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# Invertebrates in overlooked aquatic ecosystem in the middle of the town

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## Abstract

**Background and Purpose**: *Fountains are common, but usually overlooked anthrotelmata. To date, little attention has been paid to these ecosystems. This study reveals the first, more comprehensive evidence about seasonal changes of fauna in urban fountains and their insect and non-insect biodiversity.*

**Materials and Methods**: *The biodiversity of aquatic organisms from 6 fountains in the city center of Prešov (Eastern Slovakia) were studied and basic environmental characteristics, such as pH, temperature, oxygen saturation and conductivity were measured during 2014. Water depth of studied fountains varied between $10 - 30$ cm and water volume from 1.9 to 51 $m^3$. For statistical evaluation nonparametric analyses were used.*

**Results and Conclusion**: *In total, over 66 taxa of the systematic groups Rotifera, Nematoda and Arthropoda were found. The most abundant insect group was Diptera. Zavrelimyia nubila (Diptera: Chironomidae) was recorded in Slovakia for the first time. Relative abundance of the evaluated insect taxa differed depending on the sampling date, and by water characteristics. Water volume and depth correlated negatively, but not significantly with relative abundance of all evaluated insect groups. Water pH showed positive significant correlation with relative abundance of beetles, and negative, but not significant, correlation with the relative abundance of flies and mayflies.*

## INTRODUCTION

Urban fountains are in general basins or ponds with sprinkling water or anthrotelmata (sing. *anthrotelma*) – a wide variety of small, temporary water habitats artificially created as a result of human activities *(1)*. Fountains are widely distributed and frequently visited spots in urban areas with historical, esthetical and sanitary function *(2)*. Beside human usage fountains are widely exploited as a water source for birds and other vertebrate and invertebrate taxa. They are often used also by dispersing aquatic insects as a temporary shelter *(3)*. Fountains, as indicated by Smoľák et al. *(3)* are common urban anthrotelmata and can be utilized as breeding sites of epidemiologically significant mosquitoes, and could serve as ideal model systems for studies of island biogeography, colonization dynamics, assembly rules and other ecological topics. Urban fountains could play an important role in the spreading of epidemiologically significant species, e.g. in such habitat in Switzerland, Schaffner et al. *(4)* found invasive mosquito *Aedes japonicus* (Theobald, 1901). Hamerlík *(5)*, Hamerlík & Brodersen *(6)* and Bukvová & Hamerlík *(7)* present a number of records concerning fountains,
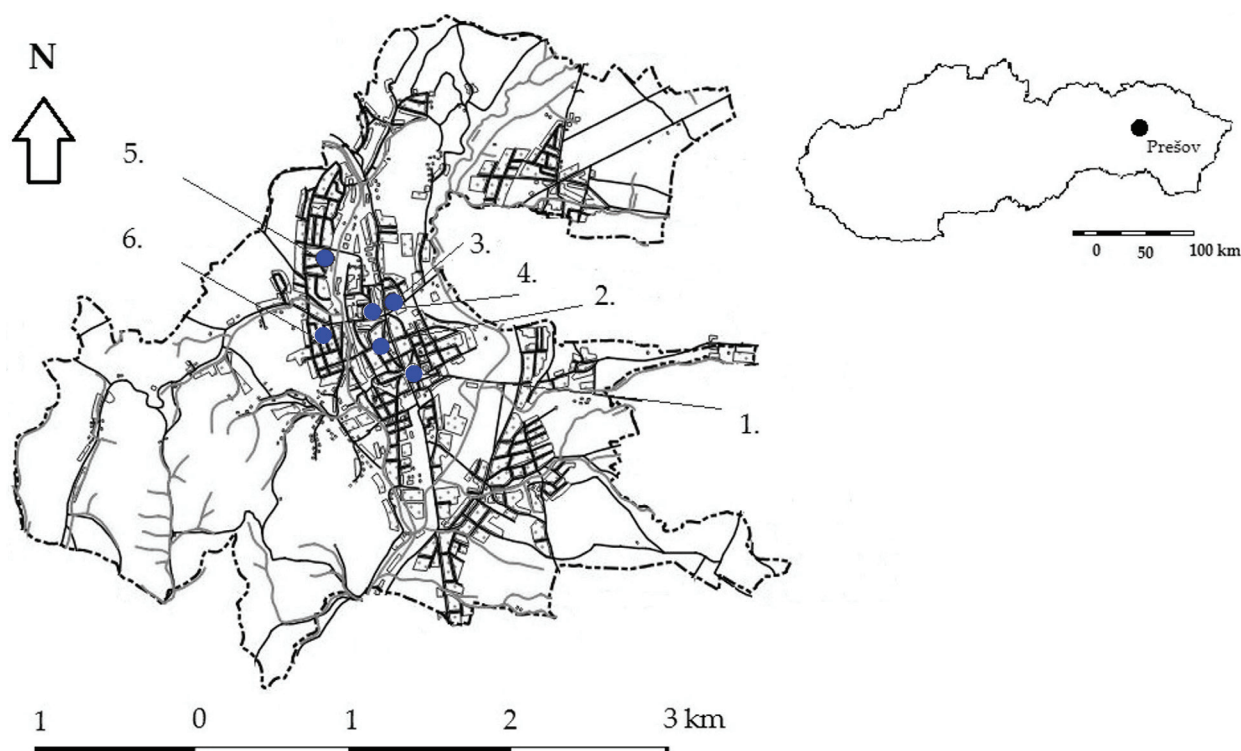
**Figure 1.** *Map shows Slovakia with studied area (right) and sampling site in Prešov town (left; list of sampled sites in Table 1.)*

