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Taxonomy & Inventories

Mayfly *Ephemera glaucops* (Ephemeroptera, Ephemeridae) recorded in the Czech Republic after almost a century

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Abstract

Background

The mayfly *Ephemera* (*Sinephemera*) *glaucops* Pictet, 1843 has been considered regionally extinct in the Czech Republic, with the last occurrence dating from 1933. Its extinction was connected with the anthropogenic changes of lowland rivers, forming the original habitat of *E. glaucops* within the area of the Czech Republic. However, the species has been reported as spreading in man-made, often post-industrial waterbodies in Germany, The Netherlands and Austria since the 1970s.

New information

We report *E. glaucops* from the Czech Republic, based on 27 larvae collected in the North Bohemia lignite basin in 2018. All individuals were found at one locality – a small kaolin pit in the shallow part near the shore, mostly without macrophytes. We provide details about the locality and morphological diagnostic characters of *E. glaucops*. This study highlights

the importance of post-industrial sites for aquatic biodiversity as surrogate biotopes for degraded original habitats.

Keywords

aquatic insects, distribution, faunistics, mayflies

Introduction

The mayfly (Ephemeroptera) assemblages have been affected by profound anthropogenic changes of freshwater habitats over the last century, which often resulted in local or regional species loss (e.g. Malmquist and Rundle 2002). Human activities concentrated mainly on large lowland rivers and their floodplains, with local fauna suffering the most significant changes in species composition and local extinctions (Soldán et al. 2017). One of the species originally inhabiting large rivers in the Czech Republic was *Ephemera glaucops* (family Ephemeridae). It disappeared from the territory of the Czech Republic early in the 20th century, with the finding from the Elbe River published by Pawlik (1933) being the last reliable record (Soldán et al. 1998, Soldán et al. 2017). This species is listed as regionally extinct in the current Red List of Threatened Species of the Czech Republic (Soldán et al. 2017).

Geographically, the species is relatively widespread; its distributional range covers large part of Europe from Sweden in the north to Spain and North Africa in the south-west and Ukraine, Romania, Serbia and possibly Greece in the south-east. The type locality is specified as Genthod, near Geneva, based on four syntypes deposited in the Natural History Museum of Geneva (Sartori and Bauernfeind 2020). Nevertheless, *E. glaucops* is generally rare with fragmentary distribution (Bauernfeind and Soldán 2012). It has been recorded from epipotamal rivers, oligotrophic or mesotrophic lakes with gravel substrate (such as Lac de Genève, Lac d'Annecy, Lago di Garda, Lac des Quatre-Cantons and Lac de Constance), but also from different man-made waterbodies (Jacob et al. 1975, Studemann et al. 1992). In Central Europe, its recent focal habitats are man-made oligotrophic waterbodies, especially originating from different types of surface mining (e.g. Jacob et al. 1975, Braasch and Mey 1977, Haybach and Fischer 1994, Hutter and Graf 1994, Zahn 2003, Koese 2008).

Apart from *E. glaucops*, three species of the genus *Ephemera* have been recorded in the territory of the Czech Republic, namely *Ephemera* (*Ephemera*) *danica* Müller, 1764, *Ephemera* (*Ephemera*) *lineata* Eaton, 1870 and *Ephemera* (*Ephemera*) *vulgata* Linnaeus, 1758. Two of these species, *E. vulgata* and *E. danica* are common, whereas *E. lineata* is very rare and considered endangered (Zahrádková et al. 2009, Soldán et al. 2017).

Recently, we conducted an extensive survey of freshwater invertebrates in northern and eastern Bohemia and identified *E. glaucops* in one of the localities studied. The goal of the present paper is to report on the occurrence of *E. glaucops* in the Czech Republic, to

provide characteristics of its habitat and to summarise the diagnostic characters of *E. glaucops* from other *Ephemera* species occurring in the Czech Republic.

Materials and methods

In 2018–2019, we surveyed altogether 20 different types of freshwater post-industrial sites, such as mining subsidence, sandpits, ash lagoons, quarries and kaolin pits in northern and eastern Bohemia. The localities were visited three times (in summer, autumn and spring). At each locality, we selected three sites of different microhabitats and sampled them by standardised methods: box trap and time standardised (5 min/site) sweeping with a kitchen strainer to maximise species capture (Klečka and Boukal 2014). We also measured physico-chemical parameters of water with a portable YSI multimeter (type 556 MPS), substrate pH with Eutech probe, equipped with an Orion 9103BNWP electrode and water transparency with the Sneller tube.

