



# A new species of *Nemoura* (Plecoptera: Nemouridae) from the Eastern Carpathians

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## RESEARCH ARTICLE

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## ABSTRACT

*Nemoura kozari* sp. n. is described on the basis of morphology of male adults collected in the Eastern Carpathians. The new species is classified as a member of the *Nemoura marginata* species group. It was found in medium elevations of the Krasna Mts, Ukraine, and the Rodna Mts, Romania, inhabiting slowly flowing, small brooks. New diagnosis of the *marginata* group and enumeration of its members are provided.

## KEYWORDS

*Nemoura kozari* sp. n., *Nemoura marginata* species group, Romania, Ukraine

## INTRODUCTION

The genus *Nemoura* Latreille, 1796 is a large and clearly paraphyletic assemblage of euholognathan stoneflies, distributed in the Holarctic and Oriental realms (Gamboa et al., 2019;

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Mo et al., 2020). Most West Palaearctic *Nemoura* belongs to the sensu stricto lineage, consisting of closely related morphological species groups and isolated species as well (Murányi, 2007; Mo et al., 2020). The species diversity is relatively evenly distributed within the subregions of the West Palaearctic, though most narrow endemics are restricted to mountainous regions (Graf et al., 2009; DeWalt et al., 2023). In regards of the Carpathians, the occurrence of 19 species is confirmed (Kis, 1974; Žiak, 2016). Four of these are Carpathian endemics and three are sub-endemics (Kis, 1974).

More than twenty years ago, a single male of an unknown *Nemoura* was found along a small open brook of the Krasna Mts, a medium high range of the Ukrainian Eastern Carpathians. Unfortunately, the epiproct of the specimen was lost during mounting, and no subsequent trip was taken to its hardly accessible habitat. Six years later, a second male specimen was found along a small forest brook at medium elevations of the Rodna Mts, Romania, about hundred kilometres far from the Krasna Mts. Collecting in various other localities of different elevations of the Rodna Mts yielded no further specimens. Due to the very limited material and the taxonomic problems around the *Nemoura marginata* species group, to which this new species belongs, we postponed its description. Recently, new species description and redescription of some *marginata* group members clarified morphological traits and limits within this complicated lineage (Vinçon and Ruffoni, 2021). Thus, herein we describe this East Carpathian *Nemoura* and give a new diagnosis of the *marginata* group, together with an enumeration of its members.

## MATERIAL AND METHODS

Specimens were collected by hand or beating sheet and stored in 75% ethanol. All materials were deposited in the Hungarian Natural History Museum, Budapest, Hungary (HNHM).

Figure 1 was made by a drawing tube mounted on a Nikon SMZ1500 microscope, and on the basis of photos taken by different microscopes. Figure 2 was made with a Keyence VHX 5000 digital microscope. To avoid destruction of the holotype male, terminalia was cleared in 10% KOH solution but the epiproct was not slide mounted.

Morphological terminology follows our previous Nemouridae papers (Murányi, 2007; Mo et al., 2020).

## RESULTS AND DISCUSSION

### *Nemoura kozari* sp. n. (Figs 1–3)

**Type material:** Holotype male: ROMANIA, Maramureş county, Rodna Mts, Săcel, forest brook above the Iza Spring, 1155 m a.s.l., N 47°34.830' E 24°32.108', leg. J. Béres, Cs. Csuzdi, J. Kontschán, D. Murányi, V. V. Pop, 20.v.2008 (HNHM: PLP2391). Paratype: UKRAINE, Zakarpatska region, Tyachivskiyi district, Krasna Mts, small, open spring and its outlet in the upper valley of Luzanka River, 1350 m a.s.l., N 48°22.971' E 23°45.039', leg. K. Balogh, B. Cser, D. Murányi, 19.v.2002: 1 male (HNHM: PLP926; epiproct lost).

