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Distribution and ecology of *Cosmarium striolatum* (Nägeli) Archer – rare species in the flora of Poland

Abstract

This paper presents information on the occurrence of *Cosmarium striolatum* (Desmidiaceae), a species that is very rare in Central and Eastern Europe, including the Polish flora. Based on an morphological analysis of data from relevant publications, recent studies, and AlgaeBase, it has been determined that all previously used names for the species, as well as its classification within the genus *Actinotaenium*, are basionyms and synonyms of the taxon *Cosmarium striolatum*. The taxon was studied using material collected from the Sulęczyno peat bog in the Bytów Lakeland (Northern Poland). Phycological analysis was performed on samples collected in June and July 1987 from sites located in water reservoirs, being the remains of the remains of a former lake. These small, very shallow depressions are concentrated in the northwestern part of the transitional mire, an area dominated by moss communities.

Keywords: basionym, Bytów Lake District, geographical distribution, peat bog, Sulęczyno reserve, synonym

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Introduction

The Kashubian Lake District is a region in Poland characterised by the presence of numerous peat bogs. These are relatively small, natural ecosystems situated in terrain depressions. Most of them have developed through the succession of acidic, dystrophic transitional bog vegetation overlying lakes and ponds, and less frequently in valley depressions within raised bogs. These plant communities represent the class *Scheuchzerio-Caricetea nigrae* (Nordh. 1937) R. Tx. 1937 and belong to the order *Scheuchzerietalia palustris* Nordh. 1937 (Jasnowska, Jasnowski, 1983a).

One of the characteristic forms of these phytocoenoses is the highly hydrated, more or less compact moss-dominated peat bog, primarily composed of *Sphagnum* sp. Such communities typically develop as the final stage of top-down terrestrialisation of dystrophic water bodies. In some cases, during the early and less advanced phases

of this process, flat, treeless *Sphagnum* communities preserve open water surfaces, which are more or less devoid of vascular vegetation (Herbich et al., 2000).

In such freshwater habitats, microscopic algae of the genus *Cosmarium*, classified as green algae (Chlorophyceae, Desmidiaceae), occur, among others. *Cosmarium* cells are constricted in the centre, giving them a bilobed appearance. Their shape varies, and the cell wall can be smooth or covered with spines, granules, or pores (Hall, McCourt, 2014). One representative of this genus is *Cosmarium striolatum* (Nägeli) Archer. This species is distinguished by its characteristic cell morphology and it has a complex taxonomic history. It has also been described under the names *Actinotaenium tessellatum* (Delp.) Pal.-Mordv. and *Cosmarium tessellatum* (Delp.) Nordst. Although *C. striolatum* has a relatively wide geographical distribution on other continents, it is considered a rare species in Poland.

This study presents data on its occurrence in the country, along with notes on its taxonomy, ecology, and overall distribution.

Study sites, material and methods

Characteristics of the plant cover of the study site

Samples used to identify the composition of the algal flora were collected in 1987 from the Sulęczyno peat bog reserve – 54°13'36"N 17°47'10"E (Fig. 1), mainly in northern part of peat bog, during research and phytosociological characterisation of moss communities in the Bytów Lakeland.

