Opusc. Zool. Budapest, 2021, 52(2): 119–139

Odonata from Batanta (Indonesia, West Papua) with description of one new species

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Abstract. Fifty-eight taxa of Odonata are herewith reported from Batanta Island (including Arefi and Birie Islands). One new species is described: *Argiolestes varga* sp. nov. The following ten species are new to the Raja Ampat Islands: *Papuagrion magnanimum* (Selys, 1876), *Gynacantha rosenbergi* Kaup, 1867, *Palaeosynthemis* cf. *cervula* (Lieftinck, 1938), *Diplacina smaragdina* Selys, 1878, *Nannophlebia amphicyllis* Lieftinck, 1933, *Pantala flavescens* (Fabricius, 1798), *Rhodothemis nigripes* Lohmann, 1984, *Rhyothemis regia* (Brauer, 1867), *Tramea transmarina propinqua* Lieftinck, 1942, *Zyxomma multinervorum* Carpenter, 1897, and fifteen are new to Batanta: *Selysioneura cornelia* Lieftinck, 1953, *P. magnanimum*, *Agyrtacantha dirupta* (Karsch, 1889), *Anax maclachlani* Förster, 1898, *G. rosenbergi*, *P.* cf. *cervula*, *D. smaragdina*, *N. amphicyllis*, *Nesoxenia mysis* (Selys, 1878), *P. flavescens*, *R. nigripes*, *R. regia*, *Tetrathemis irregularis* Brauer, 1868, *T. transmarina propinqua*, *Z. multinervorum*. *Metagrion postnodale* (Selys, 1878) and *Selysioneura* cf. *cervicornu* Förster, 1900 are deleted from the faunal lists of Odonata of Raja Ampat and Batanta Islands. The total number of species recorded for Batanta Island is 62.

Keywords. Batanta Island, Odonata, dragonflies, damselflies, new species, faunistics, distribution.

INTRODUCTION

The present paper provides a check-list and additional information on the Odonata fauna of Batanta Island, including Arefi and Birie Islands (Indonesia, West Papua) (Kovács *et al.* 2015*a*, *b*, 2016) on the basis of collecting trips carried out between 2017–2020.

MATERIAL AND METHODS

The material was collected during fieldworks between 17.02.2017 and 23.02.2020. For collecting methods of larvae, exuviae and adults see Kovács *et al.* (2015*b*). All material is preserved in 70% ethanol and deposited in the Mátra Museum of the Hungarian Natural History Museum, Gyöngyös. Data of observed but not captured individuals of easily recognisable species are also presented. The larvae and exuviae are still unidentified, except for *Drepanosticta batanta*, *Rhinocypha tincta* cf. *sagitta*, *Nososticta aurantiaca*, *Agriocnemis femina*, *Ceriagrion aeruginosum*, *Pseudagrion civicum*, *Anax maclachlani*, *Camacinia gigantea*, *Tramea transmarina propinqua*.

Abbreviations: HR = Róbert Horváth, JP = Péter Juhász, KE = Előd Kondorosy, KT = Tibor Kovács, SK = Kristian Sauyai, SR = Ronnius Sauyai; PPER = Papua Paradise Eco Resort; MM = Mátra Museum of the Hungarian Natural History Museum (Gyöngyös), ODO = Odonata, Digital Picture Gallery of the MM Insect Collection.

urn: lsid:zoobank.org:pub:430570F7-8E2D-42DD-8618-54C9C36F1E1F
HU ISSN 2063-1588 (online)
published: 02 August 2021
https://doi.org/10.18348/opzool.2021.2.119

RESULTS

ZYGOPTERA

Platystictidae Kennedy, 1920

Drepanosticta auriculata (Selys, 1878) – Kovács *et al.* 2015*b*, 2016. – **Batanta Island**, right side stream of Forum River, S00°52'09.6", E130°27'42.3", 22.02.2017, 1 male, KT-JP (2017-10). – Right side stream of Kaliselatan River, S00°53'55.6", E130°35'43.0", 28.02.2017, 1 male, KT-HR-JP-SK (2017-15.b). – Right side stream of right side of Waibin River, between S00°50'04.6", E130°45'28.8" and S00°50'12.8", E130°45'41.1", 17.02.2019, 2 males, KT-HR-JP-KE (2019-18). – Right side stream of Warai Stream, between S00°51'02.4", E130°35'17.1" and S00°51'02.8", E130°35'17.6", 23.02.2019, 1 male, KT-HR-JP-KE (2019-21.a). – Valley of Forum River, S00°52'26.5", E130°27'45.4", 22.02.2017, 1 male, KT-HR-JP (2017-10.a). – Valley of Warai Stream, between S00°50'25.19", E130°34'59.19" and S00°50'59.3", E130°35'18.0", 22.02.2019, 3 males, 2 females, KT-HR-JP-KE (2019-21). – Valley of Warai Stream, S00°50'59.3", E130°35'18.0", 27.02.2018, 3 males, 1 female, KT-HR-JP (2018-16); valley of Warai Stream, between S00°50'25.19", E130°34'59.19" and S00°50'59.3", E130°35'18.0", 24.02.2017, 2 males, 1 female, KT-HR-JP (2017-12).

Drepanosticta batanta Kovács & Theischinger, 2015 – Kovács *et al.* 2015*b*, 2016. – **Batanta Island**, valley of Kalijakut River, between S00°54'20.59", E130°38'31.7" and S00°52'49.10", E130°38'4.9", 14.02.2019, 2 males, KT-HR-JP-KE (2019-14); 19.02.2020, 1 male, 3 females, KT-HR-JP-SK-SR (2020-11; Fig. 1 = ODO-1). – Valley of Tanjung Lampu River, between S00°54'18.6", E130°36'48.6", and S00°53'43.0", E130°36'38.5", 12.02.2019, 2 females, KT-HR-JP-KE (2019-12); 18.02.2020, 6 males, 2 females, KT-HR-JP-SK-SR (2020-10); valley of Tanjung Lampu River, between S00°54'24.03", E130°36'47.64" and S00°53'43.0", E130°36'38.5", 21.02.2018, 1 male, KT-HR-JP-SK-SR (2018-12). – Valley of Warai Stream, S00°50'59.3", E130°35'18.0", 27.02.2018, 2 males, 1 female, KT-HR-JP (2018-16); valley of Warai Stream, between S00°50'25.19", E130°34'59.19" and S00°50'59.3", E130°35'18.0", 24.02.2017, 2 males, KT-HR-JP (2017-12); 22.02.2019, 1 exuvium and 1 emerged female, 2 males, 1 female, KT-HR-JP-KE (2019-21); 22.02.2020, 1 male, KT-HR-JP (2020-12). – Valley of Warmon Stream, between the lower and upper waterfall, S00°50'04.50", E130°42'54.01" and S00°50'23.25", E130°42'35.18", 20.02.2017, 1 male, KT-HR-JP (2017-6); 09.02.2019, 4 males, KT-HR-JP-KE (2019-9); 15.02.2020, 3 males, 1 female, KT-HR-JP (2020-8).

Calopterygidae Selys, 1850

Neurobasis australis Selys, 1897 – Kovács *et al.* 2015*b*.

Chlorocyphidae Cowley, 1937

Rhinocypha tincta cf. ***sagitta*** Lieftinck, 1938 – Kovács *et al.* 2015*b*, 2016. – **Batanta Island**, left side stream of Wailebet Stream, S00°53'27.7", E130°39'11.3", 01.03.2017, 1 male, KT-HR-JP-SK-SR (2017-17.b). – Right side stream of Forum River, between S00°52'22.7", E130°27'45.1" and S00°52'09.6", E130°27'42.3", 22.02.2017, 1 male, KT-HR-JP (2017-10.c). – Valley of „Wilson" Stream, S00°49'22.7", E130°48'22.0", 19.02.2017, 2 males, KT-HR-JP (2017-5). – Valley of Kalijakut River, between S00°54'20.59", E130°38'31.7" and S00°52'49.10", E130°38'4.9", 19.02.2020, 1 exuvium, 2 females, KT-HR-JP-SK-SR (2020-11). – Valley of Kaliselatan River, S00°53'42.0", E130°35'49.1", 27.02.2017, 1 female, KT-HR-JP-SK (2017-15.a). – Valley of Ron River, S00°49'36.5", E130°49'26.3", 19.02.2017, 1 male, 1 female, KT-HR-JP (2017-4). – Valley of Tanjung Lampu River, between S00°54'24.03", E130°36'47.64" and S00°53'43.0", E130°36'38.5", 21.02.2018, 1 male, KT-HR-JP-SK-SR (2018-12); valley of Tanjung Lampu River, between S00°54'18.6", E130°36'48.6", and S00°53'43.0",

Figure 1. *Drepanosticta batanta* in the valley of Kalijakut River (photo by T. Kovács).

E130°36'38.5", 12.02.2019, 1 male, 1 female, KT-HR-JP-KE (2019-12); 18.02.2020, 1 larva, 1 male, KT-HR-JP-SK-SR (2020-10). – Valley of Waibin River, between S00°49'20.8", E130° 45'56.9" and S00°49'50.9", E130°45'47.7", 18. 02.2018, 1 male, 1 female, KT-HR-JP (2018-7); 03.03.2017, 1 male, KT-HR-JP (2017-20); valley of Waibin River, between S00°49'20.8", E130° 45'56.9" and S00°50'01.9", E130°45' 24.8", 10.02.2020, 1 male, KT-HR-JP (2020-3). – Valley of Wailebet Stream, between S00°53' 37.74", E130°39'16.32" and S00°53'21.9", E130°39' 06.5", 19.02.2018, 1 male, KT-HR-JP-SK-SR (2018-8); 11.02.2019, 1 male, KT-HR-JP-KE (2019-11); valley of Wailebet Stream, between S00°53'37.74", E130°39'16.32" and S00°53' 07.1", E130°38'59.5", 17.02.2020, 1 male, KT-HR-JP-SK-SR (2020-9.b). – Valley of Warai Stream, S00°50'59.3", E130°35'18.0", 27.02. 2018, 2 males, KT-HR-JP (2018-16); valley of Warai Stream, between S00°50'25.19", E130°34' 59.19" and S00°50'59.3", E130°35'18.0", 24.02. 2017, 1 male, KT-HR-JP (2017-12); 22.02.2019, 1 female, KT-HR-JP-KE (2019-21). – Valley of Waridor River, between S00°50'30.34", E130°31' 28.71" and S00°51'22.60", E130°31'14.52", 14. 02.2020, 1 male, KT-HR-JP (2020-7); 23.02. 2020, 1 male, KT-HR-JP (2020-13). – Valley of Warmon Stream, between the lower and upper waterfall, S00°50'04.50", E130°42'54.01" and S00°50'23.25", E130°42'35.18", 20.02.2017, 1 male, KT-HR-JP (2017-6); 24.02.2018, 1 male, 1 female, KT-HR-JP (2018-14); 09.02.2019, 1 male, KT-HR-JP-KE (2019-9); 12.02.2020, 2 males, 1 female, KT-HR-JP (2020-5).

Argiolestidae Fraser, 1957

Argiolestes Selys, 1862

Kalkman & Theischinger (2013) recognised 11 species of the genus *Argiolestes*. Two species were added by Kalniņš (2014, 2017). Interestingly, the first described dragonfly species from New Guinea was *Argiolestes australis* (Guérin-Meneville, 1832) (as *Agrion*) from Waigeo Island (Hämäläinen & Orr 2016). This species can be found at several locations on Batanta (Kovács *et al.* 2016), and in three of its habitats, sympatrically with the *Argiolestes* species described as new as follows.

Argiolestes australis (Guérin-Meneville, 1832) – Kovács *et al.* 2016. – **Batanta Island**, right side stream of Forum River, between S00°52'22.7", E130°27'45.1" and S00°52'09.6", E130°27' 42.3", 22.02.2017, 1 male, KT-HR-JP (2017-10.c). – Right side stream of right side of Waibin River, between S00°50'04.6", E130°45'28.8" and S00°50'12.8", E130°45'41.1", 17.02.2019, 1 male, KT-HR-JP-KE (2019-18). – Right side stream of Waibin River, S00°49'47.31", E130°45'47.62", 02.03.2018, 1 female, KT-HR (2018-19). – Right side stream of Warai Stream, between S00°51' 02.4", E130°35'17.1" and S00°51'02.8", E130° 35'17.6", 23.02.2019, 1 male, KT-HR-JP-KE (2019-21.a). – Valley of Kalijakut River, between S00°54'20.59", E130°38'31.7" and S00°52' 49.10", E130°38'4.9", 19.02.2020, 1 female, KT-HR-JP-SK-SR (2020-11). – Valley of Tanjung Lampu River, between S00°54'18.6", E130°36' 48.6", and S00°53'43.0", E130°36' 38.5", 12.02. 2019, 2 males, KT-HR-JP-KE (2019-12). – Valley of Tanjung Lampu River, between S00° 54'24.03", E130°36'47.64" and S00°53'43.0", E130°36'38.5", 21.02.2018, 1 male, KT-HR-JP-SK-SR (2018-12). – Valley of Warai Stream, S00°50'59.3", E130°35'18.0", 27.02. 2018, 5 males, 1 female, KT-HR-JP (2018-16). – Valley of Warai Stream, between S00°50'25.19", E130° 34'59.19" and S00°50'59.3", E130°35'18.0", 22. 02.2019, 7 males, 1 female, KT-HR-JP-KE (2019-21). – Valley of Warai Stream, between S00°50' 51.0", E130°35'14.0" and S00°51'11.6", E130° 35'20.0", 09.02.2016, 1 female, KT-HR-JP (2016-2.a).

Argiolestes varga Kovács & Theischinger sp. nov.

(Figures 2–5)

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Type material – Holotype: **Indonesia**, West Papua, Batanta Island, right side stream of Kalijakut River, S00°52'49.10", E130°38'4.9", 237 m a.s.l., 19.02.2020, 1 male, KT-HR-JP-SK-SR (MM-ODOTYP-11, 2020-11). *Paratypes*: same data as holotype, 1 male (MM-ODOTYP-12, 2020-11); **Indonesia**, West Papua, Batanta Island, right side stream of Tanjung Lampu River, S00°53'43.0", E130°36'38.5", 180 m a.s.l., 21.02.2018, 1 male, KT-HR-JP-SK-SR (MM-ODOTYP-13, 2018-12); Batanta Island, right side stream of Warai Stream, S00°51'02.8", E130° 35'17.6", 250 m a.s.l., 23.02.2019, 1 male, KT-HR-JP-KE (MM-ODOTYP-14, 2019-21.a); 22. 02.2020, 1 female + 40 mature eggs, KT-HR-JP (MM-ODOTYP-15, 2020-12.b).

Diagnosis. The identification key to the males of *Argiolestes* by Kalkman *et al.* (2010) can also be used rather successfully for identification of the here described species however, the presence of the exterior submedian spine on the outer side of the superior appendages in *A. macrostylis* Ris, 1913 (Ris 1913, Lieftinck 1935, 1956) was not mentioned in this key.

Argiolestes varga sp. nov. can be distinguished from *A. australis* (Guérin-Meneville, 1832), *A. celebensis* Kalkman, 2007, *A. pallidistylus* Selys, 1878, *A. spungisi* Kalniņš, 2017 and *A. tuberculiferus* Michalski & Oppel, 2010 by the greater length of the inferior anal appendages (longer than half the length of the superior anal appendages as opposed to shorter than half the length).

The new species differs from *A. alfurus* Lieftinck, 1956, *A. amphistylus* Lieftinck, 1949, *A. foja* Kalkman, Richards & Polhemus, 2010, *A. obiensis* Lieftinck, 1956, *A. roon* Kalkman, Richards & Polhemus, 2010 and A. *zane* Kalniņš, 2014 by the presence, as opposed to absence, of a pair of large, well-defined, marks on the front of synthorax.

When compared to the species with long inferior appendages and pale marks, such as *A. muller* Kalkman, Richards & Polhemus, 2010 and *A. macrostylis* Ris, 1913, *A. varga* sp. nov. differs from *A. muller* by the lack, as opposed to the presence, of an interiorly directed, prominent, blunt protrusion of the basal flange of the superior appendages (Fig. 4a, b), and from *A. macrostylis* (with a single exterior submedian spine on the outer side of the superior appendages) by having more (4–12) spines on the outer side of the superior appendages (Fig. 4a, b, d).

In female of *A. varga* sp. nov., in contrast to the females of the *Argiolestes* species known to Kalkman *et al.* (2010), abdominal segment 10 is black with a tiny, indistinct, paler dorsal patch in the middle, and the cerci are completely black.

Description. Male (Figs. 2a, b, 3a, c, d, 4a–d). *Head* (Fig. 3a). Largely black; antennae black; from lateral ocelli to genae, next to the eyes with a light blue stripe; genae, mandible, labrum and clypeus light blue; labium yellowish; rear half of the eye light blue.

Prothorax. Pronotum largely light blue (Fig. 3a). Coxa and trochanter ivory white with dark brown pattern; femur ivory white, the distal portion dark brown; tibia and tarsus dark brown; several long hairs on the lower two edges of femur and tibia, short hairs on the two edges of tarsus.

Synthorax. Pleura black with two (Fig. 2a) or three (Fig. 2b) light blue patches: one well- defined,

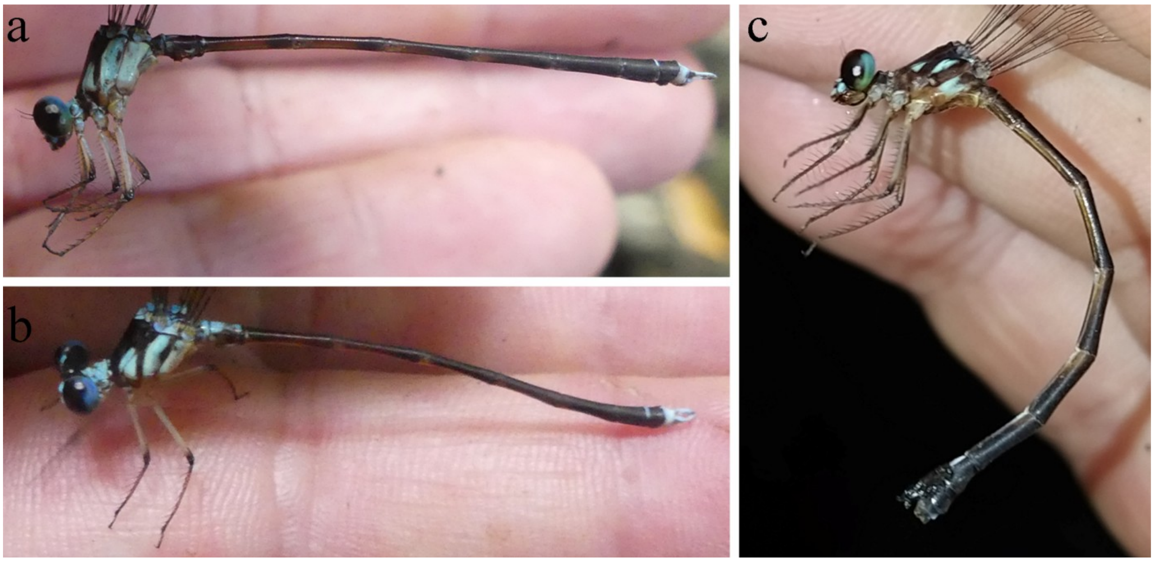

Figure 2. *Argiolestes varga* sp. nov.: a = male lateral view (side stream of Tanjung Lampu), b = male dorsolateral view (side stream of Warai Stream), c = female lateral view (mirrored horizontally) (side stream of Warai) (photos by T. Kovács).

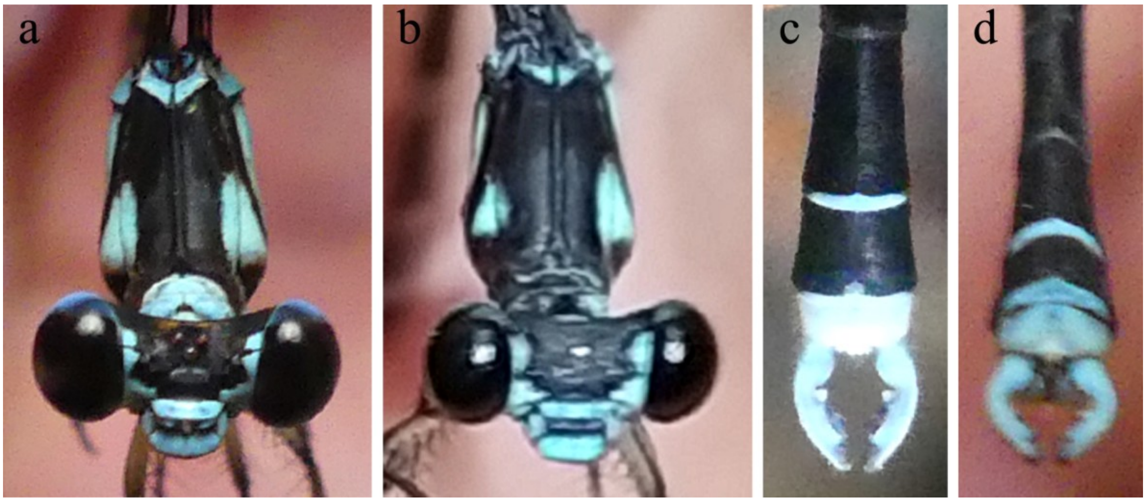

Figure 3. Figure 3. *Argiolestes varga* sp. nov. front of head and synthorax: a = male (side stream of Tanjung Lampu), b = female (side stream of Warai); end of abdomen of male: c = dorsal wiev (side stream of Warai), d = caudo-dorsal view (side stream of Tanjung Lampu) (photos by T. Kovács).

triangular in the outer third of anterior surface of mesepisternum and the inner third of anterior surface of mesepimeron; the other from the posterior edge of mesepimeron entirely through both metepisternum and metepimeron, or this large blue spot on the border of metepisternum and metepimeron divided by a black band into two. Poststernum largely bluish-ivory white. Coxae, trochanters and remainders of legs much as in prothorax. Wing venation black, membrane hyaline with slight smoky brown lustre; 21–24 postnodals in Fw, 19–23 in Hw; pterostigma dark brown, up to 1.6 mm long.

Abdomen. Dark brown to black, dorsally with light blue pattern on segments 1–2, 8–9 and segment 10. On segments 1–9 with tiny, backwards facing, dark spines and lighter hairs, on segment 10 with long, yellow hairs. The two apical lobes of the genital ligula at least four times as long as wide. Superior appendages light blue (Figs 2ab, 3cd); inferiors ivory white, longer than half the length of superiors (Fig. 4b, c). Basal flange of superior appendages with row of 7–11 blunt denticles; lower apical flange dark with a large, white patch in the middle, arising from half length of the appendage, with a basal and a middle convex curve and ending in an apical point connected to the bulb-like apex of the appendage with a deep incision (Fig 4a, b). Upper apical flange in the apical third of superior appendages, short and strongly curved with row of 11–13, blunt denticles. Superior appendages with 4–14 spines on the distal, external edge, terminating in a bulb-like part indented in the middle inner curve (Fig. 4d). Inferior appendages rather slim, widening at about ¾ length into subtriangular apex (Fig. 4b).

Measurements. Forewing 25.0–26.9 mm, hindwing 24.6–26.6 mm; abdomen (including appendages) 30.3–33.5 mm.

Female (Figs. 2c, 3b, 5a). *Head*. Much as in male (Fig. 3b).

Prothorax. Much as in male, but pronotum largely black with light blue pattern (Fig. 3b).

Synthorax. Pleura black with three light blue patches (Fig. 2c): one well-defined, triangular in the outer third of anterior surface of mesepisternum and the inner third of anterior surface of mesepimeron (similar to male); the other on the

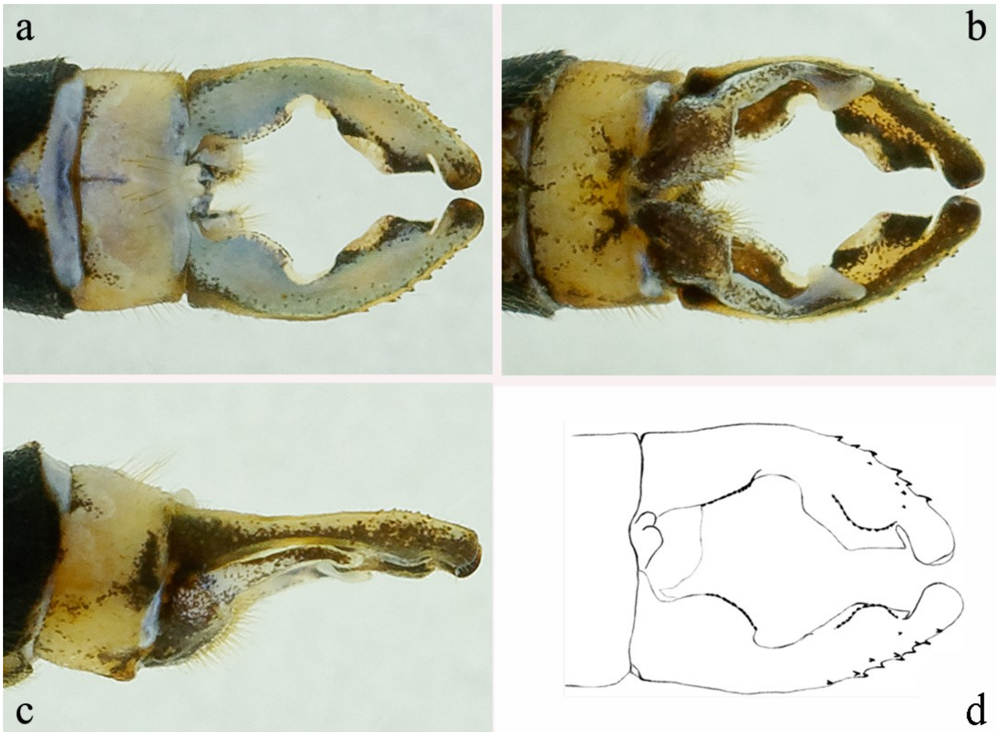

Figure 4. End of abdomen of *Argiolestes varga* sp. nov. holotype: a = dorsal view, b = ventral view, c = lateral view (photos by B. Magyar, T. Kovács), d = dorso-lateral view (photos and draw by T. Kovács). (The colour has changed in alcohol.)

outer edge of mesepimeron and the third on the middle third of the metepimeron. Poststernum largely ivory white. Legs much as in male. Wing venation black, membrane hyaline with slightly smoky brown lustre; 22–23 postnodals in Fw, 20–22 in Hw; pterostigma dark brown, up to 1.6 mm long.

Abdomen. Dark brown to black, the front and bottom of the segments lighter (Fig. 2c), at segment 8 light blue; segment 10 black, dorsally with tiny, indistinct, pale patch in the middle. Cerci black; valves largely black, approximately two-thirds as long as segments $8_{+}9$, and with more than 35 teeth along the ventral edge (Fig. 5a).

Measurements. Forewing 25.9 mm, hindwing 25.8 mm; abdomen 29.7 mm.

Egg (Fig. 5b). Cylindrical, with one end rounded and the other acuminate, slightly widening towards the acuminated end; length 0.88–0.92 mm, width 0.18–0.22 mm.

Larva. Unknown.

Habitat. *Argiolestes varga* sp. nov. was collected in tropical rainforest, between 180 and 250 m above sea level, in small tributaries of the upper course of larger watercourses (Fig. 6a, c, e). The microhabitats were located in the precipitous part of the few meters wide streams with rocky bed, where the water flowed down almost vertically and some plants were found (Fig. 6b, d, f). The adults were observed only in these shady places perching on plants, only few individuals at one and the same time. In all three locations, the species was found together with *Argiolestes australis* and *Metagrion* sp. At the side streams of Kalijakut and Tanjung Lampu Rivers several microhabitats are adjacent to each other, while at the side stream of Warai Stream, there is only one microhabitat, where two additional shade-loving species were found: *Drepanosticta auriculata* and *Idiocnemis strumidens*.

Etymology. The species is dedicated to two friends of the first author: András Varga (malacologist) his colleague, and Zoltán Varga (lepidopterologist) his teacher. They have been very supportive for more than three decades. Their surname is used as a noun in apposition to the generic name.

Figure 5. *Argiolestes varga* sp. nov. female: a = end of abdomen lateral view (photo by B. Magyar, T. Kovács), b = eggs (photo by T. Kovács).

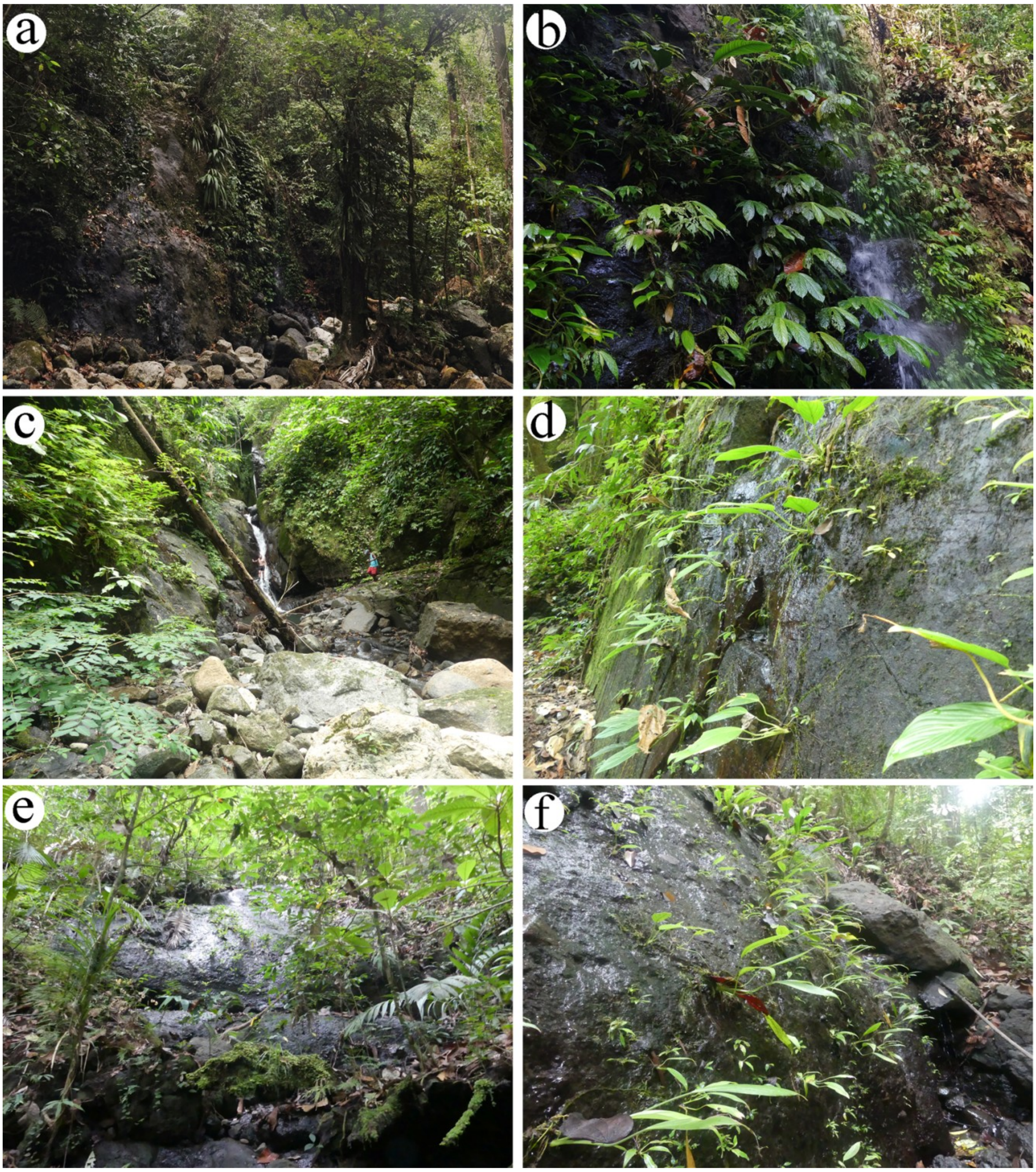

Figure 6. Habitat (a, c, e) and microhabitat (b, d, f) of *Argiolestes varga* sp. nov. a-b = right side stream of Kalijakut River - locus typicus, c-d = right side stream of Tanjung Lampu River, e-f = right side stream of Warai Stream (photos by T. Kovács).

Metagrion sp. – Kovács *et al.* 2015*b*, 2016 as *Metagrion postnodale* (Selys, 1878). – **Batanta Island**, right side stream of right side of Waibin River, between S00°50'04.6", E130°45'28.8" and S00°50'12.8", E130°45'41.1", 17.02.2019, 1 male, KT-HR-JP-KE (2019-18). – Right side stream of Waibin River, S00°49'47.31", E130° 45'47.62", 02.03.2018, 2 males, KT-HR (2018-19). – Right side stream of Warai Stream, between S00° 51'02.4", E130°35'17.1" and S00°51'02.8", E130°35'17.6", 23.02.2019, 1 male, KT-HR-JP-KE (2019-21.a). – Valley of Forum River, S00°52’26.5”, E130°27’45.4”, 22.02.2017, 1 male, KT-HR-JP (2017-10.a). – Valley of Kalijakut River, between S00°54’20.59”, E130°38’ 31.7” and S00°52’49.10”, E130°38’4.9”, 14.02. 2019, 1 male, 1 female, KT-HR-JP-KE (2019-14); 19.02.2020, 1 male, KT-HR-JP-SK-SR (2020-11). – Valley of Kaliselatan River, S00°53’42.0”, E130°35’49.1”, 27.02.2017, 1 male, KT-HR-JP-SK (2017-15.a). – Valley of Tanjung Lampu River, between S00°54’18.6”, E130°36’48.6”, and S00°53’43.0”, E130°36’38.5”, 12.02.2019, 2 males, KT-HR-JP-KE (2019-12); 18.02.2020, 3 males, 2 females, KT-HR-JP-SK-SR (2020-10); S00°54’24.03”, E130°36’47.64” and S00°53’ 43.0”, E130°36’38.5”, 21.02.2018, 1 male, KT-HR-JP-SK-SR (2018-12). – Valley of Waibin River, between S00°49’20.8”, E130°45’56.9” and S00°49’50.9”, E130°45’47.7”, 18.02.2018, 2 males, KT-HR-JP (2018-7). – Valley of Wailebet Stream, S00°53’08.4”, E130°39’00.1”, 01.03. 2017, 1 male, KT-HR-JP-SK-SR (2017-17.a). – Valley of Wailebet Stream, between S00°53’ 37.74”, E130°39’16.32” and S00°53’21.9”, E130° 39’06.5”, 19.02.2018, 2 males, 1 female, KT-HR-JP-SK-SR (2018-8); 11.02.2019, 1 male, KT-HR-JP-KE (2019-11); S00°53’37.74”, E130°39’ 16.32” and S00°53’07.1”, E130°38’59.5”, 17.02. 2020, 1 male, KT-HR-JP-SK-SR (2020-9.b). – Valley of Warai Stream, S00°50’59.3”, E130° 35’18.0”, 27.02.2018, 1 male, KT-HR-JP (2018-16). – Valley of Warai Stream, between S00°50’25.19”, E130°34’59.19” and S00°50’ 59.3”, E130°35’18.0”, 24.02.2017, 2 males, KT-HR-JP (2017-12); 22.02.2019, 5 males, 2 females, KT-HR-JP-KE (2019-21); 22.02.2020, 3 males, KT-HR-JP(2020-12). – Valley of Warmon Stream, between the lower and upper waterfall, S00°50’04.50”, E130°42’54.01” and S00°50’ 23.25”, E130°42’35.18”, 20.02.2017, 1 male, 1 female, KT-HR-JP (2017-6); 24.02.2018, 1 male, KT-HR-JP (2018-14); 09.02.2019, 2 males, 2 females, KT-HR-JP-KE (2019-9); 12.02.2020, 1 male, KT-HR-JP (2020-5); 15.02.2020, 1 male, KT-HR-JP (2020-8). – Wailebet, Stream, S00° 52’47.10”, E130°40’08.57”, 20.02.2018, 1 male, KT-HR-JP-SK-SR (2018-10).

Remark. More study is needed for the delimitation of this taxon.

Isostictidae Fraser, 1955

Selysioneura cornelia Lieftinck, 1953 – Kovács *et al.* 2015*b* as *Selysioneura* cf. *cervicornu* Förster, 1900. – **Batanta Island**, right side stream of Forum River, S00°52’22.7”, E130°27’45.1”, 19.02.2016, 1 male, KT-HR-JP (2016-10.b); right side stream of Forum River, between S00°52’22.7”, E130°27’45.1” and S00°52’09.6”, E130°27’42.3”, 22.02.2017, 1 male, KT-JP (2017-10.c). – Right side stream of right side of Waibin River, between S00°50’04.6”, E130°45’ 28.8” and S00°50’12.8”, E130°45’41.1”, 17.02. 2019, 1 female, KT-HR-JP-KE (2019-18). – Valley of „Wilson” Stream, S00°49’22.7”, E130°48’22.0”, 19.02.2017, 1 female, KT-HR-JP (2017-5). – Valley of Kalijakut River, between S00°54’20.59”, E130°38’31.7” and S00°52’ 49.10”, E130°38’4.9”, 14.02.2019, 1 male and 1 female in copula, KT-HR-JP-KE (2019-14). – Valley of Tanjung Lampu River, between S00°54’18.6”, E130°36’48.6”, and S00°53’43.0”, E130°36’38.5”, 12.02.2019, 1 male, KT-HR-JP-KE (2019-12). – Valley of Warai Stream, S00° 50’59.3”, E130°35’18.0”, 27.02.2018, 2 males, 1 female, KT-HR-JP (2018-16); valley of Warai Stream, between S00°50’51.0”, E130°35’14.0” and S00°51’11.6”, E130°35’20.0”, 09.02.2016, 1 male, KT-JP-HR (2016-2.a). – Valley of Warmon Stream, between the lower and upper waterfall, S00°50’04.50”, E130°42’54.01” and S00°50’ 23.25”, E130°42’35.18”, 20.02.2017, 1 female, KT-HR-JP (2017-6). – Valley of Warmon Stream, between the lower and upper waterfall, S00° 50’04.50”, E130°42’54.01” and S00°50’ 23.25”, E130°42’35.18”, 09.02.2019, 2 males, 1 female, KT-HR-JP-KE (2019-9). – Valley of Warmon Stream, between the lower and upper waterfall, S00°50’04.50”, E130°42’54.01” and S00°50’ 23.25”, E130°42’35.18”, 15.02.2020, 3 males, KT-HR-JP (2020-8). – Welebed, stream, S00° 52’47.10”, E130°40’08.57”, 20.02.2018, 2 females, KT-HR-JP-SK-SR (2018-10).