**Diagnosis.** Small sized species of the *Nemoura marginata* group. Male: paraproct outer lobe with elongated, slightly bent tip; cercus distinctly bent and hairy, with large and erect apical



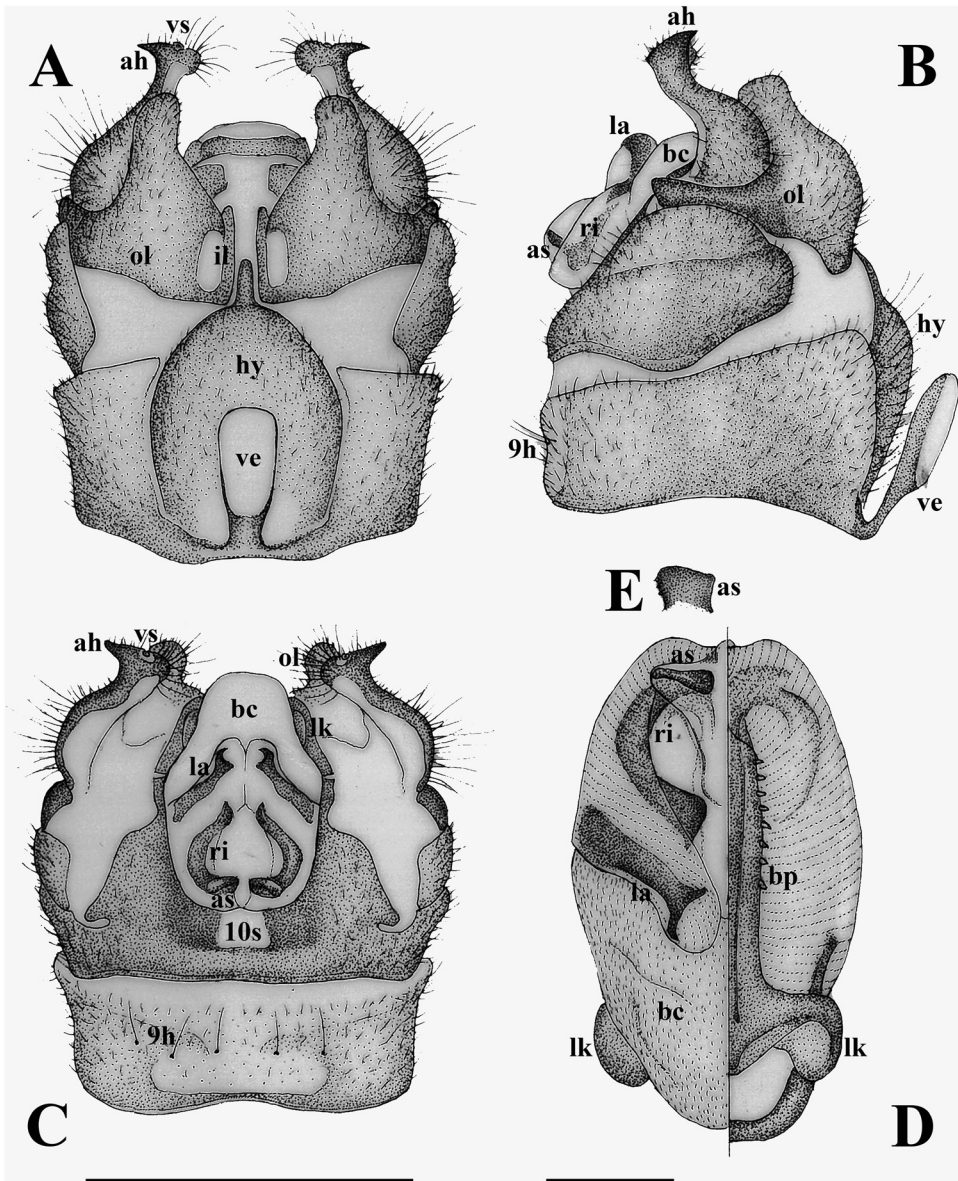


Fig. 1. Male terminalia of *Nemoura kozari* sp. n. — A: terminalia, ventral view; B: same, lateral view; C: same, dorsal view; D: epiproct, left side dorsal, right side ventral view; E: apical sclerite of epiproct, caudal view — Abbreviations: Sternum 9: hy (hypoproct), ve (vesicle); Paraproct: il (inner lobe), ol (outer lobe); Cercus: ah (apical hook), vs (vestigial second segment); Tergum 9: 9h (strong hairs); Tergum 10: 10s (medial spot); Epiproct: as (apical sclerite), bc (basal cushion), bp (spines of basal plate), la (lateral arm), lk (lateral knob), ri (ring) — scale 0.5 mm for Figs. A–C, 0.1 mm for Figs. D–E



