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The genus *Oxyethira* Eaton (Trichoptera, Hydroptilidae) in Japan

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Abstract. The Japanese species of *Oxyethira* Eaton (Trichoptera, Hydroptilidae) are reviewed confirming 8 described species, and introducing 2 new species, *O. tsuruga* and *O. shumari spp. nov.* For clear comparisons and to include new details, males of all the 10 species and females of 9 species, except *O. ozea* Oláh and Ito, 2013 are redescribed or described. *O. kakida* Oláh and Ito, 2013 is synonymized with *O. angustella* Martynov, 1933.

Keywords. Micro-caddisfly, *Oxyethira*, new species, new synonymy, variation, Japan.

INTRODUCTION

The micro-caddisfly genus *Oxyethira* Eaton, 1873 is widely distributed in the world (Marshall 1979). For Japan, 9 named species belonging subgenus *Oxyethira* Easton, 1873 were recorded (Martynov 1933, Oláh & Ito 2013). However, 2 taxonomic problems remained: (1) the taxonomic status of *O. angustella* Martynov, 1933, described from Sinano, Honshu, Japan, is unclear due to the insufficient description; (2) unidentified adults have been collected in Japan (Ohtaka *et al*. 2008, Shimura *et al*. 2014, Ito 2017).

As a consequence of this study on recently collected specimens of Japanese *Oxyethira*, 10 species are now recognized in the Japanese fauna. Adults of all named species are redescribed to enable clear, unambiguous comparisons, and 2 new species are described. One name is newly synonymized and the true nature of *O. angustella* is resolved.

MATERIALS AND METHODS

Association of male and female was based on similar general characteristics, such as color and size, within specimens collected together. Male and female genitalia were figured after treatment in about 5% KOH. In order to show genital segments in detail, segments VIII of males are drawn with thicker lines and sometimes shown in separate figures. Morphological terms mainly follow Oláh and Ito (2013) for males and Kelley (1984) for females. The type series of the new species are deposited in the collections of the Natural History Museum and Institute, Chiba (CBM–ZI). Other specimens are deposited in the collection of the senior author (T. Ito) and all specimens are preserved in 80% ethyl alcohol, unless otherwise indicated in parentheses. The collecting methods and collectors are abbreviated as follows: light trap (L), sweep net (S), Tomiko Ito (TI).

TAXONOMY

Oxyethira acuta Kobayashi, 1977

(Figures 1, 12)

Oxyethira acuta Kobayashi, 1977, 6–7, pls. 5–6, male, female, Hokkaido (Iburi); Ito & Kawamula, 1984, 313–317, pupa, larva, case, life cycle, Hokkaido (Iburi); Ito, 2005, 442, 444, larva, case; Oláh & Ito, 2013, 32, figs. 17–20, male, Hokkaido (Kushiro, Ishikari, Iburi).

Oxyethira sp.: Ohtaka *et al*., 2008, 60, Honshu (Aomori).

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Material examined. Additional records to Oláh & Ito (2013). *Hokkaido*: 15 males, 369 females, Kushiro-shi, Akan-panke-ko, 31.viii. 1996–27.vii. 2012, TI *et al*., L & S (1 female, 31.viii.1996; 1 male, 6 females, 13.viii.1997; 1 male, 1 female, 10.vii.1998; 2 females, 21.viii.1998; 7 males, 2 females, 14.ix.1998; 1 male, 1.x.2010; 5 males, 357 females, 27.vii.2012); 4 females, Kushiro-shi, Akan-kohan, Ibeshibetsu, 23.vii.1996–31.viii. 1996, TI *et al*., L (1 female, 23.vii.1996; 3 females, 31.viii.1996); 5 males, 2 females, Shibecha-cho, Shirarutoro-ko, Ikoino-ie, 29.viii.2005, TI, L; 2 males, 2 females, Shibecha-cho, Shirarutoro-ko, eastern bank, 25.vii.2008, TI, L; 6 males, 1 female, Sarufutsu-mura, Kamuito-numa, 31.vii.2007, TI, L; 119 males, 34 females, Sapporo-shi, Nopporo, Mizuho-ike, 14.vii.2004, Y. Nagayasu & TI, L; 137 males, 75 females, Tomakomai-shi, Utonai-ko, 17.v.1977–17.viii.207, TI *et al*., L & S (2 males, 9 females, 17.v.1977; 6 males, 9 females, 6.viii.1977; 2 males, 3 females, 29.vii. 1998; 5 females, 28.vi.1999; 7 males, 6 females, 22.vii.2001; 108 males, 6 females, 22.vii.2004; 12 males, 37 females, 17.viii.2007); 1 female, Tomakomai-shi, Bibi-gawa, Uenae-bashi, 22.vii.2001, TI, L; 3 males, 97 females, Tomakomai-shi, Bibi- gawa, 4 m a.s.l., 22.vii. 2001–5.viii.2010, TI, L (3 females, 8.vii.2010; 3 males, 94 females, 5.viii. 2010). *Honshu. Aomori*: 17 males, 6 females, Goshogawara-shi, Myojin-numa, 23.v–21.ix.2007, T. Ogasawara, L (mounted on slide and deposited in the personal collection of T. Ogasawara) (6 males, 4 females, 23.v.2007; 10 males, 2 females, 18.vi. 2007; 1 male, 21.ix. 2007). *Okayama*: 14 males, 3 females, Waki-cho, Fujino, Kongo-gawa, 24.vii. 2016, K. Nojima.

Adult. Wings light brown with several small lighter markings. Antennae brown to light brown with darker marking near apices. Spur formula 0, 3, 4.

Male. Length of forewing and hind wing 2.6–2.8 mm and 1.9–2.1 mm, respectively (n=5). Antennae 38–42 segmented; length 2.3–2.5 mm (n=5). Apicomesal process of sternite VII (app) short and acute. Segment VIII annular, gently protruded posteriorly in lateral view; both anterior and posterior margins with wide and shallow excision in dorsal view; anterior margin almost straight and posterior margin largely concave in ventral view. Segment IX completely enclosed within segment VIII; dorsum slightly shorter than ventrum in lateral view; subquadrate with undulate anterior margin in dorsal view; subquadrate with almost straight anterior margin in ventral view. Segment X reduced to low membranous lobe. Pair of paraproct (pp) heavily sclerotized, triangular in lateral view, semi-circular basal halves and mesally curved triangle apical halves in dorsal view. Basal plate of gonopods (bpgo) originating at basoventral margin of gonopods. Gonopods (go) small, triangle, fused to sternite IX at base. A pair of short, membranous setal lobes (sl) with a few short setae at mesal surface of gonopods. Phallic organ with paramere (pa) encircling shaft once and split into 2 tape-like arms and 1 longest filiform, elongated posteriorly, filiform shorter than aedeagus (ae) and longer than tape-like arms; arms and filiform somewhat variable individually, one of tape-like arms directed dorsad in some specimens of Lake Akan-panke-ko, Hokkaido, one of tape-like arms distinctly shorter than another arm in a male of Lake Myojin-numa, Aomori.

Female. Length of forewing and hind wing 2.7–3.2 mm and 2.3 mm, respectively (n=5). Antennae 25–26 segmented and 1.1–1.3 mm long (n=5). Sternite VI with small acute apicomesal process. Tergites of VIII and X weakly sclerotized, segment IX membranous dorsally. Sternite VIII with two round sclerites, reddish brown, conspicuous.

Remarks. This species belongs to the *ecornuta* species cluster Oláh and Ito, 2013, the *flavicornis* species group Kelley, 1984 (Oláh & Ito, 2013), and is distinguished from other congeneric Japanese species by shape of gonopods (semicircular basal half and mesally curved apical half) and phallic organ with 2 tape-like arms and longest filiform in male and 2 round sclerites of sternite VIII in female.

Distribution (Fig. 12). Hokkaido (Kushiro, Soya, Ishikari, Iburi), Honshu (Aomori, Okayama). New to Honshu.

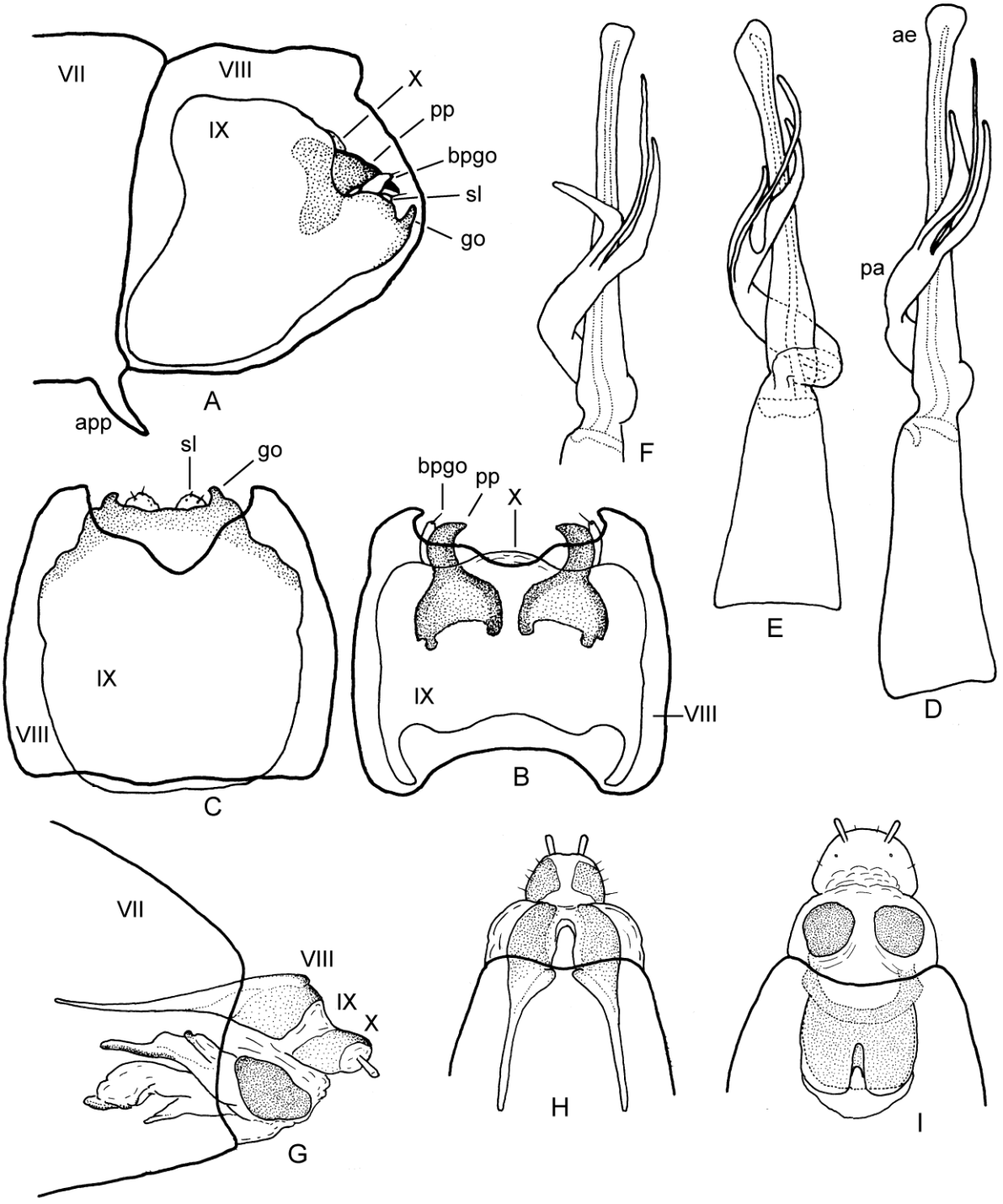

Figure 1. *Oxyethira acuta*. *Male* (A–E): A = abdominal segments VII–X, left lateral; B = genitalia, dorsal; C = same, ventral; D–F = phallus, left lateral. *Female* (G–I): G = abdominal segments VII–X, lateral; H = same, dorsal; I = same, ventral. *Materials*: A–D & G–I, Lake Utonai-ko, Hokkaido (type locality); E, Lake Myojin-numa, Aomori; F, Lake Akan-panke-ko, Hokkaido. *Abbreviations*: VII–X = abdominal segments VII–X; ae = aedeagus; app = apicomesal process; bpgo = basal plate of gonopods; go = gonopods; pa = paremere; pp = paraproct; sl = setal lobe.

Habitat and ecology. Adults of this species were collected from lakes and ponds. The larvae live in assemblages of water plants such as *Phragmites* sp. (Gramineae) and suck cell contents of filamentous algae associated to leaves and stems of the plants (Ito & Kawamula 1984). This species has an univoltine life cycle with summer emergent period in the type locality, Lake Utonai-ko, Tomakomai, Hokkaido (Ito & Kawamula 1984).

Japanese name. Hagoita-himetobikera.

Oxyethira angustella Martynov, 1933

(Figures 2, 12)

Oxyethira angustella Martynov, 1933, 139, antenna, mouth parts and wings of female, Honshu (Shinano = old name of Nagano).

Oxyethira kakida Oláh & Ito, 2013, 30–31, figs. 9–12, male, Hokkaido (Nemuro, Kushiro, Tokachi, Ishikari), Honshu (Yamagata, Tokyo, Shizuoka); Nozaki *et al*., in press, Honshu (Nagano). **New synonym**.

Material examined. Additional records to Oláh & Ito (2013). *Hokkaido*: 17 males, Shibetsu-cho, Ichani-gawa, Chishine-bashi, 12.ix.1995–21.vii. 1996, TI & A. Ohkawa, L (6 males, 12.ix.1995; 6 males, 28.vi.1996; 5 males, 21.viii.1996); 1 male, Kushiro-shi, Akan-kohan Kinetanpe, 21.ix.1996, TI, L; 1 male, Eniwa-shi, Izari-gawa, Rarumanai-no-taki, 15–21.vii.2001, TI, L; 1 male, Eniwa-shi, Izari-gawa, Eniwa-ohashi, 1.viii.2015, TI, L; 2 males, Chitose-shi, Chitose-ko, 25.viii.2001, TI, L; 67 males, Chitose-shi, Bibi-gawa, Bibi-bashi, 29.viii.1991–6.ix.2007, TI *et al*., L (36 males, 29.viii.1991; 3 males, 17.ix.1992; 2 males, 22.v.1998; 3 males, 24.ix.1999; 3 males, 15.vii. 2001; 17 males, 8.ix.2002; 3 males, 6.ix.2007); 2 males, Tomakomai-shi, Bibi-gawa, Matsubibi-bashi, 21.vii.1990–12.ix.1993, TI, L (1 male, 21. vii.1990; 1 male, 12.ix.1993); 18 males, Tomakomai-shi, Bibi-gawa, Uenae-bashi, 17.vii.1977–16.vii.2008, TI, L (7 males, 17.vii.1977; 3 males, 22.vii.2001; 6 males, 3.viii.2007; 2 males, 16. vii.2008); 9 males, Tomakomai-shi, Bibi-gawa, 4 m a.s.l., 8.vii.2010–26.vi.2012, TI, L (7 males, 8.vii.2010; 1 male, 5.viii.2010; 1 male, 26.vi. 2012). *Honshu. Yamagata*: 11 males, Kaneyama-machi, Kanayama-gawa, Arakane-bashi, 11.x. 1999, A. Ohkawa; 2 males, Kaneyama-machi, Kanayama-gawa, Kanayama-bashi, 14.x.1999, A. Ohkawa. *Nagano*: 136 males, 107 females, a spring, Shimauchi, Matsumoto, 2013–2014 (as *O. kakida*, detail data in Nozaki *et al*. in press); 1 male, Hakuba-mura, Sano, a headwater of Himekawa, 28.v.1995, T. Hattori; 1 male, Azumino-shi, a spring, 29.v.1999, H. Nishimoto.

Adult. Wings light brown with several small lighter markings. Antennae brown to light brown with darker marking near apices. Spur formula 0, 3, 4.

Male. Length of forewing and hind wing 2.2–3.0 mm and 2.5–3.1 mm, respectively (n=9). Antennae 37–45 segmented (n=61), length 2.1–2.6 mm (n=7). Apicomesal process of sternite VII short and acute. Segment VIII annular, sub quadrate with large excision at each of antero-dorsal margin and postero-ventral margin. Segment IX almost completely enclosed within segment VIII; dorsum slightly shorter than ventrum; subquadrate with asymmetrically excised anterior margin in dorsal view; subquadrate with more or less protruded anterior margin in ventral view. Segment X reduced to membranous lobe. Pair of paraproct heavily sclerotized, triangular with truncate apices in lateral view, thin triangular in dorsal view. Long basal plates of gonopods at baso-ventral margin of gonopods. Gonopods triangle, larger than paraproct in lateral view, fused to sternite IX at base. Setal lobes at mesal surface of gonopods. Phallic organ with paramere encircling shaft once and split into a filiform and a more complex arm; filiform wide at base, gradually tapered with subacute apex; complex arm thick, semi-membranous with blunt apex and an anteriad directed axial spine.

Variation. Antero-dorsal margin of segment IX variable individually; round in holotype male (incorrectly illustrated in Oláh & Ito 2013), but somewhat convex in paratype males.

Female. Length of forewing and hind wing 2.9–3.3 mm and 2.5–2.8 mm, respectively (n=5). Antennae 25–29 segmented, light brown with 4–5

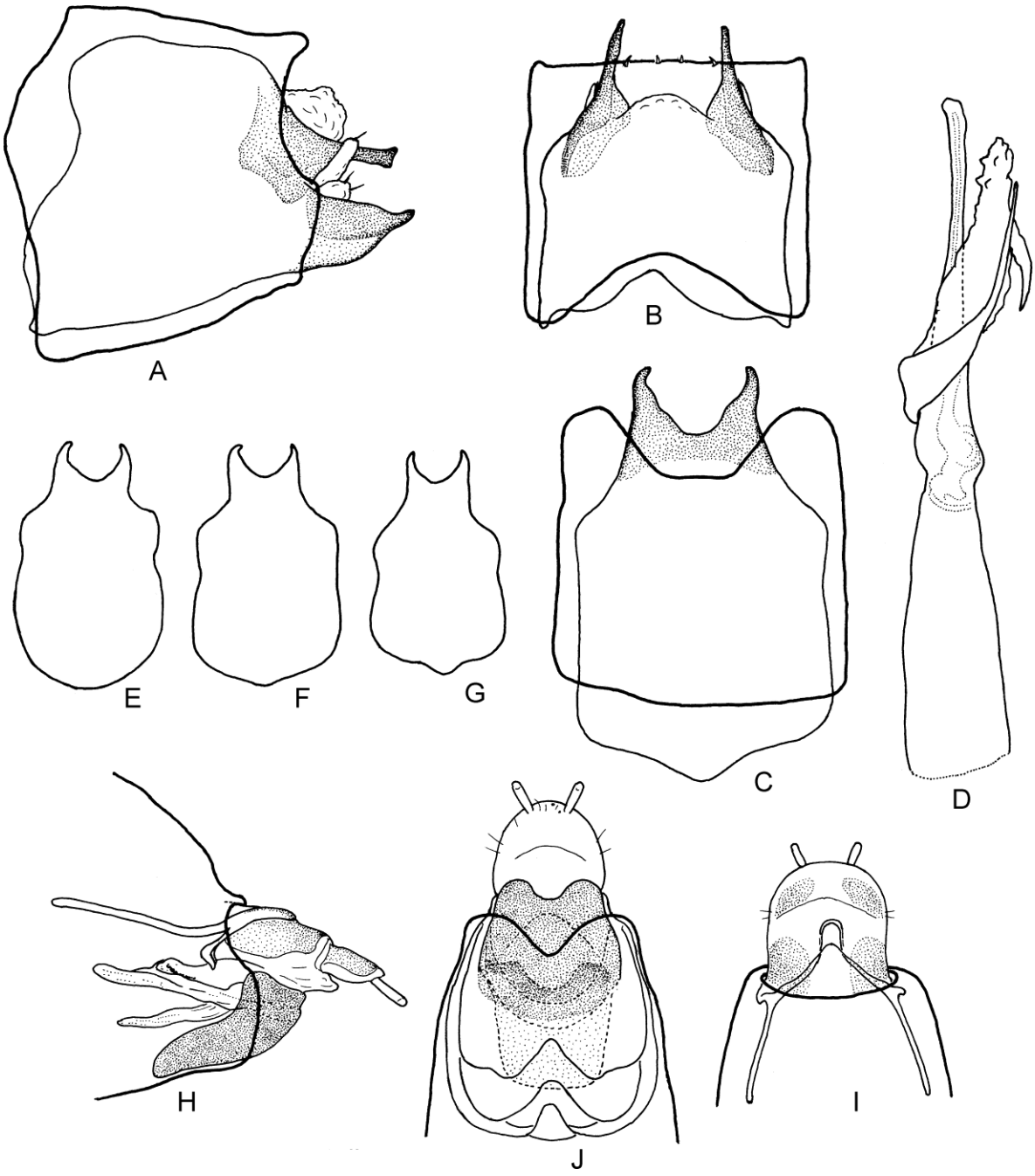

Figure 2. *Oxyethira angustella*. *Male* (A–G): A = genitalia, left lateral; B = same, dorsal; C = same, ventral; D = phallus, left lateral; E–G = segment IX, ventral. *Female* (H–J): H = abdominal segments VII–X, lateral; I = same, dorsal; J = same, ventral. *Materials*: A–D & H–J, Shimauchi-yusui, Matsumoto; E, holotype of *O. kakida*; F and G, paratypes of *O. kakida*.

dark segments sub-apically (n=28) and 1.1–1.3 mm long (n=7). Sternite VI with small acute apicomesal process. Tergites of VIII and X weakly sclerotized, IX membranous. Sternite VIII with dark brown, large subquadrate sclerite; in ventral view, anterior margin gently convex, posterior margin with middle round excision.

Remarks. This species was originally described based on a female collected from a

limnocrene, Matsumoto, Shinano (old name of Nagano Prefecture), Honshu, Japan on December 15, 1931 (Martynov 1933). The type specimen is missing (T. S. Vshivkova personal communication) and the exact site of the type locality is unknown. However, Martynov's description, especially segment number of antenna (29) and venation of hind wing, is coincided with 107 female specimens collected from a spring stream, Shimauchi, Matsumoto, Nagano Prefecture, by a Malaise trap from April 11, 2013 to June 5, 2014 (Nozaki *et al*. in press). The 136 males collected together with the females are identified to *O. kakida* Oláh & Ito, 2013 and any other congeneric species didn't occur there. Therefore, we recognized that *O. kakida* Oláh & Ito, 2013 is a junior synonym of *O. angustella* Martynov, 1933.

This species belongs to the *datra* species cluster Oláh and Ito, 2013, the *flavicornis* species group Kelley, 1984 (Oláh & Ito 2013), and is distinguished from other Japanese species by shape of paramere of phallic organ which has blunt apex and anteriorly directed axial spine of complex arm. *O. angustella* is similar to a Korean species, *O. josifovi* Kumanski, 1990 in having anteriorly directed axial spine of complex arm of phallic apparatus. However, *O. angustella* is clearly different from *O. josifovi* as follows: complex arm with 3 very sharp sclerites apically in *O. josifovi* (Kumanski 1990, Oláh & Ito 2013), but blunt apically in *O. angustella*.

Females of this species are characterized with strongly sclerotized large sclerite of sternite VIII and 4–5 dark subapical segments of antennae. However, the females of this species are rather similar to *O. chitosea* Oláh and Ito, 2013 as described below and difficult to discriminate from the later if they were deposited in alcohol more than several months. The female genitalia are described here for the first time.

Distribution (Fig. 12). Hokkaido (Nemuro, Kushiro, Tokachi, Ishikari, Iburi), Honshu (Yamagata, Tokyo, Nagano, Shizuoka). Most common species of this genus in Japan.

Habitat. Adults were widely collected from springs, mountain streams, and marshes.

Japanese name. Kakida-hagoita-himetobikera (newly given here).

Oxyethira chitosea Oláh & Ito, 2013

(Figures 3, 12)

Oxyethira chitosea Oláh & Ito, 2013, 38–39, figs. 39–42, male, Hokkaido (Kushiro, Ishikari); Ito, 2017, 3, Honshu (Fukui).

Material examined. Additional records to Oláh & Ito (2013). *Hokkaido*: 1 male, Shibetsu-cho, Ichani-gawa, Chishine-bashi, 28.vi.1996, TI & A. Ohkawa, L; 1 male, Shibecha-cho, Shirarutoro-etoro-gawa, Tomi-bashi, 26.viii.2009, TI, L; 29 males, Kushiro-shi, Akan-panke-ko, 1.vii.1996–1.x.2010, TI *et al*., L & S (12 males, 1.vii.1996; 1 male, 23.vii.1996; 3 males, 31.viii.1996; 5 males, 10.vii.1998; 4 males, 21.viii.1998; 2 males, 14.ix.1999; 2 males, 1.x.2010); 1 male, Kushiro-shi, Akan-kohan, Churui, 14.ix.1999, TI et al., L; 1 male, Eniwa-shi, Ichankoppe-zawa, 300 m a.s.l., 10.viii.2010, TI, L; 2 males, Eniwa-shi, Izari-gawa, Suisei-bashi, 17.viii.2001, TI, L; 6 males, 11 females, Eniwa-shi, Izari-gawa, Sakae-bashi, vii–viii.2016, TI, L; 2 males, Chitose-shi, Mombetsu-gawa, middle reach, 14.vii.2000, TI *et al*., L; 9 males, Chitose-shi, Chitose-ko, 8.vii–25.viii.2001, TI & A. Ohkawa, L. *Honshu*. *Fukui*: 5 males, 105 females, Tsuruga-shi, Ikenokochi-shitsugen, 2013–2016, TI, L (detail data in Ito, 2017).

Adult. Wings light brown with several small lighter markings. Antennae brown to light brown with darker marking near apices. Spur formula 0, 3, 4.

Male. Length of forewing, hind wing 2.2–2.9 mm and 1.7–2.2 mm, respectively (n=5). Antennae 35–42 segmented; length 1.8–2.2 mm (n=5). Apicomesal process of sternite VII short and acute. Segment VIII annular, subquadrate with shallow excide at dorso-posterior margin and deep

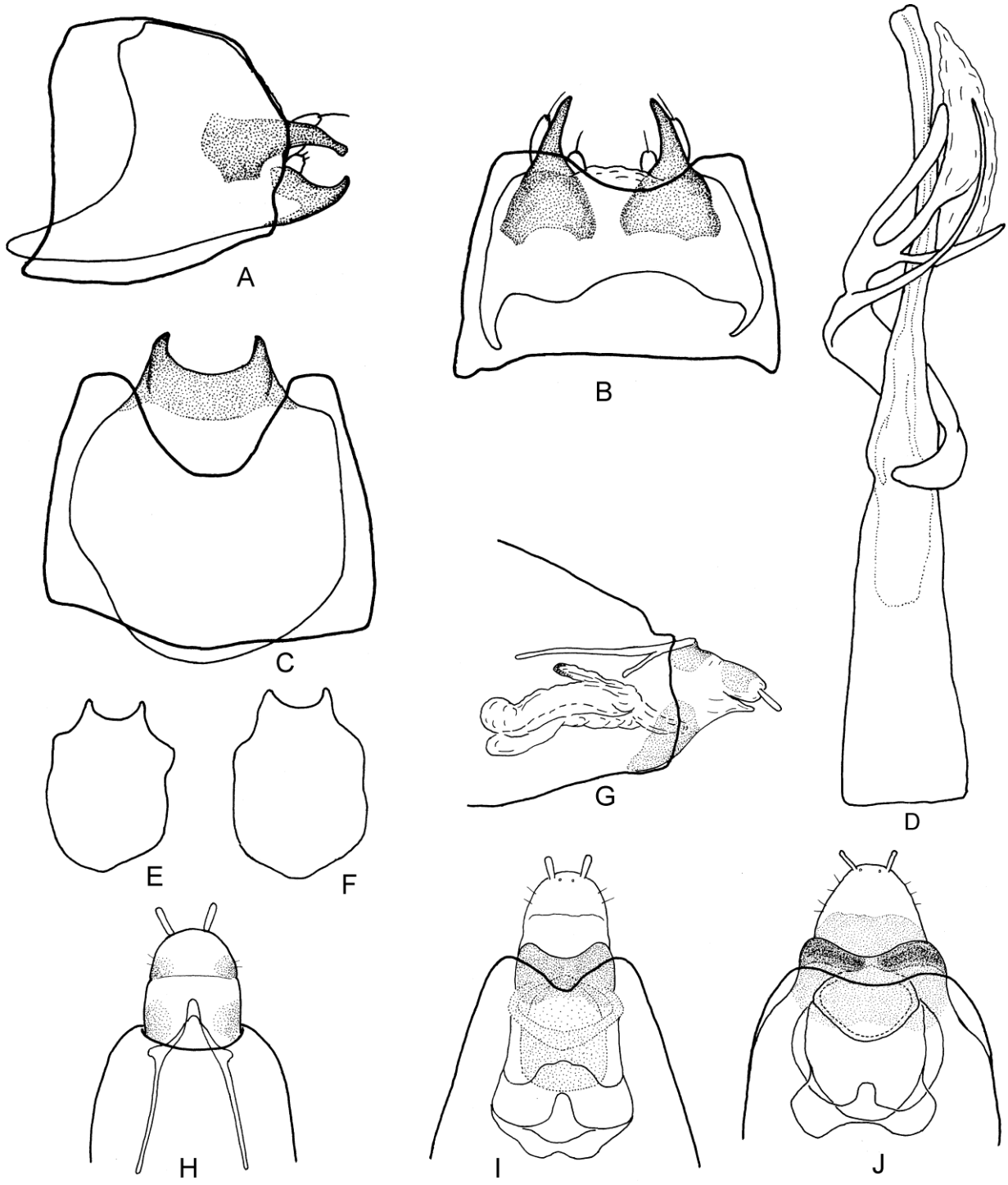

Figure 3. *Oxyethira chitosea*. *Male* (A–F): A = genitalia, left lateral; B = same, dorsal; C = same, ventral; D = phallus, ventral; E, F = segment IX, ventral. *Female* (G–J): G = abdominal segments VII–X, lateral; H = same, dorsal; I and J = same, ventral. *Materials*: A–D, holotype; E, a paratype; F, Lake Akan-panke-ko, Hokkaido; G–I, type locality; J, Ikeonokôchi-shitsugen, Fukui.

excide at ventro-posterior margin. Segment IX almost completely enclosed within segment VIII; dorsum shorter than ventrum in lateral view; subquadrate with asymmetrically excised anterior margin in dorsal view; subquadrate with more or less protruded anterior margin in ventral view. Segment X reduced to low membranous lobe. Pair of paraproct heavily sclerotized; triangular with truncate apices in lateral view, thin triangular in dorsal view. Basal plate of gonopods at baso-ventral margin of paraproct. Gonopods triangle in lateral view, curved dorso-posteriorly, fused to sternite IX at base. Setal lobes at mesal surface of gonopods. Phallic organ with paramere encircling shaft once and split into a filiform and a more complex arm; complex arm split into 3 unequal branches, middle arm longest with expanded membranous blade.