Taxon treatment

Ephemera (*Sinephemera*) *glaucops* Pictet, 1843

Nomenclature

Ephemera glaucops Pictet, 1843; Hist. nat. gen. part. Ins. Névropt., p. 132

Ephemera (*Sinephemera*) *glaucops* Pictet, 1843 in Kluge (2004)

Ephemera (*Sinephemera*) *glaucops* Pictet, 1843 in Bauernfeind and Soldán (2012)

Taxon discussion

See general Discussion below.

Analysis

A total of 27 larvae of *E. glaucops* were collected in a single locality, a kaolin pit near the village of Hudcov (Fig. 1, locality code: 5348d; the code corresponds with the number of the Czech faunistic grid mapping system), 50°37'14.67"N, 13°46'30.12"E, 217 m a.s.l., 11–14.vii. 2018 (24 larvae), 21–22.ix.2018, (3 larvae). All sampling sites were located at a mean distance of 65 cm from the shore at a depth of 20.5 cm. The kaolin pit is located in the agricultural landscape, surrounded by crop fields, partly meadows and forest. The substrate was a mixture of kaolin clay, stones, sand and organic silt, mostly with open water or very sparse vegetation (*Phragmites australis*, roots of the terrestrial vegetation). The measured mean values of physico-chemical parameters in the sites, where *E. glaucops* was found, were as follows: temperature 21.6°C, conductivity 1000.5 $\mu S.cm^{-1}$, pH 8.58, dissolved oxygen 9.47 $mg.l^{-1}$, substrate pH 6.7 and water transparency 37.7 cm.

Fish, namely native *Anguilla anguilla*, *Rutilus rutilus*, *Cyprinus carpio* and non-native *Pseurodasbora parva*, were observed at the locality (Kolar et al., unpublished). Most individuals (26) were sampled with a boxtrap and only one individual was collected by sweeping with a strainer.

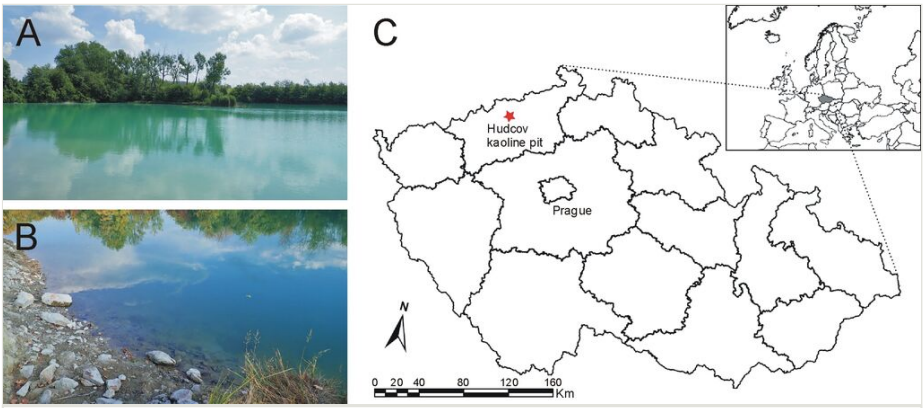

Figure 1. doi

Overview on the locality Hudcov kaoline pit (A), focused view on one of the sampled sites (B) and map of the Czech Republic with marked locality where *Ephemera glaucops* was recorded (C).

The material was preserved in denaturised ethanol (EtOH) and identified using the keys of Bauernfeind and Humpesch (2001) and Eiseler (2005). Photographs were taken using a Canon EOS1200D camera with a macro lens Canon MP-E 65 mm, attached to WeMacro Rail. All photographs were then stacked in Helicon Focus 6.3 and enhanced with Adobe Photoshop CS5. The material is housed in the collection of the Biology Centre CAS, Institute of Entomology (IECA).

