Polish Botanical Journal 50(2): 213–219, 2005

VAUCHERIA DICHOTOMA AND BACTERIA IN THE SULPHURIC SALINE HABITATS OF THE OWCZARY RESERVE (CENTRAL POLAND)

JOLANTA PIĄTEK & MARCIN PIĄTEK

Abstract. The occurrence of *Vaucheria dichotoma* (L.) C. Agardh and two sulphuric and halophilous bacteria, *Thiocystis violacea* Vinogradskij and *Thiothrix annulata* Molisch, in the Owczary Reserve in central Poland is briefly discussed. All three organisms are described and illustrated. *Vaucheria dichotoma* and *Thiocystis violacea* are considered to be facultative halophytes, while *Thiothrix annulata* probably should be treated as an obligatory halophyte.

Key words: *Vaucheria*, bacteria, sulphuric-salt spring, marsh, Owczary Reserve, Poland

Jolanta Piątek, Department of Phycology, W. Szafer Institute of Botany, Polish Academy of Sciences, Lubicz 46, PL-31-512 Kraków, Poland; e-mail: cabala@ib-pan.krakow.pl
Marcin Piątek, Department of Mycology, W. Szafer Institute of Botany, Polish Academy of Sciences, Lubicz 46, PL-31-512 Kraków, Poland; e-mail: mpiatek@ib-pan.krakow.pl

INTRODUCTION

The Owczary Reserve is one of the most interesting places in central Poland, harboring halophyte flora. The reserve covers 0.62 ha and includes a small fragment of marshy meadow with a sulphuric salt spring. This place has long been known for the remarkable vascular plants growing there, such as *Atriplex hastata* L. var. *salina* (Wallr.) Gren., *Bolboschoenus maritimus* (L.) Palla, *Bupleurum tenuissimum* L., *Lotus tenuis* Waldst. & Kit. *ex* Willd., *Melilotus dentata* (Waldst. & Kit.) Pers., *Puccinellia distans* (Jacq.) Parl., *Ruppia maritima* L., *Spergularia salina* J. Presl & C. Presl, *Tetragonolobus maritimus* (L.) Roth, *Trifolium fragiferum* L. and *Zannichellia palustris* L. (e.g., Wóycicki 1915; Dziubałtowski 1916; Piech 1934; Trzcińska-Tacik 1988, 1995). Of these, *Ruppia maritima* had its only natural inland locality in Poland in the Owczary Reserve. Many of these plants disappeared in the reserve as a result of land reclamation in the late 1960s (Trzcińska-Tacik 1988; Łajczak 2000). Currently the habitat for halophytes in the reserve is largely degraded, and most of the sulphuric saline marshy meadow is overgrown by *Phragmites australis* (Cav.) Trin. *ex* Steud. However, some remarkable halophytic vascular plants are still present in this area (Trzcińska-Tacik 1995; Łajczak 2000; Piątek & Piątek unpubl.).

In 2004 we visited the reserve to collect water samples for studies of chrysophycean stomatocysts (Piątek & Piątek 2005). During that visit we observed numerous mats of *Vaucheria* and violet colonies of bacteria. The aim of the present study is to characterize and discuss the identified species.

MATERIAL AND METHODS

Vaucheria filaments were collected on 3 May 2004 and transported in water from their natural habitat in a closed jar. In the laboratory the thalli were put in jars on 4 May 2004 and placed on a north-facing window sill. The thalli were sprinkled with distilled water so that the whole bottom of the jar was covered with a 2–3 mm layer of water (Amirowicz 1981). Thirty days later (5 June 2004), the first sparse sexual organs were observed; 13 days later (18 June 2004) antheridia and oogonia appeared in the masses. The colonies of bacteria were collected on 3 May and 12 July 2004, and

Table 1. Chemical and physical parameters of the sulphuric saline spring and drainage ditch in the Owczary Reserve.