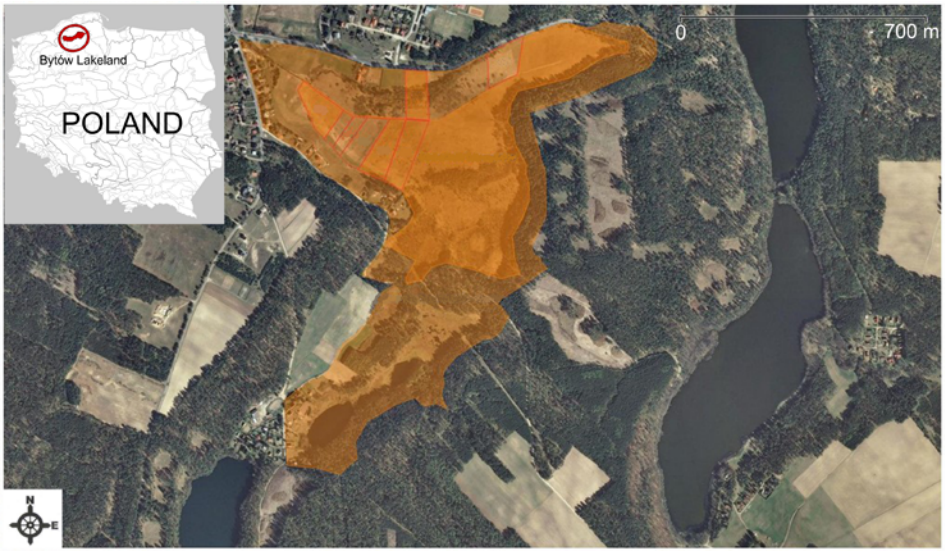

Fig. 1. Study area – Sulęczyno peat bog (Bytów Lakeland, Northern Poland)

The sites included in the ecological and floristic analysis were similar in character. Vascular plants occupied only a small portion of the aquatic areas (Herbich et al., 2000). In the contact zone with the dense moss layer, their coverage reached 10–20%, while the central part of the water surface remained devoid of any vegetation. The density of the developing moss within the water bodies was highly variable. In the marginal zone adjacent to the dense moss, the plant cover was sparse and poorly structured in terms of species composition (Herbichowa, Herbich, 2015). The dominant species in the developing community was *Sphagnum cuspidatum* Ehrh. ex Hoffm. Occasionally, in areas where the moss layer – mainly *Sphagnum fallax* (H.Klinggr.) H.Klinggr. – was forming, vascular plants such as *Drosera rotundifolia* L., *Carex rostrata* Stokes, and *Scheuchzeria palustris* L. appeared singly and were widely scattered. Phytosociological relevés and a detailed description of the initial stage of mosses development are provided in the study by Jasnowska and Jasnowski (1983a, b).

Materials, methods

The reason for analysing the taxonomic diversity of the phycoflora in the overgrowing aquatic habitat within the moss layer was the mass occurrence of *Batrachospermum turfosum* Bory emend. Sheath, Vis et Cole – a red alga characteristic of stagnant dystrophic waters. From the collected gelatinous thalli, the abundant sediment that had accumulated within them was rinsed using water from the habitat, providing additional algal material for further floristic analysis. Samples were also taken from floating peat moss shoots and from the loose, highly hydrated, early-stage moss community forming along the shoreline of the water bodies. A total of five sediment samples were collected.

The collected sediment material was placed in plastic containers and preserved with lactophenol (Starmach, 1963). Material rinsed from the thallus sediment and recovered from peat mosses was preserved in Lugol's iodine solution (J + KJ). All samples were labelled with basic data, including habitat type, collection number, and date. At the same time, the pH of the habitat waters was measured.

Result and discussion

Systematic affiliation of the species

In the original algological studies, the taxonomic position of the species was not clearly defined, both in terms of generic affiliation and species name. As a result, various names were used in the literature. Originally described by Delp. 1877, this taxon was assigned to the genus *Cosmarium* as *Cosmarium tessellatum* (Delp., 1877). In later floristic studies, this taxon was referred to as *Actinotaenium tessellatum* (Nordstedt, 1896; Palamar-Mordvintseva, 1982, 2003), *Cosmarium tesselatum* (Lenzenweger, 1999; Coesel, 2004), or *Cosmarium striolatum* (Nägeli) Archer. The literature also includes alternative

spellings of the taxonomic name, such as *Actinotaenium tesellatum* (Palamar-Mordvintseva, 2003) and *Actinotaenium tesselatum* (Delponte). Nordstedt 1896 (Palamar-Mordvintseva, 1982; Prescott et al., 1981). Coesel and Meesters (2007) assign the species to *Cosmarium striolatum* (Nägeli) Archer. This classification is consistent with the taxonomic revision published in AlgaeBase (Guiry, Guiry, 2018). All taxonomic names used in the algological literature for this species represent basionyms or synonyms.