Platycnemididae Yacobson & Bianchi, 1905

Disparoneurinae Fraser, 1957

Nososticta aurantiaca (Lieftinck, 1938) – Kovács *et al.* 2015*b*, 2016, Theischinger & Richards 2015. – **Batanta Island**, 600 m E of Waibin River Valley, stream, S00°49'46.0", E130°46'09.4", 16.02.2018, 1 male, KT-HR-JP (2018-4). – Between Valleys of Tanjung Lampu River and Kalijakut River, S00°54'38.06", E130°36'50.17" and S00°54'20.59", E130°38' 31.70", 13.02.2019, 1 female, KE (2019-13). – Right side stream of right side of Waibin River, between S00°50'04.6", E130°45'28.8" and S00° 50'12.8", E130°45'41.1", 17.02.2019, 2 males, 1 female, KT-HR-JP-KE (2019-18). – Valley of „Marko" Stream, S00°47'47.4", E130°49'07.3", 19.02.2017, 2 males, KT-HR-JP (2017-3). – Valley of „Wilson" Stream, S00°49'22.7", E130° 48'22.0", 19.02.2017, 2 males, 1 female, KT-HR-JP (2017-5). – Valley of Forum River, S00°52'26.5", E130°27'45.4", 22.02.2017, 1 male, KT-HR-JP (2017-10.a). – Valley of Kalijakut River, between S00°54'20.59", E130° 38'31.7" and S00°52'49.10", E130°38'4.9", 14.02.2019, 1 male, KT-HR-JP-KE (2019-14); 19.02.2020, 1 male, KT-HR-JP-SK-SR (2020-11). – Valley of Kalisamsem River, S00°53'46.07", E130°33'17.18", 28.02.2017, 2 males, KT-HR-JP-SK-SR (2017-16). – Valley of Kaliselatan River, S00°53'42.0", E130°35'49.1", 27.02.2017, 1 male, 1 female, KT-HR-JP-SK (2017-15.a). – Valley of Tanjung Lampu River, S00°54'24.03", E130°36'47.64", 27.02.2017, 1 male, KT-HR-JP-SK (2017-14); valley of Tanjung Lampu River, between S00°54'24.03", E130°36'47.64" and S00°53'43.0", E130°36'38.5", 21.02.2018, 1 male, KT-HR-JP-SK-SR (2018-12); valley of Tanjung Lampu River, between S00°54'18.6", E130°36'48.6", and S00°53'43.0", E130°36' 38.5", 12.02.2019, 2 males, 1 female, KT-HR-JP-KE (2019-12). – Valley of Waibin River, S00°49'59.2", E130°45'27.1", 17.02.2019, 1 exuvium and 1 emerged female, KT-HR-JP-KE (2019-18.c); valley of Waibin River, between S00°49'20.8", E130°45'56.9" and S00°49'50.9", E130°45'47.7", 03.03.2017, 1 male, KT-HR-JP (2017-20); 18.02.2018, 2 males, 1 female, KT-HR-JP (2018-7); valley of Waibin River, between S00°49'20.8", E130°45'56.9" and S00°50'01.9", E130°45'24.8", 10.02.2020, 1 male, 1 female, KT-HR-JP (2020-3). – Valley of Wailebet Stream, S00°53'08.4", E130°39'00.1", 01.03. 2017, 1 male, KT-HR-JP-SK-SR (2017-17.a); valley of Wailebet Stream, between S00°53' 37.74", E130°39'16.32" and S00°53'21.9", E130° 39'06.5", 19.02.2018, 1 male, 1 female, KT-HR-JP-SK-SR (2018-8); 11.02.2019, 1 female, KT-HR-JP-KE (2019-11); valley of Wailebet Stream, between S00°53'37.74", E130°39'16.32" and S00°53'07.1", E130°38'59.5", 17.02.2020, 3 males, 1 female, KT-HR-JP-SK-SR (2020-9.b). – Valley of Warai Stream, S00°50'59.3", E130° 35'18.0", 27.02.2018, 1 male, KT-HR-JP (2018-16); valley of Warai Stream, between S00° 50'25.19", E130°34'59.19" and S00°50' 59.3", E130°35'18.0", 24.02.2017, 4 males, 1 female, KT-HR-JP (2017-12); 22.02.2019, 1 male, 1 female, KT-HR-JP-KE (2019-21); 22.02.2020, 1 male, 1 female, KT-HR-JP (2020-12). – Valley of Waridor River, between S00°50'30.34", E130° 31'28.71" and S00°51' 22.60", E130°31'14.52", 14.02.2020, 1 male, KT-HR-JP (2020-7). – Valley of Warmon Stream, between the lower and upper waterfall, S00° 50'04.50", E130°42'54.01" and S00°50' 23.25", E130°42'35.18", 20.02.2017, 3 males, 1 female, KT-HR-JP (2017-6); 24.02.2018, 1 male, KT-HR-JP (2018-14); 09.02.2019, 1 male, KT-HR-JP-KE (2019-9); 12.02.2020, 1 male, KT-HR-JP (2020-5).

Nososticta dora Kovács & Theischinger, 2016 – Kovács *et al.* 2016. – **Batanta Island**, right side stream of right side of Waibin River, between S00°50'04.6", E130°45'28.8" and S00°50'12.8", E130°45'41.1", 17.02.2019, 2 males, 1 female, KT-HR-JP-KE (2019-18); 10.02.2020, 1 male, 1 female, KT-HR-JP (2020-3.b). – Valley of Warmon Stream, between the lower and upper waterfall, S00°50'04.50", E130°42'54.01" and S00°50'23.25", E130°42'35.18", 20.02.2017, 1 male, KT-HR-JP (2017-6); 24.02.2018, 2 males, 2 females, KT-HR-JP (2018-14); 30.06.2018, 1 female, Réka Vadnay-Horváth-HR (A2018-1);

Figure 7. *Nososticta dora* in the valley of Warmon Stream from different perspective (photos by T. Kovács).

09.02.2019, 3 males, 1 female, KT-HR-JP-KE (2019-9); 12.02.2020, 3 males, 1 female, KT-HR-JP (2020-5; Fig. 7 = ODO-2, ODO-3).

Idiocnemidinae Dijkstra, Kalkman, Dow, Stokvis & van Tol, 2014

Idiocnemis bidentata Selys, 1878 – Gassmann 2000, Kovács *et al.* 2015*b*, 2016. – **Batanta Island**, 600 m E of Waibin River Valley, Stream, S00°49'46.0", E130°46'09.4", 16.02.2018, 1 male, KT-HR-JP (2018-4). – Left side stream of Wailebet Stream, S00°53'27.7", E130°39'11.3", 01.03.2017, 4 males, 4 females, KT-HR-JP-SK-SR (2017-17.b). – Right side stream of Kaliselatan River, S00°53'55.6", E130°35'43.0", 28. 02.2017, 3 males, KT-HR-JP-SK (2017-15.b). – Right side stream of right side of Waibin River, between S00°50'04.6", E130°45'28.8" and S00°50'12.8", E130°45'41.1", 17.02.2019, 1 male, 1 female, KT-HR-JP-KE (2019-18). – Valley of „Marko" Stream, S00°47'47.4", E130°49' 07.3", 19.02.2017, 2 males, KT-HR-JP (2017-3). – Valley of „Wilson" Stream, S00°49'22.7", 39'16.32" and S00°53'21.9", E130°39' 06.5", 19.02.2018, 3 males, 2 females, KT-HR-JP-SK-E130°48'22.0", 19.02.2017, 1 female, KT-HR-JP (2017-5). – Valley of Kalijakut River, between S00°54'20.59", E130°38'31.7" and S00°52' 49.10", E130°38'4.9", 14.02.2019, 1 female, KT-HR-JP-KE (2019-14); 19.02.2020, 1 female, KT-HR-JP-SK-SR (2020-11). – Valley of Kalisamsem River, S00°53'46.07", E130°33'17.18", 28. 02.2017, 1 male, KT-HR-JP-SK-SR (2017-16). – Valley of Kaliselatan River, S00°53'42.0", E130°35'49.1", 27.02.2017, 2 males, KT-HR-JP-SK (2017-15.a). – Valley of Ron River, S00° 49'36.5", E130°49'26.3", 19.02.2017, 3 males, KT-HR-JP (2017-4). – Valley of Tanjung Lampu River, between S00°54'24.03", E130°36'47.64" and S00°53'43.0", E130°36'38.5", 21.02.2018, 1 male, 1 female, KT-HR-JP-SK-SR (2018-12); valley of Tanjung Lampu River, between S00° 54'18.6", E130°36'48.6" and S00°53'43.0", E130°36'38.5", 18.02.2020, 1 male, KT-HR-JP-SK-SR (2020-10). – Valley of Waibin River, between S00°49'20.8", E130°45'56.9" and S00° 49'50.9", E130°45'47.7", 18.02.2018, 2 males, 2 females, KT-HR-JP (2018-7). – Valley of Wailebet Stream, between S00°53'37.74", E130° SR (2018-8); 11.02.2019, 1 male, 1 female, KT-HR-JP-KE (2019-11); valley of Wailebet Stream, between S00°53'37.74", E130° 39'16.32" and S00°53'07.1", E130°38'59.5", 17.02.2020, 2 males, 1 female, KT-HR-JP-SK-SR (2020-9.b). – Valley of Warai Stream, S00° 50'59.3", E130° 35'18.0", 27.02.2018, 2 males, KT-HR-JP (2018-16); valley of Warai Stream, between S00° 50'25.19", E130°34'59.19" and S00°50'59.3", E130°35'18.0", 24.02.2017, 3 males, KT-HR-JP (2017-12); 22.02.2019, 4 males, 1 female, KT-HR-JP-KE (2019-21); 22. 02.2020, 5 males, 1 female, KT-HR-JP (2020-12). – Valley of Warmon Stream, between the lower and upper waterfall, S00°50'04.50", E130°42'54.01" and S00°50'23.25", E130°42'35.18", 20.02.2017, 2 males, KT-HR-JP (2017-6); 24.02. 2018, 1 male, KT-HR-JP (2018-14); 04.03.2018, 2 males, 4 females, KT-HR (2018-21); 12.02.2020, 2 males, KT-HR-JP (2020-5). – Wailebet, stream, S00°52'47.10", E130°40'08.57", 20.02.2018, 1 female, KT-HR-JP-SK-SR (2018-10).

Idiocnemis inornata Selys, 1878 – Kovács *et al.* 2015*b*, 2016. – **Batanta Island**, valley of Wailebet Stream, S00°53'08.4", E130°39'00.1", 01.03.2017, 1 male, KT-HR-JP-SK-SR (2017-17.a).

Idiocnemis strumidens Lieftinck, 1958 – Kovács *et al.* 2016. – **Batanta Island**, right side stream of Forum River, S00°52'09.6", E130° 27'42.3", 22.02.2017, 2 males, 1 female, KT-JP (2017-10). – Right side stream of Kaliselatan River, S00°53'55.6", E130°35'43.0", 28.02.2017, 11 males, 1 female, KT-HR-JP-SK (2017-15.b). – Right side stream of right side of Waibin River, between S00°50'04.6", E130°45'28.8" and S00° 50'12.8", E130°45'41.1", 17.02.2019, 5 males, KT-HR-JP-KE (2019-18). – Right side stream of Waibin River, S00°49'47.31", E130°45'47.62", 02.03.2018, 1 male, KT-HR (2018-19). – Right side stream of Warai Stream, between S00° 51'02.4", E130°35'17.1" and S00°51'02.8", E130°35'17.6", 23.02.2019, 2 males, 2 females, KT-HR-JP-KE (2019-21.a). – Valley of Tanjung Lampu River, between S00°54'24.03", E130°36' 47.64" and S00°53'43.0", E130°36'38.5", 21.02. 2018, 2 males, KT-HR-JP-SK-SR (2018-12). – Valley of Waibin River, between S00° 49'20.8", E130°45'56.9" and S00°49'50.9", E130°45' 47.7", 18.02.2018, 1 male, KT-HR-JP (2018-7). – Valley of Wailebet Stream, between S00°53' 37.74", E130°39'16.32" and S00°53' 21.9", E130°39'06.5", 19.02.2018, 1 male, KT-HR-JP-SK-SR (2018-8). – Valley of Warai Stream, S00° 50'59.3", E130°35'18.0", 27.02. 2018, 2 males, KT-HR-JP (2018-16); valley of Warai Stream, between S00°50'25.19", E130°34' 59.19" and S00°50'59.3", E130°35'18.0", 24.02. 2017, 2 males, KT-HR-JP (2017-12); 22.02.2019, 4 males, 1 female, KT-HR-JP-KE (2019-21); 22.02. 2020, 4 males, KT-HR-JP (2020-12). – Wailebet, stream, S00°52'47.10", E130°40' 08.57", 20. 02.2018, 3 males, 1 female, KT-HR-JP-SK-SR (2018-10).

Palaiargia charmosyna Lieftinck, 1932 – Kovács *et al.* 2016. – **Batanta Island**, valley of Tanjung Lampu River, between S00°54'18.6", E130°36'48.6", and S00°53'43.0", E130°36' 38.5", 12.02.2019, 1 male, KT-HR-JP-KE (2019-12). – Valley of Warmon Stream, between the lower and upper waterfall, S00°50'04.50", E130°42'54.01" and S00°50'23.25", E130°42' 35.18", 09.02.2019, 1 male, KT-HR-JP-KE (2019-9).

Palaiargia susannae Kovács & Theischinger, 2015 – Kovács *et al.* 2015*b*. – **Batanta Island**, valley of Warai Stream, between S00°50'25.19", E130°34'59.19" and S00°50'59.3", E130°35' 18.0", 22.02.2020, 1 male, KT-HR-JP (2020-12).

Coenagrionidae Kirby, 1890

Agriocnemis femina (Brauer, 1869) – Kovács *et al.* 2015*b*, 2016. – **Arefi Island**, Arefi, Mandur, S00°47'17.7", E130°42'20.0", 05.03.2017, 1 male and 1 female in copula, KT (2017-24); 20.02. 2017, 8 males, 3 females, KT-HR-JP (2017-7); 21.02.2017, 2 females, KT (2017-9); 03.03.2018, 1 male, KT (2018-20); 10.02.2019, 2 males, 2 females, KT-HR-JP-KE (2019-10); 21.02.2019, 1 male, 2 females, KT-JP (2019-20); 11.02.2020, 1 male, KT-JP (2020-4). – **Batanta Island**, Minlii lake, S00°47'51.62", E130°29'46.51", 06.03. 2017, 1 male, KT-HR-JP (2017-26). – Valley of

Tanjung Lampu River, S00°54'18.6", E130°36' 48.6", 12.02.2019, 1 male, KT-HR-JP-KE (2019-12.b). – Valley of Waridor River, between S00°50'30.34", E130°31'28.71" and S00°51' 22.60", E130°31'14.52", 14.02.2020, 1 male, KT-HR-JP (2020-7). – Wailebet, small stream, S00° 54'00.56", E130°39'30.28", 11.02.2019, 2 males, 2 females, KT-HR-JP-KE (2019-11.b); 17.02. 2020, 1 male, KT-HR-JP-SK-SR (2020-9). – **Birie Island**, Papua Paradise Eco Resort, marsh, S00°46'14", E130°44'51", 17.02.2017, 4 males, 2 females, KT-HR-JP (2017-2); 02.03.2017, 1 exuvium and 1 emerged male, KT (2017-19); 03.03.2017, 1 larva, 5 males, 6 females, KT (2017-22); 16.02.2018, 2 males, 2 females, KT (2018-5); 28.02.2018, 1 female, KT (2018-17); 16.02.2019, 1 male, KT (2019-15).

Argiocnemis rubescens Selys, 1877 – Kovács *et al.* 2016. – **Batanta Island**, between valleys of Tanjung Lampu River and Kalijakut River, S00°54'38.06", E130°36'50.17" and S00°54' 20.59", E130°38'31.70", 13.02.2019, 1 male, 1 female, KE (2019-13). – Valley of Kalijakut River, between S00°54'20.59", E130°38'31.7" and S00°52'49.10", E130°38'4.9", 14.02.2019, 3 males, 4 females, KT-HR-JP-KE (2019-14). – Valley of Tanjung Lampu River, S00°54'18.6", E130°36'48.6", 12.02.2019, 1 female, KT-HR-JP-KE (2019-12.b).

Ceriagrion aeruginosum Brauer, 1869 – Kovács *et al.* 2015*b*. – **Arefi Island**, Arefi, Mandur, S00°47'17.7", E130°42'20.0", 21.02. 2019, 1 male, observed, KT-JP. – **Birie Island**, Papua Paradise Eco Resort, marsh, S00°46'14", E130°44'51", 17.02.2017, 1 male, KT-HR-JP (2017-2); 03.03.2017, 2 males, KT (2017-22); 16.02.2018, 2 males, KT (2018-5); 23.02.2018, 2 larvae, 2 males, 2 females, KT (2018-13); 16.02.2019, 1 male, 1 female, KT (2019-15).

Ischnura senegalensis (Rambur, 1842) – Kovács *et al.* 2015*b*. – **Arefi Island**, Arefi, Mandur, S00°47'17.7", E130°42'20.0", 20.02. 2017, 2 females, KT-HR-JP (2017-7); 21.02.2017, 3 males, KT (2017-9); 05.03.2017, 2 males, 3 females, KT (2017-24).

Papuagrion magnanimum (Selys, 1876) – **Batanta Island**, valley of Waibin River, stagnant waters, S00°49'20.8", E130°45'56.9", 03.03. 2017, 1 female, KT-HR-JP (2017-20.b). – Valley of Wailebet Stream, S00°53'37.74", E130° 39'16.32", 19.02.2018, 1 male, KT-HR-JP-SK-SR (2018-8.b).

Pseudagrion civicum Lieftinck, 1932 – Kovács *et al.* 2015*b*, 2016. – **Batanta Island**, valley of Ron River, S00°49'36.5", E130°49'26.3", 19.02.2017, 5 males, KT-HR-JP (2017-4). – Valley of Waibin River, S00°49'59.2", E130° 45'27.1", 17.02.2019, 1 male, KT-HR-JP-KE (2019-18.c); valley of Waibin River, between S00°49'20.8", E130°45'56.9" and S00°50'01.9", E130°45'24.8", 10.02.2020, 3 males, KT-HR-JP (2020-3). – Valley of Waridor River, between S00°50'30.34", E130°31'28.71" and S00°51' 22.60", E130°31'14.52", 14.02.2020, 1 exuvium and 1 emerged female, 5 males, 3 females, KT-HR-JP (2020-7); 23.02.2020, 2 males, 2 females, KT-HR-JP (2020-13).

Pseudagrion starreanum Lieftinck, 1949 – Kovács *et al.* 2015*b*, 2016. – **Arefi Island**, Arefi, Mandur, S00°47'17.7", E130°42'20.0", 21.02. 2017, 1 male, KT (2017-9); 05.03.2017, 1 male, KT (2017-24). – **Batanta Island**, Minlii lake, S00°47'51.62", E130°29'46.51", 06.03.2017, 2 males, 1 female, KT-HR-JP (2017-26); 17.02. 2018, 3 males, KT-HR-JP (2018-6); 17.02.2019, 2 males, 1 female, KT-HR-JP-KE (2019-16). – Valley of Waridor River, between S00°50'30.34", E130°31'28.71" and S00°51'22.60", E130°31' 14.52", 23.02.2020, 1 male, KT-HR-JP (2020-13).

Teinobasis rufithorax (Selys, 1877) – Kovács *et al.* 2015*b*, 2016. – **Arefi Island**, Arefi, Mandur, S00°47'17.7", E130°42'20.0", 21.02.2017, 1 male, KT (2017-9); 10.02.2019, 1 male, KT-HR-JP-KE (2019-10); 21.02.2019, 1 male, KT-JP (2019-20) – **Batanta Island**, Minlii lake, S00°47'51.62", E130°29'46.51", 23.02.2017, 1 male, 1 female, KT-HR-JP (2017-11); 06.03. 2017, 1 male, KT-HR-JP (2017-26); 17.02.2018, 1 male, KT-HR-JP (2018-6). – Valley of Kalijakut River, between S00°54'20.59", E130°38'

31.7” and S00°52’49.10”, E130°38’4.9”, 14.02. 2019, 1 male, 1 female, KT-HR-JP-KE (2019-14). – Valley of Tanjung Lampu River, S00°54’18.6”, E130°36’48.6”, 12.02.2019, 1 male, KT-HR-JP-KE (2019-12.b); 19.02.2020, 1 female, KT-HR-JP-SK-SR (2020-10.b). – **Birie Island**, Papua Paradise Eco Resort, marsh, S00°46’14”, E130° 44’51”, 17.02.2017, 3 males, 1 female, KT-HR-JP (2017-2); 16.02.2018, 1 mele, 1 female, KT (2018-5); 16.02.2019, 1 male, KT (2019-15).

Teinobasis superba (Hagen in Selys, 1877) – Kovács *et al.* 2016. – **Batanta Island**, right side stream of Kaliselatan River, S00°53’55.6”, E130°35’43.0”, 28.02.2017, 1 male, 1 female, KT-HR-JP-SK (2017-15.b). – Right side stream of right side of Waibin River, between S00°50’04.6”, E130°45’28.8” and S00°50’12.8”, E130°45’41.1”, 17.02.2019, 1 male, KT-HR-JP-KE (2019-18). – Right side stream of right side of Waibin River, between S00°50’04.6”, E130°45’ 28.8” and S00°50’12.8”, E130°45’41.1”, 10.02. 2020, 1 male, KT-HR-JP (2020-3.b). – Right side stream of Waibin River, S00°49’47.31”, E130° 45’47.62”, 02.03.2018, 1 male, KT-HR (2018-19). – Valley of „Marko” Stream, S00°47’47.4”, E130°49’07.3”, 19.02.2017, 1 male, KT-HR-JP (2017-3). – Valley of Ron River, S00°49’36.5”, E130°49’26.3”, 19.02.2017, 1 male, KT-HR-JP (2017-4). – Valley of Tanjung Lampu River, between S00°54’18.6”, E130°36’48.6” and S00° 53’43.0”, E130°36’38.5”, 18.02.2020, 1 male, KT-HR-JP-SK-SR (2020-10). – Valley of Wailebet Stream, between S00°53’37.74”, E130°39’ 16.32” and S00°53’21.9”, E130°39’06.5”, 19.02. 2018, 1 male, KT-HR-JP-SK-SR (2018-8). – Valley of Warai Stream, S00°50’59.3”, E130°35’ 18.0”, 27.02.2018, 3 males, 1 female, KT-HR-JP (2018-16); valley of Warai Stream, between S00°50’25.19”, E130°34’59.19” and S00°50’ 59.3”, E130°35’18.0”, 22.02.2019, 1 male, 1 female, KT-HR-JP-KE (2019-21); 22.02.2020, 3 males, 1 female, KT-HR-JP (2020-12). – Valley of Warmon Stream, between the lower and upper waterfall, S00°50’04.50”, E130°42’54.01” and S00°50’23.25”, E130°42’35.18”, 09.02.2019, 1 male, KT-HR-JP-KE (2019-9).

Xiphiagrion cyanomelas Selys, 1876 – Kovács *et al.* 2015*b*. – **Arefi Island**, Arefi, Mandur, S00°47’17.7”, E130°42’20.0”, 05.03.2017, 2 males, 1 female, KT (2017-24); 21.02.2017, 3 males, 2 females, KT (2017-9); 10.02.2019, 1 male, KT-HR-JP-KE (2019-10); 21.02.2019, 1 male, KT-JP (2019-20); 11.02.2020, 2 males, KT-JP (2020-4). – **Batanta Island**, Wailebet, small stream, S00°54’00.56”, E130°39’30.28”, 17.02. 2020, 1 male, KT-HR-JP-SK-SR (2020-9). – **Birie Island**, Papua Paradise Eco Resort, marsh, S00°46’14”, E130°44’51”, 17.02.2017, 1 male, KT-HR-JP (2017-2).

ANISOPTERA

Aeshnidae Leach, 1815

Agyrtacantha dirupta (Karsch, 1889) – Kovács *et al.* 2015*b* one exuvium (2014-3) as *Gynacantha mocsaryi* Förster, 1898. – **Batanta Island**, valley of Forum River, S00°52’26.5”, E130°27’45.4”, 23.02.2017, before sunrise in the bird catching nets, 1 male, KT-HR-JP (2017-10.d). – **Birie Island**, Papua Paradise Eco Resort, marsh, S00°46’14”, E130°44’51”, 28.02.2018, 1 female, KT (2018-17).

Anax maclachlani Förster, 1898 – **Birie Island**, Papua Paradise Eco Resort, marsh, S00°46’14”, E130°44’51”, 17.02.2017, 3 exuviae, KT-HR-JP (2017-2); 23.02.2018, 1 male, KT (2018-13); S00°46’14.9”, E130°44’46.6”, 05.03. 2017, 1 male, KT-JP (2017-25).

Gynacantha mocsaryi Förster, 1898 – Kovács *et al.* 2015*b*, 2016. – **Batanta Island**, valley of Waibin River, S00°50’01.9”, E130°45’24.8”, 01.03.2018, at dusk, 1 female, KT-HR (2018-18). – **Birie Island**, Papua Paradise Eco Resort, S00°46’16.12”, E130°44’44.85”, 17.07.2019, 1 female, Gergő Vadnay-Horváth (A2020-1).

Gynacantha rosenbergi Kaup, 1867 – Kovács *et al.* 2015*b* one larva, four exuviae (2014-21, 2015-8, 2015-15a) and two females as *Gyna* *cantha mocsaryi* Förster, 1898. – **Birie Island**, Papua Paradise Eco Resort, marsh, S00°46'14", E130°44'51", 21.02.2017, before sunrise, 1 male, KT (2017-8); marsh, S00°46'14.9", E130°44' 46.6", 02.03.2017, at dusk, 1 male, 1 female, KT-JP (2017-19.b); marsh, S00°46'12.55", E130° 44'54.05", 08.02.2020, 1 female, KT-HR-JP (2020-1).

Synthemistidae Tillyard, 1911

Palaeosynthemis cf. ***cervula*** (Lieftinck, 1938) – **Batanta Island**, valley of Waibin River, S00°49'57.4", E130°45'27.2", 25.02.2019, 9:00, 1 male, KT-HR-JP-KE (2019-23).

Macromiidae Needham, 1903

Macromia euphrosyne Lieftinck, 1952 – Kovács *et al.* 2015*b*. – **Batanta Island**, valley of Warai Stream, S00°50'59.3", E130°35'18.0", 27.02.2018, 1 female, KT-HR-JP (2018-16); valley of Warai Stream, between S00°50'25.19", E130°34'59.19" and S00°50'59.3", E130°35' 18.0", 22.02.2019, 1 female, KT-HR-JP-KE (2019-21).

Libellulidae Leach, 1815

Agrionoptera insignis (Rambur, 1842) – Kovács *et al.* 2015*b*. – **Arefi Island**, Arefi, Mandur, S00°47'17.7", E130°42'20.0", 05.03.2017, 1 male, KT (2017-24); 03.03.2018, 1 male, KT (2018-20); 10.02.2019, 1 male, KT-HR-JP-KE (2019-10). – **Batanta Island**, Minlii lake, S00° 47'51.62", E130°29'46.51", 06.03.2017, 1 male, KT-HR-JP (2017-26). – **Birie Island**, Papua Paradise Eco Resort, marsh, S00°46'14", E130°-44'51", 02.03.2017, 1 male, KT (2017-19); 28.02. 2018, 1 male, KT (2018-17).

Agrionoptera longitudinalis Selys, 1878 – Kovács *et al.* 2015*b*, 2016. – **Arefi Island**, Arefi, Mandur, E, water hole, S00°47'39.7", E130°-42'28.4", 03.03.2018, 1 male, KT (2018-20.b). – **Batanta Island, valley** of Forum River, S00° 52'41.6", E130°27'30.5", 22.02.2017, 1 male, KT-HR-JP (2017-10.b). – Valley of Kaliselatan River, S00°53'42.0", E130°35'49.1", 27.02.2017, 1 male, KT-HR-JP-SK (2017-15.a). – Valley of Ron River, stagnant waters, S00°49'30.53", E130°49'13.99", 19.02.2017, 1 male, KT-HR-JP (2017-4.b). – Valley of Tanjung Lampu River, S00°54'24.03", E130°36'47.64", 27.02.2017, 1 male, KT-HR-JP-SK (2017-14). – Valley of Wailebet Stream, „dendrotelma", S00°53'22.00", E130°39'7.35", 19.02.2018, 1 male, KT-HR-JP-SK-SR (2018-8.c). – Valley of Warai Stream, S00°50'59.3", E130°35'18.0", 27.02.2018, 1 male, KT-HR-JP (2018-16). – Valley of Waridor River, stagnant waters, between S00°50'30.34", E130°31'28.71" and S00°51'22.60", E130°31' 14.52", 23.02.2020, 2 males, KT-HR-JP (2020-13.b). – **Birie Island**, Papua Paradise Eco Resort, marsh, water hole, S00°46'16.4", E130°44'50.4", 18.02.2017, 1 male, KT-HR-JP (2017-2.b); 16.02.2019, 1 male, KT (2019-15.b).

Brachydiplax duivenbodei_(Brauer, 1866) – Kovács *et al.* 2015*b*, 2016. – **Arefi Island**, Arefi, Mandur, S00°47'17.7", E130°42'20.0", 10.02. 2019, 1 male, KT-HR-JP-KE (2019-10). – **Batanta Island**, Minlii lake, S00°47'51.62", E130°29' 46.51", 17.02.2018, 1 male, KT-HR-JP (2018-6). – **Birie Island**, Papua Paradise Eco Resort, marsh, S00°46'14", E130°44'51", 17.02.2017, 1 male, KT-HR-JP (2017-2); 23.02.2018, 1 male, observed, KT.

Camacinia gigantea (Brauer, 1867) – Kovács *et al.* 2015*b*. – **Arefi Island**, Arefi, Mandur, S00°47'17.7", E130°42'20.0", 05.03.2017, 1 male, KT (2017-24). – **Birie Island**, Papua Paadise Eco Resort, marsh, S00°46'14", E130°44' 51", 17.02.2017, 2 exuviae, 1 male, KT-HR-JP (2017-2); 04.03.2017, 1 male, KT (2017-23); 05.03.2018, 1 male, KT (2018-22.a); 16.02.2019, 1 male, KT (2019-15).

Diplacina cf. ***ismene*** Lieftinck, 1933 – Kovács *et al.* 2016.

Diplacina olahi Theischinger & Kovács, 2015 – Kovács *et al.* 2015*b*.

Diplacina smaragdina Selys, 1878 – Kovács *et al.* 2016 as *Diplacina olahi* Theischinger &

Kovács, 2015. – **Batanta Island**, right side of Waibin River, between S00°50’01.9”, E130°45’ 24.8” and S00°50’04.6”, E130°45’28.8”, 17.02. 2019, 1 male, KT-HR-JP-KE (2019-18.b). – Valley of Kalijakut River, between S00°54’ 20.59”, E130°38’31.7” and S00°52’49.10”, E130° 38’4.9”, 19.02.2020, 2 males, KT-HR-JP-SK-SR (2020-11). – Valley of Tanjung Lampu River, between S00°54’24.03”, E130°36’47.64” and S00°53’43.0”, E130°36’38.5”, 21.02.2018, 1 male, 1 female, KT-HR-JP-SK-SR (2018-12); valley of Tanjung Lampu River, between S00° 54’18.6”, E130°36’48.6”, and S00°53’43.0”, E130°36’38.5”, 12.02.2019, 1 male, KT-HR-JP-KE (2019-12); 18.02.2020, 1 female, KT-HR-JP-SK-SR (2020-10). – Valley of Wailebet Stream, S00°53’08.4”, E130°39’00.1”, 01.03.2017, 1 male, KT-HR-JP-SK-SR (2017-17.a). – Valley of Warai Stream, between S00°50’25.19”, E130°34’ 59.19” and S00°50’59.3”, E130°35’18.0”, 24.02. 2017, 2 males, KT-HR-JP (2017-12); 22.02.2019, 1 female, KT-HR-JP-KE (2019-21); 22.02.2020, 2 males, KT-HR-JP (2020-12); valley of Warai Stream, S00°50’59.3”, E130°35’18.0”, 27.02. 2018, 1 male, KT-HR-JP (2018-16). – Valley of Warmon Stream, between the lower and upper waterfall, S00°50’04.50”, E130°42’54.01” and S00°50’23.25”, E130°42’35.18”, 20.02.2017, 3 males, 1 female, KT-HR-JP (2017-6); 09.02.2019, 1 male, 1 female, KT-HR-JP-KE (2019-9); 12.02. 2020, 2 males, KT-HR-JP (2020-5). – Wailebet, Stream, S00°52’47.10”, E130°40’ 08.57”, 20.02. 2018, 3 males, KT-HR-JP-SK-SR (2018-10).

Diplacodes trivialis (Rambur, 1842) – Kovács *et al.* 2015*b*, 2016. – **Arefi Island**, Arefi, Mandur, S00°47’17.7”, E130°42’20.0”, 21.02.2017, 2 males, 1 female, KT (2017-9); 05.03.2017, 1 male, KT (2017-24); 03.03.2018, 1 male, KT (2018-20); 10.02.2019, 1 male, KT-HR-JP-KE (2019-10); 21.02.2019, 1 male, KT-JP (2019-20); 11.02.2020, 2 males, KT-JP (2020-4). – **Batanta Island**, valley of Tanjung Lampu River, S00°54’ 38.06”, E130°36’50.17” and S00°54’24.03”, E130°36’47.64”, 21.02.2018, 1 female, KT-HR-JP-SK-SR (2018-12.c). – Wailebet, S00°54’ 02.43”, E130°39’35.36”, 21.02.2018, 1 male, KT-HR-JP-SK-SR (2018-12.b). – Wailebet, small stream, S00°54’00.56”, E130°39’30.28”, 17.02. 2020, 1 male, KT-HR-JP-SK-SR (2020-9). – Yensawai, stagnant waters, S00°48’21.32”, E130° 40’43.23”, 12.02.2020, 1 male, KT-HR-JP (2020-5.b). – **Birie Island**, Papua Paradise Eco Resort, marsh, S00°46’14.9”, E130°44’46.6”, 04.03.2017, 1 female, KT (2017-23.b).

Huonia epinephela Förster, 1903 – Kovács *et al.* 2015*b*, 2016. – **Batanta Island**, valley of Warmon Stream, between the lower and upper waterfall, S00°50’04.50”, E130°42’54.01” and S00°50’23.25”, E130°42’35.18”, 20.02.2017, 2 males, 1 female, KT-HR-JP (2017-6); 24.02.2018, 1 male, KT-HR-JP (2018-14); 09.02.2019, 1 female, KT-HR-JP-KE (2019-9). – Valley of Warai Stream, between S00°50’25.19”, E130°34’ 59.19” and S00°50’59.3”, E130°35’18.0”, 22.02. 2020, 2 males, 1 female, KT-HR-JP (2020-12).

Huonia thais Lieftinck, 1953 – Kovács *et al.* 2015*b*. – **Batanta Island**, right side of Waibin River, between S00°50’01.9”, E130°45’24.8” and S00°50’04.6”, E130°45’28.8”, 17.02.2019, 1 male, KT-HR-JP-KE (2019-18.b). – Valley of Forum River, S00°52’26.5”, E130°27’45.4”, 22.02.2017, 2 males, KT-HR-JP (2017-10.a). – Valley of Kalijakut River, between S00°54’ 20.59”, E130°38’31.7” and S00°52’49.10”, E130° 38’4.9”, 19.02.2020, 2 males, KT-HR-JP-SK-SR (2020-11). – Valley of Ron River, S00° 49’36.5”, E130°49’26.3”, 19.02.2017, 1 male, KT-HR-JP (2017-4). – Valley of Waibin River, between S00°49’20.8”, E130°45’56.9” and S00°49’50.9”, E130°45’47.7”, 03.03.2017, 1 male, KT-HR-JP (2017-20). – Valley of Warai Stream, between S00°50’25.19”, E130°34’59.19” and S00°50’ 59.3”, E130°35’18.0”, 22.02.2020, 1 male, KT-HR-JP (2020-12). – Valley of Waridor River, between S00°50’30.34”, E130°31’28.71” and S00°51’22.60”, E130°31’14.52”, 23.02.2020, 1 male, 1 female, KT-HR-JP (2020-13). – Valley of Warmon Stream, between the lower and upper waterfall, S00°50’04.50”, E130°42’54.01” and S00°50’23.25”, E130°42’35.18”, 12.02.2020, 1 male, KT-HR-JP (2020-5).

Hydrobasileus vittatus Kirby, 1889 – Kovács *et al.* 2015*b*. – **Arefi Island**, Arefi, Mandur, S00°47'17.7", E130°42'20.0", 10.02.2019, 1 female, KT-HR-JP-KE (2019-10); 21.02.2019, 1 female, observed, KT-JP.

Nannophlebia amnosia Lieftinck, 1955 – Kovács *et al.* 2015*b*. – **Batanta Island**, valley of Waridor River, between S00°50'30.34", E130°31' 28.71" and S00°51'22.60", E130°31'14.52", 14. 02.2020, 1 female, KT-HR-JP (2020-7). – Valley of Warmon Stream, between the lower and upper waterfall, S00°50'04.50", E130°42'54.01" and S00°50'23.25", E130°42'35.18", 20.02.2017, 1 female, KT-HR-JP (2017-6).

Nannophlebia amphicyllis Lieftinck, 1933 – Kovács *et al.* 2016 as *Nannophlebia amnosia* Lieftinck, 1955. – **Batanta Island**, valley of Kalijakut River, between S00°54'20.59", E130° 38'31.7" and S00°52'49.10", E130°38'4.9", 14. 02.2019, 1 female, KT-HR-JP-KE (2019-14). – Valley of Warai Stream, between S00°50'25.19", E130°34'59.19" and S00°50'59.3", E130°35' 18.0", 24.02.2017, 1 female, KT-HR-JP (2017-12); 22.02.2020, 3 females, KT-HR-JP (2020-12).

Nannophya cf. ***pygmaea*** Rambur, 1842 – Kovács *et al.* 2016. – **Batanta Island**, Minlii lake, S00°47'51.62", E130°29'46.51", 17.02.2018, 1 male, KT-HR-JP (2018-6); 17.02.2019, 1 male, KT-HR-JP-KE (2019-16). – Valley of Waridor River, stagnant waters, between S00°50'30.34", E130°31'28.71" and S00°51'22.60", E130°31' 14.52", 23.02.2020, 1 male, KT-HR-JP (2020-13.b). – Wailebet, small stream, S00°54'00.56", E130°39'30.28", 11.02.2019, 3 males, KT-HR-JP-KE (2019-11.b); 17.02.2020, 2 males, KT-HR-JP-SK-SR (2020-9).

Nesoxenia mysis (Selys, 1878) – **Batanta Island**, Minlii lake, S00°47'51.62", E130°29' 46.51", 17.02.2019, 1 female, KT-HR-JP-KE (2019-16). – Valley of Waibin River, between S00°49'20.8", E130°45'56.9" and S00°49'50.9", E130°45'47.7", 18.02.2018, 1 female, KT-HR-JP (2018-7).

Neurothemis ramburii (Kaup, 1866) – Kovács *et al.* 2015*b*, 2016. – **Batanta Island**, valley of Wailebet Stream, between S00°53'37.74", E130°39'16.32" and S00°53'07.1", E130°38' 59.5", 17.02.2020, 1 female, KT-HR-JP-SK-SR (2020-9.b). – Valley of Waridor River, stagnant waters, between S00°50'30.34", E130°31'28.71" and S00°51'22.60", E130°31'14.52", 23.02.2020, 3 males, KT-HR-JP (2020-13.b). – Wailebet, S00°53'58.83", E130°39'30.95", 01.03.2017, 1 male, observed, KT-HR-JP-SK-SR.

