

Placobdella cryptobranchii (Johnson & Klemm, 1977) was originally described from specimens collected from Ozark Hellbenders (*Cryptobranchus alleganiensis bishopi*) from the North Fork of the White River in Missouri, U.S.A. Leeches collected during August 2009 to August 2011 from five localities in Missouri (including the type locality) facilitated a redescription and molecular characterization of *P. cryptobranchii*. *Placobdella cryptobranchii* has a rusty, reddish-brown dorsum with 2 lateral rows of unpigmented papillae, two unpigmented nuchal bands, unpigmented patches, and pair of four pre-anal papillae. Molecular comparison of CO-I sequence data from *P. cryptobranchii* revealed a 93–94% similarity to *Placobdella ornata* and 10–17% difference among other species of *Placobdella*.

Keywords

Placobdella cryptobranchii, Batracobdella, Desserobdella, Cryptobranchus bishopi, Cryptobranchus alleganiensis bishopi, Ozark Hellbender, Glossiphoniidae, Hirudinea, Rhychobdellida, Clitellata, leech

Introduction

The hellbender (*Cryptobranchus alleganiensis alleganiensis* and *Cryptobranchus alleganiensis bishopi*) is among the largest salamanders in the world, but is unfortunately imperiled across much of its range in North America. *Batracobdella cryptobranchii* was described by Johnson and Klemm (1977) based upon specimens collected in 1972 by Nickerson and Mays (1973) on Ozark hellbenders (*C. a. bishopi*) from the North Fork of the White River in Missouri, U.S.A. Reflecting taxonomic instability in a species that had not been reported since its original description, *B. cryptobranchii* was subsequently transferred to the genus *Actinobdella* by Sawyer (1986), to the genus *Desserobdella* by Barta and Sawyer (1990), and to the genus *Placobdella* by Moser et al. (2006).

In distribution and natural history investigations, *P. cryptobranchii* was reported from additional localities in Arkansas and Missouri (Moser et al. 2006; Moser et al. 2008), but little additional morphological data were added in these accounts. Moser et al. (2008) reported a metameric pattern on the dorsal surface of *P. cryptobranchii*, however, Johnson and Klemm (1977) stated that the dorsum of preserved specimens of *P. cryptobranchii* was smooth and no metameric markings were present. Klemm (1982; 1985) noted that the dorsal surface of some preserved specimens of *P. cryptobranchii* had a metameric pattern. The present study provides a redescription and molecular characterization of *P. cryptobranchii* from its type locality and other localities.

Materials and methods

Collection of Leeches

As part of a long term monitoring program of *C. a. bishopi* populations of by one of the authors (JTB), Ozark hellbenders were captured by hand from 18 August 2009 through 26 August 2011 from the Current River (Carter Co., Ripley Co., and Shannon Co., Missouri), Eleven Point (Oregon Co., Missouri), and the type locality of *P. cryptobranchii*, North Fork of the White River (Ozark Co., Missouri), and examined for leeches. Due to the sensitive status of *C. a. bishopi*, exact localities are not given. Leeches were also removed from *C. a. bishopi* specimens collected from the Eleven Point River (Oregon Co., Missouri) and housed at the Saint Louis Zoo for propagation efforts.

Specimens were relaxed, examined, and fixed as described by Moser et al. (2006). Other specimens were maintained alive and mudpuppies (*Necturus maculosus*) were introduced as a potential host and leech activity was observed. For internal anatomy investigations, three specimens were pressed, stained with Semichon's acetocarmine, and mounted in Canada balsam for examination by light microscopy according to techniques outlined by Richardson (2006), as modified by Richardson and Barger (2006), and two specimens were dissected. Terminology for plane shapes follows Clopton

(2004). Specimens were deposited in the Smithsonian Institution, National Museum of Natural History (USNM), Washington, District of Columbia and the Peabody Museum of Natural History (YPM), Yale University, New Haven, Connecticut.

DNA Analyses

Molecular analyses were conducted on newly collected material according to Richardson et al. (2010) as follows: DNA was isolated from the caudal suckers of individual leeches with the DNeasy Blood & Tissue Kit from Qiagen (Cat. No. 69504), following the protocol given for the purification of total DNA from animal tissues (spincolumn). For the proteinase K treatment step, tissue samples were lysed overnight at 56°C. DNA was eluted from the spin columns with 150 µl of buffer.

PCR reactions were prepared using the Illustra PuRe Taq Ready-To-Go PCR beads from GE Health Care (Cat. No. 27-9559-01). Primers were purchased from Invitrogen and were comprised of 2 primers each for cytochrome c oxidase subunit I (CO-I) as specified by Light and Siddall (1999). Specifically the CO-I primers were LCO1490 (5'GGTCAACAAATCATAAAGATATTGG 3') and HCO2198 (5'TAAACTTCAGGGTGACCAAAAAATCA 3'). Final volume of PCR reactions was 25 μ l with 2 μ l of leech genomic DNA added per reaction. DNA was amplified under the following PCR conditions: 94°C for 5 min.; 35 cycles of (94°C for 30 sec, 50°C for 30 sec, 72°C for 45 sec); 72°C for 7 min. Following PCR, samples were cleaned using a QIAquick PCR purification kit from Qiagen (Cat. No. 28104).

Purified PCR products were sequenced using the HCO2198 primer and the LCO1490 primer for the Cytochrome c oxidase subunit I products by the W. M. Keck Foundation Biotechnology Resource Laboratory at Yale University. The DNA sequences were aligned using Clustal W version 2 (Larkin et al. 2007) and checked manually using SeaView 4 (Gouy et al. 2010) and then analyzed using PAUP* 4.0b10 (Swofford 2002), deposited in GenBank (http://www.ncbi.nlm.nih.gov/genbank/), and compared to other leech DNA sequences contained within Genbank.

Results and discussion

Examination of the type series of *Placobdella cryptobranchii* included the Holotype (USNM 54365) and Paratypes (USNM 54366, 10 specimens; MPM 2675-2677). All of the specimens in the type series were collected on 24 September, 1972 from the North Fork of the White River in Ozark County, Missouri, U.S.A. The USNM Holotype and Paratype lots are currently stored in 70% ethanol, however, the museum label in the vial of the Holotype indicates that it was preserved in weak formalin (4% formalin), stained in borax carmine, and cleared and stored in methyl salicylate (Figure 1). The Holotype still has a faint wintergreen odor of methyl salicylate. The museum label in the vial of the Paratype indicates that the specimens were preserved and stored in weak formalin (4% formalin).



Figure 1. Holotype specimen of *Placobdella cryptobranchii*, USNM 54365, dorsal surface. Scale bar equals 2 mm.



Figure 2. Holotype specimen of *Placobdella cryptobranchii*, USNM 54365, pre-anal papillae (arrows). Scale bar equals 0.5 mm.

Examination of the Holotype and Paratype specimens revealed a narrowly rhomboid body, caudal sucker on a short pedicel, 2 annuli between the male and female gonopores, mouthpore on the rim/lip of the oral sucker, and a faint outline of two pair of eye spots. The dorsal surface of the Holotype and a few Paratypes had minute papillae. Beginning adjacent to the anus and commencing anteriad on either side of the anus in the Holotype and a few Paratypes were two rows of four papillae (the last row -most anteriad –papillae are medially indented) (Figure 2). Any trace of pigmentation or pigmentation pattern has faded.

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The following redescription of *P. cryptobranchii* is based on the Holotype (USNM 54365), Paratypes (USNM 54366, 10 specimens), and newly collected specimens consistent with the description of *Batracobdella cryptobranchii* by Johnson and Klemm (1977) from the Current River (Carter Co., Ripley Co., and Shannon Co., Missouri) (USNM 1223071–1223080), Eleven Point River (Oregon Co., Missouri) (USNM 1223081–1223082), Eleven Point River (Oregon Co., Missouri) at the Saint Louis Zoo (USNM 1223083–1223084; USNM 1223088–1223090, three whole mount slides; YPM IZ 06339–06340), and the type locality of *P. cryptobranchii*, North Fork of the White River (Ozark Co., Missouri) (USNM 1223085–1223087).

Placobdella cryptobranchii (Johnson & Klemm, 1977) Moser et al., 2006

http://species-id.net/wiki/Placobdella_cryptobranchii Figures 3–5

Syn. Batracobdella cryptobranchii Johnson & Klemm, 1977; Actinobdella cryptobranchii Sawyer, 1986; Desserobdella cryptobranchii Barta & Sawyer, 1990

External morphology. Body very deeply ovoid to obovoid. Length of preserved specimens 3.6–13.3 mm long, mean \pm SE 6.6 \pm 0.3 mm (n=42), width at widest point (in posterior half of body) 2.1-6.6 mm, mean \pm SE 3.8 ± 0.2 mm (n=42). Dorsum rusty, reddish-brown with 2 lateral rows of unpigmented papillae (Figure 3); smaller sensillae on every annulus (absent on poorly-preserved specimens). Apical cephalic region unpigmented, extending and tapering posteriorly through two thin nuchal bands (Figure 3). Two pair of eye spots (one pair much larger than the other) within cephalic unpigmented region. Unpigmented genital bar and anal patch with some specimens possessing unpigmented patch in between unpigmented genital bar and anal patch (Figure 3). Pigmentation gradually fades in ethanol and may not be present in poorly-preserved specimens. Beginning adjacent to the anus, just anterior to the anus furrow, and commencing anteriad are two rows of 4 pre-anal papillae (the last row, most anteriad, papillae are medially indented) (Figure 4). Caudal sucker small, 0.4-1.9 mm in diameter, mean \pm SE, 1.1 \pm 0.1 (n=35), and unpigmented or with large unpigmented patches. No papillae on caudal sucker or 1 row of small papillae on the lateral edge. Ventrum unpigmented with male and female gonopores in furrows and separated by 2 annuli.

Alimentary tract. Proboscis pore just posteriad of the rim/lip of the oral sucker. Blunt-tipped proboscis, nearly uniformly cylindrical, slightly enlarged at base, and in membranous sheath (Figure 5). In the anterior third of the leech, salivary cells strewn on either side of the proboscis (Figure 5). Salivary cells most numerous in three somites at the base of the proboscis, and more scattered anteriad and posteriad of that region. Retractor muscle attached to dorsal body wall and joining salivary ductule bundles attaching at each side of the base of the proboscis. Slim, flaccid esophagus extends from the base of the proboscis with one pair sac-like mycetomes [called esophageal diverticulum by Johnson and Klemm (1977)]. Seven pair of diverticulated crop ceca, last



Figure 3. Dorsal surface of *Placobdella cryptobranchii*. A Living, YPM IZ 06339 B Preserved, YPM IZ 06340. Scale bar equals 2 mm.



Figure 4. Pre-anal papillae of *Placobdella cryptobranchii* (USNM 1223081). Scale bar equals 0.5 mm.

pair extending posteriorly and diverticulated into four sections. Four pair of simple, saccular intestinal ceca with last pair extending posteriad. Simple rectum opening to anus, located one annulus anteriad of the caudal sucker.

Reproductive system. (Male) Male gonopores slightly raised. Male atrium opening into paired very broadly orbicular atrial cornuae extending laterally and anteriorly



Figure 5. Internal anatomy of *Placobdella cryptobranchii* (USNM 1223088), ventral view, atrial cornuae (**AC**), ejaculatory duct (**ED**), intestinal ceca (**IC**), ovisac (**O**), proboscis (**Pr**), rectum (**R**), salivary cells (**Sc**), testisac (**T1–T6**). Scale bar equals 2 mm.

from male gonopore into robust, coiled, muscular ejaculatory ducts, recurving posteriorly to robust seminal vesicles and narrow vas deferentia connecting to testisacs (Figure 5). Six pair of testisacs, each testisac located in the space between a pair of crop ceca (Figure 5). (Female) Female gonopore simple, opening to pair of bifurcated ovisacs and located within coelomic space that is attached on the ventral body wall (Figure 5). Ovisac length depends on the reproductive condition of the leech. In the specimens examined in this study, the ovisac extended posteriad to the sixth testisac or past the sixth testisac. Anterior, cecum-like extensions of the ovisacs are smaller and more delicate than those of the main posterior section.

Laboratory observations on life history

- 6 May, 2013: Presented *P. cryptobranchii* with brood to *N. maculosus* in 5 gallon tank. No reaction; 2 others no reaction after one hour; 2 others left over-night-did not respond.
- 4 June, 2013: Presented 2 P. cryptobranchii to N. maculosus in 5 gal tank.--one did not respond and one exhibited vigorous host seeking behavior.: Leech examined skin of N. maculosus for about first 10 minutes but did not feed. Host seeking behavior subsided over the next few moments and the leech then exhibited no further interest.

Remarks

Johnson and Klemm (1977) found no evidence of dorsal color pattern or metameric markings on preserved specimens of *P. cryptobranchii*, however, Klemm (1982; 1985) mentioned that some preserved specimens have a metameric pattern. Moser et al. (2008) described a dorsal pigmentation pattern in *P. cryptobranchii* and this pattern was further clarified in the current study along with a description of dorsal papillae

patterns. This discrepancy is easily explained since the leech pigmentation pattern fades in ethanol (Moser et al. 2008) and is not retained in poorly preserved specimens.

Intraspecific comparison of 639 nucleotides of CO-I revealed differences of 0.3% to 3.3% (2-21 nucleotides) among seven specimens of P. cryptobranchii (GenBank KF601755-KF601761) collected from the Current River (Carter Co., Ripley Co., and Shannon Co., Missouri), Eleven Point (Oregon Co., Missouri), and the type locality of P. cryptobranchii, North Fork of the White River (Ozark Co., Missouri). In contrast, CO-I sequence data among seven specimens of P. cryptobranchii revealed interspecific differences of 5.8% to 6.8% (37-43 nucleotides) when compared to five specimens of Placobdella ornata (Verrill, 1872) (GenBank JQ8128-JQ8132) collected from the type locality (West River, New Haven County, Connecticut), differences of 6.3% to 7.1% (40-45 nucleotides) among four specimens of P. ornata collected from the type locality (Shivericks Pond, Falmouth, Barnstable County, Massachusetts) of Placobdella phalera (Graf, 1899) (junior synonym of Placobdella ornata) (Gen-Bank JQ812133–JQ812136), differences of 10.4% to 12.1% (66–77 nucleotides) among two specimens of Placobdella translucens Sawyer and Shelley, 1976 (GenBank AY047328, JX122778), differences of 14.8% to 15.4% (94-98 nucleotides) from 1 specimen of *Placobdella picta* (Verrill, 1872) (GenBank AF116020), and differences of 16.2% to 16.9% (103-109 nucleotides) from 1 specimen of Placobdella biannulata (Moore, 1900) (GenBank AF116021).

Placobdella cryptobranchii is morphologically and molecularly similar to *Placobdella ornata* as described by Verrill (1872) and redescribed by Moser et al. (2012). However, *P. cryptobranchii* has two lateral rows of white-tipped papillae and *P. ornata* has three rows of papillae (a medial and two lateral rows) with black-tipped papillae on the medial row and a medial pigment stripe. *Placobdella ornata* has two rows of five pre-anal papillae and *P. cryptobranchii* has two rows of four pre-anal papillae and the last, most anteriad row, has papillae that are medially indented. *Placobdella cryptobranchii* is distributed in the Ozark Highlands region of Arkansas and Missouri, and the Ozark Hellbender (*Cryptobranchus alleganiensis bishopi*) and mudpuppy (*Necturus maculosus*) have been reported as hosts (Johnson and Klemm 1977; Moser et al. 2006; Briggler and Moser 2008; Moser et al. 2008). *Placobdella ornata* is currently known only from New England (Moser et al. 2012). The only host record for *P. ornata* is the common musk turtle (*Sternotherus odoratus*) (Graf 1899) and this report is tenuous as no voucher specimens were deposited. Although closely related, *P. cryptobranchii* is morphologically and molecularly distinct from *P. ornata*.