Chemical and physical parameters	Spring	Drainage ditch
Ammonium (NH_4^+) mg $\cdot l^{-1}$	1.0	4.0
Nitrite (NO_2^-) mg $\cdot l^{-1}$	not detected	0.025
Nitrate (NO_3^-) mg $\cdot l^{-1}$	25.0	not detected
pH	7.2	7.8
Total hardness mmol $\cdot l^{-1}$	12.8	25.4
Carbonate hardness (acid-binding capacity) mmol $\cdot l^{-1}$	9.4	4.1
Oxygen (O_2) mg $\cdot l^{-1}$	not detected	9.1
Temperature of water °C	18.5	29.0
Conductivity μS $\cdot cm^{-1}$	13 550	19 990

taken to the laboratory where they were immediately identified. Slide preparations of the collected organisms mounted in water were examined, identified and drawn. A Nikon Eclipse 600 light microscope was used for observations. Micrographs were taken with a Nikon Coolpix 995 camera. The chemical and physical parameters of the salt spring water were investigated in 10 July 2004 using an Aquamerck® Compact Laboratory for Water Testing (Merck). The chemical and physical parameters of the salt spring and drainage ditch are presented in Table 1.

Results and discussion

VAUCHERIA

The *Vaucheria* mats occurred in the central part of the reserve in a drainage ditch, where they grew in masses intermixed with *Mougeotia* sp. On the basis of characters of the antheridia and oogonia, the material was identified as *Vaucheria dichotoma*.

Vaucheria dichotoma (L.) C. Agardh (Figs 1–8)

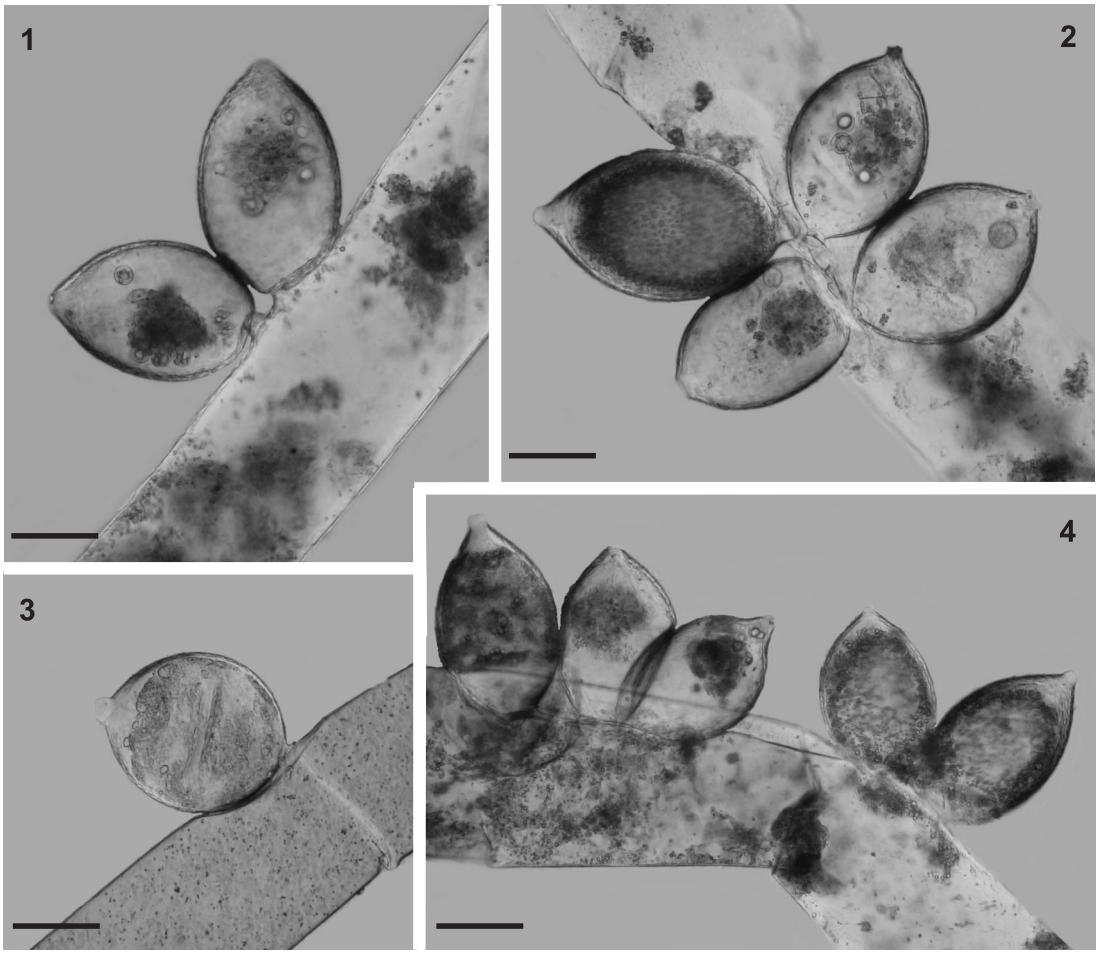
= *Vaucheria starmachii* Kadłub., *nom. inval.*

