First record of *Parochlus kiefferi* (Garrett, 1925) in a sediment sequence from a Slovak mountain lake with notes on paleolimnological interpretation

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Abstract

Subfossil larval remains of a rare Podonominae, *Parochlus kiefferi* (Garrett, 1925), were identified in a sediment sequence from a mountain lake in the Low Tatra Mountains, Slovakia, and represent the first record of the species for Slovakia. The depth at which the *P. kiefferi* remains were found, along with the taxonomic composition of the corresponding chironomid assemblage dominated by cold-stenothermal taxa, indicate that the sample can be dated back to the Little Ice Age. Additionally, notes on the chironomid remains which appear in the sediment sample are provided here and can offer further insight into paleolimnological interpretation.

Podonominae in a nutshell

The subfamily Podonominae, whose species are generally considered rheophilic, cold-tolerant and polyoxybiontic, is noted for its patchy distribution and a marked bipolarity (Brundin 1966). Most genera occur in the higher latitude regions of the southern hemisphere, with a smaller number of taxa present in the northern hemisphere. Within the Podonominae subfamily, the species-rich *Parochlus* genus shows the widest distribution. *Parochlus* species are largely concentrated in the southern hemisphere, and only one, *Parochlus kiefferi* (Garrett, 1925), is present in the Holarctic region (Brundin 1966). In Europe, it is mostly confined to its northern, and central parts (Sæther and Spies 2004, Brooks et al. 2007). The larvae are easily recognisable due to the unique mentum shape, which consists of one median tooth and seven lateral teeth, where the third laterals are nearly as tall as the median tooth, first and second laterals are short, with the first partially fused to the median tooth; the remaining lateral teeth of the mentum gradually decrease in size. Mandibles of *P. kiefferi* have five inner teeth, and their ventromental plates are weakly developed (Brooks et al. 2007). Here, the first record of *P. kiefferi* in Slovakia, in a lake sediment sequence from a mountain lake, is presented.

Studied material

Lake Vrbické pleso (48°58'12.6"N, 19°34'38"E) (Fig. 1) is a permanent, moraine-dammed mountain lake of glacial origin, situated at 1113 m a.s.l. in the Demänovská dolina valley in the Low Tatra Mountains, central Slovakia. With a surface area of 0.73 ha and a maximum recorded depth of 8 m, it is the largest natural lake in the Low Tatras. Vrbické pleso is fed by groundwater, and it does not have surface water inflow other than from snowmelt and rainwater. The lake is currently surrounded by a Norway spruce (*Picea abies*) forest, following an artificial reforestation of the area in the 19th century. The primeval fir (*Abies alba*) forest was deforested, beginning in the 15th century onward (Hronček 2015). Presently, lake Vrbické pleso and the surrounding valley are large-scale tourist destinations.

The lake was sampled on 5 November 2021, using a Kajak gravity corer. A short sediment core, measuring 49 cm, was taken at a depth of 5.5 m and then subsampled on site into 0.5 cm wide sections. For chironomid analysis, 23 samples spread out evenly along the core were picked and subsequently washed with distilled water on a 50 µm - mesh sieve. Using a Motic SMZ-171 stereoscopic microscope (10–40× magnification), a minimum of 50 larval head capsules per sample were collected. Head capsules were then mounted on permanent slides using Berlese mounting medium. Chironomid remains were identified to the lowest possible taxonomic rank on a Nikon Eclipse LV100N POL compound microscope (100–500× magnification), according to Brooks et al. (2007) and Andersen et al. (2013). The microscope slides are deposited at the Department of Biology and Ecology, Matej Bel University, Banská Bystrica, Slovakia.

Figure 1. View of lake Vrbické pleso. Photo: Ladislav Hamerlík.