Cosmarium striolatum (Nägeli, 1849) Archer, 1858
Basionim: *Dysphynctium tesellatum* Nägeli
Synonyms: *Dysphynctium striolatum* (Pritchard, 1861), *Pleurotaeniopsis tessellatum* (Delponte, 1877) De Toni (Lütkemüller, 1892, 1900), *Cosmarium striolatum* Nägeli. (Lenzenweger, 1981, 1989)

Description

Cells are elongated-elliptical in outline, slightly constricted, and slightly cylindrical with slightly convex side walls. Cell length 142.2–148.2 μm, width 68.2–69.5 μm. Isthmus 59.3 μm wide. Sinus wide open, conical in the form of a semicircular indentation. Hemicelles sometimes have more or less parallel side walls and a rounded apex. Apical view circular. Cell wall covered with large granules arranged in intervening rows. Rows of granules are semicircularly oblique to the side walls of the hemicelles. Small, irregular, triangular, or quadrangular dark pores exist between the granules. Each granule is surrounded by very faint lines, forming a pentagonal or hexagonal sector around it (Fig. 2).

The habitat of this taxon is one of several small water depressions among highly hydrated phytocoenoses, characteristic of the initial stages of moss forests. Cells of the species occurred abundantly alongside other taxa representing the Desmidiaceae family. The dominant genera here are *Cosmarium* sp. div., *Staurastrum* sp. div., *Micrasterias* sp. div., *Euastrum* sp. div., and others.

Distribution in Poland

This species was recorded four times in the algal flora of Poland in the catalogue of biodiversity of Poland (Siemińska, Wołowski, 2003) published by the W. Szafer Institute of Botany of the Polish Academy of Sciences in Kraków (Bibliography of the Iconotheca of the Institute of Botany of the Polish Academy of Sciences). Recorded localities come from the works of: Eichler (1896), Grönbland (1926), Wasylik (1961), Szymańska (1985).

General distribution and ecology

In the algological literature, information on the ecology and geographic distribution of *Actinotaenium tessellatum* (= *Cosmarium striolatum*) covers various continents.

This information is usually of a floristic nature. Hirano (1960) describes the taxon's preferences and geographic distribution, reporting that its localities include Europe, East Asia, the tropical zones of the Northern Hemisphere, and Australia and New Zealand. In the tropical zone, the taxon's presence has been recorded in the flora of Indonesia (Scott, Prescott, 1961), the Goa region on the western coast of the Indian subcontinent (Bharati, Heyde, 1982), and Bangladesh (Islam, Haroon, 1980). Hirano (1960) and Palamar-Mordvintseva (2003) provide no information on the species' occurrence in the flora of habitats in Africa, where the taxon occurs in the tropical zone. Its localities are known from floristic studies in Madagascar (Bourelly, Couté, 1991), Namibia in SW Africa (Grönbland, Croasdale, 1971), French Equatorial Africa (Round, 1961), Lake Bengweulu in Zambia (Thomasson, 1960), and the Ugandan and Lake Victoria regions (Grönbland et al., 1964). A few localities of *Actinotaenium tessellatum* are reported from North America (Prescott et al., 1981), as well as from the coastal area of East Asia (Gontcharow, 1997, 1998).

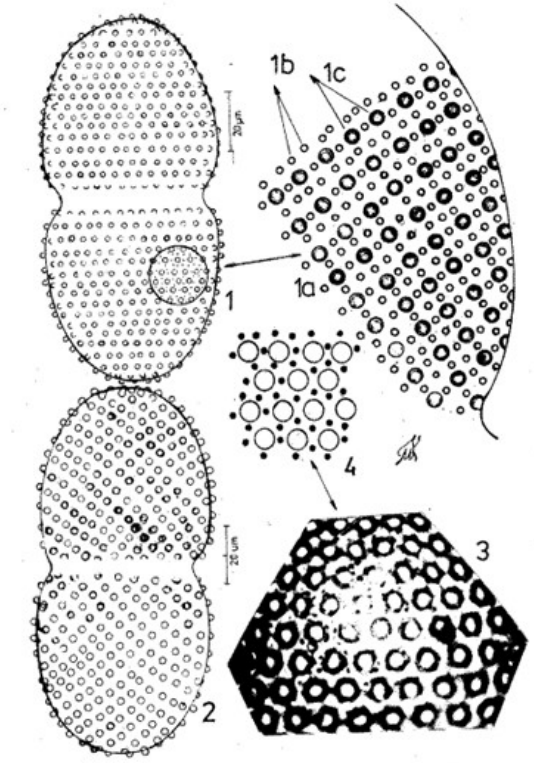

Fig. 2. *Cosmarium striolatum* (Nägeli) Archer found in study site: 1–2. Cell morphology; 1a – cell wall surface ornamentation; 1b – granules; 1c – pores in the cell wall; 3 – ornamentation of the cell wall surface according to the microscopic image; 4 – microscopic image of cell wall surface ornamentation (Drawing and photography: W.W.A. Kowalski)