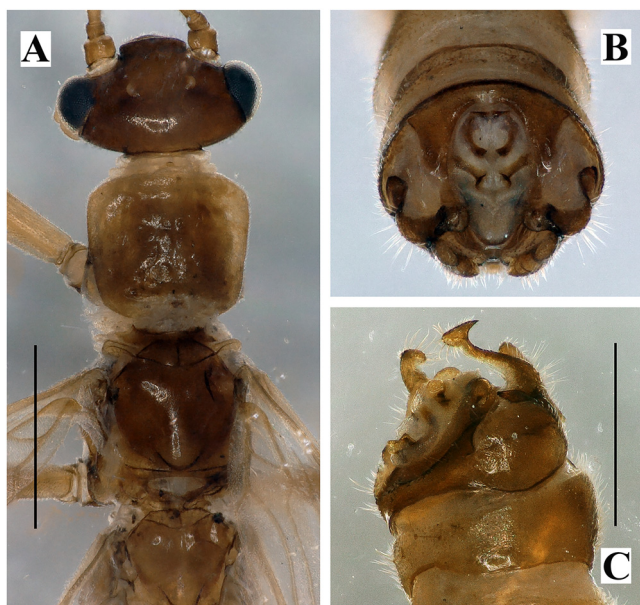


Fig. 2. Male morphology of *Nemoura kozari* sp. n. — A: head and thorax, dorsal view; B: terminalia, dorsocaudal view; C: same, dorsolateral view — scale 1 mm for Fig. A, 0.5 mm for Figs B-C

hook; epiproct with short and strong ring, apically widened lateral arms, large and plate-like apical sclerite that is rectangular in caudal view.

**Description.** Small sized species, macropterous. Forewing length: holotype male 5.2 mm, paratype male 5.8 mm. General colour brown, pilosity short and indistinct (Fig. 2A). Head brown with indistinct pattern, mouthparts and palpi yellowish, antennae light brown (Fig. 2A). Pronotum rectangular with rounded corners, wider than long, pale brown with indistinct rugosities (Fig. 2A). Meso- and metanotum brown, ventral aspect of thorax brown with whitish membranous portions (Fig. 2A). Legs pale brown, but apex of femora, basal half of tibiae and all tarsi darker. Wings hyaline, venation brown. Abdominal segments pale but terminalia brown to dark brown.

Male abdomen: Sternum 8 membranous with small, paired anterolateral sclerites. Hypoproct rounded, longer than wide, apical part very small and acute (Fig. 1A-B); vesicle spoon shaped, twice longer than wide (Fig. 1A-B). Paraproct inner lobe thin, half as long as outer lobe (Fig. 1A); the outer lobe is with convex inner margin and strongly curved outer margin, tip is elongated with apex blunt and slightly bent medially (Fig. 1A-B). Cercus long and with large apical hook (Fig. 1A-C, 2B-C); laterally well sclerotized, membranous in its inner portion and to the vestigial second segment; bent in lateral view (Fig. 1B), distinctly bent medially in dorsal and ventral views (Figs 1A-1C); apex reminds a chicken-head, with strong, nearly erect hook, and rounded, lightly sclerotized inner portion (Figs 1C, 2C); the whole cercus bears distinct, long hairs (Figs 1A, 1C, 2B). Terga 8-9 mostly membranous but with strong antecosta and light brown anterior and lateral sclerotized portions; tergum 9 with posteromedial row of 5-6 strong



