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Diatom flora of Kobylanka stream (South Poland). How many taxa can exist in a very small water-body?

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SUMMARY - *Diatom flora of Kobylanka stream (South Poland). How many taxa can exist in a very small water-body?* - As a result of a floristic study conducted in Kobylanka stream, situated approximately 30 km NW from Kraków, 309 diatom species of 64 genera have been identified, including 16 varieties, two forms, and 26 taxa identified up to genus only. Most of them, especially the dominant ones, are typical for alkaline, oligosaprobic and mesosaprobic waters, of moderate trophy and ion content. A large number of diatoms were represented only by a few specimens, in some cases only in few samples (among 480 samples studied). These rare diatoms represent a much broader range of autecological spectra, and are reported to have been found mostly in environments of different character (e.g. large rivers).

RIASSUNTO - *La microflora a diatomee del Torrente Kobylanka (Polonia meridionale). Quanti taxa possono esistere in un corpo d'acqua di dimensioni molto piccole?* - A seguito di un dettagliato studio floristico che ha avuto per oggetto il Torrente Kobylanka, situato circa 30 km a NO di Cracovia, sono state identificate 309 specie di diatomee appartenenti a 64 generi, incluse 16 varietà, due forme e 26 taxa identificati a livello di genere. La maggior parte di questi taxa, in particolare quelli dominanti, sono tipici di acque alcaline, oligosaprobie e mesosaprobiche, con un trofismo e un contenuto ionico moderati. Un elevato numero di diatomee era rappresentato solo da pochi esemplari, in alcuni casi presenti solo in pochi campioni (dei 480 studiati). Queste diatomee rare rappresentano un intervallo di spettri autoecologici molto più ampio, e sono note per essere diffuse per lo più in ambienti di diverso tipo (p. e. grandi fiumi).

Key words: Diatoms, streams, species richness, Poland
Parole chiave: Diatomee, torrenti, ricchezza di specie, Polonia

1. INTRODUCTION

Diatoms are a very diverse group of algae and one of the most common producers of organic matter in streams. They are good bioindicators (e.g. Prygiel *et al.* 1999), since assemblages composition quickly responds to environmental changes due to their relatively short life spans and rapid immigration rates (Dixit *et al.* 1992). Diatoms can be also applied in general aquatic bioassessment, which uses species richness, composition and abundance to assess human impacts on aquatic environments and global biodiversity changes (e.g. Stoermer & Smol 1999). Habitat destruction and eutrophication threaten many diatom species with extinction. The most threatened taxa are these, which occur only in restricted habitats, and are usually found in low numbers.

Species richness is related to environmental conditions, habitat heterogeneity (Wetzel 1983), depends on the sample size (Kawecka & Eloranta 1994) and survey intensity. European aquatic systems, especially those antropogenically altered, are characterized by relatively simple, well-studied and predictable diatom flora, that reflects environmental conditions related to the water-body character and water quality (Whitton & Rott 1996; Kawecka & Kwandrans 2000). Diatoms in, especially mountain, running waters have been studied for a long time (e.g. Kawecka 1980; Rott & Pfister 1988; Kwandrans 1993; Cantonati *et al*. 2001; Picińska-Fałtynowicz 2007), but no detailed taxonomic assessments have been performed for first-order streams. Despite non-mountain running waters are much more threatened by human-induced changes and habitat destruction, than these from protected

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areas, their biodiversity might be much greater than previously thought. The presence of many species, including the rarely reported ones, indicates an important role of small water bodies in biodiversity, at least on a regional scale.

2. STUDY AREA

The very small Kobylanka stream (7.3 km long, of average depth 25 cm) is one of typical southern Wyżyna Krakowsko-Częstochowska upland streams, running through an area covered by loess sediments and bed imbricated with limestone gravel and stones. Other characteristic feature of the Kobylanka stream are some sections flowing underground. Its upper course is affected by tourism and agriculture, whereas the lower course is additionally vulnerable to sewage pollution and channel modifications. Current velocity ranges from 10 to 18 cm s^{-1}. Water conductivity ranged 292-569 µS cm^{-1}, and pH values generally oscillated around 7. Detailed area description is included in the publications (e.g. Wojtal & Sobczyk 2006; Wojtal submitted).

3. METHODS

Floristic data were derived from studies carried out in the years 1993-2007, and based on 480 samples. The samples were collected from a great variety of microhabitats (epilithon, epiphyton, filamentous algae, bryophytes and other vascular plants, epipelon). They were sampled and prepared using standard methods (Krammer & Lange-Bertalot 1986). Identification was performed with a light and scanning electron microscopes, with reference to Krammer & Lange-Bertalot (1986-1991) and current taxonomical literature.

4. RESULTS

In total, 309 taxa of 64 genera have been identified. Most important and rich in species were such genera as *Navicula* (28), *Nitzschia* (36), and *Gomphonema* (16). According to classification proposed by Van Dam *et al*. (1994), most diatoms were alcaliphilous or circumneutral, oligo- to mesosaprobous, mesotraphentic, fresh-/brackish water species.

