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Pediastrum privum (Printz) Hegewald (Chlorophyceae) in Lake Małe Zmarłe, northern Poland

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Abstract

This report on *Pediastrum privum* (Printz) Hegewald in Lake Małe Zmarłe (Tuchola Forest) is only the second for Poland and the first to describe its morphological variability in a natural population. This study was performed using light microscopy (LM) micrographs, together with data on its ecology.

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INTRODUCTION

Pediastrum privum (Printz) Hegewald is a rarely noted coenobial green alga, apparently restricted to regions with a moderate or subarctic climate in the northern hemisphere. Most records are for clear northern lakes, dystrophic water bodies and peat bogs (Komárek, Fott 1983; Starmach 1989; Komárek, Jankovská 2001). However, it has also been found in two eutrophic ponds in Korea (An et al. 1999), in the Danube River in Bratislava (Hindák, Hindáková 2004, 2008) and in the Baltic Sea (Hällfors 2004).

In comparison with other species in the genus, coenobia of *Pediastrum privum* are small, with diameters of 15 – 25 μm (Komárek, Jankovská 2001; Hindák, Hindáková 2008). *Pediastrum privum* is morphologically most similar to *P. tetras* (Ehrenb.) Ralfs in terms of its small size, low number of cells in a coenobium, trapezoidal cell shape and fine cell wall ornamentation (Parra 1979; Komárek, Jankovská 2001). Several detailed molecular data reported by McManus and Lewis (2005) revealed the close phylogenetic connection of *P. privum* and *P. tetras*. *P. privum* is difficult to recognize, which helps to explain why its morphological variability of cultured material is known better (Parra 1979; An et al. 1999; Hegewald, Jeon 2000). Hegewald and Schnepf (1979) noted striking similarities between the four-celled coenobium of *P. privum* and another coccal green alga, *Crucigenia tetrapedia* (Kirchn.) W. et G. S. West, when observed by light microscopy (LM). However, the two are easy to differentiate by electron microscopy (SEM), which makes the cell wall surface clearly visible. The cell wall is sculptured in *P. privum* and smooth in *C. tetrapedia*. Undocumented localities of *P. privum*, without any species description or iconography, are impossible to verify and compare. For example, it is not possible to verify the previous Polish record from Lake Czyste Małe in the Lubuskie Lakeland (Pełechaty et al. 2007).

The aim of the present study was to describe the morphological variability of *P. privum* from Lake Małe Zmarłe in the Tuchola Forest, the first documented site in Poland. In order to achieve this, LM micrographs were used, together with an assessment of its ecological requirements.

MATERIALS AND METHODS

The material was collected on 9 June 2008 from Lake Małe Zmarłe (53º56’20’’ N, 17º49’01’’ E) in the Tuchola Forest (northern Poland; Fig. 1), a region rich in lakes on young-glacial sandy plains (Kondracki 1994). The lake is located within the administrative boundaries of the Pomorskie Province, within the Chojnice District, about 4.5 km east of Lubnia village, close to the local road from Lubnia to Wiele. The lake is oval-shaped, about 200 m long and

Fig. 1. Location of the Tuchola Forest in Poland.

150 m wide and surrounded by pine trees (*Pinus sylvestis*). Between the lake and the road there is a peat bog with *Sphagnum* L., *Vaccinium vitis-idaea* and *Ledum palustre* L. The brown colour of the water and its relatively high pH (8.2) and conductivity (148 µS cm^{-1}) indicate that the lake is midway between dystrophic and harmonic (Górniak 1996). The main members of the phytoplankton community are *Peridinium gatunense* Nygaard, *Dinobryon bavaricum* Imhof and *D. sociale* Ehrenb. var. *americanum* (Brunnth.) Bachmann. Besides *P. privum*, the following phytoplankton from the genus *Pediastrum* Meyen occur: *P. boryanum* (Turp.) Menegh. var. *perforatum* (Racib.) Nit., *P. boryanum* var. *longicorne* Reinsch, *P. duplex* Meyen var. *rugulosum* Racib., *P. angulosum* (Ehrenb.) ex Menegh. var. *angulosum* and *P. tetras* (Ehrenb.) Ralfs.