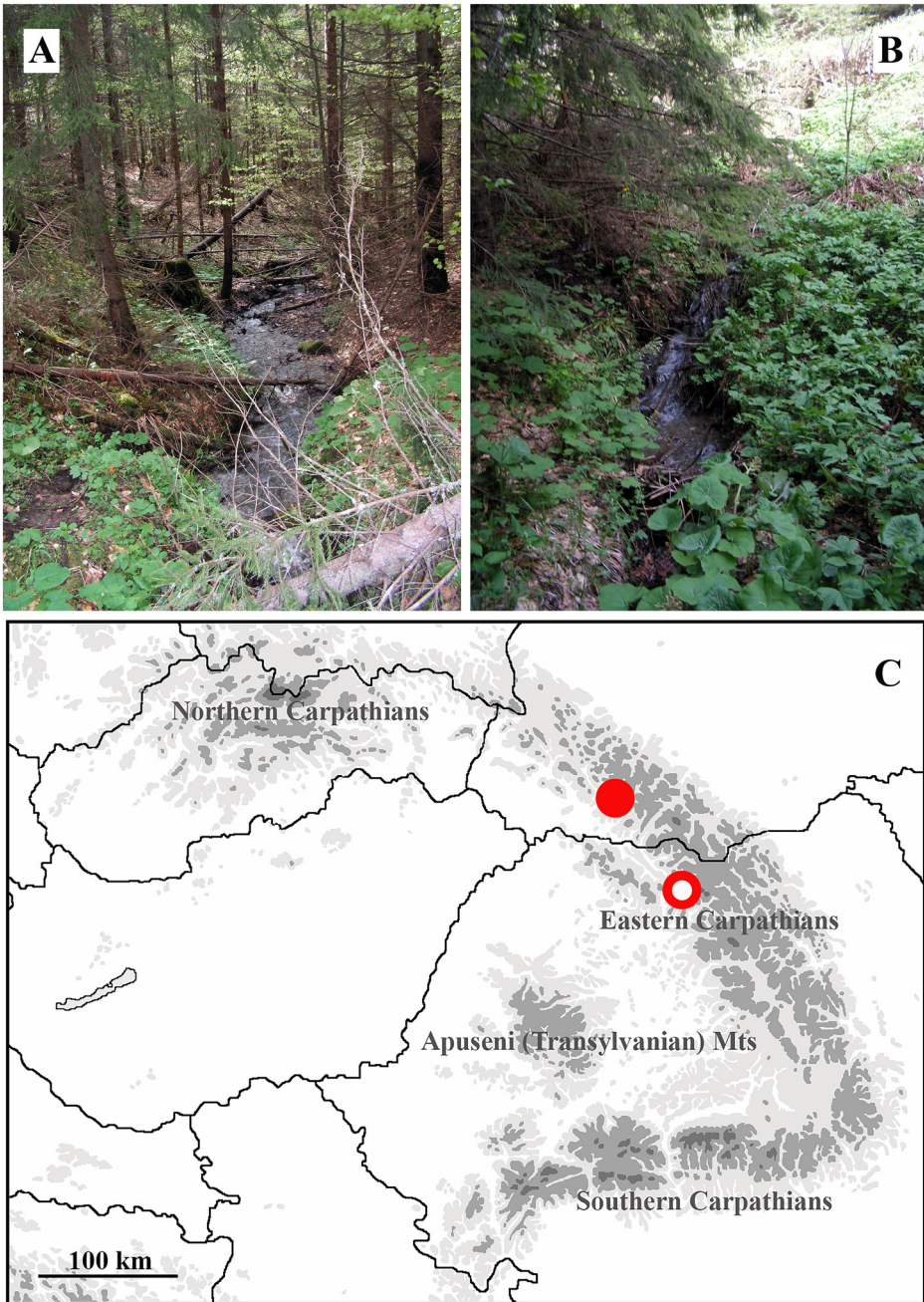


Fig. 3. Habitat and distribution of *Nemoura kozari* sp. n. — A: habitat of the holotype, downstream view; B: same, upstream view; C: distribution in the Carpathian Basin (red ring: locality of the holotype; red dot: locality of the paratype)



hairs (Figs 1C, 2B–C). Tergum 10 wide and strongly sclerotized, with a medial light spot under the tip of epiproct, lacking projections and distinct hairs (Figs 1C, 2B–C). Epiproct elongated elliptical, with large basal cushion, with short and strong ring and large, plate-like apical sclerite (Fig. 1B–E, 2B–C). Dorsal sclerite with large lateral arms, apically widened in half-moon shape (Fig. 1C–D–D, 2B). Ventral sclerite basally with pair of small lateral knobs, after the moderately broad base continued in a thin, elongated basal plate that bears rows of 7–8 small spines (Fig. 1D); ring of the ventral sclerite short but strong, regularly curved (Fig. 1C–D, 2B–C); apical sclerite erect, large and plate-like (Figs 1B, 1D–E), bears three or four very small lateral spines, rectangular in caudal view (Fig. 1E).