including the first records of well-known chironomid fauna of Denmark and the Czech Republic. However, except Chironomidae, little attention was paid to European urban fountains, their potentially epidemiological significance and their ecological survey.

The main objective of this study is to find first more comprehensive evidence about these overlooked aquatic urban ecosystems and their insect and non-insect biodiversity. Secondary purposes are to describe seasonal changes of fauna in urban fountains and to indicate their role in spreading of epidemiologically significant species.

## MATERIAL AND METHOD

The biodiversity of aquatic organisms of 6 fountains in Prešov (Eastern Slovakia, population cca 90 000, without big industry) was studied during 2014 (Figure 1). For coordinates, water volume and distance to the closest bigger water source, i.e., Torysa River, see Table 1. The studied urban fountains operate yearly from April to October. During winter, they are without water. Each of studied fountains was completely drained, cleaned and water chemically adjusted at monthly intervals (usually within 24 hours).

Basic environmental parameters, such as pH, temperature, oxygen saturation and electrical conductivity (25 °C), were measured in the field twice, at the beginning and the end of June, using a Multi 3401i (WTW). The

average values (average value of different date measurements) of the measured parameters are shown in the Table 2. Comparison of measured parameters among studied fountains showed variation in conductivity (568-1086 μS/cm), oxygen saturation (9.25-18.65 mg/l), water temperature (12.5-23.7 °C) and water pH (7.2-8.61). Water depth varied between 10–30 cm and water volume between 1.9 to 51 m³. The total amount of sampling effort was equal

Table 1. *Basic characteristics of the urban fountains.*

| Site | Fountain name | Coordinates | Water volume (m³) | Water depth (cm) | Nearest distance toTorysa river (km) |
|---|---|---|---|---|---|
| 1. | Divízia | N 48° 59' 33.2946" E 21° 14' 41.967" | 40.5 | 30 | 0.85 |
| 2. | Neptún | N 48° 59' 50.1" E 21° 14' 26.091" | 7.2 | 20 | 0.65 |
| 3. | Veľká fontána (A) | N 49° 0' 6.1122" E 21° 14' 22.8876" | 7.2 | 30 | 0.73 |
| 4. | Veľká fontána (B) | N 49° 0' 6.2388" E 21° 14' 25.2024" | 1.9 | 10 | 0.75 |
| 5. | Družba | N 49° 0' 23.292" E 21° 13' 26.3028" | 51 | 30 | 0.24 |
| 6. | Centrál | N 48° 59' 55.2948" E 21° 13' 28.2714" | 12.6 | 10 | 0.4 |