Gontcharov (1997) reports the occurrence of this taxon in the Primorsky Territory of Russia, located in the coastal part of the Asian continent, on the Sea of Japan. The study lacks detailed data on the ecology of the habitat. The author states that the research material was collected in a meandering stream habitat, marshy ponds in a peat bog, lakes, and drainage channels. Samples were collected between 1988 and 1996, primarily in July–August, at habitat water temperatures (14.0°C) ranging from 19.0°C to 26.0°C. Valuable information provided in the study includes data on the pH of the habitat and a list of desmidia species associated with the taxon's cells. The weakly acidic pH of the habitat (5.1) ranging from 6.3 to 6.8 indicates that these are marshy habitats, likely related to peat bogs. However, Gontcharov's (1997) study contains a taxonomic error. In the flora list, the author classifies cells with identical morphological features and similar dimensions as two different species, i.e., *Actinotaenium tesellatum* (Nordst.) Pal.–Mordv. (Fig. 10, pp. 62–63) and *Cosmarium striolatum* (Nägeli) Archer (Fig. 32, pp. 68–69). The taxon occurred in samples from two localities, with pH 6.3–6.8. At the same time, the author states that *Actinotaenium tesellatum* (Nordst.) Pal.–Mordv. is a new species for the flora of Russia. In a floristic study (Gontcharov, 1998), the author describes the taxon's localities within a reserve located in the same region of Russia. The taxon occurs in two small bodies of water: Lake Chuhunenko and Lake Zarya. Lake Chuhunenko is a small, rocky, shallow (1.0–1.5 m) dystrophic reservoir located in a depression in the coastal zone. The dominant macrohydrophyte species are *Scirpus tabernamontani* (C. C. Gmel.) Palla, *Potamogeton crispus* L., *P. natans* L., and *Utricularia vulgaris* L. Lake Zarya is a remnant of a mesotrophic oxbow lake surrounded by peat bog. The dominant macrohydrophyte species in its vegetation are *Carex lasiocarpa* Ehrh., *C. meyerana* Kunth, *C. pseudocuraica* F.Schmidt, *Menyathes trifoliata* L., and *Sphagnum obtusum* Warnst. The lake's water surface is covered by 70% of *Brasenia schreberii* J.F.Gmel. and other aquatic species, including *Nymphaea tetragona* var. *wenzelii* (Maack) Vorosch., *Nymphaea tetragona* Georgi, *Potamogeton crispus*, *P. natans*, and *Utricularia vulgaris*. Hydrochemical parameters of this taxon are uncharacterised in either habitat.

More detailed information on the taxon and its ecological preferences comes from Central Europe. European localities are mainly confirmed by studies from Austria and Germany (Homfeld, 1929; Krieger, 1933; Lenzenweger, 1989, 1999; Coesel, 2004; Coesel, Meesters, 2007). Valuable information on the occurrence of *Actinotaenium tessellatum* and its ecological preferences is provided by the works of Lenzenweger (1999, 2003). In the information included in the Desmid flora of Austria, the author states that the taxon occasionally occurs in acidic peat bog waters and in highly hydrated, swaying marsh phytocoenoses, especially in the coastal zone of lakes. Lenzenweger (2003) classifies the taxon as a mesotrophy, preferring habitats with a moderate to slightly acidic pH. The typical habitat of the species in the Austrian Alps is the alpine slopes formed between peat bogs and the shores of heath lakes. The species is found both in the foothills

of the Alps, at an altitude of 500–110 m above sea level, and in the mountains in the subalpine zone (1100–2000 m above sea level). In the Alps, it often occurs in masses and is widely distributed (Lenzenweger, 1999).

