

The Occurrence of Diatoms from Genus *Kobayasiella* in Southern Poland

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ABSTRACT

The *Kobayasiella* genus develops mostly in oligo- or dystrophic freshwaters with low to medium electrolyte content. The studies carried out from 2008 to 2016 in southern Poland showed the presence of four *Kobayasiella* species. These species usually occurred individually in peatland areas or in the upper sections of small rivers and streams. The species presented in the study were most frequently found in oligotrophic peatbogs, characterized by acidic or very acidic waters with low or medium conductivity values.

Keywords: flowing waters, peatbogs, *Kobayasiella okadae*, *K. parasubtilissima*, *K. subtilissima*, *K. tintinnus*.

INTRODUCTION

The genus *Kobayasiella* was distinguished from the genus *Navicula sensu lato* (Lange-Bertalot, 1996, 1999) and is widespread worldwide (Bahls, 2011; Buczkó et al. 2009; Kobayasi & Nagumo, 1988; Nagumo & Kobayasi, 1990; Vanhoutte et al. 2004). The most common species in Poland is *Kobayasiella subtilissima* (Cleve) Lange-Bertalot (Kawecka, 2012; Kwandrans, 2007; Siemińska & Wołowski, 2003). Another two species – *K. micropunctata* (Germain) Lange-Bertalot and *K. parasubtilissima* (Kobayasi & Nagumo) Lange-Bertalot – which were also noted in Poland – are endemic to the peat-bog named “Bór na Czerwonem” in Nowy Targ Basin (Wojtal et al. 1999). In southern Poland, the species of the genus *Kobayasiella* are found mainly in peat bog areas, less often in flowing waters (usually in upper sections). Three species – *K. okadae* (Skvortzov) Lange-Bertalot, *K. subtilissima* (Cleve) Lange-Bertalot and *K. tintinnus* Buczkó, Wojtal & Jahn – were found on peat-bogs in the “Międzyrzeki” natural reserve and the Roztocze National Park (Noga et al. 2014b). *K.*

parasubtilissima (Kobayasi & Nagumo) Lange-Bertalot were noted on the “Wołosate” peat bog in the Bieszczady National Park (Rybak et al. 2018), while *K. subtilissima* develops in the upper section of the rivers Morwawa and Mleczka (Pajączek et al. 2012, Noga et al. 2014a). The aim of this work was to present the occurrence sites of *Kobayasiella* species in various types of waters in southern Poland, together with their ecological characteristics.

MATERIALS AND METHODS

The field studies were conducted from 2008 to 2016 in various types of waters (mainly in flowing waters and on peat bogs) in southern Poland. The material was collected from all available habitats: stones, mud or sand, and submerged plants. Two types of samples (diatom material and water for chemical analyses) were collected from spring to autumn over the year (sites on rivers and streams) or only in spring and autumn (sites in peatland areas). The collected material was processed in the laboratory, in line with the methods commonly

used in diatom studies (Kawecka, 2012; Noga et al. 2014a). The pH and electrolytic conductivity were measured *in situ* at every site, during the field studies. Other chemical parameters were measured using a Thermo scientific DIONEX ICS-5000 + DC ion chromatograph in the laboratory at the Department of Soil Science, Environmental Chemistry and Hydrology, University of Rzeszow. Diatoms were identified and counted at 1000× magnification under oil immersion using a Nikon ECLIPSE 80i and Carl Zeiss Axio Imager A2 light microscopes. The following literature was used for diatom identification: Krammer and Lange-Bertalot (Krammer & Lange-Bertalot, 1986), Lange-Bertalot (1996, 1999) and Buczkó et al. (2009). The species abundance was obtained by counting diatom valves up to 400 in random transects of the light microscope. The species with over 5% share in a sample were considered as dominants.

RESULTS

The studies of the freshwater diatoms in the southern Poland revealed four species of the genus *Kobayasiella*: *K. okadae* (Skvortzov) Lange-Bertalot, *K. parasubtilissima* (Kobayasi & Nagumo, 1988) Lange-Bertalot, *K. subtilissima* (Cleve) Lange-Bertalot and *K. tintinnus* Buczkó, Wojtal & Jahn (Table 1, Fig. 1). The abovementioned species occurred in peatland areas. Moreover *K. tintinnus* was also found in the Krupiec stream. *Kobayasiella subtilissima* was recorded in the upper sections of flowing waters (the Mlecza and Morwawa rivers).