Ref.: Starmach 1972 (Fig. 593, 598f, pp. 587).

Dioecious, rarely monoecious. Vegetative filaments 90–135 μm in diameter. Antheridia oval or ovate, in groups, rarely single, usually perpendicular to filament, with small beak on top, 113–130 μm long, 68–93 μm wide. Oogonia spherical to slightly oval, single, sitting on filaments, 210–253 μm long, 210–250 μm wide.

Vaucheria dichotoma belongs to the class Xanthophyceae, order Vaucheriales and family Vaucheriaceae. The specimens collected in the Owczary Reserve matched well with descriptions given in the classic monographs of genus *Vaucheria* DC. (e.g., Starmach 1972; Rieth 1980; Żelazna-Wieczorek 2002), except for oogonia size, which was smaller than that given, for example, by Starmach (1972) – (225–)300–425(–515) × (84–)115–150(–231) μm. In the studied specimens we observed mostly dioecious plants, that is, with oogonia and antheridia on separate filaments. Rarely the sexual organs were observed on the same filament, and in such cases the plants were monoecious. Such monoecious specimens were described from a saline spring in Pełczyska by Kadłubowska (in Starmach 1972) as a new species, *Vaucheria starmachii* Kadłub. However, this name must be considered a *nomen invalidum* because Kadłubowska did not include a Latin description of the new species (see ICBN, Art. 36.2; Greuter *et al.* 2000). *V. starmachii* is not accepted as a separate species but as a synonym of *V. dichotoma*. Rieth (1978) showed that *Vaucheria dichotoma* has dioecious and monoecious forms, and did not find any other distinguishing characters justifying separation of *V. dichotoma* and *V. starmachii*. In fact, in the present study we observed both dioecious and monoecious plants in the same sample. In the type locality of *V. starmachii* in Pełczyska, Żelazna-Wieczorek (2002) observed only *V. dichotoma*.

Vaucheria dichotoma occurs especially often in salt waters, but sometimes also in freshwater habitats (Starmach 1972; Rieth 1980; Krzyk 2001; Żelazna-Wieczorek 2002). Therefore, the finding