**Table 2**. *The average values (with SD) of the environmental water parameters.*

| Site | Water temperature (°C) | PH | Dissolved oxygen (%) | Oxygen saturation (mg/l) | Conductivity (µS/cm) |
|---|---|---|---|---|---|
| 1. | 17.8 | 8.6 (0.01) | 120.7 (1.6) | 11.29 (1.6) | 760 (11.3) |
| 2. | 23.7 | 8.4 (0.01) | 129.8 (22.1) | 11.15 (22.1) | 787 (229) |
| 3. | 21.8 | 8.6 (0.2) | 202 (1.3) | 18.65 (5.3) | 568 (58) |
| 4. | 12.5 | 7.7 (0.7) | 125.6 (0.86) | 12.64 (2.05) | 667.5 (143) |
| 5. | 13.2 | 7.9 (1.4) | 116.1 (2.99) | 10.09 (36.8) | 1086 (201) |
| 6. | 23.4 | 7.2 (0.1) | 109.4 (0.05) | 9.25 (10.5) | 618.5 (36) |

in all the sites (1 min). Insects were collected by kicking technique using D-shaped hand net (mesh size 0.2 mm) (8), at monthly intervals from May to October (except August), transported to laboratory, preserved in 75% ethanol and then identified to the lowest possible taxonomic level, using general and specialized keys for benthic macroinvertebrates (9, 10, 11, 12). Some pupae and larvae of the family Ceratopogonidae were reared to an adult stage according to Oboňa & Dominiak (13). The material examined is deposited in the Laboratory and Museum of Evolutionary Ecology, University of Prešov, except biting midges (deposited in the Department of Invertebrate Zoology and Parasitology, University of Gdańsk, Poland) and non-biting midges (deposited in the Department of Hydrobiology, Microbiology and Ecotoxicology, Water Research Institute, Bratislava, Slovakia).

**Table 3**. *List of non-insect taxa from urban fountains (J=June and O=October).*

| Taxa | Site 1. J | Site 1. O | Site 2. J | Site 2. O | Site 3. J | Site 3. O | Site 4. J | Site 4. O | Site 5. J | Site 5. O | Site 6. J | Site 6. O |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Rotifera | | | | | | | | | | | | |
| Bdelloidae | * | | * | | * | * | * | * | * | * | * | * |
| Flosculariacea | | | | | | | | | | | | |
| Testudinellidae | | | | | | | | | | | | |
| *Testudinella patina* (Hermann, 1783) | | | * | | | * | | * | | | | |
| Philodinida | | | | | | | | | | | | |
| Habrotrochidae | | | | | | | | | | | | |
| *Habrotrocha* sp. | | | * | | * | | * | * | * | * | | |
| Ploima | | | | | | | | | | | | |
| Asplanchnida | | | | | | | | | | | | |
| *Asplanchna* sp. | | | * | | | | | | * | | | |
| Brachionidae | | | | | | | | | | | | |
| *Brachionus quadridentatus* Pallas, 1766 | | | * | | | | | | | | | |
| *Keratella cochlearis* (Gosse, 1851) | | | | | | | * | * | | | | |
| *Notholca squamula* (Müller, 1786) | | | | | | * | | | | | | |
| Dicranophoridae | | | | | | | | | | | | |
| *Encentrum* sp. | * | | * | | | | | | * | * | | |
| Euchlanidae | | | | | | | | | | | | |
| *Diplois* sp. | | | | | | | * | * | | | | |
| *Euchlanis dilatata* Ehrenberg, 1832 | | | | | | | | | * | * | | |
| Lecanidae | | | | | | | | | | | | |
| *Colurella* sp. | * | | * | | * | | | | * | | | |
| *Lecane luna* (Müller, 1776) | | | * | | * | * | * | | | | | |
| *Lecane lunaris* (Ehrenberg, 1832) | | | * | | * | | * | | | | | |
| *Lecane* sp. | | | * | | * | | * | | * | | * | |
| *Lepadella ovalis* (Müller, 1786) | | | | | | | * | * | | | | |
| *Lepadella patella* (Müller, 1786) | | | * | | | | * | | * | | | |