Neurothemis stigmatizans (Fabricius, 1775) – Kovács *et al.* 2015*b*, 2016. – **Arefi Island**, Arefi, Mandur, S00°47'17.7", E130°42'20.0", 21.02. 2017, 1 male, KT (2017-9); 05.03.2017, 1 male, KT (2017-24); 10.02.2019, 1 female, KT-HR-JP-KE (2019-10). – **Batanta Island**, valley of Ron River, stagnant waters, S00°49'30.53", E130°49' 13.99", 19.02.2017, 1 female, KT-HR-JP (2017-4.b). – Valley of Tanjung Lampu River, S00° 54'24.03", E130°36'47.64", 27.02.2017, 1 female, KT-HR-JP-SK (2017-14); between S00°54'38.06", E130°36'50.17" and S00°54' 24.03", E130°36'47.64", 21.02.2018, 1 male, KT-HR-JP-SK-SR (2018-12.c). – Wailebet, small stream, S00°54'00.56", E130°39'30.28", 17.02. 2020, 2 males, KT-HR-JP-SK-SR (2020-9). – Yensawai, stagnant waters, S00°48'21.32", E130° 40'43.23", 12.02.2020, 1 male, observed, KT-HR-JP – **Birie Island**, Papua Paradise Eco Resort, marsh, S00°46'14", E130°44'51", 23.02.2018, 1 male, KT (2018-13).

Orthetrum serapia Watson, 1984 – Kovács *et al.* 2015*b*. – **Arefi Island**, Arefi, Mandur, S00° 47'17.7", E130°42'20.0", 21.02.2017, 1 male, KT (2017-9); 03.03.2018, 1 male and 1 female in copula, observed, KT (ODO-4); 21.02.2019, 1 male, observed, KT-JP (ODO-5); 11.02.2020, 1 male, KT-JP (2020-4). – **Batanta Island**, Minlii lake, S00°47'51.62", E130°29'46.51", 17.02. 2019, 1 male, observed, KT-HR-JP-KE (ODO-6). – Valley of Tanjung Lampu River, S00°54' 38.06", E130°36'50.17" and S00°54'24.03", E130°36'47.64", 21.02.2018, 1 male, KT-HR-JP-SK-SR (2018-12.c). – Wailebet, S00°54'02.43", E130°39'35.36", 27.02.2017, 1 male, KT-HR-JP-SK (2017-14.b); Wailebet, S00°53'58.83", E130°39'30.95", 01.03.2017, 1 female, KT-HR-JP-SK-SR (2017-18). – Wailebet, small stream, S00°54'00.56", E130°39'30.28", 17.02.2020, 1 male, KT-HR-JP-SK-SR (2020-9).

Orthetrum villosovittatum (Brauer, 1868) – Kovács *et al.* 2015*b*. – **Arefi Island**, Arefi, Mandur, S00°47'17.7", E130°42'20.0", 21.02. 2019, 1 male, observed, KT-JP (ODO-7).– **Batanta Island**, between valleys of Tanjung Lampu River and Kalijakut River, S00°54'38.06", E130°36'50.17" and S00°54'20.59", E130°38' 31.70", 13.02.2019, 1 male, KE (2019-13). – Valley of Forum River, S00°52'26.5", E130° 27'45.4", 22.02.2017, 1 male, KT-HR-JP (2017-10.a). – Valley of Kalisamsem River, S00°53' 46.07", E130°33'17.18", 28.02.2017, 2 males, KT-HR-JP-SK-SR (2017-16). – Valley of Ron River, stagnant waters, S00°49'30.53", E130° 49'13.99", 19.02.2017, 1 male, KT-HR-JP (2017-4.b). – Valley of Wailebet Stream, „dendrotelma", S00°53'22.00", E130°39'7.35", 19.02.2018, 1 male and 1 female in copula, observed, KT-HR-JP-SK-SR (ODO-8). – Valley of Waridor River, between S00°50'30.34", E130°31'28.71" and S00°51'22.60", E130°31'14.52", 14.02.2020, 2 males, KT-HR-JP (MM-2020-7). – Wailebet, small stream, S00°54'00.56", E130°39'30.28", 17.02.2020, 1 male, KT-HR-JP-SK-SR (2020-9).

Pantala flavescens (Fabricius, 1798) – **Arefi Island**, Arefi, Mandur, S00°47'17.7", E130°42' 20.0", 11.02.2020, 2 males, KT-JP (2020-4). – **Batanta Island**, Wailebet, small stream, S00° 54'00.56", E130°39'30.28", 17.02.2020, 1 male, observed, KT-HR-JP-SK-SR. – Yensawai, stagnant waters, S00°48'21.32", E130°40'43.23", 12. 02.2020, 1 male, KT-HR-JP (2020-5.b).

Protorthemis coronata (Kaup, 1866) – Kovács *et al.* 2015*b*. – **Batanta Island**, between valleys of Tanjung Lampu River and Kalijakut River, S00°54'38.06", E130°36'50.17" and S00°54' 20.59", E130°38'31.70", 13.02.2019, 1 male, KE (2019-13). – Valley of Forum River, S00°52' 26.5", E130°27'45.4", 23.02.2017, 1 male, 1 female, KT-HR-JP (2017-10.d). – Valley of Waibin River, between S00°49'20.8", E130°45' 56.9" and S00°49'50.9", E130°45'47.7", 18.02. 2018, 1 male, KT-HR-JP (2018-7). – Valley of Wailebet Stream, „dendrotelma", S00°53'22.00", E130°39'7.35", 19.02.2018, 1 male, KT-HR-JP-SK-SR (2018-8.c); valley of Wailebet Stream, between S00°53'37.74", E130°39'16.32" and S00°53'21.9", E130°39'06.5", 11.02.2019, 1 male, KT-HR-JP-KE (2019-11). – Valley of Warai Stream, S00°50'59.3", E130°35'18.0", 27.02. 2018, 1 male, observed, KT-HR-JP. – Wailebet, S00°53'58.83", E130°39'30.95", 01.03. 2017, 1 male, KT-HR-JP-SK-SR (2017-18).

Raphismia bispina (Hagen, 1867) – Kovács *et al.* 2015*b*, 2016. – **Arefi Island**, Arefi, Mandur, S00°47'17.7", E130°42'20.0", 20.02.2017, 1 male, KT-HR-JP (2017-7); 21.02.2017, 1 female, KT (2017-9); 03.03.2018, 1 male, observed, KT; 21.02.2019, 1 female, KT-JP (2019-20). – **Batanta Island**, Minlii lake, S00°47'51.62", E130°29' 46.51", 23.02.2017, 1 male, KT-HR-JP (2017-11); 06.03.2017, 2 males, KT-HR-JP (2017-26); 17.02.2019, 1 male, KT-HR-JP-KE (2019-16). – Valley of Ron River, stagnant waters, S00° 49'30.53", E130°49'13.99", 19.02. 2017, 1 male, KT-HR-JP (2017-4.b). – Valley of Waibin River, between S00°49'20.8", E130°45'56.9" and S00°50'01.9", E130°45'24.8", 10.02. 2020, 1 male, KT-HR-JP (2020-3); valley of Waibin River, stagnant waters, S00°49'20.8", E130° 45'56.9", 05.03.2017, 1 male, KT-HR-JP (2017-24.b). – Wailebet, Tanjung Karan, marsh, S00° 53'54.6", E130°40'18.1", 20.02.2018, 1 female, KT-HR-JP-SK-SR (2018-11). – **Birie Island**, Papua Paradise Eco Resort, marsh, S00°46'14", E130°44'51", 23.02.2018, 1 male, KT (2018-13).

Rhodothemis nigripes Lohmann, 1984 – **Arefi Island**, Arefi, Mandur, S00°47'17.7", E130°42' 20.0", 05.03.2017, 1 male, KT (2017-24); 10.02. 2019, 1 male, KT-HR-JP-KE (2019-10); 21.02. 2019, 1 male, observed KT-JP (ODO-9). – **Birie Island**, Papua Paradise Eco Resort, marsh, S00°46'14", E130°44'51", 17.02.2017, 2 males, 1 female, KT-HR-JP (2017-2); 26.02.2017, 1 male, KT (2017-13); 23.02.2018, 1 male, KT (2018-13); 05.03.2018, 1 male, KT (2018-22.a).

Rhyothemis phyllis (Sulzer, 1776) – Kovács *et al.* 2015*b*, 2016. – **Arefi Island**, Arefi, Mandur, S00°47'17.7", E130°42'20.0", 21.02.2017, 2 males, 1 female, KT (2017-9); 05.03.2017, 1 male, KT (2017-24); 03.03.2018, 1 male, observed, KT; 10.02.2019, 1 male, KT-HR-JP-KE (2019-10). – **Batanta Island**, Minlii lake, S00° 47'51.62", E130°29'46.51", 06.03.2017, 1 female, KT-HR-JP (2017-26); 17.02.2018, 1 male, KT-HR-JP (2018-6); 09.02.2020, 1 male, KT-HR-JP (2020-2). – Wailebet, small stream, S00°54' 00.56", E130°39'30.28", 17.02.2020, 1 male, KT-HR-JP-SK-SR (2020-9). – **Birie Island**, Papua Paradise Eco Resort, marsh, S00°46'14", E130° 44'51", 04.03.2017, 1 male, KT (2017-23); 23. 02.2018, 1 male, KT (2018-13).

Rhyothemis regia (Brauer, 1867) – **Batanta Island**, Minlii lake, S00°47'51.62", E130°29' 46.51", 23.02.2017, 2 males, 1 female, KT-HR-JP (2017-11); 06.03.2017, 2 males, KT-HR-JP (2017-26); 17.02.2018, 4 males, 1 female, KT-HR-JP (2018-6); 17.02.2019, 5 males, 2 females, KT-HR-JP-KE (2019-16); 09.02.2020, 2 males, KT-HR-JP (2020-2).

Rhyothemis resplendens Selys, 1878 – Kovács *et al.* 2016. – **Arefi Island**, Arefi, Mandur, S00°47'17.7", E130°42'20.0", 21.02.2017, 1 male, observed, KT; 21.02.2019, 1 male, observed KT-JP (ODO-10).

Rhyothemis rita Kovács & Theischinger, 2016 – Kovács *et al.* 2016.

Tetrathemis irregularis Brauer, 1868 – **Batanta Island**, valley of Waibin River, between S00°49'20.8", E130°45'56.9" and S00°50'01.9", E130°45'24.8", 10.02.2020, 1 male, KT-HR-JP (2020-3). – **Birie Island**, Papua Paradise Eco Resort, marsh, water hole, S00°46'16.4", E130°44' 50.4", 18.02.2017, 1 male, KT-HR-JP (2017-2.b).

Tramea eurybia Selys, 1878 – Kovács *et al.* 2015*b*. – **Arefi Island**, Arefi, Mandur, S00°47' 17.7", E130°42'20.0", 03.03.2018, 2 males, KT (2018-20); 21.02.2019, 1 male, KT-JP (2019-20).

Tramea transmarina propinqua Lieftinck, 1942 – **Arefi Island**, Arefi, Mandur, S00°47' 17.7", E130°42'20.0", 20.02.2017, 1 male, KT-HR-JP (2017-7); 21.02.2017, 2 males, KT (2017-9); 05.03.2017, 1 male, KT (2017-24); 03.03. 2018, 1 male, KT (2018-20); 21.02.2019, 1 male, observed KT-JP (ODO-11). – **Batanta Island**, Papua Paradise Eco Resort, marsh, S00°46'14", E130°44'51", 17.02.2017, 1 exuvium, KT-HR-JP (2017-2); 26.02.2017, 1 male, KT (2017-13); 04.03.2017, 1 male, 1 female, KT (2017-23).

Zyxomma multinervorum Carpenter, 1897 – **Batanta Island**, Dugong Homestay, marsh, S00° 48'22.95", E130°38'55.71", 17.02.2019, 1 male, KT-HR-JP-KE (2019-17). – Valley of Wailebet Stream, „dendrotelma", S00°53'22.00", E130°39' 7.35", 19.02.2018, 1 male, 1 female, KT-HR-JP-SK-SR (2018-8.c). – **Birie Island**, Papua Paradise Eco Resort, marsh, S00°46'14.9", E130°44'46.6", 03.03.2017, at dusk, 4 males, 1 female, KT-JP (2017-22.b).

DISCUSSION

Fifty-eight (24 Zygoptera and 34 Anisoptera) taxa of Odonata are reported here from Batanta Island (including Arefi and Birie Islands). One new species is described: *Argiolestes varga* sp. nov. The following ten species are new to the Raja Ampat Islands: *Papuagrion magnanimum* Selys, 1876, *Gynacantha rosenbergi* Kaup, 1867, *Palaeosynthemis* cf. *cervula* (Lieftinck, 1938), *Diplacina smaragdina* Selys, 1878, *Nannophlebia amphicyllis* Lieftinck, 1933, *Pantala flavescens* (Fabricius, 1798), *Rhodothemis nigripes* Lohmann, 1984, *Rhyothemis regia* (Brauer, 1867), *Tramea transmarina propinqua* Lieftinck, 1942, *Zyxomma multinervorum* Carpenter, 1897, and fifteen are new to Batanta: *Selysioneura cornelia* Lieftinck, 1953, *P. magnanimum*, *Agyrtacantha dirupta* (Karsch, 1889), *Anax maclachlani* Förster, 1898, *G. rosenbergi*, *P.* cf. *cervula*, *D. smaragdina*, *N. amphicyllis*, *Nesoxenia mysis* (Selys, 1878), *P. flavescens*, *R. nigripes*, *R. regia*, *Tetrathemis irregularis* Brauer, 1868, *T. transmarina propinqua*, *Z. multinervorum* (Kalkman &

Orr 2013, Kovács *et al.* 2015*b*, 2016, Orr & Kalkman 2015, Theischinger & Kalkman 2014*a*,*b*, Theischinger & Richards 2015).

Metagrion postnodale (Selys, 1878) and *Selysioneura* cf. *cervicornu* Förster, 1900 are deleted from the fauna lists of Odonata of Raja Ampat and Batanta Island (misidentification). The number of species known to occur on Batanta Island is 62.

Six new species have been described from this island so far: *Drepanosticta batanta* Kovács & Theischinger, 2015, *Palaiargia susannae* Kovács & Theischinger, 2015, *Diplacina olahi* Theischinger & Kovács, 2015 (Holotype: male; unique), *Nososticta dora* Kovács & Theischinger, 2016, *Rhyothemis rita* Kovács & Theischinger, 2016 (Holotype: female; unique), *Argiolestes varga* sp. nov. Kovács & Theischinger. The taxonomic status of *Metagrion* sp. has not yet been clarified.

Additionally, in the collected material there are an undescribed *Selysioneura* species and the undescribed female and larva of *D. batanta*; two subadult *Palaiargia* males and subadult and adult *Teinobasis* females cannot be identified. The collected specimens of *Idiocnemis bidentata* also differ from the typical specimens (Gassmann 2000), and on *Palaeosynthemis* cf. *cervula* further study is required. From the known 62 species occurring on Batanta Island larvae and/or exuviae of 12 species were published and further more than 10 species await publication. Probably, the number of species will be found to be higher, if we can collect on 400 m a.s.l. However, due to the difficulty of the terrain this has not yet happened.

Acknowledgements – Special thanks to Ádám Kiss (Mátra Museum of the Hungarian Natural History Museum, Gyöngyös) for his professional support and technical help. Our sincere thanks to Albert G. Orr (Griffith School of the Environment, Griffith University, Nathan) for confirming some identifications; to Előd Kondorosy (University of Pannonia, Georgikon Faculty, Keszthely) for helping us in the field. We are especially grateful to Kristian Sauyai and Ronnius Sauyai (both from Wailebet, Batanta), our local helpers; to the Papua Paradise Eco Resort (Birie Island) for providing us the base camp and helping in organisation of our field trips and for the two anonymous reviewers for their valuable comments. Our study was carried out in compliance with the Memorandum of Understanding signed by the Research Center for Biology, Indonesian Institute of Sciences and the Hungarian Natural History Museum, on 9 April and 13 May 2014 as well as in the previous papers (Kovács *et al.* 2015*a*,*b*, 2016).

REFERENCES

GASSMANN, D. (2000): Revision of the Papuan *Idiocnemis bidentata*-group (Odonata: Platycnemididae). *Zoölogische Mededelingen, Leiden*, 74(23): 375–402.

HÄMÄLÄINEN, M. & ORR, A.G. (2016): Wilhelm Stüber (1877–1942) collector extraordinaire of New Guinean dragonflies, discoverer of the fabulous Sepik blue orchid, tragic victim of war. *Agrion*, 20(2): 68–88.

KALKMAN, V.J. & ORR, A.G. (2013): Field Guide to the Damselflies of New Guinea. *Brachytron 16 Supplement*: 3–119.

KALKMAN, V.J. & THEISCHINGER, G. (2013): Generic revision of Agriolestidae (Odonata), with four new genera. *International Journal of Odonatology*, 16(1): 1–52. doi: 10.1080/13887890.2012.749450

KALKMAN, V.J., RICHARDS, S.J. & POLHEMUS, D.A. (2010): Three new species of *Argiolestes*, with a key to the males of *Argiolestes* s. str. (Odonata: Megapodagrionidae). *International Journal of Odonatology*, 13(1): 75–88. doi: 10.1080/13887890.2010.9748361

KALNIŅŠ, M. (2014): *Argiolestes zane* sp. nov. from New Guinea (Odonata: Argiolestidae). In: TELNOV, D. (Ed.) *Biodiversity, biogeography and nature conservation in Wallacea and New Guinea, II.* The Entomological Society of Latvia, Rīga, p. 221–224, pls. 31–34.

KALNIŅŠ, M. (2017): *Argiolestes spungisi* sp. nov. (Odonata: Argiolestidae) from New Guinea. In: TELNOV, D., BARCLAY, M.V.L. & PAUWELS, O.S.G. (Eds.) *Biodiversity, biogeography and nature conservation in Wallacea and New Guinea, III.* The Entomological Society of Latvia, Rīga, p. 357–362, pls. 52–55.

KOVÁCS, T., HORVÁTH, R. & JUHÁSZ, P. (2015*a*): Szitakötők és tegzesek (Insecta: Odonata, Trichoptera) kutatása Batanta szigeten (Indonézia, Nyugat-Pápua). Study of dragonflies and caddisflies (Insecta:

Odonata, Trichoptera) on Batanta Island (Indonesia, West Papua). *Annales Musei historico-naturalis hungarici*, 107: 269–288.

KOVÁCS, T., THEISCHINGER, G. & DANYIK, T. (2016): Odonata from Batanta (Indonesia, West Papua) with description of two new species. *Folia historico-naturalia Musei Matraensis*, 40: 27–37.

KOVÁCS, T., THEISCHINGER, G., JUHÁSZ, P. & DANYIK, T. (2015*b*): Odonata from Batanta (Indonesia, West Papua) with description of three new species. *Folia historico-naturalia Musei Matraensis*, 39: 17–29.

LIEFTINCK, M.A. (1935): The dragonflies (Odonata) of New Guinea and neighbouring islands. Part III. Descriptions of new and little known species of the families Megapodagrionidae, Agrionidae and Libellulidae (Genera *Podopteryx*, *Argioestes*, *Papagrion*, *Teinobasis*, *Huonia*, *Synthemis*, and *Procordulia*). *Nova Guinea*, 17: 203–300.

LIEFTINCK, M.A. (1956): Revision of the genus *Argiolestes* Selys (Odonata) in New Guinea and the Moluccas, with notes on the larval forms of the family Megapodagrionidae. *Nova Guinea (N.S.)*, 7: 59–121.

ORR, A.G. & KALKMAN, V.J. (2015): Field Guide to the Dragonflies of New Guinea. *Brachytron 17 Supplement*: 3–155.

RIS, F. (1913): Die Odonata von Dr. H. A. Lorentz' Expedition nach Südwest-Neu-Guinea 1909 und einige Odonata von Waigëu. *Nova Guinea*, 9(3): 471–512.

THEISCHINGER, G. & RICHARDS, S.J. (2015): The genus *Nososticta* Hagen (Odonata: Platycnemididae) from the Papuan region with descriptions of ten new species group taxa. *Odonatologica*, 44(1/2): 153–224.

THEISCHINGER G. & KALKMAN V.J. (2014*a*): *Nososticta rufipes* sp. nov. from Misool, with notes on the other *Nososticta* species on the Bird's Head Peninsula and the Raja Ampat, Indonesia (Zygoptera: Platycnemididae). *International Journal of Odonatology*, 17 (4): 217–222.
doi: 10.1080/13887890.2014.975762

THEISCHINGER G. & KALKMAN V.J. (2014*b*): The genus *Teinobasis* on the Bird's Head Peninsula and the Raja Ampat Islands, Indonesia (Odonata: Coenagrionidae). *Odonatologica*, 43(3/4): 143–168.

Opusc. Zool. Budapest, 2021, 52(2): 141–147

Description of a new *Eumenescolex* species (Clitellata: Megadrili, Lumbricidae) with new data to the earthworm fauna of Corsica and Sardinia

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Abstract. Earthworm collectings on Corsica and Sardinia resulted in recording eight species belonging to the families Lumbricidae and Hormogastridae. Among them, *Octodrilus transpadanus* represents a new record for the fauna of Sardinia and *Eumenescolex zoltani* sp. nov. from Corsica is new to science.

Keywords. Earthworms, Lumbricidae, new species, new records, Corsica, Sardinia

INTRODUCTION

Sardinia is the second (24,090 km^2) and Corsica is the fourth (8,680 km²) largest island of the Mediterranean Sea. Research on the earthworm fauna of these islands dates back to the beginning of the 20th century and continued till recently. Records were published by Rosa (1893), Cognetti (1901), Chinaglia (1913), Omodeo (1954, 1984) and Rota (1992) on Sardinia and by Michaelsen (1926), Černosvitov (1942), Pop (1947), Bouché (1970, 1972) and Qiu & Bouché (1998a, 1998b) on Corsica. There are also some data in the comprehensive works of Michaelsen (1903) and Omodeo (1961).

The distribution of autochthonous earthworm species is highly affected by paleogeographic events (Omodeo 2000, James 2004, Omodeo & Rota 2008, Stojanović *et al.* 2020). The Sardo-Corsican system has a complex geohistory (Andeweg 2002, Meulenkamp & Sissingh 2003, Omodeo & Rota 2008). During the late Eocene (*ca*. 36 Mya), the Sardo-Corsican block was in connection with the Pyrenees. In the late Oligocene (*ca*. 27 Mya), the two later islands formed an independent microplate. Sardinia was disconnected from the Pyrenees, while Corsica was in contact with Provence and the Alpine region. At the beginning of the Miocene (*ca*. 24 Mya), Corsica still had its land connections and Sardinia was attached to Corsica with its northeastern part, while its southwestern part was isolated. Around 20–18 Mya, this microplate collided with the Apulian microplate and remained connected till the Tortonian (*ca*. 9 Mya) (Salvo *et al.* 2010). The Messinian salinity crisis (5.9–5.3 Mya) was the next period that gave the opportunity for fauna exchanges through establishing new land connections. During the Pleistocene Ice Age, due to the repeating decrease of the sea level, Corsica and Sardinia were again connected to the Italian peninsula and probably also to Provence, which could have opened migration corridors as well.

This geotectonic complexity is well-reflected by the distribution of the different earthworm taxa inhabiting the islands (Bouché 1983, Omodeo & Rota 1987, 2008). According to Omodeo & Rota (2008), the autochthonous fauna is originated mostly from Catalonia, and in a smaller part from Provence. The islands' most characteristic earthworm genera from the family Lumbricidae are *Eumenescolex*, *Diporodrilus*, *Prosellodrilus* and

urn: lsid:zoobank.org:pub:E2388462-EAE5-4C94-BFD8-D9F7AB29BBC9 *published: 02 August 2021*
HU ISSN 2063-1588 (online) *https://doi.org/10.18348/opzool.2021.2.141*

Scherotheca. The genus *Eumenescolex* has seven species and subspecies, of which two (*Eum. heideti* Qiu & Bouché, 1998 and *Eum. emiliae* Qiu & Bouché, 1998) live in Corsica, while *Eum. gabriellae gabriellae* (Omodeo, 1984) and *Eum. g. gallurae* (Omodeo, 1984) are distributed in Sardinia. The six species and subspecies of *Diporodrilus* are restricted to Corsica (*Di. pilosus pilosus* Bouché, 1970, *Di. p. minimus* Bouché, 1970, *Di. omodeoi omodeoi* Bouché, 1970, *Di. o. postheca* Bouché, 1970) and Sardinia (*Di. bouchei* Omodeo, 1984, *Di.* sp. and *Di. pilosus*). Most species of *Prosellodrilus* are found in Catalonia and the Pyrenees. *Pr. festae* (Rosa, 1892) was originally described from the surroundings of Tunis and was later recorded from Sardinia (Omodeo 1954). Omodeo & Rota (2008) also reported the presence of a still undescribed *Prosellodrilus* species from the island. The genus *Scherotheca* has several species distributed from the Pyrenees to the Western Alps. The subgenus *Sche.* (*Corsicadrilus*) and subspecies *Sche.* (*Rosanus*) *dugesi brevisella* Bouché, 1972 are endemic to Corsica.

The Western Mediterranean family Hormogastridae is represented with three species belonging to two genera (Omodeo & Rota 2008, Marchán *et al.* 2018). *Hormogaster redii* Rosa, 1887 is the most widespread species found on both islands and also on the continent from Tuscany to the island of Sicily. *H. samnitica* Cognetti, 1914 is distributed on Corsica, Northern Sardinia and in the northern part of the Italian peninsula. *Norana pretiosa* (Michaelsen, 1899) is endemic to Sardinia.

A recently elaborated earthworm material collected on Corsica and Sardinia in 1974 and 2006 resulted in recording eight species from the family Lumbricidae and Hormogastridae, including a new fauna record for Sardinia and an *Eumenescolex* species new to science from Corsica.

MATERIAL AND METHODS

Earthworms were collected by digging and hand-sampling. The specimens were killed in 75% ethanol and preserved in 75% ethanol or 4% formaldehyde solution, and deposited in the earthworm collection of the Hungarian Natural History Museum (HNHM).

The collecting localities are shown on Figure 1, the locality numbers are indicated with italics in the text. We don’t have exact locality data for *Norana pretiosa* (Michaelsen, 1899) therefore it is not indicated on the map.

Figure 1. Collection sites in Corsica and Sardinia. Numbers refer to the locality numbers in the text.

RESULTS

Family Lumbricidae Rafinesque-Schmaltz, 1815

Aporrectodea caliginosa (Savigny, 1826)

Enterion caliginosum Savigny, 1826: 180.
Allolobophora caliginosa: Omodeo 1984: 116. Omodeo & Rota 1987: 202.
Nicodrilus caliginosus: Rota 1992: 1385.
Aporrectodea caliginosa caliginosa: Csuzdi 2012.

Material examined. HNHM/17630 2 ex., *No. 8.* Italy, Sardinia, along Flumendosa river after San Vito in direction to mountains, N39°29', E09°27', 08.10.2006, leg. T. Pavlíček. HNHM/17632 2 ex., *No. 4.* Italy, Sardinia, near a small river from Lago Alto del Flumendosa, N39°55', E09°27', 08.10.2006, leg. T. Pavlíček.

Aporrectodea rosea (Savigny, 1826)

Enterion roseum Savigny, 1826: 182.
Eisenia rosea f. *bimastoides*: Cognetti, 1901: 17.
Helodrilus (*Eisenia*) *roseus* f. *typicus*: Chinaglia 1913: 2.
Helodrilus (*Eisenia*) *roseus* f. *bimastoides*: Chinaglia 1913: 2.
Allolobophora rosea f. *bimastoides*: Omodeo 1954: 6.
Allolobophora rosea: Omodeo 1984: 116. Omodeo & Rota 1987: 202. Rota 1992: 1385.
Aporrectodea rosea: Csuzdi 2012.

Material examined. HNHM/17629 1 ex., *No. 7.* Italy, Sardinia, near a small river between S. Basilio and Silius, N39°31' E09°17', 08.10.2006, leg. T. Pavlíček.

Dendrobaena pantaleonis (Chinaglia, 1913)

Helodrilus (*Bimastus*) *pantaleonis* Chinaglia, 1913: 5.
Bimastus (?) *pantaleonis*: Omodeo 1954: 4.
Dendrobaena pantaleonis: Omodeo 1984: 116. Omodeo & Rota 1987: 202.

Material examined. HNHM/17633 1 ex., *No. 4.* Italy, Sardinia, near a small river from Lago Alto del Flumendosa, N39°55' E09°27', 08.10. 2006, leg. T. Pavlíček.

Eiseniella tetraedra (Savigny, 1826)

Enterion tetraedrum Savigny, 1826: 184.
Eiseniella tetraedra subsp. *typica*: Cognetti 1901: 17.
Helodrilus (*Eiseniella*) *tetraedrus typicus*: Chinaglia 1913: 2.
Allolobophora (*Eiseniella*) *tetraedra* f. *typica*: Michaelsen 1926: 1.
Eiseniella tetraedra f. *typica*: Černosvitov 1942: 219. Pop 1947: 11.
Eiseniella tetraedra: Omodeo 1954: 6; 1984: 116. Omodeo & Rota 1987: 203. Rota 1992: 1385.

Material examined. HNHM/17628 1 ex., *No. 6.* Italy, Sardinia, 3 km from Esterzili, N39°45' E09°17', 09.10.2006, leg. T. Pavlíček. HNHM/ 17642 1 ex., *No. 1.* France, Corsica, E of Evisa, spring outlet at the Corte-Ajaccio crossroad (roads D84-D70), N42.253370°, E8.820180°, 938 m, 04.05.2006, leg. Z. Barina.

Eumenescolex zoltani sp. nov.

(Figure 2)

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Holotype. HNHM/17639 *No. 3.* France, Corsica, NE slope of Mt. Punta Bacinello, stream Sce de Pizzolo, N42.071740°, E9.143020°, 1882 m, 05.05.2006, leg. Z. Barina. *Paratypes*. HNHM/ 17640 1 ex., locality and date same as that of the Holotype. HNHM/17641 1 ex., *No. 2.* France, Corsica, Domaniale de Valdu Niellu, tributary of the Golo River along the road D84, N42.292080° E8.888240°, 1330 m, 05.04.2006, leg. Z. Barina.

Diagnosis. Length 65–110 mm, diameter 5–6 mm, setae closely paired. Colour pale. First dorsal pore in 10/11. Clitellum on (23) 24–35, tubercles on ½27–½33. Male pores on 15, surrounded by glandular crescents. Nephridial pores irregularly alternate between *b* and above *d*. Two pairs of vesicles in 11, 12. Spermathecae two pairs in 12/13, 13/14, open in *cd*. Calciferous diverticula in 10. Nephridial bladders J-shaped, reclinate.

External characters. Holotype 65 mm long and 5 mm wide, tail truncated. Number of segments 129. Paratypes 80–110 mm long and 5–6 mm wide. Number of segments 189–205. Secondary annulations between segments 10–24. Colour pale, pigmentation lacking. Prostomium epilobous, 1/3 closed. First dorsal pore at intersegmental furrow 10/11. Setae closely paired, setal arrangement behind clitellum: *aa*:*ab*:*bc*:*cd*: *dd* = 10:1.5:7:1:30. Male pores on segment 15, surrounded by glandular crescents, protruding into the neighbouring segments. Nephridial pores irregularly alternate between setal line *b* and above *d*. Clitellum on (23) 24–35. Tubercula pubertatis on ½27–½33. Glandular tumescences on 14, 15, 16, 27, 34, 35 *ab*.

Internal characters. Septa 5/6–6/7 thickened, 7/8–9/10 strongly strengthened. Testes and funnels paired in 10–11. Two pairs of seminal vesicles in 11 and 12. Spermathecae two pairs in 12/13, 13/14 with external openings near setal line *cd*. The left spermatheca in 13/14 of the Holotype doubled, the others single. Calciferous glands in 10–14, with lateral diverticula in 10. Last pair of hearts in 11, with a pair of extraoesophageal vessel in 12. Nephridial bladders J-shaped, reclinate. Crop in 15–16, gizzard in 17–18. Typhlosolis large, simple, lamelliform. Longitudinal musculature of intermediate type.

Etymology. The new species is dedicated to the collector and our colleague, Dr. Zoltán Barina.

Remarks. *Eum. zoltani* sp. nov. differs well from the other *Eumenescolex* species in the position of the clitellum and especially in its long tubercles. Their main characters are summarized in Table 1.

Qiu & Bouché (1998a) listed all *Eumenescolex* species as having nephridial pores aligned near setal line *b* except *Eum. simplex* (Zicsi, 1981), from which they didn't have exact data. Investigation of the type specimens of *Eum. simplex* revealed that this species has irregularly alternating nephridial pores, just like *Eum. zoltani* sp. nov. Therefore, it would be worthwhile to reinvestigate all the other *Eumenescolex* species from this point of view.

Octodrilus transpadanus (Rosa, 1884)

Allolobophora transpadana Rosa, 1884: 45.
Octodrilus transpadanus: Csuzdi 2012.

Material examined. HNHM/17631 1 ex., *No. 8*. Italy, Sardinia, along Flumendosa river after San Vito in direction to mountains, N39°29' E09°27', 08.10.2006, leg. T. Pavlíček.

Remark. This is the first data of the Trans-Aegean *Oc. transpadanus* from Sardinia.

Family Hormogastridae Michaelsen, 1900

Hormogaster redii Rosa, 1887

Hormogaster redii Rosa, 1887: 1. Cognetti 1901: 16. Michaelsen 1903: 134. Chinaglia 1913: 2. Omodeo 1954: 6; 1984: 116. Omodeo & Rota 1987: 202. Rota 1992: 1385.

Material examined. HNHM/AF5756 1 ex., *No. 4*. Italy, Sardinia, mountains near Lago Alto del Flumendosa, N39°55' E09°27', 08.10.2006, leg. T. Pavlíček. HNHM/AF5757 1 ex., *No. 5*. Italy,

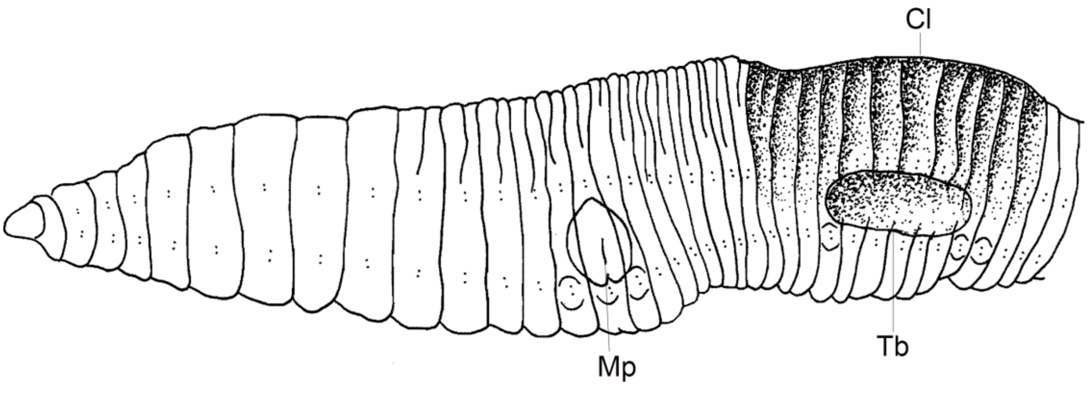

Figure 2. *Eumenescolex zoltani* sp. nov. Lateral view of the fore body. Cl = Clitellum, Mp = Male pore, Tb = Tubercles.

Table 1. Main distinguishing characters of the *Eumenescolex* species.

Taxon	**Length x width (mm)**	**Segment No.**	**Clitellum**	**Tubercles**	**Vesicles**	**Spermathecae**
Eum. zoltani sp. nov.	65–110 x 5–6	129–205	(23) 24–35	½27–½33	11, 12	12/13, 13/14 *cd*
Eum. heideti Qiu & Bouché, 1998	37–40 x 1.5–2.5	130–131	(25) 26–33	29–30 (1/3 31)	9–12	13/14 *c*
Eum. gabriellae gabriellae (Omodeo, 1984)	40–70 x 2.1–3.5	99–159	(21) 22–30, 31 (1/n 32)	(23) 25–27 (28)	9, 11, 12	13/14 *c*
Eum. gabriellae gallurae (Omodeo, 1984)	-	-	24–34	27–30 (31)	9, 11, 12	13/14 *c*
Eum. pereli (Bouché, 1972)	40–80 x 2.5–5	105–206	23–30	(3/4 25) 26–28 (1/4 29)	11, 12	12/13, 13/14 *c*
Eum. emiliae Qiu & Bouché, 1998	93–105 x 2–3	156–161	26–33	(1/n 28) 29–32 (33)	11, 12	12/13, 13/14 *c*
Eum. simplex (Zicsi, 1981)	105–112 x 5–7	99–154	26–1/2 36	29–1/2 33	9–12	13/14 *c*
Eum. proclitellatus Perez-Onteniente & Rodriguez-Babio, 2004	31–46 x 2.1–2.8	119–137	23–34	1/2 28, 29–32	?	11/12–13/14 *c*

Sardinia, 2 km to Sadali near the road from Esterzili, N39°47’ E09°15’, 09.10.2006, leg. T. Pavlíček. HNHM/AF5758 1 ex., *No. 9.* Italy, Sardinia, oak forest near Burcei, N39°21’ E09°18’, 08.10.2006, leg. T. Pavlíček.

Norana pretiosa (Michaelsen, 1899)

Hormogaster praetiosa Michaelsen, 1899: 445.
Hormogaster pretiosa: Cognetti 1901: 17. Omodeo 1954: 6; 1984: 116. Omodeo & Rota 1987: 202.
Nora pretiosa: Marchán *et al.* 2018a: 667.
Norana pretiosa: Marchán *et al.* 2018b: 89.

Material examined. HNHM/AF3376 4 ex., Italy, Sardinia, 24.10.1974, leg. L. Gozmány.

DISCUSSION

The newly elaborated earthworm material from Corsica and Sardinia resulted in recording six species from the family Lumbricidae and two from Hormogastridae. Among them, *Ap. caliginosa*, *Ap. rosea* and *Eis. tetraedra* are introduced peregrine species. *D. pantaleonis* was originally described from Sardinia but was later recorded from Albania, Greece, Turkey (Szederjesi 2018) and Cyprus (Pavlíček & Csuzdi 2016).

Omodeo & Rota (2008) stated that the genus *Octodrilus* is missing from Sardinia however, Michaelsen (1903) reported the presence of the Circum-Mediterranean *Oc. complanatus* (Dugès, 1828) from the island. Omodeo (1954) mentioned this literature record; however during his many sampling campaigns in Sardinia he never recovered this well-known species, which led him to the conclusion that Michaelsen’s record was a misprint or a misidentification. Now the recent collectings showed that the widely distributed Trans-Aegean *Oc. transpadanus* is present on Sardinia, as well.

The new species *Eum. zoltani* sp. nov. differs well morphologically from the other *Eumenescolex* species. The specimens were found on two localities in the central part of Corsica, while the other two Corsican *Eumenescolex* species (*Eum. heideti* and *Eum. emiliae*) occur in the southern part of the island.

According to Qiu & Bouché (1998c), the genus *Eumenescolex* is morphologically relatively diverse. The species' common characteristics are the absence of pigmentation, the similarity in the position of their clitellar organs and their small or middle sized body dimensions. However, there are differences in the number and position of the spermathecae, the number of vesicles and in the position of the nephridial pores.

The Corsican endemic subgenus *Scherotheca* (*Corsicadrilus*) shares some similarity with *Eumenescolex*, but their brownish or greyish pigmentation, the position of their clitellar organs, their commonality in the number of vesicles (four pairs in each species) and the number, position and the possible duplication of their spermathecae prove that they stand close to the other *Scherotheca* species.

Acknowledgement – We are grateful to all collectors of the material.