Based on the life history experiments, it was concluded that *P. cryptobranchii* does not utilize *N. maculosus* as a normal host, suggesting that the occurrence of four *P. cryptobranchii* on a Red River mudpuppy from the Eleven Point River in Missouri by Briggler and Moser (2008) may have been an isolated event. Until further data are available, *C. alleganiensis bishopi* should be considered the only primary host for *P. cryptobranchii*, which appears to exhibit a fairly high level of host specificity. The inability to induce feeding of *P. cryptobranchii* on *N. maculosus* in the laboratory suggests that any further decline of *C. alleganiensis bishopi* will place *P. cryptobranchii* in danger of extinction.

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RESEARCH ARTICLE



Two new species in the family Axinellidae (Porifera, Demospongiae) from British Columbia and adjacent waters

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Abstract

Two new species of Demospongiae are described for British Columbia and adjacent waters in the family Axinellidae, *Auletta krautteri* **sp. n.** and *Dragmacidon kishinensis* **sp. n.** They represent range extensions for both of these genera. Both are fairly commonly encountered, *A. krautteri* below diving depths (87 to at least 300 m) and *D. kishinensis* in shallow water (intertidal to 30 m). We propose an amended genus diagnosis for *Auletta* to account for the variability among species in principal spicules that form the ascending tracts to be either oxeas, styles or strongyles rather than just oxeas.

Keywords

Porifera, Demospongiae, Halichondrida, Axinellidae, northeast Pacific, Auletta krautteri, Dragmacidon kishinensis

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Introduction

A brief history of surveys and publications from 1878 to 1966 including sponges in British Columbia is presented in Austin et al. (in prep.). Of the approximately 200 demosponge species recorded for this region (Austin 1985, Austin et al. 2012), six species were regarded as members of the family Axinellidae (Austin 1985, Austin and Ott 1987). Three of these have now been removed from this family. *Syringella amphispicula* de Laubenfels, 1961 was recently shown to belong to the genus *Homaxinella* and hence to the family Suberitidae (Austin et al. in prep). *Stylissa stipitata* de Laubenfels, 1961 is not a *Stylissa* and not an axinellid; It is considered to be a synonym of *Semisuberites cribrosa* (Micklucho-Maclay, 1870) by van Soest et al. (2012). Specimens identified by us as *Phakettia* sp. aff. *beringensis* we now consider to be *Semisuberites cribrosa*. Finally, a specimen identified as *Axinella* sp. has been lost. We defer any formal description until we have more material. It has been seen twice from a submersible at 100 m. The remaining two species, both new, are described in this paper: *Auletta krautteri* sp. n. and *Dragmacidon kishinensis* sp. n.

Alvarez and Hooper (2002) provided a discussion of the history, definition and scope of the Axinellidae. They reviewed the literature and concluded that among 92 nominal genera, only 10 were valid (*Auletta, Axinella, Cymbastela, Dragmacidon, Dragmaxia, Pararhaphoxya, Phakellia, Phycopsis, Ptilocaulis*, and *Reniochalina*).

Materials and methods

Specimens housed in the Khoyatan Marine Laboratory museum (KML) were largely preserved and maintained in 70% isopropyl alcohol; some are dried. KML specimens were collected either by hand in the intertidal, by SCUBA in the shallow subtidal, or by dredge, submersible (*PISCES IV, DELTA*) or ROV (*ROPOS*) in deeper water.

Collections were examined for axinellids from the NE Pacific-at Royal BC Museum, California Academy of Sciences, and the Canadian Museum of Nature. In some cases material was brought back to KML for more detailed study.

Under material examined, for each lot we report: institution accession number, station number, location, latitude and longitude, depth, date of collection, collector, and number of specimens. Where geographic location but not latitude and longitude was recorded, we include them following the abbreviation for approximate: ca.. We endeavoured to track down missing data but were not always successful. Sources for obtaining geographic coordinates include: Google Earth, Sailing directions BC Coast (North & South Portion), United States Coast Pilots: Pacific Coast #8, southern Alaska, and #7, BC Geographical Names Information System, and Canadian Hydrographic Service charts.

Where colour photographs were taken, in situ scale bars are approximate. Photos taken together with specimens are assigned the same station number and accession number as those specimens.

Thick sections of specimens were made by excising approx. one cm³ surface blocks, dehydrating in ethanol and embedding these in 68°C melting point his-

tological paraffin. After cooling to room temperature, the blocks were trimmed to either vertical or tangential orientation and re-warmed to 40°C for one hour to prevent cracking during sectioning. Warmed tissue blocks were set into a guiding jig and sectioned by hand with a straight razor at varied, but only marginally controllable thicknesses of between 0.1 and 1.0 mm. The best sections were de-paraffinized in xylene and mounted on microscope slides in Canada balsam for observation, measurement and photography.

Tissue-free spicule preparations were made by dissolving small pieces of sponge in sodium hypochlorite. For each spicule type we measured, using a compound microscope, the diameter or length and width of 50 spicules (unless noted otherwise by N=). We scanned microscope fields for spicules of variable sizes, but ignored obviously ontogenetically young spicules in determining size ranges. We list spicule dimensions as three numbers, the minimum, mean and maximum, e.g., 200–(250)–300. All measurements are in micrometers (μ m). For scanning electron microscopy (SEM), cleaned spicules were either deposited onto membrane filters that were then taped to stubs, or deposited directly on double-sided tape attached to stubs. Preparations were coated with gold-palladium and viewed either in a Hitachi S-3500N SEM at the University of Victoria, or in one case an ETEC Biosem at Simon Fraser University.

Holotypes have been deposited in the Royal British Columbia Museum, Victoria, BC, Canada and paratypes have been deposited in the Canadian Museum of Nature, Ottawa, Ontario.

Taxa including families, genera and species are arranged alphabetically. Systematic hierarchy follows Hooper and Van Soest 2002. Abbreviations used in the text ordered alphabetically are: approx.=approximate; BC=British Columbia; CASIZ=California Academy of Sciences, Invertebrate Zoology, San Francisco, California, U.S.A.; CMNI=Canadian Museum of Nature, Ottawa, Ontario, Canada; coll.=collector; FRB=Fisheries Research Board of Canada, Ottawa, Ontario, Canada; ID=identified; KML=Khoyatan Marine Laboratory, lat.=latitude; long.=longitude; North Saanich, BC, Canada; PBS=Pacific Biological Station, Nanaimo, BC, Canada; PEI=Pacific Environment Institute, Fisheries and Oceans Canada, West Vancouver, BC, Canada; RBCM=Royal British Columbia Museum, Victoria, BC, Canada; Str.=strait.

Descriptions

Genus Auletta Schmidt, 1870

Systematics

Phylum Porifera Class Demospongiae Order Halichondrida Family Axinellidae Carter, 1875 Genus *Auletta* Schmidt, 1870 **Genus diagnosis.** Tubular, erect on peduncle or narrow base. Surface smooth or tuberculated with choanosomal spicules projecting slightly; ectosome without specialised skeleton. Choanosomal skeleton plumoreticulate, with longitudinally strongyle or sinuous oxea tracts, connected by single styles or plumose tracts of styles; masses of sinuous strongyles reinforcing the stem and may reinforce the inner tube wall. Megascleres sinuous strongyles or oxeas, always coring main spicule tracts and inner tube walls; styles and or oxeas, plumo-echinating and connecting main tracts. Microscleres absent.

(Amended from Alvarez and Hooper 2002)

Auletta krautteri sp. n.

http://zoobank.org/B1D4806D-AE5D-4D4E-8DDC-6B5E2685BB76 http://species-id.net/wiki/Auletta_krautteri Fig. 1

Etymology. Named after Dr. Manfred Krautter who organized a dive program in the submersible *DELTA* on sponge bioherms and collected the holotype.

Material examined. Holotype: RBCM 013-00114-001; KML1105 KML Sta. 71/99 Hecate Strait, BC, (52°26.4'N, 129°40.0'W), 215 m depth, July 18, 1999, coll. M. Krautter, 1 specimen. Paratype: CMNI 2013-0001, KML1106, west of Dixon Entrance, BC, (54°370'N, 133°55.0'W), 229 m depth, 1 specimen.

Other material. KML1106, PBS 65-77, west of Dixon Entrance, BC, (54°37 0'N, 133°55.0'W), 229 m depth, 21 specimens; KML1108, PBS JWS-132, Queen Charlotte Sound, BC, (51°22.5'N, 129°13.5'W), Feb. 3, 1965, 16 specimens; KML1107, KML Sta. 171/76, West of Flamingo Inlet, BC, (52°09.8'N, 131°23.8'W), 200 m depth, Aug. 31, 1976, coll. W.C. Austin, 3 specimens; KML1109, PBS 71-47, off Dixon Entrance, BC, (54°30.2'N, 135°53.3'W), 256 m depth, 3 specimens; KML1105, KML Sta. 71/99, Hecate Strait, BC, (51°21.5'N, 129°13.5'W), 183 m depth; CASIZ 020231, NODC 366501, Gulf of Alaska, (59°2.0'N, 141°3.6'W), 348 m depth, 2 specimens; KML1108, PBS 981-60, Dixon Entrance, BC, (54°N, 132°W), 128 m depth; CMN 1900-86, Forester I., Alaska, (54°48'N, 133°36'W), depth no data, coll. W. Van Vliet; CMN 1900-89, sta. LM 43, Tasu, Queen Charlotte Islands, BC, (52°45'N, 132°06'W), depth no data, coll. L. Marhue; CMN 1900 sta. JWS-93, Forester I., Alaska, (54°48'N, 133°36'W), depth no data, coll. J.W. Scogoen; CMN 1900-91, W. of Queen Charlotte Islands, BC, (53°N, 132°W), depth no data, coll. W. Van Vliet; CMN 1900-93, sta. FRB 66 221 m depth, Forester I, Alaska, (54°48'N, 133°36'W), depth no data; CMN 1900-94, sta. LM-43, Tasu, Queen Charlotte I., BC, (52°45'N, 132°06'W), depth no data, coll. L. Marhue; CMN 1900-96, sta. FRB 66-2-6, off Sitka, Alaska, (57°02.3'N, 135°20.3'W), depth no data, coll. W. Van Vliet.

Description. *Macroscopic features.* Erect, stalked tubes typically single (Fig. 1A), occasionally branched (2 to 3 tubes on a common base); branched forms uncommon. Overall height 5–13 cm, width of tubes 0.7–2 cm. Stalk comprises up to one third of overall height. A single 2–8 mm diameter osculum at the tube apex leads into an atrial



Figure 1. *Auletta krautteri* sp. n. **A** Fresh specimen, KML1107, KML Sta. 171/76, West of Flamingo Inlet, BC, scale bar 5 cm **B** KML1105, vertical longitudinal section, scale bar 3 mm **C** KML1105, cross section, scale bar 3 mm; D–O. KML1105, spicules **D** ends of style, scale bar 50 μm **E** style associated with osculum (under light microscope), scale bar 100 μm **F–I** various forms of styles **F** scale bar 100 μm; G. scale bar 100 μm **H** scale bar 200 μm **I** scale bar 300 μm **J** ends of oxea, scale bar 50 μm **K–M** various forms of oxeas **K** scale bar 300 μm **L** scale bar 200 μm **M** scale bar 300 μm **N** ends of strongyle, scale bar 50 μm.

cavity extending the length of the tube and into the stalk where the tube diameter is restricted. Wall thickness of the tube 5-10 mm. Surface felt-like to touch. Smooth inner wall penetrated by a series of elongate openings. Consistency compressible but firm and tough. Colour in life reddish-brown; grey or cream in alcohol. Specimens collected in 1965 contained oocytes 130 to 150 μ m diameter.

Microscopic features. Skeletal architecture simple, composed of one to three multispicule tracts oriented parallel to and lining the atrial cavity, which is relatively smooth as a result (Fig. 1B). Single, or multispicular tracts branch from this longitudinal tract approximately at right angles and project to the outer surface. The branches also form short brushes, and where each branch penetrates the surface, the terminal brush forms a tuft to produce a hispid appearance (Fig. 1C).

Each tract varies from 150–400 μ m in diameter. Ascending tracts are-composed primarily of straight and curved styles, and secondarily of sinuous oxeas, curved oxeas and occasional sinuous strongyles (Fig. 1O, P). Straight styles or styles curved near the base form the exterior tips of ascending fibres and curved, bent or sinuous oxeas and styles form cross tract links.

The multi-spicule tracts of the atrial cavity are $500-700 \mu m$ diameter and composed of bundles of 10 to 15 spicules cemented by spongin Ascending tracts composed of fewer, typically 5 or 6, spicules in a bundle cemented by spongin. Atrial tracts composed primarily of sinuous oxeas, secondarily of curved and straight styles; occasionally sinuous strongyles, sinuous styles, and curved oxeas located in axial tracts.

Ectosome surface forms a reticulation in the areas with pores where it is elevated about 2 mm above the general surface. Easily detachable aspicular membranes are present on dermal surface stretched between spicule tracts, and on atrial surface below the longitudinal spicule tracts (Fig. 1B, C). The choanosome occupies the space between the detachable membranes and is distinguished by radial orientation of the spicule tracts, and by the somewhat different proportion of spicules, which is quite variable among different specimens.

Oscula may be ringed by long, straight styles singly or in tufts. Fringe may be absent, but if present, extends $100-300 \mu m$ beyond the osculum.

Stalk is denser than the tube, not hollow except near the tube base, and packed with branching and anastomosing multi-spicule tracts, forming a dense reticulation of two to ten or more spicules to a bundle cemented by spongin. Stalk tracts 100–400 μ m diameter. Primary spicules sinuous strongyles which serve to reinforce the stem. The proportion of other stalk spicules is quite variable with sinuous oxeas, bent and curved and straight styles being variably the next most abundant. Sinuous styles and curved or bent oxeas are uncommon.

Spicules. Spicule types include straight (Fig. 1F) and bent (Fig. 1H) styles of the multi-spicule tracts; long, straight styles of the oscular fringe (Fig. 1E) and proximate area; sinuous (Fig. 1K, L), curved or bent (Fig. 1M) oxeas, and sinuous strongyles (Fig. 1O, P). Occasionally sinuous oxeas occur that are rounded on one end forming sinuous styles. These latter were enumerated separately to give a qualitative idea of their abundance.

Longer styles often have a reduced diameter at the head comparable to mycalostyles. Oxeas are often anisometric. Both oxeas and styles occasionally have mucronate or rounded apices. Oxeas and strongyles may occasionally be centrotylote.

Five specimens were examined in detail (Table 1).

Remarks. Evident from the Table 1 above is the relatively large variability in disposition and size of spicules from specimen to specimen.