| Taxa | Site 1. J | Site 1. O | Site 2. J | Site 2. O | Site 3. J | Site 3. O | Site 4. J | Site 4. O | Site 5. J | Site 5. O | Site 6. J | Site 6. O |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Lepadella similis* (Lucks, 1912) | | | | | | | * | | | | | |
| *Lepadella* sp. | * | | | | | | | | * | | | |
| Mytilinidae | | | | | | | | | | | | |
| *Mytilina* sp. | * | | | | | | | | | | | |
| Notommatidae | | | | | | | | | | | | |
| *Cephalodella exigua* (Gosse, 1886) | | | | | | | * | | | | | |
| *Cephalodella* sp. | * | | * | | * | | * | | * | | * | |
| *Notommata* sp. | | | | | | | * | | | | | |
| Synchaetidae | | | * | | | | | | * | | | |
| *Synchaeta oblonga* Ehrenberg, 1831 | | | * | | | | | | | | | |
| Nematoda | | | | | | | | | | | | |
| Nematoda indet. | * | | * | * | * | * | * | * | * | * | * | * |
| Arthropoda | | | | | | | | | | | | |
| Diplostraca | | | | | | | | | | | | |
| Cladocera | | | | | * | | | | | | | |
| Eurycercidae | | | | | * | | | | | | | |
| *Alona guttata* Sars, 1862 | | | * | | | | | | | | * | |
| *Alona rectangula* Sars, 1862 | | | * | | | | | | | | | |
| Daphniidae | | | | | | | | | | | | |
| *Daphnia longispina* (Müller, 1776) | | | | | * | | | | | | | |
| *Daphnia obtusa* Kurz, 1875 | * | | | | | | | | | | * | |
| *Daphnia* sp. | * | | | | | | * | | | | | |
| Copepoda | | | | | | | | | | | | |
| copepodit larvae | | | * | | * | | * | | * | | | |
| nauplii larvae | | | * | * | * | | * | | * | * | * | * |
| Calanoida | * | | | | | | | | | | | |
| Cyclopoida | | | * | | * | | * | | * | | | |
| Harpacticoida | | | * | | * | | | | | | | |
| Ostracoda | | | * | | * | | * | * | * | | | * |
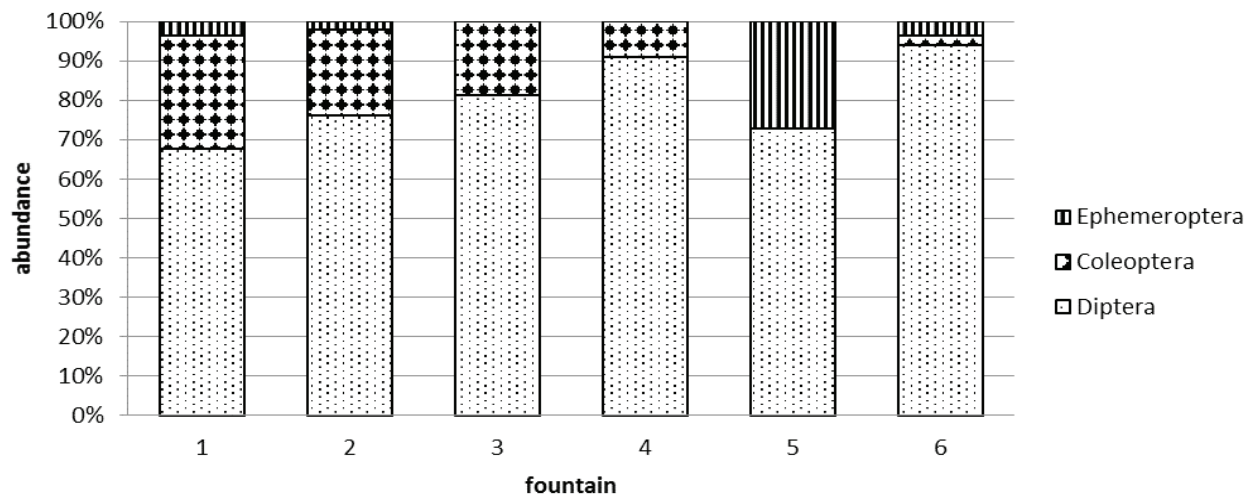
**Figure 2.** *The specimen percentage abundance of dominant insect orders in 6 sampled fountains.*

