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One problem less: the true identity of *Nemoura sahlbergi problematica* Zwick, 1973 (Plecoptera: Nemouridae)

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Abstract. By finding the epiproct slide preparation of the holotype of *Nemoura sahlbergi problematica* Zwick, 1973, which was considered to be lost, the identity of the taxon is resolved. It is raised to species rank, *Nemoura problematica* Zwick, 1973 **stat. nov.,** and *Nemoura jilinensis* Zhu & Yang, 2003 is considered as its junior synonym. The species is widespread in the Korean Peninsula, known also from NE China (Jilin Province) and the Russian Far East (Khabarovsk and Primorsky Krai). New Korean records are listed, its distribution is detailed and depicted on map. *Nemoura sahlbergi* Morton, 1896 is known from the Russian Far East but not from China and Korea.

Keywords. China, Korea, *Nemoura jilinensis* syn. nov**.**, *Nemoura problematica* comb. nov.*,* Russian Far East.

INTRODUCTION

The taxon *Nemoura sahlbergi problematica* Zwick, 1973 was described on the basis of a single male collected in the Kumgang Mts, North Korea. It was distinguished from the circumpolar *N. sahlbergi* Morton, 1896 by the different cercus and paraproct, while considered as its subspecies on the basis of similar epiproct, coloration and size (Zwick 1973). Later, several closely related Far Eastern *Nemoura* Latreille, 1796 species were described, and fine details of the epiproct proved to be essential in species distinction (Zwick 2010, Teslenko & Boumans 2018).

The holotype of *N. s. problematica* is deposited in the Hungarian Natural History Museum (HNHM) and still in good condition however, the epiproct was mounted on slide and was not found when the Korean *Nemoura* were comparatively studied a decade ago. Consequently, the taxon was regarded as a nomen dubium (Zwick 2010).

Accidentally, the epiproct slide of the holotype was found mixed in between Dermaptera slides in HNHM and so the true identity of this subspecies could be resolved. It proved to be conspecific with *N. jilinensis* Zhu & Yang, 2003, according to its complementary description by Zwick (2010). Thus, *N. sahlbergi problematica* is elevated to species rank and *N. jilinensis* is considered as its junior synonym. Its differences from *N. sahlbergi* and other related species are discussed below, and the distribution of the two species are summarized.

MATERIAL AND METHODS

The holotype specimen of *Nemoura sahlbergi problematica* is stored in ethanol in the Collection of Smaller Insect Orders, Department of Zoology, Hungarian Natural History Museum, Budapest, Hungary (HNHM); its epiproct is mounted on slide and kept in the same collection. Comparative Mongolian specimens of *N. sahlbergi* are kept in the same collection, with epiproct of two specimens mounted on slides. Recent South Korean materials of *N. problematica* were collected by Malaise traps or by hand, fixed in 80% ethanol, some of their terminalia were cleared in KOH. They are deposited in the collection of the Entomological Museum of Korea University,

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Seoul, Republic of Korea (KU), and the Department of Zoology, Eszterházy Károly Catholic University, Eger, Hungary (EKCU).

Slide preparation of epiproct of both species were made by Peter Zwick, mounted in Canada Balsam. Illustrations were made with the aid of a drawing tube applied on a Nikon SMZ1500 microscope, and a Keyence LHX5000 digital microscope. All images were adjusted and assembled into figures using Adobe Photoshop CC 2019. Terminology combine Zwick (2010) and Grubbs *et al.* (2018).

RESULTS AND DISCUSSION

Nemoura problematica Zwick, 1973 stat. nov.

(Figures 1, 3–7)

Nemoura sahlbergi problematica Zwick, 1973: 162. (original description of the male from North Korea, with figures on the male cercus and paraproct); Zwick 2010: 82. (considering as nomen dubium); Hwang & Murányi 2015: 121. (checklist).