REFERENCES

ANDEWEG, B. (2002): *Cenozoic Tectonic Evolution of the Iberian Peninsula, Causes and Effects of Changing Stress Fields.* Ph.D. thesis. Vrije Universiteit Amsterdam, Amsterdam, 178 pp.

BOUCHÉ, M.B. (1970): Remarques sur quelques Lumbricina de France et consequences de la découverte des nouveaux taxons Vignysinae (Subfam. nov.) et Diporodrilidae (Fam. nov.). *Pedobiologia*, 10: 246–256.

BOUCHÉ, M.B. (1972): *Lombriciens de France: Écologie et systematique.* Annales de Zoologie-Écologie Animale, numero hors-série, INRA, Paris, pp. 671.

BOUCHÉ, M.B. (1983): *The establishment of earthworm communities.* In: SATCHELL, J.E. (Ed.): Earthworm Ecology. From Darwin to vermiculture. Chapman and Hall, London, New York, p. 431–448. doi: 10.1007/978-94-009-5965-1_38

CHINAGLIA, L. (1913): Escursioni Zoologiche in Sardegna del dr. Enrico Festa. III. Lombrichi. *Bollettino Musei di Zoologia ed Anatomia comparata della R. Università di Torino*, 28(667): 1–6.

COGNETTI, L. (1901): Gli Oligocheti della Sardegna. *Bollettino Musei di Zoologia ed Anatomia comparata della R. Università di Torino*, 16(404): 1–26.

ČERNOSVITOV, L. (1942): Oligochaeta from various parts of the world. *Proceedings of the Zoological Society of London*, 111: 197–236. doi: 10.1111/j.1469-7998.1942.tb00050.x

CSUZDI, Cs. (2012): Earthworm species, a searchable database. *Opuscula Zoologica Budapest*, 43(1): 97–99. doi: 10.5281/zenodo.1045525

JAMES, S.W. (2004): *Planetary processes and their interactions with earthworm distributions and ecology.* In: EDWARDS, C.E. (Ed.): Earthworm Ecology. CRC Press, Boca Raton, pp. 53–62. doi: 10.1201/9781420039719.pt2

MARCHÁN, D.F., FERNÁNDEZ, R., DE SOSA, I., SÁNCHEZ, N., DÍAZ COSÍN, D.J. & NOVO, M. (2018a): Integrative systematic revision of a Mediterranean earthworm family: Hormogastridae (Annelida, Oligochaeta). *Invertebrate Systematics*, 32: 652–671. doi: 10.1071/IS17048

MARCHÁN, D.F., FERNÁNDEZ, R., SÁNCHEZ, N., DE SOSA, I., DÍAZ COSÍN, D.J. & NOVO, M. (2018b): Insights into the diversity of Hormogastridae (Annelida, Oligochaeta) with descriptions of six new species. *Zootaxa*, 4496(1): 065–095. doi: 10.11646/zootaxa.4496.1.6

MEULENKAMP, J.E. & SISSINGH, W. (2003): Tertiary palaeogeography and tectonostratigraphic evolution of the Northern and Southern Peri-Tethys platforms and the intermediate domains of the African–Eurasian convergent plate boundary zone. *Palaegeography, Palaeoclimatology and Palaeoecology*, 196: 209–228. doi: 10.1016/S0031-0182(03)00319-5

MICHAELSEN, W. (1903): *Die geographische Verbreitung der Oligochaeten.* Friedlander & Sohn, Berlin. doi: 10.5962/bhl.title.11667

MICHAELSEN, W. (1926): Beiträge zur Kenntnis der Land-und Süsswasserfauna Korsikas. 3. Lumbriciden. *Mitteilungen aus dem Museum für Naturkunde in Berlin*, 12: 223–227.

OMODEO, P. (1954): Problemi faunistici riguardanti gli Oligocheti terricoli della Sardegna. *Atti della Società Toscana di Scienze Naturali*, 61: 3–15.

OMODEO, P. (1961): Le peuplement des grandes iles de la Méditerranée par les Oligochètes terricoles. *Colloques Internationaux du Centre National de la Recherche Scientifique*, 94: 128–133.

OMODEO, P. (1984): The earthworm fauna of Sardinia. *Revue d'Écologie et Biologie du Sol*, 21: 115–126.

OMODEO, P. (2000): Evolution and biogeography of megadriles (Annelida, Clitellata). *Italian Journal of Zoology*, 67: 179–201. doi: 10.1080/11250000009356313

OMODEO, P. & Rota, E. (1987): Caractères originaux des peuplements des îles tyrrhéniennes en Oligochètes terricoles. *Bulletin de la Société Zoologique de France*, 112(1–2): 197–214.

OMODEO, P. & ROTA, E. (2008): Earthworm Diversity and Land Evolution in Three Mediterranean Districts. *Proceedings of the California Academy of Sciences, Fourth Series*, 59(suppl. 1): 65–83.

PAVLÍČEK, T. & CSUZDI, Cs. (2016): *Clitellata: Oligochaeta*. In: SPARROW, D.J. & JOHN, E. (Eds.) An introduction to the wildlife of Cyprus. Terra Cypria, Lefkosia, Cyprus, pp. 587–599.

POP, V. (1947): Lombriciens de la Corse. *Archives de Zoologie Expérimentale et Générale*, 85(1): 1–18.

QIU, J-P. & BOUCHÉ, M. (1998a): *Eumenescolex*, nouveau genre de Lumbricidae (Annelida: Oligochaeta). *Documents pédozoologiques et intégrologiques*, 4: 3–7.

QIU, J-P. & BOUCHÉ, M. (1998b): Révision morphologique, chorologique et taxonomique du genre *Scherotheca* Bouché, 1972 (Oligochaeta: Lumbricidae). *Documents pédozoologiques et intégrologiques*, 4: 117–139.

QIU, J-P. & BOUCHÉ, M. (1998c): Révision des taxons supraspécifiques de Lumbricoidea. *Documents pédozoologiques et intégrologiques*, 3: 179–224.

ROSA, D. (1884): *Lumbricidi del Piemonte*. Stamperia dell'Unione Tipografico-Editrice, Torino, pp. 54.

ROSA, D. (1887): *Hormogaster redii* n. g., n. sp. *Bollettino dei Musei di Zoologia ed Anatomia comparata della R. Universitá di Torino*, 32(2): 1–2.

ROSA, D. (1893): Revisione dei Lumbricidi. *Memorie dell'Accademia delle Scienze di Torino*, 43: 339–476.

ROTA, E. (1992): New data on the earthworm fauna of Gallura (Northeast Sardinia). *Soil Biology and Biochemistry*, 24(12): 1383–1388. doi: 10.1016/0038-0717(92)90122-E

SALVO, G., HO, S.Y.W., ROSENBAUM, G., REE, R. & CONTI, E. (2010): Tracing the Temporal and Spatial Origins of Island Endemics in the Mediterranean Region: A Case Study from the *Citrus* Family (*Ruta* L., Rutaceae). *Systematic Biology*, 59(6): 705–722. doi: 10.1093/sysbio/syq046

SAVIGNY, J.C. (1826): In: G. Cuvier: Analyse des Travaux de l'Academie royale des Sciences, pendant l'année 1821, partie physique. *Mémoires de l'Académie des Sciences de l'Institut de France Paris*, 5: 176–184.

STOJANOVIĆ, M., TSEKOVA, R., TRAKIĆ, T. & SEKULIĆ, J. (2020): On the presence of the endemic earthworm *Dendrobaena rhodopensis* (Černosvitov, 1937) in the Balkan Peninsula: biogeographical consideration and conservation status. *North-Western Journal of Zoology*, 16(1): 59–63.

SZEDERJESI, T. (2018): The first combined checklist of earthworms of the Northeastern Mediterranean region (Clitellata: Megadrili). *Opuscula Zoologica Budapest*, 48(2): 77–116. doi: 10.18348/opzool.2017.2.77

Opusc. Zool. Budapest, 2021, 52(2): 149–163

A new species of *Nemoura* (Plecoptera, Nemouridae) from the Abruzzo region (Central Italian Apennines)

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Riassunto. Una nuova specie di *Nemoura* Latreille, 1796, *N. aprutiana* n. sp., dell'Italia centrale, (Appennino Abruzzese), è descritta e illustrata, mettendo in risalto i caratteri morfologici che la differenziano dalle tre specie sorelle italiane *N. hesperiae* Consiglio, 1960, *N. lucana* Nicolai & Fochetti, 1991 e *N. palliventris* Aubert, 1953. Sono inoltre fornite notizie sulla distribuzione e sulle preferenze ecologiche di questa nuova specie e una carta di distribuzione nella Regione Italica delle quattro specie sorelle.

Abstract. A new species of *Nemoura* Latreille, 1796, *N. aprutiana* sp. n., from the Italian Abruzzo region in the central part of the Apennines, is described and illustrated, and compared to its three Italian sister species *N. hesperiae* Consiglio, 1960, *N. lucana* Nicolai & Fochetti, 1991 and *N. palliventris* Aubert, 1953. Information on the distribution and ecological preferences of this new species is also provided, as well as a distribution map of the four Italian sister species.

Keywords. stoneflies, Italy, *Nemoura aprutiana* sp. n., *N. hesperiae, N. lucana, N. palliventris.*

INTRODUCTION

Intensive collecting of Plecoptera conducted in the Italian Alps and Apennines in 2020 and 2021 by the first author (Vinçon, Reding & Ravizza 2021, Vinçon, Ravizza & Reding 2022) has resulted in the discovery of a new *Nemoura* species, *Nemoura aprutiana* sp. nov. described in this contribution and compared to three other morphologically close Italian species: *N. hesperiae* Consiglio, 1960, *N. lucana* Nicolai & Fochetti, 1991 and *N. palliventris* Aubert, 1953. This group of four species is also related to three Balkanic species: *N. flaviscapa* Aubert, 1956a, *N. vinconi* Murányi, 2007 and *N. zwicki* Sivec, 1980, and to one Alpine species *N. obtusa* Ris, 1902, all having similar epiproct characterized by its shield-shaped apical sclerite (Figs. 3–5). Nevertheless, in this group *N. obtusa* clearly differs by the rather unique shape of its cerci. Several misidentifications concerning these species occur in some collections: *N. hesperiae* was wrongly assigned to *N. erratica* (Consiglio 1958); *N. palliventris* wrongly assigned to *N. hesperiae* (Ravizza 1974, 1976, Ravizza & Ravizza Dematteis 1977) (Ravizza in lit.), indeed the identification of *N. hesperiae* or *N. palliventris* needs careful study of the epiproct in dorsal view and even also with the epiproct slightly raised since the shape of the apical sclerite looks very different according to the viewing angle and may induce misidentifications; therefore we give comparative descriptions of the 4 different species, with 3 different viewing angles (Figs. 3, 4, 5).

MATERIAL AND METHODS

Adults were collected with using a "Japanese umbrella" (beating screen).

Terminology used follows Baumann (1975). Abbreviations used: br. = brook, N. = North, R. = River, spr. = spring, tor. = torrent, (RED) = Reding collection, (RUF) = Ruffoni collection, (VIN) = Vinçon collection.

In the figures (2–5, 7–9), **c**omparative description of *N. hesperiae* is based on specimens col-

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HU ISSN 2063-1588 (online) *https://doi.org/10.18348/opzool.2021.2.149*

lected in the Abruzzi (Maiella Massif, 1720 m) nearly 40 kms from the type locality of *N. hesperiae*; the comparison of *N. lucana* is based on a male collected in Southern Italy (Basilicata: Pollino, 1600–1650 m), nearly 100 kms from the type locality of *N. lucana* and the one of *N. palliventris* is based on specimens collected in the Sila Massif (1580–1650 m), close to the type locality (Sila, Mucone).

Illustrations of the specimens were produced by the second author with the help of a stacking device connected to a Canon 550d with a 100 mm Canon macro lens or 200 mm Pentacon lens associated with an infinite Nikon CFI 10x lens; the whole is piloted by a Cognisys Stackshot. The images were assembled with Zerene Stacker (V1.04). The map and habitat photographs were provided by the first author.

All specimens are preserved in 70% ethanol. Holotype and a part of the paratypes are deposited in the Museum of Zoology, Lausanne, Switzerland (MZL). Several paratypes are in the Reding collection (RED) as well. Other specimens are kept in the Ruffoni (RUF) and Vinçon (VIN) collections.

TAXONOMY

Nemoura aprutiana Vinçon & Ruffoni sp. nov.

(Figures 1, 2, 3a, 4a, 5a, 6, 10, 11)

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Morphological diagnosis. This species is characterized in the male by the 2 apical sclerites of the epiproct that are wide and short, shield-shaped, in contrast with the other species of the same group occurring in Italy. The female cannot be separated with confidence.

Type material. *Holotype* male: Italy, Abruzzi, Val Fondillo, Tornareccia spring, 1110–1120 m, 41.771N, 13.857E, 20.05.2021 (catalogue number: GBIFCH00970961) (Fig. 10). *Paratypes*: same locality and date, 8♂, 8♀, leg. G. Vinçon

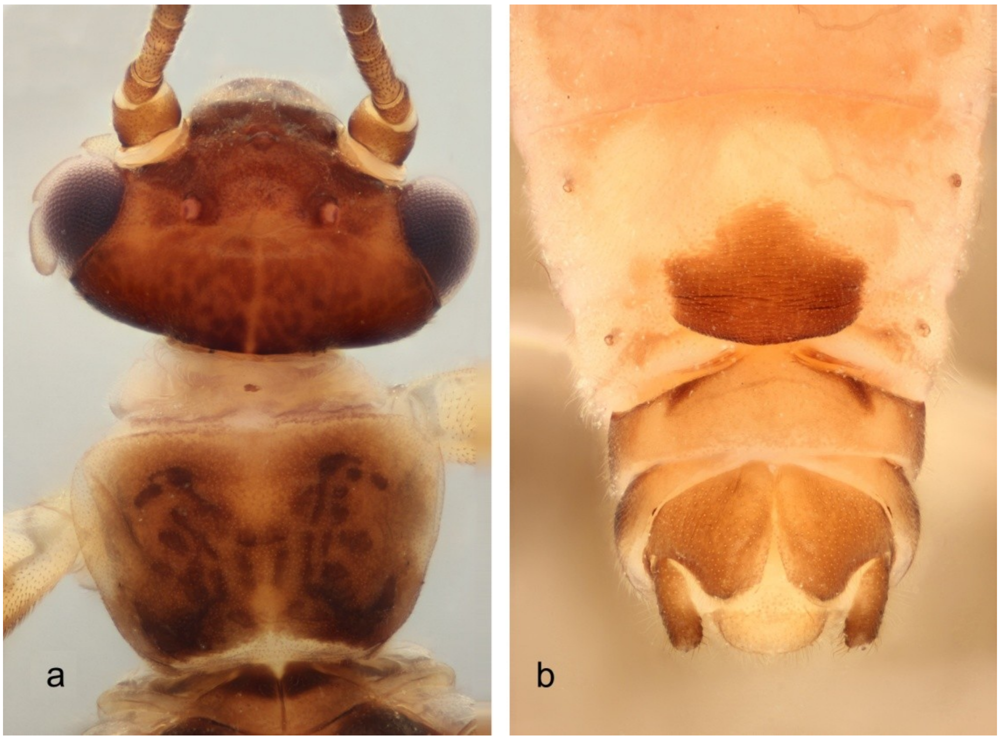

Figure 1. *N. aprutiana* sp. nov.: a = head and pronotum, b = female abdomen in ventral view.

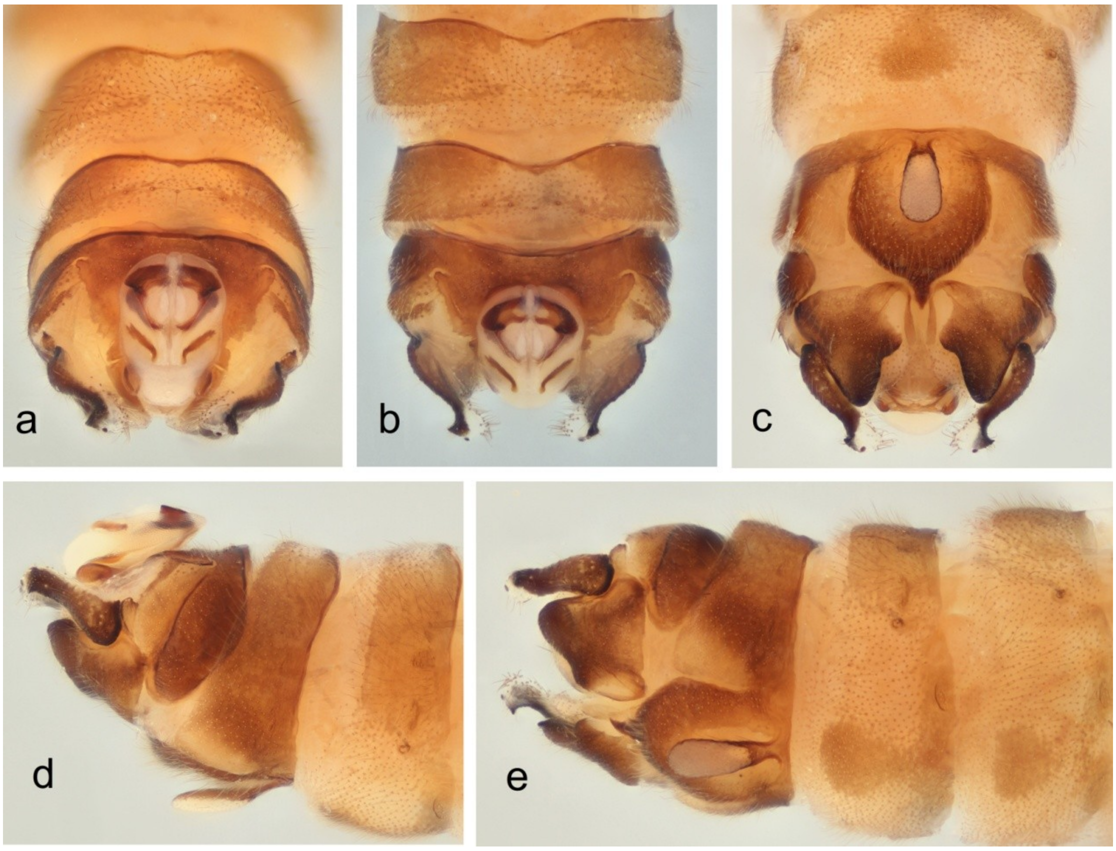

Figure 2. *N. aprutiana* sp. nov. male genitalia: a = dorsal view, b = dorsal view with tip of epiproct slightly raised, c = ventral view, d = lateral view, e = oblique ventral view.

(deposited in the MZL) (catalogue number: GBIFCH00970962), other paratypes: same locality and date, 6♂, 5♀, leg. G. Vinçon (RED); Latium, Abruzzi Massif, Prati di Mezzo, above Fontitune, spring and brook along the torrent, 1560 m, 41.653N, 13.936E, 10.06.2020, 2♂, 3♀, leg. G. Vinçon (RED) (Fig. 11).

Additional material. Italy, Latium, Abruzzi Massif, Prati di Mezzo, above Fontitune, spring and brooklet along the torrent, 1560 m, 41.653N, 13.936E, 10.06.2020, 6♀ (VIN), same locality, 21.05.2021, 15♂, 14♀ (VIN), same locality, 12.06.2021, 4♂, 5♀ (VIN); Italy, Latium, Abruzzi mountains, Vallerotonda, spring of the Collelungo River, 1480 m, 41.628N, 13.978E, 2.07.2020, 2♂, 8♀ (VIN); Italy, Abruzzi, Val Fondillo, Tornareccia spring, 1110-1120 m, 41.771N, 13.857E, 13.06.2021, 2♂, 5♀ (VIN).

Description. A large-sized *Nemoura* species. Males and females macropterous. Body length of males 6.5 to 8.1 mm, females 8.0 to 12.2 mm, forewing length of males 7.1 to 8.2, females 8.5 to 12.1 mm. General color light brown; head dark brown, except light brown between the composed eye and the ocellus; dark granulations on the occiput (Fig. 1a); antennae light brown; pronotum with dark brown marks (Fig. 1a); legs light brown. Forewings smoky brown.

Male genitalia. Tergite 8 sclerotized on its lateral edges and with median membranous field; anterior margin not interrupted and slightly curved backwards; posterior margin medially interrupted; tergite 9 similar with few scattered spines in one row on posterior edge (Figs. 2a–b). Hypoproct terminated by a short finger-shaped expansion (Fig. 2c). Ventral vesicle racket-shaped (Fig. 2c). Inner lobe of paraprocts well visible,

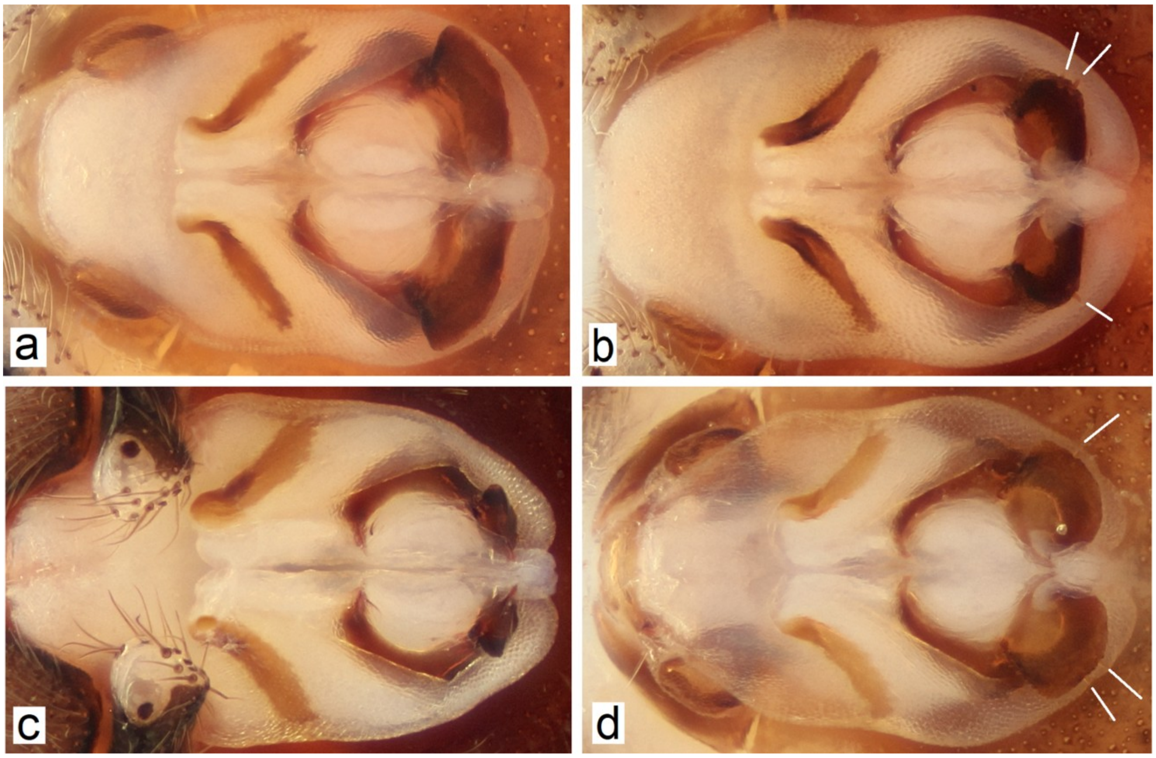

Figure 3. Epiproct in dorsal view: a = *N. aprutiana* sp. nov., b = *N. hesperiae*, c = *N. lucana*. d = *N. palliventris* (spines shown by white lines).

thin and long, projecting backwards on each side of the hypoproct expansion. Outer lobe of paraproct subtriangular, tapering toward the tip, and with an inner pre-apical constriction near mid-length (Fig. 2c); cercus with rounded base, sclerotized on its outer edge and membranous on its inner edge; cercus apex looking like a bird's head, globular, membranous and covered with long hairs on its inner part and with a strong sclerotized beak (or hook) on its outer part; the sclerotized part extends on nearly one third of the cercus head while the membranous part covers the two remaining thirds; the beak is wide and stout hardly extending on nearly a fourth of the width of the cercus head; the trace of a vestigial second segment is visible on the membranous field of the cercus head, looking like a dark spot (Figs. 2a–c); in lateral view, the cercus is slightly curved downwards (Fig. 2d), while in oblique ventral view it appears nearly rectilinear with sinuous edges (Fig. 2e). Epiproct slightly longer than wide, subrectangular with its tip rounded in dorsal view (Figs. 3a, 4a). Arms of the ventral sclerite dorsally forming a ring with: – 2 basal branches (named 'bb' in Fig. 4a), rectilinear and partly hidden by a membranous fold, – 2 inner branches ('ib', Fig. 4a), finger shaped, oriented toward the median part of the epiproct and almost touching each other medially, – 2 apical branches (also called apical sclerites) ('ab', Fig. 4a), wide and short, shield-shaped, and separated by a rounded membranous vesicle. In *Nemoura*, the sperm passes through this vesicle, guided by the apical sclerites. In lateral view, the apical sclerites looking like plates, are clearly protruding upwards and sloping downwards toward the apex (Fig. 5a), one or two spines are visible on the inner edge (Fig. 5a, red lines); the two basal ridges of the ventral sclerite of the epiproct parallel, bearing a row of several long spines (around 10).

Female. Pregenital plate of sternite 7 dark brown, protruding on sternite 8 and reaching sternite 9 medially; its posterior edge is slightly convex (Fig. 1b). Paraprocts subtriangular and cerci nearly twice as long as wide (Fig. 1b).

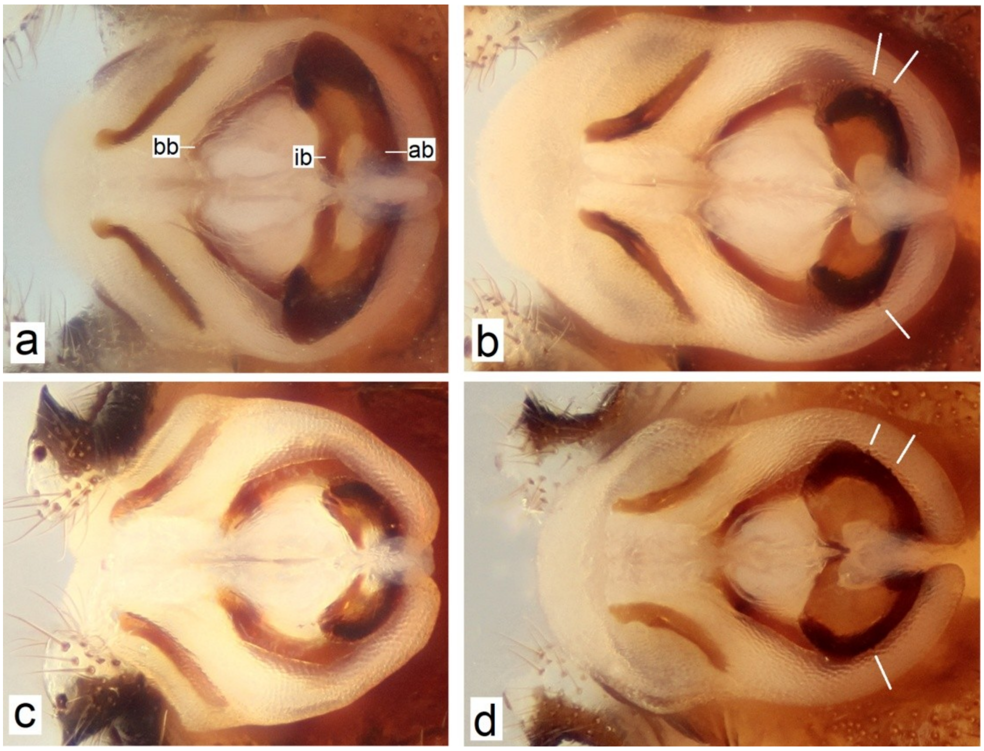

Figure 4. Epiproct in dorsal view with its tip slightly raised (nearly 30 °): a = *N. aprutiana* sp. nov., b = *N. hesperiae*, c = *N. lucana*. d = *N. palliventris* (bb = basal branch, ib = inner branch, ab = apical branch (= apical sclerite). (spines shown by white lines).

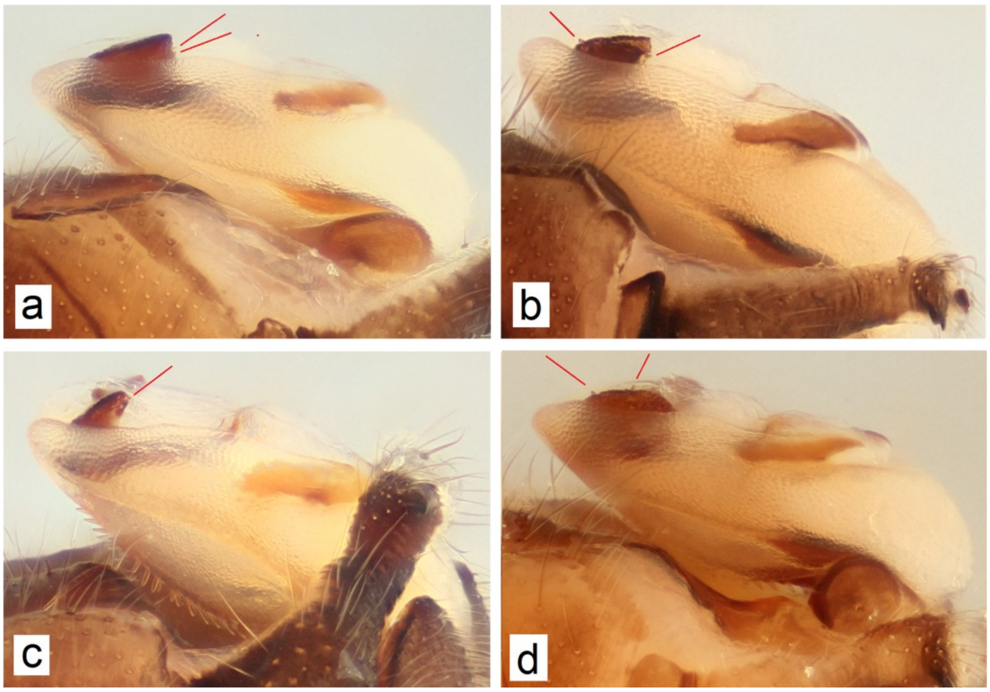

Figure 5. Epiproct in lateral view: a = *N. aprutiana* sp. n., b = *N. hesperiae*, c = *N. lucana*. d = *N. palliventris* (spines shown by red lines).

Morphological affinities. *Males.* This sister species of *N. hesperiae*, *N. lucana* and *N. palliventris* differs by the shape of the two apical sclerites of the epiproct (named 'ab' in Fig. 4a); they are wide and short in *N. aprutiana* sp. nov. (Figs. 3a, 4a), more rounded and with one or two lateral spines in *N. hesperiae* (Figs. 3b, 4b) and in *N. palliventris* (Figs. 3d, 4d) and much smaller in *N. lucana* (Figs. 3c, 4c). Moreover, *N. aprutiana* sp. nov. is also separable by the outer edge of the apical sclerites forming a blunt angle (Fig. 3a) while it is rounded in *N. hesperiae* (Fig. 3b) and in *N. palliventris* (Fig. 3d). It is also related, but to a lesser degree, to the Alpine species *N. obtusa* Ris, 1902, from which it however, clearly differs by the shape of the male cercus, twisted in lateral view and with truncate apex in *N. obtusa* (*cf.* Kis 1974, Figs. 79a, c–d). Moreover, according to the shape of the apical sclerites of the epiproct, *N. aprutiana* sp. nov. looks like three other species: *N. erratica* Claassen, 1936, occurring in western Europe, *N. pseudoerratica* Vinçon & Pardo, 2003 occurring in the Pyrenees and Northern Spain and *N. uncinata* Despax, 1934, with a central and south European distribution and also present in the Italian Alps, but it clearly differs from them by the presence of an inner branch on the apical sclerite of the epiproct (Fig. 4a, named 'ib') that is lacking in *N. erratica* or *N. pseudoerratica* (Vinçon & Pardo 2003, Figs. 1a, 2a) and in *N. uncinata* (*cf.* Kis 1974, Fig. 82c, sub. nom. *N. fulviceps*).

Females. Females of *Nemoura aprutiana* sp. nov. are actually not separable with confidence from those of *N. hesperiae*, *N. lucana* and *N. palliventris* and from those of many other congeners; their identification should be confirmed by male capture.

Distribution area and biogeographical notes. *N. aprutiana* sp. nov. is presently known only from three localities on the southwestern edge of the Abruzzi Massif (Figs. 6, 10, 11) and is probably a steno-endemic species of this region. It is a crenophilic species with a flight period spanning over spring and early summer (V–VII).

Derivatio nominis. Nemoura aprutiana sp. nov. is named after the region in which it occurs, namely the Abruzzi region (latinized as "Aprutium"). The epithet is to be treated as a Latin adjective, feminine in gender combined with *Nemoura*.

Nemoura hesperiae Consiglio, 1960

(Figures 3b, 4b, 5b, 6, 7a–d)

Type locality. Italy: Abruzzi, Lecce del Marsi, Le Prata di Lecce, 1540 m, 22.06.1954 (Consiglio coll.).

Previous data. Italy: Ligurian Apennines: (Ravizza 1974). Emilia-Romagna (Consiglio 1960, Fochetti & Campadelli, 1988, 1991); Marche (Fochetti & Nicolai 1987); (Consiglio 1958 sub nom. *N. erratica*, Consiglio 1967); Lazio (Nicolai & Fochetti 1983); Abruzzi (Consiglio 1958 sub nom. *N. erratica*, Consiglio 1967, Nicolai 1983, Nicolai, Fochetti & Dell'Agata 1988); Sicily (Ravizza & Gerecke 1991).

New data. Italy: *Toscana*: above Vinca: br. and spr., 1000 m, 44.127N, 10.175E, 2.04.2017, 4♂ (VIN); 1200 – 1300 m, br. and spr., 44.117N, 10.175E, 2.04.2017, 2♂, 1♀ (VIN); Passo del Cerreto: Crocetta Hamlet, 1280 m, spr., 44.2975 N, 10.2268E, 18.05.2021, 1♂, 3♀ (VIN); Passo del Cerreto: 1400 m, br. and spr., 44.2895N, 10.2275E, 18.05.2021, 1♂; 1420 – 1480 m, torrent, 44.288N, 10.227E, 18.05.2021, 10♂; 11.06. 2021, 2♂, 15♀ (VIN); below Passo del Cerreto: «La Gabellina», 950 m, spr., 44.3175N, 10.238E, 18.05.2021, 6♂ (VIN); Passo della Pradarena: 1570 m, spr. and br., 44.2876N, 10.3008E, 18.05. 2021, 1♂, 2♀ (VIN); 1570 m, spr., 44.2817N, 10.3035E, 18.05.2021, 1♂ (VIN); Passo di Radici: spr., 1480 m, 44.2063N, 10.4913E, 18.05. 2021, 8♂ (VIN); Val di Luce: 1600-1650 m, br., 44.123N, 10.628E, 7.06.2020, 1♂; 1560-1600 m, spr. and br., 44.131N, 10.628E, 19.05.2021, 4♂; 1380 m, spr. and br., 44.144N, 10.632E, 19.05. 2021, 11♂ (VIN); S.E. Abetone: 1270 m, spr. and br., 44.128N, 10.675E, 19.05.2021, 1♂; 1340 m, spr. and br., 44.127N, 10.665E, 19.05.2021, 2♂, 6♀ (VIN); above Reggello: spr. and br., 800 m, 43.691N, 11.575E, 8.06.2020, 1♂; 19.05.2021, 2♂, 18♀; spr. 920 m, 43.6906N, 11.582E, 19.05.

Figure 6. Distribution area of *N. palliventris, N. hesperiae, N. aprutiana* sp. nov. and *N. lucana* in the Italian region (listing only specimens confirmed by our own data and the holotype of *N. lucana.* The distribution of *N. hesperiae* and *N. palliventris* in Sicily is not given since it requires checking several collections that is outside the scope of this project)

2021, 5♂, 9♀ (VIN); Pratomagno: br. and spr., 1180 m, 43.613N, 11.688E, 20.05.2021, 1♂, 9♀; spr., 1400–1450 m, 43.652N, 11.649E, 20.05. 2021, 5♂, 8♀ (VIN). *Emilie-Romagna*: West passo di Cerreto: spr. of Secchia R., 1620 m, 44.322N, 10.192E, 30.06.2020, 1♂, 1♀ (VIN); below Passo del Cerreto: spr. below the capture, Secchia tributary, 1200 m, 44.305N, 10.226E, 2.04.2017, 3♂, 1♀ (VIN); Passo delle Radici: N. slope, 1500 m, spring, 44.194N, 10.502E, 4.06. 2020, 1♂, 11♀ (VIN); Balze: Tevere spr., 1300 m, 43.787N, 12.075E, 3.04.2015, 1♂ (VIN). *Abruzzi*: Prati di Tivo: spring and brook below the fountain, 1550–1580 m, 42.502N,13.573E, 14.06. 2020, 14♂, 2♀; 1700-1740 m, 42.495N, 13.579E, 14.06.2020, 1♂, 2♀; 26.05.2021, 21♂, 18♀ (VIN); Prati di Tivo: 1320 m, 42.515N, 13.573E, 26.05.2021, 4♂, 6♀ (VIN); Arno spr., 1450-1500 m, 42.486N, 13.542E, 26.05.2021, 1♂, 3♀ (VIN); Casale San Nicola, above Montario al Vomano, 1000 m, br. and spr., 42.478N, 13.599E, 4.04. 2015, 7♂, 3♀ (VIN); Maiella: top of San Spirito Valley, below the capture, spr. and br., 1720 m, 42.1664N, 14.118E, 2.07.2020, 2♂, 1♀ (VIN); 13.06.2020, 5♂, 3♀ (RUF); 25.05.2021, 1♂, 2♀; San Spirito Valley, large sliding flagstones, 1530m, 42.166N, 14.113E, 2.07.2020, 4♂, 1♀; 25.05.2021, 9♂, 9♀ (VIN); N. Maiella, Foro valley, spr., 1200 m, 42.1806N, 14.1252E, 25.05. 2021, 2♂ (VIN). *Basilicata*: Pollino, 1650 m, spr.