Zooplankton samples were collected twice from each fountain in June and October. The samples (20 litres for each fountain) were filtered through the plankton net on 0.5 m long handle with 90 μm mesh size (25 cm diameter). The zooplankton was collected in a net micro-bucket of 50 mls and transferred into plankton bottles and fixed with 70% ethanol. Samples were identified using a microscope according to several identification keys (14, 15, 16, 17).

Friedman's Rank Sum test (18) was used to test temporal differences in taxonomic richness and water parameters. In order to test differences in taxonomic richness between 6 evaluated fountains, non-parametric Kruskal-Wallis test (19) was used. Spearman's correlation coefficient was used to test relationships significance between water characteristics and relative abundance of insects specimens at three taxonomic levels (order, family and species).

## RESULTS

### Community composition

No significant differences (P=0.95) among fountains in specimen abundance was found. In total, 66 taxa of the phyla Rotifera, Nematoda and Arthropoda (Cladocera, Copepoda, Ostracoda and Insecta: Coleoptera, Diptera, Ephemeroptera, Heteroptera) were found in the studied fountains (see list of taxa – Table 3, Table 4 and Figure 2).

As many as 410 insect specimens were collected in the fountains, belonging to 4 orders, 7 families and 28 species/taxa (Table 4). The Diptera with 349 identified specimens represent the most abundant order, followed by Coleoptera (46 specimens), Ephemeroptera (12 specimens) and Heteroptera (3 specimens). The relative abun-
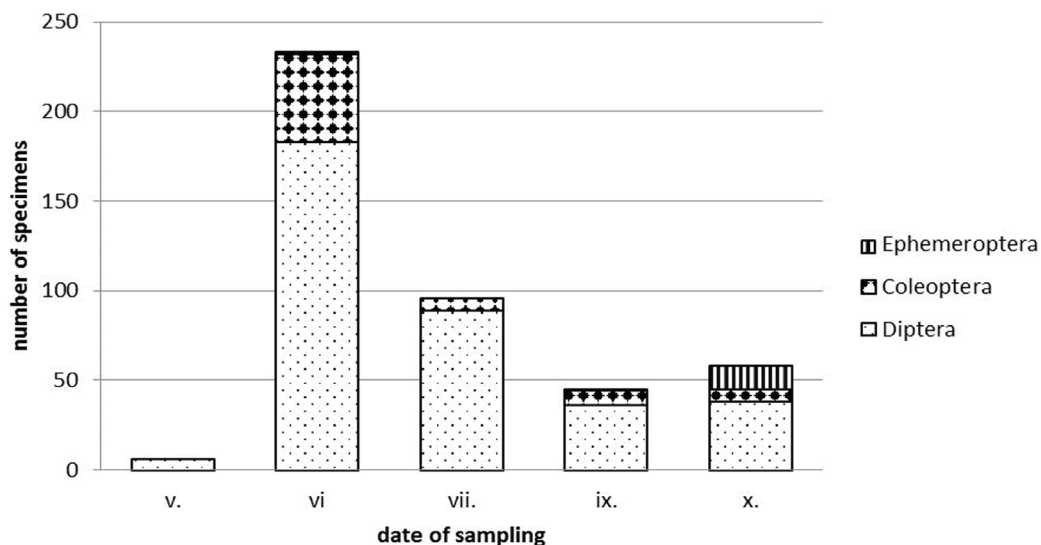