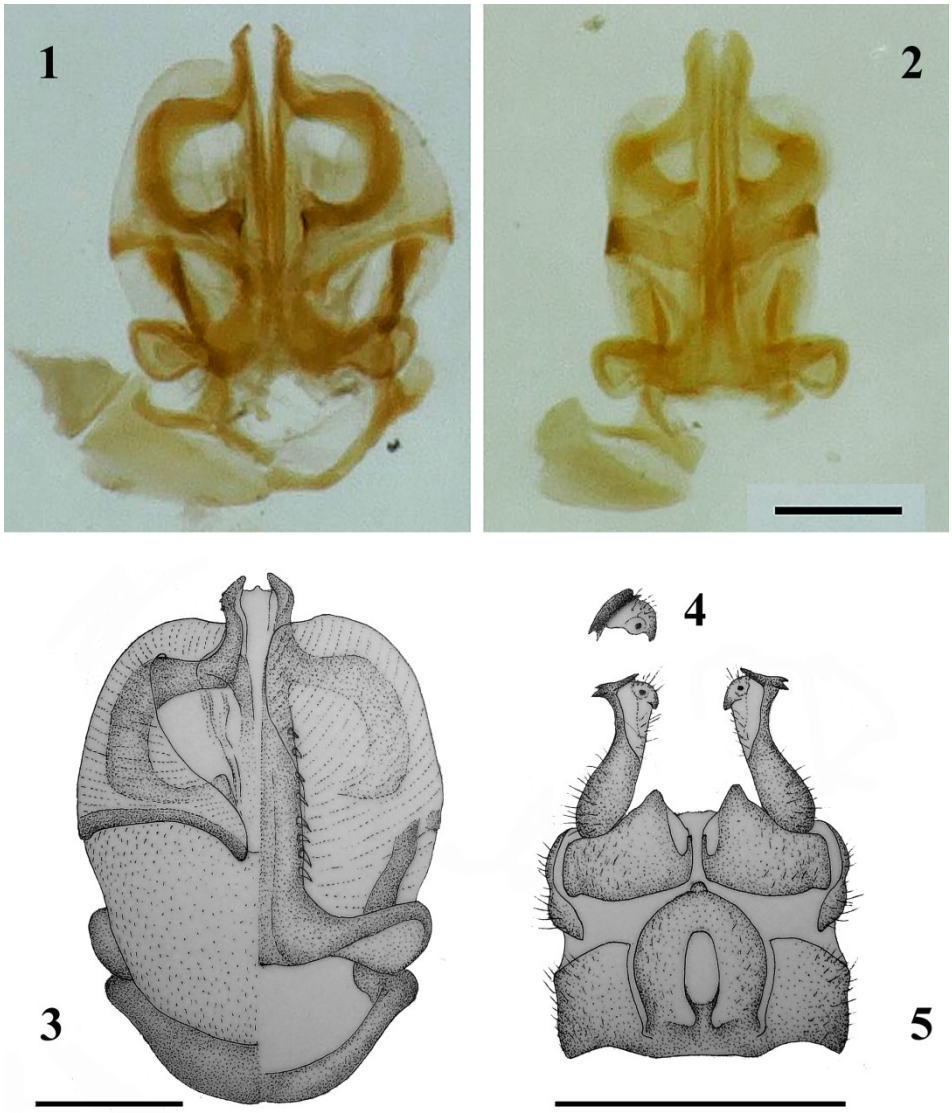
Nemoura sahlbergi Morton, 1896: Hwang & Murányi 2020: 47. (new record from South Korea).

Nemoura jilinensis Zhu & Yang, 2003: 474. (original description of the male and female from China, with figures on the male and female terminalia, male epiproct and paraproct); Zwick 2010: 83. (complementary description of the male from South Korea, with figures on the male epiproct and cercus head); Yang *et al.* 2015: 363. (monograph, repeating the original illustrations from Zhu & Yang 2003); Teslenko 2016: 580. (description of the larva, first records from Russian Far East); Yang & Li 2018: 19. (catalogue); Hwang & Murányi 2020: 47. (checklist); DeWalt *et al.* 2022 (catalogue). **Syn. nov.**