All noted *Kobayasiella* species occurred in most studied samples, but occasionally, as single valves. Only one species – *K. parasubtilissima* formed numerous populations and dominated in the diatom assemblages. On the Wołosate peat bog, *K. parasubtilissima* reached from 30% to 85% share in assemblages, developing among various *Sphagnum* species. On the Orawa peatland, species formed numerous populations (>50%) in small depressions, filled with water and overgrowth by peat moss (*Sphagnum* spp.). The water samples from peat bog areas were characterized by low pH (<5), while the pH values the samples from flowing waters (rivers and streams) exceed 5. The conductivity values in peat bogs were low or medium and usually did not exceed 200 $\mu\text{S}\cdot\text{cm}^{-1}$. At sites in rivers and streams conductivity was higher (>300 $\mu\text{S}\cdot\text{cm}^{-1}$). Other chemical parameters

had low values on most sites, often below the limit of determination. Generally, elevated values of nitrates occurred mainly in flowing waters, the highest (9.42 $\text{mg}\cdot\text{dm}^{-3}$) was observed in the Krupiec stream, where a large amount of dead organic matter (mainly in the form of leaf litter) was deposited in a stream bed (Table 1).

In the peatbog areas, where *Kobayasiella* species developed most often, the diatom assemblages were mainly composed of the following species: *Brachysira seriata* Ross, *Eunotia exigua* (Brébisson) Rabenhorst, *Eunotia paludosa* Grunow, *Frustulia saxonica* Rabenhorst and *Pinnularia subcapitata* var. *elongata* Krammer. Diatom assemblages developing in rivers and streams were dominated by *Achnanthydium minutissimum* (Kützing) Czarnecki, *A. pyrenaicum* (Hustedt) Kobayasi, *Gomphonema olivaceum* (Hornemann) Brébisson, *Navicula lanceolata* (Agardh) Ehrenberg and *Planothydium lanceolatum* (Brébisson) Lange-Bertalot. Moreover, in the Krupiec stream the most numerous species were: *Achnanthydium bioretii* (Germain) Monnier, Lange-Bertalot & Ector, *Cocconeis pseudothumensis* Reichardt and *Psammodium rechtense* (Leclercq) Lange-Bertalot.

DISCUSSION

Many species of the genus *Kobayasiella* occur in freshwaters with low or medium content of electrolytes – oligotrophic or dystrophic (Lange-Bertalot 1996). Among the four species presented in this work, *K. subtilissima* was observed the most often. This cosmopolitan species develops frequently on raised bogs occurring in small depressions filled with water and overgrown by *Sphagnum* spp. and characterized by extremely low pH as well as electrolyte content (Krammer & Lange-Bertalot, 1986). Fairly rare species – *K. okadae* and *K. parasubtilissima* have similar ecology to *K. subtilissima* (Krammer & Lange-Bertalot, 1986; Lange-Bertalot & Metzeltin, 1996). The least frequently recorded species in Poland and also in the world is *K. tintinnus*. The species was described from the St. Anne Lake in Romania (Buczkó et al. 2009), then recorded also in peat bogs in the Roztocze National Park (Poland) (Noga et al. 2014b) and in the Netherlands (Veen et al. 2015). Detailed information on the occurrence and ecology of *K. okadae*, *K. subtilissima* and *K. tintinnus* is presented in Noga et al. (2014b). In the investigated material, all three species always