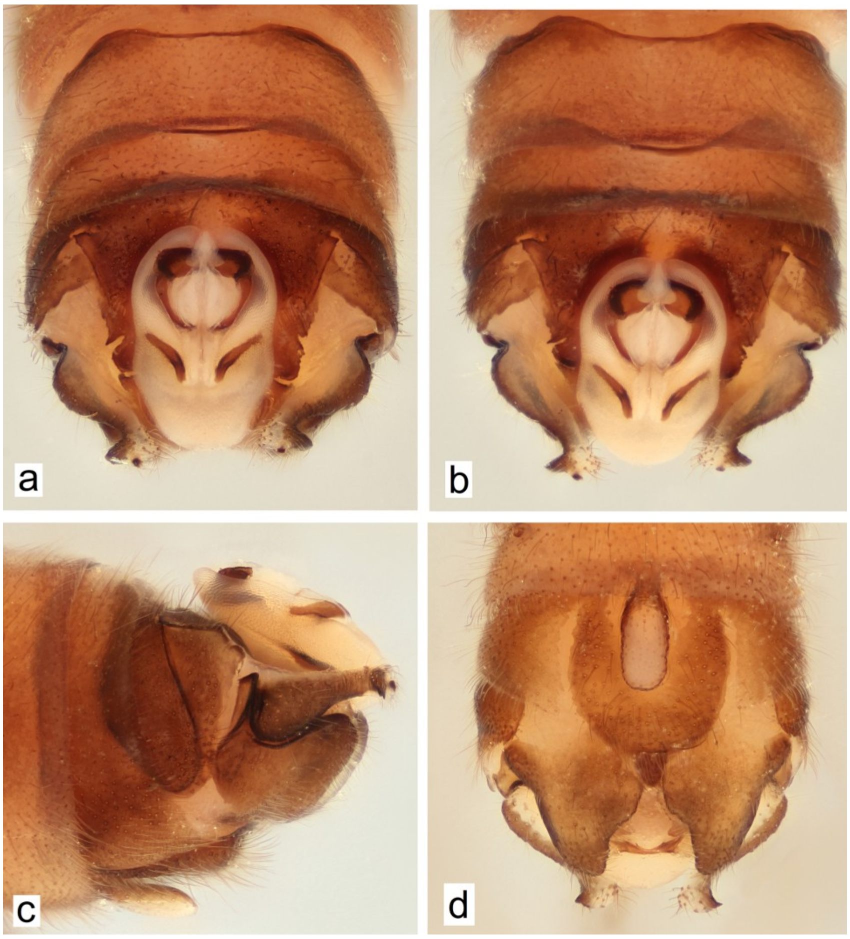

Figure 7. *N. hesperiae*, male genitalia: a = dorsal view, b = dorsal view with tip of epiproct slightly raised, c = lateral view, d = ventral view (specimen from the Maiella Massif, 1720 m, 42.1664N, 14.118E, 13.06.2020).

and br., 39.922N, 16.187E, 24.05.2021, 1♂, 3♀ (VIN). *Calabria*: Sila grande, many lateral springs, 1720 m, 39.2915N, 16.439E, 22.05.2021, 1♂ (VIN).

Description of male genitalia (Figs. 3b, 4b, 5b, 6, 7a–d). Outer lobe of paraproct subtriangular with an inner concavity near mid-length (Fig. 7d); cercus with rounded base and globular apex forming a strong beak outward, and inward looking like a rounded membranous head covered with long hairs and bearing a vestigial second segment with dark sclerotized spot nearly looking like a small tooth (Figs. 7a–b, 7d); in lateral view, the cercus is slightly curved downwards (Fig. 7c). Epiproct bearing two strong apical sclerites separated by a globular vesicle (Figs. 3b, 4b); each sclerite is half circle shaped and bears one or two lateral spines visible in dorsal view (Fig. 4b, white lines) and one spine on the inner edge visible in lateral view (Fig. 5b, red lines); the inner branch is short, oriented toward the median part of the epiproct and separated from the apical sclerite by a rounded membranous field (Fig. 4b). In lateral view, the apical sclerites of the epiproct are clearly protruding upwards and sloping downwards, toward the apex (Fig. 5b); the two basal ridges of the ventral sclerite of the epiproct bear a row of several long spines.

Affinities. *N. hesperiae* is a sister species of *N. aprutiana* sp. nov. from which it differs by having more rounded apical sclerites of the epiproct in dorsal view, less developed inner branches of the

Figure 8. *N. lucana*, male genitalia: a = dorsal view, b = dorsal view with tip of epiproct slightly raised, c = lateral view, d = ventral view (specimen from Pollino, 1600-1650 m, spr. + br., 39.916N, 16.177E, 10.06.2020).

epiproct and one or two lateral spines on the apical sclerite of the epiproct that are lacking in *N. aprutiana* sp. nov. (compare Figs. 3a, 4a with Figs. 3b, 4b). It is separable from *N. lucana* that has smaller apical sclerites (Figs. 3c, 4c) and from *N. palliventris* with much larger apical sclerites (Fig. 4d).

Distribution area and biogeographical notes. N. hesperiae has a wide distribution area in the Italian Peninsula from the Ligurian Apennines up to Calabria (Aspromonte) and it also occurs in Sicily, though we don't depict it on the map (Fig. 6) since we did not check any Sicilian specimens.

The species has a wide altitudinal range (570–1740 m) and inhabits preferentially crenal and hypocrenal biotopes (orophilic and crenophilic species). The flight period is in spring and early summer (IV–VII).

Nemoura lucana **Nicolai & Fochetti, 1991**

(Figures 3c, 4c, 5c, 6, 8a–d).

Type locality. Italy: Basilicata, small tributary of Riofreddo Stream (1100 m) near Rifreddo (Potenza), 21.05.1984 (Nicolai & Fochetti 1991).

Previous data. Until now, this species was reported only from its type locality, but has recently been found also in the Pollino Massif (Vinçon, Ravizza & Reding 2022).

Material examined. Italy: *Basilicata*: Pollino, 1600–1650 m, spr. + br., 39.916N, 16.177E, 10. 06.2020, 1♂ 4♀ (RUF).

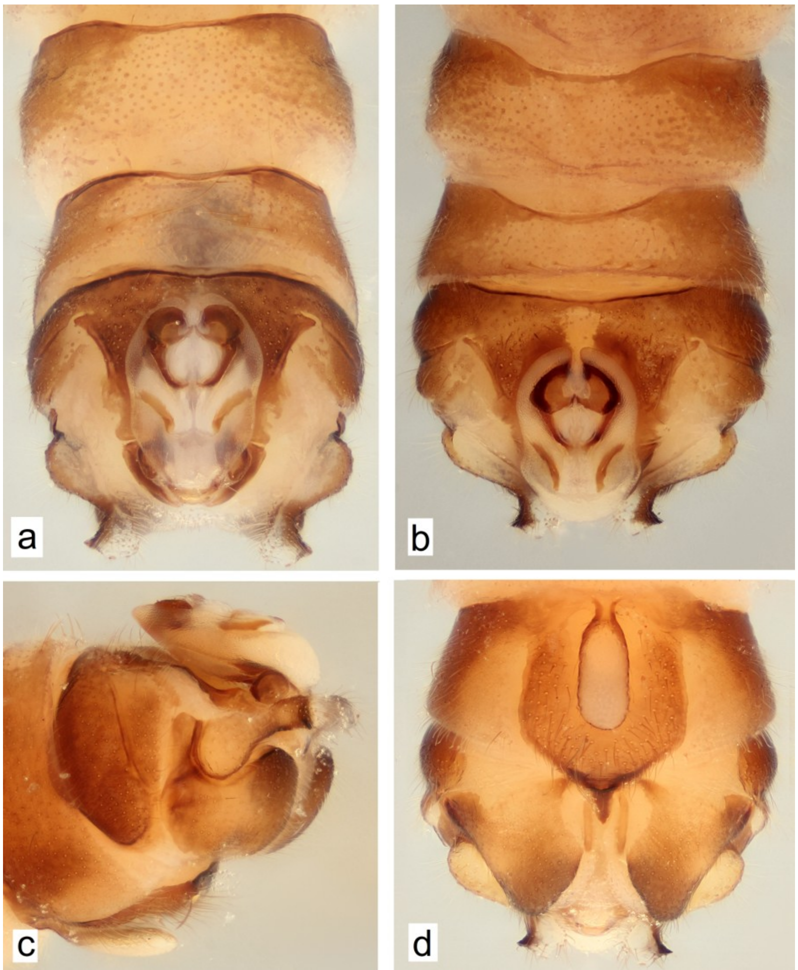

Figure 9. *N. palliventris*, male genitali: a = dorsal view, b = dorsal view with tip of epiproct slightly raised, c = lateral view, d = ventral view (specimen from the Sila Massif, 1580-1650 m, 39.32N, 16.401E, 11.06.2020).

Description of male genitalia. Outer lobe of paraproct subtriangular with a very slight inner concavity near mid-length (Fig. 8d); cercus with rounded base and globular apex forming a strong beak outward, and inward looking like a rounded membranous head covered with long hairs and bearing a vestigial second segment with dark spot (Figs. 8a–b); in lateral view, the cercus is nearly rectilinear (Fig. 8c). Epiproct: the two apical sclerites very short, nearly rounded, shield-shaped, and separated by a membranous vesicle, in dorsal view (Figs. 3c, 4c); in lateral view, they are narrow and strongly raised (Fig. 5c) and carrying one or two short spines on their inner edge (Fig. 5c, red line). The inner branches are very short, oriented toward the median part of the epiproct and getting thinner toward their apex (Fig. 4c). The two basal ridges of the ventral sclerite of the epiproct bear a row of several long spines.

Affinities. *N. lucana* is close to *N. hesperiae* and to a lesser degree to *N. aprutiana* sp. nov. and *N. palliventris.* it mainly differs from both of them by the smaller apical sclerite of the epiproct in dorsal and lateral views (Figs. 3, 4, 5).

Distribution area and biogeographical notes. *N. lucana* is known only from high altitude brooklets and springs in the southern Apennines, from Potenza to the Pollino Mount (Basilicata) (1100–1650 m) (Fig. 6). Its flight period is in spring (V–VI).

Nemoura palliventris **Aubert, 1953**

(Figures 3d, 4d, 5d, 6, 9a–d)

Nemoura silana Aubert, 1953, Syn. fide Aubert (1958).

Type locality: *Italy*: Calabria, Sila, Mucone, 19.05.1952 (Aubert 1953).

Previous data. Switzerland: Lepontine Pre-Alps, Tisino (Aubert *et al.* 1996). *Italy*: Cottian Alps (Ravizza & Ravizza Dematteis 1986, Ravizza Dematteis & Ravizza 1988). Ligurian Alps (Consiglio 1967, Ravizza & Ravizza Dematteis 1977 sub. nom. *N. hesperiae*). *France*: Maritime Alps (Aubert 1986, Vinçon 1996). *Italy*: Ligurian Apennines (Ravizza 1974 sub. nom. *N. hesperiae*, Ravizza 1976 sub. nom. *N. hesperiae,* Ravizza & Ravizza Dematteis 1983). Emilia-Romagna (Fochetti & Campadelli 1991). Marche (Aubert 1956b, Fochetti & Nicolai 1987). Lazio (Nicolai & Fochetti 1983). Abruzzi (Consiglio 1958). Campania (Nicolai & Fochetti 1991). Basilicata (Aubert 1953, 1958, Nicolai & Fochetti 1991). Calabria (Aubert 1953, ex parte sub. nom. *N. silana*, Nicolai & Fochetti 1991). Sicily (Aubert 1957, Consiglio 1961, Ravizza & Gerecke 1991).

New data. Italy: Pennine Alps: Aosta Valley, above Settimo-Vitonne, tor., 450 m, 45.554N, 7.839E, 31.03.2000, 6♂ (VIN). Graian Alps: below Viu, br., 600 m, 45.235N, 7.432E, 1.04. 2000, 3♂, 1♀ (VIN). Ligurian Apennines: Beigua Mount, spr. and br., 1000 m, 44.428N, 8.543E, 1.04.2017, 1♂, 3♀ (VIN); Pianpaludo, above Veirera, SW Urbe, 950 m, 44.458N, 8.553E, 7.04. 2015, 1♂ (VIN). Toscana: Apuane mountains: road to Vinca, big resurgence above the river, 330 m, 44.15N, 10.135E, 5.04.2015, 8♂, 1♀; 2.04. 2017, 3♂, 1♀ (VIN); road to Vinca, br. and spr., 500 m, 44.14N, 10.146E, 5.04.2015, 2♂, 3♀ (VIN); above Vinca, br. and spr., 1200 - 1300 m, 44.117N, 10.175E, 2.04.2017, 2♂, 2♀ (VIN); road to Passo del Cerreto, crossroad to Sassalbo, 1020 m, 44.28N, 10.202E, 28.06.2016, 1♂, 1♀ (VIN); Val di Luce, 1600–1650 m, br., 44.123N, 10.628E, 7.06.2020, 1♂ (VIN); S.E. Abetone, 1270 m, spr. and br., 44.128N, 10.675E, 19.05. 2021, 3♂ (VIN); SE Reggello, Pratomagno Mountains, 1300-1400 m, br. and spr., 43.645N, 11.665E, 8.06.2020, 14♂, 9♀ (VIN). Abruzzi: Prati di Tivo, spr. and br. 1550–1580 m, 42.502N, 13.573E, 14.06.2020, 1♂ (VIN); Prati di Tivo, br. and spr., 1370 m, 42.51N, 13.574E, 14.06.2020, 14♂, 8♀ (VIN); Val Fondillo, br. and spr., 1300 m, 41.749N, 13.865E, 9.06.2020, 1♂ (VIN); Maiella Massif, Roccamorice, above Sanctuario Santo Spirito, spr., 1300–1400 m, 42.169N, 14.102E, 13.07.2009, 1♂, 3♀ (VIN). Basilicata: NE Lagonegro, spr., 1350 m, 40.152N, 15.808E, 22.05.2021, 5♂, 10♀ (VIN); Pollino Mountains, 1500-1600 m, spr. and br., 39.925N, 16.177E, 11. 06.2020, 2♂ (VIN). Calabria: Sila grande: spr., 1650-1700 m, 39.32N, 16.401E, 11.06.2020, 16♂, 30♀; 22.05.2021, 9♂, 8♀ (VIN); Sila Grand: spr., 1580-1650 m, 39.32N, 16.401E, 11.06.2020, 10♂, 24♀; spr., 1320 m, 39.32N, 16.385E, 22.05.2021, 13♂, 18♀ (VIN); Aspromonte: 1420 m, spr. and br., 38.144N, 15.842E, 12.06.2020, 7♂, 9♀; 23. 05.2021, 18♂, 5♀ (VIN); below Montalto, 1760-1800 m, spr. and br., 38.1649N, 15.916E, 23.05. 2021, 7♂, 7♀ (VIN).

Description of male genitalia (3d, 4d, 5d, 6, 9a-d). Outer lobe of paraproct subtriangular (Fig. 9d); cercus with rounded base and globular apex forming a strong beak outward, and inward looking like a rounded membranous head covered with long hairs and bearing a vestigial second segment with dark spot (Figs. 9a–b, 9d); in lateral view, the cercus is slightly bent downwards (Fig. 9c). Epiproct: the two strong apical sclerites are half circle shaped, with one or two lateral spines visible in dorsal view (Fig. 4d, white lines), and separated by a globular, transparent vesicle (Figs. 3d, 4d); the two inner branches are oriented toward the median part of the epiproct and getting thinner toward their apex (Figs. 4d, 9b). In lateral view, the apical sclerites are very wide and clearly protruding upwards and sloping downwards, toward the apex (Fig. 5d, 9c); the two basal ridges of the ventral sclerite bear a row of several long spines.

Affinities. *N. palliventris* is close to *N. hesperiae* and to a lesser degree to *N. aprutiana* sp. nov. from which it differs by the larger apical sclerite of the epiproct in dorsal and lateral views (Figs. 3–5).

Distribution area and biogeographical notes. *N. palliventris* has a wide distribution area covering the western Alps, the whole Apennine Cordillera and Sicily. It extends northwards in the French Pre-Alps up to the Vercors and Dévoluy Massifs (Vinçon 1996). It occurs in a wide altitudinal range (200–2000 m). The flight period is in spring and early summer, often according to the altitude (III–VII) (Vinçon, Ravizza & Reding 2022).

Acknowledgements – We are especially grateful to Jean Paul G. Reding and Carlalberto Ravizza for the revision of the manuscript and helpful comments, and to David Murányi for his careful correction of the text.

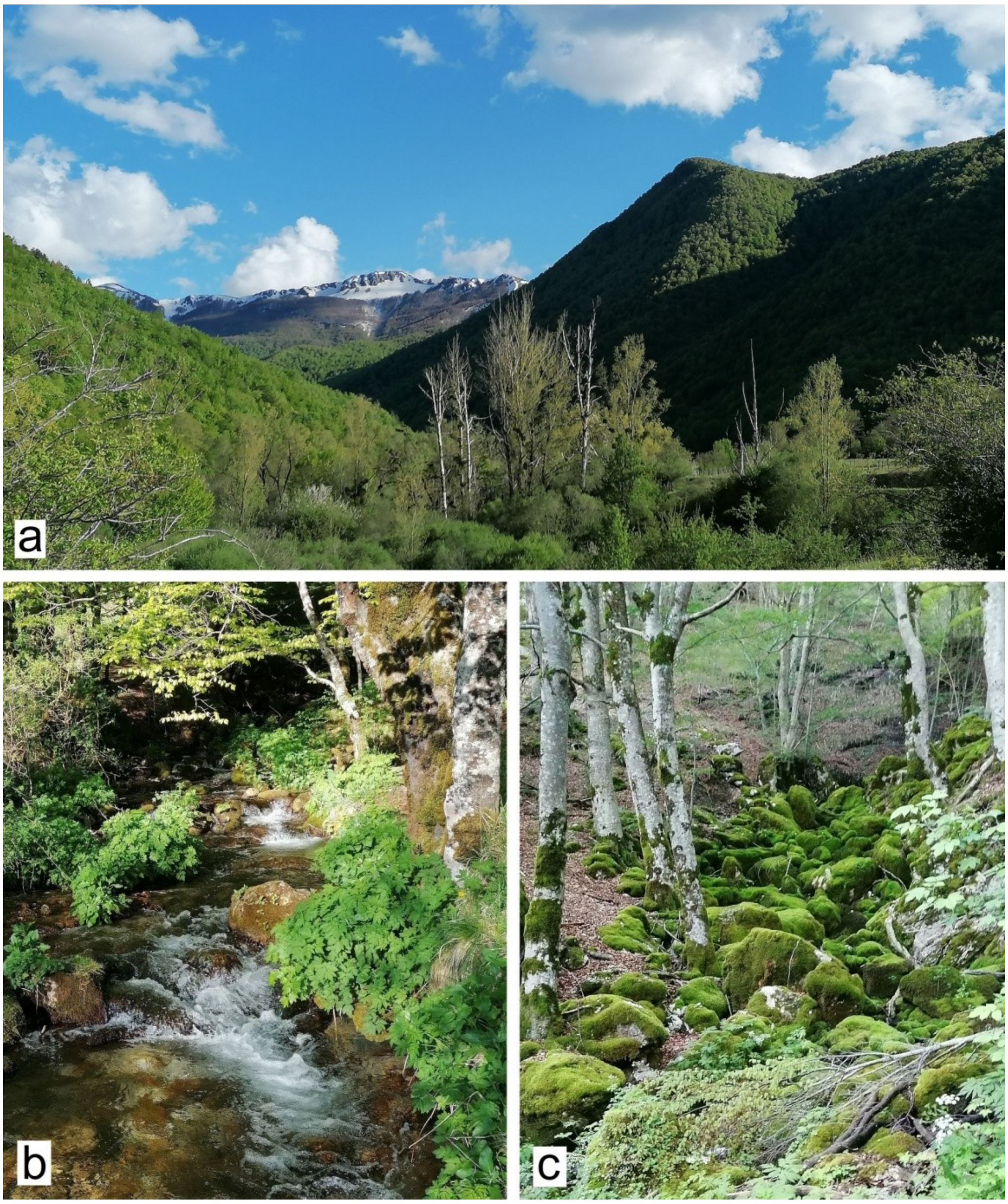

Figure 10. Collecting localities of *N. aprutiana* sp. nov. in the Abruzzi, Val Fondillo, 1110–1120 m, 41.771N, 13.857E: a = Val Fondillo, b = Tornareccia spring 1110 m, c = Tornareccia spring 1120 m.

Figure 11. Collecting localities of *N. aprutiana* sp. nov. in the Abruzzi, Prati di Mezzo, 1550–1600 m, 41.653N, 13.936E: a + c = main torrent, b = lateral spring at 1550 m.

REFERENCES

AUBERT, J. (1953): Contribution à l'étude des Plécoptères et des Ephéméroptères de la Calabre. *Annuario dell'Istituto e museo di zoologia dell'Università di Napoli*, 5(2): 1–35.

AUBERT, J. (1956a): Contribution à l'étude des Plécoptères de Grèce. *Bulletin de la Société entomologique Suisse*, 29: 187–213.

AUBERT, J, (1956b): Plécoptères des Monts Sibillins. *Memorie Museo Civico Storia Naturale, Verona*, 5: 89–91.

AUBERT, J. (1957):. Quelques plécoptères récoltés en Sicile. *Bulletin de la Société entomologique Suisse*, 30: 175–177.

AUBERT, J. (1958): Ricerche zoologiche sul massiccio des Pollino (Lucania-Calabria). XXV. Les Plécoptères de Calabre (Italie méridionale). *Annuario dell'Istituto e museo di zoologia dell'Università di Napoli*, 10(4): 1–51.

AUBERT, J. (1958): Les Plécoptères de Calabre (Italie méridionale). *Annuario dell'Istituto e museo di zoologia dell'Università di Napoli*, 10(4): 1–51.

AUBERT, J. (1986): Les Plécoptères des Alpes Françaises. *Annales de la Société Entomologique de France*, 22(1): 81–104.

AUBERT, J., AUBERT, C.E., RAVIZZA, C. & RAVIZZA DEMATTEIS, E. (1996): Les Plécoptères du canton du Tessin, des vals de Mesolcina et de Calanca (canton des Grisons). *Bulletin de la Société entomologique Suisse*, 69: 9–40.

BAUMANN, R.W. (1975): *Revision of the stonefly family Nemouridae (Plecoptera): A study of the world fauna at the generic level*. Smithsonian contributions to zoology, No. 211, 74 pp. doi: 10.5479/si.00810282.211

DESPAX, R. (1934): Plécoptères pyrénéens VIII. Étude et description de quelques formes de Nemoures apparentées à *Nemura marginata* (Pict.) Klap. *Bulletin de la Société d'Histoire Naturelle de Toulouse*, 66(2): 255–270.

CONSIGLIO, C. (1958): Plecotteri dei Monti Picentini. *Memorie Museo Civico Storia Naturale, Verona,* 6: 327–331.

CONSIGLIO, C. (1960): Fauna di Romagna (Collezioni Zangheri). Plecotteri. *Memorie della Società Entomologica Italiana*, 39: 36–40.

CONSIGLIO, C. (1961): Plecotteri di Sicilia e d'Aspromonte e classificazione delle Isoperla Europee. *Memorie Museo Civico Storia Naturale, Verona*, 9: 173–196.

CONSIGLIO, C. (1967): Lista dei Plecotteri della regione Italiana. *Fragmenta entomologica. (Roma)*, 1: 1–66.

FOCHETTI R. & CAMPADELLI, G. (1988): Plecotteri di Romagna: nuove segnalazioni. *Bollettino dell' Istituto Entomologico "G. Grandi", Bologna,* 43: 63–67.

FOCHETTI, R. & CAMPADELLI, G. (1991): Nuove acquisizioni sui Plecotteri di Romagna. *Bollettino dell'Istituto Entomologico "G. Grandi", Bologna,* 46: 63–69.

FOCHETTI, R. & NICOLAI, P. (1987): I plecotteri dell'alta valle del fiume Tenna (Monti Sibillini, Italia Centrale) (Plecoptera). *Bollettino Associazione Romana Entomologica (Roma)*, 42: 9–18.

KIS, B. (1974): *Plecoptera*. Fauna Republicii Socialiste Romania, Bukarest, Insecta, 8, 271 pp.

MURANYI, D. (2007): New and little-known stoneflies (Plecoptera) from Albania and the neighbouring countries. *Zootaxa*, 1533: 1–40. doi: 10.11646/zootaxa.1533.1.1

NICOLAI, P. (1983):. Osservazioni fenologiche sui Plecotteri di una sorgente abruzzese a temperatura costante (Plecoptera). *Bollettino Associazione Romana Entomologica (Roma)*, 38: 9–19.

NICOLAI, P. & FOCHETTI, R., (1983): La fauna a Plecotteri di un sistema reocrenico di alta qualitá: il tratto sorgivo del T. Cosa (Monti Ernici, Lazio) (Plecoptera). *Rivista di Idrobiologi*, 22(2–3): 187–202.

NICOLAI, P. & FOCHETTI, R. (1991): *Nemoura lucana*, a new species from the Italian southern Apennine (Plecoptera, Nemouridae). *Aquatic Insects*, 13: 245–249. doi: 10.1080/01650429109361451

NICOLAI, P., FOCHETTI, R. & DELL'AGATA, M. (1988): *La plecotterofauna del fiume Orfento (Abruzzo, Italia)*. Atti XV Congresso Nazionale Italiano di Entomologia, L'Aquila, p. 1059–1061

RAVIZZA, C. (1974): Ricerche ecologico-faunistiche sui Plecotteri della Val Staffora (Appennino Lombardo). *Bollettino Museo Civico Storia Naturale, Verona*, 1: 195–248.

RAVIZZA, C. (1976): Ricerche ecologico-faunistiche sui Plecotteri del torrente Erro (Appennino Ligure) (Plecoptera). *Bollettino Museo Civico Storia Naturale, Verona*, 3: 331–361.

RAVIZZA, C. & GERECKE, R. (1991): A review of the distribution of Plecoptera on Sicily. *Memorie della Società Entomologica Italiana*, 70 (2): 9–31.

RAVIZZA, C. & RAVIZZA DEMATTEIS, E. (1977): La plecotterofauna dell'alta valle del Tanaro (Alpi Liguri) (Plecoptera). *Memorie della Società Entomologica Italiana*, 55: 182–215.

RAVIZZA, C. & RAVIZZA DEMATTEIS, E. (1983): Sull'ininterrotta presenza di Plecotteri adulti in un ruscello dell'Appennino Ligure occidentale. Analisi della plecotterocenosi e dei periodi di volo (Plecoptera). *Redia (Firenze)*, 66: 615–634.

RAVIZZA, C. & RAVIZZA DEMATTEIS, E. (1986): Les Plécoptères du Grana (Alpes Cottiennes méridionales) (Plecoptera). *Bollettino del Museo regionale di Scienze Naturali, Torino*, 4(2): 311–339.

RAVIZZA DEMATTEIS, E. & RAVIZZA, C. (1988): Les Plécoptères de la vallée supérieure du Pô (Alpes Cottiennes). Notes faunistiques et écologiques. *Annales de Limnologie (Toulouse)*, 24(3): 243–260. doi: 10.1051/limn/1988021

RIS, F. (1902): Die schweizerischen Arten der Perlidengattung *Nemura*. *Bulletin de la Société entomologique suisse*, 10: 387–405.

SIVEC, I., (1980): Notes on Stoneflies (Plecoptera) from South West Yugoslavia, with Description of a New *Nemoura*. *Aquatic Insects*, 2: 91–95 doi: 10.1080/01650428009361012

VINÇON, G. (1996): Les Plécoptères des Alpes françaises. *Bulletin de la Société entomologique suisse*, 69: 61–75.

VINÇON, G. & PARDO, I. (2003): Two new *Nemoura* species from the northwestern Iberian Peninsula and the Pyrenees (Plecoptera, Nemouridae). *Nouvelle Revue d'Entomologie (N.S.)*, 20: 29–38.

VINÇON, G., REDING, J.-P.G. & RAVIZZA, C. (2021): Two new species of *Protonemura* Kempny, 1898 (Plecoptera: Nemouridae) from the Italian Alps. *Zootaxa*, 4985(4): 493–512. doi: 10.11646/zootaxa.4985.4.4

VINÇON, G., RAVIZZA, C. & REDING, J.-P.G. (2022): Stoneflies (Insecta: Plecoptera) from the Italian region: New species, nomenclatural changes, updated and annotated checklist. *Opuscula Zoologica Budapest*, In press

The composition and heterogeneity of the rich and diverse rotifers (Rotifera: Eurotatoria) of the floodplain lakes (*beels*) of the Majuli River Island, Assam State (Northeast India)

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Abstract: The tropical and subtropical floodplain lakes are hypothesized as one of the globally interesting rotifer rich ecosystems. Our study indicating the biodiverse Rotifera of ten 'slightly acidic to circum-neutral, moderately hard-water and de-mineralized' tropical floodplain lakes (*beels*) of the Majuli River Island of the Brahmaputra river basin of northeast India endorses this hypothesis. Total richness, the richness of important families and community similarities affirm heterogeneity of the rotifer species composition amongst the *beels*. The species richness registers significant spatio-temporal variations with seasonal differences amongst the *beels* and individually in each *beel,* and lacks significant influence of the recorded abiotic factors. The constellations of 76-81 species in three *beels* during winter and 76 species in one *beel* during pre-monsoon are noteworthy instances of 'Rotifera paradox'. The rotifer fauna of the Majuli *beels* registers affinity with Southeast Asian and Oriental faunas, records several species of the regional distribution interest and exhibits the littoral-periphytic nature, while application of $Q_{B/T}$ and $Q_{L/B}$ quotients depicts limitations. This study merits ecological diversity interest for Rotifera vis-a-vis the floodplain lakes of India and elsewhere from the tropics and subtropics, and assumes biodiversity conservation importance due to threat of extinction of the Majuli – an alluvial floodplain of the Brahmaputra basin.

Keywords. Alluvial floodplain, *beels*, Brahmaputra basin, ecological diversity, Rotifera paradox.

INTRODUCTION

The floodplain lakes comprise integral elements of landscapes of large riverine systems world-wide. These generally shallow wetlands are characterized as ecotones with environmental heterogeneity due to variations of hydrological conditions and growth of macrophytes, and are known for high biodiversity and ecological value (Funk *et al*. 2009, Górski *et al*. 2013, Dembowska & Napiórkowski 2015, Napiórkowski *et al*. 2019). Segers *et al*. (1993) hypothesized the tropical and subtropical floodplain lakes as one the globally important Rotifera rich habitats, and the diverse assemblages examined by Shiel *et al.* (1998), Green (2003), Bonecker *et al*. (2005, 2020) and Diniz *et al*. (2021) endorse the global biodiversity importance of these wetlands. Our rotifer diversity studies (Sharma & Sharma 2014a, 2019a) extend Segers's hypothesis to the floodplain lakes (*beels* and *pats*) of northeast India (NEI). Referring to NEI in particular, the notable related works of ecological diversity importance are limited to the selected *beels* of Assam (Sharma 2005, Sharma & Sharma 2001, 2008, 2019a, 2019b, Sharma *et al*. 2018a) and *pats* of Manipur (Sharma 2009, Sharma & Sharma 2018a). On the contrary, the reports elsewhere from the Indian floodplains (Sinha *et al*. 1994, Sanjer and Sharma 1995, Khan 1997, 2002, 2003, Ganesan & Khan 2008, Datta 2011, Sharma *et al*. 2011, Chandra *et al*. 2021) indicate poor rotifer biodiversity value due to incomplete species inventories, inadequate sampling, overlooking identification of smaller species of the taxon and limitations of taxonomic expertise (Sharma & Sharma 2021a). The limnology literature thus depicts disparity on Rotifera ecological diversity works from the floodplains of the different river basins of India, and highlights the scope for augmenting intensive studies from

urn: lsid:zoobank.org:pub:E4CDC429-4F86-4E29-B8BE-7AC68C4E8B93 *published: 03 December 2021*
HU ISSN 2063-1588 (online) *https://doi.org/10.18348/opzool.2021.2.165*

the floodplains lakes of this country as well as NEI *vis-à-vis* the hypothesis of Segers *et al.* (1992) and the 'Rotiferologist effect' (Fontaneto *et al.* 2012).

Realizing the global and regional importance of Rotifera biodiversity assessment of the floodplain lakes, the present study attempts an intensive analysis of the rotifer assemblages of ten floodplain lakes (*beels*) of the Majuli River Island of the Brahmaputra river basin of NEI. Comments are made on the species composition, the richness and its spatio-temporal variations, important taxa and interesting speciose constellations observed from the sampled *beels* of this alluvial floodplain of Assam state. The results are discussed in comparisons with Rotifera faunal diversity reports from the floodplain lakes of India and elsewhere globally, and our earlier preliminary survey (Sharma *et al*. 2015) of certain Majuli *beels*.

MATERIALS AND METHODS

The present study is based on the limnological survey (undertaken during 2016) of ten *beels* (Table 1) of the Majuli River Island (26° 45′N – 27°12′N, 93°39′E–94°35′E) located in the upper reaches of the Brahmaputra river, Assam state of NEI (Fig. 1). The sampled *beels* indicate various aquatic macrophytes namely *Azolla pinnata* Brown, *Eichhornia crassipes* (Martius) Solms, *Euryale ferox* Salisbury, *Hydrilla verticillata* (L.f.) Royle, *Lemna minor* Linnaeus, *Nymphaea carpensis* Thunb., *Nelumbo nucifera* Gaertn., *N. lutea* Willdenow, *Pistia stratiotes* Linnaeus, *Salvinia cucullata* Roxb. ex Bory, *Trapa bispinosa* Roxb., and *Utricularia aurea* Loureiro.

Water and plankton samples were collected from the different *beels* (Table 1) during winter

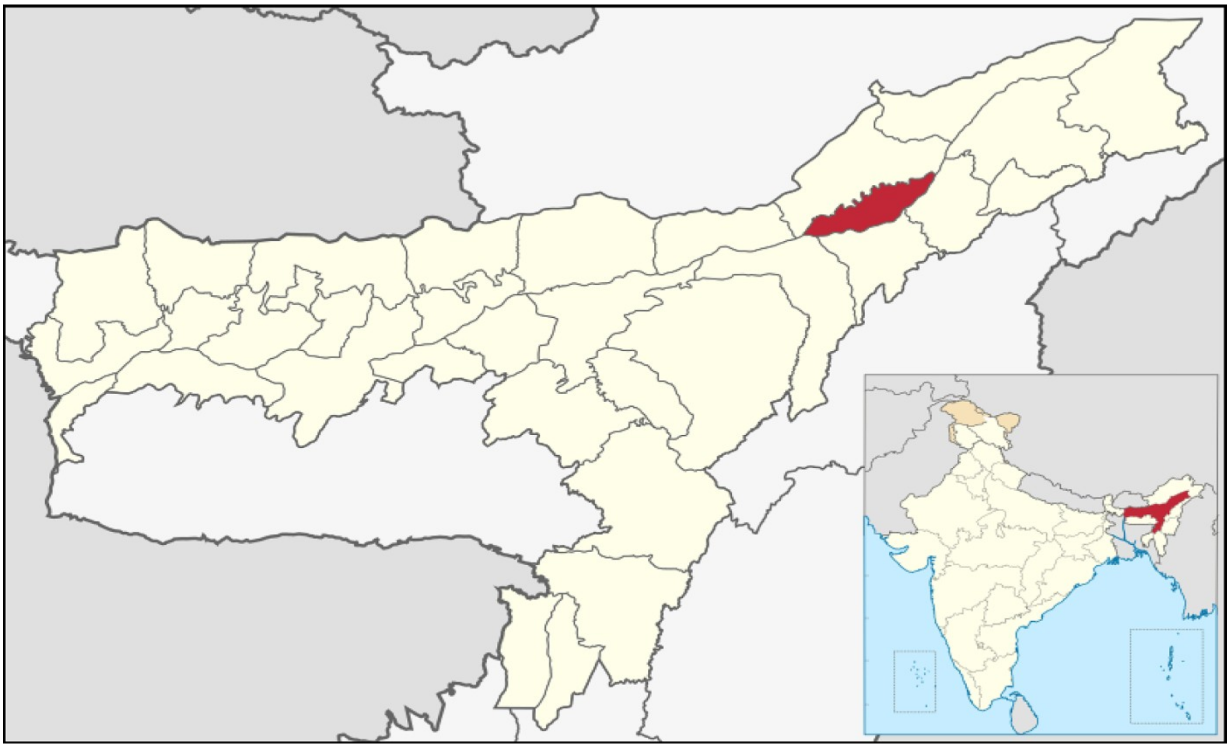

Figure 1. The district map of Assam state (light yellow color) showing location of the Majuli River Island (red color), inset map of India indicating Assam state (red color) of northeast India (Source: Google map)

Table 1. List of the sampled Majuli *beels*

Beels↓ Location→	**Latitude**	**Longitude**
Mohorichuk	26°55′40.4″ N	94°01′47.7″ E
Baalichapori	26°55′42.0″ N	94°02′44.7″ E
Dighaliya	26°56′15.5″ N	94°03′45.7″ E
Karatipar	26°56′39.4″ N	94°04′13.5″ E
Lingri	26°56′47.4″ N	94°12′28.8″ E
Khorkhoria	26°57′02.7″ N	94°05′05.3″ E
Gokhai	26°57′07.0″ N	94°09′04.2″ E
Noldunga	26°58′09.4″ N	94°03′03.4″ E
Bor	26°59′25.9″ N	94°13′08.0″ E
Baatomaari	27°05′13.2″ N	94°22′41.8″ E

(January – February), pre-monsoon (April – May), monsoon (July – August) and post-monsoon (October – November) seasons. Water samples were examined for certain abiotic factors; water temperature and specific conductivity were recorded with the field probes, dissolved oxygen was determined by Winkler's methods, and total alkalinity and total hardness were estimated following APHA (1992). A total of 600 qualitative plankton samples, including 15 samples per *beel* per season, were collected from the littoral and semi-limnetic regions of the different *beels* by towing plankton net (# 40 µm) and were preserved in 5% formalin. All the collections were screened with WILD binocular microscope, various rotifers were isolated and mounted in polyvinyl alcohol-lactophenol mixture, and observed with Leica (DM 1000) stereoscopic phase contrast microscope fitted with an image analyzer.

Rotifera species are identified following the works of Sharma (1983), Segers (1995), and Sharma & Sharma (1999, 2000, 2008, 2014b, 2014c, 2015, 2021a). The percentage similarities between the rotifer species composition amongst the different *beels* are calculated *vide* Sørensen's index (Sørensen 1948). The hierarchical cluster analysis is done using SPSS (version 20) and dendrogram is plotted using average linkage between groups (community similarity values). Two-way ANOVA is used to ascertain significance of the spatial and temporal Rotifera richness variations amongst the *beels* and seasons, respectively. The relationships between abiotic factors and richness are determined by Pearson's correlation coefficients (r); P values are calculated and significance is ascertained after Bonferroni corrections.

RESULTS

Water temperature ranged between 23.9 ± 4.2–25.2 ± 3.8°C; pH between 6.68 ± 0.14–6.79 ± 0.20; specific conductivity between 130.2 ± 15.0–152.0 ± 14.6 µS/cm; dissolved oxygen between 6.4 ± 0.7–7.0 ± 0.8mg/l; total alkalinity between 74.5 ± 12.6–88.2 ± 12.3mg/l; and total hardness between 69.8 ± 14.3–81.2 ± 14.2 mg/l in the Majuli *beels* (Table 2) during this study. The significance of the spatio-temporal (vide ANOVA) variations of abiotic factors is indicated in Table 3.