Material examined. **North Korea:** Kangwon Province, Kosong-gun, Kumgang Mts, Manmulsang Rock (locality No. 68), N38°43' E128°07', 30.v.1970, leg. Sándor Mahunka, Henrik Steinmann: holotype male (HNHM). **South Korea:** Bangtaesan Natural Recreation Forest, Bangdong-ri, Girin-myeon, Inje-gun, Gangwon-do, 16.viii. 2010, Malaise trap, leg. NIBR staff members: 1♂ 1♀(?) (HNHM); Saem Spring beneath Sangwonsa, Chiaksan National Park, Seongnam-ri, Sillim-myeon, Wonju-si, Gangwon-do, 1025m, N37° 18.284', E128°03.262' 14.v.2016, leg. Jeong Mi Hwang, Dávid Murányi: 1♂ 1♀, 1 larva (EKCU), 1♂ (KU); Bangtaesan Natural Recreation Forest, Bangdong-ri, Girin-myeon, Inje-gun, Gangwon-do, 690m, N37°54'29.57" E128°24'25.14", 11.v.–21.vi.2019, Malaise trap, leg. Daseul Ham, Sunghwan Park: 1♂ 1♀(?) (KU); Sangwon-sa Temple, Chiaksan National Park, Seongnam-ri, Sillim-myeon, Wonju-si, Gangwon-do, 588m, N37°17'38.08" E128°04'09.01", 29.v.2020, leg. Jeong Mi Hwang, Ji Hyoun Kang, Daseul Ham, Sunghwan Park: 1♂ (KU); same locality and collectors, 29.v.–04.vii.2020, Malaise trap: 19♂ 21♀(?) (KU); Gariwangsan Natural Recreation Forest in Hoedong-ri, Jeongseon-eup, Jeongseon-gun, Gangwon-do, 750m, N37°24'35.51" E128° 32'03.10", 26.v.–20.vi.2020, Malaise trap, leg. Jeong Mi Hwang, Ji Hyoun Kang, Daseul Ham, Sunghwan Park: 1♂ 2♀(?) (KU); Mireukam Temple, Odaesan National Park, Odaesan-ro, Jinbu-myeon, Pyeongchang-gun, Gangwon-do, 1296 m, N37°48'12.82", E128°34'03.02", 1.v.–29.v. 2020, Malaise trap, leg. Jeong Mi Hwang, Ji Hyoun Kang, Daseul Ham, Sunghwan Park: 19♂ 17♀(?) (KU); same locality and collectors, 23.vi.–28.vii.2020, Malaise trap: 119♂ 89♀(?) (KU); same locality and collectors, 24.vi.–28.vii.2020, Malaise trap: 1♂ 3♀(?) (KU); Sobaeksan National Park, Gyochon-ri, Punggi-eup, Yeongju-si, Gyeongsangbuk-do, the Korea National Park Research Institute staff members: 2014-IX-22: 3♂ (KU), same locality and collectors, 2015-IV-26, 2♂ 2♀ (KU).

Diagnosis. Male: Epiproct rhomboid, as long as wide; apical sclerite long and thin but distinctly shorter than the ring (looped sclerite); tip of the apical sclerite conical and bent inwards, armed with wrinkles and very small teeth. Cercus lacks big accessory (outer) spine, apex with small inner and longer, usually double outer teeth; in caudal view, the apical teeth connected with straight edge above vestigial segment; inner tip of apical membranous portion down hanging, darkly pigmented. Paraproct outer lobe triangular, pointed or slightly excised. Female: usual for the group, lacks distinctive character. Larva: see Teslenko (2016).

Remarks. Variability consists of the number of outer apical teeth of the cercus and the tip of the



Figures 1–5. *Nemoura problematica* Zwick, 1973 **stat. nov.** holotype male (1, 3–5) and *Nemoura sahlbergi* Morton, 1896 male from Mongolia (2). 1 = epiproct, mounted on slide; 2 = same; 3 = epiproct, left dorsal, right ventral view; 4 = tip of left cercus, caudal view; 5 = terminalia, ventral view. Scales 0.1 mm for Figs. 1–3, 1 mm for Figs. 4–5.

paraproct outer lobe. The holotype has double teeth on both cerci and the paraproct is pointed. Some South Korean specimens has single outer teeth, as shown on fig. 19 in Zwick (2010). The holotype of *N. jilinensis* supposedly bear two teeth, according to fig. 3 in Zhu & Yang (2003). The paraproct is described as excised by Zwick (2010) for his South Korean specimens, and so for the holotype of *N. jilinensis* (figs. 2, 5 in Zhu & Yang (2003)). Some of our South Korean specimens have slightly excised tip of the paraproct, but never to the extent as illustrated by Zhu & Yang (2003).