**Figure 3.** *The specimen abundance of dominant insect orders depending on the sampling date.*

**Table 4**. *List of insect taxa from urban fountains with presence in sampling periods.*

| Insect taxa | v.2014 | vi.2014 | vii.2014 | ix.2014 | x.2014 |
|---|---|---|---|---|---|
| Coleoptera | | | | | |
| Dytiscidae | | | | | |
| Colymbetinae | | | | | |
| *Rhantus frontalis* (Marsham, 1802) | * | * | * | * | * |
| Copelatinae | | | | | |
| *Copelatus haemorrhoidalis* (Fabricius, 1787) | | | | | * |
| Hydroporinae | | | | | |
| *Hydroglyphus geminus* (Fabricius, 1792) | * | * | * | * | * |
| Colymbetinae | | | | | |
| *Rhantus frontalis* (Marsham, 1802) | * | * | * | * | * |
| Hydrophilidae | | | | | |
| Helophorinae | | | | | |
| *Helophoru sminutus* Fabricius, 1775 | * | * | | | |
| Laccobiini | | | | | |
| *Laccobius simulatrix* d'Orchymont, 1932 | * | * | | | |
| cf. *Laccobius* larva | | * | * | | |
| Diptera | | | | | |
| Ceratopogonidae | | | | | |
| Dasyheleinae | | | | | |
| *Dasyhelea bilineata* Goetghebuer, 1920 | | * | * | * | |
| Culicoidini | | | | | |
| *Culicoides festivipennis* Kieffer, 1914 | | * | | | |
| Chironomidae | | | | | |
| Chironominae | | | | | |
| *Chironomus* spp. | * | * | * | * | * |
| *Endochironomus tendens* (Fabricius, 1775) | | | | | * |
| *Glyptotendipes* (s. str.) *pallens* (Meigen, 1804) | | * | | | |
| *Kiefferulus tendipediformis* (Goetghebuer, 1921) | | * | | * | * |

| Insect taxa | v.2014 | vi.2014 | vii.2014 | ix.2014 | x.2014 |
|---|---|---|---|---|---|
| Orthocladiinae | | | | | |
| *Acricotopus lucens* (Zetterstedt, 1850) | * | | * | | |
| *Cricotopus* (*Isocladius*) *sylvestris* (Fabricius, 1794) | | * | * | * | |
| *Orthocladius* (*Eudactylocladius*) *fuscimanus* (Kieffer, 1908) | * | * | * | | |
| *Psectrocladius* (s. str.) *limbatellus* (Holmgren, 1869) | | * | * | | * |
| *Thienemanniella* sp. | | | | | * |
| Tanytarsinae | | | | | |
| *Micropsectra notescens* (Walker, 1856) | | | | | * |
| *Tanytarsus* sp. | | | | * | |
| Tanypodinae | | | | | |
| *Zavrelimyia barbatipes* (Kieffer, 1911) | | | * | * | * |
| *Zavrelimyia nubile* (Meigen, 1830) | | | | | * |
| *Zavrelimyia* sp. | | | | | * |
| Culicidae | | | | | |
| Anophelinae | | | | | |
| *Anopheles maculipennis* s.l. Meigen, 1818 | | * | * | * | |
| Culicinae | | | | | |
| *Culex pipiens* Linnaeus, 1758 | * | * | * | * | |
| Ephemeroptera | | | | | |
| Baetidae | | | | | |
| Baetidae | | | | | |
| *Cloeon dipterum* (Linnaeus, 1761) | | | | * | * |
| Heteroptera | | | | | |
| Corixidae | | | | | |
| Corixinea | | | | | |
| *Sigara nigrolineata* (Fieber, 1848) | | * | | | |
| *Sigara lateralis* (Leach, 1817) | | | | | * |

dance of the insect orders (Coleoptera, Diptera, Ephemeroptera and Heteroptera) across 6 fountains are presented in Figure 2. Samples were dominated by *Chironomus* spp. (25%), *Dasyhelea bilineata* (13%), *Psectrocladius limbatellus* (11%), *Culex pipiens* (9%), *Orthocladius* (*Eudactylocladius*) *fuscimanus* (7.5%), *Cricotopus* (*Isocladius*) *sylvestris* (5%), *Anopheles maculipennis* (5%) species. Another 18 taxa were represent by 0.2–4.6 % portion. The larvae and pupae of the family Chironomidae were present in almost every fountain. *Zavrelimyia nubila* (Diptera: Chironimidae) was recorded in Slovakia for the first time. The non-insect fauna was represented by 38 identified taxa (Table 3). Among Rotifera (23 taxa, 9 families), most abundant and with highest frequency of occurrence in fountains were the family Bdelloidae and

the genera *Habrotrocha* and *Cephalodella*. Nematodes were present in all fountains. Cladocera occurred in these water bodies only sporadically, but Copepoda have a greater frequency of occurrence. Relatively common, especially in samples from October, were Ostracoda.

