

# Invertebrate fauna in municipal wells in Kraków, Poland

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## Abstract

This study of fauna in municipal wells continues our previous investigations performed in rural areas (Dumnicka et al. 2017). The invertebrate fauna of city wells was rarely studied: by Vejdovský (1882) and Řehačková (1953) in Prague, Jaworowski (1893) in Kraków and recently by Koch et al. (2020) in Karlsruhe.

In 2019-2020 studies of fauna composition and water chemistry were done twice (spring-summer and autumn period) in 91 wells situated in various parts of the Kraków city. This work evaluated fauna distribution and diversity with patchy bedrock geological structure and local water pollution.

Water temperature and conductivity were measured in situ using a portable Elmetron CX-742 pH meter. In contrast, chemical analyses were done in the laboratory with DIONEX ICS 2000 unit and a DIONEX ICS 5000 unit, equipped with a DIONEX AS18 anion column and a DIONEX CS16 cation column. For fauna studies, 100 l of water was filtered by a plankton net (50  $\mu$  m mesh size), and invertebrates were sorted in vivo under a stereoscopic microscope with 10x magnification. The material was determined to family level, except for Rotifera.

Our results showed that water chemistry in Kraków wells varied strongly spatially and between sample collection times – this was also stated by various authors and summarized by Chowaniec et al. (2007). The depth of the wells varied from 5.0 to 100 m. Water temperature was relatively high (average value  $12.95 \pm 1.4$  °C) and pH almost neutral ( $7.13 \pm 0.34$ ). Water conductivity values were very high ( $1324.3 \pm 572$   $\mu$ S) due to high concentrations of calcium ( $170.3 \pm 66$  mg L<sup>-1</sup>), sulfates ( $151.8 \pm 81.4$  mg L<sup>-1</sup>), and less frequently chlorides ( $155.5 \pm 143.7$  mg L<sup>-1</sup>). In many wells, ammonium ion was present ( $0.354 \pm 0.764$  mg L<sup>-1</sup>), whereas, in other samples, nitrate concentrations varied strongly from 0.1 to 130.5 mg L<sup>-1</sup> (average value  $21.92 \pm 27$  mg L<sup>-1</sup>).

The occurrence of invertebrates (at least from one taxonomic group) was stated in 74 wells. Copepoda (family Cyclopidae) were found most frequently (in 40 wells) and in highest numbers (it means that in some wells several dozens of individuals were caught).

Nematods and annelids were stated in 19 and 17 wells respectively, but in small number. The remaining groups, such as turbellarians (Catenulida and Rhabdozoa), rotifers and ostracods were present in a few wells only, while amphipods (*Niphargus tatrensis* morphospecies) exclusively in two wells. Moreover, dipterans larvae (from families: Anisopodidae, Chironomidae, Culicidae, Empididae, Limoniidae, Psychodidae and Rhagionidae) were found in 13 wells, whereas Collembola, considered to be terrestrial fauna, were found in 49 wells. In the majority of cases all springtails and fly larvae were alive. The presence of Diptera and Collembola inside the wells might result from leak of pump mechanisms; therefore these invertebrates could just survive for some time inside pumps.

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Statistical analysis (Student t-test) revealed that the presence of fauna was not dependent on the depth of the wells ( $p < 0.12$ ). The effect of water pollution (expressed as increased concentrations of ammonium and chloride ions) on the presence of fauna was also not statistically significant, except for sulfide ions ( $p < 0.058$ ).

In wells situated close to small running waters located on karstic bedrock or alluvial sediments, the presence of stygobionts (*Niphargus tatrensis* morphospecies, *Trichodrilus cernosvitovi* and *Typhlocypris* cf. *eremita*) was stated, whereas in wells situated along Vistula River no aquatic fauna was found probably due to the impermeable clay layer, which isolated wells water from water table of the river.

The only study of fauna in dug municipal wells in Kraków made by Jaworowski (1893) showed higher water pollution than was found in this study: the crustaceans were found rarely, whereas ciliates were abundant and diversified.

Collected material demonstrated the occurrence of relatively rich invertebrate fauna in subterranean city waters, but the effect of various parameters on its distribution has not been firmly established.

## Keywords

subterranean waters, urban area, Crustacea, Annelida, Diptera larvae

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## Conflicts of interest

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