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							Length	(un) u		
ID	Location	Latitude	Longitude	(m)	Straight Stude	Curved	Sinuous	Curved	Sinuous	Oscular
KML1105	Hecate Strait, BC	52°26.4'N	129°40.0'W	215	270-1350	240-880	440-1300	330-1070	420–1595	none
Spicule Abundance	Many straight and curved : Curved oxeas uncommon i	ttyles, and sin n stem. Bent	nuous oxeas thr and curved ox	oughout. St	rongyles abu non to mode	ndant in ste rately comm	m, rare in atr on.	iosome, unc	ommon in e	ctosome.
KML1106	Dixon Entrance, BC	54°37.0'N	133°55.0'W	229	320-1280	220-990	380-1274	220-880	250-1430	none
Snicula Abundanca	Styles and sinuous oxeas ab	undant in ec	tosome and ati	riosome, un	common to r	noderately c	ommon in st	em. Strongy	les abundant	in stem,
oprute Anutuation	uncommon in ectosome ar	d rare in atri	osome. Bent al	nd curved o	xeas uncomn	non to rare.				
KML1108	Goose Bank, QC Sound BC	51°30.0'N	128°0.0'W	92	111-1300	119–940	310-1100	250-880	300-1150	970-2375
Spicule Abundance	Straight styles abundant in throughout. Strongyles abu	ectosome, co ndant in ster	mmon in atrio n, uncommon	some, unco in atriosom	mmon in ste e, rare in ecto	m; bent style some. Bent	es abundant and curved of	throughout. oxeas modera	Sinuous oxea ttely commo	s common n except
	rare in stem.									
KML1109	Dixon Entrance, BC	54°30.2'N	133°53.3'W	256	250-1500	230-720	105-1250	123–920	440-1120	680-2450
Snicula Abundance	Styles and sinuous oxeas ab	undant throu	aghout. Sinuoi	us strongyles	abundant in	stem, unco	mmon elsew	here. Bent ar	nd curved ox	eas rare in
opicate amazida	stem, common elsewhere.									
KML1107	W of Flamingo Inlet, BC	52°89.8'N	131°23.8'W	200	325-926	220-790	325-1005	276–768	286-1281	926-1050
Spicule Abundance	Styles and sinuous oxeas ab	undant in th	e ectosome and Bent & curved	d atriosome:	uncommon	to rare in th	e stem. Stror where	ıgyles abund	ant in the ste	m, rare in
	aurosonic, ancontinon m			n navas tat	<u>, , , , , , , , , , , , , , , , , , , </u>		MILLIO.			

Our specimens fit the diagnosis for *Auletta* by Alvarez and Hooper (2002) except that the sinuous diacts are primarily oxeas in the tube and strongyles in the stem. Several species of *Auletta* are reported to have sinuous oxeas but no strongyles (e.g., *Auletta aurantiaca* Dendy, 1889, *Auletta consimilis* Thiele, 1898, *Auletta pedunculata* Topsent, 1896, *Auletta lyrata* (Esper, 1794)).

The following species are not conspecific with *A. krautteri* based on the absence of one or more spicule types.

Auletta andamensis Pattanayak, 2006, p. 66	No strongyles
Auletta aurantiaca Dendy, 1889, p. 92	No strongyles
Auletta consimilis Thiele, 1898, p. 55	No strongyles
Auletta dendrophora Wilson, 1904, p. 158	No oxeas
Auletta grantioides Lévi & Vacelet, 1958, p. 243	No oxeas
Auletta halicondroides Thiele, 1898, p. 55	No strongyles
Auletta lyrata (Esper, 1794)	No strongyles
Auletta lyrata var. brevispiculata Dendy, 1922	No strongyles
Auletta pedunculata Topsent, 1896	No strongyles
Auletta sessilis Topsent, 1904	No oxeas
Auletta sycinularia Schmidt, 1870	No oxeas
Auletta tubulosa (Ridley & Dendy, 1886), p. 482	No oxeas or strongyles

Auletta tuberosa Alvarez, Van Soest & Rützler, 1998, forms clusters of tubes which are tuberculate rather than smooth as in *A. krautteri*. It does have oxeas, but they are smaller (340–430–530) than in *A. krautteri*. Auletta elongata Dendy, 1905: external form consists of multiple tubes branching off a single stem rather than single tubes on each stem as in *A. krautteri*. The axial skeleton consists of stout fibres with short perpendicular anastomosing branches rather than single to three longitudinal axial fibres with relatively long arching perpendicular fibres that branch but do not anastomose. Auletta elongata var. fruticosa Dendy, 1916, is similar to *A. elongata* except it has smaller spicules.

Two other sponges originally assigned to *Auletta* have been reassigned to other genera: *Auletta elegans* Vosmaer, 1882, is now accepted as *Semisuberites cribrosa* (Miklu-cho-Maclay, 1870) (van Soest et al. 2005): Barents Sea. *Auletta elebensis* Thiele, 1899 is now accepted as *Stylissa massa* (Carter, 1887) (Van Soest et al., op. cit.): West Pacific.

Stone et al. (2011) briefly described and showed images of a tubular form they identified as *Axinella rugosa* (Bowerbank, 1866) that might be con-specific with *Auletta krautteri*. However, *A. rugosa* in the N. Atlantic is described as bushy with irregular branches (van Soest 2013). Lambe (1895) identified four specimens from Chika Island and Unalaska Island as belonging to *Axinella rugosa*. However, Cuenot (1913) argued that these were not *A. rugosa* and proposed a new name *Phakellia lambei* Topsent, 1913. Lambe (1895) described his specimens as dividing close to the base into two branches which subdivide above into two lobate expansions.

Conclusions. No described species have a suite of characters matching those of our specimens. We therefore propose that the *Auletta* in British Columbia and Alaska

be considered a new species, *Auletta krautteri*. We suggest that the tubular forms recorded by Stone et al. (2011) are likely *Auletta krautteri*.

Bathymetric range. 180 to 320 meters depth; 87 to 712 meters depth if include *Axinella rugosa* of Stone et al. (2011).

Zoogeographic range. Gulf of Alaska and south to the southern end of the Queen Charlotte Islands, BC, also central Aleutian Islands if include *Axinella rugosa* of Stone et al. (2011).

Ecology. The sponge is a moderately common dredged species found on rock, gravel or mud substrates. Some individuals have been found with a small red copepod (unidentified) burrowed into the surface. Two individuals examined contained a species of the isopod *Gnathia*, oriented head down. Unidentified gammarid amphipods and unidentified spionid polychaetes have also been observed. Numbers of the crinoid *Florometra serratissima* (A.H. Clark, 1907) were observed clinging to specimens of *Auletta krautteri* in Hecate Strait, BC.

Genus Dragmacidon Hallman, 1917

Genus diagnosis. Unbranched, club-shaped, lobate, shrub-like, thickly encrusting or massive habit. Surface with short connules or tubercles; oscules circular, flush or slightly elevated, sometimes with superficial canals leading to opening. Ectosome without specialised skeleton. Choanosomal skeleton plumoreticulate with ascending plumose tracts, anastomosing or interconnected by secondary multispicular tracts; not differentiated into axial or extra-axial regions. Megascleres oxeas and/or styles generally in similar proportions and dimensions. Microscleres, if present, raphids in tightly packed trichodragmas (Alvarez and Hooper 2002)

Dragmacidon kishinensis sp. n.

http://zoobank.org/53DA9618-DE0A-47E4-B78F-BB772C1D1400 http://species-id.net/wiki/Dragmacidon_kishinensis Fig. 2

Etymology. After the ancient First Nation (aboriginal) village site kiix?in (pronounced keeshin) which includes Execution Rock Cave, Barkley Sound, BC, where a specimen was collected in the low intertidal.

Material examined. Holotype: RBCM 013-00115-001, KML1111, PEI 44, Steep I., Discovery Passage, BC, (50°4.94'N, 125°15.35'W), 30 m depth, coll. N. McDaniel, Feb. 26, 1976, 1 specimen & in situ image. Paratype: CMNI 2013–0002, KML1113, KML139/80, Limestone I., BC, (ca. 52°55'N, 131°36'W), 3 m depth, coll. W.C. Austin, July 4, 1980, 1 specimen.

Other material. KML1112, PEI 130, Copper Cliffs, Discovery Passage, BC, (50°6.40'N, 125°15.35'W), 15 m depth, coll. N. McDaniel, Apr. 16, 1978, 1 speci-



Figure 2. *Dragmacidon kishinensis* sp. n. **A** Holotype **B–H** Paratype **A** KML1111, in situ Steep I., BC, scale bar approx. 10 cm **B** KML1114, in situ Texada I., scale bar approx. 5 cm **C** KML1113, long. section, periphery to right, scale bar 3 mm **D** KML1113, cross section scale bar 500 μm **E** KML1113, oxea, scale bar 500 μm **F** KML1113, oxea tip, scale bar 100 μm **G** KML1113, style, scale bar 500 μm **H** KML1113, head of style, scale bar 100 μm.

men; KML1114, PEI 53, Grilse Pt. Texada I, BC, (49°48.03'N, 124°35.79'W), 10 m depth, coll. N. McDaniel, Mar. 13, 1977, 1 specimen; KML1116, PEI 49, Vivian I., BC, (49°50.28'N, 124°41.96'W), 15 m depth, coll. N. McDaniel, Apr.

10, 1976, 1 specimen; KML1121, Sta. no data, Rennell Sound, BC, (ca. 53°24'N, 132°44'W.), depth no data, coll. M. LeBlanc, Apr. 14, 1989, 2 specimens; KML1294, KML127/76, Execution Rock Cave (48°48.9'N, 125°10.6'W), 0.2 m height, coll. W.C. Austin, July 28, 1976, 1 specimen; RBCM 976-1081, Entrance I., Tasu Sound, BC, (ca. 52°46.04'N, 132°03.55'W), depth no data, coll. P. Lambert, 1976, 1 specimen; RBCM 974-230-3, Brundige Inlet, BC, (ca. 54°37'N, 130°50'W), coll. P. Lambert, June 19, 1974, depth no data.

Description. *Macroscopic features.* Thick, encrusting, unbranched form, $20 \times 20 \times 4$ cm thick in holotype. Surface with abundant, small (1 mm diam.) and large (1 cm $\times 1-3$ cm) irregular tubercles (Fig. 2A). Consistency preserved: moderately compressible but tough. Oscula numerous, flush with surface and ranging from 0.2 to 4 mm diameter. Aquiferous canals tangential with those near surface leading to oscula. Orange colour in life (Fig. 2A), light tan in alcohol.

Microscopic features. Ostia about 0.5 mm diam. in situ penetrate a thin surface membrane between lobes (Fig. 2B); weakly developed plumoreticulate skeleton of 50-100 um diameter fibers extend from base to surface; uni or pauci spicular cross connections (Fig. 2C); halichondroid (confused) skeleton toward the base. No specialized ectosomal skeleton and no axial skeleton.

Spicules. Spicule types include straight oxeas (Fig. 2E), slightly curved styles (Fig. 2G), and strongyles. Oxea tips gradually and sharply pointed; style heads smoothly rounded, slightly narrower than main style body. Styles and oxeas mostly slightly curved or straight; a few strongly curved or sinuous. Strongyles uncommon to rare.

Table 2 lists spicule dimensions.

Oxea and styles in about equal numbers, and of equivalent length. A second category of styles (styles II), while of comparable length to style 1, much thinner. Also much less abundant in two specimens and absent in eight other specimens. Strongyles of comparable width to oxeas and style I, but shorter; few in number in seven specimens and absent in three other specimens. No loose raphids or trichodragmas observed.

Remarks. The paucity of thin styles suggests that these are developmental stages. The strongyles may be anomalies or, alternatively, may be associated with one area of the sponge such as the oscula or the area of attachment to the substrate.

The choanosomal skeleton of *Dragmacidon kishinensis* sp. n. is only weakly plumose. In our material the linear tracts are also less dense than in the type species *Dragmacidon agariciformis* (Dendy, 1905). In other respects it fits the diagnosis for *Dragmacidon* which includes species that are thickly encrusting, the surface with tubercles, ectosome without a specialized skeleton, and skeleton not differentiated into an axial or extra-axial region. It also has both oxeas and styles of similar form and in similar numbers.

It does not fit the diagnosis for *Axinyssa* where the choanosomal skeleton is confused; and where the spicules may be oxeas, strongyloxeas or stylote modifications of oxeas (Erpenbeck and Van Soest 2002)

Twenty-six species of *Dragmacidon* are presently recognized (van Soest et al. 2005, World Porifera Database, accessed February 2013).

4 · N	T	о т :	Styles 1	
Accession No.	Location	Sponge Tissue	L (µm)	W (µm)
KML1113	Limestone I., BC		493-(916)-1300	11-(16.1)-28.6
KML1111	Steep I., BC		550-(1037)-1960	7.4-(18.0)-33
KML1112	Copper Cliffs, BC		630-(851)-1100	11-(19.6)-30.8
KML1114	Texada I, BC		520-(955)-1285	11-(14.5)-28.6
KML1116	Vivian I., BC	Ectosome	330-(738)-1060	11-(16.9)-26.1
KML1116	Vivian I., BC	Choanosome	580-(872)-1180	6.6-(15.7)-24.2
KML1121		E .	200 (501) 070	0.0 (1() 2(/
Specimen A	Kennell Sound, BC	Ectosome	300-(391)-970	8.8-(16)-26.4
KML1121	Rennell Sound BC	Choanosome	460-(809)-1150	8 8_(14 7)_22
Specimen A	Termen Sound, DC	Choanosonic	100 (00)) 11)0	0.0 (11.7) 22
KML1121	Rennell Sound BC	Ectosome	550-(930)-1238	8.8-(13.8)-19.8
Specimen B				
Specimen B	Rennell Sound BC	Choanosome	530-(910)-1060	4.4-(11.9)-17.6
KML1113	Limestone L. BC		580-(857)-1200	2.2-(6.1)-11
			500-(816)-1050	
KML1111	Steep I., BC		(n=19)	2.2-(7.4)-11 (n=19)
KML1112	Copper Cliffs, BC		n=0	
KML1114	Texada I, BC		n=0	
KML1116	Vivian I., BC	Ectosome	n=0	
KML1116	Vivian I., BC	Choanosome	n=0	
KML1121 Specimen A	Rennell Sound, BC	Ectosome	n=0	
KML1121 Specimen A	Rennell Sound, BC	Choanosome	n=0	
KML1121 Specimen B	Rennell Sound BC	Ectosome	n=0	
KML1121 Specimen B	Rennell Sound BC	Choanosome	n=0	
KML1113	Limestone I., BC		690-(1033)-1300	14.4-(20.8)-30.8
KML1111	Steep I., BC		904-(1200)-1593	12.4-(27.3)-42.2
KML1112	Copper Cliffs, BC		670-(983)-1214	15.4-(28.1)-46.2
KML1114	Texada I, BC		670-(1029)-1380	15.4-(24.2)-33
KML1116	Vivian I., BC	Ectosome	480-(890)-1200	15.4-(27.1)-37.4
KML1116	Vivian I., BC	Choanosome	780-(1021)-1238	13.2-(25.1)-35.2
KML1121 Specimen A	Rennell Sound, BC	Ectosome	390-(701)-1010	11-(21.9)-35.2
KML1121 Specimen A	Rennell Sound, BC	Choanosome	440-(966)-1285	15.4-(26.9)-33
KML1121 Specimen B	Rennell Sound BC	Ectosome	810-(1096)-1380	8.8-(19.3)-26.4
KML1121 Specimen B	Rennell Sound BC	Choanosome	500-(1006)-1285	3.3-(15.2)-26.4
KML1113	Limestone I., BC		520-(707)-800 (n=3)	22-(26.4)-33 (n=3)

Table 2. Spicule measurements of six specimens of *D. kishinensis* sp. n. examined in detail N=50 unless indicated.

Accession No. Location Second Times		Styles 1		
Accession INO.	Location	Sponge Hissue	L (µm)	W (µm)
KML1111	Steep I., BC		n=0	
KML1112	Copper Cliffs, BC		580-(660)-770 (n=3)	15.4–(23.5)–28.6 (n=3)
KML1114	Texada I, BC		580-(750)-900 (n=4)	15.4-(18.2)-22 (n=4)
KML1116	Vivian I., BC	Ectosome	220-(622)-900 (n=14)	15.4–(31.1)–44 (n=14)
KML1116	Vivian I., BC	Choanosome	570-(735)-900 (n=2)	22-(27.5)-33 (n=2)
KML1121 Specimen A	Rennell Sound, BC	Ectosome	210-(399)-730 (n=19)	17.6–(26.2)35.2 (n=19)
KML1121 Specimen A	Rennell Sound, BC	Choanosome	170-(467)-690 (n=6)	19.8–(26.4)–35.2 (n=6)
KML1121 Specimen B	Rennell Sound BC	Ectosome	n=0	
KML1121 Specimen B	Rennell Sound BC	Choanosome	n=0	

Eight species can be excluded from being conspecific based on their having trichodragmas which are lacking in *D. kishinensis* sp. n. All but two of the remaining species without trichodragmas have oxeas and styles which are at least 50% shorter than those in *D. kishinensis* sp. n. The first exception is *Dragmacidon oxeon* which has styles and oxeas only slightly shorter than those in *D. kishinensis* sp. n.; however, it differs from *D. kishinensis* sp. n. in having a well developed detachable membrane. The second exception is *Dragmacidon egregium* (Ridley, 1881) which has two classes of styles, one 650–900 µm in length but the other as well as the oxeas only up to 400–450 µm in length.