Female and larva: unknown.

**Affinities.** The new species can be assigned to the *Nemoura marginata* species group, according to the diagnosis of the group as discussed below. The nominal *N. marginata* Pictet (1836) can be easily distinguished from the new species on the basis of triangular paraproct outer lobe, straight cercus in lateral view, and much lower and wider apical sclerite of epiproct in caudal view (see Fig. 1k–m in Zwick, 1970; Figs 83A–D in Kis, 1974; Fig. 3 in Ravizza and Ravizza Dematteis, 1995; Figs on page 343 in Roesti, 2021). The more morphologically similar Carpathian species are *Nemoura flexuosa* Aubert (1949) and *Nemoura hamata* Kis, 1965. *Nemoura flexuosa* can be distinguished on the basis of less elongated tip of the paraproct outer lobe, stout cercus that is straight in lateral view, and the plate-like apical sclerite of epiproct that is rounded instead of rectangular (see Figs 1a–c in Zwick, 1970; Figs 85A–D in Kis, 1974; Fig. 2 in Ravizza and Ravizza Dematteis, 1995; Figs on page 341 in Roesti, 2021). *Nemoura hamata* differs by the triangular paraproct outer lobe, the large apical hook of cercus bent downwards, and the apical sclerite of epiproct is bilobed (see Figs 2–5 in Kis, 1965; Figs 91A–D in Kis, 1974).

**Ecology and distribution.** The species was found in the medium elevations of the Krasna Mts, Ukraine (paratype male), and the Rodna Mts, Romania (holotype male) (Fig. 3C). Both specimens were caught in the second half of May, along relatively slowly running, small brooks. The habitat in the Rodna Mts is a montane brook that flows in spruce forest, with dense riparian vegetation dominated by *Petasites hybridus* along sunny patches where spruce allows it (Figs 3A–B). The brook has a sandy-gravelly substrate and steep bank, with spruce twigs traversing. Besides the holotype, one male and three females of *Leuctra dalmoni* Vinçon and Murányi (2007) were caught, but the stream was not checked for larvae. The habitat in the Krasna Mts is similar in size, substrate and bank, but located in grassland on a steep slope, just above the forested gorge of a large montane stream. The spring and most of the investigated section of the brook is overhanged by tussocks of *Nardus stricta*. The paratype was the only adult stonefly collected, while pharate, ultimate and penultimate larvae and one exuviae of *Nemoura fusca* Kis, 1963 were collected from and nearby the water.

**Etymology.** The species is dedicated to our late colleague, Dr. Ferenc Kozár (1943–2013), renowned world specialist of scale insects. Used as the genitive of a noun of male gender.

### Delimitation and composition of the *Nemoura marginata* species group

The *marginata* group was first defined on the basis of the cercus armed with a single apical tooth by Aubert (1946). The assemblage he listed included many European species, some that later were transferred to subsequently defined morphological groups. Since then, some of the species closely related to *N. marginata* were treated as the *Nemoura flexuosa*-*marginata* complex (e.g.