In her study of green algae from the class *Conjugatophyceae*, order *Desmidiales*, Palamar-Mordvintseva (1982) provides a brief general description of the taxon, stating that it is a very rare species occurring in peat bog habitats in Ukraine. However, more detailed information on the nature of the habitats is lacking. Information on the approximate location of localities is provided in Palamar-Mordvintseva (2003). The description of the taxon also includes data on its geographic distribution. The taxon's range primarily covers the Alpine regions of Austria and Italy, as well as mountainous regions of Canada. According to Palamar-Mordvintseva (2003), the taxon is an Arctic–Atlantic flora element associated with the Holarctic type.

Comparison and systematic position of species that are basionyms and synonyms of the taxon *Actinotaenium tessellatum* and *Cosmarium striolatum*

To document the species previously classified in the literature as distinct species (Lenzenweger, 1999; Palamar-Mordvienceva, 2003; Gontcharov, 1997, 1998; Coesel, Meesters, 2007), a comparative analysis of their morphological characteristics was conducted. Information regarding their characteristics is summarised in a table (1) – Appendix 1, along with literature data. This primarily concerns morphological characteristics, such as cell shape, cell wall surface sculpture, and size parameters, as well as sparse information on habitat and distribution.

Conclusions

Analysis of data on cell morphology, dimensions, and cell wall sculpture clearly shows that all species names used in published works (Wasylik, 1961; Gontcharov, 1997, 1998; Lenzenweger, 2003; Palmar-Mordvienceva, 2003; Coesel, Meesters, 2007, and others) refer to the same taxon. These are therefore its basionyms and synonyms, which have appeared in various floristic publications. The taxonomic affiliation provided in AlgaBase (Guiry, Guiry, 2018) and in the study by Coesel and Meesters (2007) is the final and correct definition of the taxon's systematic position. The cell characteristics found in Pomerania and the nature of the habitat are consistent with descriptions in the literature. The new position is also of a similar nature and does not differ from the information available in the literature.

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Conflict of interest

The author declare no conflict of interest related to this article.

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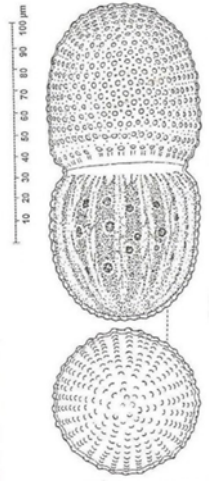
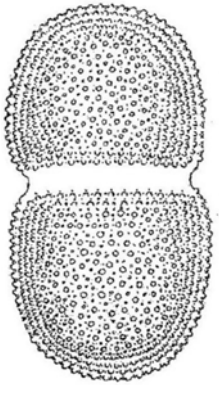
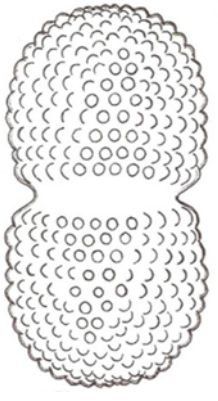
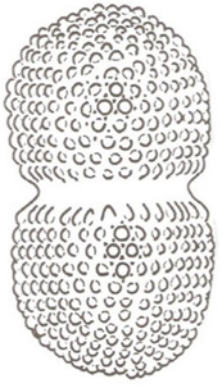
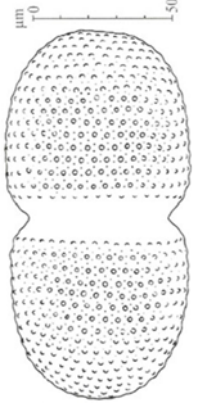
Tab. 1. *Cosmarium striolatum*, its basionyms and synonyms in the algological literature (compiled based on literature data)