Littoral samples were taken using a plankton net size 25. Physicochemical water parameters were measured with an Elmetron pH/conductivity meter CPC-401 and electrode EPS-1. The material was preserved in the field with 2 – 4% formaldehyde. Light microscopy (LM) studies were made using a Nikon OPTIPHOT-2 microscope with Nomarski interference contrast. Micrographs were taken with a PixeLINK PL-A661.

SPECIES DESCRIPTION

Pediastrum privum (Printz) Hegewald in Hegewald et Schnepf 1979 (Fig. 2)

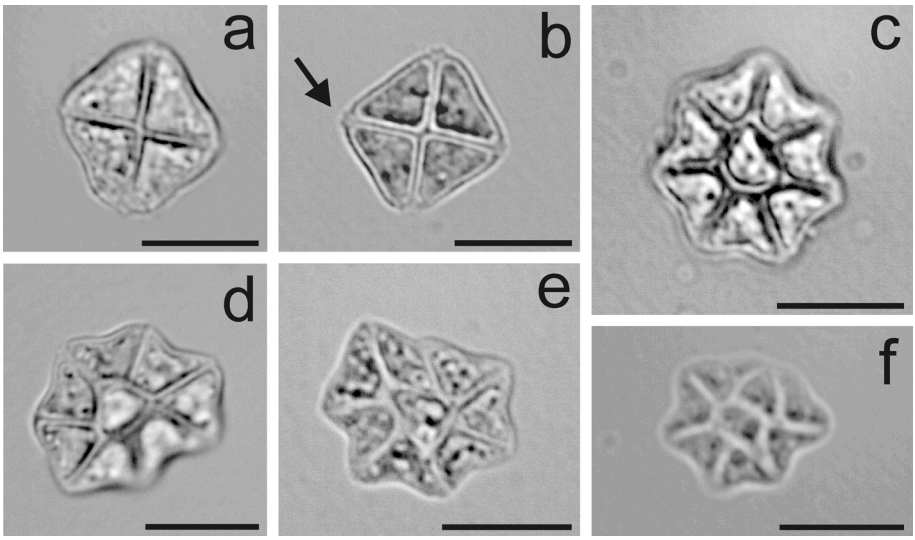

Fig 2. Morphological variability of *Pediastrum privum*: a,b – Four-celled coenobia; c,d,e,f - Eight-celled coenobia; Arrow: process, Scale bars: 10 μm

Basionym: *Pediastrum integrum* Nägeli var. *privum* Printz 1913

Coenobia 10 – 18 μm diameter, mostly composed of four cells and square-shaped in outline, rarely eight-celled and oval-shaped in outline, without holes, with completely joined cell sides. Cells 3 – 6 μm long, 4 – 10 μm wide, outer cell walls straight or slightly concave. All cells in the four-celled coenobium are triangular (Fig. 2a,b). Seven outer cells in the eight-celled coenobium are usually trapezoidal or triangular with the longest side directed outward (Fig. 2c,f), occasionally triangular with the longest side directed inward (Fig. 2f) or parallelogrammatic (Fig. 2e). One central cell in this coenobium is triangular (Fig. 2d,e), rectangular (Fig. 2f) or nearly trapezoidal (Fig. 2c), and is always slightly smaller than the outer cells. Processes are very short, hyaline, visible only on some cells as small warts at the coenobium corners (Fig. 2b, arrow).

DISCUSSION

Morphological variability of *Pediastrum privum* in natural populations has not been completely recognized yet. Most often four-celled and occasionally eight-celled coenobia have been observed. The former are square-shaped, and only occasionally rectangle-shaped (Hindák, Hindáková 2008). The latter are generally composed of one central and seven outer trapezoidal or triangular cells with the longest side directed outward (Wołoszyńska 1918; Prescott 1962; Hegewald, Schnepf 1979; An et al. 1999; Geriš 2004). However, Wawrik (1986) recorded one seven-celled and one nine-celled coenobium from Austria.