Parochlus kiefferi occurrence and distribution

One of the analysed sediment core samples, from the depth of 42–42.5 cm, contained a particularly interesting find - that of the larval head capsule of a podonomine, *Parochlus kiefferi* (Fig. 2). This species was identified only in the aforementioned subsample, and not found in others. In the past, *P. kiefferi* has been recorded in the neighbouring Czech Republic, Poland and Austria (Sæther and Spies 2004, Syrovátka and Langton 2015). However, this finding represents the first record of the species in Slovakia, either in recent benthic fauna (Sæther and Spies 2004), or in lake sediment samples from paleolimnological studies (P. Bitušík, personal communication). Though it is not possible to identify the larval remains to species level, *P. kiefferi* is the only species of the genus known in Europe (Brundin 1966), therefore, the larval remains can confidently be attributed to *P. kiefferi*. It is a cold-stenothermal species which usually requires a constant flow of water, and so is typical of springs and fast-flowing brooks, streams and rivers (Brooks et al. 2007, Moller Pillot 2013 and references therein). However, *P. kiefferi* has also been found among mosses in a high-altitude glacial pond in the Italian Alps (Lencioni et al. 2009) and in cool Icelandic lakes (Brooks et al. 2007 and references therein). *P. kiefferi* is seemingly never abundant in the localities where it has been recorded, and is quite rarely found in lake sediments (Brooks et al. 2007, Hayford 2012 and references therein).

Including *P. kiefferi*, a total of 66 head capsules were found in the sample, and 19 chironomid taxa were identified, belonging to six subfamilies: Podonominae, Tanypodinae, Diamesinae, Prodiamesinae, Orthocladiinae and Chironominae, including the two tribes of Chironomini and Tanytarsini. The chironomid assemblage was dominated by the Tanytarsini, with *Tanytarsus lugens*-type making up 42% of all identified head capsules, followed by the Orthocladiinae, notably *Psectrocladius psilopterus*-type and *Limnophyes/Paralimnophyes* sp.; however, most orthoclad taxa were present in low abundances. A full list of all chironomid taxa recorded in the sediment sample, along with their relative abundances, is shown in Table 1.

Several other taxa like *P. kiefferi* were recorded in the sample, such as the similarly cold-stenothermal and rheophilic *Prodiamesa* sp. and *Pseudodiamesa* sp., although the latter genus can also be found in cold lakes and ponds. Additionally, the cold-stenothermal *Derotanypus* sp., *Paratanytarsus austriacus*-type and *T. lugens*-type, as well as the rheophilic *Chaetocladius piger*-type, and *Rheocricotopus effusus*-type were identified. Generally, the chironomid assemblage of the lake sediment sample is indicative of cold, oligotrophic conditions, and of the presence of an increased water flow. The sediment sequence has not yet

Figure 2. Detail of the head capsule of *Parochlus kiefferi* found in lake Vrbické pleso. Photo: Martina Jambrović.

Table 1. Relative abundances of all chironomid taxa identified from the 42–42.5 cm depth sample from the lake Vrbické pleso short sediment core.

Taxon	Relative abundance [%]
Podonominae	
Parochlus kiefferi (Garrett, 1925)	1.5
Tanypodinae	
Derotanypus sp.	4.5
Zavrelimyia sp.	7.6
Diamesinae	
Pseudodiamesa sp.	1.5
Prodiamesinae	
Prodiamesa sp.	1.5
Orthocladiinae	
Chaetocladius piger-type	1.5
Corynoneura lobata-type	1.5
Heterotrissocladius marcidus-type	3.0
Limnophyes/Paralimnophyes sp.	4.5
Orthocladius/Cricotopus sp.	1.5
Orthocladius (*Euorthocladius*) sp.	4.5
Psectrocladius psilopterus-type	6.1
Rheocricotopus effusus-type	1.5
Orthocladiinae indet.	3.0
Chironominae - tribe Chironomini	
Microtendipes pedellus-type	1.5
Chironominae - tribe Tanytarsini	
Micropsectra sp.	1.5
Paratanytarsus austriacus-type	1.5
Paratanytarsus sp.	3.0
Tanytarsus lugens-type	42.4
Tanytarsus pallidicornis-type	1.5
Tanytarsini indet.	4.5

been dated. However, owing to the depth of the sample within the sequence, and its comparison with other sequences from the Tatra Mountains (Stoklasa et al. 2017), we assume that the *P. kiefferi* head capsule can be dated back to the Little Ice Age.

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