Affinities. The species belongs to a northern Holarctic lineage of *Nemoura* that can be characterized by straight and long, upward and forward directed apical sclerite of the epiproct and at least two apical spines on the long cerci. Two species are recently considered as circumpolar Holarctic (Grubbs *et al.* 2018): *N. arctica* Esben-Petersen, 1910 and *N. sahlbergi.* However, Teslenko &

Boumans (2018) considered *N. arctica* as a species complex. A further species seems to be restricted to northern Scandinavia (*N. viki* Lillehammer, 1972a), three to Inner Asia (Pamir-Alay range: *N. alaica* Zhiltzova, 1976; Altai-Sayan range: *N. dulkeiti* Zapekina-Dulkeit, 1975; Mongolia: unnamed species sensu Judson & Nelson (2012)), one is known from east Mongolia to the Russian Far East (*N. nigrodentata* Zhiltzova, 1980), two are known only from the Russian Far East (*N. sirotskii* Teslenko, 2018 (in: Teslenko & Boumans 2018) and *N. lazoensis* Zwick, 2010). Besides the more widespread *N. problematica,* two species are known only from South Korea: *N. gemma* Ham & Lee, 1998 and *N. rugosa* Zwick, 2010. Finally, *N. hikosan* Shimizu, 2016 and an unnamed species sensu Shimizu *et al.* 2005 are known from the Japanese isles Honshu, Shikoku and Kyushu. The male of *N. problematica* can be distinguished from all of these congeners on the basis of character combination: epiproct's apical sclerite long and thin, tip conical and bent inwards; cercus lacks big accessory (outer) spine; in caudal view, the apical teeth connected with straight edge above vestigial segment, and inner tip of apical membranous portion darkly pigmented; paraproct outer lobe triangular. The female is presently indistinguishable; description of Teslenko (2016) can be consulted for the larval characters.

Distribution and ecology. In the Russian Far East, the species was found at several forests springs and streams on the western slopes of the Sikhote-Alin range (Khor-Ussuri-Amur basin) and the southernmost RFE territories on the Black Mountains eastern slopes (northern part of the Changbai (Baekdu) range) (Teslenko 2016; under the name *N. jilinensis*). Mature nymphs appear from May to July, both in fast and slow water flows with stony or gravely substrate (Teslenko 2016). The only Chinese record consists of the type series of *N. jilinensis* (one male and one female), collected in early August in Hunjiang, Jilin Province (western slope of the Changbai (Baekdu) range); no additional data were detailed (Zhu & Yang 2003). The only known North Korean specimen is the holotype, collected during late May in the Kumgang Mts, northern portion of the Thebaek range (Zwick 1973). The specimen was caught along a roadside in a stream valley (Mahunka & Steinmann 1971). The first South Korean specimens were reported from both the Thebaek and Sobaek ranges (Gangwon and South Gyeongsang Provinces), collected by Malaise traps in different forests during late May and June (Zwick 2010). The second South Korean report is from the Thebaek range, from North Gyeongsang Province (Hwang & Murányi 2020; under the name *N. sahlbergi*). All of our recent materials are from the Thebaek range (Gangwon and North Gyeongsang Provinces), collected along springs and small forest streams from early May to late August, with most of the adults caught in late June. It was far the most common *Nemoura* at the collecting sites, usually caught together with other congeners.

***Nemoura sahlbergi* Morton, 1896**

(Figures 2, 6)

Nemoura sahlbergi Morton, 1896: Grubbs *et al.* 2018: 52. (for complete synonymy).

Material examined. **Mongolia:** Several specimens from different localities as enumerated in Raušer (1968) (HNHM).

Diagnosis. Male: Epiproct rhomboid, slightly longer than wide; apical sclerite long and thin, as long or longer than the ring (looped sclerite); tip of the apical sclerite blunt and not bent inwards, armed with wrinkles and very small teeth. Cercus with big accessory (outer) spine, apex with variable inner and outer teeth; in caudal view, the apical teeth connected with edge curved around vestigial segment; apical membranous portion not produced. Paraproct outer lobe truncate. Female: usual for the group, lacks distinctive character. Larva: see Lillehammer (1972b).