The population of *P. privum* in Lake Małe Zmarłe is composed of four-celled and single eight-celled coenobia, similar to other natural populations (Hegewald, Schnepf 1979; An et al. 1999; Geriš 2004; Hindák, Hindáková 2004, 2008) and cultures (Parra 1979; *An et. al.* 1999; Hegewald, Jeon 2000). The eight-celled coenobia consist of one central and seven outer cells, which are not only typically trapezoidal or triangular with the longest side directed outward, but also triangular with the longest side directed inward (Fig. 2f) or parallelogrammatic (Fig. 2e). Hindák and Hindáková (2008) noticed an eight-celled coenobium with one pentagonal outer cell. The central cell can be triangular (Fig. 2d,e), rectangular (Fig. 2f) or nearly trapezoidal (Fig. 2c), and is always slightly smaller than the outer cells. Hegewald and Jeon (2000) noted that the central cell of *P. privum* was asymmetrical, smaller on one side and bigger on the other side of the coenobium. It is possible that coenobia in Lake Małe Zmarłe were observed only from the side where the cell is bigger.

Short hyaline processes are clearly visible on some outer cells (Fig. 2b, arrow). However, it was impossible to verify whether or not these reduced processes also occur on other cells. According to Hegewald and Schnepf (1979), An et al. (1999), and Hegewald and Jeon (2000) *P. privum* does not have processes, but only small warts at the coenobium corners. This opinion is questionable because processes are recorded in all other *Pediastrum* species, so they might be expected in at least a reduced form in *P. privum*. Starmach (1989) writes about very small processes in *P. privum*, sometimes in the form of warts. Processes in other *Pediastrum* species, for example *P. boryanum* and *P. duplex*, have a tiny pore on the top, through which tufts of bristles at specimens living in plankton (Petersen 1912) or drops of gelatinous substance at benthic specimens (Wołoszyńska 1924, 1925) are released. Such types of products have never been observed in *P. privum*, so it cannot be stated if its processes have pores.

Dinophyceae and Chrysophyceae dominate in Lake Małe Zmarłe. Chrysophyceae dominate in dystrophic Lake Kuusjärvi (Finland) as well (Hegewald, Schnepf 1979). In a dystrophic pond in the Czech Republic Bacillariophyceae and Desmidiales (Geriš 2004) dominate, and in clear Lake

Świteź (Lithuania), where *Lobelia dortmanna* L. occurs, Chlorococcales and Desmidiales (Wołoszyńska 1918) are the main groups of phytoplankton. *P. privum* occurs in Lake Małe Zmarłe and in the above-mentioned lakes sporadically. In Lake Świteź the same species of *Pediastrum* as in Lake Małe Zmarłe were observed, namely *P. privum*, *P. boryanum*, *P. angulosum* and *P. tetras*. This group of species indicates that environmental conditions, which are very similar in both of the lakes, are suitable for each of these species. According to Komárek and Jankovská (2001), *P. privum* is a good indicator of clear, cold, dystrophic water bodies. Pełechaty et al. (2007) reported the species from a small shallow lake with relatively low trophy, situated in a woody area. Hindák and Hindáková (2004; 2008) observed *P. privum* in the Danube River in Bratislava, apparently representing material that had drifted into an upstream part of the river from an Alpine lake in Austria. They had also observed the species earlier in plankton samples from South Indian Lakes, Manitoba, in central Canada (in material collected by Dr. H. Kling). An et al. (1999) noted the species in two eutrophic ponds in Korea. As mentioned above, Lake Małe Zmarłe is between a dystrophic and harmonic water basin. This suggests that the ecological requirements of *P. privum* are not very restrictive. It probably occurs in other localities in Central Europe as well, but was overlooked, due to its small size and very low participation in phytoplankton communities. Persistence is necessary to find the small, pale coenobium of *P. privum*.

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