## Taxonomic composition of insect fauna

The presence of studied insect taxa differed depending on the sampling date (Figure 3), but was also influenced by the water characteristics. Correlations between fountain water characteristics and relative abundance of insect taxa are presented in Table 5. Significant positive correlation (P<0.05) was found between dates (from May to October) and the relative abundance of *Zavrelimyia* sp.,

*Kiefferulus tendipediformis* and *Cloeon dipterum*. On the contrary, decreasing abundance of taxa with increasing sampling period was reported for *D. bilineata, Laccobius simulatrix* and *Helophorus minutus*. Water volume and water depth negatively (P>0.06) correlated with abundance of all evaluated orders. The higher water depth significantly negatively influenced the abundance of *Psectrocladius limbatellus* (P<0.05) and *C. pipiens* (P<0.01). Water pH was significantly positively related only with abundance of Coleoptera. At the family level, pH impacted positively with the abundance of the family Hydrophilidae (P<0.05). In general, the abundance of Diptera and Ephemeroptera correlated negatively (P>0.06) with water pH. When considering species level, increasing pH have significant positive influence on abundance of *D. bilineata* (P<0.05) and significantly negative influence on abundance of *C. pipiens* (P<0.01), *P. limbatellus* (P<0.05), and *A. maculipennis* (P<0.01).

Many insects were present in fountains in almost all samples throughout the season (e.g. *Chironomus* spp., *Hydroglyphus geminus*, see Table 4), but some taxa (e.g. *Acricotopus lucens, H. minutus*) have shown tendency to colonize fountains at the beginning of their operation (May–June). On the contrary, some taxa (e.g. *Endochironomus tendens, Micropsectra notescens* and *C. dipterum*) tend to colonize the fountains at the end of the season (September–October).

## DISCUSSION

Artificial water bodies are generally known to support lower species richness than natural ponds, and their physicochemical environment is harsher as well (20, 21, 22). In urban areas, anthrotelmata represent refuges for dispersing aquatic or semi-aquatic organisms. Hence, the fountain habitat seems to be a unique urban aquatic environment with insect communities formed mainly by species from surrounding natural water bodies. Oboňa et al. (23) studied small temporary rain pools in Upper Nitra region (Slovakia) and found relatively different insect community except perhaps *C. pipiens*. However, these small anthrotelmata had a completely different substrate (loam, leaf litter or plant roots), which is not present in fountains. Rieradevall & Cambra (24) studied urban freshwater ecosystems in Barcelona and found that character of the substrate as well as size of the water body influence colonization of urban waters. The urban fountains are anthrotelmata with limited resources, and that could at least partly explain why different taxa colonize these habitats in different seasons. At the beginning of the fountain life (May), only minimum resources were present in the fountain (e.g. pollution from urban air, soils). In summer (July, August), due to sunlight, the fountains often turned green due to the growth of algae, and at the end of the fountain sprinkling period (September, October) due to frequent fell, wind transport of organic particles and leaf litter from the surrounding. Each season can be therefore characterized by different resource base, to which can reflect on presence of different groups of insect. Although the fountains were cleaned every month, the initial results suggest the possibility of functioning of the seasonal variability.

Despite their high dependence on natural colonization sources of insects, artificial urban water bodies do not seem to be only reflection of the status of surrounding water bodies. Instead of this, they probably could contribute to the regional biodiversity (25).