The weakly developed skeleton is similar to that in *Dragmacidon grayi* (Wells & Wells in Wells et al. 1960) as described by Alvarez et al. (1998).

D. kishinensis sp. n. shows some similarities to species of *Axinyssa* (Halichondridae) including a disorganized skeleton with, in some species, vaguely ascending vertical tracts toward the periphery. Spicules include oxeas and/or strongyloxeas, here considered to have a fusiform shaft which is pointed at one end and rounded at the other. *D. kishinensis* sp. n. spicules consist of oxeas and styles, the latter are isodiametric rather than being fusiform. There are 28 described species of *Axinyssa* (van Soest et al. consulted August 2013). They are nearly all tropical.

Conclusions. Based on the comparisons listed in Table 3, our *Dragmacidon* is a new species. The combination of spicule types and sizes in *Dragmacidon kishinensis* sp. n. do not match any other *Dragmacidon* species described. The reduction of a plumoreticulate skeleton and evidence of unoriented spicules suggests a possible affinity with *Axinyssa* spp. but the latter have only oxeas or strongyloxeas while our species has both oxeas and styles as found in some *Dragmacidon* spp. Finally, we would not expect to find an *Axinyssa* sp. in the cold temperate waters of British Columbia.

Bathymetric range. One intertidal record (0.2 m above 0 m [low tide]) in a cave; otherwise 3 m to 30 m depth.

<i>Dragmacidon agariciforme</i> (Dendy, 1905), p. 186	Indian Ocean	Has trichodragmas
<i>Dragmacidon australe</i> (Bergquist, 1970), p. 20	Australia, New Zealand	Surface extremely hispid, oxeas 217–260–339, styles 320–367–406
Dragmacidon clathriforme (Lendenfeld, 1888), p. 82	Australia	Sponge lobate; has trichodragmas
Dragmacidon coccineum (Keller, 1891), p. 307	Indian Ocean	Has trichodragmas
Dragmacidon condylia (Hooper & Lévi, 1993), p. 1405	New Caledonia	Oxeas 208–289–360, styles same
<i>Dragmacidon debitusae</i> (Hooper & Lévi, 1993), p. 1437	New Caledonia	Oxeas 223–503 styles same, rare
<i>Dragmacidon decipiens</i> (Wiedenmayer, 1989), p. 47	Bass Str., Australia	Strongyles 542–770; oxeas styles 278–350–483
Dragmacidon durissimum (Dendy, 1905)	Indian Ocean	Has trichodragmas
<i>Dragmacidon egregium</i> (Ridley, 1881)	S. Chile; N. Atlantic	Ectosomal styles 230–450, oxeas 280–400, axial styles 650–900
Dragmacidon explicatum (Wiedenmayer, 1977), p. 159	Bahamas, N. Carolina	Styles 255–332–400 and oxeas 287–333–375
Dragmacidon fibrosum (Ridley & Dendy, 1886), p. 481	Str. of Magellan	No oxeas; styles 630
Dragmacidon grayi (Wells, Wells & Gray, 1960)	N. Carolina	Oxeas 360–460 and styles 240–300
Dragmacidon incrustans (Whitelegge, 1897), p. 339	Gilbert/Ellise Is., S. Pacific	Styles 200–400 and oxeas 350
<i>Dragmacidon lunaecharta</i> (Ridley & Dendy, 1886), p. 481	Cape Verde E. Atlantic, Africa	No styles and oxeas 350–400
<i>Dragmacidon mexicanum</i> (de Laubenfels, 1935), p. 6	Gulf of California	Sponge very hispid; styles 400, and oxeas 300–465
<i>Dragmacidon mutans</i> (Sarà, 1978)	Tierra del Fuego	Styles 100–220, oxeas 200
<i>Dragmacidon ophisclera</i> de Laubenfels, 1935, p. 7	Gulf of California	Styles 1200; oxeas 650 smaller; loose raphids and trichodragmas present
<i>Dragmacidon oxeon</i> (Dickinson, 1945), p. 32	Gulf of California	Easily detached dermal membrane; styles 900, oxeas 600–1150, slightly smaller than <i>D. kishinensis</i> sp. n.
Dragmacidon reticulatum (Ridley & Dendy, 1886), p. 481	Gulf of California	Styles 450 and oxeas 450
Dragmacidon sanguineum (Burton, 1933)	Natal	Styles 140 and oxeas 211
Dragmacidon tuberosum (Topsent, 1928), p. 178	Boavista Is., E. Atlantic, Africa	Has trichodragmas; styles 315–420, oxeas 370–420
Dragmacidon tumidum (Dendy, 1897), p. 236	S. Australia	No oxeas; small styles 180

Table 3. Compares the spicules of D. kishinensis sp. n. to other species of Dragmacidon.

Zoogeographic range. Recorded from Barkley Sound (49°N) to Rennell Sound (53°N), BC.

Ecology. *D. kishinensis* sp. n. is recorded from high wave or high current energy habitats. The tough, encrusting, non branching form would be structurally adaptive for the physical impacts of strong water movement.

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RESEARCH ARTICLE



Hesperentomon yangi sp. n. from Jiangsu Province, Eastern China, with analyses of DNA barcodes (Protura, Acerentomata, Hesperentomidae)

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Abstract

Hesperentomon yangi **sp. n.** is described from eastern China. Its DNA barcodes are sequenced and compared to the similar species of the genus. *Hesperentomon yangi* **sp. n.** is characterized by 12 posterior setae on tergites II–VI, 8 posterior setae on sternites IV–VI (seta *Pc* absent), absence of seta *sd4* on head, absence of seta *P2a* on tergite VII, 6 and 8 anterior setae on mesosternum and metasternum respectively, and few teeth on comb. It differs from *H. xiningense* Bu & Yin, 2007 and *H. nanshanensis* Bu & Yin, 2007 in the chaetotaxy of mesosternum and metanotum, maxillary gland, length and shape of some sensilla on foretarsus, as well as the body porotaxy. The genetic divergences of DNA barcodes sequences between *Hesperentomon yangi* **sp. n.**, *H. xiningense* and *H. nanshanensis* are 24.1% on average, which is distinctly higher than the divergences between individuals of the new species (0.5%). Molecular data provide a solid evidence of the new species identified by the morphological characters.

Keywords

Protura, Hesperentomon, molecular data, genetic divergence, chaetotaxy

Introduction

The genus *Hesperentomon* Price, 1960 currently contains 17 species, which with 14 species have been found in China (Bu and Yin 2007a, 2007b, Bu et al. 2011, Shrubovych 2010, Szeptycki 2007, Wu and Yin 2008, Yin 1999). During a collection from Qixia Mountain, Nanjing City, East China (Jiangsu Province), some specimens of the genus *Hesperentomon* were first found from that area. They were identified as a new species and described as *Hesperentomon yangi* sp. n. in the present paper. In order to confirm the morphological identification, the DNA barcodes of the new species and two similar congeners *H. xiningense* and *H. nanshanensis* were sequenced and analyzed.

Materials and methods

The specimens were collected with Tullgren funnels. All specimens were mounted on slides in Hoyer's medium and dried for three days in an oven at 60°C. Specimens were identified and drawn with the aid of a NIKON E600 phase contrast microscope. Type specimens are deposited in the Shanghai Entomological Museum (SEM), Institute of Plant Physiology & Ecology, Shanghai Institutes for Biological Sciences, Chinese Academy of Sciences.

Abbreviations used in the text follow the paper of Bu and Yin (2007b). Head setae and pores are marked according to Rusek et al. (2012).

For DNA barcodes, genomic DNA was extracted from each individual separately by means of a non-destructive method (after Gilbert et al. 2007) with minor modifications. The information for the species is given in Table 1. After the DNA extraction, the cuticles of proturans were retrieved and mounted on the slides as voucher specimens. DNA barcoding sequences of mitochondrial COI gene were amplified and sequenced by primer pair LCO/HCO (Folmer et al. 1994). The barcodes sequences are deposited in GenBank. The genetic divergence and nucleotide composition were calculated using MEGA version 5 (Tamura et al. 2011).

Classification	Species	Locality	Number of individuals	GenBank Accession Numbers
Protura				
Acerentomata				
Hesperentomidae				
Hesperentomon	<i>H. yangi</i> sp. n.	China: Jiangsu	3	KF530824 KF530825 KF530826
	H. xiningense	China: Qinghai	1	KF530827
	H. nanshanensis	China: Qinghai	1	KF530828

Table 1. Information for the species used in the study.

Taxonomy

Hesperentomon yangi sp. n.

http://zoobank.org/B4190939-D197-4E2E-ACF3-2A7635941DC3 http://species-id.net/wiki/Hesperentomon_yangi Figs 1–25, Table 2

Material examined. Holotype, female (No. NJ-8), East China, Jiangsu Province, Nanjing City, extracted from the soil samples under some big trees of Qixia Mountain, 32°09.45'N, 118°57.60'E, elev. 200 m, 29-XI-2012. coll. Y. M. Yang. Paratype, 6 females (Nos. NJ-2, NJ-3, NJ-4, NJ-7, NJ-12, NJ-13), 6 males (Nos. NJ-1, NJ-5, NJ-6, NJ-9, NJ-10, NJ-11), same data as holotype. Other materials, 1 maturus junior (No. NJ-14) and 1 larva II (No. NJ-15). Specimens NJ-13, NJ-14 and NJ-15 are voucher specimens with DNA barcodes sequenced. Type specimens are deposited in Shanghai Entomological Museum (SEM), Institute of Plant Physiology & Ecology, Chinese Academy of Sciences.

Description. Adult body length 1300–1400 μ m (n=13), yellow-brown, and fore-tarsus with deeper color (Fig. 1).

Head. Oblong, length 125–130 μ m, width 85–95 μ m. Dorsal setae long, other setae short. Setae *d6* and *sd6* present, *sd4* absent. Seta *d6* 14–15 μ m, *d7* 6–7 μ m in length. Paired pores *cp*, *ip* and *op* present, pore *fp* absent (Fig. 12). Pseudoculus pear-shaped, with short posterior extension, length 12–15 μ m, width 8–9 μ m. PR=9–11 (Figs 2, 13). Canal of maxillary gland with sausage-like calyx, posterior dilation about equal to length of calyx. CF=7–9 (Fig. 14). Labial palpus well developed, without basal sensillum (Fig. 15). Maxillary palpus with two tapering sensilla, dorsal one (8–9 μ m) distinctly longer than lateral one (5–6 μ m) (Fig. 16).

Foretarsus. Length 73–83 µm, claw length 18–23 µm, without inner flap, TR=3.5–4.4; empodium length 3–4 µm, EU=0.14–0.18. Dorsal sensilla *t*-1 and *t*-2 slender and long (14–15 µm), BS=1.1; *t*-3 slengder, not reaching base of claw. Exterior sensilla all sward-like and in different length, *a* surpassing base of *c*, *b* and *c* subequal in length, *d* close to *t*2, *e* broad, *f* short, *g* long. Interior sensilla also sward-like in different length, *a*' short, *b*'-1 longer than *b*'-2, *c*'-2 longer than *c*'-1. Relative length of sensilla: b'-2 < c'-1 < f < a' < t3 < b'-1 < (b = c = e) < d < (g = c'-2) < a < t2 < t1 (Figs 17, 18). Length of middle tarsus 35–37 µm, claw length 18–20 µm. Length of hind tarsus 38–40 µm, claw length 20–23 µm.

Thorax. Thoracic chaetotaxy given in Table 2. Setae *1* and *2* on pronotum subequal in length; mesonotum with eight pairs of posterior setae, *P5a* and *P5a* 'minute; metanotum with seven pairs of posterior setae, *P5a* minute; setae *P1* and *P2* on mesonotum 13–15 μ m and 17–20 μ m respectively. (Figs 3–5). Prosternum without anterior seta *A2*, mesosternum and metasternum with 6 and 8 anterior setae respectively (Figs 8–10). All setae on thoracic sternites setiform. Pronotum and prosternum without pores. Mes-



Figures 1–11. *Hesperentomon yangi* sp. n. Holotype. I Habitus 2 pseudoculus 3 pronotum 4 mesonotum (*sl* = sublateral pore) 5 metanotum 6 sternite II 7 sternite IV 8 prosternum 9 mesosternum 10 metasternum 11 sternite VII. Arrows show pores. Scale bar: 100 μ m in Fig. 1, others, 20 μ m.



Figures 12–22. *Hesperentomon yangi* sp. n. Holotype. **12** Head, dorsal view (*cp* = clypeal pores, *ip* = interpseudocular pores, *op* = occipital pores) **13** pseudoculus **14** canal of maxillary gland **15** labial palpus **16** maxillary palpus, **17** foretarsus, exterior view **18** foretarsus, interior view **19** tergite VII, left side (*al* = anterolateral pore, *psm* = posterosubmedial pore, *psl* = posterosublateral pore) **20** sternite VII and lateral part of tergite VII **21** Comb **22** female squama genitalis. Arrows show pores. Scale bar: 20 μ m.

S t		Dorsal		Ventral	
Seg	ment	Formula	Setae	Formula	Setae
Thorax	Ι	4	1, 2	(2-2)/6	A1, M P1, 2, 3
	II	6/4	A2, 4, M P1, 2, 2a, 3, 4, 5, 5a, 5a'	(6-2)/5	A1, 2, 3, M Pc, 1, 2
	III	6/14	A2, 4, M P1, 2, 2a, 3, 4, 5, 5a	(8-2)/5	A1, 2, 3, 4, M Pc, 1, 2
Abdomen	Ι	4/10	A1, 2 P1, 2, 3, 4, 5	4/4	A1, 2 P1, 2
	II–III	8/12	A1, 2, 4, 5 P1, 2, 3, 4, 4a, 5	4/5	A1, 2 Pc, 1a, 2
	IV–VI	8/12	A1, 2, 4, 5 P1, 2, 3, 4, 4a, 5	4/8	A1, 2 P1, 1a, 2, 3
	VII	8/16	A1, 2, 4, 5 P1, 1a, 2, 3, 3a, 4, 4a, 5	4/9	A1, 2 Pc, 1, 1a, 2, 3
	VIII	6/14	A1, 2, 5 P1, 1a, 2, 2a, 3, 3a, 5	6	1, 1a, 2
	IX	12	1, 2, 2a, 3, 3a, 4	6	1, 1a, 2
	Х	10	1, 2, 3, 3a, 4	6	1, 1a, 2
	XI	8	1, 2, 3, 4	6	1, 1a, 2
	XII	9		8	

Table 2. Adult chaetotaxy of *Hesperentomon yangi* sp. n.

onotum and metanotum with pores sl (Figs 4, 5). Mesosternum and metasternum each with single median pore, situated anterior to level of setae M (Figs 9, 10).

Abdomen. Abdominal chaetotaxy given in Table 2. Tergite I with two pairs of anterior setae (*A1*, *A2*) and five pairs of posterior setae. Tergites II–VI with four pairs of anterior setae (*A1*, *A2*, *A4*, *A5*) and six pairs of posterior setae, *P1a*, *P2a* and *P3a* absent. Tergite VII with 8 posterior setae, *P2a* absent. Posterior central seta *Pc* absent on sternites IV–VI (8 posterior setae) (Fig. 7), present on sternite VII (Figs 11, 20). Bases of setae on segments X–XII without surrounding ciliation. Tergites IX–XI, and sternite X with broad, coarsely serrated posterior lamella (Figs 23, 25).