We report a total of 170 Rotifera species belonging to 39 genera and 19 families (Appendix 1). The richness in the individual *beels* ranges between 78–128 species (Fig. 2) and records 57.1–79.5% community similarities *vide* Sørensen's index (Table 4); the hierarchical cluster analysis between Rotifera assemblages is shown in Fig. 3. The cumulative richness of important families namely Lecanidae, Lepadellidae, Brachionidae and Trichocercidae in the different *beels* ranges between 54–90 species (Fig. 2). Individual and cumulative richness contributions of important families of the sampled *beels* are indicated in Table 5. The rotifer richness indicates seasonal variations (Table 6) ranging between 56±7 – 71±9

Table 2. Temporal variations of abiotic parameters (Mean ± SD) of the Majuli *beels*

Parameters → **Beels↓**	Water temperature °C	pH	Specific Conductivity µS/cm	Dissolved oxygen mg/l	Total Alkalinity mg/l	Total Hardness mg/l
Mohorichuk	24.7 ± 4.0	6.76 ± 0.12	130.4 ± 10.2	6.5 ± 0.4	74.5 ± 12.6	69.8 ± 14.3
Baalichapori	23.9 ± 4.2	6.69 ± 0.11	131.4 ± 12.7	6.6 ± 0.6	80.8 ± 15.4	76.4 ± 22.6
Dighaliya	24.6 ± 3.8	6.77 ± 0.15	142.6 ± 15.9	6.7 ± 0.8	76.4 ± 12.6	70.2 ± 15.6
Karatipar	24.6 ± 3.9	6.72 ± 0.14	150.2 ± 17.8	6.6 ± 0.8	85.8 ± 14.0	80.2 ± 16.2
Lingri	24.0 ± 3.8	6.68 ± 0.14	152.0 ± 14.6	6.9 ± 0.9	88.2 ± 12.3	81.2 ± 14.2
Khorkhoria	25.2 ± 3.8	6.76 ± 0.12	130.2 ± 15.0	6.8 ± 0.9	77.3 ± 12.2	70.8 ± 12.6
Gokhai	24.7 ± 4.0	6.79 ± 0.20	135.2 ± 16.3	7.0 ± 0.8	82.2 ± 11.4	73.8 ± 10.6
Noldunga	24.9 ± 4.1	6.72 ± 0.20	133.6 ± 15.2	6.6 ± 0.7	80.3 ± 12.3	74.2 ± 14.6
Bor	25.0 ± 3.9	6.71 ± 0.19	134.2 ± 15.9	6.4 ± 0.7	82.5 ± 16.2	79.5 ± 13.2
Baatomaari	24.9 ± 3.9	6.75 ± 0.16	144.2 ± 18.5	6.5 ± 1.0	80.9 ± 12.9	78.4 ± 12.0

Table 3. The spatio-temporal significance of abiotic factors and Rotifera richness

Parameters	**Beels**	**Seasons**
Abiotic factors		
Water temperature	-	$F_{3,39}$=1247.571, P=4.690E-29
pH	-	$F_{3,39}$=11.692, P=4.319E-05
Specific conductivity	$F_{9,39}$ = 2.706, P = 0.022	$F_{3,39}$ = 249.967, P = 8.428E-20
Dissolved oxygen	-	$F_{3,39}$=120.100, P=9.990E-16
Total alkalinity	$F_{9,39}$ = 4.057, P = 0.002	$F_{3,39}$=293.610, P=1.032E-20
Total hardness	$F_{9,39}$ = 6.239, P = 9.589E-05	$F_{3,39}$=354.516, P=8.700-22
Biotic factor		
Rotifera richness	$F_{9,39}$ = 14.637, P = 2.982E-05	$F_{3,39}$=84.637, P=7.530E-14

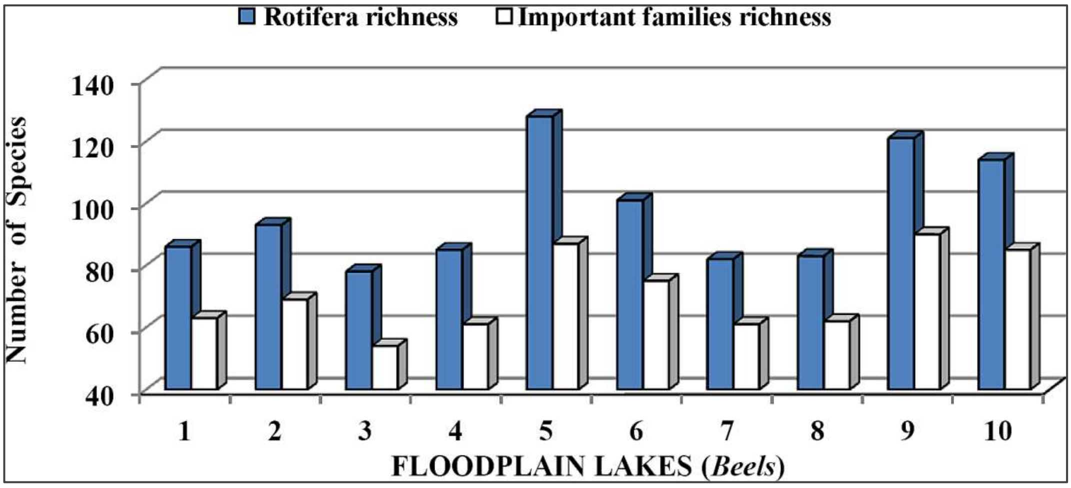

Figure 2. Richness of Rotifera and important families in the Majuli *beels*
1–Mohorichuk, 2–Baalichapori, 3–Dighaliya, 4–Karatipar, 5–Lingri, 6–Khorkhoria, 7–Gokhai, 8–Noldunga, 9–Bor, 10–Baatomaari

species) amongst the *beels* and between 50±3–71±6 species in individual *beels* (50±3–71±6 species). The spatio-temporal significance (vide ANOVA) of Rotifera richness variations between *beels* and seasons is indicated in Table 3. Our collections reveal the speciose constellations of 76–81 species in three *beels* during winter and 76 species in one *beel* during pre-monsoon.

The globally interesting species observed in our Majuli collections include the Australasian *Brachionus dichotomus reductus* and *B. kostei*; the Oriental *Filinia camasecla*, *Keratella edmondsoni*, *Lecane blachei, L. niwati* and *L. superaculeata*; the Paleotropical *Keratella javana*, *Lepadella discoidea*, *L. vandenbrandei*, *Lecane eswari*, *L. lateralis*, *L. simonneae*, *L. stichoclysta*, *L. unguitata*, *Testudinella brevicaudata*, *T. greeni*, and *T. hollaerti*; the Indian endemic *Testudinella* sp.; the Holarctic *Lecane elongata* and *Trichocerca uncinata*; the Palaearctic *Cephalodella trigona* and *Lecane bifastigata*; the Indo-Chinese *Lecane dorysimilis*; the cosmo (sub) tropical *Brachionus durgae*; and three other species namely *Lecane rhenana, Testudinella amphora* and *Trichocerca edmondsoni*.

DISCUSSION

The Majuli *beels* indicate 'slightly acidic to circum-neutral, moderately hard and oxygenated' waters, water temperature concurs with geographical location of this river island, and total alkalinity is attributed to bicarbonate ions. Low specific conductivity denotes low ionic concentrations, highlights 'de-mineralized nature' and warrants inclusion of the sampled *beels* under 'Class I category' of trophic classification *vide* Talling & Talling (1965). ANOVA affirms significant spatial (between *beels*) and temporal (seasonal) variations of specific conductivity, total alkalinity and total hardness register, while water temperature, pH and dissolved oxygen register significant seasonal variations.

The present study reveals a total of 170 rotifer species belonging to 37 genera and 19 families. The reported taxa represent significant fractions of species (~39%, ~56% and ~68%), genera (~54%, ~61% and ~80%) and families (76%, 79% and 94%) of the phylum known from India, NEI and Assam, respectively (Sharma & Sharma 2019a, 2021a) and thus highlight the speciose and diverse Rotifera of the Majuli *beels*. The biodiverse nature of the taxon is hypothesized collectively to habitat diversity and environmental heterogeneity of the sampled *beels* due to occurrence of varied macrophytes (Segers *et al*. 1993, Green 2003, Bonecker *et al*. 2005, 2020, Sharma & Sharma 2019a) and the 'Rotiferologist effect' (Fontaneto *et al.* 2012).

The Majuli *beels* reveal diverse Rotifera as compared with the reports from the floodplains of the Danube–Dráva National Park in Hungary (78 species: Schöll & Kiss 2008; 75 taxa: Schöll *et al.* 2010), the river Ravi of Pakistan (101 species: Hussain *et al.* 2016), the Rio Pilcomayo National park (114 species: Jose De Paggi 2001) of Argentina, the river Warta valley of central-western Poland (143 species: Joniak and Kuczynska-Kippen 2016), the lower Vistula river of Poland (Napiórkowski *et al*. 2019), and the La Plata river basin of South America (106 species: Martins *et al*. 2020). The richness known from the limited geographical area of this alluvial floodplain of the Brahmaputra river basin is relatively lower than the well studied wider areas of the floodplains of Upper Paraná River of Brazil (184 species: Bonecker *et al*. 2005, 224 species: Diniz *et al*. 2021) and the Niger delta of Africa (207 species: Segers *et al*. 1993). Further, the rotifer species examined from the Majuli *beels* merit ecological diversity interest as ~70% and ~78% of species of the phylum known from the floodplain lakes of Assam (244 species: Sharma & Sharma 2021a) and Manipur (218 species: Sharma & Sharma 2021a) states of NEI, while comparisons with the floodplains elsewhere from India are not possible because of poor species inventories. Referring to NEI in particular, our species tally concurs with the report from the *beels* of the Barak river basin of south Assam (170 species: Sharma & Sharma 2019b), and broadly compares with the richness

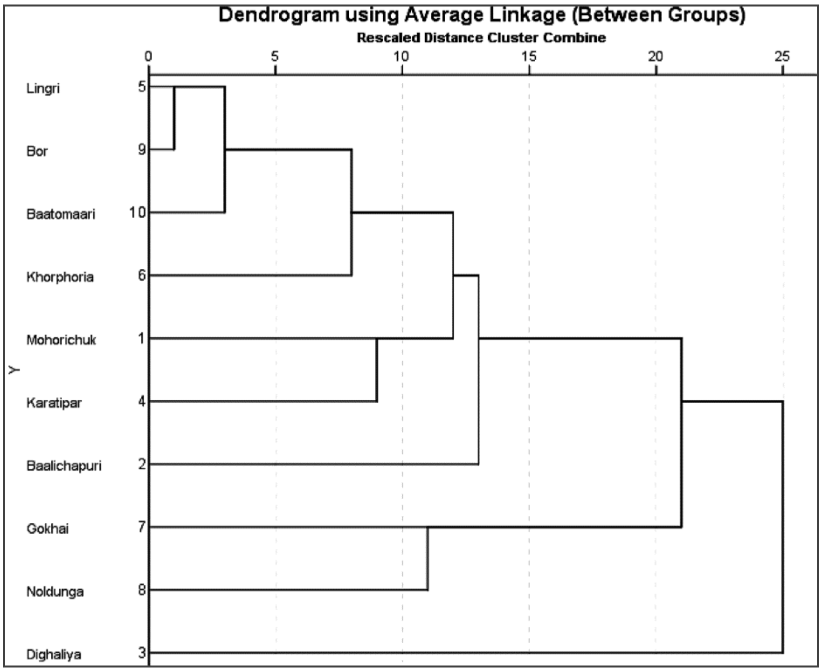

Figure 3. Hierarchical cluster analysis of Rotifera assemblages of the Majuli *beels*

Table 4. Percentage similarities between Rotifera assemblages of the Majuli *beels*

Beels	1	2	3	4	5	6	7	8	9	10
1	-	70.4	63.4	71.3	71.0	70.6	59.5	66.3	71.5	69.0
2		-	71.3	65.2	69.7	70.1	66.3	68.2	69.2	71.5
3			-	67.5	61.2	61.4	60.0	57.1	60.3	64.5
4				-	67.1	67.7	62.3	61.9	71.8	71.3
5					-	69.0	61.9	66.3	79.5	78.5
6						-	69.9	65.2	73.8	75.3
7							-	70.3	61.1	69.4
8								-	67.7	68.0
9									-	77.4
10										-

1–Mohorichuk, 2–Baalichapori, 3–Dighaliya, 4–Karatipar, 5–Lingri, 6–Khorkhoria, 7–Gokhai, 8–Noldunga, 9–Bor, 10–Baatomaari

Table 5. Richness of important Rotifera families in the Majuli *beels*

Families↓ Beels→	1	2	3	4	5	6	7	8	9	10
Lecanidae	32	34	30	30	45	37	29	29	48	40
Lepadellidae	11	15	11	13	18	18	17	14	19	20
Brachionidae	12	11	7	9	11	12	8	11	12	12
Trichocercidae	8	9	6	9	13	8	7	8	11	13
Total species	63	69	54	61	87	75	61	62	90	85

1–Mohorichuk, 2–Baalichapori, 3–Dighaliya, 4–Karatipar, 5–Lingri, 6–Khorkhoria, 7–Gokhai, 8–Noldunga, 9–Bor, 10–Baatomaari

Table 6. Temporal variations of Rotifera Richness in the Majuli *beels*

Beels↓ Richness→	Winter	Pre-monsoon	Monsoon	Post-monsoon	Mean	SD
Mohorichuk	68	64	48	62	61	8
Baalichapori	72	69	50	66	64	8
Dighaliya	60	62	45	57	56	7
Karatipar	67	63	48	59	59	7
Lingri	81	76	56	69	71	9
Khorkhoria	76	69	50	62	64	10
Gokhai	68	66	48	63	61	8
Noldunga	63	65	49	62	60	6
Bor	79	72	55	67	68	9
Baatomaari	72	69	52	63	64	8

known from 15 *beels* of lower Assam (164 species: Sharma 2005), and the *beels* of Barpeta (176 species), Dibrugarh (179 species) and Tinsukia (169 species) districts of Assam (Sharma & Sharma 2021a). The Majuli *beels*, however, indicate relatively speciose Rotifera than the reports from four *beels* of lower Assam (160 species: Sharma *et al*. 2018), 15 *pats* of Manipur state (151 species: Sharma 2009), the floodplain lakes of the Kashmir Himalayas (140 species: Sharma & Sharma 2018b) and the Gangetic West Bengal (152 species: Sharma & Sharma 2021a), and the Yamuna river floodplains at Delhi (110 species: Arora & Mehra 2003). The stated comparisons highlight the global biodiversity interest of Rotifera of the tropical Majuli *beels* in conformity with the hypothesis of Segers *et al.*(1993) and categorize these wetlands as one of the rotifer-rich environs of the Indian sub-region. The notable meta-diversity increase as compared with earlier survey of the Majuli floodplain lakes (124 species: Sharma *et al.* 2015) is hypothesized to greater micro-habitat diversity of the varied nature of *beels* sampled presently and the sampling intensity following Fontaneto *et al.* (2012). Further, we record distinctly diverse Rotifera than the report from 12 *beels* of the Pobitora wild-life sanctuary of Assam (64 species: Sharma 2006) limited to analysis of only summer assemblages, and caution on comparisons with incomplete species inventories reported elsewhere from the Indian floodplains (Sinha *et al*. 1994; Sanjer and Sharma 1995, Khan 1997, 2002, 2003, Ganesan & Khan 2008, Sharma *et al*. 2011).

Four monogonont families: Lecanidae > Lepadellidae > Trichocercidae ≥ Brachionidae collectively influence (71% species) total Rotifera richness of the Majuli *beels*. Of these, Lecanidae contributes dominant fraction (~32% species), and Brachionidae (~11% species) deserves cautious mention in view of the paucity of *Brachionus* species; the latter is attributed to slightly acidic to circum-neutral nature of the sampled *beels* concurrent with the reports of Sharma & Sharma (2018a, 2021b). Testudinellidae, Notommatidae, Euchlanidae and Mytilinidae contribute ~16% species. Three genera *Lecane* > *Lepadella* = *Trichocerca* collectively influence total richness (~56% species), and *Testudinella* (9 species) deserves mention *vis-à-vis* richness known from India (Sharma & Sharma 2021a). Our study, however, registers notably high richness of *Lecane*, *Trichocerca* and *Testudinella* in contrast to earlier limited survey of the Majuli *beels* (Sharma *et al*. 2015).

The richness importance of the stated taxa imparts the littoral-periphytic nature to Rotifera of the sampled *beels* concurrent with the remarks of Sharma & Sharma (2019a). The predominance of Lecanidae, represented by ‘the tropic centered’ *Lecane*, concurs with Southeast Asian Rotifera (Segers 2001, Sa-Ardrit *et al*. 2013); this notable feature also corresponds the composition of the rotifer assemblages from the floodplain lakes of Argentina (Jose De Paggi 2001), Brazil (Bonecker *et al*. 2005, 2020) and Africa (Green 2003).

Our collections include 28 species (16.5 %) of the global biogeographic importance; these merit interest as notable fractions (~25%, ~37 % and ~51%) of globally important species known to-date from India (Sharma & Sharma 2021a), and NEI and Assam (Sharma & Sharma 2019a), respectively. Amongst these, two Australasian, five Oriental, 11 Paleotropical and one Indo-Chinese species impart distinct affinity of Rotifera of the Majuli *beels* with the Southeast Asian and Oriental faunas. We hypothesize incursion of these elements through the 'Assam gateway'– a unique biogeographic corridor of India following the remarks of Sharma & Sharma, (2019a, 2021a). Besides, the reports of the tropical-latitude populations of the Holarctic *Lecane elongata* and *Trichocerca uncinata*, and the Palaearctic *Cephalodella trigona* and *Lecane bifastigata* deserve biogeography interest. The globally interesting species, however, mark a distinct contrast to only 10 such species listed vide earlier survey (Sharma *et al*. 2015). Further, our study reveals 27 species (15.9%) with their Indian distribution known to-date restricted to NEI, 23 species (13.5%) indicate regional distribution interest in India, and *Mytilina michelangellii* exhibits restricted disjunct distribution with reports from NEI and the Kashmir Himalayas (Sharma & Sharma 2018b). The present study thus highlights both the global and regional biogeography interest of Rotifera of the Majuli *beels*.

Rotifera record notable richness variations (97±17 species) amongst the Majuli *beels*. Lingri and Bor reveal 128 and 121 species, and Baaomaari, Khorkhoria and Baalichapori *beels* record 114, 101 and 93 species respectively. Higher richness reported from the stated wetlands with more diverse aquatic macrophytes differs from lower richness (78–86 species) observed from the remaining five *beels* invaded by *Eichhornia crassipes*. The richness variations are thus hypothesized to habitat heterogeneity amongst the sampled *beels* resulting from varied macrophytes while specific observations on the rotifer-macrophytic associations are desired from the study area and even on the Indian Rotifera (Sharma & Sharma 2021a). High richness known individually from Lingri, Bor, Baatomaari and Khorkhoria *beels* merits biodiversity interest as compared with the reports from Thale-Noi Lake (106 species: Segers & Pholpunthin 1997) of Thailand; Lake Guarana (130 species: Bonecker *et al*. 1994) of Brazil; Oguta Lake from Niger delta (124 species: Segers *et al*. 1993) of Africa; Laguana Bufeos (104 species: Segers *et al*. 1998) of Bolivia; and certain *beels* from Assam (103 species, Sharma 2005; 124 species, Sharma *et al*. 2018) and *pats* of Manipur (120 species: Sharma 2009). Besides, our study (78–128 species) indicates Rotifera ecological diversity interest as compared with the reports of 71–103 (Sharma 2005) and 69–93 (Sharma & Sharma 2008) from various *beels* of Assam, and 62–120 species from 15 *pats* of Manipur (Sharma 2009). Further, we report higher richness variations (97±17 species) than earlier survey from the Majuli (77±12 species: Sharma *et al*. 2015) with the majority of *Eichhornia crassipes* infested *beels* indicating 60–82 species.

The rotifer assemblages of the different Majuli *beels* register 57.1–79.5% community similarities (*vide* Sørensen's index); peak affinity is noted between the speciose Lingri and Bor *beels*, while Dighaliya and Noldunga register the lowest similarity. Lower community similarity values (61–70%) in ~59% instances in the similarity matrix affirm heterogeneity of species composition amongst the different *beels*. The species heterogeneity is further affirmed by the hierarchical cluster groupings which endorse the closer affinity between Lingri and Bor while Dighaliya > Gokhai > Noldunga *beels* register distinct divergence. The rotifer heterogeneity is apparently influenced by rare occurrence of ~51% species amongst the *beels*. Lecanidae, Lepadellidae, Trichocercidae, and Brachionidae collectively (71±12 species) influence total richness variations (97±17 species), record rare occurrence of 24, 11, 12 and 11 species respectively, and notably contribute to species heterogeneity amongst the sampled *beels*. Our results present a notable contrast to Rotifera homogeneity reported earlier (Sharma *et al*. 2015) from the Majuli *beels*; this deviation is attributed to greater microhabitat diversity and species heterogeneity of the presently sampled *beels vis-à-vis* occurrence of *Eichhornia crassipes* and species composition variations in majority of *beels* noted in the earlier survey.

Rotifera richness registers the spatio-temporal variations in the Majuli *beels* during the present study. This trend is supported by the seasonal species tally varying between 45–62 (56±7) – 56–81 (71±9) species in individual *beels*, and between 62–76(68±4), 45–55 (50±3), 57–67(63±3) and 60–81 (71±6) species amongst the *beels* during pre-monsoon, monsoon, post-monsoon and winter seasons, respectively, and is affirmed by the significant seasonal richness variations in individual *beels* and seasonal richness differences amongst the *beels* noted vide ANOVA. Further, all the sampled *beels* record lowest richness during monsoon, the species tally registers partial increase during post-monsoon, and eight *beels* (except Dighaliya and Noldunga) indicate peak richness during winter. Low monsoon richness is hypothesized to increased turbidity and loss of macrophytes due to flooding of these wetlands, while habitat heterogeneity associated with the growth of diverse macrophytes during winter is hypothesized to result in peak richness in majority of the sampled *beels*. Nevertheless, specific observations are desired to affirm the stated remarks. In general, the seasonal richness variations broadly concur with the reports of Sharma (2005) and Sharma & Sharma (2008). The present study, however, lacks significant influence of individual abiotic factors namely water temperature, specific conductivity, dissolved oxygen, total alkalinity and total hardness on the rotifer richness variations of the sampled *beels*.

Our study reveals the speciose winter constellations of 76–81 rotifer species in three *beels* and that 76 species in one *beel* during pre-monsoon. These notable constellations, categorized as 'Rotifera paradox' analogous to the reports of Sharma & Sharma (2019a, 2021a) as well as the classical 'paradox of the plankton' *vides* Hutchinson (1961), depict an intriguing possibility of the co-existence of a number of species due to high amount of niche overlap as hypothesized by MacArthur (1965). The stated assemblages concur with the consortia of 79 species from Deepor beel (Sharma & Sharma 2013) of Assam, and 79 species from Loktak Lake (Sharma *et al*. 2016) of Manipur as well as with the recent reports of 85 species each (December and January samples) from Deepor beel, and 84 and 81 species (during May and June) from a *beel* of upper Assam (Sharma & Sharma 2021a). Nevertheless, our results differ distinctly from the earlier reports of only 53 and 54 species per sample from Doriya and Chereki *beels* from the Majuli floodplain (Sharma *et al*. 2015).

Sládeček (1983) proposed $Q_{B/T}$ quotient based on the ratios between *Brachionus*: *Trichocerca* species to depict trophic status of different ecosystems or individual samples. Sharma (2005) and Sharma *et al*. (2018) ascertained suitability of application of Sládeček's quotient to certain *beels* of Assam. Besides, Sharma *et al*. (2018) proposed $Q_{L/B}$ quotient based on *Lecane*: *Brachionus* species ratios to characterize habitat nature as well as temporal habitat variations of the selected *beels* of lower Assam. Application of the two quotients depicts limitation due to the paucity of *Brachionus* species reported vide the present study from acidic-circumneutral waters of the Majuli *beels*.

To conclude, the rich and diverse Rotifera of the 'slightly acidic to circum-neutral, moderately hard-water and de-mineralized' Majuli *beels* reveal sizeable fractions of species of global and regional biogeography interest, and register affinity with Southeast Asian and Oriental faunas. Total richness variations and heterogeneity of species composition are attributed to habitat heterogeneity amongst the *beels*. The significant spatio-temporal variations of species richness with seasonal differences amongst the *beels* and individually in each *beel,* the qualitative predominance of Lecanidae, the species-rich *Lepadella*, *Trichocerca* and *Testudinella* and the paucity of *Brachionus* species are interesting features. The noteworthy instances of speciose constellations of 76–81 species highlight ability of co-existence of high number of species in these ecotones. The plankton and semi-plankton collections examined from the Majuli *beels* result in the paucity of the sessile and bdelloid rotifers, while the observations on Rotifera-macrophytic associations deserve attention. Our study is a useful contribution to ecological diversity Rotifera from the floodplain lakes of India and elsewhere from the tropics and subtropics.

Acknowledgements – The study is supported by the Ministry of Environment, Forests and Climate Change (Govt. of India) sponsored project. The senior author thanks the Head, Department of Zoology, NEHU, Shillong for laboratory facilities, and Messer's A. Hazarika, B. Hazarika and D. Thakuria for logistic support to facilitate the field work. We thank our anonymous reviewers for the comments and suggestions. The authors declare no conflict of interests.

REFERENCES

A.P.H.A. (1992): *Standard methods for the examination of water and wastewater* (18th Ed.) American Public Health Association, Washington D.C. 2538 pp.

ARORA, J. & MEHRA, N.K. (2003): Species diversity of planktonic and epiphytic rotifers in the backwaters of the Delhi segment of the Yamuna River, with remarks on new records from India. *Zoological Studies*, 42(2): 239–247.

BONECKER, C.C., COSTA, C.L.D., VELHO, L.F.M. & LANSAC-TÔHA, F.A. (2005): Diversity and abundance of the planktonic rotifers in different environments of the Upper Paraná River floodplain (Paraná State – Mato Grosso do Sul State, Brazil). *Hydrobiologia,* 546: 405–414. doi: 10.1007/s10750-005-4283-2

BONECKER, C.C., DINIZ, L.P., BRAGHIN, L.S.M., MANTOVANO, T., SILVA, J.V.F., BOMFIM, F.F. & LANSAC-TÔHA, F.A. (2020): Synergistic effects of natural and anthropogenic impacts on zooplankton diversity in a subtropical floodplain: A long-term study. *Oecologia Australis*, 24: 524−537.

doi: 10.4257/oeco.2020.2402.20

BONECKER, C.C., LANSAC-TÔHA, F.A. & STAUB, A. (1994): Qualitative study of Rotifers in different environments of the high Parana River floodplain (Ms), Brazil. *Revista UNIMAR,* 16: 1–16.

CHANDRA, K., BHARTI, D., KUMAR, S., RAGHUNATHAN, C., GUPTA, D., ALFRED, J.R.B. & CHOWDHURY, B.R. (2021): *Faunal Diversity in Ramsar Wetlands of India*. Jointly published by Zoological Survey of India, and Wetland division, Ministry of Environment, Forest and Climate Change, Government of India, 292 pp.

DATTA, T. (2011): Zooplankton diversity and physico-chemical conditions of two wetlands of Jalpaiguri district, India. *International Journal of Applied Biology and Pharmaceutical Technology,* 2(3): 576–583.

DEMBOWSKA, E.A. & NAPIÓRKOWSKI, P. (2015): A case study of the planktonic communities in two hydrologically different oxbow lakes, Vistula River, Central Poland. *Journal of Limnology*, 74(2): 326–337. doi: 10.4081/jlimnol.2014.1057

DINIZ, L.P., PETSCH D.K. & BONECKER C.C. (2021): Zooplankton β diversity dynamics and metacommunity structure depend on spatial and temporal scales in a Neotropical floodplain. *Freshwater Biology,* 66(7): 1328–1342. doi: 10.1111/fwb.13719

FONTANETO, D., MÁRCIA BARBOSA, A., SEGERS, H. & PAUTASSO, M. (2012): The 'rotiferologist' effect and the other global correlates of species richness in rotifers. *Ecography,* 35: 174–182.

doi: 10.1111/j.1600-0587.2011.06850.x

FUNK, A., RECKENDORFER, W., KUCERA-HIRZINGER, V., RAAB R. & SCHIEMER, F. (2009): Aquatic diversity in a former floodplain: Remediation in an urban context. *Ecological Engineering,* 35: 1476–1484. doi: 10.1016/j.ecoleng.2009.06.013

GANESAN, L & KHAN, R.A. (2008): *Studies on the ecology of zooplankton in a floodplain wetland of West Bengal*. In: SENGUPTA, M. & DALWANI, R. (Eds.) Proceeding of Taal 2007, the 12th World Lake Conference, p. 67–73.

doi: 10.1016/j.ecoleng.2009.06.013

GÓRSKI, K., COLLIER, K.J., DUGGAN, I.C., TAYLOR, C.M. & HAMILTON, D.P. (2013): Connectivity and complexity of floodplain habitats govern zooplankton dynamics in a large temperate river system. *Freshwater Biology,* 58: 1458–1470. doi: 10.1111/fwb.12144

GREEN, J. (2003): Associations of planktonic and periphytic rotifers in a tropical swamp, the Okavango Delta, Southern Africa. *Hydrobiologia*, 490: 197–209. doi: 10.1023/A:1023475217987

HUSSAIN, A., SULEHRIA, A.Q.K., EJAZ, M. & MAQBOOL, A. (2016): Population dynamics of rotifers in the floodplain of river Ravi, Pakistan. *Pakistan Journal of Zoology,* 48(1): 215–225.

HUTCHINSON, G.E. (1961): The paradox of the plankton. *American Naturalist,* 95: 137–145. doi: 10.1086/282171

JONIAK, T. & KUCZYNSKA-KIPPEN, N. (2016): Habitat features and zooplankton community structure of oxbows in the limnophase: reference to transitional phase between flooding and stabilization. *Limnetica,* 35 (1): 37–48. doi: 10.23818/limn.35.03

JOSÉ DE PAGGI, S. (2001): Diversity of Rotifera (Monogononta) in wetlands of Rio Pilcomayo national park, Ramsar site (Formosa, Argentina). *Hydrobiologia,* 462: 25–34. doi: 10.1023/A:1013157914860

KHAN, M.A. (1987): Observations on Zooplankton composition, abundance and periodicity in two flood‒plain lakes of the Kashmir Himalayan valley. *Acta Hydrochemica et Hydrobiologica*, 15: 167–174. doi: 10.1002/aheh.19870150211

KHAN, R.A. (2002): The ecology and faunal diversity of two floodplain Ox-bow lakes of South-Eastern West Bengal. *Records of the Zoological Survey of India, Occasional Paper No*. 195: 1–57.

KHAN, R.A. (2003): Faunal diversity of zooplankton in freshwater wetlands of South-eastern West Bengal. *Records of the Zoological Survey of India, Occasional Paper No.* 204: 1–107.

MACARTHUR, R.H. (1965): Patterns of species diversity. *Biological Review,* 40: 510–533. doi: 10.1111/j.1469-185X.1965.tb00815.x

MARTINS, B.A., COELHO, P.N., NOGUEIRA, M. & PERBICHE-NEVES, G. (2020): Composition and richness of monogonont rotifers from La Plata River Basin, South America. *Biota Neotropica*, 20(4): e20201001. doi: 10.1590/1676-0611-BN-2020-1001

NAPIÓRKOWSKI, P., BĄKOWSKA, M., MROZIŃSKA, N., SZYMAŃSKA, M., KOLAROVA, N. & OBOLEWSKI, K. (2019): The effect of hydrological connectivity on the zooplankton structure in floodplain lakes of regulated large river (the Lower Vistula, Poland). *Water,* 11: 1924: 2–17. doi: 10.3390/w11091924

SA-ARDRIT, P., PHOLPUNTHIN, P. & SEGERS, H. (2013): A checklist of the freshwater rotifer fauna of Thailand (Rotifera, Monogononta, Bdelloidea). *Journal of Limnology,* 72(2): 361–375. doi: 10.4081/jlimnol.2013.s2.e18

SANJER, L.R. & SHARMA, U.P. (1995): Community structure of plankton in Kawar lake wetland, Begusarai, Bihar, II Zooplankton. *Journal of Freshwater Biology*, 7: 165–167.

SCHÖLL, K. & KISS, A. (2008.): Spatial and temporal distribution patterns of zooplankton assemblages (Rotifera, Cladocera, Copepoda) in the water bodies of the Gemenc floodplain (Duna-Dráva National Park, Hungary). *Opuscula Zoologica Budapest,* 39: 65–76.

SCHÖLL, K., KISS, A., DINKA, M. & BERCZIK, A. (2010): Flood-pulse effects on zooplankton assemblages in a river-floodplain system (Gemenc Floodplain of the Danube, Hungary). *International Review of Hydrobiology* 97(1): 41–54. doi: 10.1002/iroh.201111427

SEGERS, H. (1995): *Rotifera 2: Lecanidae*. In: DUMONT, H.J. & NOGRADY, T. (Eds.) Guides to identification of the Microinvertebrates of the Continental waters of the world. SPB Academic Publishing bv. Amsterdam, the Netherlands, No. 6, 226 pp.

SEGERS, H. (2001): Zoogeography of the Southeast Asian Rotifera. *Hydrobiologia,* 446/447: 233–246. doi: 10.1023/A:1017524011783

SEGERS, H., FERRUFINO, N.L. & DE MEESTER, L. (1998): Diversity and Zoogeography of Rotifera (Monogononta) in a flood plain lake of the Ichilo River, Bolivia, with notes on little known species. *International Review of Hydrobiology,* 83(5–6): 439–448. doi: 10.1002/iroh.19980830512

SEGERS, H, NWADIARO, C.S. & DUMONT, H.J. (1993): Rotifera of some lakes in the floodplain of the river Niger (Imo State, Nigeria). II. Faunal composition and diversity. *Hydrobiologia*, 250: 63–71. doi: 10.1007/BF00007495

SEGERS, H. & PHOLPUNTHIN, P. (1997): New and rare Rotifera from Thale Noi Lake, Pattalang Province, Thailand, with a note on the taxonomy of *Cephalodella* (Notommatidae). *Annals de Limnlogie*, 33: 13–21. doi: 10.1051/limn/1997001

SHARMA, B.K. (1983): The Indian species of the genus *Brachionus* (Eurotatoria: Monogononta: Brachionidae). *Hydrobiologia*, 104: 31–39. doi: 10.1007/bf00045949

SHARMA, B.K. (2005): Rotifer communities of floodplain lakes of the Brahmaputra basin of lower Assam (N. E. India): biodiversity, distribution and ecology. *Hydrobiologia*, 533: 209–221. doi: 10.1007/s10750-004-2489-3

SHARMA, B.K. (2009): Rotifer communities of floodplain lakes of Manipur (North-East India), biodiversity, distribution and ecology. *Journal of the Bombay Natural History Society,* 106(1): 45–56.

SHARMA, B.K., HAOKIP, T.P. & SHARMA, S. (2016): Loktak Lake, Manipur, northeast India: a Ramsar site with rich rotifer (Rotifera: Eurotatoria) diversity and its meta-analysis. *International Journal of Aquatic Biology,* 4(2): 69–79. doi: 10.7508/ijab.2016.02.001

SHARMA, B.K., KHAN, S.I. & SHARMA, S. (2018): Biodiverse rotifer assemblage (Rotifera: Eurotatoria) of floodplain lakes of the Brahmaputra basin of lower Assam, northeast India: composition and ecosystem diversity. *Journal of Oceanology and Limnology*, 36(2): 362–375. doi: 10.1007/s00343-017-6251-x

SHARMA, B.K. & SHARMA, S. (1999): Freshwater rotifers (Rotifera, Eurotatoria). *Fauna of Meghalaya, State Fauna Series, Zoological Survey of India, Calcutta,* 4(9): 11–161.

SHARMA, B.K. & SHARMA, S. (2000): Freshwater rotifers (Rotifera, Eurotatoria). *Fauna of Tripura, State Fauna Series*, *Zoological Survey of India, Calcutta*, 7(4): 163–224.

SHARMA, B.K. & SHARMA, S. (2001): Biodiversity of Rotifera in some tropical floodplain lakes of the Brahmaputra river basin, Assam (N. E. India). *Hydrobiologia,* 446/447: 305–313. doi: 10.1023/a:1017517822377

SHARMA, B.K. & SHARMA, S. (2014a): Northeast India – An important region with a rich biodiversity of Rotifera. In: SHARMA, B.K., DUMONT, H.J. & WALLACE, R.L. (Eds.) Rotifera XIII: Rotifer Biology – A structural and functional Approach. *International Review of Hydrobiology*, 99(1–2): 20–37. doi: 10.1002/iroh.201301701

SHARMA, B.K. & SHARMA, S. (2014b): Indian Lecanidae (Rotifera: Eurotatoria: Monogononta) and its distribution. In: SHARMA, B.K., DUMONT, H.J. & WALLACE, R.L. (Eds.) Rotifera XIII: Rotifer Biology – a Structural and Functional Approach. *International Review of Hydrobiology*, 99(1–2): 38–47. doi:10.1002/iroh.201301702

SHARMA, B.K. & SHARMA, S. (2014c): The diversity of Indian Brachionidae (Rotifera: Eurotatoria: Monogononta) and their distribution. *Opuscula Zoologica Budapest,* 45(2): 165–180.

SHARMA, B.K. & SHARMA, S. (2015): The diversity and distribution of Lepadellidae (Rotifera: Eurotatoria: Monogononta) of India. *International Review of Hydrobiology*, 100(1): 34–42. doi: 10.1002/iroh.201401739

SHARMA, B.K. & SHARMA, S. (2018a): Loktak Lake, Manipur revisited: A Ramsar site as the rotifer (Rotifera: Eurotatoria) biodiversity hot-spot of the Indian sub-region. *Bonn zoological Bulletin,* 67(1): 5–13.

SHARMA, B.K. & SHARMA, S. (2018b): The rotifers (Rotifera: Eurotatoria) from the Kashmir Himalayan floodplains and Rotifera biodiversity of Jammu & Kashmir, north India. *International Journal of Aquatic Biology*, 6(4): 208–220. doi: 10.22034/ijab.v6i4.507

SHARMA, B.K. & SHARMA, S. (2019a): The biodiverse rotifers (Rotifera: Eurotatoria) of Northeast India: faunal heterogeneity, biogeography, ecosystem diversity and interesting species assemblages. *Bonn zoological Bulletin,* 68(1):147–162. doi: 10.20363/BZB-2019.68.1.147

SHARMA, B.K. & SHARMA, S. (2019b): The biodiverse rotifers (Rotifera: Eurotatoria) of the floodplain wetlands of Barak valley of Assam state, northeast India. *Opuscula Zoologica Budapest,* 50(1): 3–15. doi: 10.18348/opzool.2019.1.3

SHARMA, B.K. & SHARMA, S. (2021a): Biodiversity of Indian Rotifers (Rotifera) with remarks on biogeography and richness in diverse ecosystems. *Opuscula Zoologica Budapest,* 52(1): 69–97. doi: 10.18348/opzool.2021.1.69

SHARMA, B.K. & SHARMA, S. (2021b): Zooplankton diversity of a sub-tropical small urban wetland of Meghalaya, northeast India with remarks on spatial variations. *Journal of Limnology & Freshwater Fisheries Research,* 7(1): 213–228. doi: 10.17216/limnofish-754060

SHARMA, B.K., SHARMA, S. & HATIMURIA, M.K. (2015): Rotifer assemblages (Rotifera: Eurotatoria) of the floodplain lakes of Majuli River Island, the Brahmaputra river basin, northeast India. *International Journal of Aquatic Biology,* 3(1): 1–13.

SHARMA, G., SINHA, P & SINHA, P. (2011): Zooplankton diversity. *Faunal Diversity of Chaurs of North Bihar*, *Wetland Ecosystem Series*, *Zoological Survey of India, Kolkata*, 14: 7–19.

SHARMA, S. (2006): Rotifer diversity (Rotifera: Eurotatoria) of floodplain lakes of Pobitora Wild-Life Sanctuary, Assam. *Records of the Zoological Survey of India,* 106(3): 76–89.

SHARMA, S. & SHARMA, B.K. (2008): Zooplankton diversity in floodplain lakes of Assam. *Records of the Zoological Survey of India, Occasional Paper No.* 290: 1–307.