Ravizza and Ravizza Dematteis, 1995), or briefly discussed as the *marginata* group (e.g. Zhiltzova, 2003; Murányi, 2007), but the group was not precisely defined. In the genus level revision of the Nemouridae, Baumann (1975) distinguished two species complexes within *Nemoura* but not treated the *marginata* group as a taxonomical or operational unit. Recently, Mo et al. (2020) pointed out, that the limits of *Nemoura* sensu stricto is hard to define morphologically, the paraphyletic *Nemoura* sensu lato requires erection of further genera, and that species groups within *Nemoura* are generally hard to define because of intermediate morphology of several species. However, *Nemoura* presently includes nearly 200 valid species (DeWalt et al., 2023), and species grouping is necessary for operational reasons, even if some of the groups will prove to be not true evolutionary lineages by future molecular studies. Thus, we propose to distinguish the *marginata* group on the basis of the following morphological characters: cercus with a single, distinct apical hook on the outer lateral portion (vestigial tooth may present on the inner lateral surface); ring of the epiproct's ventral sclerite short but strong, lacks apical lobes; apical sclerite of the epiproct erect in lateral view, at least as wide as the sclerite that is forming the ring, and always bear small, lateral spines. A distinct set of closely related species are distinguished as the *palliventris* subgroup, on the basis of presence of a plate-like expansion on the epiproct's apical sclerite.

The members of the *marginata* group of the present sense are listed, with their distribution and available descriptions, below:

*Nemoura apollo* Zwick (1978): Greece; known only from the original description.

*Nemoura braaschi* Joost (1970): Bulgaria; known only from the original description.

*Nemoura caspica* Aubert (1964): Iran; known only from the original description.

*Nemoura ceciliae* Aubert (1956b): Spain and Portugal; complementary described by Tierno de Figueroa et al. (2003).

*Nemoura confusa* Zwick (1970): France; complementary described by Ravizza and Ravizza Dematteis (1995).

*Nemoura erratica* Claassen (1936): Western Europe and Pyrenees, but not in the Alps; redescribed by Vinçon and Pardo (2003).

*Nemoura flexuosa* Aubert (1949): most of Europe but not in Iberia and the British Isles, extends to Anatolia; redescription by Zwick (1970), complementary descriptions e.g. in Kis (1974), Lillehammer (1974), Ravizza and Ravizza Dematteis (1995), Roesti (2021).

*Nemoura hamata* Kis, 1965: Romania; complementary described in Kis (1974).

*Nemoura marginata* Pictet (1836): Central Europe and the Balkans; redescription by Zwick (1970), complementary descriptions e.g. in Kis (1974), Ravizza and Ravizza Dematteis (1995), Roesti (2021).

*Nemoura minima* Aubert (1946): subendemic to the Alps, spreads to the western Balkans; complementary described e.g. in Kis (1974), Roesti (2021).

*Nemoura oropensis* Ravizza & Ravizza Dematteis (1980): Italy; known only from the original description.

*Nemoura pesarinii* Ravizza & Ravizza Dematteis (1979): Italy and Switzerland; complementary described by Roesti (2021).

*Nemoura pseudoerratica* Vinçon & Pardo (2003): France, Andorra and Spain; known only from the original description.

*Nemoura pygmaea* Braasch & Joost (1972): Bulgaria; known only from the original description.



*Nemoura rivorum* Ravizza & Ravizza Dematteis (1995): Italy and France; known only from the original description.

*Nemoura sabina* Fochetti & Vinçon (2009): Italy; known only from the original description.

*Nemoura undulata* Ris (1902): Alps; redescribed by Aubert (1950), complementary described in Roesti (2021).

*Nemoura wittmeri* Zwick (1975): Turkey; known only from the original description.

*palliventris* subgroup:

*Nemoura aprutiana* Vinçon & Ruffoni (2021): Italy; known from its recent description.

*Nemoura flaviscapa* Aubert (1956a): Greece; known only from the original description.

*Nemoura hesperiae* Consiglio (1960): Italy; recently redescribed by Vinçon and Ruffoni (2021).

*Nemoura lucana* Nicolai & Fochetti (1991): Italy; recently redescribed by Vinçon and Ruffoni (2021).

*Nemoura obtusa* Ris (1902): Alps, presence in the Carpathians needs confirmation; complementary description e.g. in Kis (1974), Roesti (2021).

*Nemoura palliventris* Aubert (1953): Italy, France and Switzerland; recently redescribed by Vinçon and Ruffoni (2021) and Roesti (2021).

*Nemoura vinconi* Murányi (2007): Albania; known only from the original description.

*Nemoura zwicki* Sivec (1980): Kosovo; known only from the original description.

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