Female. Length of forewing and hind wing 2.9–3.0 mm and 2.3–2.5 mm, respectively (n=5). Antennae 25–26 segmented, light brown with 3 dark segments sub-apically and 1.1–1.3 mm long (n=5). Sternite VI with small acute ventral process. Tergites VIII and X very weakly sclerotized, segment IX membranous. Sternite VIII with brown, large subquadrate sclerite; in ventral view, anterior margin almost straight, posterior margin with middle wide excision; posterior margin heavily sclerotized in Fukui specimens.

Remarks. This species belongs to the *tinovae* species cluster Oláh and Ito, 2013, the *flavicornis* species group Kelley, 1984 (Oláh & Ito 2013), and is similar to *O. angustella* Martynov, 1933, but clearly discriminated from the later by three branched complex arm of phallic apparatus in male. The female is described here for the first time and characterized by large subqudrate ventral sclerite of segment VIII and 3 dark subapical segments of antennae. However, the females of this species are rather similar to *O. angustella* as described above and difficult to discriminate from the later if they were deposited in alcohol more than several months.

Distribution (Fig. 12). Hokkaido (Nemuro, Kushiro, Ishikari), Honshu (Fukui).

Habitat. Adults were collected from upper reaches of streams and small lakes in forests.

Japanese name. Chitose-hagoita-himetobikera.

Oxyethira hiroshima Oláh & Ito, 2013

(Figures 4, 5, 12)

Oxyethira hiroshima Oláh & Ito, 2013, 35–36, figs. 29–33, male, Honshu (Hiroshima).

Material examined. Additional records to Oláh & Ito (2013). *Honshu*. *Aomori*: 1 male, Mutsu-shi, Shimo-ogawa, Shozu-gawa, 66 m, 17.ix. 2010, TI, L. *Shizuoka*: 1 male, Shizuoka-shi, Akazawa, 4.x. 2011, T. Hattori. *Shiga*: 1 female, Higashi-omi-shi, Eigenji-cho, Kanzaki-gawa, Kazakoshi-zawa, 5.ix. 1998, T. Hattori, L; 5 females, same locality, 6 & 30.ix.2013, TI, L; 3 males, 2 females, same locality, 9.ix.2014, TI, L & S; 1 female, same locality, 29.v.2015, S. *Okayama*: 1 male, Maniwa-shi, Hiruyama, Bessho, Ohara, 15. v.2016, K. Nojima; 3 maels, 4 females, Mimasaka-shi, Takinomiya, 20. vii.2016, K. Nojima.

Adult. Wings light brown with several small lighter markings. Antennae brown to light brown with darker marking near apices. Spur formula 0, 3, 4.

Male. Length of forewing and hind wing 3.1 mm and 2.7 mm, respectively (n=1). Antennae 31 segmented; length 1.8 mm (n=1). Apicomesal process of sternite VII short and acute. Segment VIII annular with postero-lateral processes in lateral view, processes heavily sclerotized with spiny apices. Segment IX almost completely enclosed within segment VIII; dorsum shorter than ventrum; oval in dorsal and ventral views. Segment X reduced to membranous lobe. Pair of paraproct heavily sclerotized, very complex, shape rather variable locally, individually and even in opposite side of a single specimen; in lateral view, consisted of dorsally directed comb-like bar, posteriorly directed thick board with dorso-caudad directed and ventro-caudad directed bars apically; in ventro-posterior view, circular with 2–3 short triangular projections.

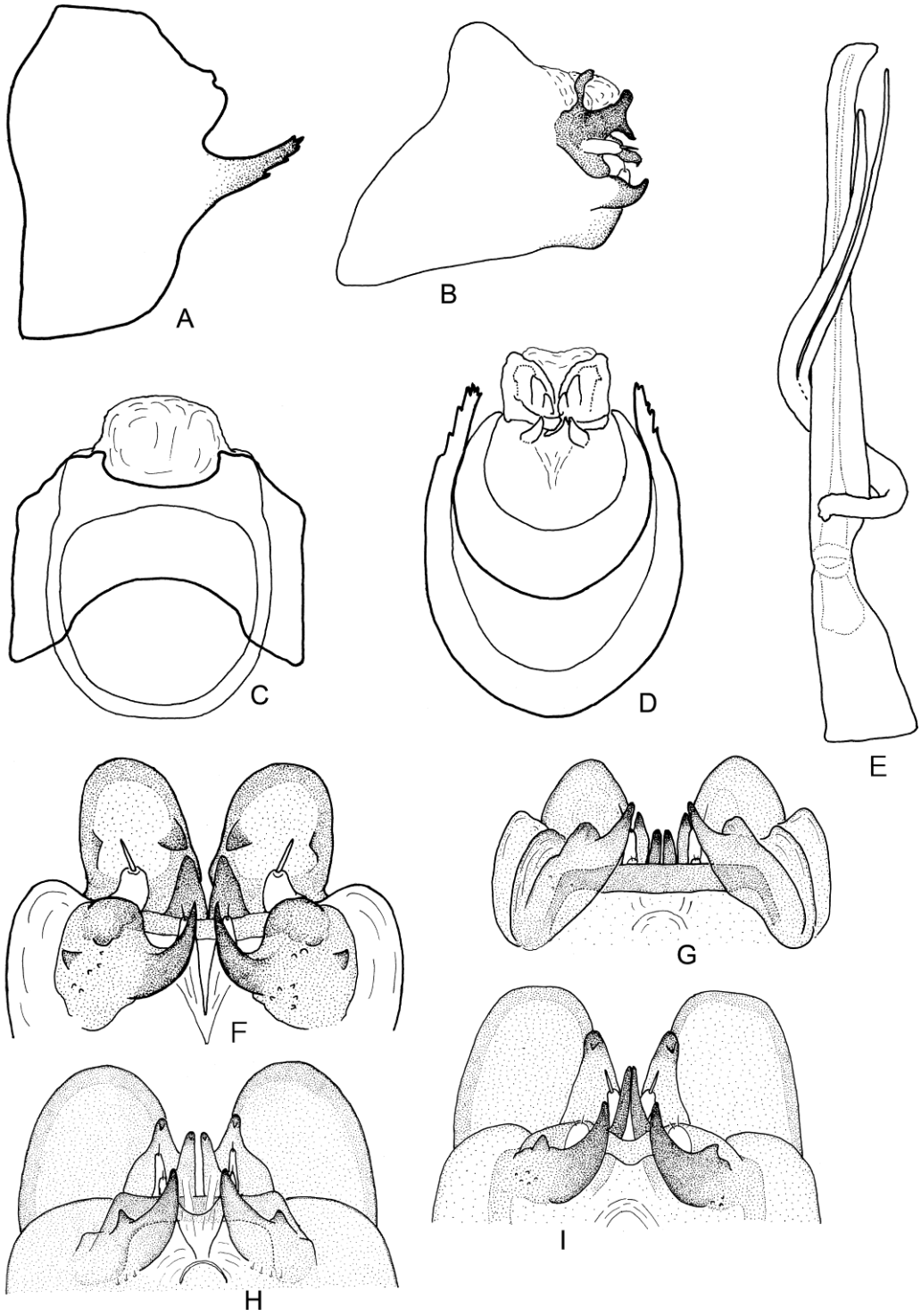

Figure 4. *Oxyethira hiroshima*. *Male*. A = segment VIII, left lateral; B = genitalia excluding segment VIII, lateral; C = genitalia, dorsal; D = same, ventral; E = phallus, dorsal; F–I = ventro-caudal view of genitalia, variation. *Materials*: A–F, holotype; G= Shozu-gawa, Aomori; H= Akazawa, Shizuoka; I= Hiruyama, Okayama.

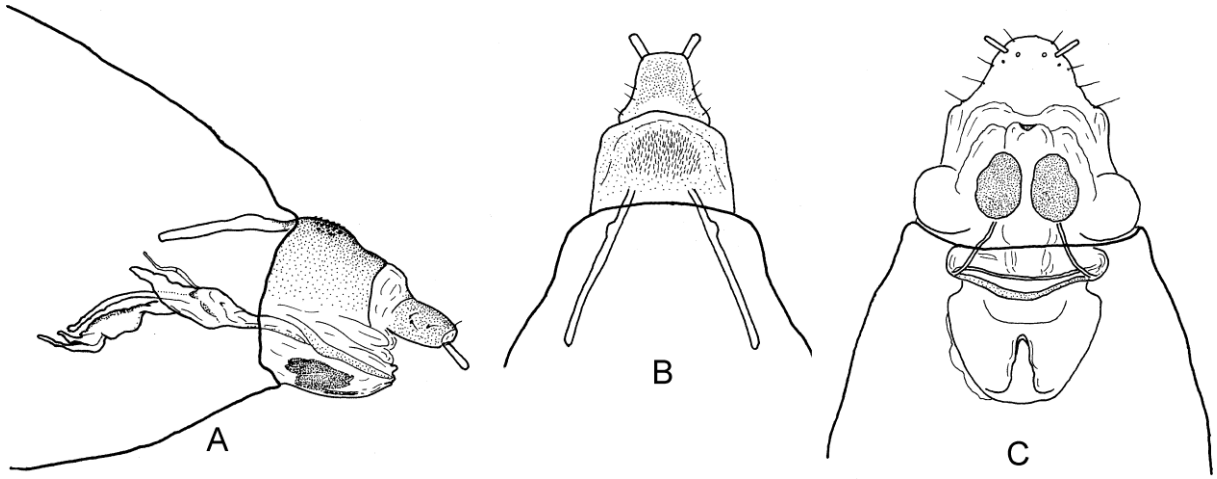

Figure 5. *Oxyethira hiroshima*. *Female*. A = segments VII–X, lateral; B = same, dorsal; C = same, ventral. *Material*: Kanzaki-gawa, Shiga.

Basal plate of gonopods at basoventral margin of paraproct. Gonopods triangle, slightly curved dorso-posteriorly in lateral and ventro-posterior views, fused to sternite IX at base. Setal lobes at mesal surface of gonopods. Phallic organ with paramere encircling shaft once and split into 2 arms; 2 arms elongated to posteriorly, shorter than aedeagus; one of arms longer and slender than another.

Female. Length of forewing and hind wing 2.1–2.2 mm and 1.8–1.9 mm, respectively (n=2). Antennae 22–23 segmented and 0.8–0.9 mm long (n=2). Sternite VI with small acute apicomesal process. Tergite of VIII weakly sclerotized with assemblage of short spiny setae. Two egg-shaped sclerites on sternite VIII brown, conspicuous. Tergite X weakly sclerotized.

Remarks. This species belongs to the *hiroshima* species cluster Oláh and Ito, 2013, the *flavicornis* species group Kelley, 1984 (Oláh & Ito 2013), and is distinguished from any other species by the heavily sclerotized complex paraproct. The female is described here for the first time and is characterized by egg-shaped sclerites of sternite VIII. As shown below, the females of *O. mekunna* Oláh and Ito, 2013, also have egg-shaped sclerites on sternite VIII and difficult to discriminate each other based on the shape. However, the distributions of the two species are separated at present time (Fig. 12).

Distribution (Fig. 12). Honshu (Aomori, Shizuoka, Shiga, Okayama, Hiroshima).

Habitat. Adults were collected near hygropteric zones and small rapid streams.

Japanese name. Hiroshima-hagoita-himetobikera (newly given here).

Oxyethira mekunna Oláh & Ito, 2013

(Figures 6, 12)

Oxyethira mekunna Oláh & Ito, 2013, 36–37, figs. 34–38, male, Hokkaido (Tokachi, Kamikawa, Sorachi, Shiribeshi).

Material examined. Additional records to Oláh & Ito (2013). *Hokkaido*: 9 males, Kami-shihorocho, Tokachi-mitsumata, 13.vii.1996, A. Ohkawa; 1 female, Horokanai-cho, Shumarinai, Shumarinai-gawa, small tributary, 21.viii.2014, TI, S; 1 male, 1 female, same locality, 19.vi.2015, TI, S & L; 1 male, Uryu-numa, Uryu-cho, 4–6.viii.1976, T. Hattori, L (mounted on slide); 48 males, 15 females, Iwanai-cho, Mekunnai-shitsugen, 1.viii. 1998, M. Ōhara; 29 males, 5 females, Iwanai-cho, Penke-mekunnai-shitsugen, 13.vii.1998, A. Yamamoto *et al*.

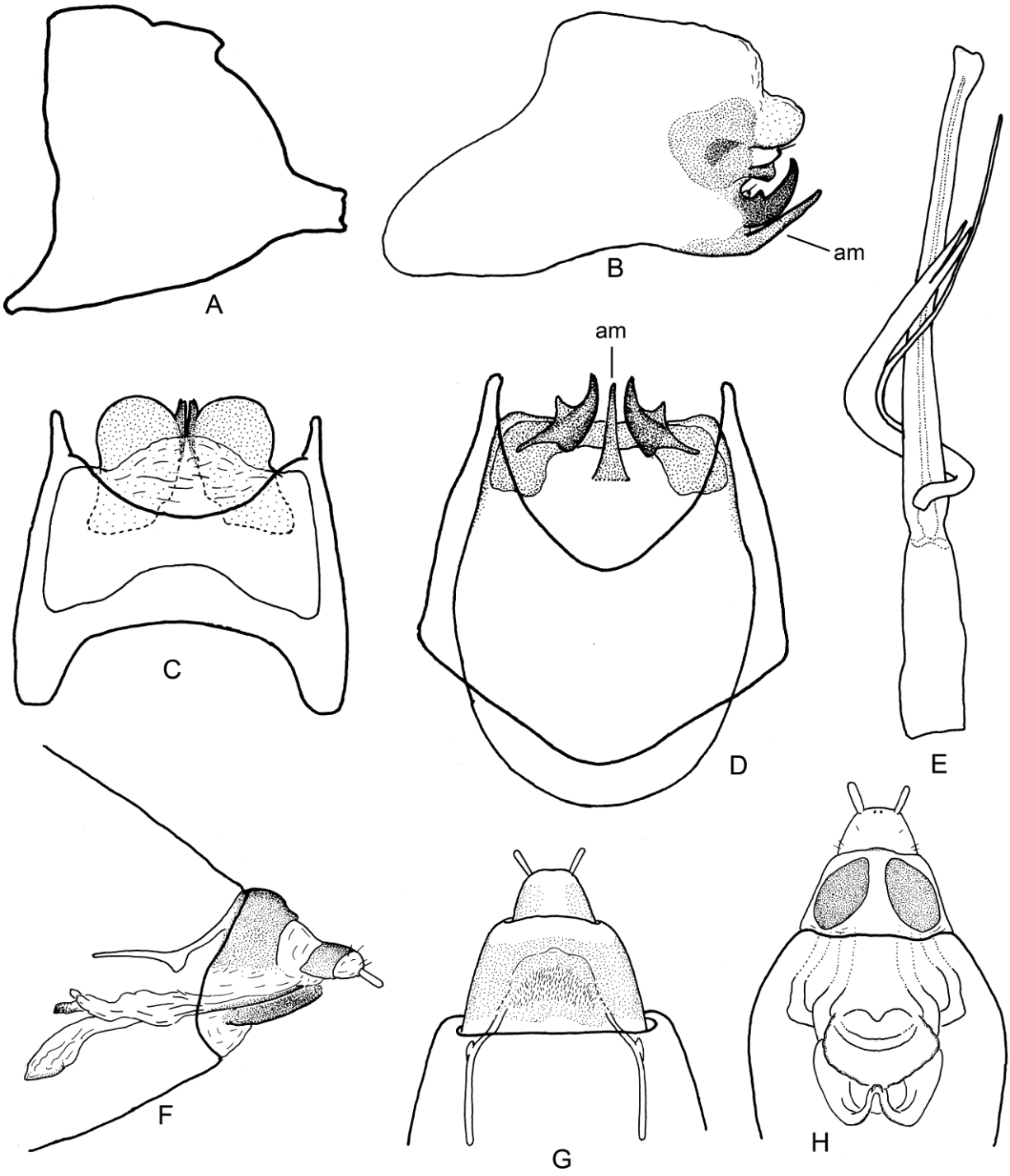

Figure 6. *Oxyethira mekunna*. *Male* (A–E): A = segment VIII, left lateral; B = genitalia excluding segment VIII, left lateral; C = genitalia, dorsal; D =same, ventral; E = phallus, dorsal. *Female* (F–H): F = abdominal segments VII–X, lateral; G = same, dorsal; H = same, ventral. *Materials*: A–E, holotype; F–H, type locality.
Abbreviations: am, apicomesal process of segment IX.

Adult. Wings light brown with several small lighter markings. Antennae brown to light brown with darker marking at half way and near apices. Spur formula 0, 3, 4.

Male. Length of forewing and hind wing 2.5–2.7 mm and 2.0–2.4 mm, respectively (n=5). Antennae 26–31 segmented; length 1.3–1.6 mm (n=5). Apicomesal process of sternite VII short and acute. Segment VIII annular, dorsum slightly shorter than ventrum, with postero-lateral processes in lateral view, processes slightly sclerotized, quadrate; wide large excisions at anterior and posterior margins in dorsal view; largely convex at anterior margin and largely excised at posterior margin in ventral view. Segment IX almost completely enclosed within segment VIII; dorsum distinctly shorter than ventrum; broad subquadrate in dorsal view and oval with apicomesal long process (am) in ventral view. Segment X reduced to low membranous lobe. Pair of paraproct seimi-circular with short barlike ventral projections in lateral and dorsal views. Basal plate of gonopods near baso-lateral margin of paraproct. Gonopods triangle with low acute blade at dorso-lateral margin, curved dorso-posteriorly in lateral and ventral views, fused to sternite IX at base. Short setal lobes at mesal surface of gonopods. Phallic organ with paramere encircling shaft once and split into a filiform and tape-like arm; tape-like arm bifid at apical 1/5; filiform longer than tape-like arm but shorter than aedeagus.

Female. Length of forewing and hind wing 2.4–2.5 mm and 2.0–2.4 mm, respectively (n=5). Antennae 25 segmented and 1.3 mm long (n=1). Sternite VI with small acute apicomesal process. Tergite of VIII weakly sclerotized with assemblage of short spiny setae. Two ellipsoidal or egg-like sclerites on sternite VIII brown, conspicuous. Segment IX membranous and tergite X weakly sclerotized.

Remarks. This is a species of the *hiroshima* species cluster Oláh and Ito, 2013, the *flavicornis* species group Kelley, 1984 (Oláh & Ito, 2013) and distinguished from other Japanese species by apicomesal long process of sternite IX and dorso-lateral acute lobe of gonopods in male. The female is described here for the first time and is characterized by ellipsoidal or egg-like sclerites of sternite VIII, but difficult to discriminate from *O. hiroshima* as described above, if males are not collected at same site.

Distribution (Fig. 12). Hokkaido (Tokachi, Kamikawa, Sorachi, Shiribeshi).

Habitat. Most adults were collected from marshes and small streams in forests.

Japanese name. Mekunna-hagoita-himetobikera (newly given here).

Oxyethira miea Oláh & Ito, 2013

(Figures 7, 12)

Oxyethira miea Oláh & Ito, 2013*,* 42–43, figs. 53–56, male, Honshu (Mie).

*Material examine*d. Additional records to Oláh & Ito (2013). *Honshu*. *Shizuoka*: 1 male, Shizuoka-shi, Nyujima, 9.ix.2008, T. Hattori. *Aichi*: 15 males, 75 females, Shinshiro-shi, Toyooka, Ichinose, Ōtsutani-gawa, 29.vi.2013–17.viii.2014, H. Nishimoto *et al*., L (2 males, 11 females, 29.vi. 2013; 8 males, 49 females, 18.vii.2013; 7 females, 20.ix.2013; 5 males, 8 females, 17.viii.2014); 1 female, Shinshiro-shi, Tsukuride-moriyoshi, Tokaizu-gwa, 22.ix.2013, H. Nishimoto. *Shiga*: 1 male, Higashi-omi-shi, Eigenji-cho, Kanzaki-gawa, 5.ix.1998, T. Hattori.

Adult. Wings light brown with several small lighter markings. Antennae brown to light brown with darker marking at half way and near apices. Spur formula 0, 3, 4.

Male. Length of forewing and hind wing 2.0–2.7 mm and 1.9–2.3 mm, respectively (n=5). Antennae 32–35 segmented; length 1.5–1.6 mm (n=2). Apicomesal process of sternite VII short and acute. Segment VIII annular, with short acute projections at middle of anterior margin and

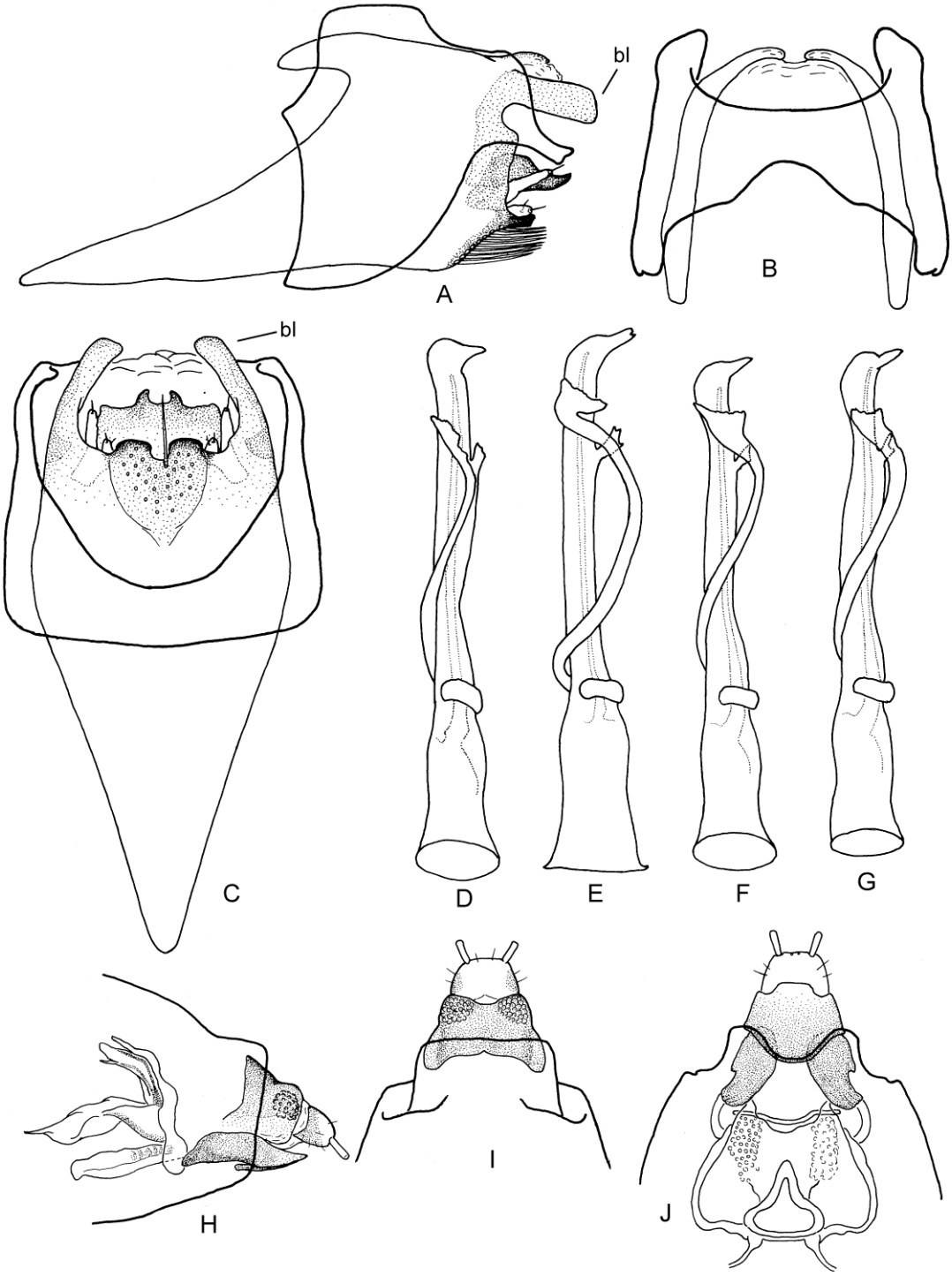

Figure 7. *Oxyethira miea*. *Male* (A–G): A = genitalia, left lateral; B = same, dorsal; C = same, ventral; D–G = phallus, dorsal. *Female* (H–J): H= abdominal segments VII–X, lateral; I= same, dorsal; J= same, ventral. *Materials*: A–D, holotype; E, Kanzaki-gawa, Shiga; F, Nyujima, Shizuoka; G–J, Ōtsutani-gawa, Aichi.
Abbreviations: bl, board-like lobe of segment IX.

subquadrate projections at middle of posterior margin in lateral view. Segment IX almost enclosed within VII–VIII; ventrum very long reaching to end of segment VI, narrowing in lateral and ventral views; dorsum short band producing short dorsolateral narrowing lobes anteriorly and large board-like lobes posteriorly in dorsal view; board-like lobes curved mesally in ventral view. Segment X reduced to low membranous lobe. Pair of paraproct triangle, slightly curved dorsally in lateral view; fused at basal 4/5, subquadrate with small acute process at posterior margin in ventral view. Basal plate of gonopods near baso-lateral margin of paracropt. Gonopods fused to sternite IX at base, heavily sclerotized, short truncate lobes in ventral view, with many thick setae. Short setal lobes at mesal surface of gonopods. Phallic organ with paramere encircling shaft once and armed with serrated lobe apically; serrated lobe variable in size locally and individually; aedeagus with a small truncate process at 1/5 way from apex and with heavily sclerotized short beak-shaped process apically; shapes of small truncate process and beak-shaped process slightly variable locally.

Female. Length of forewing and hind wing 2.2–2.7 mm and 1.9–2.7 mm, respectively (n=5). Antennae 26–27 segmented and 1.0–1.2 mm long (n=4). Sternite VI with small acute apicomesal process. Tergite VIII weakly sclerotized with assemblages of granules posterolaterally. Sclerite of sternite VIII pentagon-shaped with gently convex anterior margin and squarely convex posterior margin in ventral view. Two ellipsoidal sclerites connected to sternite VIII antero-laterally, slightly curved laterally with excise at outer margin in ventral view. Segment IX membranous and tergite X weakly sclerotized.

Remarks. This is a species of the *ramosa* species group Kelley, 1984 (Oláh & Ito 2013), and is distinguished from other species by short truncate gonopods with thick and long setae, paramere with serrated apex and aedeagus with truncate lobe subapically in male. In the original description, small subapical truncate lobe of male aedeagus is incorrectly figured on the paramere (Oláh & Ito 2013 fig. 56) but the lobe is on subapical part of aedeagus. The female is described here for the first time and characterized by pentagon-shaped sclerite of sternite VIII.

Distribution (Fig. 12). Honshu (Shizuoka, Aichi, Mie, Shiga).

Habitat. Adults were collected from beside streams.

Japanese name. Mie-hagoita-himetobikera (newly given here).

Oxyethira okinawa Oláh & Ito, 2013

(Figures 8, 12)

Oxyethira okinawa Oláh & Ito, 2013, 43–44, figs. 57–60, male, Ryukyu Islands (Okinawa-jima); Kuhara & Ito, 2017, 16, Ryukyu Islands (Yakushima).
Oxyethira sp.: Shimura *et al*., 2014, 45, Ryukyu Islands (Amami-oshima).

Material examined. Additional records to Oláh & Ito (2013). *Ryukyu Islands. Yakushima*: 1 male, 3 females (detail data in Kuhara & Ito, 2017). *Amami-oshima*: 3 females, Yamato-son, Materia-gawa, 27.iii.2014, N. Shimura; 7 females, same locality, 21.x.2014, TI, L & S. *Okinawa-jima*: 5 females, Nago-shi, Genka-kawa, Hogen-hashi (type locality), 17–19.x.2014, TI, L & S; 1 female, Nago-shi, Teima-gawa, 14.ix.1990, TI; 11 females, Kunigami-son, Yona-gawa, Nakafukuji-hashi, 18.x.2014, TI, L; 1 male, Kunigami-son, Nishime-dake, headwater of Zatsun-gawa, 28.vii. 1997, R. B. Kuranishi (deposited in the personal collection of R. B. Kuranishi).