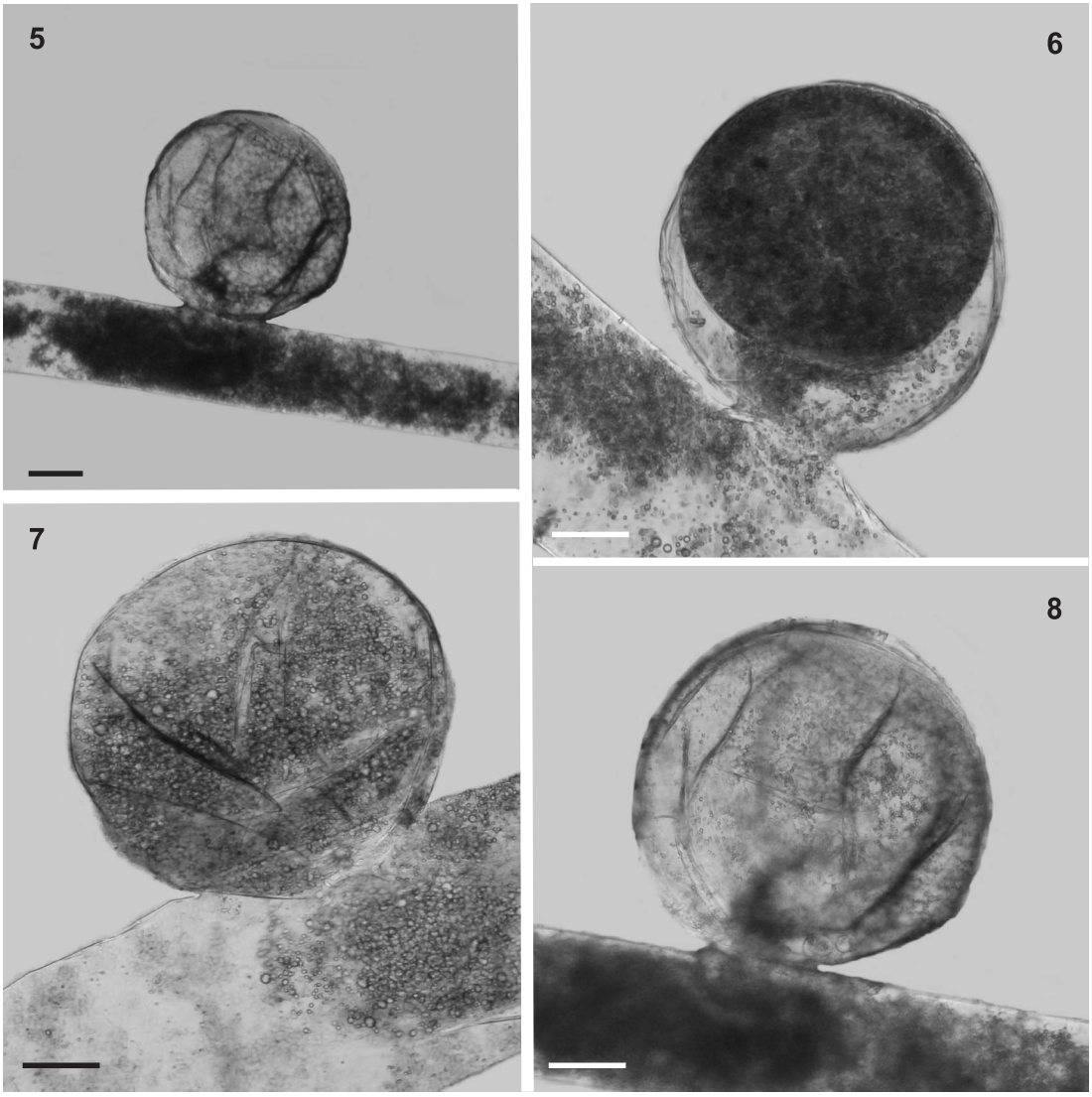
Figs 1–4. Antheridia of *Vaucheria dichotoma* (L.) C. Agardh. Scale bars = 50 μm.

of this species in sulphuric saline waters of the Owczary Reserve is in agreement with its ecological requirements.

Vaucheria dichotoma is seldom reported from Poland. Most records of this alga are from the end of the 19th century and the beginning of the 20th century, mainly by German phycologists (see Siemińska & Wołowski 2003). In this period, Marchewianka (1927) reported '*Vaucheria dichotoma* fo. *marina* Hauk' from the Baltic Sea shore, without any description or comments on this taxon. The only recent findings of *Vaucheria dichotoma* in Poland are from Jezioro Ełckie lake (Krzyk 2001) and Pełczyska (Żelazna-Wieczorek 2002). The locality in the Owczary Reserve presented in this paper may not be completely new, since Wóycicki (1915) reported this species from ponds in Owczary and/or Nadole. He enumerated a long list of cyanophytes and algae from these two ponds without specifying in which pond particular taxon was found. If Wóycicki (1915) found it in Owczary, the present finding indicates that *Vaucheria dichotoma* may have persisted there all this time.

BACTERIA

The violet colonies of bacteria overgrew remnants of reed grass (*Phragmites australis*)



Figs 5–8. Oogonia of *Vaucheria dichotoma* (L.) C. Agardh. Scale bars = 50 μm.