Tergites I–VI with pores *psm* and *al*, VII with pores *psm*, *psl* and *al* (Fig. 19), VIII with pores *psm* and *pl*, IX, X and XII each with single posteromedial pore (*pm*), XI without pores (Figs 23, 25). Sternites I–VI each with one medial pore (Fig. 6), VII with one medial pore and one pair of lateral pores (Figs 11, 20), VIII–X each with single medial pore, XI without pores, XII with 3+3 pores.

Abdominal appendages typical of the genus, each with two segments and four setae. Striate band on abdominal segment VIII reduced and only single serrate line present (Fig. 23). Comb on abdomen VIII rectangular, with 7–8 teeth (Fig. 21).

Female squama genitalis robust. Each acrostylus with one slender flap on its outer side (Fig. 22). Male squama genitalis with 2+2 setae on dorsal side and 2+2 setae on ventral side (Fig. 24).

Etymology. The species is named after Mr. Yi-Ming Yang who collected the specimens and in remembrance of his great contribution to the collection of Protura in China.



Figures 23–25. *Hesperentomon yangi* sp. n. **23** Tergites VIII–XII, left side (*pm*= posteromedial pore) **24** male squama genitalis **25** sternites VIII–XII (*pl* = posterolateral pore) **23** and **25** holotype **24** paratype NJ-10. Arrows show pores. Scale bar: 20 μm.

Chaetal variability. Chaetal variations were observed in 5 specimens : on pronotum, with 5 seate, presence of 1 additional seta on left side (No. NJ-2); on prosternum, asymmetrical absence of *A1* of right side (No. NJ-3); on sternite I, presence of *Pc* (Nos. NJ-4, NJ-6, NJ-12); on sternite IV and V, presence of *Pc* (No. NJ-12).

Distribution. Jiangsu (Nanjing), China.

Diagnosis. *Hesperentomon yangi* sp. n. is characterized by 12 posterior setae on tergites II–VI, 8 posterior setae on sternites IV–VI (seta *Pc* absent), absence of seta *sd4* on head, absence of seta *P2a* on tergite VII, 6 and 8 anterior setae on mesosternum and metasternum respectively, and few teeth on comb.

Remarks. Hesperentomon yangi sp. n. is similar to H. xiningense Bu & Yin, 2007 and H. nanshanensis Bu & Yin, 2007 in having 8 posterior setae on sternites IV–VI (seta Pc absent), 12 posterior setae on tergite IV–VI, and the absence of seta P2a on tergite VII. It can be distinguished from those two species by the chaetotaxy of mes-

osternum and metasternum (6 and 8 anterior setae in *H. yangi* sp. n. respectively vs. 4 and 6 anterior setae in *H. xiningense* and *H. nanshanensis*), chaetotaxy of head (setae sd4 absent in *H. yangi* sp. n. vs. present in the later two species), porotaxy of head (frontal pores fp absent and interpseudocular pores ip present in *H. yangi* sp. n. vs. fp present and ip absent in the later two), porotaxy of sternite VII (3 pores in *H. yangi* sp. n. vs. 1 pore in the later two). It also differs from *H. xiningense* in the length of foretarsal sensillum *b* subequal length to *c* (*b* distinctly longer than *c* in *H. xiningense*), short sensillum b^2-2 which not reaching base of seta a7 (b^2-2 surpassing base of seta a7 in *H. xiningense*), and the presence of regular teeth on hind margin of striate band (with sparse unregular teeth in *H. xiningense*). It also differs from *H. nanshanensis* in the chaetotaxy of abdominal segment X (10 and 6 setae on tergite and sternite repectively in *H. yangi* sp. n. vs. 8 and 4 setae in *H. nanshanensis*) and shape of maxillary gland (posterior dilation about equal length of the calyx in *H. nanshanensis*).

The DNA barcodes analyses

The standard DNA barcoding sequence (COI gene) from 3 individuals (Nos. NJ-13, NJ-14, and NJ-15) of *H. yangi* sp. n., 1 individual of *H. xiningense* and 1 individual of *H. nanshanensis* were sequenced and deposited in GenBank. The accession numbers given in Table 1. Except a 6 base pairs deletion was found in *H. xiningense* (652 base pairs), other sequences each contains 658 base pairs. The nucleotide compositions as A = 34.3%, T = 33.6%, C = 18.9%, G = 13.1% on average in *H. yangi* sp. n., A = 27.0%, T = 35.5%, C = 22.4%, G = 15.1% in *H. xiningense*, and A = 29.7%, T = 35.8%, C = 20.2%, G = 14.3% in *H. nanshanensis*. The genetic divergence between individuals of *H. yangi* sp. n. is 0.5% on average, between three species is 24.1% on average. The results of molecular data well support the new species identified by morphological characters.

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RESEARCH ARTICLE



A new species of Pseudodiaptomus (Crustacea, Copepoda, Calanoida, Pseudodiaptomidae) from the Prasae River Estuary, Gulf of Thailand

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Abstract

A new species of the calanoid copepod genus *Pseudodiaptomus* was collected from the Prasae River Estuary, Rayong Province, on the eastern coast of the Gulf of Thailand. This species is definitely assigned to the *lobus* species group sensu Walter (1986a). The female of the new species differs from other congeners in the elongate genital double-somite with a blunt process ventrally and the second urosomite about 2.54 times as long as wide. The male is also easily distinguished from other congeners by the structure of the right fifth leg.

The present new species is a euryhaline species and occurred in brackish waters with salinity ranging from 0.7 to 23.3. Its breeding season may be from June to October, as indicated by the presence of egg-sacs.

Keywords

Copepoda, Calanoida, Gulf of Thailand, Prasae River, Pseudodiaptomus, new species

Introduction

We have been intensively investigating the taxonomy, biology and ecology of gelatinous and crustacean zooplankters in Thailand since 1997 (Pinkaew et al. 1997, 2000; Pinkaew 2003; Ohtsuka et al. 1999, 2003, 2010, 2012; Fukuoka and Pinkaew 2003; Fukuoka et al. 2005; Nishida and Nishikawa 2011; Nishikawa et al. unpublished). Special attention has been paid to copepods, mysids and rhizostome jellyfish, due to their numerical importance in the plankton communities in the coastal and estuarine waters.

During our survey in estuaries of Thailand in 2004-2012 a new species of the calanoid copepod genus Pseudodiaptomus was found at the mouth of Prasae River, Gulf of Thailand. Pseudodiaptomus is broadly distributed in freshwater to marine habitats in the Atlantic and Indo-Pacific regions, and frequently comprises a main component in the zooplankton communities (Walter 1987). Recently some pseudodiaptomids have been introduced into new habitats via ballast water: the Indo-West Pacific species P. trihamatus was found along the Northeastern Coast of Brazil (Medeiros et al. 1991; Medeiros et al. 2006); the West Pacific species P. marinus has so far been recorded from Hawaii (Jones 1966), San Francisco Bay (Orsi and Walter 1991), Iraq (Khalaf 1992), the southern bight of the North Sea, France (Brylinski et al. 2012), Todos Santos Bay, Baja California (Jiménez-Pérez and Castro-Longoria 2006), and the North Adriatic Sea (Olazabal and Tirelli 2011). In addition the Asian species P. inopinus has been introduced to Oregon, Washington, and British Columbia Estuaries (Cordell and Morrison 1996); and another Asian species P. forbesi has been introduced to the new world, and been devastating the native ecosystems as an invasive alien (Orsi and Walter 1991, Cordell et al. 1992, 2007, 2008, Ohtsuka et al. 2004).

The genus *Pseudodiaptomus* has so far accommodated 77 species (Boxshall and Halsey 2004, Walter and Boxshall 2012) and been taxonomically divided into seven species groups and four unassigned species which can be characterized mainly by sexual dimorphic features (Walter 1986a, Walter et al. 2006). In Thailand only eight species have hitherto been recorded: *P. andamanensis* Pillai, 1976, *P. aurivilli* Cleve, 1901, *P. bulbiferus* Rose, 1957, *P. clevei* A. Scott, 1909, *P. dauglishi* Sewell, 1932, *P. mertoni* Früchtl, 1923, *P. tollingerae* Sewell, 1919, *P. trihamatus* Wright, 1937 (Suvapepun 1984, Walter 1986a, Suwanrumpha 1987, Walter et al. 2002, Pinkaew 2003, Srinui 2007). The present paper deals with a detailed description of the new species of *Pseudodiaptomus* collected from Thailand with remarks on the zoogeography and ecology.

Materials and methods

Copepods were collected at 2 stations from the near-bottom of the Prasae River Estuary, Rayong Province, in June 2011 and August 2004, 2012 using a plank-



Figure 1. Sampling stations in Prasae River Estuary, Rayong Province.

ton net (0.1 mm in mesh size) and a sledge net (0.3 mm) (Fig.1). Samples were fixed in 5% neutralized formaldehyde/seawater solution immediately after capture. Calanoid copepods were sorted out of the original samples under a stereo microscope. Copepod specimens were transferred directly from preservative to polyvinyl lactophenol and dissected with a pair of fine needles. All drawings were made with the aid of a camera lucida attached to a compound microscope (Olympus BX50). Each segment and appendage is numbered using Arabic numerals. Terminology follows Huys and Boxshall (1991). The female urosome of the new species was examined with a scanning electron microscope (Jeol-JSM-6510LV). The temperature, salinity and dissolve oxygen at the sampling site were measured at 1-m depth by using a multi-parameter probes YSI model 6600-M. The type specimens of the new species were deposited in the Institute of Marine Science, Burapha University (BIMS-Z00-0129).

Systematics

Order Calanoida G.O. Sars, 1903 Family Pseudodiaptomidae G.O. Sars, 1902 Genus *Pseudodiaptomus* Herrick, 1884

Pseudodiaptomus siamensis sp. n. http://zoobank.org/4DE3A857-3BDE-4107-8758-F1B74325C573 http://species-id.net/wiki/Pseudodiaptomus_siamensis Figs 2–5

Material. Prasae River Estuary, the Gulf of Thailand, station1: $(12^{\circ}42.66'N; 101^{\circ}42.37'E; station 2: 12^{\circ}41.14'N; 101^{\circ}42.49'E)$ (Fig. 1), 23 August 2004 (6 \bigcirc \bigcirc); 4 June 2011 (8 \bigcirc \bigcirc , 6 \bigcirc \bigcirc); 13 August 2012 (11 \bigcirc \bigcirc , 1 \bigcirc).

Types. Holotype: $1\bigcirc$ station 1, 4 June 2011, dissected and mounted on 2 glass slides (BIMS-Z00-0130), allotype: $1\bigcirc$ station 1, 4 June 2011, dissected and mounted on 5 glass slides (BIMS-Z00-0131); paratypes: $4\bigcirc \bigcirc$, station 1, 13 August 2012, 3 $\bigcirc \bigcirc$ station 2, 23 August 2004 partly dissected and mounted on 3 glass slides (BIMS-Z00-0132).

Description. Female. Total length, 1.29–1.41 mm (mean±SD= 1.37 ±0.04 mm, N=5; holotype, 1.29 mm); prosome length, 0.75–0.82 mm (0.79±0.02 mm; holotype, 0.75 mm); prosome width, 0.31–0.34 mm (0.32±0.01 mm; holotype, 0.32 mm). Habitus (Figs 2A, B) with anterior margin of cephalosome rounded in dorsal view. Rostrum with paired filaments (Fig. 2C). Cephalosome and first pedigerous somite completely fused; fourth and fifth pedigerous somites totally fused. Prosomal ends rounded; dorsolateral spines on fifth pedigerous somites. Urosome 4-segmented. Genital double-somite asymmetrical in dorsal view, elongate, ca. 2.54 times as long as wide; postero-dorsal and lateral margins with somewhat irregular row of spinules; in ventral view, genital area furnished with blunt, linguiform process midway, transverse rows of spinules anteriorly and paired flaps originating from genital opercula (see Fig. 5); each of paired egg-sacs consisting of 9-14 eggs, attached to lateral of genital opening (Fig. 2A). Proportional lengths of urosomites and caudal ramus 43:15: 15: 7: 20 (=100); length to width ratios 2.5, 1.3, 1.3, 0.4, and 3.6, respectively. Second and third urosomites with row of minute spinules along postero-dorsal and lateral margins. Caudal rami with hair on inner margin and symmetrical with 6 setae: seta I absent, seta II with fine setules only along inner margin; setae III-VI plumose; seta VII located dorsally.

Antennule (Fig. 2D) reaching beyond posterior end of genital double-somite, symmetrical, 22-segmented; segments 6-7 incompletely fused; segments 6, 15, 16, 18-21 each without aesthetasc (ae). Fusion pattern and setal elements as follow: 1 - 1 + ae, 2 - 3 + ae, 3 - 2 + ae, 4 - 3 + ae, 5 - 3 + ae, 6 - (1 spiniform element), 7 - 2 + ae, 8 - 2 + ae, 9 - 2 + ae, 10 - (1 spiniform element) + ae, 11-14 - 2 + ae, 15-16 - 2, 17 - 2 + ae, 18-19 - 1, 20-21 - 2, 22 - 6 + ae.

Antenna (Fig. 2E) coxa with single seta; basis with 2 setae at inner corner; endopod 2- segmented, first segment with 2 setae, second segment with 7 and 8 setae on terminal



Figure 2. *Pseudodiaptomus siamensis*, sp. n., female (holotype). **A** habitus, dorsal view **B** habitus, lateral view **C** rostrum, ventral view **D** right antennule, arabic numerals denote segment numbers **E** right antenna **F** mandible **G** maxilla.

and subterminal lobes, respectively, and lateral row of fine setules; exopod 4-segmented, first segment with 1 seta, second segment with 1 proximal, 2 medial and 1 terminal setae; third segment with 3 setae; fourth segment with 1 medial and 3 terminal setae.

Mandible (Fig. 2F) with basis bearing 4 setae along inner margin; endopod 2-segmented, first segment with 4 setae, second with 9 setae; exopod 5-segmented, first to fifth segments with 1, 1, 1, 1, 2 setae, respectively. Gnathobase (coxa) with serrate dorsal seta and 3 cuspidate and 4 blunt teeth.

Maxillule (Fig. 3A) with preacoxal arthrite bearing 9 strong and 6 fine setae and small spinules; coxa with 4 setae on endite and 9 setae on epipodite; basis with 4 and 5 setae on proximal and distal endites, respectively; basal exite with 1 seta; endopod 3-segmented, with 4, 4 and 6 setae from first to third segments, respectively; exopod foliaceous with 10 setae along outer margin.

Maxilla (Fig. 2G) with first and second praecoxal endites having 4 and 3 setae, respectively; first coxal endite with 3 long setae, second endite with 1 short strong and 2 long setae; basis with 1 short and 2 long setae; endopod with 9 setae.

Maxilliped (Fig. 3B) with praecoxa and coxa completely fused; endites with 0, 2, 3, 4 setae, respectively; basis with 3 setae; endopodal segment having 6 segments, first segment with 2 setae, second segment with 2 bifurcated setae and 1 seta, third and fourth segments with 1 bifurcated seta and 1 seta, fifth and sixth segments with 3 and 4 setae, respectively.

Legs 1–4 (Figs 3C–F) biramous with 3-segmented rami; coxa and basis of both rami with spinules on distal corner. Seta and spine formula as follows:

	Coxa	Basis	Exopodal segment	Endopodal segment
Leg1	0-1	0-0	I-1; 0-1; II, 1, 3	0-1; 0-1; 1-2-3
Leg2	0-1	0-0	I-1; I-1; II-1-5	0-1; 0-2; 2-2-4
Leg3	0-1	0-0	I-1; I-1; II-1-5	0-1; 0-2; 2-2-4
Leg4	0-1	I-0	I-1; I-1; II-1-5	0-1; 0-2; 2-2-3

Leg 5 (Fig. 3G) uniramous and almost symmetrical; in posterior view, basis with short medial seta and spinular rows; exopod 3-segmented, first segment produced into small pointed process at inner subterminal corner, with distolateral spine and one or two rows of spinules; second segment having short and thickned disto-lateral process and medial serrate spine; third segment spiniform, tapering distally with inner spinules and proximo-medial spine.