Adult. Wings light brown with several small lighter markings. Antennae brown to light brown with darker marking at half way and near apices. Spur formula 0, 3, 4.

Male. Length of forewing and hind wing 2.1– 2.7 mm and 2.0–2.6 mm, respectively (n=3). Antennae segments 36, length 2.8 mm (n=1). Apicomesal process of sternite VII short and acute. Segment VIII annular, with low subacute projecti-

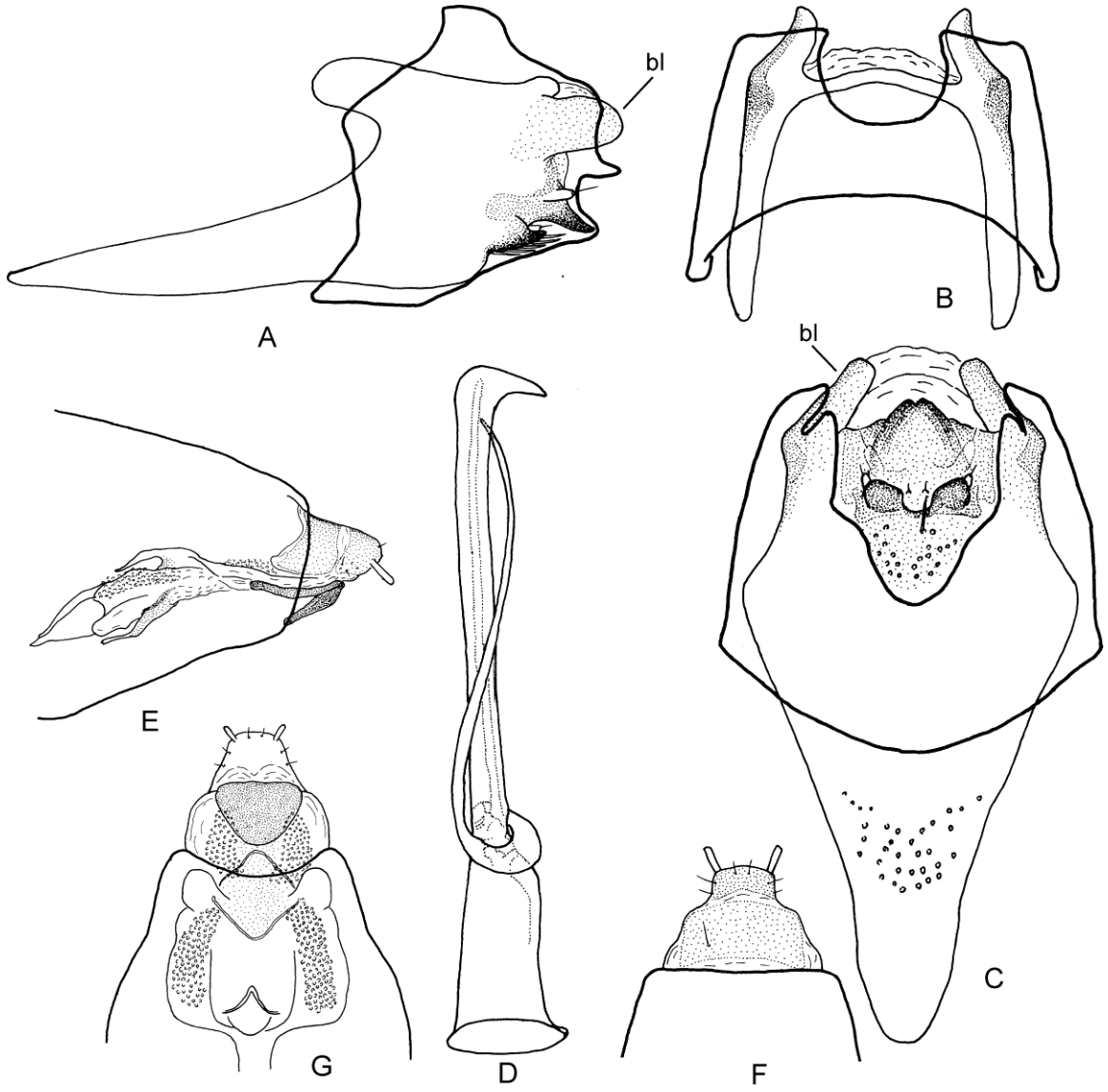

Figure 8. *Oxyethira okinawa*. *Male* (A–D): A = genitalia, left lateral; B = genitalia, dorsal; C = same, ventral; D = phallus, dorsal. *Female* (E–G): E = abdominal segments VII–X, lateral; F = same, dorsal; G = same, ventral. *Materials*: A–D, holotype; E–G, type locality. *Abbreviations*: bl, board-like lobe of segment IX.

ons at middle of anterior and posterior margins in lateral view; subquadrate with large round excision at posterior margin in dorsal view; subquadrate with deep wide excision at posterior margin in ventral view. Segment IX almost enclosed within VII–VIII; ventrum very long reaching to end of segment VI, narrowing in lateral and ventral views; dorsum short band producing long dorsolateral lobes anteriorly and board-like lobes posteriorly in dorsal view; board-like lobes directed postero-mesad in dorsal and ventral views. Segment X reduced to short membranous lobe. Pair of paraproct triangle in lateral view; almost completely fused each other with middle small excision posteriorly in ventral view. Basal plate of gonopads near baso-lateral margin of paracropt. Gonopods heavily sclerotized, small, fused to sternite IX at base, triangular in lateral view and truncate lobes in ventral view, with many thick setae. Short setal lobes at mesal surface of gono-

pods. Phallic organ with paramere encircling shaft once; aedeagus with heavily sclerotized short beak-shaped process apically; paramere slender, shorter than aedeagus.

Female. Length of forewing and hind wing 2.2–2.6 mm and 1.7–2.4 mm, respectively (n=5). Antennae 25–26 segmented and 0.8–1.2 mm long (n=5). Sternite VI with small acute apicomesal process. Tergites of VIII and X weakly sclerotized, segment IX membranous. Sternite VIII with large subtriangular sclerite in ventral view. Many granules on inner apparatus.

Remarks. This is a species of the *ramosa* species group Kelley, 1984 (Oláh & Ito 2013), and similar to *O. miea* Oláh & Ito, 2013, but distinguished from the later by triangular paraprocts largely fused each other at base and simply elongated paramere in male. The female is described here for the first time and characterized by subtriangular sclerite on sternite VIII.

Distribution (Fig. 12). Ryukyu Islands (Yakushima, Amami-oshima, Okinawa-jima).

Habitat. Adults were collected beside streams.

Japanese name. Okinawa-hagoita-himetobikera.

Oxyethira ozea Oláh & Ito, 2013

(Figures 9, 12)

Oxyethira ozea Oláh & Ito, 2013*,* 41–42, figs. 50–52, male, Honshu (Gunma).

Material examined. Holotype male, Gunma, Oze, Yamanohama, 1400 m, 2.ix.1996, T. Nozaki, L.

Adult. Wings light brown with several small lighter markings. Antennae brown to light brown with darker marking at half way and near apices. Spur formula 0, 3, 4.

Male. Length of forewing and hind wing 2.5 mm and 2.0 mm, respectively (n=1). Antennae 29, 31 segmented (left and right one with differently segmented) and 1.6 mm (n=1). Apicomesal process of sternite VII short and acute. Segment VIII annular, with large triangular postero-lateral projections and small subacute projections in lateral view; circular with subacute excision at anterior margin and large round excision at posterior margin in dorsal view; circular with deep wide excision at posterior margin in ventral view. Segment IX almost enclosed within VIII; ventrum longer than dorsum; dorsum short band with concave anterior and posterior margins in dorsal view; sternite with oval anterior margin and almost straight posterior margin in ventral view. Segment X reduced to large membranous lobe. Pair of paracropt triangle, gently curved ventroposteriorly in lateral view; thin triangle, fused each other at base in ventral view. Basal plate of gonopods near baso-lateral margin of paracropt. Gonopods sclerotized, triangle, slightly curved dorsally in lateral view; triangle and fused to sternite IX at base in ventral view. Short setal lobes at mesal surface of gonopods. Phallic organ with paramere encircling shaft once; aedeagus with pair of sclerotized spine-like structures subapically.

Female. Unknown.

Remarks. This is a species of the *grisea* Group Kelley, 1984, and distinguished from other Japanese species by pair of sclerotized spine-like structures of aedeagus.

Distribution (Fig. 12). Honshu (Gunma). Known only from the type locality.

Habitat. Adult was collected in a highland marsh.

Japanese name. Oze-hagoita-himetobikera (newly given here).

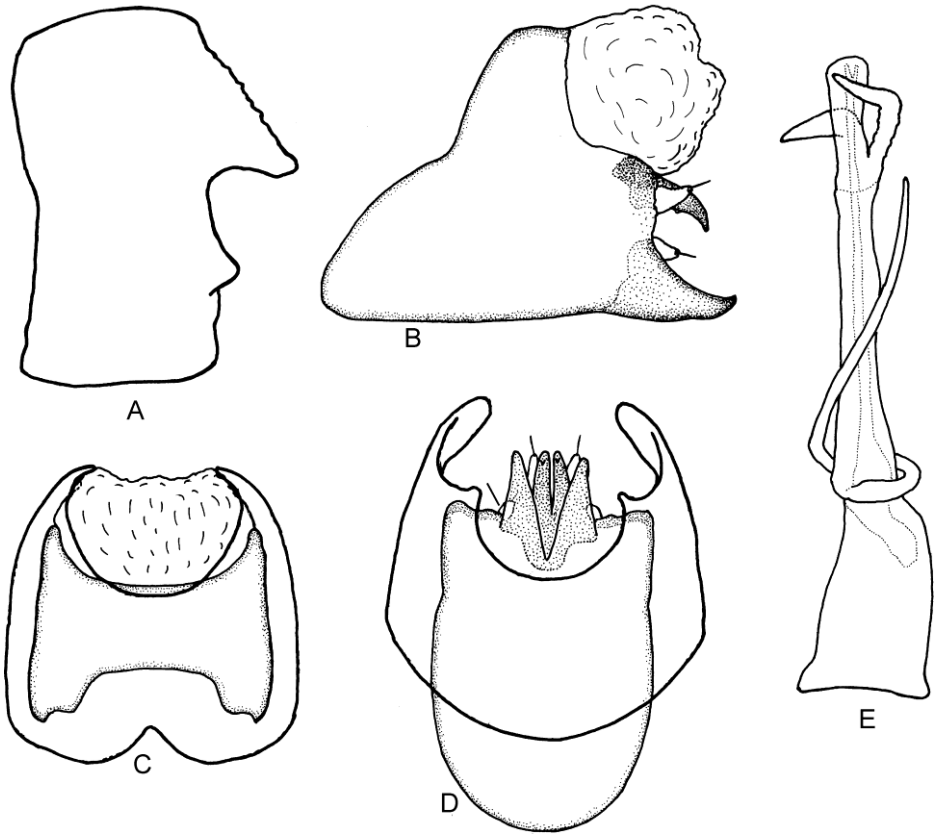

Figure 9. *Oxyethira ozea*. *Male*. A = segment VIII, left lateral; B = genitalia excluding segment VIII, left lateral; C = genitalia, dorsal; D = same, ventral; E = phallus, left lateral. *Material*: holotype.

***Oxyethira tsuruga* sp. nov.**

(Figures 10, 12)

Oxyethira sp., Ito, 2017, 3, Honshu (Fukui).

Holotype male, Honshu, Fukui, Tsuruga-shi, Ikenokôchi Marsh, (35˚40' N, 136˚08' E, 300 m above sea level), 11.vi.2016, TI, L (CBM-ZI 164638). *Paratypes*. 4 males 5 females, same data as holotype (CBM-ZI 164639–164647).

Other specimens examined. 67 males, 581 females, same data as holotype. *Hokkaido*: 1 male, Kushiro-shi, Akan-cho, Ibeshibetsu-gawa, near small marsh, 27.vii.1999, TI, L.

Diagnosis and remarks. Male of this species resembles to those of *Oxyethira ozea* Oláh & Ito 2013, described from central Honshu, and *O. lumosa* Ross, 1948, distributed in southeastern North America (Kelly 1985), in having relatively large membranous lobe of segment X, triangular paracropt and triangular gonopods. However, *O. tsuruga* is distinguished by the shape of segment VIII from the two latter as follows: postero-lateral margin of segment VIII with quadrate projections in *O. tsuruga* (*cf.* with triangle projections in *O. ozea* and with no projection in *O. lumosa*); postero-ventral margin of segment VIII with large subtriangle excision in *O. tsuruga* (*cf.* with large circular excision in *O. ozea* and with very shallow excision in *O. lumosa*). Moreover, *O. tsuruga* is different from *O. ozea* in the shape of aedeagus as follows; with a very short apical spine in *O. tsuruga* (*cf.* with 2 subapical spines in *O. ozea*). This species belongs to the *grisea* species group Kelley, 1984.

Adult. Wings light brown with several small lighter markings. Antennae brown to light brown with darker marking at half way and near apices. Spur formula 0, 3, 4.

Male. Length of forewing and hind wing 2.4–2.6 mm and 2.0–2.3 mm, respectively (n=6). Antennae segments 38, length 2.0 mm (n=1). Apicomesal process of sternite VII short and acute. Segment VIII annular, subquadrate with large quadrate projections at posterior margin in lateral view; large circular excision at posterior margin and almost straight anterior margin in dorsal view; with middle deep subacute excision at ventro-posterior margin and circular anterior margin in ventral view. Segment IX almost completely enclosed in segment VIII; ventrum longer than dorsum, anterior margin circularly convex in ventral view and circularly concave in dorsal view. Segment X reduced to relatively large membranous lobe. Pair of paracropt triangle, heavily sclerotized; strongly curved ventro-posteriorly in lateral view; triangle, strongly curved venro-mesally in ventral view. Basal plate of gonopods near baso-lateral margin of paracropt. Gonopods sclerotized, triangle, apical 1/3 strongly curved dorsally in lateral view; triangle and fused to sternite IX basally in ventral view. Short setal lobes at mesal surface of gonopods. Phallic organ with paramere twice encircling shaft; aedeagus ax-like with short submesal spine apically.

Female. Length of forewing and hind wing 2.9–3.0 mm and 2.3–2.6 mm, respectively (n=5). Antennae 25 segmented and 1.2–1.4 mm long (n=5). Sternite VI with small acute apicomesal process. Tergites VIII weakly sclerotized with setose lobe at middle. Segment IX membranous and tergite X weakly sclerotized. Pair of large round sclerites and transversely long sclerite conspicuous in venter VIII.

Etymology. The name "*tsuruga*" is a noon in apposition, coined from the type locality.

Distribution (Fig. 12). Hokkaido (Kushiro), Honshu (Fukui).

Habitat. Adults were collected from small marshes.

Japanese name. Tsuruga-hagoita-himetobikera.

***Oxyethira shumari* sp. nov.**

(Figs. 11, 12)

Holotype male, Hokkaido, Horokanai-cho, Shumarinai, Shumarinai-gawa River, a small tributary (44˚17' 56" N, 142˚09' 31" E, 270 m above sea level), 3.viii.2016, TI, L (CBM-ZI 164648). *Paratypes*. 1 male, same data as holotype (CBM-ZI 164649).

Other specimens examined. 24 females, same data as holotype.

Diagnosis and remarks. Male of this species is discriminated from other congeneric species by strongly sclerotized paracropt directed ventro-mesad, gonopods direcred posteriod, aedeagus with long acute apex and 1.5 times curled paramere. This species belongs to subgenus *Oxyethira* but the species group is unknown.

Adult. Wings, antennae and body brown to light brown. Spur formula 0, 3, 4.

Male. Length of forewing and hind wing 2.5–2.6 mm and 2.0 mm, respectively (n=2). Segments and length of antennae indistinct due to specimen condition. Apicomesal process of sternite VII short and acute. Segment VIII annular, with short spines lined at middle of postero-dorsal corner and postero-lateral margin in lateral view; shallow quadrate excision at posterior margin in dorsal view; middle deep and large subacute or semicircular excision at posterior margin in ventral view. Segment IX almost completely enclosed in segment VIII; ventrum longer than dorsum; anterior margin undulate in lateral view, with middle circular excision in dorsal view; with largely protruded anterior margin in ventral view. Segment X reduced to relatively large membranous lobe. Pair of paracropt triangle, heavily

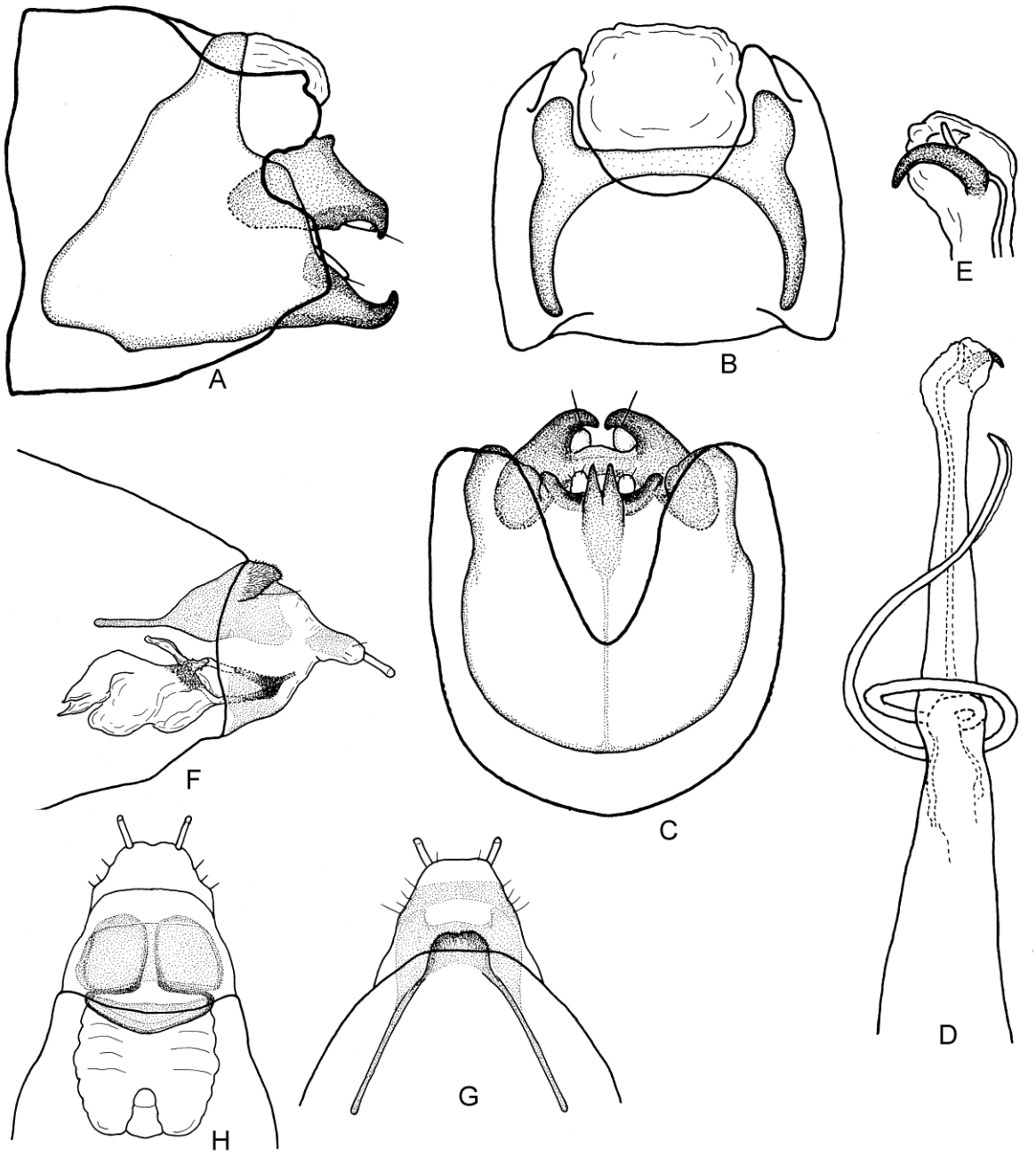

Figure 10. *Oxyethira tsuruga*. *Male* (A–E): A = genitalia, left lateral; B = same, dorsal; C = same, ventral; D = phallus, lateral; E = apex of phallus, ventro-lateral. *Female* (F–H): F = abdominal segments VII–X, lateral; G = same, dorsal; H = same, ventral. *Materials*: A–E, holotype; F–H, type locality.

sclerotized; strongly curved ventro-posteriorly in lateral view, strongly curved mesally in ventral view. Basal plate of gonopods near baso-lateral margin of paracropt. Gonopods sclerotized, triangular, directed posteriod; apical 1/4 slightly curved laterally in ventral view. Short setal lobes at mesal surface of gonopods. Phallic organ with paramere 1.5 times encircling shaft; aedeagus slightly thickened at apical 1/7, then gradually narrowing with acute apex.

Female. Length of forewing and hind wing 2.3–2.8 mm and 2.0–2.3 mm, respectively (n=5). Antennae 22–23 segmented and 0.9–1.0 mm long (n=3). Sternite VI with small acute apicomesal process. Tergites VIII and X weakly sclerotized, segment IX membranous. Weakly sclerotized rectangular plate in venter VIII. Roundish sclerite and horizontal lamella conspicuous.

Etymology. The name "*shumari*" is a noon in apposition, coined from the type locality.

Distribution (Fig. 12). Hokkaido (Kamikawa). Only known in the type locality.

Habitat. Adults were collected from a small stream.

Japanese name. Shumari-hagoita-himetobike-ra.

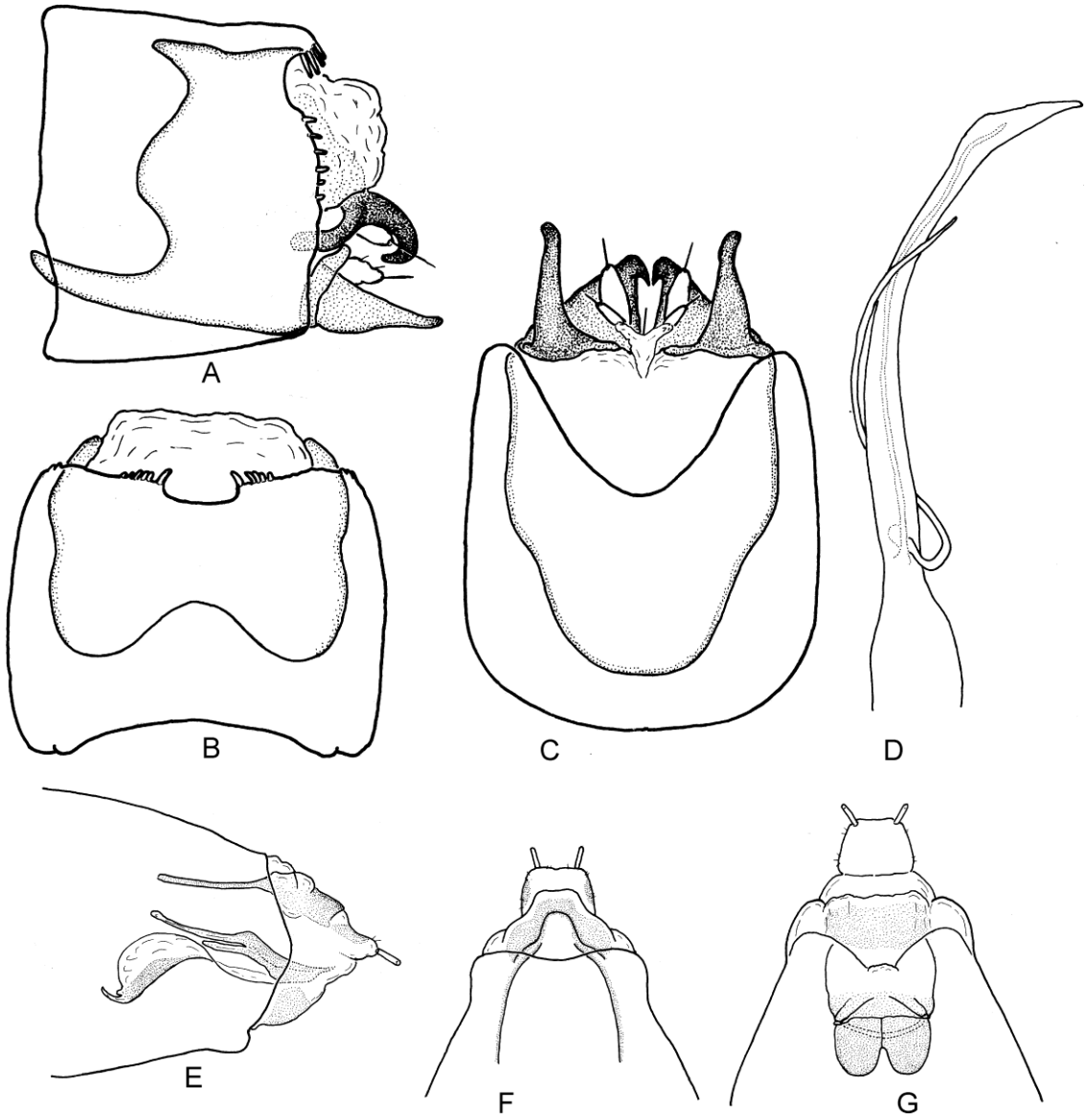

Figure 11. *Oxyethira shumari*. *Male* (A–D): A = genitalia, left lateral; B = genitalia, dorsal; C = same, ventral; D = phallus, dorso-lateral. *Female* (E–G): E = abdominal segments VII–X, lateral; F = same, dorsal; G = same, ventral. *Materials*: A–D, holotype; E–G, type locality.

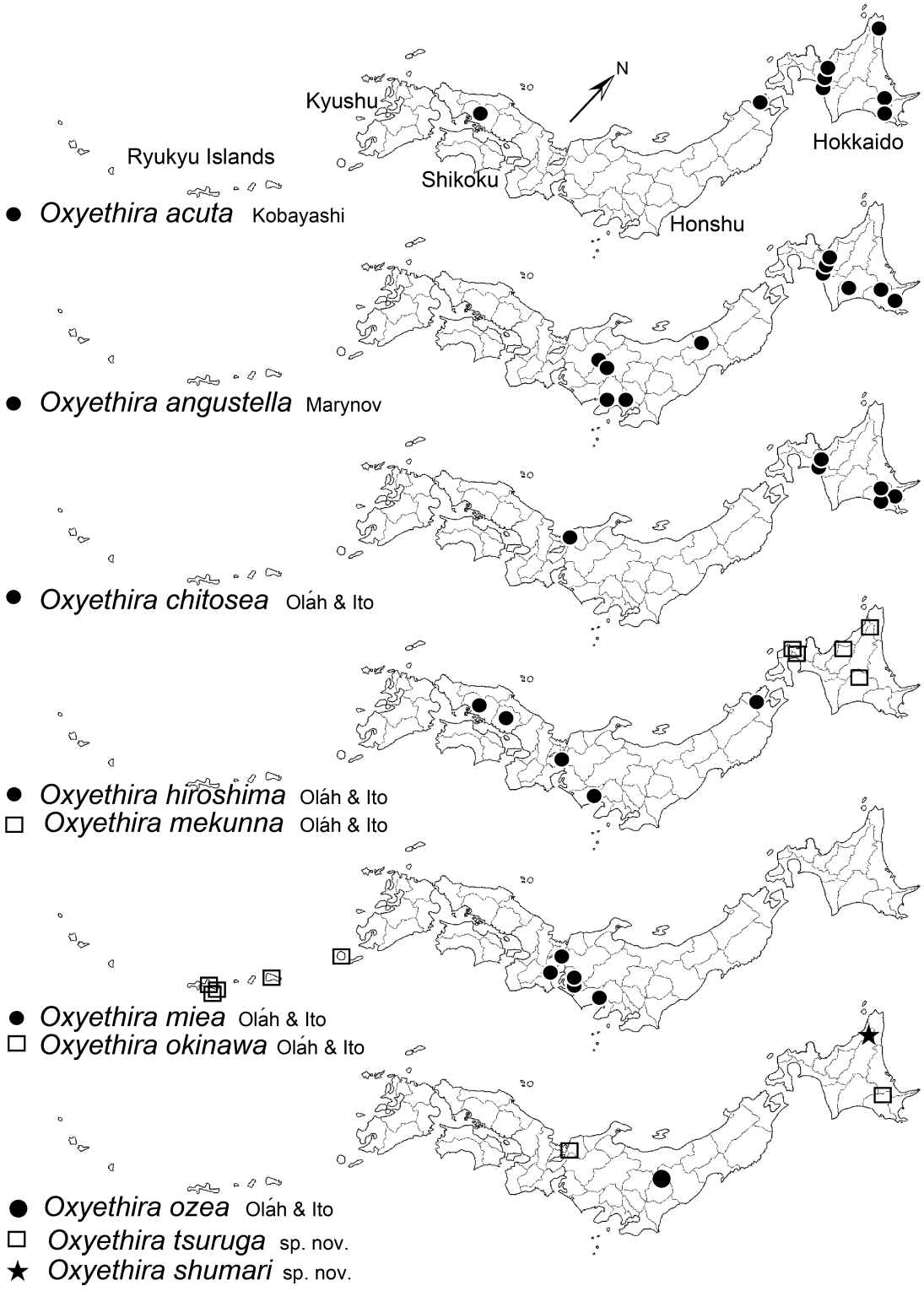

Figure 12. Distributions of 10 named species of *Oxyethira* in Japan.