Most of the taxa, were recorded in low or very low frequencies, in several cases only once during 14 years of study. Diatoms of broader saprobic tolerance limits were represented by polysaprobous diatoms e.g. *Craticula accomoda* (Hustedt) D.G. Mann, *Mayamaea atomus* var. *permitis* (Hustedt) Lange-Bertalot, *Nitzschia palea* (Kützing) W. Smith, as well as oligosaprobous e.g. *Fragilaria gracilis* Oestrup, *Staurosira construens* var. *binodis* (Ehrenberg) Hamilton, *Rossithidium petersenii* (Hustedt) Round *et* Bukhtiyarova, *Achnanthidium affine* (Grunow) Czarnecki, *Eucocconeis alpestris* (Brun) Lange-Bertalot, *Cymbella aspera* (Ehrenberg) Cleve. From the most common diatoms, classified by Van Dam *et al.* (1994) as fresh or brackish water species, the following have been found: e.g. freshwater *Tabellaria flocculosa* (Roth) Kützing, *Adlafia bryophila* Moser, Lange Bertalot *et* Metzeltin, *Sellaphora hustedtii* (Krasske) Lange-Bertalot *et* Werum, as well as brackish water *Planothidium delicatulum* (Kützing) Round *et* Bukhtiyarova, *Cylindrotheca gracilis* (Brébisson) Grunow, *Nitzschia sigma* (Kützing) W.M. Smith; and brackish-/freshwater e.g. *Fallacia pygmaea* (Kützing) Stickle *et* D.G. Mann, *Caloneis amphisbaena* (Bory) Cleve, *Navicula gregaria* Donkin, *N. lanceolata* (Agardh) Ehrenberg, *N. reichardtiana* Lange-Bertalot, *N. veneta* Kützing, and *Amphora veneta* Kützing. Aerophilic and terrestrial diatoms were represented by e.g. *Achnanthes coarctata* (Brébisson) Grunow in Cleve *et* Grunow, *Diadesmis gallica* W. Smith, *Amphora montana* Krasske, *Stauroneis thermicola*, but species regarded as strictly aquatic were also present, e.g. *Cyclotella atomus* Hustedt, *Discostella pseudostelligera* (Hustedt) Houk *et* Klee, *Stephanodiscus hantzschii* Grunow, *Thalassiosira pseudonana* Hasle *et* Heimdal, and *Nitzschia recta* Hantzsch. Diatoms regarded as rare (in terms of general distribution) were found as well, e.g. *Gomphonema parallelistriatum* Lange-Bertalot, *Sellaphora bacilloides* (Hustedt) Levkov, Krstic *et* Nakov, *S. nana* (Hustedt) Lange-Bertalot, *Naviculadicta brockmannii* (Hustedt) Lange-Bertalot, *Stauroneis tackei* (Hustedt) Krammer *et* Lange-Bertalot.

5. DISCUSSION

In contrast to lakes, where diatom frustules can be accumulated in sediments for a long time, their presence in small streams reflects the current environmental state of a very small area. Moreover, a possibility of an input of allochtonous living diatoms and empty frustules is also much more limited than in the case of e.g. large rivers, even if part of frustules in a stream could originate from aerial and subaerial habitats (e.g. bryophytes, soil). In first-order streams, the range of physical, chemical variables and microhabitats diversity is additionally much more limited than in the case of large rivers. Surprisingly, even a very small "river", of only few millimeters depth, was found to be successfully inhabited by several diatoms typical for flowing waters (Round 2001).

Most diatoms in natural communities occur at low frequency, but their species richness is highest at the least impacted localities (Cao *et al.* 1998). Diatoms, which can tolerate or resist even heavy pollution, could occur in waters of better quality, and at least some sensitive taxa could be found, in a very low number, in waters of poor quality (Lange-Bertalot 1979). Many of the diatoms, which were rare in the Kobylanka stream, possess similar autecology, compared to those, which were abundant and common. The presence of the species, whose tolerance limits seem to be broader than those proposed by Van Dam *et al*. (1994), and which usually could remain hidden amongst weedy taxa, could increase diversity of the system and could enhance ecological stability of a water body. Diatoms, which occur at low frequency can be also considered as propagules, able to rapid growth (in terms of cell number) in favourable environmental condition, or can be constantly represented by scarce specimens. They might provide the "ecological memory" of the community (Padisák 1991).

The occurrence of rarely reported diatoms, such as e.g. *Sellaphora bacilloides* or *Stauroneis tackei* in the stream studied, may suggest underestimation of their real distribution. They can belong to the group of diatoms, which rarely develop large populations, or are constantly represented by scarce specimens.

High diatom species richness of such a small waterbody suggests large underestimation of biodiversity during standard studies, and an important contribution of small aquatic environments on at least regional scale, despite inconspicuous area and far from near-natural condition.

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