Discussion

Species identification

From all three remaining species of *Ephemera* distributed in the Czech Republic, the larvae of *E. glaucops* can be distinguished by the colouration of the abdomen (terga VII–IX with two pairs of relatively narrow stripes, median pair less pronounced and terga II–VI with one pair of indistinct dark markings, Fig. 2). The shape of the fore-tibiae with apical protuberance (Fig. 3c) is also characteristic. However, this protuberance is sometimes reported as poorly developed and more easily observable from the dorsal view, since it bends slightly outwards (Wagner, pers. comm.). The number of prominent setae on pedicel is given as 2–3 (Bauernfeind and Humpesch 2001, Bauernfeind and Soldán 2012), which corresponds with our specimens. Apart from the colouration and shape of the fore-tibiae, this character can be used to distinguish the species from co-occurring *E. vulgata* with 4–9 setae (Bauernfeind and Humpesch 2001). In our samples from northern Bohemia, *E.*

glaucops is also distinguishable from *E. vulgata* by smaller size (the last-instar larvae 13.5–14.5 mm long in *E. glaucops*, compared to 20–21 mm in *E. vulgata*). In our specimens of *E. glaucops*, we also noted a characteristic shape of clypeus, with strongly divergent lateral margins (Fig. 3a). This character was not used in recent identification keys and might be a subject of variability.

Figure 2. doi

Habitus of *Ephemera glaucops*. Scale: 2 mm.

Habitat properties and species distribution

Of the total 20 post-industrial freshwater localities investigated in the area of northern and eastern Bohemia, *E. glaucops* was recorded only in the locality "kaolin pit Hudcov". Other mayfly species co-occurring in the same locality include related burrowing *Ephemera* (*Ephemera*) *vulgata* Linnaeus, 1758, walking/sprawling species *Caenis luctuosa* (Burmeister, 1839) and *Caenis horaria* (Linnaeus, 1758) and fish-like active species *Cloeon* (*Cloeon*) *dipterum* (Linnaeus, 1761) s.l. and *Cloeon* (*Similicloeon*) *simile* Eaton, 1870 s.l.; they are all very common in the Czech mayfly fauna (Zahrádková et al. 2009).

Overall scarce historical records of *E. glaucops* from the Czech Republic were limited to lowland rivers in north-west Bohemia: Ohře (Eger) River near Cheb (Dalla-Torre 1878), Berounka River in Nová Huť (coll. Klapálek, National Museum, Prague, R. Godunko rev.) and Labe (Elbe) River near Ústí nad Labem (Pawlik 1933). The finding of the species in the kaolin pit is consistent with numerous recent records from Germany, The Netherlands and Austria, documenting the colonisation of artificial habitats, such as lakes and ponds in open-pit lignite mines and sand and gravel pits (Jacob et al. 1975, Braasch and Mey 1977, Haybach and Fischer 1994, Hutter and Graf 1994, Zahn 2003). These habitats were often in the early successional stage, without macrophytes and with high water transparency (Haybach and Fischer 1994, Hutter and Graf 1994, Zahn 2003). Larvae dwelled in shallow gravel-sand littoral zone, freely burrowing in the sediment (without burrowing of tubes) (Haybach and Fischer 1994). It seems larvae colonise only littorals with stable substrate, for example, places where swimming is prohibited in lakes (Haybach and Fischer 1994). Assuming from the presence of *E. glaucops* in just a single locality, it is still very rare in the Czech Republic. The species was not found in recent studies examining a similar geographic area in northern Bohemia (Polášková et al. 2017, Bartošová et al. 2019, Poláková et al. 2022), nor in other localities we sampled in 2018–2019 (Kolar et al.,

unpublished). However, *E. glaucops* is likely recovering in some areas, as an increase in abundance of the species has recently been reported from Germany (Haybach 2021) and new records have been published from Hungary (Kovács 2001), Belgium (Lock and Goethals 2011) and Croatia (Vilenica et al. 2019). The closest point of occurrence to our locality near Hudcov was reported by Lässig et al. (2000) in Weiditz (north from Rochlitz, Saxony, Germany), approximately 85 km from our sampling site. Thanks to the high dispersal ability of the species (cf. Blanke et al. 1993), the spreading of species in northern Bohemia is likely. For monitoring the species occurrence, the usage of light trapping to collect adults would be very useful to employ in the future, since it generally represents an effective way for collecting *E. glaucops*.