Male. Total length 0.94-1.02 mm (mean±SD= 0.97±0.03, N= 4; allotype, 1.02 mm). Prosome length 0.62-0.66 mm (mean±SD= 0.64±0.01, allotype, 0.66 mm), width 0.26-0.27 mm (mean±SD= 0.26±0.005, allotype, 0.26 mm).

Habitus (Figs 4A, B) similar to that of female, except for urosome. Urosome 5segmented; proportional lengths of urosomites and caudal ramus 13: 25: 21: 17: 11:13 (=100); length to width ratios 0.5, 1.1, 1.2, 1, 0.6 and 1.7. Genital somite nearly symmetrical with one or two rows of spinules ventrally. Urosomites 2–4 with spinular row along posterior margin. Caudal rami symmetrical, with six setae as in female.

Right antennule (Fig. 4C) geniculate and indistinctly 20-segmented; setal formula as follows: 1 -1 + ae, 2 - 2 + ae, 3 - 2 + ae, 4 - 1, 5 -1 + ae, 6 - (1 spiniform element), 7 - 1 + ae, 8 - (1 spiniform element), 9 - 2 + ae, 10 - (1 spiniform element), 11 - 1 +



Figure 3. *Pseudodiaptomus siamensis*, sp. n., female (holotype). **A** maxillule **B** maxilliped **C** leg 1, posterior view **D** leg 2, posterior view **E** leg 3, anterior view **F** leg 4, posterior view **G** leg 5, posterior view.

ae, 12 - (1 spiniform element) + ae, 13 - 1 + ae, 14 - 16 - 2 + ae, 17 - 18 - 1 + (1 process), 19 - 2 + (1 process), 20 - 9 + ae.

Leg 5 (Figs 4D, E, F, G) highly asymmetrical and biramous; intercoxal sclerite and both coxae fused; coxa with fine spinular rows on anterior surface. Right leg (Figs 4D, E) with basis having outer spinular row; endopod rudimentary, represented by knob-like process with fine setule at tip; exopod (Fig. 3F) 3-segmented, first segment protruded into outer process reaching middle of third segment, proximal process with 1 spine and spinular row; second segment expanded midway, each side with spine; third segment curved inward with 3 rows of spinules on anterior surface and middle swelling, distal to which tapering distally. Left leg (Figs 4D, E) with elongated basis having triangular process at midlength; endopod (Fig. 4G) highly developed, bifurcated, inner medial process smoothly curved outward reaching distal tip of second exopod, outer process thickened, foliaceous with 1 subterminal and 4 thin terminal protrusions; exopod 2-segmented, first segment as long as basis, irregularly sinuated along inner margin; second segment triangular with hirsute process proximally and stout serrated protrusion at medio-lateral margin, with 3 processes of unequal length terminally.

Remarks. The present new species can be definitely assigned to the *lobus* species group sensu Walter (1986a, b, 1987) and Walter et al. (2006) in having a combination of the following features: (1) paired egg-sacs; (2) a fusion between the cephalosome and first pedigerous somite; (3) the presence of a large endopod of male left leg 5; (4) the presence of a rudimentary endopod of male right leg 5. Its estuarine habitat in the West Pacific also supports this assignment (see Walter et al. 2002). In this species group two subgroups, *forbesi*-subgroup and *poppei*-subgroup, are distinguished and can be readily differentiated by the terminal shape of the endopod of male left leg 5: bi-fid (*poppei*-subgroup) or not (*forbesi*-subgroup) (Walter 1986a). The new species with a bifd tip of the endopod clearly belongs to the *poppei*-subgroup. The following four species have so far been accommodated: *P. poppei* Stingelin 1900, *P. smithi* Wright, 1928, *P. tollingerae* Sewell, 1919, and *P. siamensis* sp. n.

In the *poppei*-subgroup the new species is most closely related to *P. tollingerae* from the Indian waters (Pillai 1976, Reddy and Radhakrishna 1982) in sharing the following features: (1) the genital double-somite of female is relatively elongate; (2) the right endopod of male leg 5 is rudimentary; (3) the terminal exopodal segment of male right leg 5 is swollen midway; (4) the shape of the left endopod of male leg 5 is similar between the two species; (5) the terminal exopodal segment of male left 5 bears 3 stout processes terminally. However, the new species can be easily distinguished from *P. tollingerae* in: (1) the presence of a ventral linguiform process on the genital double-somite in the female (absent in *P. tollingerae*); (2) the second exopodal segment of male right leg 5 smoothly curved outward (abruptly curved at mid-length); (4) the distal process of the left endopod of male leg 5 tapering distally (expanded terminally and divided at tip). In addition, the female of the new species is unique in having



Figure 4. *Pseudodiaptomus siamensis*, sp. n., male (allotype). **A** habitus, lateral view **B** habitus, dorsal view **C** right antennule, arabic numerals denote segment numbers **D** leg 5, anterior view **E** leg 5, posterior view **F** anterior view of exopod of right leg 5 **G** posterior view of inner process and outer process of endopod of left leg 5.



Figure 5. SEM micrograph of ventral side of genital double-somite of female *Pseudodiaptomus siamensis*, showing blunt process anterior to genital area.

a small, inner terminal process on the first exopodal segment of leg 5, which is much more conspicuous in the three known species of the subgroup.

Etymology. The species was named after the type locality "Siam" (an old name of Thailand).

Disscussion

Zoogeography

Walter et al. (2002) recognized three types of the distributional patterns in the *lobus* species group: Type I= wide distribution of the Indo-West Pacific; Type II= confined distribution mainly or restrictedly in the Indian Ocean; Type III= confined distribution mainly or restrictedly in the West Pacific. In the *poppei*-subgroup of the species group, *Pseudodiaptomus tollingerae* is assigned to Type I, while *P. poppei* and *P. smithi* to

Type III (Pillai 1976, Walter 1986a, Walter et al. 2002). *Pseudodiaptomus siamensis* has so far been recorded only from the type locality or the Gulf of Thailand, and tentatively belongs to Type III. It seems that the *poppei-* subgroup is highly restricted to estuarine waters of the Indo-Malayan realm.

As mentioned above, *P. siamensis* composes a sister group with *P. tollingerae. Pseudodiaptomus poppei* from Celebes (Walter 1986a, b) and *P. smithi* from the Phillipines (Walter 1986b) share synapomorphic characters such as an elongated terminal segment of male right leg 5. Therefore the distributional pattern of these two pairs in the *poppei-*subgroup implies a speciation around the Huxley's line. A recent molecular analysis of the Indo-West Pacific populations of the giant freshwater prawn *Macrobrachium rosenbergii* Murphy and Austin (2002), using 16S ribosomal RNA mitochondrial DNA, clearly recognized two clades, each of which is located on either eastern or western side of Huxley's line (Bruyn et al. 2004). Actually these two clades are suggested to represent two distinct species based on great sequence divergences (6.2 % in maximum) (Bruyn et al. 2004). Although exact vicarious events around Huxley's line are still unknown, the scenario might be applied to the speciation of the *poppei*subgroup of *Pseudodiaptomus* occurring in the brackish waters. The important point is that prawn also needs estuarine environments for reproduction (Bruyn et al. 2004).

Ecology

The habitat of the present new species, the Prasae Estuary was euryhaline, where the salinity widely ranged between 0.7 and 23.3 during the present investigation. Dominant copepods that co-occurred with the new species seasonally differed with salinity: *Acartia plumosa* Scott, 1894, *Bestiolina similis* Sewell, 1914, *Parvocalanus crassirostris* Dahl, 1894, *Pseudodiaptomus annandalei* Sewell, 1919, and *Oithona simplex* Farran, 1913, were abundant in the wet season (May–October), while *B. similis*, *P. crassirostris*, *O. simplex*, and *O. dissimilis* Lindberg, 1940 in the dry season (November-April) (Srinui 2007). In the estuary other environmental factors such as water temperature and dissolved oxygen were nearly constant throughout the investigation, 28.1 to 29.5 °C and 4.3 to 5.3 mg/L, respectively.

Although our collections of planktonic copepods were intermittently carried out, some information of the breeding of the new species was obtained. The ovigerous and/ or spermatopore-bearing females of the new species were found during the wet season (June to October). In addition, the density of immature females reached 139 individuals per cubic meter in August 2004, suggesting it was an active breeding season.

Key to species of the *poppei*-subgroup

Seventy-eight species of *Pseudodiaptomus*, including the new species *P. siamensis*, have been recorded from the world (Walter 1986a, 1987, Walter et al. 2002, Walter et al.

2006, present study). Walter (1984, 1986a, 1987) has also recognized seven species groups in *Pseudodiaptomus* based mainly on sexual dimorphic features. The *lobus* species group, to which the present new species belongs, has so far accommodated two subgroups and 15 species. The new species is classified into the *poppei*-subgroup with 4 species. A key to 4 species of the subgroup is provided here.

Female

1	First urosomite symmetrical without blunt linguiform process on mid-ven-
	tral
_	First urosomite asymmetrical with blunt linguiform process on mid-ventral
	P. siamensis
2	First urosomite with pair of anterodorsal spines and posterodorsal cluster of
	3 spinules
_	First urosomite without pair of anterodorsal spines and posterodorsal cluster
	of 3 spinules
3	Prosomal ends with one pair of processes dorsally P. tollingerae
_	Prosomal ends with two pairs of processes dorsally

Male

1	Fifth pair of legs without left endopodal segmentP. poppei
_	Fifth pair of legs with left endopodal segment
2	First exopodal segment of fifth right legs with recurved process at distolateral
	corner
_	First exopodal segment of fifth right legs with straight process at distolateral
	corner
3	Endopod of fifth left leg with outer process tapering distally P. siamensis
_	Endopod of fifth left leg with outer process concave at the tip P. tollingerae

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RESEARCH ARTICLE



Two new species of *Meropidia* Hippa & Thompson, 1983 (Diptera, Syrphidae) from the Andes Mountains

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Abstract

Two new species of *Meropidia* Hippa & Thompson, 1983 (Diptera, Syrphidae) are described, *Meropidia nitida* Morales, **sp. n.** and *M. flavens* Hippa & Ståhls **sp. n.**, from Bolivia and Colombia respectively. A key to all described *Meropidia* species is provided.

Keywords

Description, Eristalinae, Meropidia, identification key, Neotropical region, taxonomy

Introduction

The Neotropical region has a very high diversity of flower flies (Diptera, Syrphidae), comprising just over 30% of the currently recognized species in the world (Thompson et al. 2010) and many species new to science have continuously been described for genera confined to this region (e.g. Rotheray et al. 2007, 2009, Carvalho Filho and Esposito 2009, Morales et al. 2009, Ricarte et al. 2012). However, few studies on re-

gional Syrphidae fauna in the Neotropical region exist, particularly on South America (see Thompson and Marinoni 2003, Montoya et al. 2012 for a review).

The genus *Meropidia* was described by Hippa and Thompson in 1983, comprising three species: *Meropidia nigropilosa* Thompson, *M. neurostigma* Hippa and *M. rufa* Thompson. All described species are confined to the Neotropical region, specifically occurring on Tropical Andes (Hippa and Thompson 1983, Montoya et al. 2012).

Meropidia Hippa & Thompson, 1983 belongs to the subfamily Eristalinae and was placed in the tribe Milesiini, subtribe Tropidiina (Hippa and Thompson 1983). This subtribe comprises seven genera in addition to *Meropidia: Calcaretropidia* Keiser, 1971, *Macrozelima* Stackelberg, 1930, *Nepenthosyrphus* Meijere, 1932, *Orthoprosopa* Macquart, 1850, *Senogaster* Macquart, 1843, *Syritta* Lepeletier & Serville, 1828 and *Tropidia* (Meigen, 1822). Of these genera only *Meropidia* and *Senogaster* are confined to the Neotropical region, while species of *Syritta* and *Tropidia* also occur in the region (Thompson 2013). These genera can be readily distinguished from *Meropidia* by a swollen metafemur, often with armature, as *Meropidia* has a slightly thickened throughout and slightly arcuate metafemur, with no modifications (Thompson 1972).

Besides the simple metafemur, *Meropidia* is recognized as a moderately pilose taxa, with sexually dimorphic face (male with a broad, low, medial tubercle and female concave), with pollinose pattern on mesonotum and pilose metasternum. It has eye bare and male is very narrowly dichoptic. The wing has variable numbers of stigmatic crossveins; cell r1 open; vein R4+5 slightly sinuate, with a short petiole; vein r-m strongly oblique and long, ending at outer ¼ of discal cell, vein A1+CuA2 very long. The male sex is known only for one species, *M. neurostigma* (Hippa and Thompson 1983). The authors of this genus suggest that *Meropidia* is sister group of *Orthoprosopa* and *Paratropidia* Hull, 1949, being these three taxa the plesiomorphic sister group to the other genera of Tropidiina (Hippa and Thompson 1983).

The most appropriate identification key to run for the genus *Meropidia* is that published in Thompson (1999). Because *Meropidia* is a small genus with species confined to a very particular region, there is no information about biology of its species, neither about immature stages. In addition to the original description work (Hippa and Thompson 1983) and the identification key for Neotropical genera (Thompson 1999), *Meropidia* is also cited by Montoya et al. (2012), where is presented a review for flower flies fauna of Colombia and a comprehensive review of the literature concerning Colombia and the Neotropical region. It is noteworthy that in a previous work presenting a faunal list of Colombia, Gutierrez et al. (2005) had omitted the genus *Meropidia* from that list, but Montoya et al. (2012) included the omitted species *Meropidia neurostigma* Hippa, 1983 and recorded *M. nigropilosa* Thompson, 1983 as new to Colombia.

No additional species have been described for *Meropidia* since 1983, and in the present work two new species, *Meropidia nitida* Morales, sp. n. and *M. flavens* Hippa & Ståhls, sp. n., from Bolivia and Colombia respectively, are described.

Material and methods

Terminology follows Thompson (1999). The identification key was constructed based on the key from Hippa and Thompson (1983).

Type localities and holotype holding institutions are specified for each species. Location and identifications labels are indicated with quotation marks (""), and which line on the label separated by a forward slash (/). Handwritten information on labels is indicated in italics. The acronyms used for collections follow the standard of the *Systema Dipterorum* (Thompson 2013), and their equivalents are listed below:

AMNH American Museum of Natural History, New York, USA.MNHN Muséum National d'Histoire Naturelle, Paris, France.

All measurements are in millimeters and were taken using a reticule in a Nikon SMZ1000 stereomicroscope. Photographs of all new species were provided and were composed using the Combine ZP software based on images of pinned specimens.

In addition, were also provided photographs of the *M. nigropilosa* holotype, which is deposited at Natural History Museum, London, UK, and has no images available in an online source.

Description of new species

The species described here do not have a concave face, neither a wholly pollinose face as defined in Hippa and Thompson 1983 as diagnostic characters for *Meropidia* females; but, it is flat with a sub-medial and sub-developed tubercle, and shiny medially. A full generic description of *Meropidia* is not necessary here, but it is necessary to record that concavity and pollinosity of female face are not diagnostic characters for the genus *Meropidia*. Otherwise we have no additions or changes to the generic description.

Meropidia nitida Morales, sp. n.

http://zoobank.org/791B17B7-CC3C-4413-A750-8EDD936EBF7C http://species-id.net/wiki/Meropidia_nitida Figs 1–8

Type specimens. HOLOTYPE. Adult female, missing left midleg. Deposited at AMNH, New York City, USA. Type locality: BOLIVIA. Labels (Figs 6–8) "BOLIVIA: Sta Cruz Dept. / Caballero Prov., PN Amboró / 17°50.124'S, 64°23.454'W / 2070 m, X.18–19.2001 / S. Spector & J. Ledezma / mallaise 'sic' trap"; "COBIMI0011824"; "HOLOTYPE / *Meropidia nitida* / Morales, 2013".