Distribution. Grubbs *et al.* (2018) recently discussed the Holarctic circumpolar distribution of the species. However, regarding to its European distribution, Teslenko & Boumans (2018) noted that occurrence in Latvia was erroneously

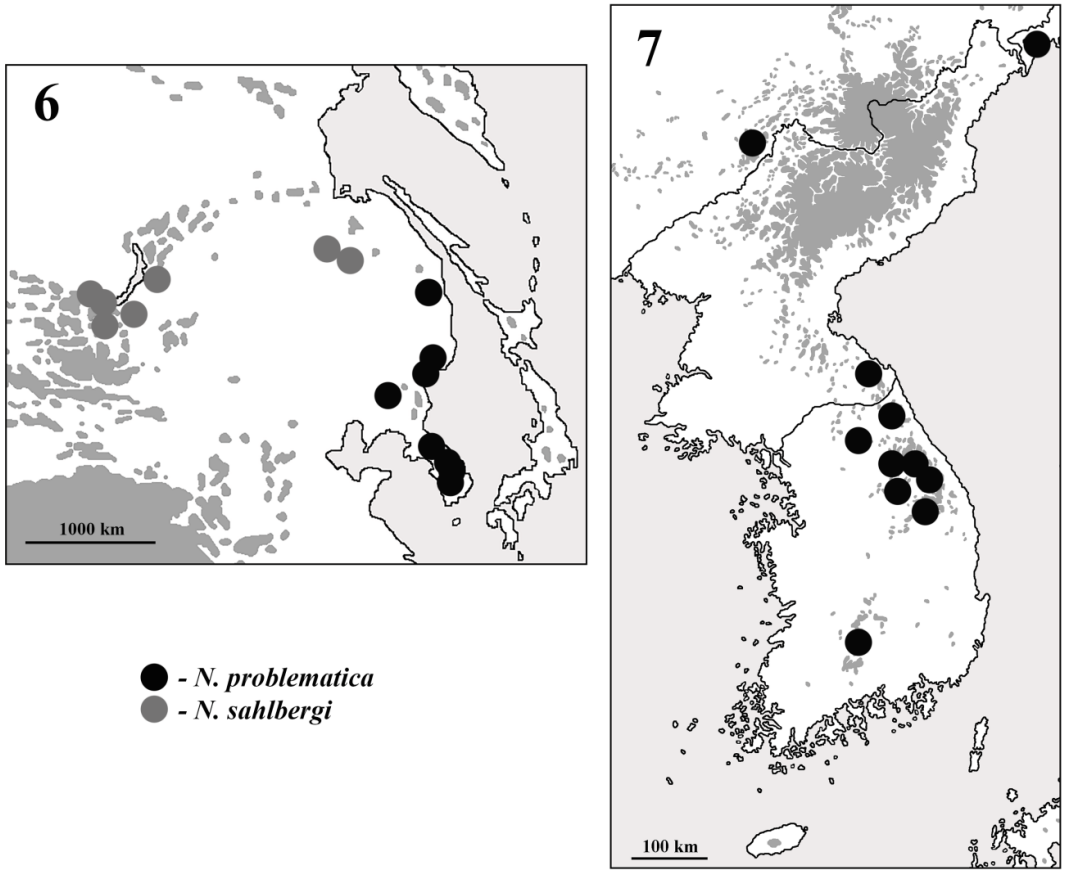


Figure 6–7. Distribution of *Nemoura problematica* Zwick, 1973 **stat. nov.**, and the Asian distribution of *Nemoura sahlbergi* Morton, 1896. 1 = East Asia; 2 = Korean Peninsula. Grey areas are above 2000 meters on Fig. 6, 1000 meters on Fig. 7.

reported. In Asia, occurrence of *N. sahlbergi* is confirmed from northern Mongolia (Judson & Nelson 2012) and southern Siberia of Russia (Zhiltzova 2003), with the easternmost records known from the Zeya River and Bureya River basins, Amur Oblast (Teslenko 2014). It was not yet reported from China. Our South Korean record (Hwang & Murányi 2020) refers to *N. problematica*.

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