Study of Holland & Jenkins (26) indicates that local conditions (habitat permanence and resource availability) has the greatest effect on zooplankton species richness. Comparison of cumulative species richness shows a significant reduction of species richness in temporary treatments compared to permanent ones. Cumulative species richness was not significantly affected by nutrient enrich-

**Table 5.** *Significant correlation relationship between fountain water characteristics and relative abundance of insect taxa*

| | *Zavrelimyia* sp. | *Psectrocladius* (s. str.) *limbatellus* (Holmgren, 1869) | *Kiefferulus tendipediformis* (Goetghebuer, 1921) | *Culicoides festivipennis* Kieffer, 1914 | *Dasyhelea bilineata* Goetghebuer, 1920 | *Anopheles maculipennis* s.l.Meigen, 1818 | *Culex pipiens* Linnaeus, 1758 | *Rhantus frontalis* (Marsham, 1802) | *Laccobius simulatrix* d'Orchymont, 1932 | *Helophorus minutus* Fabricius, 1775 | *Cloeon dipterum* (Linnaeus, 1761) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| water volume (m³) | | | | | | | | | | | |
| water depth (cm) | | −0.45* | | −0.58** | | | | | | | |
| pH | | −0.42* | | | 0.37* | −0.49** | −0.47** | | | | |
| oxygen saturation (mg/l) | 0.36* | | | | | −0.36* | | | | | |
| conductivity (µS/cm) | −0.39* | −0.41* | | | | | | | | | |
| nearest distance to Torysa river (km) | 0.38* | | | | 0.48** | | | −0.47** | | | |
| date | 0.44* | | 0.37* | | −0.41 | | | | −0.36* | −0.37** | 0.42* |

ment. Similarly, drying has the greatest effect on colonization curves, or species richness through time. Zooplankton occurence in all sampling sites, even after short time after fountain draining and cleaning, indicates high dispersalability in all zooplanktonic groups (Cladocerans, Copepods and Rotifers) in a short period of time.

Our study affirms Frisch et al. (27) finding about colonization rates. Based on cumulative species richness colonization rate differed between zooplankton taxa according to which rotifers are the fastest and copepods the slowest colonizators. Most probably, copepods as obligate sexuals, may show delayed colonization due to a stronger Allee effect compared to cyclical parthenogens, such as rotifers and cladocerans. During present studies, we recorded 23 rotifera and 4 cladoceran taxons mostly in adult stage in contrary to mostly unidentified juvenile copepods.

The studied fountains showed high oxygen content, variation in conductivity, temperature and pH (from slightly acidic to slightly alkaline water). The loss of water and completely cleaning of these habitats in general cause a potential catastrophic event on aquatic insects. However, some species (e.g. larvae of the families Chironomidae and Ceratopogonidae) are able to persist cleaning cycles and were found in fountains immediately after filling with water. Some insects of anthrotelmata exhibit traits of r-selected species, especially high power of dispersal, rapid growth, short life-span, small size, opportunistic/generalistic feeding and poor competitive capabilities (28). Apparently, these taxa are probably most common and the most successful insects colonizers of strictly seasonal urban aquatic fountains. However, not only the environmental conditions, but also spatial configuration determines the species composition of aquatic habitats (29), and moreover, the surrounding colonization sources play a key role in community structure of temporary water bodies (20). According to our findings, the distance to Torysa River has been not significantly limiting factor for evaluated taxa. We assume that these ecosystems are probably colonized from small temporary water bodies from surrounding. However, Hamerlík & Brodersen (6) suppose that the distance to river source has probably also impact on fountain colonization.

Urban fountains in Prešov are also occupied by epidemiologically significant species. During our studies two species of mosquitoes were recorded, these are *C. pipiens* and *A. maculipennis*, as well as one haematophagous species belonging to biting midges, namely *Culicoides festivipennis*. Becker et al. (12) summarized the variability of mosquito-borne diseases. According to this paper (12), mosquitoes occuring in fountains are potential vectors of various viruses, e.g. the West Nile virus transmitted by *C. pipiens* or by *A. maculipennis* the Batai virus (strain: Calovo virus) transmitted by *A. maculipennis* (30), or Sindbis virus, which was isolated from *C. pipiens* (31, 32). Biting midge *C. festivipennis* is host generalists (33, 34, 35, 36, 37, 38), attacking different groups of vertebrates, and

thus, this species can facilitate the emergence of new diseases (39).

Our studies on urban fountains are preliminary ones and for sure it is necessary to examine these ecosystems more carefully.

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