Cosmarium tesselatum (Delp.) Nordst. (Lenzenweger, 1999)	***Actinotaenium tesellatum*** (Palmar–Mordvienceva, 2003)	***Actinotaenium tessellatum*** (Delp.) Nordst. (Gontcharov, 1997)	***Cosmarium striolatum*** Nägeli (Gontcharov, 1998)	***Cosmarium striolatum*** (Nägeli) Archer (Coesel, Meesters, 2007)
		Taxon cell parameters		
		cell length		
130.0–160.0 [µm]	128.0–140.0 [µm]	102.5 [µm]	110.0–112.5 [µm]	130.0–160.0 [µm]
		cell width		
65.0–85.0 [µm]	65.0–66.0 [µm]	58.0 [µm]	62.5–68.0 [µm]	65.0–85.0 [µm]
		istmus		
55.0–65.0 [µm]	51.0–54.0 [µm]	45.0 [µm]	47.0–50.0 [µm]	no data
		cell thickness*		
no data	no data	no data	no data	no data
		sinus		
wide open, with a narrow conical and rounded internal indentation	wide open, shallow, semicircular cut	wide open, shallow, conical, with a slightly rounded top in the inner part	wide open, narrowing towards the inner rounded corner	open, shallow, conical, narrowly indented, with a sharp peak
		bibliographic illustrations		
		Fig. 10, p. 62, 63		Fig. 8, p. 289

Cosmarium tesselatum (Delp.) Nordst. (Lenzenweger, 1999)	***Actinotaenium tesellatum*** (Palmar–Mordvienceva, 2003)	***Actinotaenium tessellatum*** (Delp.) Nordst. (Gontcharov, 1997)	***Cosmarium striolatum*** Nägeli (Gontcharov, 1998)	***Cosmarium striolatum*** (Nägeli) Archer (Coesel, Meesters, 2007)
				
Ecological classification				
no detailed data	holarctic arctic-atlantic taxon	no data	no data	mesotrophic taxon
Occurrence				
inhabits slightly acidic waters (pH 6.8) of lowland and kettle bogs, the coastal zone of lakes, in the Alps up to 2000 m, also the subalpine area	peat bogs among *Sphagnum* mosses and in marshes, Ukraine, western Polesie.	among wetland habitats and peat bog water bodies, Primorsky Krai in eastern Russia, in the coastal zone of the Sea of Japan. Also in Ukraine.	among the vegetation of marsh habitats, water bodies on peat bogs, Primorsky Krai in eastern Russia, in the coastal zone of the Sea of Japan.	a rare taxon, occurring in some heathlands in the Oisterwijk area and in some heath peat valleys in the Vienna area.

* the circular view of the cells from the top allows us to conclude that their thickness corresponds to their width

Występowanie i ekologia *Cosmarium striolatum* (Nägeli) Archer – rzadkiego gatunku we florze Polski

Streszczenie

Analiza parametrów komórkowych i morfologii *Actinotaenium tessellatum* oraz *Cosmarium tessellatum* wskazuje, że taksony występujące pod różnymi nazwami należą do tego samego gatunku. Stosowana w algologii terminologia taksonomiczna odnosi się zatem do basonimów i synonimów jednego taksonu – *Cosmarium striolatum* (Nägeli) Archer. Na podstawie analizy bibliograficznej określono również aktualny zasięg występowania tego gatunku. Notowany jest on we wschodniej i południowej części Azji subtropikalnej, w Afryce, Ameryce Północnej, Australii oraz Nowej Zelandii. W Europie występuje pospolicie, szczególnie w Alpach Austriackich i na terenach sąsiednich. W Polsce jednak gatunek ten został stwierdzony tylko na czterech stanowiskach. Dotychczas nie odnotowano go w krajach sąsiednich, w Skandynawii ani na rozległych torfowiskach Finlandii. Rozmieszczenie geograficzne na różnych kontynentach oraz ograniczone dane ekologiczne dotyczące jego siedlisk utrudniają jednoznaczne określenie preferencji troficznych i pełnego zasięgu geograficznego. Wydaje się jednak, że jest on związany z siedliskami mezotroficznymi. Na tego rodzaju wymagania wskazują zarówno badania Lenzenwegera (2003), jak i obserwacje dotyczące obecności gatunku oraz charakteru siedlisk przedstawione przez Gontcharova (1998).

Słowa kluczowe: basonim, Pojezierze Bytowskie, rozmieszczenie geograficzne, torfowisko, rezerwat Sulęczyno, synonim

Information on the author

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The author is a specialist in the field of algology. His research interests concern both single species of algae and whole groups of marine and freshwater algae, with particular emphasis on rare and endangered taxa. A special taxonomic group of interest are the taxa associated with the ecosystems of peat bogs, as well as freshwater red algae. Now, he is a retired researcher at the Department of Botany and Nature Conservation, West Pomeranian University of Technology in Szczecin.