Figures 1–8. *Meropidia nitida* Morales, sp. n., Holotype. I head, anterior view 2 head, dorsal view 3 habitus dorsal 4 abdomen, dorsal view 5 habitus lateral 6–8 labels.

Paratype. Adult female. BOLIVIA. Deposited at AMNH, New York City, USA. Labels: same data as Holotype; "COBIMI0011826"; "PARATYPE / *Meropidia nitida* / Morales, 2013".

Description. Adult female. Body size: 9–10.5 mm

Head. Face shiny black medially, becoming brownish to yellowish laterally, white pollinose laterally to bases of antenna, yellow pilose on pollinose area (Figs 1, 5), with a subdeveloped tubercle on inferior half (Fig. 5); gena shiny black, white pollinose and yellow pilose posteriorly (Fig. 5); facial stripes brown pollinose, with short yellow pile; lunula dark brown; frons shiny black in an anterior triangular area (Figs 1, 2), with brownish pile which became yellowish on their apexes, yellow pollinose elsewhere, sparse medially, intermixed with brownish and yellow pile; ocelli yellowish; ocellar triangle slightly isosceles obtuse (Fig. 2); occiput dark, yellowish pollinose dorsally, white pollinose elsewhere (Fig. 5), brownish and yellowish pilose dorsally, light yellow pilose elsewhere. *Antenna*. Scape and pedicel 2× longer than broad, dark brown (Fig. 1); arista dark brown, except apex reddish, with very short vestiture, downy; distance between antenna approximately 1.5 times its basal diameter (Figs 1, 2).

Thorax. Postpronotum yellow, densely pale pollinose and yellow pilose; scutum black, golden pollinose on lateral margins and on transverse suture, four longitudinal pale pollinose vittae extending in front of scutellum (Fig. 3), long yellow pilose (Fig. 5); scutellum yellowish, with longer yellow pile than scutum (Figs 3, 4), with scattered brownish pile on margin. Postalar callus with longer pile than scutum pile, as long as in scutellum, anterodorsal edge with long pile on posterior half, postalar wall bare. Calypter, haltere, plumula and spiracles yellow. Pleura dark brown, sparsely pale pollinose, except densely pollinose on posterior anepisternum, dorsal part of katepisternum and anterior anepimeron. Proepimerum, posterior anepisternum and anterior anepimeron somewhat produced posteriorly. Katepisternum mostly yellow pilose, except a few dark brown pile ventrally; metasternum black pilose.

Legs: simple, coxae and trochanters dark brown, mostly yellow pilose, intermixed with brownish pile. Pro and mesofemora brownish on basal half and yellow on apical half, yellow pilose, with longer pile ventrally; metafemur mostly dark brown, but apically yellow (Fig. 5), yellow pilose, ventral pile shorter than anterior and posterior surfaces, but longer than dorsal surface, longest pile on anterior and posterior surfaces erect, tilted apically elsewhere. Tibiae yellow, except metatibia slightly brownish medially (Fig. 5), yellow pilose. Metatarsus dark brown (Fig. 5), mostly brownish pilose, with few scattered yellow pile on anterior and posterior surfaces; pro and mesotarsus brown, lighter than metatarsus, yellow pilose.

Wing: completely microtrichose; vein CuP long, almost reaching the level of posterior apex of cell bm (Fig. 5); alula shorter than anal lobe;

Abdomen. Tergum I black (Figs 3, 4), lateral corners brownish yellow, with long yellow erect pile laterally, shortest black tilted backward pile elsewhere; tergum II mostly black, with yellow pile on the yellow maculae region (Figs 3, 4), laterally they are erect and longer, on anteromedial 1/3 yellow pilosity tilted backward, pile black and

tilted backward elsewhere, scattered pale pollinose on anterior half; tergum III mostly black, with yellow pile on lateral corners and on the yellow macula region (Figs 3, 4), black, posteriorly inclined pile elsewhere, whitish pollinose on anterior half; tergum IV black (Figs 3, 4), black pilose, except white pilose on anterior corners, whitish pollinosity forming two anterior triangular–like macula. Sterna dark brown, slightly pale pollinose; sterna I–III yellow pilose, IV yellow pilose intermixed with brownish pile; sternum V brownish pilose.

Comments. The holotype has four stigmatic crossveins on the left wing and five on the right; in the paratype there are six stigmatic crossveins on both wings. Only type material is known.

Meropidia flavens Hippa & Ståhls, sp. n.

http://zoobank.org/5B54C6D3-4E88-4DD3-A585-810EB9DED488 http://species-id.net/wiki/Meropidia_flavens Figs 9–15

Type specimen. HOLOTYPE. Adult female, in good condition, except arista missing. Postabdominal segments V and beyond removed and placed in plastic vial on the same pin as the specimen. Deposited at NMNH, Paris, France. Type locality: COLOMBIA. Labels (Figs 13–15) "*Bogota | October | 1892*"; "*This lable* 'sic'*| made by | Hippa | 1984*"; "HOLOTYPE / *Meropidia flavens |* Hippa & Ståhls, 2013".

Description. Adult female. Body size: 11 mm

Head. Elliptical in frontal view, (Fig. 11); face with a subdeveloped tubercle on inferior half (Fig. 10), shiny yellow medially, with brown U-shaped shiny area surrounding tubercle (Fig. 9), yellowish pollinose elsewhere, yellow pilose on pollinose areas; gena densely pale pollinose and long yellow pilose (Fig. 10); facial stripes brownish, short, matte, pale pollinose and pilose; lunula yellow, frontal area above lunula dark brown (Fig. 9), bare, brownish pilose; frons broad, densely yellowish pollinose and long pale pilose, antero-medial roundish and ocellar area bare; ocellar triangle slightly isosceles obtuse (Fig. 11), brownish long pilose; occiput densely pale pollinose, pale pilose, with some short black pile. *Antenna*: Scape brownish, 2× longer than broad, short dark pilo dorsally; pedicel brownish about 2.5–3× longer than broad, with short dark pile dorsally and ventrally; basoflagellomere darkbrown, shorter than high (Figs 9, 10); distance between antenna approximately twice its basal diameter (Fig. 9).

Thorax. Postpronotum yellow, densely pale pollinose and yellow pilose; scutum blackish, with four broad, longitudinal pale pollinose vittae extending to transverse pollinose area in front of scutellum (Fig. 11), long pale pilose, pale pollinose around transverse suture; anterodorsal edge of postalar callus with long pile on posterior half; scutellum yellowish (Fig. 11), long pale pilose, margin with pale pilosity with apex becoming browner, pile as long as scutellum. Calypters yellow with yellow marginal pilosity. Haltere yellow. Pleura brownish, slightly pollinose, except densely pale pollinose on posterior anepisternum, dorsal katepisternum and katepimeron.



Figures 9–15. *Meropidia flavens* Hippa & Ståhls, sp. n., Holotype 9 head, anterior view 10 head, lateral vie 11 habitus dorsa 12 habitus lateral 13–15 labels.

Propleura, posterior anepisternum, dorsal and ventral katepisternum, anepimeron with long yellow pilosity, katatergum with shorter yellow pilosity; metasternum black pilose.

Legs: simple, metafemur straight; yellow, except for coxae and trochanters brown (Fig. 12), femora narrowly brown antero-basally, and metatarsal segments 1–4 dark brown (Figs 11, 12).

Wing: completely microtrichose; slightly brownish along veins, wing veins brownish-yellow; four stigmatic crossveins; vein CuP long, almost reaching the level of posterior apex of cell bm (Fig. 11); alula shorter than anal lobe.

Abdomen. Tergum I yellow (Fig. 11), yellow pilose anteriorly, black short pilose posteriorly; tergum II yellow with brown spot antero-medially and posterior brownish stripe (Fig. 11), with long yellow pile at anterior corners and triangular area with short black pile; tergum III with antero-lateral corners broadly yellow (Fig. 11) and with yellow pile, with posterior brownish stripe with short black pile; tergum IV brown with antero-lateral corners yellow (Fig. 12) with short black pile. Sterna brownish, long pale pilose; sternum II with lateral areas yellow.

Comments. Only type known.

Identification key for the Meropidia species

1	First tergum black (Figs 4, 16), at least yellowish to orange on posterior mar-
	gin; metafemur mostly black, at least on basal 1/52
_	First tergum and femora entirely yellow or orange4
2	Pro and mesofemora orange (Fig. 17); metafemur very narrowly black in
	basal 1/5 or less; metabasitarsus partially black (Fig. 17); mesonotum and
	scutellum with extensive black pile; (Colombia)
_	Pro and mesofemora black on basal half and yellow on apical half; mesono-
	tum and scutellum with extensive yellow pile
3	Face shiny black medially (Fig. 1); frons shiny black in an anterior triangular
	area (Figs 1, 2); metatibia slightly brownish medially (Fig. 5); (Bolivia)
	Meropidia nitida Morales, sp. n.
_	Face and frons (or frontal triangle) yellowish orange, extensively yellow pol-
	linose; metatibia entirely yellow, without markings; (Bolivia)
	Meropidia neurostigma Hippa
4	Face shiny yellow medially, with a brown U-shaped shiny area surround-
	ing tubercle (Fig. 9); scutum with broad and longitudinal black markings
	(Fig. 11); metatarsal segments 1–4 dark brown (Figs 11, 12); (Colombia)
	Meropidia flavens Hippa & Ståhls, sp. n.
_	Face orange, without dark brown markings surrounding tubercle; scutum
	with very narrow longitudinal black markings; metatarsal segments orange;
	(Ecuador) Meropidia rufa Thompson



Figures 16–17. *Meropidia nigropilosa* Thompson. Holotype deposited at Natural History Museum, London, UK 16 habitus dorsal 17 habitus lateral. Scale bar: 1mm.

Discussion

The Tropical Andes, including parts of Venezuela, Colombia, Ecuador, Peru, Bolivia and Argentina, is the biologically richest and most diverse of Earth's biodiversity hotspots areas,

mainly for vertebrates and plants (Myers et al. 2000). Although that area retains about 25% of its primary vegetation, is believed to contain, at least, 20,000 known plant endemics and probably thousands of species remain to be discovered there (Myers et al. 2000). Because many insects are associated with plants, the extreme plant endemism of the Tropical Andes suggests a similar high level of insect diversity and endemism (Larsen et al. 2011).

The high altitudes of the Andes (above 3000 masl) include the most endangered and vulnerable ecosystem in South America and it is one of the three areas where the largest changes in fauna are predicted as a result of climate change (e.g. Lawler et al. 2009, Larsen et al. 2011).

Montoya et al. (2012) found that the Colombian Andes has the highest diversity and number of endemic species of Syrphidae. Species in the Neotropical genera *Macrometopia* Philippi, 1865, *Meropidia*, *Talahua* Fluke, 1943 and *Tuberculanostoma* Fluke, 1943 were in their study found to be restricted to the high altitudes above 3000 masl of the Colombian Andes.

Therefore, these taxa might be considered focus groups in future conservation projects due to the predictions of the impact of the climate change. The species described here also occur at altitudes between 2000–3000 masl and are thus important additions to the knowledge of the biodiversity of the high Andes flower fly fauna.

Of the five *Meropidia* species now known for the science, the male sex is still only known for *M. neurostigma*. The hitherto described *Meropidia* species are distributed in Bolivia, Colombia and Ecuador.

Acknowledgments

We thank Nigel Wyatt (Natural History Museum, London) for kindly providing pictures of *Meropidia nigropilosa* Thompson. The first author thanks CNPq, Science Without Borders Program, Brazil, for financial support (proc. 201536/2012–9).

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RESEARCH ARTICLE



Two new species of Entomobryidae (Collembola) of Taibai Mountain from China

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Abstract

Taibai Mountain is the highest peak of Qinling Mountain Ridge, a climate and geographical demarcation of the southern and northern China. Collembolan species of family Entomobryidae are reported from this region for the first time in this paper. Two new species, *Homidia taibaiensis* **sp. n.** and *Sinella triseta* **sp. n**. of Entomobryinae are described. Illustrations and differences with similar species are provided.

Keywords

Entomobryinae, new species, chaetotaxy, Qinling

Introduction

Entomobryidae is the largest family of Collembola with 1736 species recorded worldwide (Bellinger et al. 1996–2013). Among them, 60 and 64 species belong to the genera *Homidia* and *Sinella*, respectively. The two genera are affiliated to Entomobryinae, without scales on body and abundant mac (Chen and Christiansen

1993; Pan et al. 2012). The genus *Homidia* is characterized by spines present on the inner edge of dentes and "eyebrow" mac on anterior Abd. IV in adults, 8+8 ommatidia, mucro bidentate with subapical tooth larger than apical one, and mostly with a significant colour pattern (Pan et al. 2011). *Sinella* is characterized by reduced ommatidia number and pigment, bidentate mucro and without apical bulb on Ant. IV (Brook 1882).

Qinling is the east-west axial ridge, forming a natural climate and geographical barrier between the southern and northern China. Taibai Mountain is the highest peak along this ridge, located in Baoji City, Shaanxi Province, with a peak rising up to 3767.2 m. Before our study, there was no Entomobryinae species first reported from Taibai Mountain. Hear, two new species of this group are described.

Materials and methods

Specimens were cleared in lactic acid, mounted under a coverslip in Marc André II solution, and observed using Nikon 80i microscope with phase contrast. Photographs were taken with a Nikon SMZ1000 stereomicroscope mounted with a Nikon DS-Fi1 camera. Illustrations were completed to photographs using Photoshop CS2 (Adobe Inc.). All length data were measured with NIS-Elements Documentation 3.1 software (Nikon). Cephalic dorsal chaetotaxy for the genera *Homidia* and *Sinella* were designated following Szeptycki's (1973) and Chen and Christiansen's system (1993), respectively, with labial palp chaetae after Fjellberg (1998), labial chaetae after Gisin (1964), dorsal chaetotaxy of terga after Szeptycki (1979).

Abbreviations: Ant. –antennal segment; Th. –thoracic segment; Abd. –abdominal segment; ms –Specialized microchaeta(e); s –Specialized ordinary chaeta(e); mac – macrochaeta(e); mic –microchaeta(e).

Taxonomy

Homidia taibaiensis sp. n.

http://zoobank.org/D764D6D5-81D2-4461-97F3-78A2ED1C89B2 http://species-id.net/wiki/Homidia_taibaiensis Figures 1–21

Holotype. 1^Q on slide, Baoji City, Mei County, Haoping Temple manage department, Shaanxi Province, CHINA, 34°05.67'N, 107°42.40'E, sample number S4333, collected by Xiang-Qun Yuan and Zhi-Xiang Pan, 13.VII.2012.

Paratypes. 2^{\bigcirc} on slide and 3 in alcohol, same data as holotype, all types deposited in School of Life Sciences, Taizhou University.

Etymology. Named after the type locality. **Description.** Body length up to 2.95 mm.



Figures 1-3. Habitus of *H. taibaiensis* sp. n. 1 lateral view 2 dorsal view 3 ventral view.

Colour pattern. Ground colour yellow in alcohol, including ventral side; ommatidium patches dark blue; whole head dark brown; antennae yellow except Ant. IV with slight brown pigment and gradually deeper from base to tip; dorsal side of Th. II to Abd. II with slight brown pigment and gradually lighter, posterior Abd. II with a middle and narrow white band close to Abd. III; Abd. III and Abd. V dark brown except bilaterally; Abd. IV with brown pigment and gradually deeper from anterior to posterior edge; coxae of fore and mid leg with slight brown pigment; ventral tube and furcula also yellow (Figs 1–3).