Oxyethira sp.

These specimens appear to be an undescribed or unrecorded species collected in southern Ryukyu and will be dealt with when male material becomes available.

Material exmined. *Ryukyu Islands*. *Ishigaki-jima*: 1 female, Shiramizu, Nagura-gawa, small tributary, 25.x.2015, TI, S; 1 female, same loclity, 18.iii.2016, TI, S; 2 females, foot of Mt. Omoto-dake, 18-19.iii.2002, I. Oshima *et al*., L. *Iriomote-jima:* 1 female, Nishi-funatsuki-gawa, Nishi-funatsuki-bahi, 20.iii.1996, F. Nishimoto, L; 1 female, same locality, 23.iii.216, TI, l; 1 female, Airagawa, lower reach, 28-30.x.2012, TI, P.

Species erroneously assigned to the genus *Oxyethira*

Hydroptila dampfi Ulmer, 1929

Oxyethira ezoensis Kobayashi, 1977, 5–7, pl. 5, Japan (Hokkaido); Kelley, 1984, 442. Synonymized with *Hydroptila itoi* Kobayashi by Ito and Kawamula (1984).

Remarks. The senior author (T. Ito) examined the type series of *Oxyethira ezoensis* in the laboratory of Dr. Mineo Kobayashi, Kanagawa Prefectural Museum (Yokohama) in March, 1978 and recognized it as the females of *Hydroptila itoi* Kobayashi, 1977 (Ito & Kawamula 1984, p. 315). *H. itoi* was synonymized to *H. dampfi* Ulmer by Ito *et al*. (2011).

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Male secondary sexual characters in Aphnaeinae wings (Lepidoptera: Lycaenidae)

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Abstract. Male secondary sexual characters have been discovered on the hindwing verso of genera *Aphnaeus* Hübner, [1819], *Cigaritis* Donzel, 1847, *Lipaphnaeus* Aurivillius, 1916 and *Pseudaletis* Druce, 1888 representing the Palaeotropical subfamily Aphnaeinae (Lycaenidae: Lepidoptera). Relevant wing parts are illustrated, described, and some observations on the organs are briefly annotated. With an appendix and 14 figures.

Keywords. Androconia, hair tuft, classification, Palaeotropics, scaling.

INTRODUCTION

One of the most characteristic features of Lepidoptera is the scaled membranous wing surface of the imagines. The scales covering the membrane have various functions often determined sexually, hence they show specialized structures. In the family Lycaenidae male secondary sexual characters in the wings are widely distributed and highly variable, hence they drew the attention of classical workers focused on the diversity, classification, and systematics of the family. In a world-wide review, John Nevill Eliot († 2003) mapped and discussed Lycaenidae male secondary sexual characters in great detail for his classification (see Eliot 1973).

The subfamily Aphnaeinae was recently the subject of important studies (Heath 1997, Boyle *et al.* 2015). These were inspired by Eliot who pointed out the peculiarity of this lycaenid assemblage and recorded morphological traits for his classification (Eliot 1973: 470 in footnote no. 11; and Eliot 1990). However, Eliot did not indicate any male secondary sexual characters in this subfamily, nor did any of the previous or subsequent workers (*eg*. Stempffer 1954, Heath 1997, Libert 2013).

Whilst curating aphnaeine material in the Hungarian Natural History Museum one of us became aware of special scaling present on the hindwing underside of certain males (Figs. 1–2). This character was recorded and described in detail in the case of genera *Pseudaletis* and *Aphaneus* without using the expression that they may have a sexual role (*cf*. Libert 2007: 11; Libert 2013: 212–13). After studying additional material and conduct some microscopic studies it became obvious that hitherto unrecognized secondary male sexual characters in Aphnaeinae were discovered. The aim of this paper is to report on this discovery, to describe the characters, to present a brief overview of their generic distribution, and to comment our results in the light of recent knowledge regarding the subfamily.

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MATERIAL AND METHODS

All material examined are listed in Appendix. Genus-level classification of the Aphnaeinae follows Boyle *et al*. (2015).

Specimens were first inspected using a hand magnifier, then relevant wing areas were digitised using a binocular stereo microscope Olympus SZX12 supplemented by camera DP70 in the Hungarian Natural History Museum (HNHM). In the Institute of Technical Physics and Materials Science (Centre for Energy Research, Hungarian Academy of Sciences) (CER-HAS) images of high magnification were taken using an optical miscroscope Zeiss Axio Imager A1.

Terminology of veins, wing regions and scales follows Ehrlich & Ehrlich (1961), Eliot (1973) and Scott (1990).

RESULTS

Examining the hind wing ventral surfaces of the aphnaeine genera in the representatives of *Aphnaeus* Hübner, [1819] (type species: *Papilio orcas* Drury, [1782]), *Lipaphnaeus* Aurivillius, 1916 (type species: *Aphnaeus spindasoides* Aurivillius, 1916), *Pseudaletis* Druce, 1888 (type species: *Pseudaletis agrippina* H. H. Druce, 1888) and several taxa in *Cigaritis* Donzel, 1847) (type species: *Cigaritis zohra* Donzel, 1847) we have found male secondary sexual characters (Figs. 1–6), that we briefly describe below.

Aphnaeus, Cigaritis and *Lipahnaeus* (Figs. 1, 4–6, 7–8, 10, 12, 14)*:* In the intervenial area of the cell formed by veins Cubitus 1–2 there is a "line" comprised of long plume scales erecting caudad from the wing membrane. These hair scales form a tuft that can be seen even under low magnification. The tuft forms a somewhat differently coloured (darker compared to the background) delicate line running from the submedian area to the postmedian region. The line never reaches the base nor the margin of the wing. The region between the veins is often creased, especially in *Aphnaeus*.

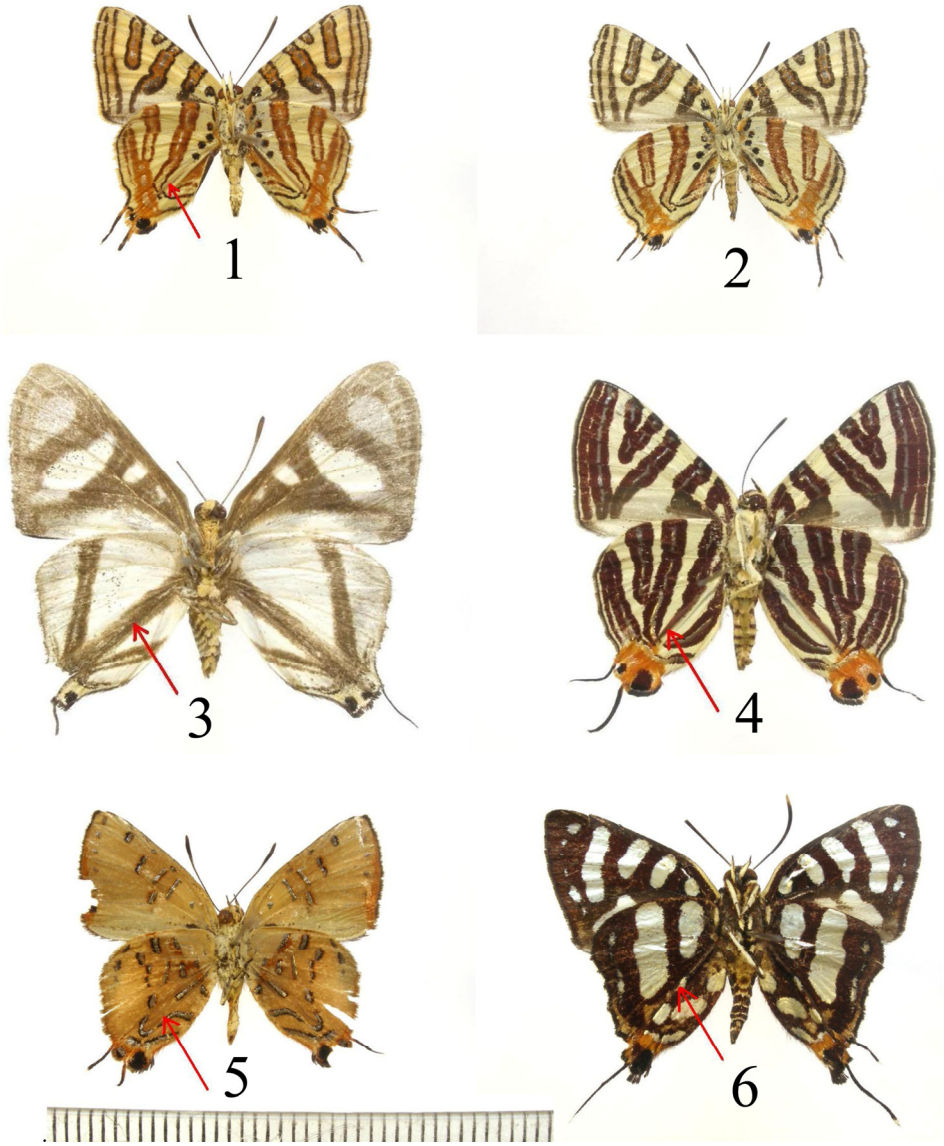
The tuft is more easily seen in living individuals, because in set museum specimens the hair scales are often adpressed to the level of the cover scales, hence they are difficult to detect. This may explain why this scaling has hitherto remained unnoticed. In living specimens the space involved is often creased, and this results in the tuft being exposed and clearly visible when the individual perches (Fig. 14).

Regarding *Aphnaeus* our material was limited (see Appendix), but consulting recent literature (d'Abrera 2009, Libert 2013) it seems that the presence of the tuft is not limited to the species of *A. orcas* and *A. argyrocyclus* as has been indicated but it is more widespread. This has been confirmed by our studies.

The representatives of *Cigaritis* are well documented in the folio books of d'Abrera (1986, 1993, 2009) also in (Kielland 1991, Larsen 1994, Weidenhoffer & Bozano 2007). We found that whilst Afrotropical and Oriental species probably all possess the tuft, species inhabiting the Palaearctic region do not. Although we could examine only two species of the less diverse genus *Lipaphnaeus* (n = 4, *sensu* Heath 1997), we presume that all the species possess the male secondary character discussed as the figures in d'Abrera (2009) suggest this is the case.

Pseudaletis (Figs 3, 9–10, 13): The wing membrane in the cell formed by the veins Cubitus 1–2 from the postbasal area to the outer margin is covered by long plume scales erecting caudad but they do not form any tuft. Along the veins Cubitus 2 there are androconia (presumably scent disseminating) mixed with ordinary cover- and ground-scales. The membrane of the intervenial area is creased.

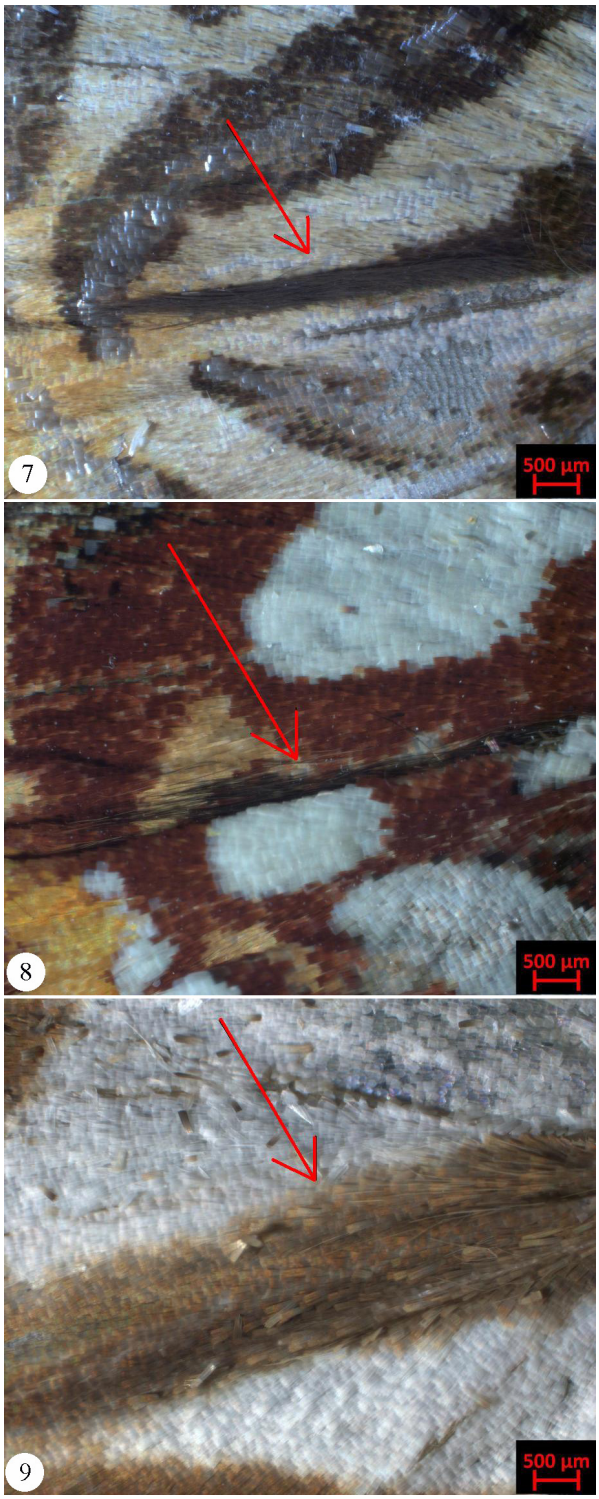
According to the current literature (Libert 2007, d'Abrera 2009) There are 24 species in *Pseudaletis* divided into three species-groups. We recorded alar male sexual character only in the taxa representing the species group *P. leonis*.



Figures 1-6. Imagines of Aphnaeinae, in ventral view. The arrows indicate the position of the alar male sexual character. 1 = *Cigaritis larseni* (Bouyer, 2012), male (Ghana), 2 = ditto, female (no brush organ); 3 = *Pseudaletis leonis* (Staudinger, [1888], male; 4 = *Cigaritis syama* (Horsfield, [1829]), male (Thailand); 5 = *Lipaphnaeus leonina* (Bethune-Baker, 1904), male (Iberia); 6 = *Aphnaeus orcas* (Drury, 1782), male (Ghana) (all at the same magnification, 1mm scale as indicated) (photos: G. Katona, HNHM).

DISCUSSION

It is curious that despite much of scientific attention, aphnaeine male secondary sexual characters remained overlooked for a long time, and it is surprising that classical workers paying great attention to special characters, missed them. Although it is not surprising that in lithographic figures the delicate and hardly visible alar brush organ is never conspicuous (for example: Aurivillius 1925, Murray 1935), in more recent publications the figures produced using more advanced photography, we found the pattern formed by the specialized hair scales is often more clearly visible, or at least detectable with greater certainty (see d'Abrera 1986, Kielland 1991, Larsen 1991,



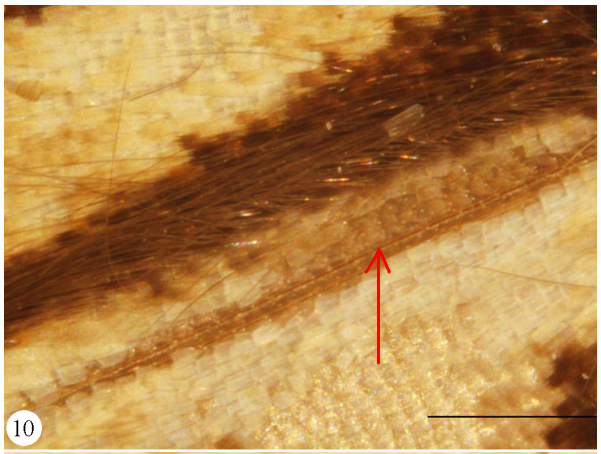
Figures 7-9. Male aphnaeine hindwing ventral surface sexual characters at high magnification, indicated by red arrows. 7 = *Aphnaeus orcas* (Drury, 1782); 8 = *Cigaritis lohita* (Horsfield, [1829]), 9 = *Pseudaletis leonis Staudinger,* [1888], (scales as indicated) (Photos: K. Kertész, CER-HAS).

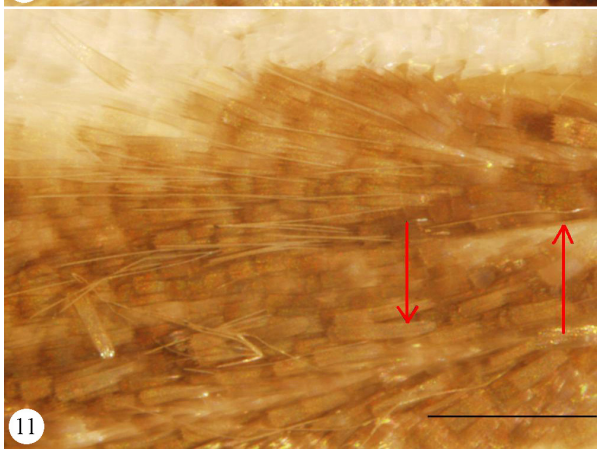
1993, Weidenhoffer & Bozano 2016, Libert 2007, d'Abrera 2009; Libert, 2013 and Weidenhoffer *et al*., 2016).

Because of the complex optical appearance of the *Aphnaeus* ventral wing surface, and that the space is often creased, it is sometimes difficult to detect the tuft in illustrations or even in actual specimens. Therefore careful examination of museum material is obligatory for mapping the distribution of the male secondary character in the genus.

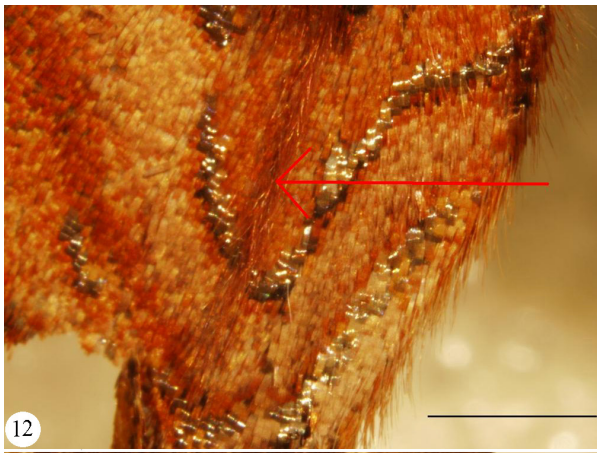
An interpretation of our findings in *Cigaritis* is problematic in regard to genus-level classification. According to Boyle *et al.* (2015) the genus *Cigaritis* includes all the taxa, which were formerly classified as *Spindasis* Wallengren, 1857 (type species: *Spindasis masilikazi* Wallengren, 1857) and *Apharitis* Riley, 1925 (type species: *Polyomamtus epargyros* Eversmann, 1854). Taxa considered representing the genus *Spindasis* by some workers (*e.g.* Larsen 2005, d'Abrera 2009) all have the hair tuft, whilst *Cigaritis sensu str.* and *Apharitis* do not. This suggests that lumping *Apharitis* with *Cigaritis* may reflect the reality, but Palaeotropical *Cigaritis* might deserve the generic name *Spindasis* (having almost 60 species according to Bridges 1994) – if we take the hair tuft as an important character for classification. However, the uniform type of male genitalia as well as their facies mitigate against such splitting, and also there is a growing evidence that male secondary characters are not stable (see for example Robbins *et al.* 2012, 2015 and Martins *et al.* 2016). Nevertheless this needs a thorough analysis of all the taxa, as male secondary sexual characters are often difficult to interpret regarding phylogenetics.

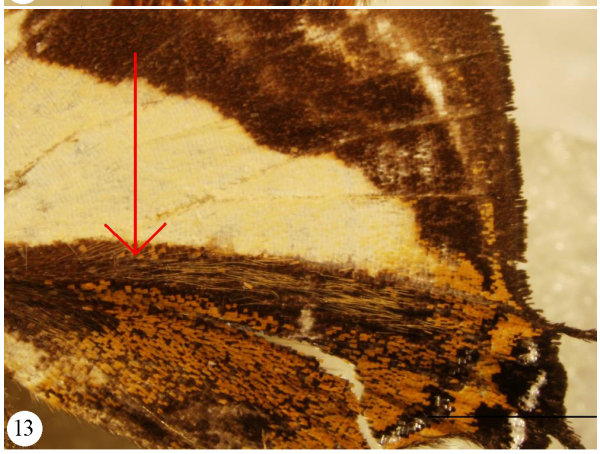
The four aphnaeine genera (*Aphnaeus*, *Cigaritis, Lipaphnaeus* and *Pseudaletis*) possessing male secondary sexual character are paraphyletic in the hypothetical phylogenetic tree provided by the most recent paper on the subfamily (Boyle *et al.* 2015). We note that these genera represent both of the main aphnaeine lineages being sisters to each other, and in one of the lineages there is a basal genus with androconia (*Pseudaletis*).





Figures 10-11. Aphnaeine scaling at high magnification. 10 = *Cigaritis formosanus* (Moore, 1877), the vein Cubitus 2 is well visible in the lower half of the image (indicated by arrow pointing up) and there are no androconia around or under the long plume scales. 11 = *Pseudaletis leonis* Staudinger, [1888]), a small part of the naked vein Cubitus 2 is visible on the right side of the image (arrow pointing up), and androconial scales (indicated by arrow pointing down) mixed with hair scales, ordinary cover- and ground scales are detectable (Scale bars: 160µm) (photos: Zs. Bálint, HNHM).





Figures 12-13. Aphnaeine male hindwing ventra with special scaling: 12 = *Lipaphnaeus aderna* (Plötz, 1880), red arrow indicates the long plume scales erecting caudad from the wing membrane in the cell formed by the veins Cubitus1–2 and forming a tuft (scale bar: 2 mm); 13 = *Pseudaletis antimachus* (Staudinger, 1888), red arrow indicates the long plume scales dispersed on the wing membrane between the cell area formed by the veins Cubitus 1–2 (scale bar: 4 mm) (photos: Zs. Bálint, HNHM).

Although the sister group of Aphnaeinae has not yet been identified, it is suggested that it is the sister of the lineage containing all the other subfamilies recognized in Lycaenidae (Boyle *et al.* 2015: 7). If so, *Pseudaletis* represents one of the most basal lineages of the family. What this might imply is that the presence of a ventral hindwing male sexual organ was once a general character, but it was subsequently lost and later regained several times independently.

It is interesting, that Eumaeini, which can be considered as a "primitive" group in Lycaenidae (see Eliot 1973: 454), offers analogues for the aphnaeine male secondary sexual characters (see Faynel & Bálint 2012). For example in the genus *Theritas* Hübner, [1818] and its relatives there is a ventral hindwing cubital pouch (see Bálint 2006 and Robbins *et al.* 2012). In the genus *Brangas* Hübner, [1819], there is a pouch with hairpencils between vannal veins 2 and 3 (Bálint & Faynel 2009). And in this context it is also interesting

that the character of a female abdominal tuft is also shared by aphnaeine (*Pseudaletis, Chloroselas* Butler, 1886 and *Trimenia* Tite & Dickson, 1973) and eumaeine lycaenids (for *Neolycaena* de Nicéville, 1890 and *Satyrium* Scudder, 1876 see in Weidenhoffer *et al.,* 2016).

Female abdominal tufts are also present in Riodinidae (*eg*. *Sarota* Westwood, [1851], see Hall 1998) and also in some hesperiid genera (*eg*. *Tagiades* Hübner, 1819, Alan Heath, unpublished), and even some moths in the Geometridae and Tortricidae (see Pellmyr 1980). Hence, the abdominal tufts also pose interesting questions regarding higher level classification in Lycaenidae, as well as in other Lepidoptera families (see for Hesperiidae: Warren *et al*., 2009).

What is the function of these aphnaeine organs *in vivo* we reported on? We do not know yet. For *Pseudaletis* probably it is a scent-disseminating organ, as we were able to detect androconia at the base of the hair scales, which supposedly contained aphrodites. The physiological role of a hair tuft in *Aphnaeus*, *Cigaritis* and *Lipaphnaeus* is a mystery to us as we were unable to find any androconia under the hair-scales, or on the hindwing dorsal surface of the female there is nothing unusual, merely the normal scaling. Is it an organ that has lost its function? These questions need to be answered in future studies.

Figure 14. Perching male of *Cigaritis natalensis* (Westwood, 1852); the red arrow indicates the exposed hair tuft situated between the veins Cubitus 1–2 (Photo: A. Schutte).

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APPENDIX

Aphaeninae material examined. All specimens are deposited in the HNHM Lepidoptera collection excluding 16 individuals which are in loan. These specimens are indicated with RCS (= research collection of Szabolcs Sáfián, Sopron, Hungary). Genus-level classification follows Boyle *et al.* (2015). Genera and species are listed in alphabetical order. Species given in bold possesses male secondary sexual character on their hindwing verso. Geographical Provenance of the specimens is given verbatim according to the labels; „?Patria?" means lack of geographical data.

ALOEIDES Hübner, [1819] – *A. aranda* (Wallengren, 1857): ♂, South Africa. *A. conradsi* Aurivillius, 1907: ♂, Kenya. *A. dentatis* (Swiestra, 1909): ♂, South Africa. *A. pallida* Tite & Dickson, 1968: ♂, South Africa. *A. pierus* (Cramer, 1777): ♂, South-Africa.

APHNAEUS Hübner, [1819] – *A. gilloni* Stempffer, 1996: ♂, Ghana. ***A. hutchinsoni*** Trimen, 1887: ♂ South Africa. ***A. jacksoni*** Stempffer, 1954: ♂, Ghana (RCS). ***A. nimbaensis*** Sáfián & Libert, 2013: ♂, Liberia (RCS). ***A. orcas*** (Drury, 1782): 3 ♂♂, ♀, Ghana (♂, ♀: RCS). ***A. zanzibarensis*** Grose-Smith, 1889: 2 ♂♂, Kenya (♂: RCS).

ARGYROSPODES Tite & Dickson, 1973 – *A. argyraspsis* (Trimen, 1873): ♂, South Africa.

AXIOCERSES Hübner, [1819] – *A. amanga* (Westwood, 1881): ♀ Congo; ♂ Tanganyika. *A. coelescens* Heming & Hemming, 1996: ♂ South Africa. *A. harpax* (Fabricius, 1775): 4♂♂, Gambia; 2♂♂, 2♀♀, Ghana; 20♂♂, 2♀♀, Guinée; ♀ Kenya; ♂, South Africa; ♂, 2♀♀, Tanzania; ♂, 2♀♀, Togo; 11♂♂, 2♀♀, Yemen.

CHLOROSELAS Butler, [1886] – *C. argentomaculata* (Pagenstecher, 1902): 4 ♂♂, ♀ Abyssinia. *C. pseudozeritis* (Trimen, 1873): ♂, South Africa.

CHRYSORITIS Butler, [1898] – *C. aethon* (Trimen, 1887); ♂ South Africa. *C. beaufortius* (Dickson, 1966); ♂ South Africa. *C. felthami* (Trimen, 1904); ♂ South Africa. *C. palmus* (Stoll, 1781); ♂ South Africa. *C. penningtoni* (Riley, 1938); ♂ South Africa. *C. pyramus* (Pennington, 1953); ♂ South Africa. *C. zonarius* (Riley, 1938); 2 ♂ South Africa.

CIGARITIS Donzel, 1847 – *C. acamas* (Klug, 1834): ♀, Afghanistan; ♂, ?Patria?; ♂, ♀ Syria ("Cupidopsis acamas dueldueli" syntypes). ***C. crustaria*** (Holland, 1890): ♂ Belgian-Congo. ***C. elima*** (Moore, 1877): ♂, ♀, Nepal; ♂ ?Patria?. *C. epargyros* (Eversmann, 1854): ♀ Caucasus; ♀ Kazakhstan; 4 ♂♂, 8 ♀♀, Mongolia; ♂, ♀, ?Patria?; ♂ Uzbekistan; 2 ♂♂, 3 ♀♀, Turkestan; 25 ♂♂ , 10 ♀♀, Turkmenistan. *C. farsica* (Rose & Schurian, 1977): ♂ Mesopotamia; ♂,♀, Syria. ***C. formosanus*** (Moore, [1877]): 24 ♂♂, 6 ♀♀, Taiwan. ***C. homeyeri*** (Dewitz, 1886): ♂, Zambia (RCS). ***C. iza*** (Hewitson, 1865): ♂, Zambia (RCS). ***C. larseni*** (Bouyer, 2012): ♂, 2 ♀♀, Gambia; ♀, Ghana; 2 ♂♂, Togo. *C. maxima* (Staudinger, 1901): ♀ Afghanistan; 9 ♂♂, Iran; 4 ♂♂, Syria. ***C. natalensis*** (Westwood, [1851]): ♂, South Africa. ***C. lohita*** Horsfiled, [1829]): ♂, Indonesia; 3 ♂♂, 6 ♀♀, Thailand. ***C. namanga*** (Trimen, 1847): ♂, South Africa. ***C. phanes*** (Trimen, 1873): ♂ South Africa. ***C. seliga*** (Fruhstorfer, [1912]: ♂ Borneo; 3 ♂♂, China; ♂, Indonesia; ♂, Java; ♀, Nepal; ♀, ?Patria?; 5 ♂♂ , 3 ♀♀, Philippines; 2 ♂♂, Thailand. *C. siphax* Lucas, 1849: 2 ♀♀, Algeria; 2 ♂♂, 5 ♀♀, Tunisia. ***C. syama*** (Horsfield, [1829]): ♂, Nepal; 2 ♂♂, 2 ♀♀ Vietnam. ***C. takanonis*** (Matsumura, 1906): ♂, ♀ North Korea. ***C. trimeni*** (Neave, 1910): ♂, Liberia (RCS). *Cigaritis zohra* Donzel, 1847: ♂, ♀, Algeria.