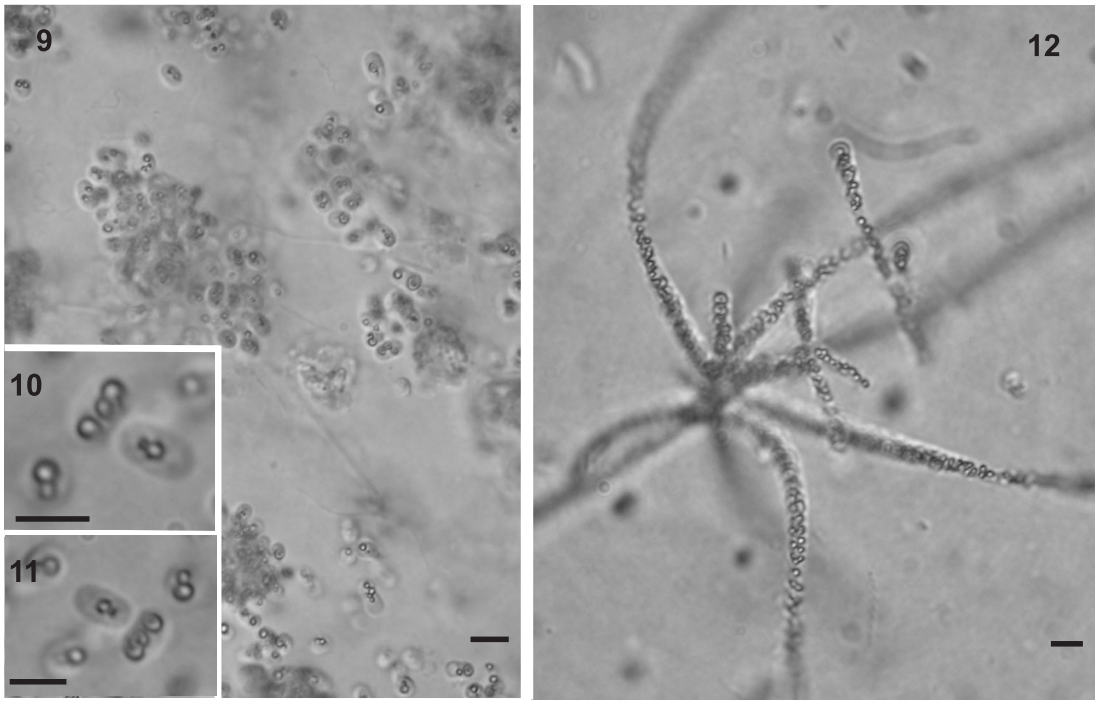
submerged in sulphuric saline water. They occurred abundantly in a sulphuric saline spring and occasionally in other parts of the reserve, especially in a drainage ditch in the middle of the area. Microscopic examination revealed that the colonies are composed of two species intermixed with each other. On the basis of microscopic characters they were identified as *Thiocystis violacea* Vinogradskij and *Thiothrix annulata* Molisch.

Thiocystis violacea Vinogradskij (Figs 9–11)

Ref. Häusler 1982 (Fig. 22: 56–58).

Colonies gelatinous and mucilage colorless, with cells in groups. Cells oval, 3–5 μm long, 2.0–3.5 μm wide.

Thiocystis violacea belongs to the class Schizomycetes, order Rhodospirillales and family Chromatiaceae. The species is known from freshwater and saline water, where it occurs in insolated



Figs 9–12. 9–11 – *Thiocystis violacea* Vinogradskij, 12 – *Thiothrix annulata* Molisch. Scale bars = 5 μm.

places. It is also found often in sulphuric waters (Häusler 1982; Topińska-Luchter 1951; Rajchel *et al.* 2002). The habitat conditions prevailing in the Owczary Reserve are in agreement with the ecological requirements of this bacterium. The most suitable conditions are directly in the saline spring, where this bacterium was most abundant. Previously, *Thiocystis violacea* was noted in the Owczary Reserve by Topińska-Luchter (1951). Later it was reported from two sulphuric springs: Główne and Jerzy in the Polish Carpathians (Rajchel *et al.* 2002).

Thiothrix annulata Molisch (Fig. 12)

Ref. Häusler 1982 (Fig. 111: 200–201).

Filament 2–3 μm wide, *ca* 80–180 μm long, arranged in smaller or bigger clumps attached to substrate by gelatinous pad.