SHARMA, S. & SHARMA, B.K. (2013): Faunal diversity of aquatic invertebrates of Deepor Beel (a Ramsar site), Assam, northeast India. *Wetland Ecosystem Series, Zoological Survey of India, Kolkata*, 17: 1–226.

SHIEL, R.J., GREEN, J.D. & NIELSEN, D.L. (1998.): Floodplain biodiversity: why are there so many species? *Hydrobiologia*, 387/388: 39–46. doi: 10.1023/A:1017056802001

SINHA, A.K., BARUAH, A., SINGH, D.K. & SHARMA, U.P. (1994): Biodiversity and pollution status in relation to physico-chemical factors of Kawar Lake (Begusarai), North Bihar. *Journal of Freshwater Biology*, 6: 309–331.

SLADECEK, V. (1983): Rotifera as indicators of water quality. *Hydrobiologia*, 100: 169–201. doi: 10.1007/BF00027429

SØRENSEN, T. (1948): A method of establishing group of equal amplitude in plant sociology based on similarity of species content and its application to analyse the vegetation of Danish commons. *Biologiske Skrifter*, 5: 1–34.

TALLING, J.F. & TALLING, I.B. (1965): The chemical composition of African lake waters. *Internationale Revue der gesamten Hydrobiologie,* 50: 421–463. doi: 10.1002/iroh.19650500307

Appendix 1: Species composition of Rotifera assemblages of the Majuli *beels*

Rotifer taxa↓ Beels→	1	2	3	4	5	6	7	8	9	10
Order: Ploima										
Subclass: Monogononta										
Family: Asplanchnidae										
Asplanchna priodonta Gosse,1850**	-	+	+	+	+	+	+	-	+	+
Family: Brachionidae										
Anuraeopsis fissa Gosse,1851**	+	+	-	+	+	+	+	+	+	-
Brachionus angularis Gosse,1851*	+	-	-	-	-	-	-	-	+	+
B. calyciflorus Pallas,1766*	+	-	-	-	+	-	-	+	-	+
B. dichotomus reductus Koste & Shiel,1980*	-	+	-	-	-	-	-	+	-	-
B. diversicornis (Daday,1883) *	-	-	-	+	-	+	-	-	-	-
B. durgae Dhanapathi,1974*	-	-	-	-	-	+	+	-	-	+
B. falcatus Zacharias,1898	+	-	+	-	+	+	-	+	+	+
B. kostei Shiel,1983*	-	-	-	-	-	+	-	+	-	-
B. mirabilis Daday,1897*	+	-	-	+	+	-	-	-	+	-
B. quadridentatus Hermann,1783**	+	+	+	+	+	+	+	+	+	+
Keratella cochlearis (Gosse,1851) **	+	+	+	+	+	+	+	+	+	+
K. edmondsoni Ahlstrom,1943*	-	+	-	-	+	-	-	-	-	+
K. javana Hauer,1937*	+	-	-	-	-	-	-	-	+	-
K. lenzi Hauer,1953*	+	+	-	+	+	-	-	-	+	+
K. tecta (Gosse,1851)	-	+	-	-	-	+	+	+	-	+
K. tropica (Apstein,1907) **	+	+	+	+	+	+	+	+	+	+
Platyias leloupi (Gillard,1967) *	-	+	+	-	-	-	-	-	+	-
P. quadricornis (Ehrenberg,1832) **	+	+	+	+	+	+	+	+	+	+
Plationus patulus (O.F.Muller,1786) **	+	+	+	+	+	+	+	+	+	+
Family: Dicranophoridae										
Dicranophoroides caudatus (Ehrenberg,1834) *	+	-	-	+	+	-	-	-	+	-
Dicranophorus forcipatus (O.F.Müller,1786) *	-	-	-	-	+	-	-	+	-	-
Family: Euchlanidae										
Beauchampiella eudactylota (Gosse,1886) **	+	+	+	+	+	+	-	-	+	+
Dipleuchlanis propatula (Gosse,1886) **	+	-	+	+	+	+	+	+	+	+
Euchlanis dilatata Ehrenberg,1832**	+	+	+	+	+	+	+	+	+	+
E. incisa Carlin,1939*	-	-	+	+	+	-	-	-	+	+
E. triquetra Ehrenberg,1838*	+	+	-	-	+	-	-	-	+	+
Tripleuchlanis plicata (Levander,1894)	-	+	+	+	+	-	+	+	-	+
Family: Flosculariidae										
Sinantherina socialis (Linne,1758)	-	+	-	-	+	+	+	+	+	+
S. spinosa (Thorpe,1893) **	+	+	+	+	+	+	+	+	+	+
Family: Gastropodidae										
Ascomorpha ovalis (Bergendal,1892) *	-	-	-	-	+	-	-	-	-	-
Family: Lecanidae										
Lecane aculeata (Jakubski,1912)	+	+	+	+	+	+	=	=	+	+
L. aeganea Harring,1914*	-	-	+	+	+	-	-	-	+	+
L. arcula Harring,1914*	-	-	-	-	+	+	+	-	+	-
L. bifastigata Hauer,1938*	+	-	-	+	+	-	-	+	+	+
L. bifurca (Bryce,1892)	+	-	-	-	+	-	+	+	+	+
L. blachei Berzins,1973	-	+	+	+	-	+	+	-	+	+
L. bulla (Gosse,1851) **	+	+	+	+	+	+	+	+	+	+
L. closterocerca (Schmarda,1859)**	+	+	+	+	+	+	+	+	+	+
L. crepida Harring,1914	-	+	+	-	+	+	-	-	+	+
L. curvicornis (Murray,1913) **	+	+	+	+	+	+	+	+	+	+

Rotifer taxa↓ Beels→	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Lecane decipiens (Murray,1913) *	-	-	-	-	-	+	-	-	+	+
L. doryssa Harring,1914	+	+	-	-	+	+	-	+	+	+
L. dorysimilis Trinh Dang, Segers & Sanoamuang,2015*	-	-	-	-	+	-	+	-	+	+
L. elegans Harring,1914*	-	+	-	-	+	-	-	-	-	-
L. elongata Harring & Myers,1926*	+	-	-	-	-	-	-	-	+	-
L. eswari Dhanapathi,1976*	-	-	+	-	+	-	-	-	-	-
L. flexilis (Gosse,1886)	-	+	-	-	+	-	+	+	+	+
L. furcata (Murray,1913) **	+	+	+	+	+	+	+	+	+	+
L. haliclysta Harring & Myers,1926*	+	-	-	-	+	+	-	-	+	+
L. hamata (Stokes,1896) **	+	+	+	+	+	+	+	+	+	+
L. hastata (Murray,1913) *	-	-	+	+	-	-	-	-	-	+
L. hornemanni (Ehrenberg,1834)	+	+	-	+	+	+	-	-	+	+
L. inermis (Bryce,1892)	+	+	+	-	+	-	-	+	+	+
L. inopinata Harring & Myers,1926	+	+	-	-	+	+	-	-	+	-
L. lateralis Sharma,1978	+	-	+	+	+	+	+	+	-	-
L. leontina (Turner,1892) **	+	+	+	+	+	+	+	+	+	+
L. ludwigii (Eckstein,1883) **	+	+	+	+	+	+	+	+	+	+
L. luna (O.F. Müller,1776) * *	+	+	+	+	+	+	+	+	+	+
L. lunaris (Ehrenberg,1832) **	+	+	+	+	+	+	+	+	+	+
L. monostyla (Daday,1897) *	-	+	-	-	+	+	-	+	+	-
L. nitida (Murray,1913) *	-	+	+	-	+	-	+	+	+	-
L. niwati Segers, Kotethip & Sanoamuang,2004*	-	-	-	+	+	+	-	-	+	+
L. obtusa (Murray,1913) **	+	+	+	+	+	+	-	-	+	+
L. ohioensis (Herrick,1885) **	+	+	-	+	-	+	+	+	+	+
L. papuana (Murray, 1913) **	+	+	+	+	+	+	+	+	+	+
L. paxiana Hauer, 1940*	-	-	-	+	+	+	-	-	+	-
L. ploenensis (Voigt,1902) **	+	+	+	+	+	+	+	+	+	+
L. pusilla Harring, 1914*	+	+	+	-	-	-	+	-	+	+
L. pyriformis (Daday,1905) **	+	+	+	+	+	+	+	+	+	+
L. quadridentata (Ehrenberg,1830) **	+	+	+	+	+	+	+	+	+	+
L. rhenana Hauer,1929*	+	-	-	-	+	-	-	+	+	+
L. rhytida Harring & Myers,1926*	-	-	-	-	-	+	+	-	-	-
L. signifera (Jennings, 1896)	+	+	+	+	+	+	+	+	+	+
L. simonneae Segers,1993*	-	-	-	+	+	-	-	-	+	+
L. stichoclysta Segers,1993*	-	-	-	-	+	-	-	-	+	-
L. stenroosi (Meissner,1908) **	+	+	+	+	+	+	-	-	+	+
L. styrax (Harring & Myers,1926) **	-	+	-	+	+	+	+	+	+	+
L. subtilis Harring & Myers,1926*	+	-	-	-	+	-	-	-	-	-
L. superaculeata Sanoamuang & Segers,1997*	-	+	-	-	-	-	-	-	+	-
L. syngenes (Hauer,1938) *	-	-	+	-	-	-	-	-	-	-
L. tenuiseta Harring,1914*	-	-	-	-	+	+	-	+	+	+
L. thienemanni (Hauer,1938)*	-	-	+	-	-	+	+	-	+	-
L. undulata Hauer,1938**	-	+	-	-	+	+	+	+	+	+
L. unguitata (Fadeev,1925) **	+	+	+	+	+	+	+	+	+	+
L. ungulata (Gosse,1887) **	+	+	+	+	+	+	+	+	+	+
Family: Lepadellidae										
Colurella adriatica Ehrenberg,1831*	-	-	-	+	+	-	-	+	+	+
C. colurus (Ehrenberg,1830) *	-	+	+	-	-	-	-	-	-	-
C. obtusa (Gosse,1886) **	+	+	+	+	+	+	+	+	+	+
C. sulcata (Stenroos,1898) *	-	-	-	-	+	+	-	-	+	-

Rotifer taxa↓ Beels→	1	2	3	4	5	6	7	8	9	10
Colurella uncinata (O.F.Müller,1773) **	+	+	+	+	+	+	+	+	+	+
Lepadella acuminata(Ehrenberg,1834) **	+	+	-	+	+	+	-	-	+	+
L. apsida Harring,1916	+	+	-	+	+	-	+	-	+	+
L. apsicora Myers,1934	+	-	-	-	+	+	-	+	+	-
L. benjamini Harring,1916**	-	+	+	+	+	+	+	-	+	+
L. biloba Hauer,1958	-	-	+	+	-	+	-	+	+	+
L. costatoides Segers,1992	-	+	-	-	+	+	+	+	-	+
L. dactyliseta (Stenroos,1898) *	-	-	-	-	-	-	+	-	-	-
L. discoidea Segers,1993	+	+	+	-	+	+	-	+	+	+
L. ehrenbergi Perty,1850**	+	+	+	+	+	+	+	+	+	+
L. eurysterna Myers,1942*	-	-	+	-	-	-	-	-	+	+
L. heterostyla (Murray,1913)	-	+	-	+	+	+	+	+	+	+
L. lindaui Koste,1981*	-	-	-	-	+	-	-	-	+	+
L. minuta (Weber & Montet,1918) *	-	+	-	-	-	-	+	+	-	-
L. ovalis (O.F. Muller,1786) **	+	+	+	+	+	+	+	+	+	+
L. patella (O.F. Muller,1773) **	+	+	+	+	+	+	+	+	+	+
L. quinquecostata (Lucks,1912) *	-	-	-	-	-	+	+	-	-	+
L. rhomboides (Gosse,1886	+	+	+	-	-	+	+	+	-	+
L. triba Myers,1934	-	-	-	-	-	+	+	-	+	+
L. triptera Ehrenberg,1832*	-	-	-	+	+	-	+	+	+	+
L. vandenbrandei Gillard,1952*	-	-	-	-	+	+	+	-	-	+
Squatinella lamellaris (O.F. Müller,1786) **	+	+	-	+	+	+	+	-	+	-
Family: Mytilinidae										
Mytilina acanthophora Hauer,1938	+	+	-	-	+	-	+	+	+	-
M. bisulcata (Lucks,1912)	+	-	+	+	-	+	+	-	-	+
M. brevispina (Ehrenberg,1830)	-	-	+	+	+	-	-	-	+	-
M. michelangellii Reid & Turner,1988*	-	-	-	+	-	+	+	+	+	+
M. ventralis (Ehrenberg,1830) **	+	+	+	+	+	+	-	-	+	+
Family: Notommatidae										
Cephalodella forficula (Ehrenberg,1830) *	-	+	+	-	+	-	-	+	+	-
C. gibba(Ehrenberg,1830) **	+	+	+	+	+	+	+	+	-	-
C. mucronata Myers,1924*	-	-	-	-	-	-	-	+	+	-
C. trigona (Rousselet,1895) *	-	+	+	-	+	-	-	-	-	+
Monommata longiseta (O.F. Müller,1786)	+	+	+	+	+	+	-	-	-	+
M. maculata Haring & Myers,1930*	-	-	-	-	+	-	-	-	-	+
Notommata pachyura (Gosse,1886) *	+	-	-	-	-	+	-	-	-	-
Family: Scaridiidae										
Scaridium longicaudum (O.F. Müller,1786)	+	+	-	-	+	+	-	+	+	=
Family: Synchaetidae										
Pleosoma lenticulare Herrick,1885*	-	+	-	-	+	+	+	-	-	+
Polyarthra vulgaris Carlin,1943	+	+	+	+	+	+	+	+	+	+
Order: Flosculariaceae										
Family: Conochilidae										
Conochilus unicornis Rousselet,1892*	-	-	-	-	-	+	+	+	+	+
Family: Hexarthridae										
Hexarthra mira (Hudson,1871) *	-	+	-	-	-	+	-	-	+	+
Family: Testudinellidae										
Testudinella amphora Hauer,1938*	+	-	-	+	+	-	-	+	+	+
T. brevicaudata Yamamoto,1951*	-	-	-	-	+	+	-	-	+	+
T. dendradena de Beauchamp,1955*	-	-	-	+	+	-	-	-	+	-

Rotifer taxa↓ Beels→	1	2	3	4	5	6	7	8	9	10
Testudinella emarginula (Stenroos,1898)**	+	+	+	-	+	+	+	+	+	+
T. greeni Koste,1981*	-	-	+	-	+	-	-	-	-	-
T. parva (Ternetz,1892) *	+	-	-	-	+	-	-	-	-	-
T. patina (Hermann.1783) **	+	+	+	+	+	+	+	+	+	+
T. tridentata Smirnov,1931*	-	-	-	-	+	+	-	+	+	+
T. sp. Sharma and Sharma,2018*	-	+	-	-	-	-	-	-	-	-
Pompholyx sulcata Hudson,1885	+	-	-	+	+	-	+	-	+	+
Family: Trichocercidae										
Trichocerca bidens (Lucks,1912)	+	+	-	+	+	-	-	+	1	+
T. bicristata (Gosse,1887) **	+	-	-	+	+	+	+	+	+	+
T. capucina (Wierzejski & Zacharias,1893)	-	+	+	-	-	-	-	-	-	-
T. cylindrica (Imhof,1891) **	+	+	+	+	+	+	-	-	+	+
T. edmondsoni (Myers,1936) *	-	-	-	-	+	-	-	-	-	+
T. elongata (Gosse,1886) *	-	-	-	+	-	-	+	+	-	+
T. hollaerti De Smet,1990*	-	-	-	+	-	-	-	+	+	-
T. insignis (Herrick,1885) **	+	+	+	-	+	+	+	-	+	+
T. insulana (Hauer,1937) *	-	-	-	-	+	+	-	-	-	+
T. longiseta (Schrank,1802)	-	+	+	+	-	-	-	-	+	-
T. maior Hauer,1936*	-	-	-	+	+	-	-	-	-	+
T. pusilla (Jennings,1903)	+	-	-	-	+	+	-	-	+	-
T. rattus (O.F. Muller,1776) **	+	+	+	+	-	+	+	+	+	+
T. scipio (Gosse,1883) *	-	-	-	-	+	-	+	-	-	+
T. similis (Wierzejski,1893) **	+	+	-	+	+	+	-	+	+	+
T. tenuior (Gosse,1886) *	-	-	-	-	+	-	-	+	+	-
T. tigris (O.F. Muller,1786)	+	+	-	-	+	+	+	+	-	+
T. uncinata (Voigt,1902) *	-	-	+	-	-	-	-	-	-	-
T. voluta (Murray,1913) *	-	+	-	-	-	-	-	-	-	-
T. weberi (Jennings,1903) *	-	-	-	-	+	-	+	-	+	+
Family: Trichotriidae										
Macrochaetus collinsi (Gosse,1867) *	-	-	+	-	+	-	-	-	-	-
M. longipes Myers,1934*	-	+	+	-	+	-	-	+	+	+
M. sericus (Thorpe,1893)	+	+	+	+	+	+	-	-	-	+
Trichotria tetractis (Ehrenberg,1830) **	+	+	+	+	+	+	+	+	+	+
Wolga spinifera (Western,1894) *	-	-	-	-	+	-	-	-	-	-
Family: Trochosphaeridae										
Filinia camasecla Myers,1938*	-	-	-	+	-	+	-	-	+	-
F. longiseta (Ehrenberg,1834) **	+	+	+	+	+	-	+	+	-	+
Trochosphaera aequatorialis Semper,1872*	-	-	-	-	+	+	+	-	-	-
Sub-class: Digononta										
Order: Bdelloidea										
Family: Philodinidae										
Philodina citrina Ehrenberg,1832*	-	-	-	-	+	-	+	-	+	-
Rotaria neptunia (Ehrenberg,1830) *	+	-	-	+	-	+	-	-	+	-
R. rotatoria (Pallas,1766) *	-	-	+	-	+	-	+	-	-	-
TOTAL ROTIFERA RICHNESS	**86**	**93**	**78**	**85**	**128**	**101**	**82**	**83**	**121**	**114**

+ present; - absent; *rare occurrence; **occurring in all beels or nearly in all beels
The sampled beels: 1–Mohorichuk, 2–Baalichapori, 3–Dighaliya, 4–Karatipar, 5–Lingri, 6–Khorkhoria, 7–Gokhai, 8–Noldunga, 9–Bor, 10–Baatomaari

The subfamily Pteromalinae (Chalcidoidea: Pteromalidae) in South-Eastern Iran

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Abstract. A faunistic survey on the parasitic wasps of the subfamily Pteromalinae Dalman, 1820 (Hym., Chalcidoidea, Pteromalidae) of South-Eastern Iran (Kerman province) was done. In total 46 specimens representing 10 genera and 16 species are identified, among them, *Dinarmus altifrons* (Walker, 1862) and *Syntomopus incurvus* Walker, 1833 are recorded for the first time for the fauna of Iran. Previously recorded species of Pteromalinae from this area are also reviewed and listed. Faunistic analysis of the known species according to their distribution both in Iran and in a broader biogeographical sense is also discussed.

Keywords. Parasitoids, Iran, fauna, new records, distribution, map.

INTRODUCTION

Pteromalidae is one of the most diverse families of the parasitic wasps with a worldwide distribution, comprising 33 subfamilies with a wide variety of taxonomic complications (Noyes 2019). About 98% of Pteromalidae are recognised as parasitoids on various stages of insects of many orders or rarely, of spiders, therefore they play a significant role in the control of many pests in agriculture, forestry, and natural areas (Bouček & Rasplus 1991). The subfamily Pteromalinae Dalman, 1820 is the most species-rich group within Pteromalidae with more than 2330 described species in over 317 genera, distributed worldwide (Noyes 2019). Still, very little is known about the Pteromalinae fauna in Iran. Lotfalizadeh & Gharali (2008) provided the first checklist of Iranian Pteromalidae, which includes 78 species from various regions. The recently published checklist of Pteromalidae (Hymenoptera: Chalcidoidea) of Iran (Abolhassanzadeh *et al*. 2017) includes 62 genera and 129 species, of which 44 genera and 91 species belong to the subfamily Pteromalinae. Further Pteromalinae species have recently been found by the subsequent research (Moravvej *et al*. 2018, Lotfalizadeh *et al*. 2020, Rahmani *et al*. 2019, 2020, Shojaey *et al*. 2019, 2021, Gibson *et al*. 2021) bringing the number of known Iranian species of Pteromalinae to 113, and this also indicated the least contribution on this diverse group of parasitoids. Among the explored areas in South-Eastern parts of Iran, a moderately good knowledge of Pteromalinae is already devoted to Kerman province (Mitroiu *et al*. 2011, Lotfalizadeh *et al*. 2012, Mahdavi & Madjdzadeh 2013, Ziaaddini *et al*. 2014, Mahdavi *et al*. 2015, Rahmani *et al*. 2019, Shojaey *et al*. 2019, 2021), the areas contributed as the largest province of Iran with a

urn: lsid:zoobank.org:pub:8602A654-E284-4292-A385-D54A69F076CE
HU ISSN 2063-1588 (online)
published: 15 December 2021
https://doi.org/10.18348/opzool.2021.2.183

rather wide variety of climatic and habitat diversity. Our recent infrequent surveys in these areas led to the discovery of additional Pteromalinae species, presented in this paper.

MATERIAL AND METHODS

The material for the present study was sporadically collected in various regions of the South-Eastern part of Iran (Kerman province) by Malaise traps and using a sweep net, during 2013–2019. The specimens were treated and prepared according to the AXA protocol (van Achterberg 2009), then card mounted and labelled. The external morphology of the specimens was studied under a Nikon® SMZ645 stereomicroscope and photographed using a Canon® EOS 700D (Canon® Inc., Japan) camera, mounted with an adapter on Hund® Stereomicroscope (Wetzlar Inc., Germany). Identification of the specimens was done based on the relevant keys and descriptions (Graham 1969, Sureshan & Narendran 2001, Dzhanokmen 2009, Mitroiu 2012). The terminology of the morphological characters generally follows that of Graham (1969) and Gibson *et al*. (1997). Data about the distribution of species are mainly extracted from Noyes (2019). The studied specimens are deposited in the collection of the Department of Plant Protection, University of Zabol, Iran (DPPZ). Previously recorded species of Pteromalinae from Kerman province were also listed.

The following abbreviations have been used for some morphological terms: POL for posterior ocellar distance; OOL for ocello-ocular distance.

The institutes, where the type specimens were deposited are as follows: BMNH − The Natural History Museum, London, England; CUTT − Plant Protection Department, Cumhuriyet Universitesi, Tokat Ziraat Fakültesi, Tokat, Turkey; LUZN − Zoological Museum, Lund University, Sweden; MLSF - Museum "La Specola", Florence, Italy; NHRM − Naturhistoriska Riksmuseet, Stockholm, Sweden; QMB - Queensland Museum, Brisbane, Australia, and ZMUC – Zoologiske Museum, Copenhagen, Denmark.

RESULTS

In total, 16 species belonging to 10 genera of the subfamily Pteromalinae are listed, among them, four genera and eight species are first records for the fauna of Kerman province. *Dinarmus altifrons* (Walker, 1862) and *Syntomopus incurvus* Walker, 1833 are also recorded for the first time from Iran. Newly recorded species are marked with an asterisk (*).

Family Pteromalidae Dalman, 1820

Subfamily Pteromalinae Dalman, 1820

Genus *Caenocrepis* Thomson, 1878

Caenocrepis Thomson, 1878: 51.

Type species: *Dimachus arenicola* Thomson, 1878, by monotypy.

Caenocrepis arenicola (Thomson, 1878)

Dimachus arenicola Thomson, 1878: 51, Lectotype ♀. – LUZN, Sweden.

Material examined. 1♀, Iran, Kerman province, Jiroft (28°40'31.17"N, 57°44'16.69"E, 686 m), swept on *Mentha pulegium*, 04.09.2014, N. Amirinasab, leg.

Distribution in Iran. Kerman province (Shojaey *et al*. 2019, 2021, current study).

General distribution. Eastern Palaearctic (Iran – Shojaey *et al*. 2019, Kazakhstan), Western Palaearctic (Europe, Morocco, Turkey).

Genus *Cheiropachus* Westwood, 1829

Cheiropachus Westwood, 1829: 23.

Type species: *Ichneumon quadrum* Fabricius, 1787, by original designation.

Cheiropachus quadrum (Fabricius, 1787)

Ichneumon quadrum Fabricius, 1787: 270, ♂. – ZMUC, Germany.

Material examined. 8♀♀, Iran, Kerman province: Baft (29°22'35.96"N, 56°40'18.22"E, 2736 m), Malaise trap, 11.05.2018, 3♀♀; Golbaf (29°52'54.53"N, 57°43'40.71"E, 1743 m), Malaise trap, 10.04.2018, 5♀♀, Sh. Mohebban, leg.

Distribution in Iran. Ardabil (Basiri *et al*. 2012), East Azarbaijan (Lotfalizadeh & Gharali 2008), and Kerman (Mitroiu *et al*. 2011, current study) provinces.

General distribution. Eastern Palaearctic (China, Iran, Kazakhstan, Kyrgyzstan, Pakistan, Turkmenistan), Nearctic (Canada, U.S.A), Neotropical (Argentina, Chile), Oriental (India), Western Palaearctic (Armenia, Europe, Caucasus, Egypt, Israel, Lebanon, Morocco, North Africa, Russia, Tunisia, Turkey).

Genus: *Dinarmus* Thomson, 1878

Dinarmus Thomson, 1878: 56 (as subgenus of *Dimachus* Thomson).

Type species: *Dimachus acutus* Thomson, 1878. Designated by Ashmead 1904.

Dinarmus altifrons (Walker, 1862)*

(Figures 1–2)

Pteromalus altifrons Walker, 1862: 388, Lectotype ♀. – BMNH, South Africa.

Material examined. 6♀♀, 2♂♂, Iran, Kerman province, Bardsir (29°56'20.01"N, 56°34'41.84"E, 2040 m): swept on *Sophora* sp., 12.08.2013, 3♀♀; swept on *Glycyrrhiza glabra*, 06.08.2013, 3♀♀, 1♂; swept on weed, 17.06.2013, 1♂, M. Azad-Biglari, leg.

Diagnosis. Female (Figs 1–2A). Body length: 2.8–3.0 mm. Head in frontal view 1.24–1.25 times wider than high; (Fig. 1A). Clypeal margin bidentate (Fig. 1A). Toruli inserted above lower margins of eyes (Fig. 1A). Antenna with scape reaching lower edge of median ocellus (Fig. 1A). Width of head 2.7–2.9 times its median length (dorsal view) (Fig. 1B). POL 2–2.14 times longer than OOL (Fig. 1B). Eye height 1.54–1.64 times longer than its length (lateral view) (Fig. 1C). Mesoscutum 1.6–1.8 times wider than its length (Fig. 1D). Fore wing with basal cell and basal fold glabrous, marginal, postmarginal and stigmal veins almost equal in length, stigma large (Fig. 1E). Propodeum coarsely reticulate, median carina and costula absent; plicae weakly indicated (Fig. 1F). Gaster sessile, ovate, elongate. Body metallic green with bronze-copper reflection, wings hyaline, veins yellow, setae pale yellow and stigma dark brown (Fig. 2A).

Male (Fig. 2B). Body length: 2–2.3 mm. Similar to female, but antenna with two anelli and six funicular segments, costal cell forewing widened with dense bristles, marginal vein shorter and wider, body metallic green with weak bronze-copper reflection, wings hyaline, veins and setae brown.

Distribution in Iran. Kerman province (current study).

*General distribution***.** Afrotropical (South Africa), Oriental (India), Eastern (Pakistan, Iran [**New record**]) and Western (Algeria, Israel) Palaearctic.

Genus: *Euneura* Walker, 1844

Euneura Walker, 1844: 331.

Type species: *Euneura augarus* Walker, 1844, by monotypy.

Euneura lachni (Ashmead, 1887)

Pachycrepis lachni Ashmead, 1887: 193.

Material examined. 5♀♀, Iran, Kerman province: Rayen (29°35'51.22"N, 57°28'03.04"E, 2093 m), Malaise trap, 25.05.2018, 3♀♀; Rabor (29°18'11.39"N, 56°52'53.28"E, 2440 m), Malaise trap, 20.06.2018, 2♀♀, Sh. Mohebban, leg.

Distribution in Iran. Ardabil, Hamadan, Tehran (Rakhshani *et al*. 2005), and Kerman (current study) provinces; No exact locality cited (OILB 1971).

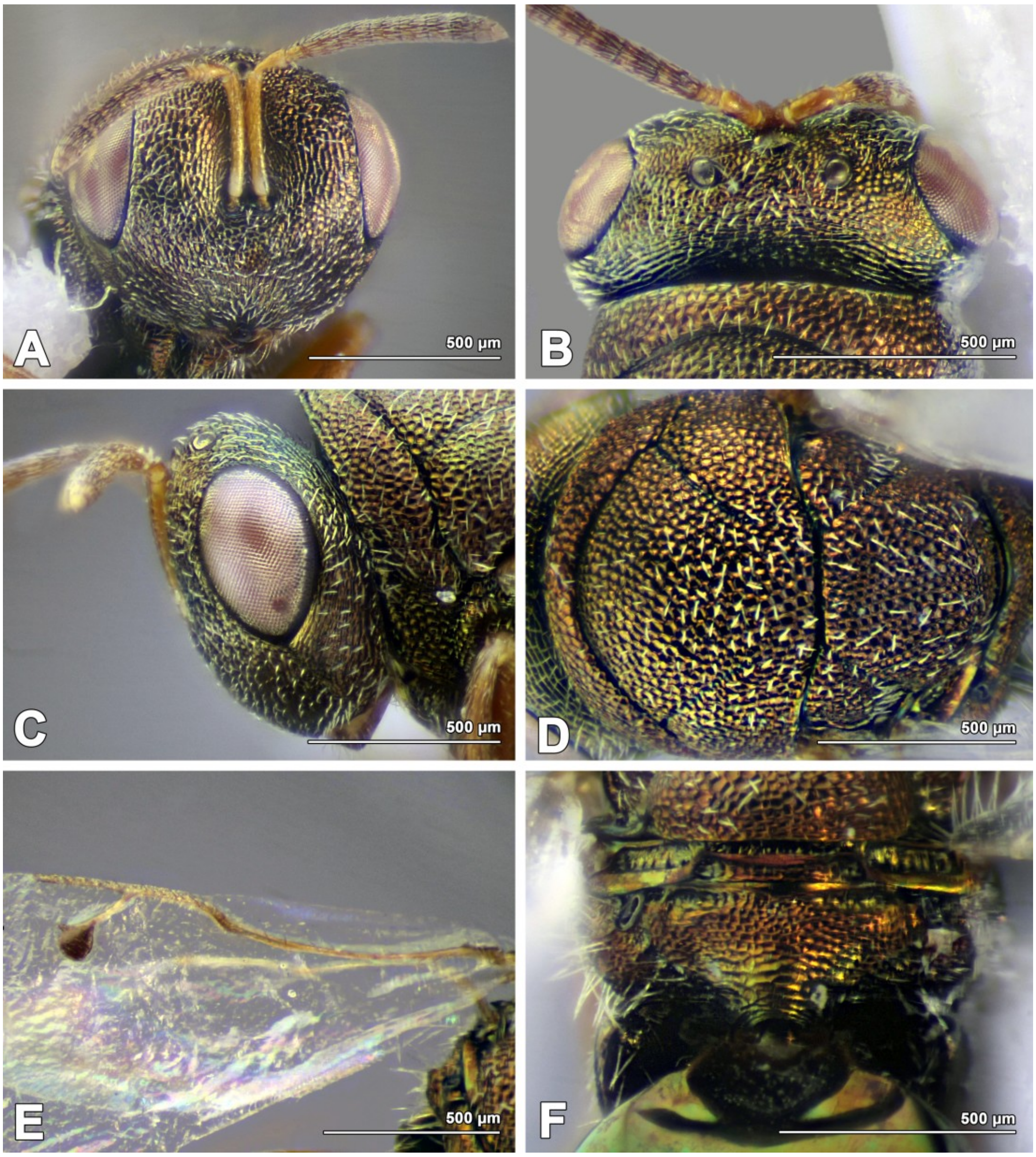


Figure 1. *Dinarmus altifrons* (Walker, 1862). Female. A = Head in frontal view, B = Head in dorsal view, C = Head in lateral view, D = Mesosoma in dorsal view, E = Fore wing venation, F = Propodeum in dorsal view.

General distribution. Eastern Palaearctic (Iran, Japan, Kyrgyzstan, Korea, Pakistan, China), Nearctic (Canada, USA), Oriental (India), Western Palaearctic (Europe, Russia).

Genus *Habritys* Thomson, 1878

Habritys Thomson, 1878: 54 (as subgenus of *Dimachus* Thomson).

Type species: *Pteromalus brevicornis* Ratzeburg 1844, by monotypy.

Habritys brevicornis (Ratzeburg, 1844)

Pteromalus brevicornis Ratzeburg, 1844: 201.

Material examined. 1♀, Iran, Kerman province, Bardsir (29º52'04.69"N, 56º38'53.36"E,

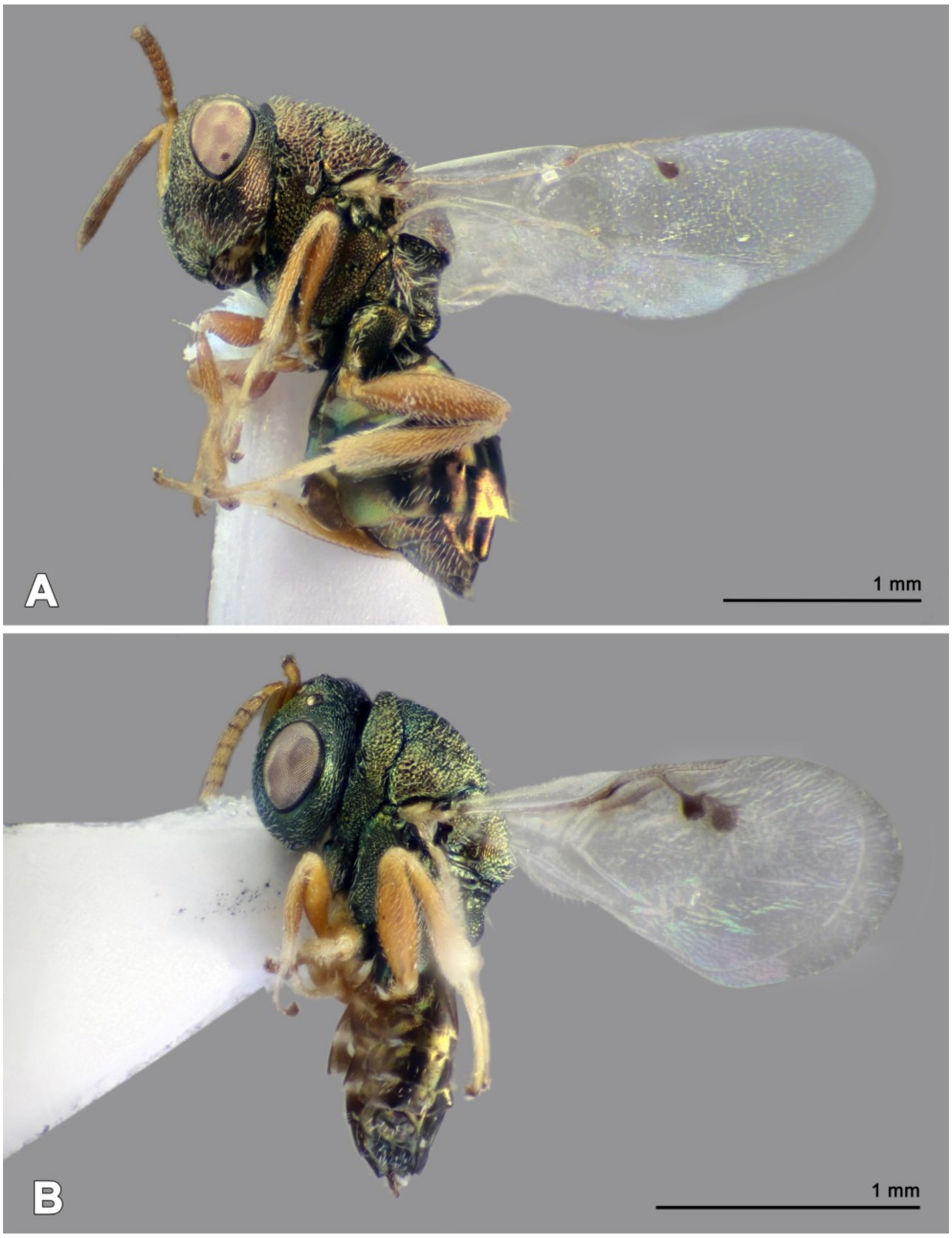


Figure 2. *Dinarmus altifrons* (Walker, 1862). Lateral view of habitus, A = Female, B = Male

2088 m), Malaise trap, 03.05.2018, Sh. Mohebban, leg.

Distribution in Iran. East Azarbaijan, West Azarbaijan (Hassan-Pashaimehr & Lotfalizadeh 2015), and Kerman (current study) provinces.

General distribution. Eastern Palaearctic (Iran – Hassan-Pashaimehr & Lotfalizadeh 2015, Kazakhstan), Nearctic (Canada, U.S.A), Western Palaearctic (Europe).

Genus: *Homoporus* Thomson, 1878

Homoporus Thomson, 1878: 60, 64.

Type species: *Pteromalus fulviventris* Walker, 1835. Designation by Ashmead, 1904.

Homoporus apharetus (Walker, 1839)

Pteromalus apharetus Walker, 1839: 228, Lectotype ♂. – BMNH, United Kingdom.

Material examined. 1♀, Iran, Kerman province, Koohpayeh (30°28'50.65"N, 57°19'17.98" E, 1803 m), Malaise trap, 28.06.2018, Sh. Mohebban, leg.

Distribution in Iran. Kerman province (Shojaey *et al*. 2021, current study).

General distribution. Eastern (China, Iran, Kazakhstan, Kyrgyzstan, Russia) and Western (Europe) Palaearctic.

Genus *Pachycrepoideus* Ashmead, 1904

Pachycrepoideus Ashmead, 1904: 329.

Type species: *Pachycrepoideus dubius* Ashmead, 1904, by monotypy.

Pachycrepoideus vindemmiae (Rondani, 1875)

Pteromalus vindemmiae Rondani, 1875: 145–148, Lectotype ♀. – MLSF, Italy.

Material examined. 1♀, Iran, Kerman province, Jiroft (28º33'16.99"N, 57º43'38.84"E, 602 m), Malaise trap, 10.05.2019, Sh. Mohebban, leg.

Distribution in Iran. Kerman (Shojaey *et al*. 2021, current study), and Qom (Farahani *et al*. 2010) provinces.

General distribution. Cosmopolitan.

Genus: *Pachyneuron* Walker, 1833

Pachyneuron Walker, 1833: 371, 380.

Type species: *Pachyneuron formosum* Walker, 1833, by monotypy.

Pachyneuron aphidis (Bouché, 1834)

Diplolepis aphidis Bouché, 1834: 170, ♀♂. – Germany.

Material examined. 2♀♀, Iran, Kerman province, Bardsir (29°56'20.01"N, 56°34'41.84"E, 2040 m), swept on Weed, 30.05.2013, M. Azad-Biglari, leg.