CRUDARIA Wallengren, 1875 – *C. leroma* (Wallengren, 1879): ♂, South Africa.

ERIKSSONIA Trimen, 1891 – *E. edgei* Gardiner & Terblanche, 2010: ♂, South Africa.

LIPAPHNAEUS Aurivillius, 1916 – ***L. aderna*** (Plötz, 1880): ♂, ♀, Uganda (RCS). ***L. leonina*** (Sharpe, 1890): ♂, Ghana (RCS); ♂, ♀, Liberia (♀: RCS).

PHASIS Hübner, [1819] – *P. clavum* Murray, 1935: ♂, South Afrika. *P. pringlei* Dickson, 1977: ♂, South Africa. *P. thero* (Linnaeus, 1764): ♂, 2 ♀♀, Süd Afrika.

PSEUDALETIS H. H. Druce, 1888 – ***P. antimachus*** (Staudinger, [1888]): ♂, Cameroon (RCS). ***P. jolyana*** Libert, 2007: ♂, Liberia (RCS). ***P. leonis*** (Staudinger, [1888]: ♂, ♀, Ghana (♀: RCS); ♂, ♀, Liberia (RCS).

TRIMENIA Tite & Dickson, 1973 – *T. malagrida* (Wallengren, 1857): ♂, South Africa. *T. wallengrenii* (Trimen, 1887): ♂, South Africa.

TYLOPAEDIA Tite & Dickson, 1973 – *T. sardonyx* (Trimen, 1868): ♂, South Africa.

VANSOMERENIA Heath, 1997– *V. rogersi* Riley, 1832: ♀, Tanzania.

ZERITIS Boisduval, 1836 – *Z.* (Boisduval, 1836): 2 ♂♂, Guinée.

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Contribution to the knowledge of the pseudoscorpion fauna of the North-Eastern Carpathians, Ukraine (Arachnida: Pseudoscorpiones)

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Abstract. Investigating the soil samples of the Hungarian Natural History Museum collected in the North-Eastern Carpathians, a total of six species belonging to two families were found. One of them, *Neobisium brevidigitatum* (Beier, 1928) is new for the fauna of Ukraine; a brief description of the new specimen is given. The pseudoscorpion species reported earlier from the region are briefly summarized. According to these new and the preceding literature data the pseudoscorpion fauna of Ukraine now counts twenty-six species.

Keywords. pseudoscorpions, Ukraine, faunistics, new records, soil fauna.

INTRODUCTION

The pseudoscorpion fauna of Ukraine is one of the least studied in Europe – the online catalogue of Harvey (2013) lists only 22 species from the country, although many more are likely to occur. This is particularly so for the mountainous western part of Ukraine that covers the North-Eastern Carpathians (Fig. 1). This mountain range is a biodiversity hotspot in the heart of Europe and widely known for high species richness and local endemism (Mráz & Ronikier 2016). The area was studied for pseudoscorpions several times in the last 140 years (Daday 1888, Rafalski 1937, Hadži 1939, Szent-Iványi 1941, Schawaller 1989) but our knowledge of its fauna is still fragmentary.

This part of the Carpathians comprises five distinct mountain areas: the Beskid, Gorgan, and the Maramaros Mountains, the Polonines Mounts and the Vihorlat-Gutin Mountain area. From a geographical point of view, elements of the North-Eastern Carpathians also extend into Eastern Slovakia and Northern Romania. However, only the Ukrainian part of the area is discussed here for practical reasons.

Only a handful of faunistic and taxonomic studies have documented pseudoscorpions here. The first record was established by Daday (1888) who reported three species: *Neobisium sylvaticum* (C. L. Koch, 1835) (as *N. dumicola*) from the Ivan Pop Mountain, *Rhacochelifer peculiaris* (L. Koch, 1873) (as *Chelifer peculiaris*) and *Neobisium carcinoides* (Hermann, 1804) (as *Obisium carcinoides*) from Galambos village (in Ukranian Голубине).

Almost a half century later, *N. polonicum* Rafalski, 1937 was described from numerous localities between the area of the Cheremosh and San rivers; some of them situated in the outer arch of the North-Eastern Carpathians in Ukraine [Horod (Город); Jaremcse (Яремче); Schronisko w dolinie Świcy; Vorohta (Ворохта))] (Rafalski 1937).

Some years later Hadži provided new occurrences of several pseudoscorpion species from the Ivan Pop Mountain in the North-Eastern Carpathians (Hadži 1939): *Chthonius heterodactylus* Tömösváry, 1882 (as *C. knesemani*); *Neobisium sylvaticum* (as *N. sylvaticum inaculeatum*); *N carcinoides* (as *N muscorum*); *N carpaticum* Beier, 1935 (as *N. muscorum carpaticum*); *N. polonicum* Rafalski, 1936; and *Roncus transsylvanicus* Beier, 1928.

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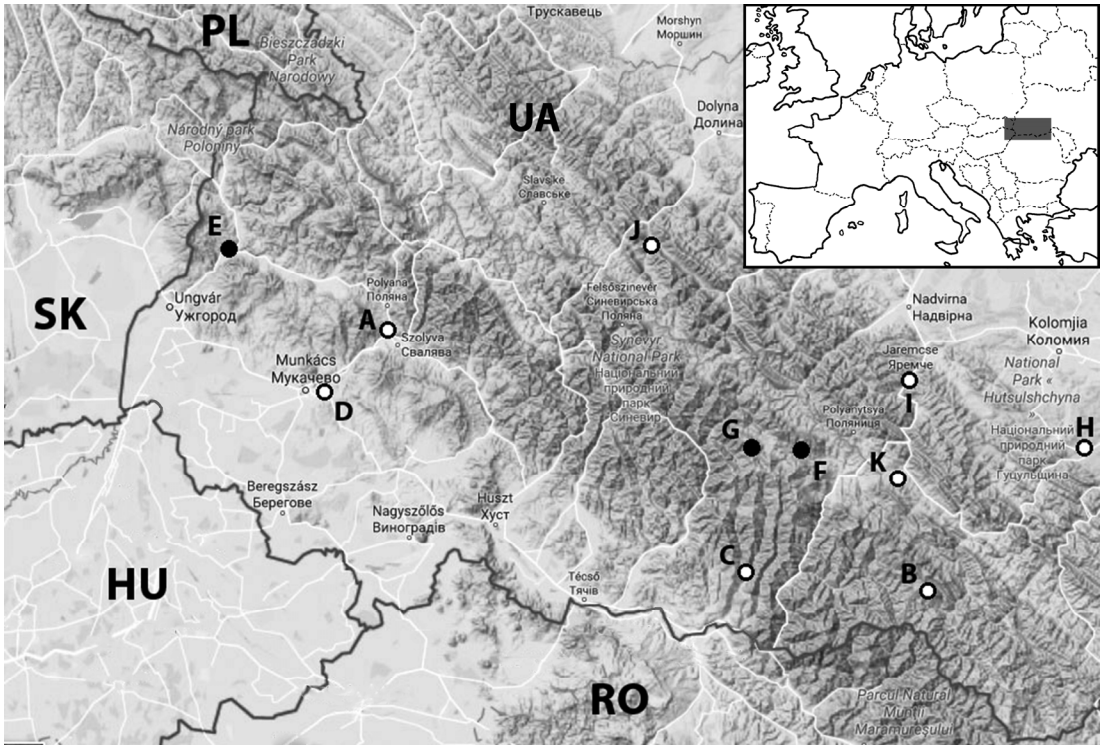

Figure 1. Collecting localities of present study (full circles) and older literature (empty circles). A = Galambos; B = Ivan Pop Mount; C = Gyertyánliget; D = Mukacheve; E = Perecseny; F = Source of Black Tisza River; G =: Svidovec; H = Horod; I = Jaremcse; J = Schronisko w dolinie Świcy; K =Vorohta.

Six species were also reported from Gyertyánliget village (Кобилецька Поляна) by Szent-Iványi (1941): *C. heterodactylus*; *N. fuscimanum* (C. L. Koch, 1873); *N. carpaticum*; *N. polonicum* (as *N. biharicum* Beier, 1939 [synonymized by Novák & Hörweg (2016)]); *Lamprochernes chyzeri* (Tömösváry, 1882); *Chelifer cancroides* (Linnaeus, 1758).

Almost 50 years later Schawaller (1989) added *Mundochthonius carpaticus* Rafalski, 1948; *Chthonius heterodactylus* (as *Chthonius diophthalmus*); *C. tetrachelatus* (Preyssler, 1790); *N. crassifemoratum* (Beier, 1928); *N. sylvaticum* and *R. transsilvanicus* from localities near to Mukacheve (Мукачеве in Ukranian and Munkács in Hungarian).

Herewith a list of pseudoscorpions from the North-Eastern Carpathians is presenter on the basis of museum material collected between 1939 and 2012. The aim of this study is to summarize our knowledge on the pseudoscorpion fauna of the North-Eastern Carpathians, by reporting the results of determination of the pseudoscorpion samples housed in the Hungarian Natural History Museum from this area.

MATERIALS AND METHODS

All specimens were collected by hand sampling, sifting and pitfall traps. Representative specimens were cleared in lactic acid and examined with a stereo- and a Zeiss Axioskop 2 compound light microscope. The specimens were identified according to the keys and descriptions of Beier (1928, 1963), Chrystophoriová *et al*. (2011) and Mahnert (2004) by the author. Drawings were made with the aid of a Zeiss Axioskop 2 microscope. Measurements were made with the Olympus Soft Imaging analySIS work 5.0 software. The specimens are stored in 70% ethanol and deposited in the Hungarian Natural History Museum (HNHM). All specimens

are registered and accompanied with an inventory number („HNHM Pseud-Nr). Unfortunately, in case of older material no exact locality data were available on the collection label. In Figure 1. not all type localities of *N. polonicum* have been marked because several of them fall outside of the region, and a couple of them could not be traced due to the outdated or dubious locality names used in the original description.

RESULTS

Family Chthoniidae Daday, 1888

Chthonius (Ephippiochthonius) tetrachelatus (Preyssler, 1790)

Locality. Perecseny (Перечин), Pliska Mts, 10.08.1944, leg.: János Balogh (HNHM Pseud-1968: 1 juv.).

Remarks. The species has yet been recorded from the studied region near to Mukacheve (Schawaller 1989). Only a single juvenile specimen was found during the present investigation.

Chthonius heterodactylus Tömösváry, 1882

Localities. Black-Tisza Source, pine forest, from moss, 10.08.2012, leg: Józsefné Jely (HN HM Pseud-1965: 1♀); Svidovec (Свидівець), sifted from moss, 07.07.1939 (HNHM Pseud-1966: 3♂); Svidovec (Свидівець), pine forest, 1300m asl., 08.1939 (HNHM Pseud-1967: 1♀).

Remarks. The species is known from several localities of the North-Eastern Carpathians (Hadži 1939; Szent-Iványi 1941; Schawaller 1989). Hadži (1939) recorded it for the first time from the area as *Chthonius knesemani* Hadži, 1939, but this name later proved to be a junior synonym of *C. heterodactylus* (Gardini 2014). It was recently found in neighbouring Hungary (Kárpáthegyi 2006) and redescribed by Gardini (2014). Some of the newly found specimens had only one pair of praeocular setae, and one female (HNHM Pseud-1965) had only a rudimentary epistome – according to Gardini (2014), these are rare, but normal character variations in case of this species.

Neobisiidae Chamberlin, 1930

Neobisium brevidigitatum (Beier, 1928)

(Figures 2A–G)

Locality. Svidovec (Свидівець), pine forest, 1300m asl. 07.1939 (HNHM Pseud-1970: 1♀).

Description of the specimen. Measurements (in mm) and ratios (in parentheses). Body length 2.1. Carapace 0.66/0.68. Cheliceral hand: 0.41/0.24; finger: 0.27. Palpal femur: 0.84/0.25(3.36x); patella 0.62/0.31 (2.02x); Chelal hand 0.66/0.43; pedicel 0.09; finger 0.83.

Carapace (Fig. 2A). Approximately as long as wide, smooth, epistome triangular and pointed. Two pairs of eyes with lenses. Setal formula: m4m:6:6:6. Two pairs of slitlike lyrifissures in the ocular region and one pair near the posterior margin.

Coxal area. Manducatory process with 6 setae, rest of pedipalpal coxa with 8–10 setae; pedal coxa I with 9–11 setae; II: 7; III: 8; IV: 11–12. Anterolateral process of coxa I long and traingular; medial process prominent, with denticles (Fig. 2B).

Opisthosoma. Chaetotaxy of tergites I–X: 8:10:12:14:14:12:10:10:10:10. Segment XI with 10 setae, 4 of them tactile. Anal cone with 2 ventral and 2 dorsal setae. Chaetotaxy of sternites IV–X: 10:12:14:14:12:14:14. Female genital region: sternite II with 12 small setae, sternite III with 16 small setae in a row.

Chelicera (Fig. 2C). with 7 setae on hand. Spinneret prominent and rounded, with 7 hyalin ducts. Fixed finger with 13 little and medium teeth, movable with 9–10 medium teeth.

Pedipalp (Fig. 2D). Surface smooth, trochanter with tubercle. Femur 3.36, patella 2.02 times as long as broad. Chela (Fig. 2E). Pedicel with 5 dorsal micropores. Fixed chelal fingers with 63 close-set teeth of slightly unequal length (Fig. 2F-G). Movable chelal finger with 54 flattened teeth. Trichobotria on chelal fingers disributed as on

Figure 2E. Distance between trichobothria *ib* and *ist* approximately twice that between *ist* and *it*.

Legs. Surface smooth. Claws simple and smooth, arolia not longer than claws. Tibia IV with a medial, tarsus IV with basal, telotarsus IV with a sub-medial tactile seta.

Remarks. This is a new species for the fauna of Ukraine. The species has previously been reported from Georgia, Poland, Slovakia, and Romania (Harvey 2013), and recently from Hungary (Novák 2015). The specimen described here corresponds well with Beier's description (Beier 1928, 1963) and with the specimens found in Hungary. However, it is evident that the species might have somewhat larger variation in morphological and morphometrical characters than noted in the literature (Beier 1963; Novák 2015). The new specimen has larger spinneret and wider chelal hand (chelal hand length/width ratio in the specimen from Ukraine: 1.48x; specimens from Hungary: 1.64x; in Beier's description: 1.5–1.6x), and its body is smaller (2.1mm long) than in earlier descriptions [2.5–3.5mm (Beier 1963) and 2.72mm (Novák 2015)].

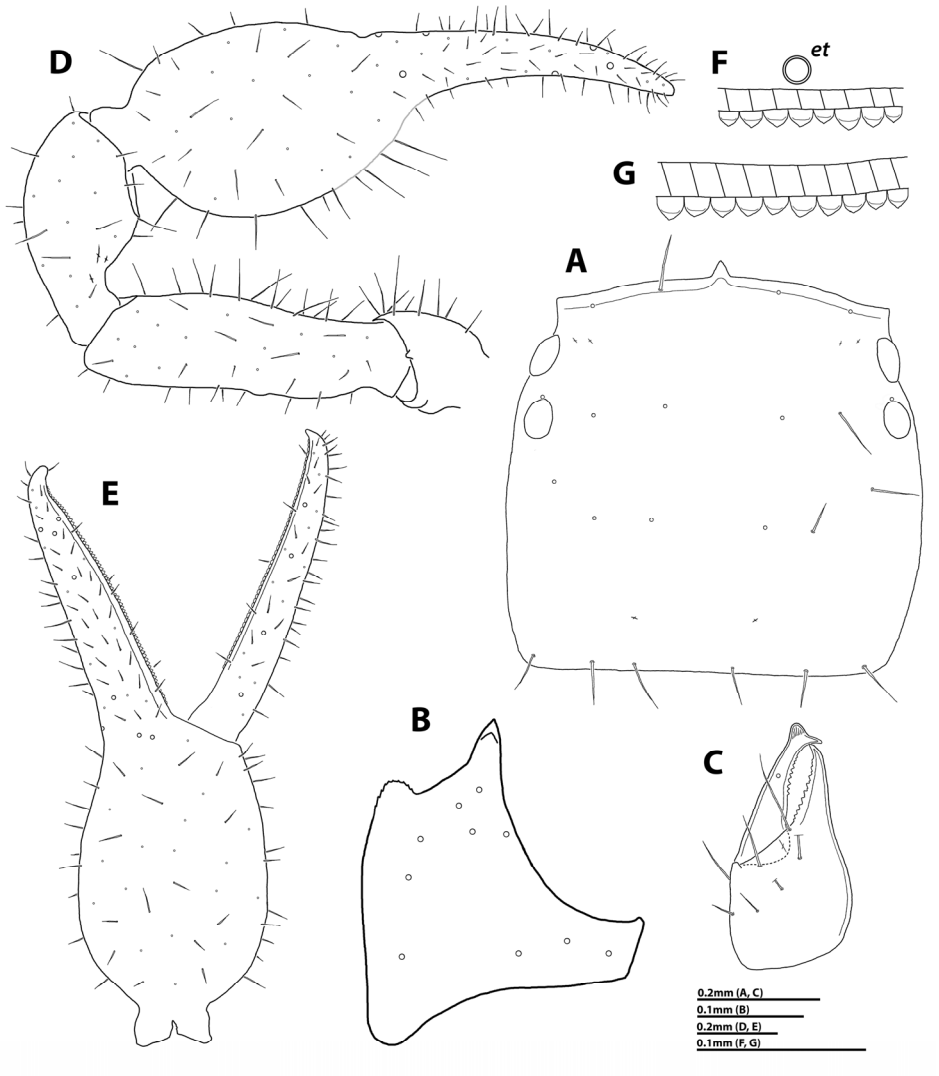

Figure 2. *Neobisium (N.) brevidigitatum* (HNHM Pseud-1970). A = carapace, dorsal view; B = coxa I, ventral view; C = left chelicera, dorsal view; D = left pedipalp, dorsal view; E = right chela, lateral view; F = chelal teeth of fixed Finger at the level of *et*; G = chelal teeth of fixed finger at the level of *ist*.

***Neobisium carcinoides* (Hermann, 1804)**

Locality. Perecseny (Перечин), 10.08.1944, leg.: János Balogh (HNHM Pseud-1969: 1♀).

Remarks. Common species in Europe (Harvey 2013). It was reported earlier from the studied area by Daday (1888) and Hadži (1939).

***Neobisium carpaticum* Beier, 1935**

Locality. Perecseny (Перечин), 10.08.1944, leg.: János Balogh (HNHM Pseud-1971: 1 juv.).

Remarks. Known from Poland, Romania, Serbia, and Slovakia (Harvey 2013), with several additional records from the North-Eastern Carpathians (Hadži 1939, Szent-Iványi 1941). Only one juvenile was found during the present investigation.

***Neobisium crassifemoratum* (Beier, 1928)**

Locality. Black-Tisza Source, pine forest, from moss, 10.08.2012, leg: Józsefné Jely (HNHM Pseud-1965: 1♂).

Remarks. The species occurs in Middle and Eastern Europe, Anatolia and the Caucasus (Harvey 2013). Schawaller (1989) has previously recorded *N. crassifemoratum* from the region studied here.

DISCUSSION

Altogether six pseudoscorpion species belonging to two families were reported here from the North-Eastern Carpathians. *Neobisium brevidigitatum* (Beier, 1928) is a new record for the fauna of Ukraine. With this new record the number of the pseudoscorpion species known from the region has raised from eleven to twelve.

Five of the species reported from the study area are distributed mostly in the Carpathians (*C. heterodactylus*; *M. carpaticus*; *N. carpaticum*; *N. polonicum*; *R. transsilvanicus*). *Neobisium brevidigitatum* has been reported from only one locality outside of the Carpathian Ranges and the Carpathian Basin, namely from Georgia (Kobakhidze 1966). In contrast, *Neobisium crassifemoratum* and *N. fuscimanum* show a trans-aegean distribution pattern.

It is important to mention that this study focused on a single area of the Carpathians and utilised material from a single collection only. Large parts of the North-Eastern Carpathians still have not been investigated, and the region is still understudied for pseudoscorpions. It is important to mention, that the present study is based principally on morphology. As we know the presence of cryptic speciation in some species of *Neobisium* (Šťáhlavský 2003), molecular data may be used in the future to re-test the species hypotheses established here.

Considering also the pseudoscorpion fauna of the neighbouring areas, the occurrence of some further pseudoscorpion species are also expected: *Chthonius (C.) hungaricus* Mahnert, 1980; *Neobisium (N.) erythrodactylum* (L. Koch, 1873); *Roncus lubricus* L. Koch, 1873; *Dactylochelifer latreillii* (Leach, 1817); *Chernes montigenus* (Simon, 1879); *Dinocheirus panzeri* C. L. Koch, 1837; *Pselaphochernes scorpioides* (Hermann, 1804).

It is worth noting that this region has been part of five different countries over the course of the last century [Austro-Hungarian Monarchy (–1918); Czechoslovakia and Poland (1918–1939); Hungary (1939–1945); Soviet Union (1945–1991) and finally Ukraine (1991–)], which makes the search and study of relevant literature a complicated task. These difficulties may be reflected in the relevant world catalogues and keys that sometimes omit the data for species occurring here (Beier 1963, Harvey 2013).

In the light of these considerations, adding to the catalogue of Harvey (2013) *R. peculiaris* (Daday 1888), *N. fuscimanum* and *L. chyzeri* (Szent-Iványi 1941) and the new data presented here the up-to-date species number recorded for Ukraine is twenty-six.

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On the enchytraeid fauna of Kőszeg Mountains with description of a new *Fridericia* species (Clitellata, Enchytraeidae).

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Abstract. The enchytraeid fauna of Kőszeg Mountains (Western Hungary and Eastern Austria), hitherto unknown, was investigated in this study. Fifteen enchytraeid genera including 59 species and two other annelid worms (*Hrabeiella periglandulata* Pižl & Chalupský, 1984 and *Parergodrilus heideri* Reisinger, 1925) were identified. The latter is a new record for Hungary. One enchytraeid species, proved to be new to science, is described in this paper as *Fridericia szoevenyii* sp. nov. The new species is distinguished from similar species on the basis of both morphological characters and molecular data (mitochondrial cytochrome c oxidase subunit I and nuclear histone 3 gene sequences). Based on the presence of subalpine-alpine species, the enchytraeid fauna of Kőszeg Mountains is similar to that of Rax Mountains (Northern Alps, Austria). The two most species-rich sites were the alder carr at a creekside near Paprét (33 species) and a mesophile montane hay meadow at Steirer Houses (27 species). Interestingly, a mixed forest with dense underwood of *Vaccinium myrtillus* harbored only a single species.

Key words. new *Friedericia* species, enchytraeid fauna, Kőszeg Mts., CO1 gene

INTRODUCTION

The enchytraeid fauna of western Hungary (Kőszeg Mountains and Őrség National Park) was studied between 2014–2016. The composition of enchytraeid fauna in Őrség National Park has already been published (Dózsa-Farkas & Felföldi 2016). Two other works (Dózsa-Farkas *et al.* 2017 and Dózsa-Farkas & Felföldi 2017a) dealt with the comparative morphological and molecular taxonomic analysis of *Cernosvitoviella* and *Achaeta* species of this area including the description of a new *Cernosvitoviella* and a new *Achaeta* species (*C. farkasi* and *A. tothi*, respectively). Here, we present the faunistic results from Kőszeg Mountains with the description of a new *Fridericia* species, *Fridericia szoevenyii* sp. nov. The morphological studies was supplemented with molecular taxonomic analysis targeting the mitochondrial cytochrome c oxidase subunit I (CO1) and nuclear histone 3 (H3) genes.

MATERIAL AND METHODS

Study area. Kőszeg Mountains is the easternmost unit of the Alps, and has an area of *ca*. 60 km^2. The territory of the mountain range is shared between Austria and Hungary. The highest point of Kőszeg Mts. is Írott-kő with a height of 883 m, but the majority of this area is hilly with an average altitude of 300–700 m. The main mass of the mountains is built of crystalline rocks (schist). The mean annual temperature of this region is 9.2°C, at the Steirer Houses site is 8.5–9.0°C. The mean temperature in January is -2 – -3°C, the mean temperature in July is 19°C. The winter is mild and due to the low temperature fluctuation, submediterranean vegetation could also be found, but the cool summer favors dealpine elements in the flora. Annual sunshine hours has the lowest value in this region within Hungary (< 1800 h). The average precipitation in the last 50 years was 779 mm in Kőszeg town (285 m a.s.l.) and 912

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mm at Steirer Houses (551 m a.s.l.) with a maximum in July. Majority of this area belongs to the mountain beech forest zone. The characteristic soil types are non-podzolic brown forest soils, which are extremely acidic, while in the deeper valleys pseudogley brown forest soils are more common (Markovics 1994).

Collection sites. In total, 20 macro- and microhabitats were sampled at 16 localities (Appendix 1).

Morphological methods. Animals were extracted from the soil by the wet funnel method (O'Connor 1962). Worms were first studied and measured alive, and subsequently preserved in 70% ethanol. Later, a part of the adult specimens was stained with borax-carmine then passed through an ethanol (70% to absolute) dehydration series, mounted temporarily in clove oil, and later mounted in Euparal on a slide between two coverslips. The important morphological structures were recorded *in vivo*, drawn, and photographed using an Axio Imager.A2 microscope with DIC (differential interference contrast) illumination and an AxioCam MRc 5 (Zeiss) digital camera with Axiovision software. The whole-mounted specimens were reinvestigated and also photographed. Holotype and paratypes of the new species are deposited in the collection of the Department of Systematic Zoology and Ecology, Eötvös Loránd University (Budapest, Hungary).

Methods of molecular analysis. Genomic DNA was extracted from the specimens with the DNeasy Blood & Tissue Kit (Qiagen) following the instructions given by the manufacturer. The mitochondrial cytochrome c oxidase subunit I (CO1) and the nuclear histone 3 (H3) genes were amplified using the primers HCO2198 (5'-TAA ACT TCA GGG TGA CCA AAA AAT CA-3') and LCO1490 (5'-GGT CAA CAA ATC ATA AAG ATA TTG G-3') (Folmer *et al.* 1994), and H3a-F (5'-ATG GCT CGT ACC AAG CAG ACV GC-3') and H3a-R (5'-ATA TCC TTR GGC ATR ATR GTG AC-3') (Colgan *et al.* 1998) [if amplification failed, with primers designed by AllGenetics, A Coruña (and used here with permission of ECT Oekotoxikologie GmbH, Flörsheim), H3Frid-M13F (5'-GTA AAA CGA CGG CCA GTT ACC AAG CAG ACG GCH CGY-3') with H3Frid-M13tR (5'-GCG GAT AAC AAT TTC ACA CAG GGG CGT GAA TBG CRC ACA GGT-3')], respectively. PCRs were performed applying the parameters given by Dózsa-Farkas & Felföldi (2015). Purification and sequencing of PCR products were carried out by LGC Genomics GmbH (Berlin, Germany). Removal of primer sequences and manual correction of automatic base calling on chromatograms were performed using the Chromas software v. 1.45 (Technelysium). Phylogenetic analysis (which included the search for the best-fit model) was conducted with the MEGA 7.0 software (Kumar *et al.* 2013). Sequences determined in this study were deposited in GenBank under the following accession numbers: MF142359-MF142361 (CO1) and MF361128-MF361130 (H3).

RESULTS

Results of morphological analysis

In total, 59 species were recorded which belonged to 15 enchytraeid genera, moreover two terrestrial polychaete species, *Hrabeiella periglandulata* Pižl & Chalupský, 1984 and *Parergodrilus heideri* Reisinger, 1925 were also detected in the samples (Appendix 1). *Parergodrilus heideri* is a new record for the fauna of Hungary, while all enchytraeid species represent new records for the Kőszeg mountain range. One species (described here as *F. szoevenyii* sp. nov.) is new to science and the status of *Fridericia* sp. and *Enchytraeus* sp. has not been ascertained yet. Probably, they also represent new species for science, but further investigations are needed to clarify their taxonomic status. A list of species recorded in individual samples, which represented microhabitats at the studied sites, is given in Appendix 1.

It should be mentioned that the presence of the terrestrial polychaete *Parergodrilus heideri*, was

recorded not during this sampling campaign, but was found earlier and but has not been published yet.

These samples were collected at a site near Velem village, in a mixed deciduous forest (hornbeam-oak-beech-pine), 47º35.194 N, 16º48.583 E, 430 m a.s.l., 07.09.2008, leg. B. Németh. About the anatomy of this very small polychaeta (0.8–1 mm long, Fig. 4A–B) detailed description can be found in Reisinger (1925, 1960), Karling (1958), Rota (1998), and ultrastructure analysis in Purschke (1987, 1988, 2002). Here, only some micrographs on the Hungarian female specimens are given (only female specimens were found): forepart (Fig. 4C–D) and body-end (Fig. 4E–F), the nephridia in II–III segments (Fig. 4G) and the chaetae at the body-end (Fig. 4H).

DESCRIPTION OF THE NEW SPECIES

Fridericia szoevenyii sp. nov.

(Figures 1–3)

Type material. Holotype. F. 28. slide No. 2138, DNS 939, Velem, in Irottkő landscape protection area, Hungary, streamside area of willow (site 16.a), 47°20.271 N, 16°30.047 E, 325 m a.s.l., 27.03.2016. Leg. G. Szövényi. *Paratypes.* In total 6 specimens. P.111.1–111.6 slide No. 2139, 2142–2143, 2145–2147, at the type locality, 27.03.2016.