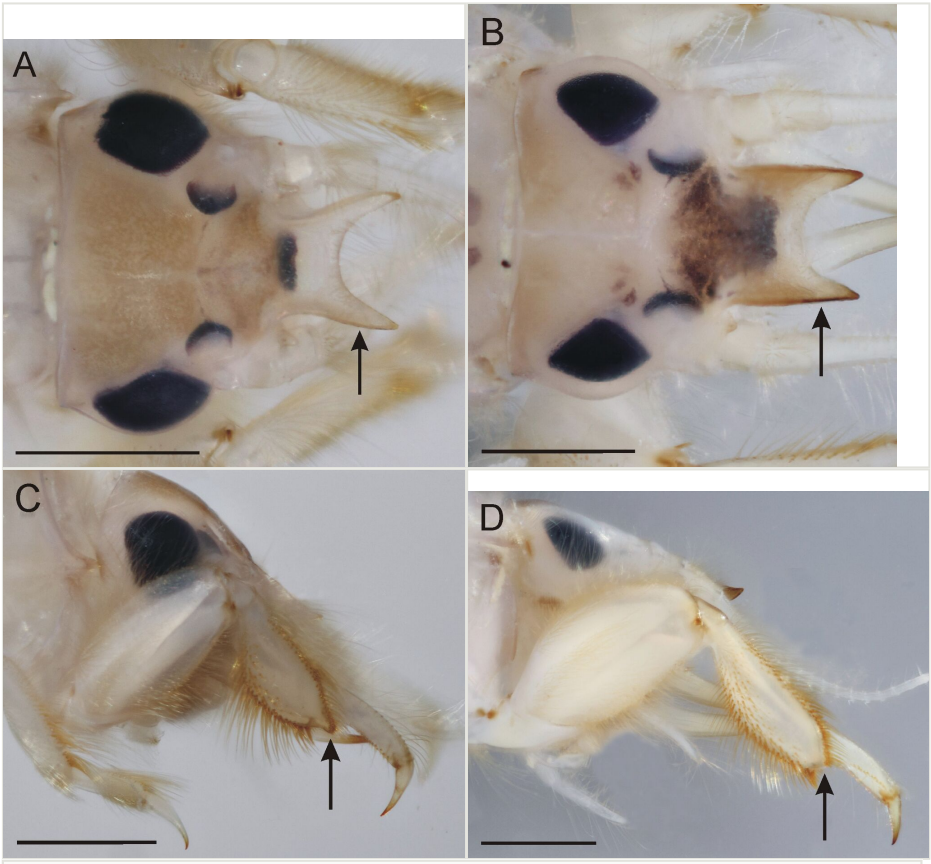

Figure 3.

Morphological characters distinguishing *Ephemera glaucops* (A, C) and comparison with *Ephemera vulgata* (B, D) from the same locality. Scale: 1 mm

a: Head of *E. glaucops*, dorsal view (arrow points to clypeus). doi

b: Head of *E. vulgata*, dorsal view (arrow points to clypeus). doi

c: Fore-leg of *E. glaucops*, lateral view (arrow points to apical protuberance on fore-tibia). doi

d: Fore-leg of *E. vulgata*, lateral view (arrow points to apex of fore-tibia without protuberance). doi

Our study shows the remarkable value of post-industrial sites for aquatic biodiversity, which is well-known for terrestrial biota (Tropek and Řehounek 2011, Tropek et al. 2012, Tropek et al. 2013, Heneberg and Řezáč 2014). Many recent studies (Tichanek and Tropek 2015, Harabiš 2016, Sroka et al. 2016, Polášková et al. 2017, Bartošová et al. 2019, Kolar et al. 2021a, Kolar et al. 2021b, Poláková et al. 2022) recorded numerous aquatic species from different groups, mainly aquatic beetles, heteropterans, dipterans (especially Stratiomyidae, Psychodidae, Limoniidae and Chironomidae) and odonates, which found suitable conditions in these man-made habitats, probably due to the degradation of natural wetlands. However, the biota of kaolin pits is still unknown with the exception of dragonflies and aquatic beetles (Boukal et al. 2007, Bobrek 2020). On the other hand, these localities could also serve as ecological traps, where the species cannot survive due to different stressors, such as unpredictable disturbances due to soil instability or extreme ion concentrations (Harabiš and Dolný 2012, Bartošová et al. 2019, Chmelová et al. 2021).

As an effective means of management to increase the abundances of *E. glaucops*, we recommend regular small-scale disturbances of shallow parts of the waterbody to slow down succession, especially by removing macrophyte vegetation as *E. glaucops* prefers the early successional stage. On the other hand, the disturbances should be applied in a mosaic i.e. with parts left overgrown, as different groups of organisms could have different habitat requirements (e.g. Sroka et al. 2016, Kolar et al. 2021a, Kolar et al. 2021b).

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