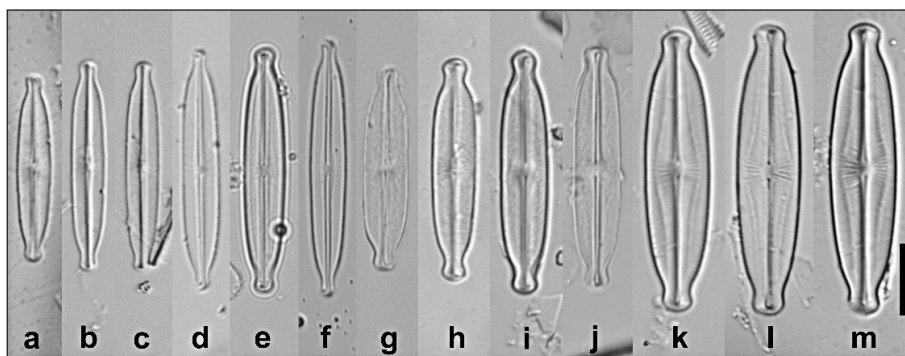


Fig. 1. Images of diatoms from genus *Kobayasiella*: a–c – *K. tintinnus*, d–f – *K. parasubtilissima*, g–j – *K. subtilissima*, k–m – *K. okadae*.

Table 1. The occurrence of species from genus *Kobayasiella* on investigated sites with chemical parameters values.

Studied site	Diatom species			
	<i>K. okadae</i>	<i>K. parasubtilissima</i>	<i>K. subtilissima</i>	<i>K. tintinnus</i>
Mlecza River	–	–	+	–
Morwawa River	–	–	+	–
Krupiec Stream	–	–	–	+
Międzyrzeki peatbogs	+	–	+	+
Wołosate peatbog	–	30–85%	–	–
Orawskie peatbogs	–	>50%	–	–
Chemical parameters				
pH	3.1–3.6	3.0–4.2	3.1–7.6	3.1–5.7
Conductivity	57–152	35–168	57–473	57–302
Cl ⁻	3.33–6.91	3.76–7.07	3.33–6.91	3.33–18.41
NO ₃ ⁻	<0.01–3.09	<0.01–1.98	<0.01–3.09	<0.01–9.42
SO ₄ ²⁻	10.24–27.59	0.87–7.11	10.24–27.59	10.24–27.59
Dominant taxa in a assamblage				
Mlecza River	–	–	<i>Gomphonema olivaceum</i> <i>Navicula lanceolata</i> <i>Planothidium lanceolatum</i>	–
Morwawa River	–	–	<i>Achnantheidium minutissimum</i> <i>A. pyrenaicum</i>	–
Krupiec Stream	–	–	–	<i>Achnantheidium bioretii</i> <i>A. minutissimum</i> <i>Cocconeis pseudothumensis</i> <i>Psammothidium rechtense</i>
Międzyrzeki peatbogs	<i>Brachysira serians</i> <i>Eunotia exigua</i> <i>E. paludosa</i> <i>Frustulia saxonica</i>	–	<i>Brachysira serians</i> , <i>Eunotia exigua</i> <i>E. paludosa</i> , <i>Frustulia saxonica</i>	–
Wołosate peatbog	–	<i>Eunotia paludosa</i> <i>Pinnularia subcapitata</i>	–	–
Orawskie peatbogs	–	var. <i>elongata</i> <i>Frustulia saxonica</i>	–	–

Note: + species occurred in form of individual valves, – species did not occur.

occurred in the form of single valves. The species found in rivers or streams were extremely rare (maximum few valves per sample) and therefore may occur there accidentally. Only one species – *K. parasubtilissima* – created mass populations

on peat bogs, in small and shallow depressions filled with water, abundantly overgrown by peat moss (*Sphagnum* spp.). The species was one of the main dominants in the diatom assemblage, both on the peat bog Wołosate (Rybak et al. 2018)

and on the Orawa peat bogs. The research shows that it prefers highly acidic habitats (pH: 3–4) with usually low conductivity.

CONCLUSIONS

The studies confirmed that species of the genus *Kobayasiella* prefer acid or very acid oligotrophic waters of with low or medium values of conductivity. They develop mainly on peat bogs, usually in the form of individual valves, very rarely creating numerous populations, whereas in rivers and streams they probably appear accidentally and only in the upper sections. For this reason, the authors inscribed all four species found in southern Poland on the Red List of algae in Poland (Siemińska et al. 2006), to the category of vulnerable (V) or at least rare (R).

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