Etymology. Named in the honor of our colleague, Dr. Gergely Szövényi, who collected samples with this species.

Diagnosis. The new species can be recognized by the following combination of characters: (1) large size (body length 13–19 mm *in vivo*), segments 44–56; (2) maximum 4 chaetae per bundle; (3) clitellum weakly and only laterally developed, interrupted ventrally and dorsally, hyalocytes and granulocytes arranged in transverse rows; (4) five preclitellar pairs of nephridia;

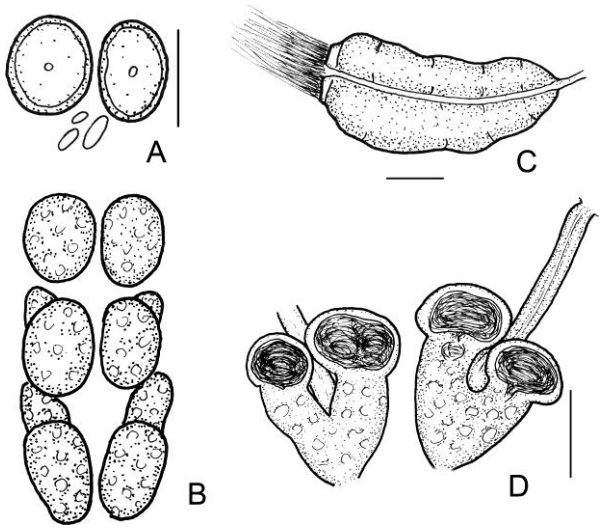

Figure 1. *Fridericia szoevenyii* sp. nov. A = coelomocytes, B = pharyngeal glands in dorsal view, C = sperm funnel, D = spermathecae; schematic, scale bars = 100 μm (exept in A 50 μm).

(5) coelomo-mucocytes b-type with a thickened cell border, lenticytes large 10–23 μm; (6) chylus cells in IX–X; (7) bursal slit H-shaped; (8) seminal vesicle in XI; (9) subneural glands absent; (10) sperm funnel cylindrical, approximately as long as body diameter or slightly shorter, collar narrower as funnel body, sperm 120–170 μm long, sperm heads 50–80 μm long (*in vivo*); (11) spermathecae separate entally, with two large stalked, spherical diverticula, ectal glads absent.

Description. Large, milk-white (caused by the large chloragocytes filled with very strong refractile vesicles), strong and slow-moving worms. *Holotype* 15.3 mm long, 380 μm wide at VIII and 490 μm at the clitellum (*in vivo*). The fixed worms 9.3 mm long 480 μm wide at VIII and 500 μm at the clitellum, 44 segments (from the last 8 segments, a 2.15 mm-long region was removed for molecular analysis). Body length of the *paratypes* 13–17.5 mm, width 350–450 μm at VIII and 400–540 μm at the clitellum (*in vivo*). Length of fixed specimens 8.3–11 mm, width 400–480 μm at VIII and 420–450 μm at the clitellum.

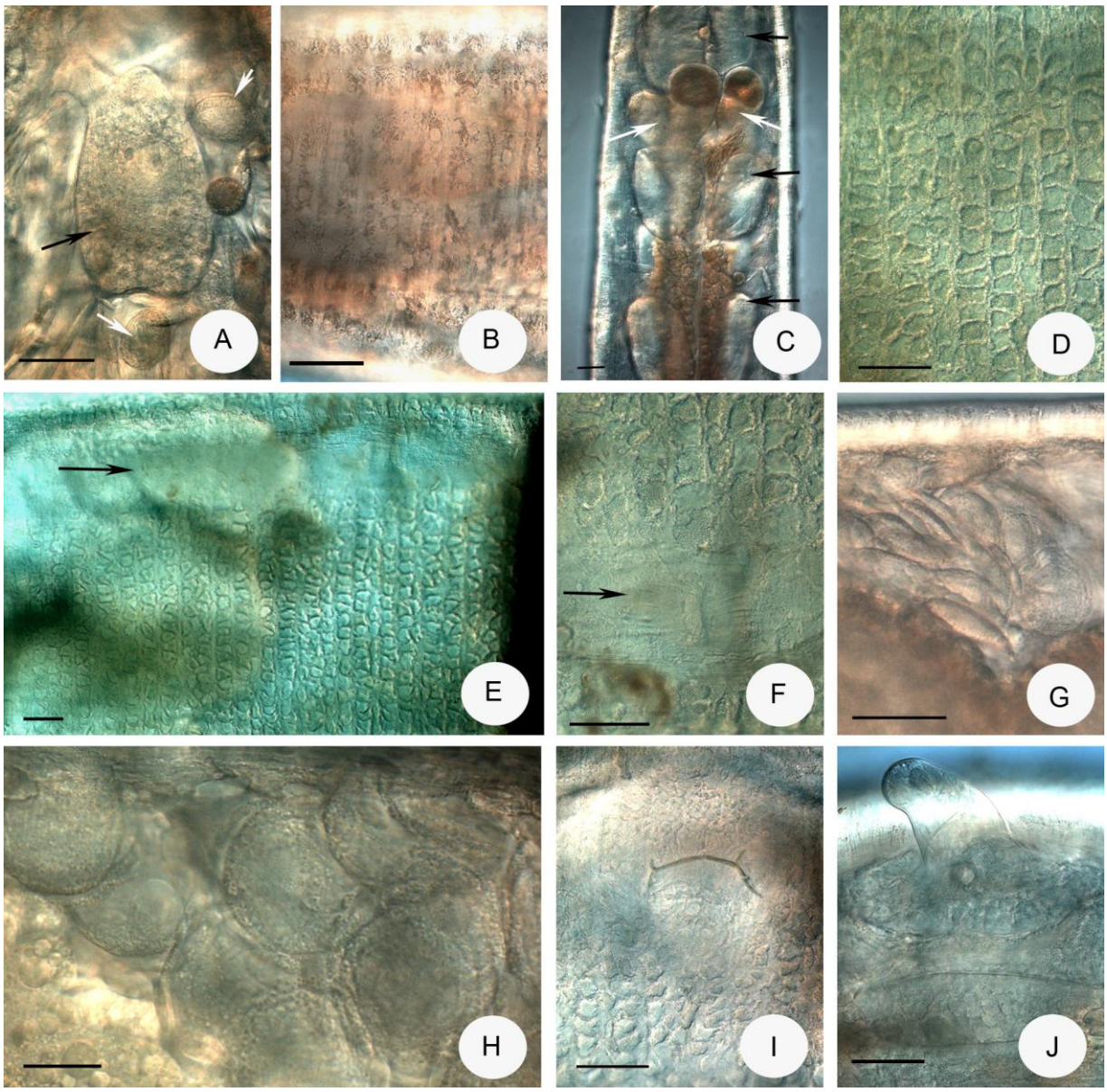

Figure 2. Micrograph of *Fridericia szoevenyii* sp. nov. A = brain (coelomo-mucocytes marked with arrows), B = epidermal glands, C = pharyngeal glands (marked with black arrows, spermathecae marked with white arrows), D = clitellar glands in lateral view, E = clitellar glands in dorso-lateral view (dorsal gap marked with arrow), F = dorsal gap of clitellar glands (marked with arrow), G–H = coelomocytes, I = bursal slit, J = everted bursa; all *in vivo*; scale bars = 50 µm (except in H = 20 µm).

Segments 44–56. Chaetal formula: 2,3,4,5 – 4,3,2 : (2),3,4 – 4,3,(0),2. In segment XII two chaetae present laterally. As in other *Fridericia* species, chaetae in bundles arranged in pairs with the outer pairs being longer and thicker than the inner pairs: 70–73 x 4–5 µm against 41–48 x 3.5–4 µm (preclitellar bundles), after the clitellum about in 10–15 segments slightly shorter. At the body-end only 2 chaetae per bundle, size about 60–80 x 5 µm. Head pore at 0/I. Dorsal pores from VII. Epidermal gland cells mostly weakly developed sometimes 5–6 brownish glands (in

transmittent light) in transverse rows (Fig. 2B). Clitellum in XII–1/2XIII, only laterally, hyalocytes and granulocytes arranged in transverse rows, about the same size (14–19 µm, *in vivo*) (Fig. 2D), dorsally and ventrally absent, but in some specimens weakly developed glands also observable (dorsally the gap 60–70 µm wide) (Fig. 2E–F). Body wall about 27–35 µm, cuticle about 1–1.5 µm, fixed.

Brain egg-shaped, about 150 µm long, 1.5 times

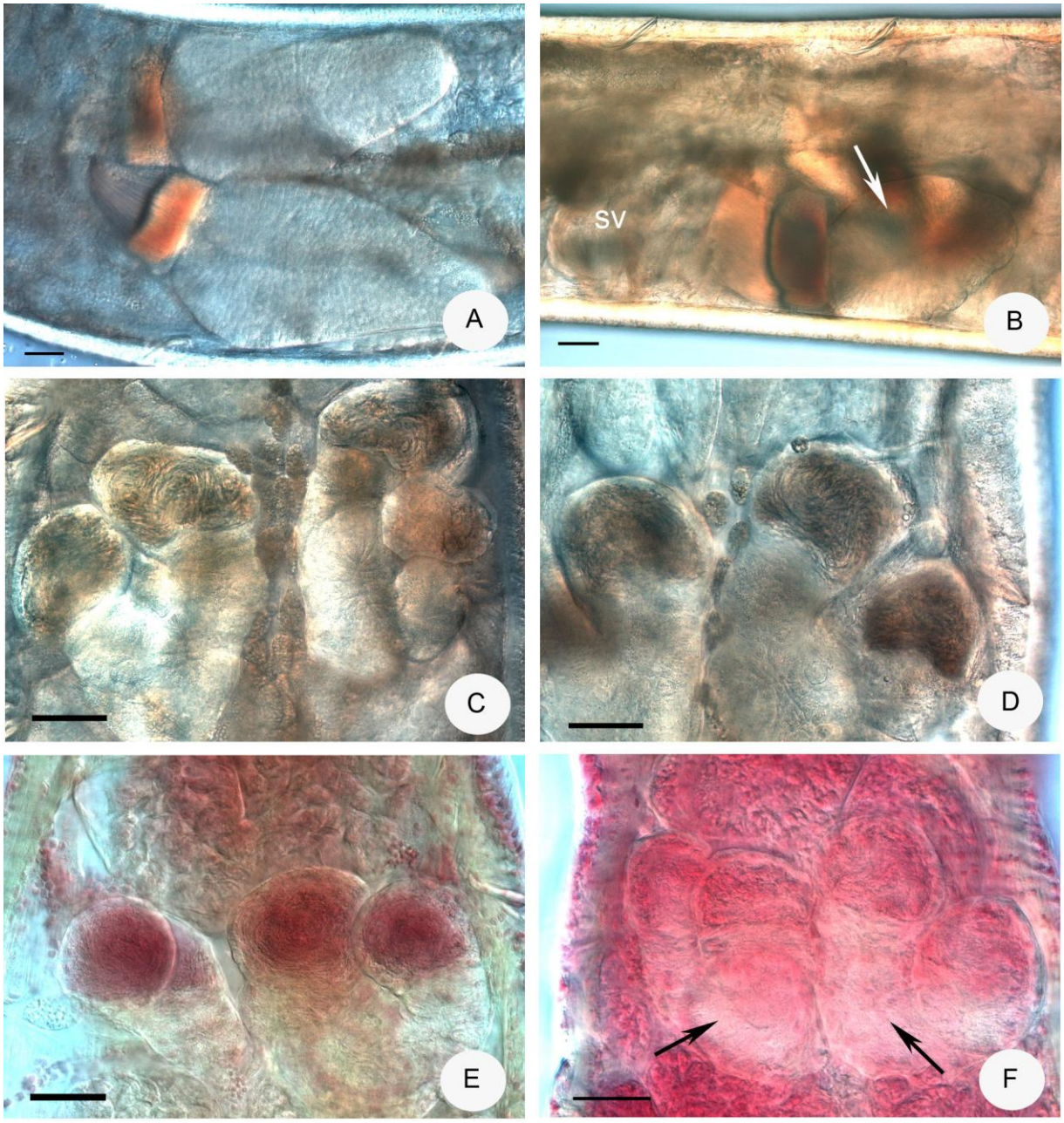

Figure 3. Micrograph of *Fridericia szoevenyii* sp. nov. A–B = sperm funnels (in B marked with arrow, sv = seminal vesicle) C–F = spermathecae (in F marked with arrows); A–D *in vivo*, E–F fixed, stained; scale bars = 50 µm.

longer than wide *in vivo* (Fig. 2A), and 120 µm in the fixed specimens. Oesophageal appendages a-type, short, with wide lumen, without branches. All pharyngeal glands free dorsally, with ventral lobes in V and VI, all primary lobes ca. the same in size (Fig. 1B, 2C). Chloragocytes from V, 28–33 µm long and dark-brown in transmittent light *in vivo*, therefore the worms have milk-white color under top light. Dorsal vessel from XV–XVI, blood colourless. Midgut pars tumida not observable. Five pairs of preclitellar nephridia from 6/7 to 10/11, length ratio anteseptale : postseptale about 1:1 or preseptale slightly shorter than postseptale, midventral origin of efferent duct. Coelomo-mucocytes with refractile vesicles mainly peripherally with a thickened cell border (length 36–50 µm *in vivo*, (22–23 µm fixed), lenticytes large and wide 11–20 by 6–7 µm *in vivo* (Fig. 1A, 2G–H), fixed 8–10 µm. Chylus cells between IX–X, occupying 2 segments, difficult to observe. Seminal vesicle in XI not brown (Fig. 3B). Sperm funnel (Figs. 1C, 3A–B) cylindrical, approximately as long as body diameter or slightly shorter, about 300–500 µm long *in vivo* and 150–200 µm, fixed, 1.5–2 times as long as wide, collar narrower as funnel body, spermatozoa about 120–170 µm long, sperm heads 50–80 µm long *in vivo*, while in fixed specimens 85–100 µm and 30–35 µm, respectively. Diameter of sperm ducts 9 µm (*in vivo*). Male copulatory organs 180–200 µm long, 100–130 µm wide and 70–80 µm high (*in vivo*) (170–185, 90–100 and 40–60 µm in fixed specimens, respectively) with large evertable bursa (Fig. 2J). Bursal slits longitudinal with additional transverse extension or H-shaped (Fig. 2I). Subneural glands absent. Spermathecae (Figs. 1D, 3C–F): no ectal gland, ectal ducts about 200–270 µm long and 25–27 µm wide, canal 5 µm *in vivo* (180–230 µm long, 21–26 µm wide, fixed). Duct projecting into ampulla without ental bulb. Ampullae longer than wide, about 100–125 µm wide (fixed), thick-walled, tapering proximad, no separation into distal and proximal part. Separate communication of ampullae with oesophagus. Two very large spherical diverticula with unequally long, thick-walled stalks (length of stalks 50–65 µm *in vivo*, 35–55 µm fixed). The diverticula thin-walled, diameter 75–100 µm *in vivo* and fixed alike, mostly filled with brown sperm (in transmitted light), sperm not rotating. One, rarely two mature eggs at a time.

Distribution and habitat. Known only from the type locality: Velem, in Irottkő landscape protection area in the western geographic region of Hungary, creekside area of willow, 47°20.271 N 16°30.047 E, 325 m. a.s.l.

Remarks. The new species can easily be distinguished from all *Fridericia* species that also possess two globular spermathecal diverticula with well-developed stalks, and entally separate ampullae: *F. rendsinata* Dózsa-Farkas, 1972, *F. perrieri* (Vejdovksý, 1878), *F. healyae* Schmelz, 2003, *F. dozsae* Schmelz, 2003, *F. omeri* Stephenson, 1932 and *F. galba* (here the form with 2 spermathecal diverticula, see Dózsa-Farkas 2009, Table 5), moreover from *F. connatiformis* Dózsa-Farkas, 2015. The new species differs from all these species leaving other characters out of consideration, by the very large spermathecal diverticula without ciliated subchambers, so that sperm is not rotating, by the origin of dorsal vessel in XV–XVI (in the other species more backwards) and by the preclitellar position of the chylus cells. Additionally, *F. perrieri*, *F. healyae*, *F. dozsae*, *F. omeri* and *F. galba* have more than 4 chaetae in a bundle, and *F. connatiformis* has only 2 chaetae in a bundle and larger extra sexual glands.

Results of molecular analysis

Two specimens (including the holotype) of *Fridericia szoevenyii* sp. nov. were subjected to molecular taxonomic analysis. Based on the mitochondrial CO1 and nuclear H3 genes, sequences of the new species formed highly supported (100% and 99% bootstrap value respectively) and well separated clades on the phylogenetic trees (Fig. 5) which confirms that *F. szoevenyii* sp. nov. is a distinct species.

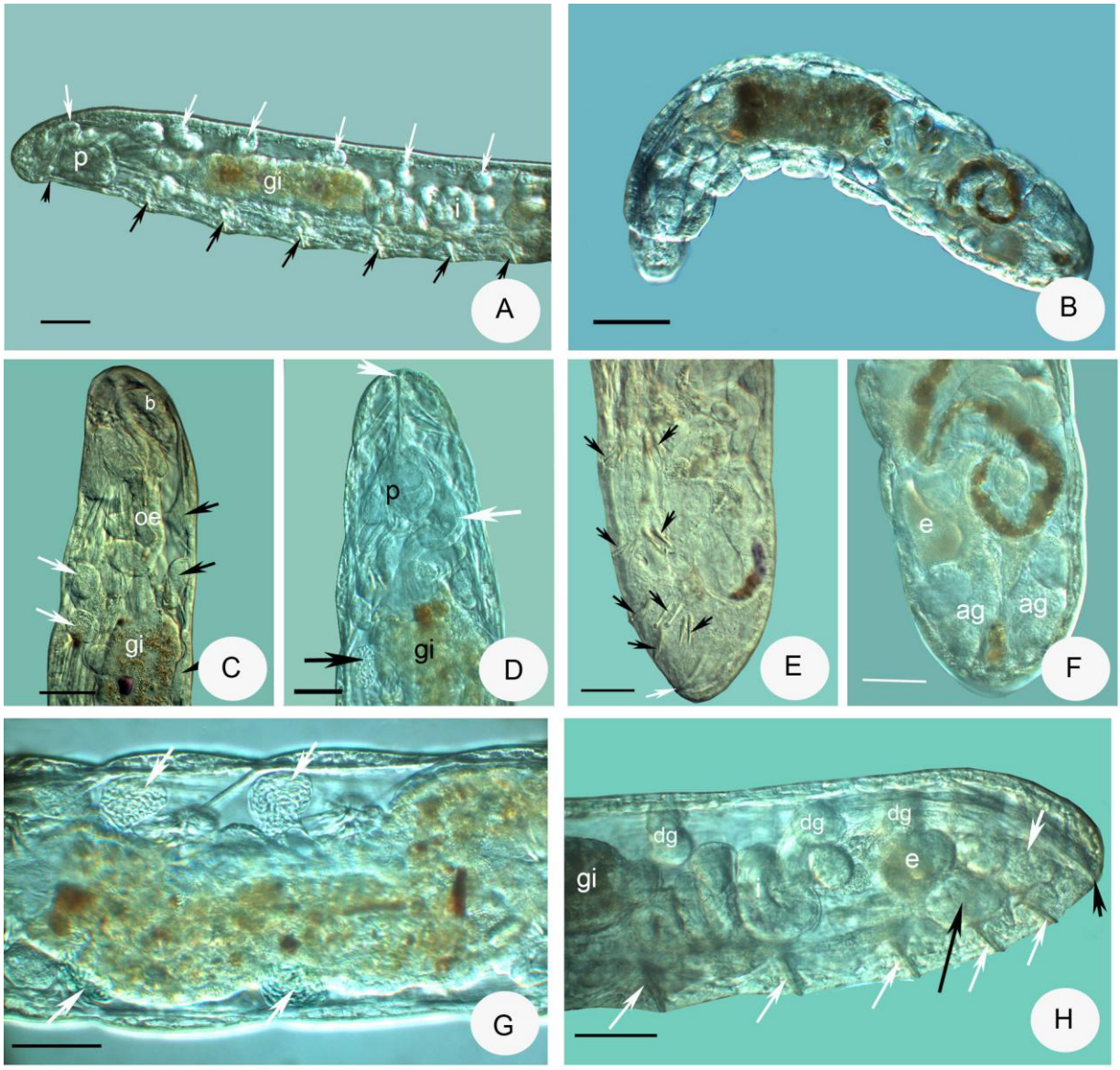

Figure 4. Micrograph of *Parergodrilus heideri* Reisinger, 1925. A–B = entire specimens (chaetae marked with black arrows, dorsal glands marked with white arrows, mouth marked with short arrow, p = pharynx, gi = gastrointestine, I = intestine), C = forepart of body lateral view (dorsal glands marked with black arrows, ventral glands marked with white arrows, b = brain, oe = oesophagus, gi = gastrointestine, D = forepart of body dorsal view (oesophages marked with white arrow, nephridium marked with black arrow, mouth marked with short white arrow, p = pharynx, gi = gastrointestine), E = body-end lateral view (chaetae marked with black arrows, anus marked with white arrow), F = body-end dorsal view (ag = anal glands, e = egg), G = nephridia in II–III segments (marked with arrows), H = posterior part of body lateral view (chaetae marked with white arrows, anal gland marked with short white arrow, subneural gland marked with long black arrow, anus marked with short black arrow, gi = gastrointestine, dg = dorsal glands, e = egg).

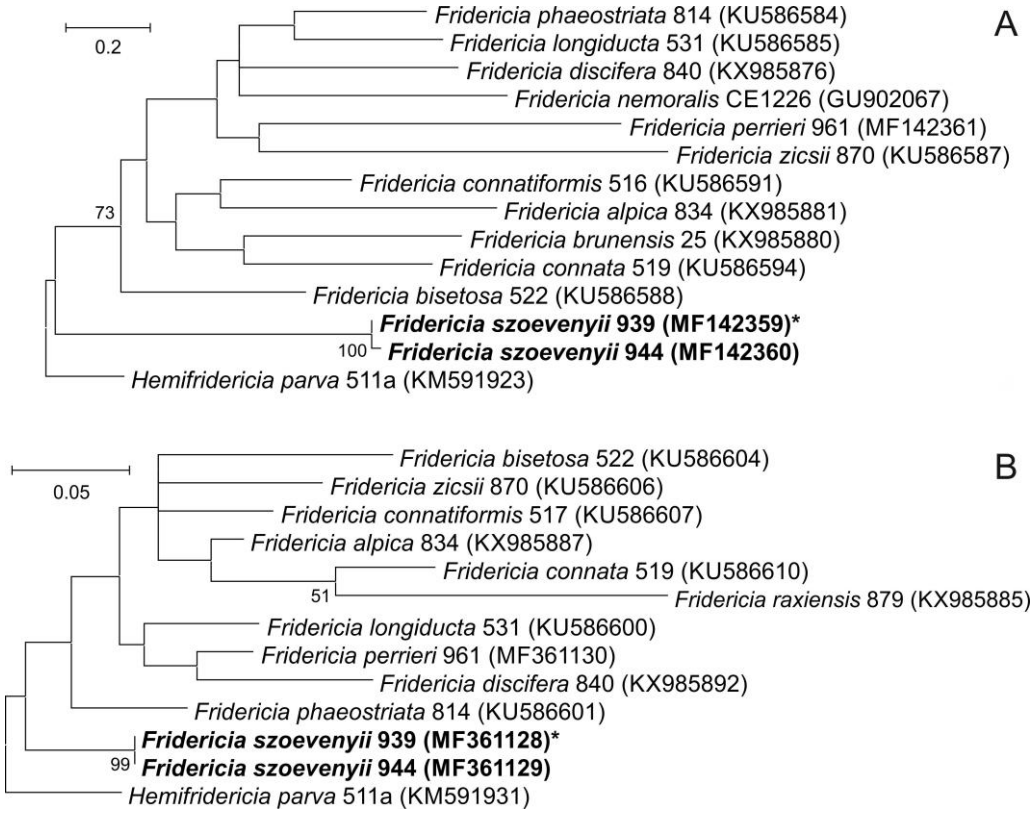

Figure 5. Maximum likelihood phylogenetic tree of selected *Fridericia* species based on the CO1 (A) and H3 (B) genes (439 and 181 nucleotide positions, TN93+G+I and K2+G substitution models, respectively). Bootstrap values greater than 50 are shown at the nodes. Sequences from the new species described here appear in bold (holotype marked with an asterisk).

DISCUSSION

The diverse enchytraeid fauna consisting of 59 species distributed in 15 genera (Appendix 2) of Kőszeg Mts. is worth comparing with the fauna of Rax Mts. in Austria (Dózsa-Farkas & Felföldi 2017b); both have subalpine or alpine climate. Comparing these two regions, similarities could be found regarding the enchytraeid fauna, which includes some characteristic species of the Alps. For example, *F. alpica* described from Rax was also found in Kőszeg Mts., moreover, at site 15a (alder carr at creekside) with its very cool and humid subclimate, a habitat is provided for such species as *F. discifera, F. raxiensis, Euenchytraeus clarae* and *Fridericia* sp. This latter represents a new species within the genus which will be described soon. Additionally, these four species were recorded only from the Kőszeg Mts (in site 15a) and nowhere else within Hungary, therefore they could be regarded as relict species from the Ice age.

Euenchytraeus clarae is possibly identical with *Euenchytraeus bisetosus*, which was described by Bretscher (1906) from Swiss Alps but, based on immature material (Schmelz & Collado 2010, Martinsson *et al.* 2014). For the correct synonimization, it will be necessary to compare individuals from the type locality with those from Kőszeg Mts. It is also worth mentioning that *Oconnorella tubifera,* which is widespread from Sweden to Italy in moist soils (Schmelz & Collado 2010), was found at first time in Hungary in the Kőszeg Mts., only from the sites 15a (alder carr along a creek) and site 10 (spruce forest).

From Kőszeg Mts., three new species, namely *Fridericia szoevenyii* sp. nov. (described here), *Achaeta tothi* Dózsa-Farkas & Felföldi, 2017 and

Cernosvitoviella farkasi, Dózsa-Farkas *et al.,* 2017 were also found. Two of them occurred only in one locality: *F. szoevenyii* only at site 16a (Velem, area of willow along a creek) and *C. farkasi* only at site 8b (Ólmod, young Scots pine forest in stagnant mud); while *A. tothi* were recorded from three sites: site 10 (near Hörmann-spring, spruce forest), site 12 (Steirer Houses, mesophile montane hay meadow) and site 11 (between Hörmann-spring and Velem village, mixed forest). It is possible that all are endemic to this region.

In terms of species numbers recorded at the investigated sites, the alder carr at a creekside near Paprét (site 15) showed the highest value with 33 species. The second is in this regard was the mesophile montane hay meadow at Steirer Houses (site 13) with 27 species. Remarkable that in a mixed forest on a hillside (site 12) only a single species (*Marionina clavata*) was found, probably due to the dense underwood of *Vaccinium myrtillus*.