Head. Ommatidia 8+8, G and H smaller than others and always difficult to observe under light microscope; interocular chaetae as p, r, t, chaeta p largest (Fig. 4). Antenna 2.05–3.31 times as long as cephalic diagonal; antennal segments ratio as I : II : III : IV = 1 : 1.24-1.97 : 0.91-1.52 : 1.71-2.46. Ant. I base with 3 dorsal spiny chaetae, ventral side unclear; Ant. II with 2 dorsal, 3 ventral basal smooth chaetae (Fig. 5), 2–5 distal rod-like S-chaetae (Fig. 6); Ant. III organ with 2 rod-like and 3 short guard S-chaetae (Fig. 7); apical bulb of Ant. IV bilobed (Fig. 8). Dorsal cephalic chaetotaxy with 3 antennal (A), 3 ocellar (O) and 5 sutural (S) mac, posterior cephalic chaetotaxy unclear (Fig. 4). Prelabral and labral chaetae as 4/5, 5, 4, all smooth, without labral papillae. Maxillary outer lobe with 1 apical, 1 subapical chaetae and 3 sublobal hairs on sublobal plate, subapical chaeta slightly larger than apical one (Fig. 9). Proximal with 5 smooth chaetae. Chaetal formula of labial base as MREL₁L₂, all ciliate (Fig. 10). Five papillae A–E on labial palp with 0, 5, 0, 4, 4 guard chaetae, respectively. Lateral process (l.p.) with tip not reaching apex of papilla E (Fig. 11). Mandible with 4/5 (left/right side) teeth.



Figures 4–10. *H. taibaiensis* sp. n. **4** dorsal cephalic chaetotaxy **5** basal spiny chaetae of Ant. II **6** distal Ant. II **7** Ant. III organ **8** apical bulb of Ant. IV **9** maxillary outer lobe **10** labial base **11** labial palp.

Thorax. Complete body s as 22/122 (Abd. IV unclear) 3; ms as 10/10100. Th. II with 4 (m1, m2, m2i and m2i2) medio-medial, 3 (m4, m4i and m4p) medio-sublateral and 3 S-chaetae (ms antero-internal to s); posterior with 26–30 mac; p4, p4i, p4i2 and p5 as mac, p6 as mic. Th. III with about 40 mac and 2 S-chaetae; p4 as mac (Fig. 12). Coxal macrochaetal formula as 3 (2 p)/4+1, 3 (3 p)/4+2 (number of pseudopores unclear). Trochanteral organ with 40–45 smooth chaetae (Fig. 13). Tenent hair clavate and slightly shorter than inner edge of unguis in length. Distal smooth chaeta on hind leg subequal to tenent hair in length. Unguis with 4 inner, 2 lateral and 1 outer teeth. Unguiculus lanceolate with outer edge serrated (Fig. 14).

Abdomen. Abd. IV as 6–11 times as Abd. III in dorsal axial length. Abd. I with 12–14 (a1–3, a1a, a5, m2–4, m2i, m4i, m4p and m5; one unclear homological mac near to pseudopore and m2i2 sometimes absent) mac and 2 S-chaetae (ms antero-external to



Figures 12–14. *H. taibaiensis* sp. n. **12** dorsal chaetotaxy of Th. II –III **13** trochanteral organ **14** apical tibiotarsus and claw of hind leg.

s). Abd. II with 6 (a2, a3, m3, m3e, m3ea and m3ep) central, 1 (m5) lateral mac and 2 Schaetae. Abd. III with 2 (a2 and m3) central, 4 (am6, pm6, p6 and m7a) lateral mac and 3 S-chaetae (Fig. 15). Abd. IV with many (precise number unclear) elongate and 2 (as and ps) short S-chaetae; "eyebrow" with 8–10 mac arranged in irregular transverse row; posterior central with 8–9 (A4–6, Ae6, Ae7, B4–6; Ae5 sometimes absent). Abd. V with 3 S-chaetae; m3a as mic and a5i as mac (Fig. 18). Anterior face of ventral tube (VT) with many ciliate chaetae, 3+3 of them as mac, line connecting proximal (Pr) and externaldistal (Ed) mac parallel to median furrow (Fig. 16); posterior face with 3 or 4 (1+1+1 or 2+2) subapical smooth chaetae; lateral flap with 6 smooth and 16–18 ciliate chaetae



Figures 15–17. *H. taibaiensis* sp. n. 15 dorsal chaetotaxy of Abd. I–III 16 anterior face of ventral tube 17 posterior face and lateral flap of ventral tube.

on each side (Fig. 17). Manubrial plaque with 3 pseudopores and 8–11 ciliate chaetae (Fig. 19). Dentes with 32–49 spines; basal chaetae (bs1 and bs2) spiny, bs1 shorter than bs2; pi ciliated and slightly longer than bs2 (Fig. 20). Mucro bidentate with subapical tooth larger than apical one; basal spine short, with tip not reaching apical tooth; distal smooth part of dentes subequal to mucro in length (Fig. 21). Tenaculum with 4+4 teeth and 1 large, multi-laterally basal ciliate chaeta.

Ecology. Found in the leaf litter of *Brassica campestris* L. on farmland, altitude 1165±8 m.

Remarks. This new species is characterized by unique colour pattern, such as ground colour yellow (especially VT and furcula), dark brown head (including ventral side), Abd. II with posterior white band, labial basal chaetae E and L_1 ciliate, m5 as mac on Abd. I and 8 mac present on median posterior Abd. IV.

The new species is closest to *Homidia socia* Denis, 1929 in chaetotaxy, relative to the ciliate labial base chaetae E and L_1 , m5 on lateral Abd. I as mac, A4–6 and B4–6 as mac on posterior Abd. IV. However, it can be easily discriminated from the latter by colour pattern (without longitudinal stripe in the former, three stripes in the latter)


Figures 18–21. *H. taibaiensis* sp. n. 18 dorsal chaetotaxy of Abd. IV–V 19 manubrial plaque 20 basal dentes 21 apical dentes and mucro.

and other characters, such as 3 mac in S sets on dorsal head (4 in the latter), m3 as mac on middle Abd. III (as mic in the latter) and without mac anterior to "eyebrow" on Abd. IV (with 2 mac in the latter). Also, this species is similar to *Homidia similis* Szeptycki, 1973 in chaetotaxy, detailed differences between them are listed in Table 1.

Characters	<i>H. taibaiensis</i> sp. n.	H. socia	H. similis			
Dark longitudinal stripes from head to Abd. III	-	+	-			
Whole head brown	yes	no	no			
Length ratio of Abd. IV/III	6–11	<4 ^b	>4 ^b			
Morphology of chaeta E on labial base	ciliate	ciliate	smooth			
Labral papillae	0	4 ^b	4			
Antennal mac on dorsal head	3	4 ^b	3			
Mac in "eyebrow" of anterior Abd. IV	8–10	7 ^b	7–9ª			
Mac on manubrial plate	8-11	9–13ª	8 ^b			
Chaetae on lateral flap of ventral tube						
smooth chaetae	6	5–6ª	5ª			
ciliate chaetae	16–18	12–24ª	8-12ª			
Smooth chaetae on posterior of ventral tube	3 or 4	2ª	4 or 5ª			
Relative position of ms/s on lateral Th. II	antero-internal	antero-internal ^a	antero-external ^a			
Mac m5 on Abd. I	+	+ ^a	_ ^a			
Mac of Abd. IV						
anterior to "eyebrow"	-	+ ^a	_ ^a			
A4a	-	+ ^a	_ ^a			
A6e	+	_ ^a	+ ^a			
Distribution	China	China, Japan, Vietnam ^b	Chinaª, Korea			

Table 1. Differences between H. taibaiensis sp. n. and other two closest species of Homidia.

Notes: a: based on author's observation; b: based on Jordana's description (2012); +: present; -: absent.

Sinella triseta sp. n.

http://zoobank.org/13C71E41-EA08-40ED-84E0-8731E64DAEB0 http://species-id.net/wiki/Sinella_triseta Figures 22–40

Holotype. 1^Q on slide, Baoji City, Mei County, Haoping Temple manage department, Shaanxi Province, CHINA, 34°05.18'N, 107°42.08'E, sample number S4325, collected by Xiang-Qun Yuan, Zhi-Xiang Pan, 11.VII.2012.

Paratypes. 5° , 1° on slide and 3 in alcohol, same data as holotype, all types deposited in School of Life Sciences, Taizhou University.

Etymology. Named using the Latin words "tri+seta" (three mac on each side of posterior Abd. IV).

Description. Body length up to 1.17 mm, white (Fig. 22).

Head. Antenna 1.27–1.61 times as long as cephalic diagonal. Antennal segments ratio as I : II : III : IV = 1 : 1.67–2.05 : 1.42–1.71 : 1.95–3.28. Smooth spiny mic at base of antennae as 3 dorsal, 4 ventral on Ant. I (Fig. 24) and 4 on Ant. II (Fig. 25). Ant. III organ with 5 rod-like S-chaetae (Fig. 26). Ommatidia absent. Dorsal cephalic chaetotaxy with 4 antennal (An), 5 sutural (S) and 4 mac in Gr. II (Fig. 23). Clypeus with 7 chaetae arranged in two lines (4 ciliate and 3 smooth) (Fig. 27). Labral papillae



Figure 22. Habitus of S. triseta sp. n.

absent; prelabral and labral chaetae as 4/5, 5, 4, all smooth; labial intrusion U-shaped (Fig. 28). Subapical chaeta of maxillary outer lobe shorter than apical one; 3 smooth sublobal hairs on maxillary outer lobe. Labial chaetae as $MREL_1L_2$, all smooth; chaetae R subequal to M; chaetae X and X₄ as peg-like, smooth mic; chaetae X₂ and X₃ absent (Fig. 29). Five papillae A–E on labial palp with 0, 5, 0, 4, 4 guard chaetae, respectively. Lateral process (l.p.) of labial palp as thick as normal chaetae, with tip beyond apex of labial papilla E (Fig. 30). Mandible with 4/5 (left/right side) teeth.

Thorax. Complete body s as 22/122 (14–16) 3; ms as 10/10000. Th. II with 4 (m1, m2, m2i and m2i2) medio-medial, 3 medio-lateral (m4, m4i, m4p), 18–21 posterior mac and 3 S-chaetae (ms internal to s); p4 as mac, p5 and p6 as mic, p1i2 and p4i sometimes absent. Th. III with about 30 mac and 2 lateral S-chaetae; p5, p6 and a5e as mic, p4 rarely as mac (Fig. 31). Coxal macrochaetal formula as 3 (2 p)/4+1, 3 (2 p)/4+2 (2 p) (Fig. 32). Trochanteral organ with 8–12 smooth spiny chaetae; 5–11 in arms and 2–3 between them (Fig. 33). 3–4 inner differentiated tibiotarsal chaetae "smooth" with ciliations closely appressed to axis. Tenent hair all acuminate and subequal to inner edge of unguis. Unguis with 3 inner teeth, basal paired teeth unequal, outer one larger. Unguiculus acuminate with a large tooth on outer edge (Fig. 34).



Figures 23–29. *S. triseta* sp. n. 23 dorsal cephalic chaetotaxy 24 basal chaetae of Ant. I 25 basal chaetae of Ant. II 26 Ant. III organ 27 clypeus 28 labrum 29 labial base 30 labial palp.

Abdomen. Abd. IV 2.94–4.34 times as Abd. III in dorsal axial length. Abd. I with 6 (a3, m2–4, m2i, m4p) mac and 2 S-chaetae (ms antero-external to s). Abd. II with 3 (m3, m3e, m3ep) central, 1 (m5) lateral mac and 2 S-chaetae. Abd. III with 1 (m3) central, 3 (am6, pm6, p6) lateral mac and 2 S-chaetae (lateral ms absent) (Fig. 35). Abd. IV with 3 central (A6, B5 and anterior one homology uncleared mac), 4 lateral mac (F1, E2–4), 12–14 elongate and 2 normal S-chaetae. Abd. V with 3 obvious mac (m2, m3 and m5) and 3 S-chaetae (Fig. 36). Tenaculum with 4+4 teeth and one large



Figures 31–34. *S. triseta* sp. n. 31 dorsal chaetotaxy of Th. II–III 32 coxal mac formula (A fore leg; B mid leg; C hind leg) 33 trochanteral organ 34 tip tibiotarsus and claw of hind leg.

basal chaeta. Anterior face of ventral tube with 5+5 ciliate chaetae (Fig. 37); posterior with 2+2 basal weekly ciliate and 2+2 subapical smooth chaetae, an additional smooth chaeta sometimes present between basal and apical region; lateral flap with 7–8 smooth chaetae, among them 0–2 weekly ciliated among them (usually unclear under light microscope) (Fig. 38). Manubrium without smooth chaetae. Manubrial plaque with 2 pseudopores and 3 ciliate chaetae (Fig. 39). Distal smooth part of dentes approximately 2 times as mucro in length. Mucro bidentate with basal spine long with tip reaching apex of apical tooth (Fig. 40).

Ecology. Found under stones in forest, altitude 1185±10 m.



Figure 35. dorsal chaetotaxy of Abd. I-III of S. triseta sp. n.

Remarks. This new species is characterized by 3 mac on posterior middle Abd. IV, ommatidia absent, labial base chaeta R subequal to M in length, X_2 and X_3 on ventral side of head absent, Abd. I–III with 6, 4, 4 mac, respectively, and clypeus with 7 mac arranged in two lines.

This species is most similar to *Sinella yunnanica* Zhang & Deharveng, 2011 in colour pattern, without ommatidia, claw, mucro, lateral process of labial palp, manubrial plaque and chaetotaxy of head and Th. II–Abd. III. However, it differ from latter in labial base chaeta R subequal to M (obviously short in the latter), X₂ absent (present



Figures 36–40. *S. triseta* sp. n. 36 dorsal chaetotaxy of Abd. IV–V 37 anterior face of VT 38 posterior face and lateral flap of VT 39 manubrial plaque 40 apical dentes and mucro.

in the latter), 3 central mac on Abd. IV (5 in the latter), ventral tube with 5+5 mac on anterior face (about 8 in the latter) and 8–9 smooth chaetae on posterior face (12 in the latter). Also, this new species is similar to *Sinella colorata* Zhang et al. 2010 and *Sinella pauciseta* Qu et al. 2010 in 3 mac on posterior median Abd. IV, detailed differences between them are listed in Table 2.

Characters	S. triseta sp. n.	S. yunnanica	S. colorata	S. pauciseta
Colour pattern	white	white	beige-violet to pale orange	white
Number of ommatidia	0+0	0+0	3+3	1+1
Chaetae on ventral side of head	·			·
ratio of R/M	≈1.0	0.15-0.20	≈0.50	≈0.54
X	smooth mic	smooth mic	smooth mac	ciliate mac
X4	smooth mic	smooth mic	ciliate mac	ciliate mac
Inner teeth of unguis	3	3	3	2
Tenent hair	acuminate	clavate	acuminate	acuminate
Ventral tube				
posterior smooth chaetae	8	10-12	6–10	8
smooth chaetae on lateral flap	7-8	7–10	5	6
Manubrial plaque	·			
pseudopores	2	2	2	?
ciliate chaetae	3	3	2	?
Mucronal basal spine	II	II	Ι	Ι
Mac of Th. II	·			
m2i2	+	-	-	-
p4i	-	+	- (+)	-
Mac a3 of Abd. I	+	+	-	+
Mac of Abd. II	• •			
a2	-	-	+	-
m3ep	+	+	-	+
Chaetae of Abd. III				
mac am6 on lateral	+	+	-	+
ms	-	+	+	?
Mac on Abd. IV				
A3	-	+	-	-
B4	-	+	-	-
E2p	-	+	+	+
D3	-	-	+	+

Table 2. Differences between S. triseta sp. n. and other three similar species of Sinella.

Notes: ?: unclear characters; I: mucronal basal spine reaching apex of subapical tooth; II: mucronal basal spine reaching apex of apical tooth; -: absent; +: present

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