Distribution in Iran. Ardabil (Lotfalizadeh & Gharali 2008), Kerman (Mitroiu *et al*. 2011, Shojaey *et al*. 2021, current study), Khorasan-e Razavi (Hasani & Madjdzadeh 2012), Khuzestan (Moravvej *et al*. 2018), and Tehran (Rakhshani *et al*. 2004) provinces.

General distribution. Cosmopolitan.

Pachyneuron erzurumicum Doğanlar, 1986

Pachyneuron erzurumicum Doğanlar, 1986: 25, 26–30, Holotype ♀. – CUTT, Turkey.

Material examined. 5♀♀; Iran, Kerman province, Rayen (29°35'51.22"N, 57°28'03.04"E, 2093 m), Malaise trap, 25.05.2018, Sh. Mohebban, leg.

Distribution in Iran. Ilam (Lotfalizadeh & Gharali 2008), Kerman (Mitroiu *et al*. 2011, current study), and Khorasan-e Razavi (Hasani & Madjdzadeh 2012) provinces.

General distribution. Eastern Palaearctic (Iran, Kazakhstan), Western Palaearctic (Turkey).

Pachyneuron formosum Walker, 1833

Pachyneuron formosum Walker, 1833: 380, Lectotype ♀♂. – BMNH, United Kingdom.

Material examined. 1♀, Iran, Kerman province, Rabor (29°18'11.9"N, 56°52'53.28"E, 2440 m), Malaise trap, 24.06.2018, Sh. Mohebban, leg.

Distribution in Iran. Ilam (Lotfalizadeh & Gharali 2008), Kerman (current study), and Kordestan (Dehdar & Madjdzadeh 2016) provinces.

General distribution. Eastern Palaearctic (China, Iran, Japan, Kazakhstan, Kyrgyzstan, Tadzhikistan), Western Palaearctic (Europe, Morocco, Turkey).

***Pachyneuron grande* Thomson, 1878**

Pachyneuron grande Thomson, 1878: 29, Lectotype ♀. – LUZN, Sweden.

Material examined. 1♀, Iran, Kerman province, Jiroft (28°40'31.17"N, 57°44'16.69"E, 686 m), swept on weed, 10.04.2013, N. Amirinasab, leg.

Distribution in Iran. Kerman province (current study), and Northern coastal (Sadeghi & Ebrahimi 2001).

General distribution. Eastern Palaearctic (China, Iran, Kazakhstan, Kyrgyzstan), Western Palaearctic (Europe).

***Pachyneuron groenlandicum* (Holmgren, 1872)**

Pteromalus groenlandicus Holmgren, 1872: 100, Lectotype ♀. – NHRM, Greenland.

Material examined. 1♀, Iran, Kerman province, Baft (29°22'35.96"N, 56°40'18.22"E, 2736 m), Malaise trap, 11.05.2018, Sh. Mohebban, leg.

Distribution in Iran. Alborz (Haeselbarth 1983), Ilam (Lotfalizadeh & Gharali 2008), Khorasan-e Razavi (Hasani & Madjdzadeh 2012), and Kerman (Mitroiu *et al*. 2011, current study) provinces.

General distribution. Afrotropical (Yemen), Oriental (India), Nearctic (Greenland), Eastern Palaearctic (China, Iran, Japan, Kazakhstan, Korea), Western Palaearctic (Europe, Turkey).

***Pachyneuron muscarum* (Linnaeus, 1758)**

Ichneumon muscarum Linnaeus, 1758: 567, Sweden.

Material examined. 2♀♀, Iran, Kerman province, Koohpayeh (30°28'50.65"N, 57°19' 17.98" E, 1803 m), Malaise trap, 28.06.2018, Sh. Mohebban, leg.

Distribution in Iran. Alborz (Ebrahimi 2014), East Azarbaijan (Lotfalizadeh *et al*. 2014), Fars (Lotfalizadeh & Ahmadi 2000 – as *Pachyneuron concolor* Förster, 1841, Ebrahimi 2014), Kerman (current study), Kermanshah (Jalilvand *et al*. 2014), and Tehran (Haeselbarth 1989 – as *Pachyneuron concolor*) provinces.

General distribution. Afrotropical (Saudi Arabia), Oriental (India), Neotropical (St Vincent & Grenadines), Eastern Palaearctic (China, Iran, Kazakhstan, Taiwan), Western Palaearctic (Armenia, Europe, Caucasus, Georgia, Israel, Russia, Turkey).

***Pachyneuron nelsoni* Girault, 1928**

Pachyneuron nelsoni Girault, 1928: 2, Holotype ♀. – QMB, Australia-Queensland.

Material examined. 3♀♀, Iran, Kerman province, Rayen (29°35'51.22"N, 57°28'03.04"E, 2093 m), Malaise trap, 25.05.2018, Sh. Mohebban, leg.

Distribution in Iran. East Azarbaijan (Lotfalizadeh & Gharali 2008), Kerman (Shojaey *et al*. 2021, current study), Khorasan-e Razavi (Hasani & Madjdzadeh 2012), and Kordestan (Dehdar & Madjdzadeh 2016) provinces.

General distribution. Cosmopolitan

Genus: *Rhaphitelus* Walker, 1834

Rhaphitelus Walker, 1834: 168, 178.

Type species: *Rhaphitelus maculatus* Walker, 1834, by monotypy.

***Rhaphitelus maculatus* Walker, 1834**

Rhaphitelus maculatus Walker, 1834: 179, Holotype ♀. – BMNH, United Kingdom.

Material examined. 2♀♀, Iran, Kerman province: Rayen (29°35'51.22"N, 57°28'03.04"E, 2093 m), Malaise trap, 27.07.2018, 1♀; Golbaf (29°52'54.53"N, 57°43'40.71"E, 1743 m), Malaise trap, 19.04.2018, 1♀, Sh. Mohebban, leg.

Distribution in Iran. Alborz, Ardabil, East Azarbaijan, Hamedan, Isfahan, Markazi, Zanjan (Abolhassanzadeh *et al*. 2017), and Kerman (current study) provinces.

General distribution. Australian (Australia), Eastern Palaearctic (Iran, Japan, Kazakhstan, Kyrgyzstan, China, Turkmenistan, Uzbekistan), Nearctic (Canada, USA), Neotropical (Argentina, Chile), Oceanic (New Zealand), Oriental (India), Western Palaearctic (Egypt, Europe, Israel, Russia, Tunisia, Turkey).

Genus: *Syntomopus* Walker, 1833

Syntomopus Walker, 1833: 371, 372:

Type species: *Syntomopus thoracicus* Walker, 1833. Designation by Westwood 1839.

Syntomopus incurvus Walker, 1833*

(Figures 3–4)

Syntomopus incurvus Walker, 1833: 372, Lectotype ♀. – BMNH, United Kingdom.

Material examined. 3♀♀, 1♂, Iran, Kerman province: Koohpayeh (30°28'50.65"N, 57°19' 17.98"E, 1803 m), Malaise trap, 07.02.2018, 1♀; Fahraj (28º53'10.57"N, 58º47'22.88"E, 726m), Malaise trap, 12.06.2019, 1♀, 1♂, Sh. Mohebban, leg.; Jiroft (28°40'31.17"N, 57°44'16.69"E, 686 m), swept on *Mentha pulegium*, 21.05.2014, 1♀, N. Amirinasab, leg.

Diagnosis. Female (Figs 3–4A). Body length: 1.9–2.25 mm. Head in frontal view 1.23–1.29 times wider than high (Fig. 3A). Toruli inserted above lower margins of eyes (Fig. 3A). Antenna with scape not reaching lower edge of median ocellus; funicular segments transverse except first segment quadrate (Fig. 3A). Width of head 2.33–2.46 times its length (dorsal view) (Fig. 3B). POL 1.55–1.75 times longer than OOL (Fig. 3B). Eye height 1.66–1.76 times longer than its length (lateral view) (Fig. 3C). Pronotum with lateral angles almost prominent. Mesoscutum 1.8–1.84 times wider than its length (Fig. 3D). Fore wing with basal cell and basal fold almost glabrous except few setae on basal fold, marginal vein 1.2–1.23 times longer than postmarginal vein and 2.36–2.4 times longer than stigmal vein (Fig. 3E). Propodeum with median area coarsely reticulate, lateral parts smooth, median carina complete, plicae distinct (Fig. 3F). Gaster 1.61–1.65 times longer than wide; petiole 1.8–1.9 times longer than wide and with parallel sides; posterior margin of first tergite emarginated. Head and mesosoma dark green with metallic yellow reflection; Antenna dark brown with scape yellow; Legs with coxa concolorous with mesosoma, remainder segments yellow. Wings hyaline, venation light brown; metasoma dark brown with petiole black (Fig. 4A).

Male (Fig. 4B). Body length: 1.55–1.75 mm. Similar to female, but antenna with funicular segments slightly longer than width, decreasing in length towards apex; marginal vein 2.1–2.12 times longer than stigmal vein.

Distribution in Iran. Kerman province (current study).

General distribution. Eastern (Iran [**New record**], Kazakhstan, China) and Western (Europe, Turkey) Palaearctic.

DISCUSSION

On the basis of the new findings, four genera (*Euneura* Walker, *Habritys* Thomson, *Rhaphitelus* Walker and *Syntomopus* Walker) and eight species of Pteromalinae (*Dinarmus altifrons*, *Euneura lachni*, *Habritys brevicornis*, *Pachyneuron formosum*, *Pachyneuron grande*, *Pachyneuron muscarum*, *Rhaphitelus maculatus*, and *Syntomopus incurvus*) are first recorded for Kerman province. Considering the habitat diversity in Kerman province as the largest province of Iran, many more species than the listed taxa (Table 1)

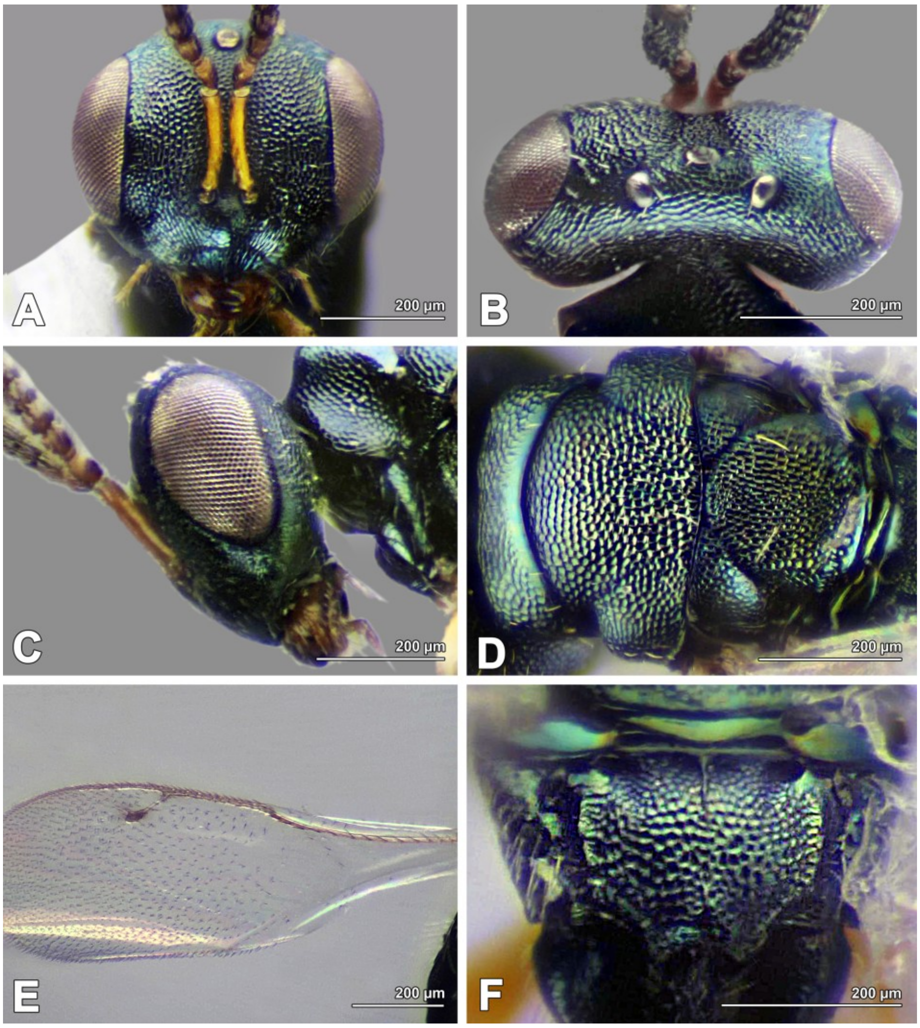


Figure 3. *Syntomopus incurvus* Walker, 1833. Female. A = Head in frontal view, B = Head in dorsal view, C = Head in lateral view, D = Mesonotum in dorsal view, E = Fore wing venation, F = Propodeum in dorsal view.

are expected. On the other hand, very little is known about the occurrence of the known species in other provinces of Iran (Figure 5). The 45 species of Pteromalinae recorded in Kerman comprise only 39.8% of the known Pteromalinae from Iran (Abolhassanzadeh *et al*. 2017, Moravvej *et al*. 2018, Lotfalizadeh *et al*. 2020, Rahmani *et al*. 2019, 2020, Shojaey *et al*. 2019, 2021, Gibson *et al*. 2021). Two species, *Dinarmus altifrons* and *Syntomopus incurvus* are also representing new records for the fauna of Iran. Three *Dinarmus* species (Eslami 1998, Hasani *et al*. 2011, Mitroiu *et al*. 2011) and only a single *Syntomopus* species (Lotfalizadeh & Gharali 2008) were already recorded from Iran. The genera *Dinarmus* and *Syntomopus* have seven and nine species in the Palaearctic region, respectively (Noyes 2019).

The Iranian specimens of *Dinarmus altifrons* were rather similar to the description of the lectotype from South Africa (Rasplus 1989). The marginal clypeal dentacles make a V-shape incision, a character that is slightly different from the U-shape incision illustrated in the African specimens and more similar to the Indian specimens of *D. altifrons* (Sureshan & Narendran 2001). The scape reaches the lower margin of the median ocellus and the propodeal nucha sculpture

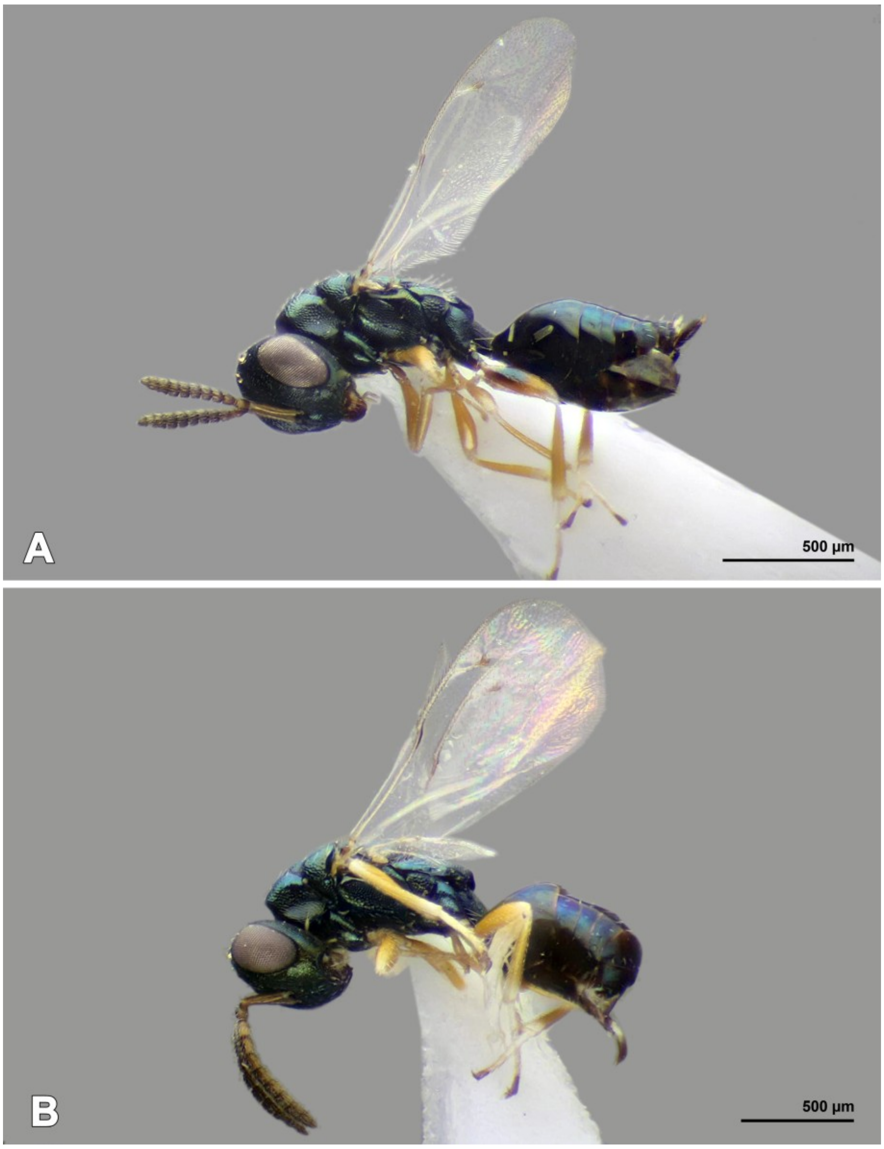
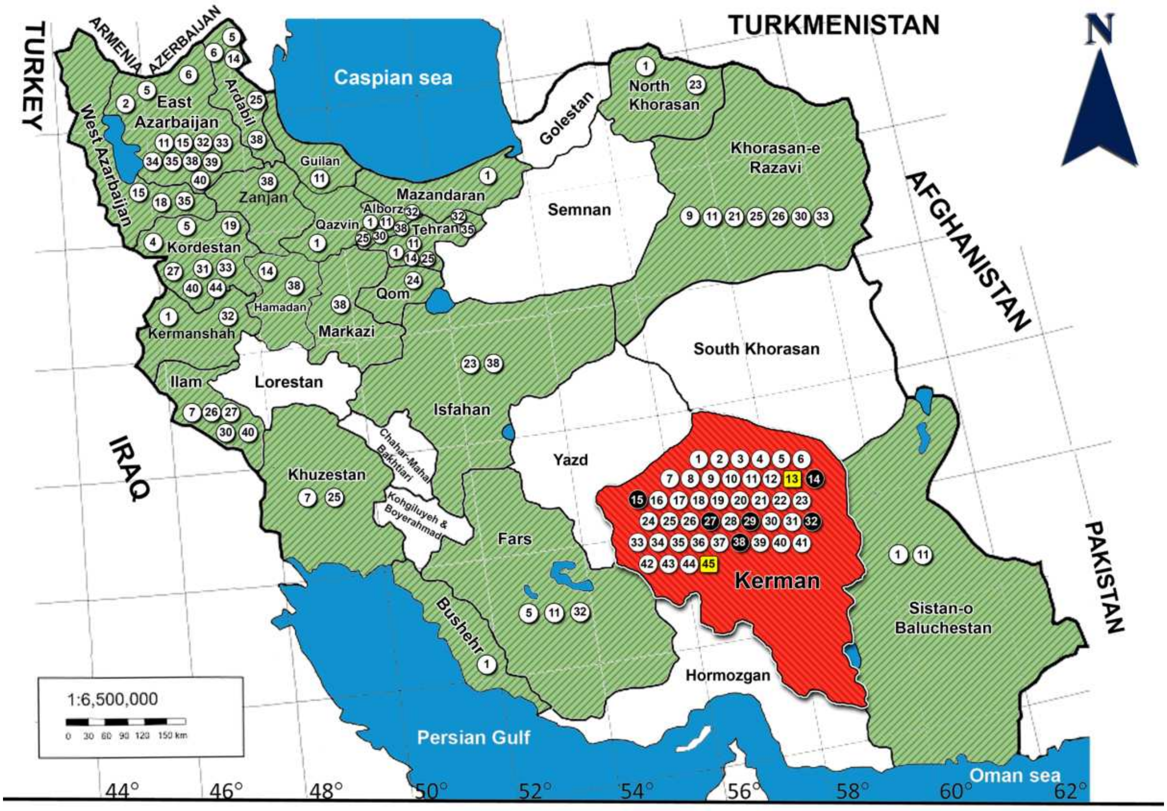


Figure 4. *Syntomopus incurvus* Walker, 1833 – Lateral view of habitus. A. Female; B. Male.

is a bit different. Considering the type locality, and the few minor differences, the specimens outside South Africa may represent a different species. This should be verified by a direct examination of the type specimens (BMNH London), and also by assessing the intraspecific variability through examination of many specimens from various regions. A world revision of the genus or at least of the species group would also be necessary to include molecular data.

The majority of the known Pteromalinae species in Kerman (42.2%) are not recorded outside the Palaearctic region. On the other hand, 20% of species share a distribution both in the Palaearctic and the Nearctic regions (Table 2). Not enough data are yet gathered to make an appropriate judgment about such distribution unless a complete faunal analysis based on extensive exploration is made throughout the whole area of southeastern Iran.



1. *Anisopteromalus calandrae* (Howard, 1881)
2. *Caenacis inflexa* (Ratzeburg, 1848)
3. *Caenocrepis arenicola* (Thomson, 1878)
4. *Callitula bicolor* Spinola, 1811
5. *Catolaccus crassiceps* (Masi, 1911)
6. *Cheiropachus quadrum* (Fabricius, 1787)
7. *Chlorocytus spicatus* (Walker, 1835)
8. *Coelopisthia areolata* Askew, 1980
9. *Cyrtoptyx latipes* (Rondani, 1874)
10. *Dibrachys lignicola* Graham, 1969
11. *Dibrachys microgastri* (Bouché, 1834)
12. *Dinarmus acutus* (Thomson, 1878)
13. *Dinarmus altifrons* (Walker, 1862)
14. *Euneura lachni* (Ashmead, 1887)
15. *Habritys brevicornis* (Ratzeburg, 1844)
16. *Hobbya stenonota* (Ratzeburg, 1848)
17. *Homoporus apharetus* (Walker, 1839)
18. *Homoporus febriculosus* (Girault, 1917)
19. *Homoporus fulviventris* (Walker 1835)
20. *Mesopolobus fasciiventris* Westwood, 1833
21. *Mesopolobus sericeus* (Forster, 1770)
22. *Norbanus brevicornis* Szelenyi, 1974
23. *Novitzkyanus cryptogaster* Bouček, 1961
24. *Pachycrepoideus vindemmiae* (Rondani, 1875)
25. *Pachyneuron aphidis* (Bouché, 1834)
26. *Pachyneuron erzurumicum* Doğanlar, 1986
27. *Pachyneuron formosum* Walker, 1833
28. *Pachyneuron gibbiscuta* Thomson, 1878
29. *Pachyneuron grande* Thomson, 1878
30. *Pachyneuron groenlandicum* (Holmgren, 1872)
31. *Pachyneuron leucopiscida* Mani, 1939
32. *Pachyneuron muscarum* (Linnaeus, 1758)
33. *Pachyneuron nelsoni* Girault, 1928
34. *Peridesmia discus* (Walker, 1835)
35. *Pteromalus bedeguaris* (Thomson, 1878)
36. *Pteromalus cyniphidis* (Linnaeus, 1758)
37. *Pteromalus dolichurus* (Thomson, 1878)
38. *Rhaphitelus maculatus* Walker, 1834
39. *Sphegigaster ineus* Mitroiu, 2008
40. *Sphegigaster nigricornis* (Nees, 1834)
41. *Sphegigaster pedunculiventris* (Spinola, 1808)
42. *Sphegigaster persiana* Mitroiu & Madjdzadeh, 2011
43. *Sphegigaster truncata* Thomson, 1878
44. *Stenoselma nigrum* Delucchi, 1956
45. *Syntomopus incurvus* Walker, 1833

Figure 5. Distribution map for species of Pteromalinae in Kerman province. Number in black and yellow shapes indicating newly recorded species from Kerman and Iran, respectively.

Table 1. List of the known Pteromalinae species in Kerman province.

	Species name	References
1	*Anisopteromalus calandrae* (Howard, 1881)	Shojaey et al. (2021)
2	*Caenacis inflexa* (Ratzeburg, 1848)	Mahdavi et al. (2015)
3	*Caenocrepis arenicola* (Thomson, 1878)	Shojaey et al. (2019, 2021), current study
4	*Callitula bicolor* Spinola, 1811	Shojaey et al. (2021)
5	*Catolaccus crassiceps* (Masi, 1911)	Shojaey et al. (2021)
6	*Cheiropachus quadrum* (Fabricius, 1787)	Mitroiu et al. (2011); current study
7	*Chlorocytus spicatus* (Walker, 1835)	Shojaey et al. (2021)
8	*Coelopisthia areolata* Askew, 1980	Shojaey et al. (2021)
9	*Cyrtoptyx latipes* (Rondani, 1874)	Mitroiu et al. (2011), Shojaey et al. (2021)
10	*Dibrachys lignicola* Graham, 1969	Ziaaddini et al. (2014)
11	*Dibrachys microgastri* (Bouché, 1834)	Mitroiu et al. (2011)
12	*Dinarmus acutus* (Thomson, 1878)	Mitroiu et al. (2011)
13	*Dinarmus altifrons* (Walker, 1862)	Current study
14	*Euneura lachni* (Ashmead, 1887)	Current study
15	*Habritys brevicornis* (Ratzeburg, 1844)	Current study
16	*Hobbya stenonota* (Ratzeburg, 1848)	Lotfalizadeh et al. (2012)
17	*Homoporus apharetus* (Walker, 1839)	Shojaey et al. (2021), current study
18	*Homoporus febriculosus* (Girault, 1917)	Shojaey et al. (2021)
19	*Homoporus fulviventris* (Walker 1835)	Mitroiu et al. (2011), Shojaey et al. (2021)
20	*Mesopolobus fasciiventris* Westwood, 1833	Mahdavi & Madjdzadeh (2013)
21	*Mesopolobus sericeus* (Förster, 1770)	Mahdavi et al. (2015)
22	*Norbanus brevicornis* Szelenyi, 1974	Shojaey et al. (2021)
23	*Novitzkyanus cryptogaster* Bouček, 1961	Rahmani et al. (2019)
24	*Pachycrepoideus vindemmiae* (Rondani, 1875)	Shojaey et al. (2021), current study
25	*Pachyneuron aphidis* (Bouché, 1834)	Mitroiu et al. (2011), Shojaey et al. (2021), current study
26	*Pachyneuron erzurumicum* Doğanlar, 1986	Mitroiu et al. (2011), current study
27	*Pachyneuron formosum* Walker, 1833	Current study
28	*Pachyneuron gibbiscuta* Thomson, 1878	Shojaey et al. (2021)
29	*Pachyneuron grande* Thomson, 1878	Current study
30	*Pachyneuron groenlandicum* (Holmgren, 1872)	Mitroiu et al. (2011), current study
31	*Pachyneuron leucopiscida* Mani, 1939	Shojaey et al. (2021)
32	*Pachyneuron muscarum* (Linnaeus, 1758)	Current study
33	*Pachyneuron nelsoni* Girault, 1928	Shojaey et al. (2021), current study
34	*Peridesmia discus* (Walker, 1835)	Shojaey et al. (2021)
35	*Pteromalus bedeguaris* (Thomson, 1878)	Lotfalizadeh et al. (2012)
36	*Pteromalus cyniphidis* (Linnaeus, 1758)	Mahdavi et al. (2015)
37	*Pteromalus dolichurus* (Thomson, 1878)	Mahdavi et al. (2015)
38	*Rhaphitelus maculatus* Walker, 1834	Current study
39	*Sphegigaster ineus* Mitroiu, 2008	Shojaey et al. (2021)
40	*Sphegigaster nigricornis* (Nees, 1834)	Shojaey et al. (2021)
41	*Sphegigaster pedunculiventris* (Spinola, 1808)	Shojaey et al. (2021)
42	*Sphegigaster persiana* Mitroiu & Madjdzadeh, 2011	Mitroiu et al. (2011)
43	*Sphegigaster truncata* Thomson, 1878	Mitroiu et al. (2011)
44	*Stenoselma nigrum* Delucchi, 1956	Shojaey et al. (2021)
45	*Syntomopus incurvus* Walker, 1833	Current study

Table 2. Biogeographical distribution of the Pteromalinae species in Kerman province.

Distribution	No of species	Frequency (%)
Palaearctic	19	42.2
Holarctic (Palaearctic and Nearctic)	9	20
Palaearctic and Oriental	3	6.7
Palaearctic, Afrotropical and Oriental	3	6.7
Palaearctic, Nearctic and Oriental	1	2.2

Acknowledgments − This study was supported by grant No. UOZ-GR-9618-6, University of Zabol. The authors also thank Sh. Mohebban, M. Azad-Biglari, and N. Amirinasab, for collecting the core material for this study.

REFERENCES

ABOLHASSANZADEH, F., LOTFALIZADEH, H. & MADJDZADEH, S.M. (2017): Updated checklist of Pteromalidae (Hymenoptera: Chalcidoidea) of Iran, with some new records. *Journal of Insect Biodiversity and Systematics*, 3(2): 119–140.

BASIRI, N., LOTFALIZADEH, H. & KAZEMI, M.H. (2012): Introduction to parasitoids of bark beetles (Coleoptera: Scolytidae) in Meshkin-Shahr, Ardebil province, Iran. *Journal of Field Crop Entomology*, 2(1): 53–64.

BOUČEK, Z. & RASPLUS, J.Y. (1991): *Illustrated key to West-Palearctic genera of Pteromalidae (Hymenoptera: Chalcidoidea)*. Institut National de la Recherche Agronomique, Paris, 140 pp.

DEHDAR, K. & MADJDZADEH, S.M. (2016): Pteromalidae (Hymenoptera: Chalcidoidea) from Kordestan province, western Iran. *Far Eastern Entomologist*, (315): 11–20.

DZHANOKMEN, K.A. (2009): Review of Kazakhstan species of the genus *Pachyneuron* Walker, 1833 (Hymenoptera: Chalcidoidea: Pteromalidae). *Zoosystematica Rossica*, 18(1): 73–82. doi: 10.31610/zsr/2009.18.1.73

EBRAHIMI, E. (2014): Parasitoid and hyperparasitoid wasps of scale insects in Hayk Mirzayans Insect Museum, Iran. *Journal of Entomological Society of Iran*, 34(1): 73–83.

ESLAMI, J. (1998): *The proof of larval gregarism in Dinarmus vagabundus (Hym.: Pteromalidae) and a study of some of its population problems.* Proceeding of the 13th Iranian Plant Protection Congress, 23–27August, Karaj, Iran, p. 70.

FARAHANI, H.K., GOLDANSAZ, S.H., SABAHI, G. & BAUR, H. (2010): First report of *Pachycrepoideus vindemmiae* (Hym.: Pteromalidae) from Iran. *Journal of Entomological Society of Iran*, 29(2): 117–118.

GIBSON, G.A., HUBER, J.T. & Woolley, J.B. (Eds.) 1997: *Annotated Keys to the Genera of Nearctic Chalcidoidea (Hymenoptera)*. NRC Research Press, Ottawa, Ontario, Canada. 794 pp.

GIBSON, G.A., DZHANOKMEN, K.A., VAN NOORT, S., GHAHARI, H. & DOGANLAR, M. (2021): *Family Pteromalidae Dalman, 1820. Chalcidoidea of Iran: (Insecta: Hymenoptera)*. In*:* GHAHARI, H., GIBSON, G. & VIGGIANI, G. (Eds.) Chalcidoidea of Iran:(Insecta: Hymenoptera). CABI. pp. 295–353. doi: 10.1079/9781789248463.0295

GRAHAM, M.W.R.D.V. (1969): The Pteromalidae of North-Western Europe (Hymenoptera: Chalcidoidea). *British Museum, Natural History*, 16: 1–908. doi: 10.5962/p.258046

HAESELBARTH, E. (1983): Determination list of entomophagous insects. No. 11. *Bulletin Section Regionale Ouest Palaearctique Organisation Internationale de Lutte Biologique* 12(7): 1–62.

HASANI, A. & MADJDZADEH, S.M. (2012): Contribution to the knowledge of the Pteromalidae (Hymenoptera: Chalcidoidea) from Khorasan Razavi province, Northeastern Iran. *Iranian Journal of Animal Biosystematics*, 8 (1): 57–69.

HASANI, A., MITROIU, M.D. & MADJDZADEH, S.M. (2011): New records of Pteromalidae (Hymenoptera: Chalcidoidea) from Northeastern Iran. *Acta Zoologica Bulgarica*, 63(3): 323–325.

HASSAN-PASHAIMEHR, M. & LOTFALIZADEH, H. (2015): Discovery of *Habritys brevicornis* (Ratzeburg, 1844) (Hymenoptera: Pteromalidae) in the Middle-East. *Journal of Insect Biodiversity and Systematics*, 1(1): 33–36.

JALILVAND, K., SHIRAZI, M., FALLAHZADEH, M., VAHEDI, H.A., SAMIH, M.A. & NAGHADEH, N.M. (2014): Survey of natural enemies of mealybug species (Hemiptera, Pseudococcidae) in Kermanshah province, western Iran to inform biological control research. *Journal of the Entomological Research Society*, 16(3): 1–10.

LOTFALIZADEH, H. & AHMADI, A. (2000): Natural enemies of cypress tree mealybug *Planococcus vovae* (Nasonov) and their parasitoids in Shiraz, Iran. *Iran Agricultural Research*, 19(2): 145–154.

LOTFALIZADEH, H. & GHARALI, B. (2008): Pteromalidae (Hymenoptera: Chalcidoidea) of Iran: New records and a preliminary checklist. *Entomofauna,* 29(6): 93–120.

LOTFALIZADEH, H., RAJABI, M. & MADJDZADEH, S.M. (2012): Parasitoids community of *Diplolepis fructuum* (Rübsaamen) (Hym.: Cynipidae) in Kerman province, with checklist of its associated Hymenoptera fauna in Iran. *North-Western Journal of Zoology*, 8(1): 125–131.

LOTFALIZADEH, H., ZARGARAN, M.R. & TAGHIZADEH, M. (2014): Species diversity of Coccoidea parasitoids wasps (Hym.: Chalcidoidea) in the northern parts of East-Azarbaijan province, Iran. *North-Western Journal of Zoology*, 10(1): 60–66.

LOTFALIZADEH, H., KARIMPOUR, Y., DELVARE, G. & RASPLUS, J.Y. (2020): Chalcidoidea (Hymenoptera) obtained from common reed, *Phragmites australis* (Cav.) Trin. ex Steud. (Poaceae) in Iran with new records and descriptions of two new species. *European Journal of Taxonomy*, 710: 1–35. doi: 10.5852/ejt.2020.710

MAHDAVI, M. & MADJDZADEH, S.M. (2013): Contribution to the knowledge of Chalcidoidea (Pteromalidae and Eupelmidae) of Iran. *North-Western Journal of Zoology*, 9(1): 94–98.

MAHDAVI, M., MADJDZADEH, S.M. & MITROIU, M.D. (2015): Pteromalidae (Hymenoptera: Chalcidoidea) associated with plant galls in the south-eastern Iran, with three new records. *Journal of Insect Biodiversity and Systematics*, 1(1): 47–54.

MITROIU, M.D. (2012): The genus *Caenocrepis* Thomson (Hymenoptera: Pteromalidae) in the Afrotropical region, with a key to world species. *Zootaxa*, 3557(1): 49–55. doi: 10.11646/zootaxa.3557.1.5

MITROIU, M.D., ABOLHASSANZADEH, F. & MADJDZADEH, S.M. (2011): New records of Pteromalidae (Hymenoptera: Chalcidoidea) from Iran, with description of a new species. *North Western Journal of Zoology,* 7(2): 243–249.

MORAVVEJ, S.A., LOTFALIZADEH, H. & SHISHEHBOR, P. (2018): A contribution to the study of Pteromalidae (Hymenoptera: Chalcidoidea) of Khuzestan in southwestern Iran. *Journal of Insect Biodivesity and Systematics*, 4(2): 91–97.

NOYES, J.S. (2019): Universal Chalcidoidea Database. World Wide Web electronic publication. http://www.nhm.ac.uk/chalcidoids (accessed 21 June, 2021).

OILB (1971): Liste d'identification des entomophages. *Organisation Internationale de Lutte Biologique (OILB), Genève*, 8: 1–18.

RAHMANI, Z., RAKHSHANI, E., LOTFALIZADEH, H. & MOKHTARI, A. (2019): Two small genera, *Ischyroptyx* Delucchi and *Novitzkyanus* Bouček (Hymenoptera: Pteromalidae) new to fauna of Iran. *Oriental Insects*, 54(4): 564–573. doi: 10.1080/00305316.2019.1697767

RAHMANI, Z., RAKHSHANI, E., LOTFALIZADEH, H. & MOKHTARI, A. (2020): First records of the genera *Psilocera* Walker, 1833 and *Stinoplus* Thomson, 1878 (Hymenoptera, Pteromalidae) in Iran. *Journal of Insect Biodiversity and Systematics*, 6(3): 213–221.

RAKHSHANI, E., TALEBI, A.A., SADEGHI, E., KAVALLIERATOS, N.G. & RASHED, A. (2004): Seasonal parasitism and hyperparasitism of valnus aphid, *Chromaphis juglandicola* (Hom.: Aphididae) in Tehran province. *Journal of Entomological Society of Iran*, 23(2): 1–11.

RAKHSHANI, E., TALEBI, A., STARÝ, P., MANZARI, S. & REZWANI, A. (2005): Re-description and biocontrol information of *Pauesia antennata* (Mukerji) (Hym., Braconidae, Aphidiinae), parasitoid of *Pterochloroides persicae* (Chol.) (Hom., Aphidoidea, Lachnidae). *Journal of Entomological Research Society*, 7(3): 59–59.

RASPLUS, J.Y. (1989): Révision des espèces afrotropicales du genre *Dinarmus* Thomson (Hymenoptera: Pteromalidae). *Annales de la Société Entomologique de France*, 25(2): 135–162.

SADEGHI, S.E. & EBRAHIMI, E. (2001): New report of *Pachyneuron grande* Thomson (Hym.: Pteromalidae) from Iran. *Journal of Entomological Society of Iran*, 21(1): 113–114.

SHOJAEY, M., KHAYRANDISH, M., MADJDZADEH, S.M. & LOTFALIZADEH, H. (2019): First record of *Caenocrepis arenicola* (Thomson, 1878) (Hymenoptera: Pteromalidae) from Iran. *Journal of Insect Biodiversity and Systematics*, 5(2): 121–126.

SHOJAEY, M., KHAYRANDISH, M., MADJDZADEH, S.M. & LOTFALIZADEH, H. (2021): New records of Pteromalinae (Hymenoptera: Chalcidoidea, Pteromalidae) from Iran. *Far Eastern Entomologist,* 439: 14–23. doi: 10.25221/fee.439.2

SURESHAN, P.M. & NARENDRAN, T.C. (2001): Taxonomic studies on *Dinarmus* Thomson (Hymenoptera: Chalcidoidea: Pteromalidae) of India and adjacent countries. *Zoos'print Journal*, 16(12): 643–650. doi: 10.11609/JoTT.ZPJ.16.12.643-50

VAN ACHTERBERG, C. (2009): Can Townes type Malaise traps be improved? Some recent developments. *Entomologische Berichten*, 69: 129–135.

ZIAADDINI, M., LOTFALIZADEH, H., MOHAMMADI KHORAMABADI, A. & JALALI, M.A. (2014): First report of *Dibrachys lignicola* (Hym.: Pteromalidae) from Iran. *Journal of Entomological Society of Iran*, 34(1): 97–98.