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Appendix 1. **Investigated sites and habitats (with sampling dates) in Kőszeg Mts. with the recorded enchytraeid and the two Polychaeta species (dominant species are underlined).**

1. **Near Reichnitz, Austria, mixed deciduous forest** with *Fagus silvatica* and *Quercus petreae*, 47°20.194' N, 16°23.993' E, 671 m a.s.l., 21.05.2014. **8+1 species** (*Chamaedrilus chlorophilus, Enchytraeus norvegicus, Enchytronia parva, Fridericia bisetosa, F. alpica, F. sohlenii, Mesenchytraeus glandulosus, Oconnorella cambrensis, Hrabeiella periglandulata*).
2. **Near Reichnitz, Austria, mixed forest** with *Fagus silvatica*, *Quercus petreae, Pinus silvestris*, *P. nigra* and *Picea abies*, 47°19.749' N, 16°25.666' E, 634 m a.s.l., 21.05.2014. **6 species** (*Achaeta* cf. *danica, Bryodrilus ehlersi***,** *Buchcholzia appendiculata***,** *Enchytraeus buchcholzi s.l.*, *E. norvegicus, Marionina clavata*).
3. **Near Reichnitz, Austria, clearing in the woodland**, 47°20.195' N, 16°23.992' E, 624 m a.s.l., 21.05.2014. **8 species** (*Buchcholzia appendiculata, Enchytraeus buchcholzi s.l., Enchytronia parva, Fridericia benti, F. bisetosa, F. bulboides, F. miraflores, Henlea perpusilla*).
4. **Between Reichnitz and Lockenhaus, Austria, spruce (*Picea abies*) forest**, 47°20.195' N, 16°23.992' E, 739 m a.s.l., 21.05. 2014. **3 species** (*Achaeta cf. danica, Enchytraeus norvegicus, Fridericia dura*).
5. **Hammerteich, Austria, hay meadow**, 47°24.630' N, 16°26.680' E, 327 m a.s.l., 21. 05.2014. **8 species** (*Enchytraeus bulbosus, Enchytronia christenseni, En. parva, Fridericia bisetosa, F. bulboides, F. connata, F. miraflores, F. paroniana*)
6. **Alsóerdő, Hungary, old *Sphagnum* mire**, 47°40.370' N, 16°56.460' E, 350 m a.s.l., 31. 10.2014. **4 species** (*Cernosvitoviella atrata, C. minor, Chamaedrilus chlorophilus, Mesenchytraeus pelicensis*).
7. **Alsóerdő, Hungary, mixed forest near an old *Sphagnum* mire**, 47°24.241' N, 16° 33.882' E, 345 m a.s.l., 27.03.2016. **5 species** (*Achaeta affinis, A. camerani, Chamaedrilus chlorophilus, Marionina clavata, Mesenchyraeus pelicensis*)
8. **Near Ólmod, Hungary**, 47°24.345' N, 16°33.918' E, 319 m a.s.l.
   a. ***Sphagnum* mire**, 21.05.2014, 13.10.2014. **4 species** (*Cernosvitoviella minor, Chamaedrilus glandulosus* s.l.*, Ch. cognettii, Globulidrilus riparius*).
   b. **Young Scots pine forest (*Pinus sylvestris*), on the edge of a *Sphagnum* mire, stagnant mud with *Molinia* stocks**, 47°24.345' N, 16°33.918' E, 319 m a.s.l., 21.05.2014, 13.10.2014 and 24.10.2016. **11 species** (*Achaeta camerani, A.* cf. *danica, Cernosvitoviella atrata, C. minor, C. farkasi, Chamaedrilus chlorophilus, Fridericia dura, F. paroniana, Marionina simillima, M. vesiculata, Mesenchytraeus pelicensis*).
9. **Meadow, Hungary, near a Scots pine forest**, 47°24.116' N, 16°33.600' E, 297 m a.s.l., 13.10.2014. **15 species** (*Achaeta camerani, A. unibulba, Buchcholzia appendiculata, Cernosvitoviella minor, Enchytraeus buchcholzi s.l., Fridericia connata, F. dura, F. galba* with 5–8 diverticula*, F. hegemon, F. nemoralis, F. ratzeli, F. schmelzi, F. semisetosa, F. sohlenii, Marionina argentea*).
10. **Near Hörmann-spring, Hungary, spruce forest**, 47°21.493' N, 16°27.642' E, 757 m a.s.l., 21.05.2014, 13.10.2014, 20.06.2015, 24.10.2016. **12 species** (*Achaeta* cf. *danica, A. tothi, Bryodrilus ehlersi, Chamaedrilus chlorophilus, Enchytraeus norvegicus, Enchytronia parva, En. baloghi, Fridericia alpica, Marionina simillima, Mesenchytraeus pelicensis, Oconnorella cambrensis, O. tubifera*).
11. **Between Hörmann-spring and Velem village, Hungary, mixed forest** with *Carpinus betulus*, *Quercus petraea* and *Pinus*

sylvestris, 47°21.058' N, 16°29.110' E, 467 m a.s.l., 2014.10.13. **7+1** species (*Achaeta tothi, Chamaedrilus chlorophilus, Ch. glandulosus* s.l.*, Fridericia dura, F. sohlenii, Marionina simillima, Mesenchytraeus pelicensis, Hrabeiella periglandulata*).

12. **Near Hörmann-spring, Hungary, mixed forest** with *Fagus sylvatica, Quercus robur, Laryx decidua* and *Vaccinium*, 47°22.088' N, 16°28.277' E, 667m a.s.l., 21.05.2014. **1 species** (*Marionina clavata*).

13. **Steirer Houses, Hungary**, 47°22.201 N 16°28.045 E, 667 m a.s.l.

    a. **Mesophile montane hay meadow**, 21.05. 2014, 13.10.2014, 20.06.2015, 24.10.2016. **26+1 species** (*Achaeta affinis, A. bohemica* s.s., *A.* cf. *danica, A. tothi, Buchholzia appendiculata, Cernosvitoviella minor, Chamaedrilus chlorophilus, Ch. glandulous* s.l.*, Enchytraeus buchholzi s.l., E. bulbosus, E. sp., Enchytronia christenseni, En. parva, Fridericia benti, F. bisetosa, F. connata, F. connatiformis, F. dura, F. maculata, F. miraflores, F. nemoralis, F. paroniana, F. perrieri, F. schmelzi, F. semisetosa, F. sohlenii, F. sp.* (with only ventral chaeta)*, Hrabeiella periglandulata*).

    b. **Near „Ciklamen-spring", wet soil under old *Picea abies* trees**, 21.05.2014. **4 species** (*Enchytraeus lacteus*, *Fridericia perrieri, Henlea perpusilla, Marionina argentea*).

14. **Near Steirer Houses, Hungary, mixed deciduous forest with Quercus robur and Fagus silvatica**, 47°22.685' N, 16°30.026' E, 521 m a.s.l., 21.05.2014. **9+1 species** *(Buchholzia simplex, Enchytraeus norvegicus, Enchytronia parva, Fridericia bisetosa, F. connata, F. alpica, F. dura, F. ratzeli, F. sohlenii, Hrabeiella periglandulata*).

15. **Near Paprét, Hungary, alder carr at Creekside.** 47°24.091' N, 16°26.878' E, 478 m a.s.l.

    a. **Soil and leaf-litter**, 21.05.2014, 13.10. 2014, 24.10.2016. **31+1 species** (*Achaeta affinis, A. camerani, A.* cf. *danica, Bryodrilus ehlersi, Buchcholzia appendiculata, B. simplex, Cernosvitoviella minor, Chamaedrilus cognettii, Ch. glandulosus* s.l.*, Enchytraeus buchcholzi s.l., E. norvegicus, Enchytronia parva, Euenchytraeus clarae, Fridericia benti, F. discifera, F. alpica, F. dura, F. galba* with 5-8 diverticula*, F. perrieri, F. phaeostriata, F. raxiensis, F. ratzeli, F. sohlenii, Globulidrilus riparius, Henlea perpusilla, Marionina argentea, Mesenchytraeus armatus, M. glandulosus, M. pelicensis, Oconnorella cambrensis, O. tubifera, Hrabeiella periglandulata*).

    b. **Decaying bark on tree stumps**, 21.05. 2014. **3 species** (*Bryodrilus ehlersi, Chamaedrilus chlorophilus, Mesenchytraeus pelicensis*).

16. **Velem, Hungary, creekside area of willow**, 47°20.451' N, 16°30.078' E, 325 m a.s.l., 27. 03.2016, 24.10.2016.

    a. **Creekside under *Salix* sp. on the side of the road.** 47°20.451' N, 16°30.078' E **20+1 species** (*Achaeta* cf. *danica, Buchcholzia appendiculata, Cernosvitoviella aggtelekiensis, Chamaedrilus chlorophilus, Ch. glandulosus* s.l.*, Enchytraeus buchcholzi s.l., Enchytronia parva, Fridericia benti, F. connata, F. dura, F. galba* with 5-8 diverticula*, F. miraflores, F. paroniana, F. perrieri, F. phaeostriata, F. sohlenii, **F. szoevenyii sp. n.**, Henlea perpusilla, Mesenchytraeus armatus, Oconnorella cambrensis, Hrabeiella periglandulata*).

    b. **Creekside under *Salix* sp. on the other side of the road** 47°20.501' N, 16° 30.173E**. 10 species** (*Buchcholzia appendiculata, Chamaedrilus glandulosus* s.l.*, Enchytraeus buchcholzi s.l., Fridericia benti, F. maculata, F. perrieri, F. phaeostriata, Globulidrilus riparius, Henlea perpusilla, Marionina argentea*).

Appendix 2. List of Enchytraeidae and Hrabeiellidae species recorded in the Kőszeg Mountains.

(the *Cernosvitoviella* and *Achaeta* species of this mountain have already been published by Dózsa-Farkas *et al.* 2017 and Dózsa-Farkas & Felföldi 2017a)

Achaeta affinis Nielsen & Christensen, 1959
Achaeta bohemica (Vejdovský, 1879) *sensu stricto*
Achaeta camerani (Cognetti, 1899)
Achaeta cf. *danica* Nielsen & Christensen, 1959
Achaeta tothi Dózsa-Farkas & Felföldi, 2017
Achaeta unibulba Graefe, Christensen & Dózsa-Farkas, 2005
Bryodrilus ehlersi Ude, 1892
Buchholzia appendiculata (Buchholz, 1862)
Buchholzia simplex Nielsen Christensen, 1963
Cernosvitoviella aggtelekiensis Dózsa-Farkas, 1970
Cernosvitoviella atrata (Bretscher, 1903)
Cernosvitoviella farkasi Dózsa-Farkas, Csitári & Felföldi, 2017
Cernosvitoviella minor Dózsa-Farkas, 1990
Chamaedrilus (*Cognettia*) *chlorophilus* Friend, 1913
Chamaedrilus (*Cognettia*) *cognettii* (Issel, 1905)
Chamaedrilus (*Cognettia*) *glandulosus sensu lato* (Michaelsen, 1888)
Enchytraeus buchholzi Vejdovský,1879 *sensu lato*
Enchytraeus bulbosus Nielsen & Christensen, 1963
Enchytraeus lacteus Nielsen & Christensen, 1961
Enchytraeus norvegicus Abrahamsen, 1969
Enchytraeus sp.
Enchytronia baloghi Dózsa-Farkas, 1988
Enchytronia christenseni Dózsa-Farkas, 1970
Enchytronia parva Nielsen & Christensen, 1959
Euenchytraeus clarae Bauer, 1993
Fridericia alpica Dózsa-Farkas & Felföldi, 2017 (in press)
Fridericia benti Schmelz, 2003
Fridericia bisetosa (Levinsen, 1884)
Fridericia bulboides Nielsen & Christensen, 1959
Fridericia connata Bretscher, 1902
Fridericia discifera Healy, 1975
Fridericia dura (Eisen, 1879) (=*F. ratzeli* sensu Dózsa-Farkas 2005)
Fridericia galba (Hoffm., 1843) with 5–8 diverticula
Fridericia hegemon (Vejdovský, 1878)
Fridericia maculata Issel, 1905
Fridericia miraflores Sesma & Dózsa-Farkas, 1993
Fridericia nemoralis Nurminen, 1970
Fridericia paroniana Issel, 1904
Fridericia perrieri (Vejdovský, 1878)
Fridericia phaeostriata Dózsa-Farkas, 2015
Fridericia ratzeli (Eisen, 1872) (=*F. eiseni* Dózsa-Farkas, 2005)
Fridericia raxiensis Dózsa-Farkas & Felföldi, 2017
Fridericia schmelzi Cech & Dózsa-Farkas, 2005
Fridericia semisetosa Dózsa-Farkas, 1970
Fridericia sohlenii Rota et al., 1998
***Fridericia szoevenyii* sp.n.**
Fridericia sp.
Globulidrilus riparius (Bretscher, 1899)
Henlea perpusilla Friend, 1911
Marionina argentea (Michelsen, 1889) *sensu lato*
Marionina clavata Nielsen & Christensen, 1961
Marionina simillima Nielsen & Christensen, 1959
Marionina vesiculata Nielsen & Christensen, 1959
Mesenchytraeus armatus (Levinsen, 1884)

Mesenchytraeus glandulosus (Levinsen, 1884)
Mesenchytraeus pelicensis Issel, 1905
Oconorella cambrensis (O'Connor, 1963)
*Oconorella tubifera (*Nielsen & Christensen, 1959)
Stercutus niveus Michelsen, 1888

Hrabeiella periglandulata Pižl & Chalupský, 1984
Parergodrilus heideri Reisinger, 1925

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New earthworm records from Turkey (Clitellata: Lumbricidae, Megascolecidae)

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Abstract. Elaboration of an earthworm material collected in different parts of Turkey resulted in recording altogether eighteen species and subspecies. The Levantine *Dendrobaena orientalis* Černosvitov, 1940 was reported for the first time outside the Levant. The new occurrence of the Caucaso-Anatolian *D. alpina armeniaca* (Rosa, 1893) from Hatay province, Levantine Turkey shows that this species has a much larger distribution area than previously expected.

Keywords. Earthworms, Turkey, new records, Dendrobaena alpina armeniaca

INTRODUCTION

The beginning of the organized earthworm researches in Turkey is dated to the end of the 1980s', when the first larger scale expeditions took place. These two collecting trips, led by the Italian zoologist Pietro Omodeo, mainly focused on the northern and the south-western part of the country. As a result, several new species and a new genus were described (Omodeo & Rota 1989, 1991).

Another milestone in the earthworm researches of Turkey was the comprehensive work of Csuzdi *et al.* (2006), compiling and critically reviewing all previous earthworm records from the country. Since then, the researches are more or less continuous: seven new species were described from different parts of Turkey in the last decade (Csuzdi *et al.* 2007, Szederjesi *et al.* 2014a, 2014b) and also a huge amount of new data were published as a result of the different faunistical studies (Mısırlıoğlu 2008, 2010, 2010, Mısırlıoğlu & Szederjesi 2015).

This present paper summarizes the results of the collecting expeditions to different parts of Turkey, accomplished between the years 2006 and 2016.

MATERIAL AND METHODS

Earthworms were collected by digging and hand-sorting. The specimens were killed and fixed in 80% ethanol.

The valid names are given according to the online name database of Csuzdi (2012).

RESULTS

Family Lumbricidae Rafinesque-Schmaltz, 1815

Allolobophora chlorotica (Savigny, 1826)

Enterion chloroticum Savigny, 1826: 182.
Allolobophora chlorotica: Csuzdi *et al.* 2006: 2.

Material examined. 2 ex., Muğla, Ulaş district, leg. F. Türkmen, 17.01.2015.

urn: lsid:zoobank.org:pub:A2AAF4BE-0C6C-4DEE-AB24-7AC0E66BF513 *published: 30 June, 2017*
HU ISSN 2063-1588 (online), HU ISSN 0237-5419 (print) *http://dx.doi.org/10.18348/opzool.2017.1.55*

Aporrectodea caliginosa caliginosa (Savigny, 1826)

Enterion caliginosum Savigny, 1826: 180.
Aporrectodea caliginosa (part.): Csuzdi *et al.* 2006: 4.

Material examined. 12 ex., Adana, Sarıçam district, barren land, N37°01.976', E035°24.987', 179 m, leg. B. Or, 10.09.2015.

Aporrectodea caliginosa trapezoides (Dugès, 1828)

Lumbricus trapezoides Dugès, 1828: 289.
Aporrectodea caliginosa trapezoides: Mısırlıoğlu & Szederjesi 2015: 101.

Material examined. 3 ex., Karaman, Doğu Kışla quarter, barren countryside, non-grass area, leg. A. Çınar, 05.12.2009. 11 ex., Konya, Karatay, Taşra, Üzümlü quarter, Kanal street, grassy land, leg. O. Şen, 26.04.2015. 24 ex., Muğla, Milas district, Kafaca village, leg. F. Türkmen, 30.03.2014. 3 ex., Konya, Doğanhisar, Başköy village, shore of Başköy pond, leg. M.A Biçer, 02.11.2012. 5 ex., Muğla, Ulaş district, Beçin, leg. F. Türkmen, 31.03.2014. 23 ex., Eskişehir, Sivrihisar district, Bahçecik, wooded region, village fountain, leg. E. Yılmaztürk, 22.11.2015. 2 ex., Aydın, Kuşadası district, Davutlar area, home garden, tomato plantation, leg. D. Çankaya, 18.08.2013. 13 ex., Afyon, Emirdağ district,Yusufağaç, home garden, among plant roots, leg. B. Şengül, 21.04.2014. 2 ex., Ankara, Güdül district, Kocakaya Mt, Tekke fountain, grassy area with oak trees, leg. A. Şen, 28.11.2009. 9 ex., Karaman, Kisecik, fields surrounding the canal, leg. A. Çınar, 05.12.2009. 1 ex., Konya, Ilgın, pasture, leg. M.A. Biçer, 04.11.2012. 1 ex., Muğla, Ulaş district, leg. F. Türkmen, 17.01.2015. 5 ex., Kocaeli, Gebze district, Istasyon quarter, Darıca turnout, barren land, leg. A. Çinar, 06.12.2009. 1 ex., Muğla, Milas district, Karağaç, leg. F. Türkmen, 04.10.2014. 2 ex., Kırklareli, Lüleburgaz district, Yenibedir, 80 m, leg. O. Mol, M. Karavuş, O. Şen. 5 ex., Adana, Karaisalı district, Gökkuyu Village, roadside, barren land, N37°04.222', E035°05.727', 180 m, leg. B. Or, 10.09.2015. 1 ex., Muğla, Ulaş district, leg. F. Türkmen, 17.01.2015. 4 ex., Muğla, Milas district, Kafaca, leg. F. Türkmen, 06.10.2014. 1 ex., Edirne, Kırkpınar district, leg. O. Mol, M. Karavuş, O. Şen, 18.01.2014. 1 ex., Sakarya, Merkez, city center, leg. A.M. Bozkurt, H. Sayın, 11.11. 2015. 3 ex., Edirne, Sarayakpınar, leg. O. Mol, M. Karavuş, O. Şen, 18.01.2014. 6 ex., Muğla, Milas district, Kafaca, leg. F. Türkmen, 04.10.2014. 2 ex., Bilecik, Merkez, Osmangazi quarter, Beyond TOKI Houses, under blackberry, leg. Ö. Perk, 11.12.2016. 2 ex., Eskisehir, Tepebaşı district, Kumlubel quarter, home garden, leg. B. Şengül, 26.03.2014.

Aporrectodea jassyensis (Michaelsen, 1891)

Allolobophora jassyensis Michaelsen, 1891: 15.
Aporrectodea jassyensis: Csuzdi *et al.* 2006: 6.

Material examined. 2 ex., Muğla, Ulaş district, leg. F. Türkmen, 17.01.2015. 3 ex., Muğla, Çamköy, leg. F. Türkmen, 23.01.2015.

Aporrectodea rosea (Savigny, 1826)

Enterion roseum Savigny, 1826: 182.
Aporrectodea rosea: Csuzdi et al. 2006: 6.

Material examined. 7 ex., Konya, Karatay, Taşra, Üzümlü quarter, Kanal street, grassy land, leg. O. Şen, 26.04.2015. 1 ex., Artvin, Murgul district, near the State Hospital, under snow, barren land, leg. Ş. Oktay, 13.12.2016. 11 ex., Afyon, Emirdağ district,Yusufağaç, home garden, among plant roots, leg. B. Şengül, 21.04.2014. 8 ex., Muğla, Ulaş district, leg. F. Türkmen, 17. 01.2015. 3 ex., Muğla, Milas district, Kafaca, leg. F. Türkmen, 04.10.2014.

Dendrobaena alpina armeniaca (Rosa, 1893)

(Figure 1)

Allolobophora alpina v. *armeniaca* Rosa, 1893: 431.
Dendrobaena alpina armeniaca: Csuzdi *et al.* 2006: 8.

Material examined. 1 ex., Eskişehir, Beşik Deresi, edge of the stream, leg. K. Kayalı,

07.05.2013. 1 ex., Hatay, Islahiye district, 1774 m, around *Pinus nigra*, leg. K. Özgişi, 01. 06.2015.

External characters. Length 36–59, width 3–4.5 mm. Number of segments 115–131. Pigmentation slight pinkish. Prostomium epilobous ½ closed. First dorsal pore at 5/6. Setae distantly standing. Setal arrangement behind clitellum: *aa*:*ab*:*bc*:*cd*:*dd* = 2.6:1.2:1.3:1:2.9. Male pores on segment 15, surrounded by a glandular crescent Nephridial pores irregularly alternate between setal line *b* and above *d*. Clitellum on segments 27–33, 1/n34. Tubercula pubertatis on segments 30–32.

Internal characters. Dissepiments 6/7–12/13 slightly thickened, 13/14–14/15 thickened. Testes and funnels paired in segments 10–11, covered by perioesophageal testis sac in segment 10 and 11. Three pairs of seminal vesicles in 9, 11, 12. Two pairs of spermathecae in 9/10, 10/11 with external openings near the mid-dorsal line. Calciferous glands in segment 11–12. The last pair of hearts in 10. Nephridial bladders octaedra-type, rarely sausage-shaped. Crop in segments 15–16, and gizzard in segments 17–18. Typhlosolis lamelliform. The cross-section of the longitudinal muscle layer is of pinnate type.

Remark. D. alpina armeniaca is distributed on the northern part of the county. This is its first record from Hatay, the Levantine part of Turkey.

***Dendrobaena hortensis* (Michaelsen, 1890)**

Allolobophora subrubicunda var. *hortensis* Michaelsen, 1890: 15.
Dendrobaena hortensis: Csuzdi *et al.* 2006: 10.

Material examined. 9 ex., Ankara, Güdül district, Kocakaya Mt, Tekke fountain, grassy area with oak trees, leg. A. Şen, 28.11.2009. 12 ex., Kocaeli, Gebze district, Istasyon quarter, Darıca turnout, barren land, leg. A. Çinar, 06.12.2009. 3 ex., Samsun, Arakum, DSI street, asphalt road edge, grassy and bushy area, leg. Y. Yılan, 22.11.2009.

***Dendrobaena orientalis* Černosvitov, 1940**

(Figure 2)

Dendrobaena orientalis Černosvitov, 1940: 444. Csuzdi *et al.* 2006: 11.

Material examined. 1 ex., Konya, Karatay, Taşra, Üzümlü quarter, Kanal street, grassy land, leg. O. Şen, 26.04.2015. 1 ex., Hatay, Islahiye district, 1774 m, around *Pinus nigra*, leg. K. Özgişi, 01.06.2015.

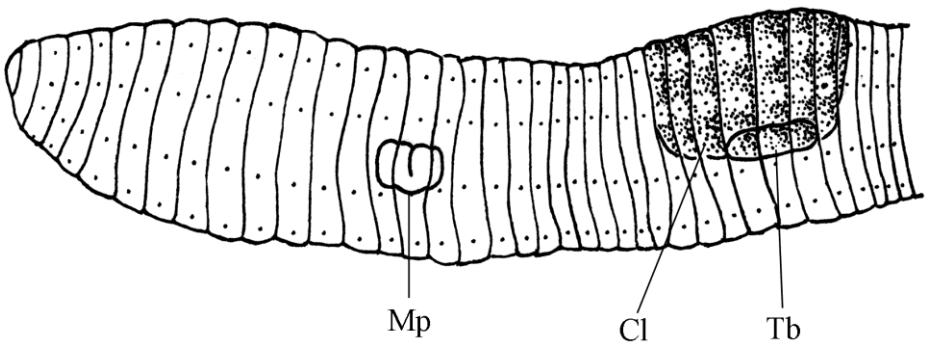

Figure 1. Ventrolateral view of *Dendrobaena alpina armeniaca* (Rosa, 1893). Cl = clitellum, Tb = tubercles, Mp = male pore.

External characters. Length 24–41, width 2.5–3 mm. Number of segments 93–99. Pigmentation red-violet. Prostomium tanylobous. First dorsal pore at 5/6. Setae distantly standing. Setal arrangement behind clitellum: *aa*:*ab*:*bc*:*cd*:*dd* = 1.8:1.1:1.6:1:1.9. Male pores on segment 15, surrounded by a glandular crescent, protruding into the neighbouring segments. Nephridial pores irregularly alternate between setal line *b* and above *d*. Clitellum on segments 23, 24–33. Tubercula pubertatis on segments 30–32. Glandular tumescence on 10, 15 *ab*.

Internal characters. Dissepiments 6/7–12/13 slightly thickened. Testes and funnels paired in segments 10–11, covered by perioesophageal testis sac in segment 10 and 11. Three pairs of seminal vesicles in 9, 11, 12. Two pairs of spermahecae in 9/10, 10/11 with external openings in setal line *c*. Calciferous glands in segment 11–12. The last pair of hearts in 11. Nephridial bladders octaedra-type. Crop in segments 15–16, and gizzard in segments 17–18. Typhlosolis bilobate. The cross-section of the longitudinal muscle layer is of pinnate type.

Remark. This is a Levantine species, recorded in Turkey only from Hatay (Levantine part of Turkey). This is the first record of *D. orientalis* from the Anatolian part.

***Dendrobaena pentheri* (Rosa, 1905)**

Allolobophora (*Notogama*) *pentheri* Rosa, 1905: 6.
Dendrobaena pentheri: Csuzdi *et al.* 2006: 12.

Material examined. 2 ex., Konya, Karatay, Taşra, Üzümlü quarter, Kanal street, grassy land, leg. O. Şen, 26.04.2015. 1 ex., Mersin, Aslanköy, 1818 m, leg. K. Özgişi, 30.05.2015.

***Dendrobaena veneta* (Rosa, 1886)**

Allolobophora veneta Rosa, 1886: 674.
Dendrobaena veneta veneta: Csuzdi *et al.* 2006: 15.

Material examined. 1 ex., Konya, Doğanhisar, Başköy village, shore of Başköy pond, leg. M.A Biçer, 02.11.2012. 1 ex., Eskişehir, Beşik Deresi, edge of the stream, leg. K. Kayalı, 07.05.2013. 1 ex., Artvin, Murgul district, near the State Hospital, under snow, barren land, leg. Ş. Oktay, 13.12.2016. 10 ex., Konya, Ilgın, pasture, leg. M.A. Biçer, 04.11.2012. 1 ex., Eskişehir, Seyitgazi district, home garden with ornamental plants, leg. Y. Dikici, 26.09.2015. 1 ex., Muğla, Ulaş district, leg. F. Türkmen, 17.01.2015. 2 ex., Eskisehir, Tepebaşı district, Kumlubel quarter, home garden, leg. B. Şengül, 26.03.2014.

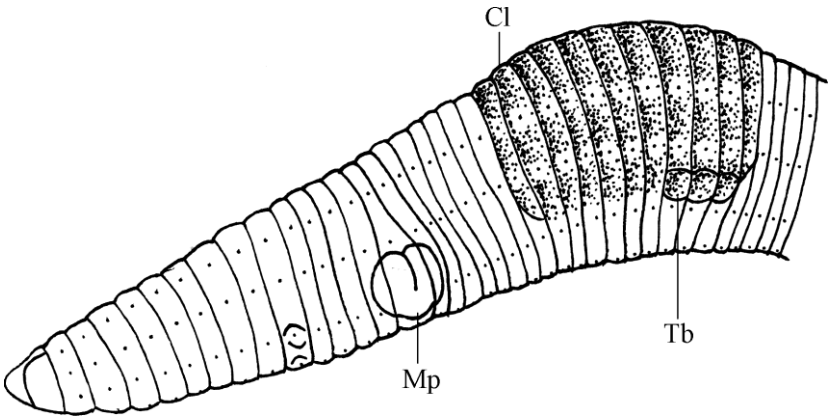

Figure 2. Ventrolateral view of *Dendrobaena orientalis* Černosvitov, 1940. Cl = clitellum, Tb = tubercles, Mp = male pore.

Eisenia fetida (Savigny, 1826)

Enterion fetidum Savigny, 1826: 182.
Eisenia fetida: Csuzdi *et al.* 2006: 18.

Material examined. 3 ex., Tekirdağ, Karacakılavuz quarter, pasture, leg. E. Uzun, 16.12.2016. 5 ex., Adana, Karaisalı district, Gökkuyu Village, roadside, barren land, N37°04.222', E035°05.727', 180 m, leg. B. Or, 10.09.2015.

Eiseniella tetraedra (Savigny, 1826)

Enterion tetraedrum Savigny, 1826: 184.
Eiseniella tetraedra: Csuzdi *et al.* 2006: 19.

Material examined. 1 ex., Ankara, Güdül district, Kocakaya Mt, Tekke fountain, grassy area with oak trees, leg. A. Şen, 28.11.2009. 1 ex., Muğla, Milas district, Karağaç, leg. F. Türkmen, 04.10.2014.

Healyella syriaca (Rosa, 1893)

Allolobophora syriaca Rosa, 1893: 461.
Healyella syriaca: Csuzdi *et al.* 2006: 22.

Material examined. 10 ex., Adana, Misis district, under trees, N36°57.427', E035°37.495', 18 m, leg. B. Or, 10.09.2015. 2 ex., Amasya, Merzifon district, S of Gökçebağ village,grassy area, leg. Y. Yılan, 25.11.2009. 2 ex., Amasya, Merzifon district, Tavşan Mt. slopes, Kürt river, leg. Y. Yılan, 29.11.2009. 1 ex., Amasya, Merzifon district, Tavşan Mt. eastern slopes, edge of the Yakacık village road, leg. Y. Yılan, 29.11. 2009.

Lumbricus rubellus Hoffmeister, 1843

Lumbricus rubellus Hoffmeister, 1843: 187. Csuzdi *et al.* 2006: 23.

Material examined. 3 ex., Edirne, Kırkpınar district, leg. O. Mol, M. Karavuş, O. Şen, 18.01. 2014. 1 ex., İstanbul, Yakacık, Sabiha Gökçen Airport surroundings, leg. M. Buldak, 06.10.2006.

Octodrilus complanatus (Dugès, 1828)

Lumbricus complanatus Dugès, 1828: 289.
Octodrilus complanatus: Csuzdi *et al.* 2006: 24.

Material examined. 1 ex., Bursa, Yenişehir district, Söylemiş, Karaca stream bank, grassy area, leg. I. Sarı, 19.04.13.

Octodrilus transpadanus (Rosa, 1884)

Allolobophora transpadana Rosa, 1884: 45.
Octodrilus transpadanus: Csuzdi *et al.* 2006: 24.

Material examined. 1 ex., Edirne, Kırkpınar district, leg. O. Mol, M. Karavuş, O. Şen, 18.01. 2014. 2 ex., Bilecik, Merkez, Osmangazi quarter, Beyond TOKI Houses, under blackberry, leg. Ö. Perk, 11.12.2016.

Octolasion lacteum (Örley, 1881)

Lumbricus terrestris var. *lacteus* Örley, 1881: 584.
Octolasion lacteum: Csuzdi *et al.* 2006: 24.

Material examined. 1 ex., Muğla, Ulaş district, leg. F. Türkmen, 17.01.2015.

