

Subterranean populations of cyclopoid copepods (Copepoda: Cyclopoida) collected at a historical mining area in Central Bohemia (Czech Republic)

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Abstract. Cyclopoid copepods collected in the St. Anne water tunnel in a historical mining area in Central Bohemia, Czech Republic, were investigated. Two species were identified: *Megacyclops viridis* (Jurine, 1820) and *Paracyclops fimbriatus* (Fischer, 1853). Since there is a lack of recent information on the groundwater fauna in the Czech Republic, this contribution also summarizes the data in the literature.

Key words. Copepoda, *Megacyclops viridis*, *Paracyclops fimbriatus*, subterranean water, Czech Republic.

INTRODUCTION

Groundwater fauna is typically studied in karstic systems where a high number of different, more or less connected, subterranean habitats house a relatively high number of subterranean crustaceans. There are approximately 800 species of cyclopoid copepods (Copepoda: Cyclopoida) inhabiting various aquatic habitats (Boxshall & Defaye 2008). According to Galassi (2001), 290 of them are stygobionts. Since cyclopoid copepods inhabit a wide range of habitats it is not surprising that populations of some epigeic species are able to exist subterraneanly (e.g. Pipan et al. 2006).

Some subterranean habitats are formed by human activity, especially those located in places with a history of mining. The lack of time needed for the development of their own stygofauna and a limited potential for the disperion of stygobionts differentiates artificial from natural groundwater environments.

Groundwater cyclopoid copepods have been occasionally studied in the Czech Republic. This contribution describes findings of cyclopoid copepods in an artificial subterranean habitat, which is connected to the surface, and summarizes previous studies on groundwater Cyclopoida carried out in the Czech Republic and adjacent countries.

MATERIAL AND METHODS

Copepods were collected from the St. Anne water tunnel (49° 41' 09.4" N, 13° 59' 28.8" E), which forms part of a historical mining centre at Příbram, Czech Republic. The St. Anne water tunnel, located 20 m below the surface, was built in the 18–19th century on 16th century foundations. The 330 m long tunnel served as a connection between two shafts. Surface water leaks into the tunnel through fissures between the stone blocks which reinforce its walls. Besides leakage, there are also several connections with the surface through which water can enter the tunnel, especially a side corridor located approximately in the middle of the tunnel. The water level ranged from 0 to 30 cm. Plant roots were recorded at some places.

Qualitative samples of microcrustaceans were collected on 6 January 2010 and 2 November 2010 by means of a plastic bottle, the contents of which were filtered through a plankton net with a 40 µm mesh. Unpreserved samples were transported to the laboratory where living specimens were microscopically examined, dissected and photographed. Species were identified using the identification keys of Šrámek-Hušek (1953), Dussart (1969) and Einsle's (1996). The rest of

Table 1. Abiotic parameters measured in the St. Anne water tunnel on 2 November 2010

sample site	depth	temperature	dissolved oxygen	oxygen saturation	conductivity
	[cm]	[°C]	[mg.l ⁻¹]	[%]	[μS.cm ⁻¹]
water tunnel	0–5	8.6	4.0	36.6	483
side corridor*	30	9.5	9.5	88.3	180

*side corridor is directly connected with the surface.

specimens were preserved in 4% formaldehyde solution. The basic abiotic parameters, such as temperature, dissolved oxygen concentration and conductivity, were also measured.

RESULTS AND DISCUSSION

In the St. Anne water tunnel there is a near-surface groundwater environment. Abiotic conditions in the tunnel and the side corridor differed in that temperature and oxygen levels were higher in the latter probably because of the inflow of surface water (Table 1). The relatively high conductivity of the water in the St. Anne water tunnel (483 μS.cm⁻¹) indicates that the water there mainly comes from leaking through the walls.

Two species of cyclopoid copepods were found during the survey: *Megacyclops viridis* (Jurine, 1820) and *Paracyclops fimbriatus* (Fischer, 1853). We collected 12 adult females of *M. viridis*, eight females of *P. fimbriatus* and many copepodite larvae of both species. Most of the species of *Megacyclops* inhabit subterranean water. The fact that *M. viridis* commonly occurs in hypogean ecosystems throughout Europe suggest it is a ubiquitous stygophilous species (e.g. Kiefer 1964, Pandourski & Dethier 2006). We found several adult females with an average body size of 1.95 mm. All diagnostic features of these specimens are the same as those cited in the comprehensive description given in Einsle (1996). This is one of the few published records of subterranean populations of *M. viridis* in the Czech Republic. The previous records were of populations in the Macocha (Štěrba 1954) and Mladeč Caves (Štěrba 1956).

The second cyclopoid copepod, *P. fimbriatus*, is probably the most common species of the genus *Paracyclops* regularly occurring in surface water. There is significant variability within *P. fimbriatus* populations, which is demonstrated mainly by the length: width ratio of caudal rami (Karaytug 1999). Caudal rami of specimens from St. Anne water tunnel were 4 times longer than broad. The ratio 4:1 is characteristic of *P. imminutus*, which has also been recorded in the Czech Republic (Šrámek-Hušek 1939), but the specimens lack a well-developed spinular row on the antennal coxobasis, which is also a characteristic of *P. imminutus* (Karaytug 1999). There are many records of *P. fimbriatus* occurring in subterranean habitats in the Czech Republic (Ertl 1957, Řeháčková 1956, Štěrba 1956, Kulhavý 1961, Štěrba 1978).

P. fimbriatus together with *Eucyclops serrulatus*, *Diacyclops nanus* and *D. bicuspidatus* were recorded during a survey of wells in Prague at the end of 19th century (Vejdovský 1882), the first reference to the occurrence of groundwater cyclopoids in the Czech Republic. More recently Sládeček & Řeháčková (1951) and Ertl (1957) found and sampled the remaining wells in Prague and in addition to regularly finding *P. fimbriatus* they identified *D. languidoides*, which was probably misidentified by Vejdovský (1882) as *D. nanus*.

Apart from the previously mentioned species, there are two other cyclopoids recorded in subterranean habitats in the Czech Republic: *Graeteriella unisetigera* reported by Kulhavý (1960) and *Acanthocyclops venustus* by Štěrba (1956). There is at least one cyclopoid copepod, *Diacyclops*

crassicaudis, which is reported in karst water systems in Slovakia but has not been found in the Czech Republic.

The nearest areas with a well described subterranean fauna (representing mainly the river alluvium) are probably the Danube Flood Plain National Park in Austria with 10 species of cyclopoid copepods (Danielopol & Pospisil 2001) and Baden-Württemberg in Germany with 29 species (Steenken 1998).

In addition to the two species of cyclopoids recorded here only a few other species are recorded in the Czech Republic. This contribution reveals the need for additional research of groundwater habitats, which definitely deserve more attention.

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