Family Megascolecidae Rosa, 1891

Amynthas corticis (Kinberg, 1867)

Perichaeta corticis Kinberg, 1867: 102.
Amynthas corticis: Mısırlıoğlu 2012: 104.

Material examined. 1 ex., Adapazarı, Sapanca district, Uzunkum, leg. S. Gençay, 04.12.2011.

DISCUSSION

The present study resulted in recording altogether 18 species and subspecies of which 17 belong to the family Lumbricidae. Most of the recorded species are peregrine and / or widely distributed, *eg*. the Trans-Aegean *Aporrectodea jassyensis* (Michaelsen, 1891) or the Circum-Mediterranean *Octodrilus complanatus* (Dugès, 1828).

The Levantine *Dendrobaena orientalis* Černosvitov, 1940 was first reported outside the Levant, which suggest that the distribution area of this species is probably much larger than previously expected. The situation is similar in case of *D. alpina armeniaca* (Rosa, 1893) – this species was known mostly from the northern part of the country, but the new record from Hatay shows that the area of this species crosses the ranges of the Taurus Mts to south.

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Corrected synonymies: the identities of *Strymon bicolor* (Philippi, 1859) and *Strymon heodes* (Druce, 1909) (Lepidoptera: Lycaenidae)

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Abstract. The South American hairstreak species *Strymon bicolor* (Philippi, 1859) and *S. heodes* (Druce, 1909) are diagnosed and their synonymies are revised. The distribution of *S. bicolor* is restricted to the Andean-Patagonian region south of the Atacama Desert and represented now in Argentina and Chile by seven available species group names, considered as subjective synonyms. However, some of these names can most probably be considered as valid taxa. A key to identification is given for distinguishing the superficially most similar *Strymon* species patterned by orange scaling in the dorsal wing surfaces. It is noted that the Austral *S. bicolor* group and the Central Peruvian *S. heodes* appear to belong to a mimicry ring inhabiting the dry areas of the Andes.

Keywords. Argentina, Chile, Peru, characters, Eumaeini, *Strymon*, *Eiseliana*, *Heoda*, *bicolor, heodes*, mimicry.

INTRODUCTION

The nominal species *Lycaena bicolor* was described on the basis of an unstated number of male and female specimens originating from the vicinity of Santiago de Chile, Chile (Philippi 1859). No type material is known to be extant. The genus *Eiseliana* was erected by Ajmat de Toledo (1978) based on the type species *Eiseliana koehleri*, described as new. The genus was reviewed by Johnson *et al*. (1992) transferring several taxa to *Eiseliana* from various genera, including *Lycaena bicolor*, as a widely distributed hairstreak in Chile and placed in its synonymy two names established subsequent to Philippi.

In the above mentioned paper Johnson and his co-authors also erected the genus *Heoda* based on *Thecla heodes* Druce, 1909 as type species. The nominal species *Thecla heodes* was described by Druce (1909) on the basis of at least two syntype specimens collected in „Uramarca" [= Yuracmarca] (one putative male) and „San Marcas" [= San Marcos] (one female), both allegedly located in department Ancash, Peru. The putative male syntype (which is actually a female) was designated as lectotype by Johnson *et al*. (1992), and this specimen was illustrated in colour by D'Abrera (1995: 1259, as „*E. heodes ?* ♀ R"). Later the genus was reviewed by Benyamini & Johnson (1996) describing *Heoda erani* as new and listing *H. atacama* Johnson & Miller, 1992, *H. nivea* Johnson, Miller & Herrera, 1992, *H. shapiroi* Johnson, Miller & Herrera, 1992, *H. suprema* Johnson, Miller & Herrera, 1992 and *H. wagenknechti* (Ureta, 1947) as congeners.

The generic names *Eiseliana* and *Heodes* were combined with several species-group names in the subsequent literature (*cf*. Bridges 1994, Peña & Ugarte 1997). Robbins & Nicolay (2002) presented a new concept of the genus *Strymon* Hübner, 1818; they considered *Eiseliana* and *Heodes* as junior subjective synonyms of *Strymon*. Moreover, *Thecla heodes* was placed in the synonymy of *Strymon bicolor* with further

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seven species-group names in the *Strymon istapa* group, but without any remarks. Making the situation more complicated Robbins (2004) listed *Strymon heodes* as a valid species, again without any note, but indicating five species-group names originally combined with the generic names *Eiseliana*, *Heoda* and *Thecla* as junior subjective synonyms. Beside this action *Strymon bicolor* was kept as a valid species having just two synonyms, reflecting the work of Johnson *et al.* (1992).

The species *Strymon bicolor* with dorsally orange coloured wing surfaces and its look-alike species are widely distributed in the Andes from central Peru south to the Patagonian Andes of Argentina and Chile. The Peruvian *Strymon heodes* is the most northerly taxon and is one of the most poorly known *Strymon*, because modern published faunistic data are non-existent and in museum collections specimens are rare. Orange *Strymon* hairstreaks are far better represented in both sides of the Andes south of the Atacama region and display wide phenotypical variability, many of them having been treated as valid species (Peña & Ugarte 1997) but synonymized by Robbins (2004).

For a revision of the Chilean fauna (Benyamini *et al.* in prep.) it is crucial to understand this diversity. Therefore, in this paper we address the following issues (1) what is the taxonomic identity of *S. heodes* ?; (2) what is the taxonomic identity of *S. bicolor* ?; (3) present an identifycation key to the most similar orange species placed in the *Strymon istapa* group of Robbins & Nicolay (2002); (4) correct the synonymic list of *S. bicolor*; and (5) discuss some aspects regarding these species.

MATERIALS AND METHODS

125 male and 89 female specimens of the *Strymon bicolor* complex from Chile (n = 163) and Argentina (n = 51) have been examined. From Peru (department Ancash) altogether 19 specimens of *S. heodes* (ten males and nine females) were studied. These specimens are deposited in the collection of Dubi Benyamini (Bet Aryre, Israel), in the Hungarian Natural History Museum (HNHM; Budapest, Hungary), in the Museo de Historia Natural, Universidad Nacional Mayor de San Marcos (MUSM; Lima, Peru), and in the Natural History Museum (NHMUK; London, UK) and in the Smithsonian Institution National Museum of Natural History collection (SINMNH; Washington D.C., USA).

The genitalia of 26 specimens have been dissected (*S. bicolor*: 7 males, 16 females; *S. heodes*: 2 males, 1 female) databased and digitized in the HNHM following the serial numbers of Zsolt Bálint. Abdomens were dissected using standard techniques, and the preparations are kept with the relevant specimens in plastic microvials filled with glycerin.

References for the two taxa discussed are given, also indicating the supplementing figures, when they are extant.

RESULTS

Key to the orange species of the *Strymon istapa* group

1. Dorsal wing-surfaces are generally brown or black in both sexes forewing ventral surface limbal area white, grey or brown ..... *Strymon* (various species of the genus-group)

Dorsal wing-surfaces are with more or less extended orange colouration in both sexes, forewing ventral surface limbal area orange (*S. bicolor* group)..... **2**

2. Dorsal hindwing surface entirely orange coloured in both sexes, hindwing with tail .....*S. wagenknechti*

Dorsal hindwing surface limbal area orange coloured otherwise brown in both sexes, hindwing without tail (*S. bicolor* and *S. heodes*) **3**

3. Dorsal wing-surface basal areas in both sexes with gleaming scales, hindwing submargin with light scaling..... *S. heodes*

Dorsal wing-surface basal areas in both sexes without gleaming scales, hindwing margin without light scaling..... *S. bicolor*

Identity of *Strymon heodes*

(Figures 1–5, 10,)

Thecla heodes Druce, 1909: 437, pl. 11, figs 10–11; Draudt 1920: 810, pl. 145, row k, figs. "heodas [sic]"

Eiseliana heodes (Druce): Bridges 1988: II.33; D'Abrera 1995: 1244, 1259, figs. „E. heodes ♂ R", "E. heodes ♀ V," [paralectotype], "E. heodes ? ♀ R." [lectotype].

Heoda heodes (Druce): Johnson *et al*. 1992: 129 (p. 130: lectotype designation), figs. 11AB (lectotype), 14.

Strymon heodes (Druce): Robbins & Nicolay 2002: 90 (in synonymy of *Strymon bicolor*); Robbins 2004: 131.

The original type series of *Thecla heodes* consisted of at least two syntypes, which Druce regarded as a male (his fig. 10), from "Uramarca", and a female (his fig. 11) from "San Marcas [sic]". Druce also remarked that his "male" lacked a FW scent pad (p. 438: "differs from *T. quadricmaculata* Hew. and its allies by the male wanting the prominent patch of dark scales at the end of the cell of the fore-wing"), which means he was actually dealing with a female.

The localities of the syntype specimens are in need of clarifications. "Uramarca" is almost without doubt Yuracmarca, located in Ancash at 08º 46' S, 77º 54' W, 1,450 m, a locality visited by Simons in December 1899; "San Marcas" or "San Marco" should be a locality (San Marcos) in Cajamarca (at 07º 20' S, 78º 10' W, 2245 m) that Simons visited in November 1899 (*cf.* Lamas 1976) (see Fig. 11).

Johnson *et al*. (1992) designated as lectotype the female specimen of Druce (their figs. 11A–B), which they said was from "San Marcas". But that specimen (in NHMUK) bears now the labels "Uramarca" and "Type ♂" and matches precisely Druce's fig. 10, Johnson *et al.*'s figs 11A–B, and D'Abrera's fig. "E. heodes ? ♀ R". It seems thus that someone switched the labels between the specimen from "Uramarca" and that from "San Marcas" as indicated by D'Abrera (1995: 1244). As shown by D'Abrera (1995), the specimen now labelled "San Marcas" ("San Marco" according to D'Abrera, who calls it "heodes ♀ V") matches quite well Druce's fig. 11, though we wonder if that female is the same model used for Druce's fig. 11.

The species *Strymon heodes* can be easily separated from any other taxon included in *Strymon* by the following characters, which are unique in the genus.

1. Basal areas of dorsal wing-surfaces in both sexes covered by iridescent scales which reflect different colours (silver, golden, light blue) depending on angle of observation.
2. Antemarginal area of hindwing in both sexes without intercellular submarginal black spots but there are light blue scales at the end of cubital veins and the end of vannal vein 2.

The characters listed are stable, only in the case of worn specimens it is difficult to detect, especially the light antemarginal scaling. According to these two characters all the synonyms placed under *Strymon heodes* by Robbins (2004) have to be removed and tentatively placed under *S. bicolor*, as had originally been proposed by Robbins & Nicolay (2002). None of these taxa have the characters listed above but they show clear affinity to *S. bicolor*. Consequently the species level status proposed by Robbins (2004) is confirmed by us here by the following evidences: (1) *S. heodes* can be separated from all *Strymon* on the ground of wing characters and (2) *S. heodes* geographically is highly isolated from any other members of the *S. bicolor* species complex (*cf.* Figs. 10–11).

The most striking traits still are (1) the large male dorsal forewing scent pad (which can be easily detected also in the ventral wingsurface), (2) the orange scaling of the wing-surfaces with wide black margin in both sexes and (3) no basal white scaling on the ventral surface of the hindwing basal area. All the *Strymon* taxa which have these three traits were placed in the *Strymon istapa* group by Robbins & Nicolay (2002).

Figures 1-5. *Strymon heodes* (Druce, 1909) from Peru, Ancash, Caraz, 2400 m, 2002, leg. Weigend, MUSM: 1 = male dorsal, 2 = male ventral, 3 = female dorsal, 4 = female ventral; (scale: 1 mm). The gleaming scales are well visible in the basal area of the wings in both sexes. 5 = Fresh male of *Strymon heodes* (Druce) in nature perching on a red flower of *Calliandra* sp. (Mimosoideae, Fabaceae) in Peru, Department Ancash, Huaylas, at 2820m taken on 9.XII.2016. (photos: Dubi Benyamini).

The genital structures of *Strymon heodes* are qualitatively identical to the species placed in the *Strymon istapa* group, namely the down-turned male aedeagus tip and the vesica containing a single slender cornutus, the female ductus seminalis arises from a point anterior to a sclerotized patch on the dorsal surface of the corpus bursae, and the 8th tergum is furrowed. Probably there are genitalia characters which could be used to discriminate quantitatively the taxa (see Johnson & Miller 1992).

Identity of *Strymon bicolor*

(Figures 6–9, 11)

Lycaena? bicolor Philippi, 1859: 1092.
Thecla bicolor (Philippi): Hewitson 1877: 208, pl. 83, figs. 695-697; Butler 1881: 468; Elwes 1903: 289; Draudt 1920: 810, pl. 145, row k, figs. "bicolor".
Eiseliana bicolor (Philippi): Bridges 1988: II.33; Johnson *et al*. 1992: 115, figs. 2A–D, 4A–D, 9A–C, 10A–C; D'Abrera 1995: 1244, 1245, figs. "E. bicolor"; Peña & Ugarte 1997: 210 (figs. female and male).
Strymon bicolor (Philippi): Robbins & Nicolay 2002: 99; Robbins 2004: 131.

The species *S. bicolor* can be easily separated from any other taxon belonging in *Strymon* by the unique combination of the following characters:

1. Male dorsal forewing with black scent pad in the apical area of the discal cell.
2. Basal area in both wing surfaces is black in both sexes.
3. Limbal area in both wing surfaces is orange in both sexes.

Beside *Strymon heodes* the only similar congeneric species is *S. wagenknechti* (Ureta), but in that species the basal and discal wing surface areas are orange, and the hindwing ventral surface median and submarginal areas are covered by white scaling, there is no orange colouration. The hindwing of *S. wagenknechti* is tailed.

Distribution and synonyms of *Strymon bicolor*

(Figure 11)

Lycaena? bicolor Philippi, 1859, type locality: Chile, „Le halla en las immediaciones de la Capital" [= Santiago de Chile] (male and female syntypes, not extant).
Thecla quadrimaculata Hewitson, 1874, type locality: "Chili", ["Valparaiso"] (male and female syntypes).
Thecla bicolor f. *leptocosma* Hayward, 1949, type locality: Argentina, "Zapala, Neuquén" (male holotype).
Thecla bicolor ab. *tricolor* Ureta, 1949, type locality: Chile, "Las Trancas, Vicuña" (female holotype) (unavailable name).
Eiseliana probabila Johnson, Miller & Herrera, 1992, type locality: "Valparaíso, Chile" (male holotype).
Heoda suprema Johnson, Miller & Herrera, 1992, type locality: Argentina, "Chubut Prov., Esquel" (female holotype).
Heoda shapiroi Johnson, Miller & Herrera, 1992, type locality: Chile, "Las Cruces, Cordillera Parral, Liná res [sic]" (female holotype).
Heoda atacama Johnson & Miller, 1992, type locality: Chile, "Coquimbo, Elqui, C[ues]ta Pajunales [sic]" (male holotype).

According to Robbins & Nicolay (2002) *Strymon bicolor* has many synonyms. Some of these names were proposed for distinctive populations living on the western or the eastern sides of the southern Andes, from the Atacama region to Patagonia.

According to our best knowledge the most northerly record of the species is a female specimen collected in Iquique, Chile by María Etcheverry Campaña in 1949 (deposited in SINMNH). But this is a unique specimen, and it can be a stray, or an accidentally introduced individual, or simply it has been mislabelled. The most northerly reliable data of *S. bicolor* is from Vallenar (Atacama, Chile) based on the personal observations of the junior author.

In the following paragraph we list all the names we place tentatively in synonymy with *Strymon bicolor* as they can be identified as such with the key we presented above. This list is identical with the synonymic list given for *Strymon bicolor* by Robbins & Nicolay (2002) (except that we removed *Thecla heodes* from synonymy), but differs from the list of Robbins (2004) as we indicated in the Introduction. We are of the opinion that some of these names represent real

Figures 6-9. *Strymon bicolor* (Philippi, 1859) from Chile (Santiago, Villa Paulina, 2000 m, 1999, ex larva, leg. et coll. Dubi Benyamini, Bet Arye, Israel): 6 = male dorsal, 7 = male ventral, 8 = female dorsal, 9 = female ventral; (scale: 1 mm) (photos: Gergely Katona, HNHM).

biological entities, therefore they deserve to be taxonomically recognized as species (*cf*. Peña & Ugarte 1997: 210–215).

DISCUSSION

Problems with *Strymon heodes* historical material

Johnson *et al*. (1992) mention one male from "Guarajunga, 2840 m [sic]", as well as another "male" from "Pampa Incas", and a third "male" from "Carohuas [= Carhuaz, Ancash], 2500 m" all three in NHMUK. In total, Johnson *et al*. (1992) mentioned having examined 4♂♂ and 3♀♀ of "Heoda heodes" as they indicate the existence of another female from "San Marcos", and another one from "Urumarca" in the collection. They provide illustrations of ♂ and ♀ genitalia.

Beside documenting *Thecla heodes* type material, one specimen from "Guarapunga, 2450 m"

has been illustrated by D'Abrera as "heodes ♂ R" (but also given as 2480 m on p. 1258), which ought to be the same as Johnson *et al.*'s "male", but with different spelling and elevation of the locality. That specimen is definitely not a syntype, as it was not mentioned in the original description, and it is also not a male individual.

"Guarajunga" of Johnson *et al.* and "Guarapunga" of D'Abrera should be Huayrapongo, also in Cajamarca, at 07º 11' S, 78º 27' W, 2600 m. The name "Pampa Incas" might refer to Baños del Inca (07º 10' S, 78º 28' W, 2650 m), also in Cajamarca, another locality visited by Simons in November 1899, or else La Pampa (08º 39' S, 77º 54' W, 1800m), in Ancash (*cf*. Lamas 1976).

Although it is written that "all *Heoda* species have forewing androconial brands in males" by Johnson *et al.* (1992: 121), they never mention this character in relation of their "Heoda heodes". It seems to be important to revise the seven NHMUK specimens and their labels, and compare them carefully with Druce's, Johnson *et al*.'s and D'Abrera's images in order to sex them properly, and if there are really any males of *heodes* among the NHMUK specimens examined by Johnson *et al*. (1992), and if the genital illustrations given in that paper (their figs. 14A–B) match actual specimens of *heodes.*]

Mimicry ring

In a review of the Chilean lycaenid butterfly life histories the junior author worked out a remarkable mimicry ring (Benyamini 1995). All the ring members have contrasting brown-orange imaginal wing surfaces displaying apparently warning colouration and many of them utilize toxic plants as larval hosts. Without any question the species *Strymon heodes* belongs to this mimicry ring (see Benyamini 1995, fig. 11) and suggests that the biota exhibiting this phenomenon is also present in the Ancash-Cajamarca region in Peru. Consequently the mimicry ring has an almost continuous distribution from Patagonia via Chile-Argentina-Bolivia to Peru and most probably it takes an important ecological role in the dry areas of the Andes. This is underlined by the existence of further orange-brown lycaenid butterfly species as *Penaincisalia aurulenta* Johnson, 1990 also known from the Peruvian Ancash region, the hairstreak *Penaicisalia felizitas* Bálint, 2004 from the Cuzco region and by an undescribed *Rhamma* species recorded as "Strymon heodes" from the La Paz valley, Bolivia (see Guerra *et al*. 2013), plus *Rhamma eiselei* (Johnson, 1992) and *Penaincisalia matusikorum* (Johnson, 1992), both from Tucumán, Argentina.

Generic placements

Robbins & Nicolay (2002) employed a wide concept for *Strymon*. They established nine species groups within the genus, and recognized 48 species, but later the number has been indicated as 55 (Robbins 2004) or 54 (Nicolay & Robbins 2005). *Strymon bicolor* and *S. heodes* have been placed in the *Strymon istapa* group, characterized as follows: (1) male with a scent patch on the dorsal surface of the forewing; (2) no basal patch of white scales on the ventral surface of the hindwing; (3) aedeagus tip down-turned with a single slender cornutus; (4) ductus bursae with sclerotized loop simple; (5) ductus seminalis arises either from the unsclerotized posterior end of the corpus bursae or from a point anterior of a sclerotized patch on the dorsal surface of the corpus bursae; and (6) female with 8th tergum furrowed and with imbedded presumed vestigial spiracles. The last character was emphasized by the authors.

As the phylogenic relationships between the species of the *Strymon istapa* group are unresolved, there is no basis to apply the generic names *Eiseliana* and *Heoda*. The

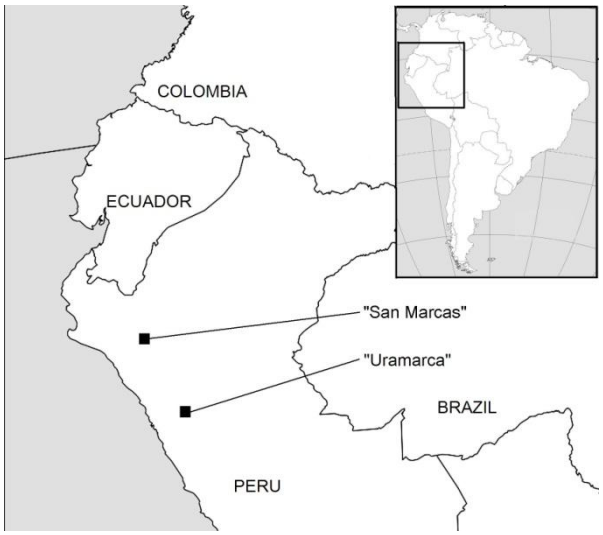

Figure 10. Localities of *Thecla heodes* Druce, 1909 syntype material; "Uramarca" = Yuracmarca, "San Marcas" = San Marcos (by Gergely Katona, HNHM).

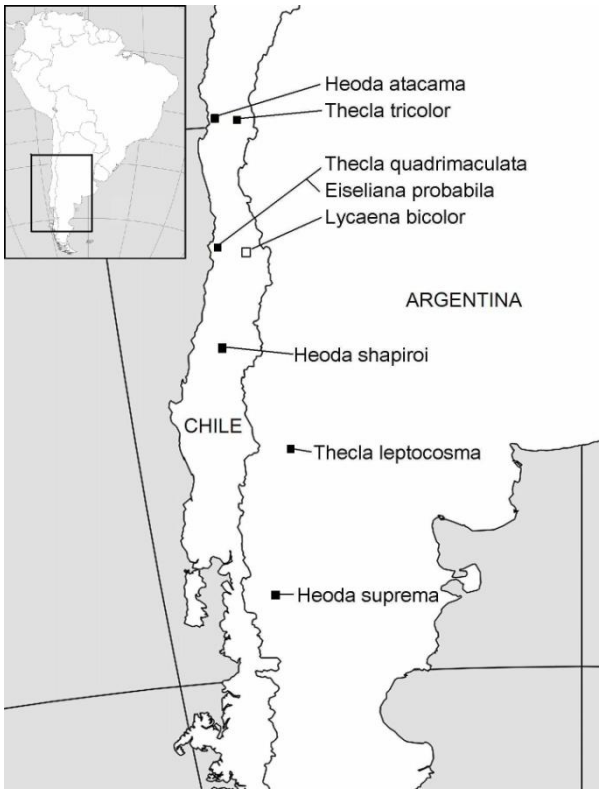

Figure 11. Type locality of *Lycaena bicolor* Philippi, 1859) (open square) and further nominal taxa placed currently under synonymy (black squares) indicating the general distribution of the group (by Gergely Katona, HNHM).

generic name *Eiseliana* might be used for *S. koehleri* and its relatives, and *Heoda* for *S. heodes* and its relatives. The previous attempts of Johnson and his colleagues to construct several species groups within these genera were unsuccessful. This is especially apparent when we take into consideration that taxa obviously closely related have been placed either in *Heoda* or *Eiseliana* or *Strymon*. For example *Thecla flavaria* Ureta, 1956 has been placed in *Eiseliana* by Johnson *et al*. (1992: 114), but an apparently closely related species (or a synonym according to Robbins 2004), *erani* Benyamini & Johnson, 1996, has been described in *Heoda* (see Benyamini & Johnson 1996). Similarly, the nominal species *Heoda atacama* Johnson & Miller, 1992 is surprisingly similar to *Eiseliana bicolor*, and its placements in different genera appears to be unjustified, as well as the case of the brown taxa *Strymon peristictos* Johnson, Eisele & McPherson, 1990 (a synonym of *Strymon eurytulus* Hübner, [1819] according to Robbins 2004) and *Heoda nivea* Johnson, Miller & Herrera, 1992. At our present knowledge of the genus *Strymon* the argument of Robbins & Nicolay (2002) against the application of the generic names *Heoda* and *Eiseliana* seems to be justified, but the species-group level synonyms they proposed for the Austral *Strymon* fauna in South America are in need of revision.

With this paper we make a first step and clarify the identity of *Strymon heodes* showing that although it is not a member of the Austral fauna, it is an endemic species of the *Strymon bicolor* group with restricted distribution in the Central Andes in Peru, but represents the same mimicry ring in which *S. bicolor* is also involved. However, we point to the situation that under the name of *S. bicolor* there are several species whose validity we trust to demonstrate by evidences in our forthcoming works.

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Geometra papilionaria (Linnaeus, 1758) (Lepidoptera: Geometridae): a new species for the fauna of Greece

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Abstract. The first record of *Geometra papilionaria* L. from Greece is provided, extending the known area of the species in the Balkan Peninsula and raising the Geometrinae fauna of Greece to 18 species. A brief characterisation of the collecting site is also given. The voucher specimen is deposited in the Hungarian Natural History Museum, Budapest. With two figures.

Keywords. Geometrinae, new record, macchia shrubland, Balkan Peninsula, Hungarian Natural History Museum

INTRODUCTION

The emerald moth *Geometra papilionaria*, unlike its congeners, has a vast range in the cool temperate zone of the Palaearctic Region from its Pacific to the Atlantic coasts. In Europe, this species is distributed from the northernmost point of the Scandinavian Peninsula to the northern latitude of 39° in the Iberian and Italian Peninsulae, and to Southeastern Macedonia in the Balkan Peninsula (Hausmann 2001, Huemer *et al.* 2011). It can easily be distinguished from all other European geometrid moths by its large size and deep green ground-colour. The species primarily inhabits woodlands with birch or alder.

Exploration of the fauna of the Balkan Peninsula has a long history in Hungary. As early as the first half of the 19th century several Lepidoptera species were described by Hungarian scientists *e.g. Plebejus sephirus*, *Behounekia freyeri* or *Phragmatobia placida* (Frivaldszky 1835) and new faunistic data have been published in recent years as well (Tóth *et al.* 2013). Last but not least, it must be mentioned that the greatest monographer of the Lepidopteran fauna of Greece hitherto known is the late László Gozmány (1921–2006), former curator of the Hungarian Natural History Museum (see Gozmány 2012).

The aim of this publication is to provide the first record of *G. papilionaria* from Greece, thus continue the tradition of investigation the fauna of the Balkans.

MATERIAL AND METHODS

One male was collected at light by Hungarian coleopterists during an expedition to Greece. The specimen is pinned and mounted, deposited in the Hungarian Natural History Museum (HNHM), Budapest.

Material examined. 1 ♂: "GREECE, Makedonia, pref. Florina, 5 km E Kella macchia, 40°47' 53.23"N, 21°46'07.95"E, 635 m, at light, 26.VI. 2012, No. 7, leg. A. Kotán, A. Márkus, P. Nemes & T. Németh".

RESULTS AND DISCUSSION

The specimen (Fig. 1) was found during sorting out unidentified accession material in the HNHM. The wingspan and the date of collecting of the specimen fall within the mean range of these two variables. The shape and pattern of wings are also characteristic for this species (Hausmann 2001), hence genital dissection was considered to be unnecessary.

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Figure 1. Image of *Geometra papilionaria* L. from Greece.

Figure 2. Distribution of *G. papilionaria* in the Balkan Peninsula; grey dots are from Hausmann (2001) and Huemer *et al.* (2011), the new record from Greece is marked by black square.

The collecting site is situated at the southern foothills of the Kaimaktsalan Mountains, *ca.* 15 km south of the Greek-Macedonian border, close to Vegoritida Lake (Fig. 2). The habitat type is Mediterranean macchia shrubland, which is highly atypical for this species. The closest suitable habitats, *i.e.* montane beech forests or cool stream-valleys with alder, can be found several

kilometres away, therefore the specimen was likely showing dispersal behaviour. This phenomenon could rarely appear according to faunistic data of the HNHM collection.

As this species regularly comes to light, the method of collection is ordinary.

This record represents the southernmost locality of *G. papilionaria* in the Balkan Peninsula, raising the number of Geometrinae species occurring in Greece to 18.

Checklist of the subfamily Geometrinae in Greece. Taxa are listed in systematic order according to Hausmann (2001):

Aplasta ononaria (Fuessly, 1783)
Pseudoterpna pruinata (Hufnagel, 1767)
Pseudoterpna coronillaria cinerascens (Zeller, 1847)
Geometra papilionaria (Linnaeus, 1758); new record
Comibaena bajularia ([Denis & Schiffermüller], 1775)
Proteuchloris neriaria (Herrich-Schäffer, 1852)
Thetidia smaragdaria (Fabricius, 1787)
Hemistola chrysoprasaria (Esper, 1795)
Xenochlorodes olympiaria (Herrich-Schäffer, 1852)
Eucrostes indigenata (de Villers, 1789)
Jodis lactearia (Linnaeus, 1758)
Thalera fimbrialis (Scopoli, 1763)
Hemithea aestivaria (Hübner, 1789)
Chlorissa viridata (Linnaeus, 1758)
Chlorissa cloraria (Hübner, 1813)
Phaiogramma etruscaria (Zeller, 1849)
Phaiogramma faustinata (Millière, 1868)
Microloxia herbaria (Hübner, 1813)

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