Thiothrix annulata belongs to the class Schizomycetes, order Cytophagales and family Leucotrichaceae. This species is characteristic of salt waters; Häusler (1982) mentioned that it was hitherto not found in freshwater habitats although its occurrence in such habitats is possible. *Thiothrix annulata* was first found in the sea near Trieste in Italy (after Häusler 1982). Later, Bavendam (1924) observed it on algae in a saline spring in Sperenberg near Berlin, and Rajchel *et al.* (2002) noted this bacterium in the Jerzy and Stanisław sulphuric springs in the Polish Carpathians. The habitat conditions in the Owczary Reserve (presence of saline water) confirm the ecological requirements of *Thiothrix annulata*. Like the previous species, *T. annulata* occurred most abundantly in the saline spring. It is surprising that Topińska-Luchter (1951), who reported various bacteria in the Owczary Reserve, did not find this remarkable species.

Conclusion

The organisms we found during our study in the Owczary Reserve are connected with sulphuric

and/or saline habitats. However, *Vaucheria dichotoma* and *Thiocystis violacea* are rather facultative halophytes, as they may occur also in freshwater habitats. *Thiothrix annulata* probably should be treated as an obligatory halophyte, but this is not completely clear since it was found twice in sulphuric springs (Rajchel *et al.* 2002). *Thiocystis violacea* and *Thiothrix annulata* occurred most abundantly in the sulphuric saline spring and singly in the drainage ditch. This finding is probably connected with the higher salinity in the spring than in the ditch. Salinity in the ditch is diluted by fresh water. *Vaucheria dichotoma* occurred abundantly there. In the late 1940s, Topińska-Luchter (1951) reported many more bacteria species than we found during our investigation. The absence of some of them does not necessarily mean that they have disappeared completely; we did not collect materials at various times of the vegetative season. Another reason for the disparity may be various unfavorable changes that have taken place since those earlier studies.

Although the sulphuric salt marsh in the Owczary Reserve has been seriously damaged by human activity, it still harbors remarkable halophyte vascular plants, algae and bacteria.

ACKNOWLEDGEMENTS. We are grateful to Professor Konrad Wołowski (Kraków) for consultation on the method for culturing *Vaucheria* species, and to the anonymous reviewer for useful suggestions and improvements. This work was supported by the Polish Ministry of Education and Science for 2005–2008, grant no. 2 P04G 023 28.

REFERENCES

AMIROWICZ A. 1981. Macroscopic algae from Bolechowicki Stream (Cracow-Częstochowa Upland, Southern Poland). *Fragm. Flor. Geobot.* **27**(4): 668–675.

BAVENDAM W. 1924. Die farblosen und roten Schwefelbakterien des Süß- und Salzwassers. Pflanzenforschung 2, Jena.

DZIUBAŁTOWSKI S. 1916. Stosunki geobotaniczne nad dolną Nidą. *Pamiętn. Fizjogr.* **23**: 107–202.

GREUTER W., MCNEILL J., BARRIE F. R., BURDET H. M., DEMOULIN V., FILGUEIRAS T. S., NICOLSON D. H., SILVA P. C., SKOG J. E., TREHANE P., TURLAND N. J. & HAWKSWORTH D. L. (eds) 2000. International Code of Botanical Nomenclature (Saint Louis Code) adopted by the Sixteenth International Botanical Congress St. Louis, Missouri, July–August 1999. Koeltz Scientific Books, Königstein.

HÄUSLER J. 1982. Schizomyceten Bakterien. In: H. ETTL, J. GERLOFF & H. HEYNIG (eds), *Süßwasserflora von Mitteleuropa*. **20**. VEB G. Fischer, Jena.

KRZYK A. 2001. New localities of several species of *Vaucheria* (Xanthophyceae) in Poland. *Polish Bot. J.* **46**(2): 169–174.

ŁAJCZAK A. 2000. The endangerment and conservation of mineral sources in Ponidzie as exemplified by the Owczary Nature Reserve. *Chrońmy Przyr. Ojcz.* **56**(5): 43–76.

MARCHEWIANKA M. 1927. Ze studiów nad glonami polskiego Bałtyku. *Czasopismo Przyrodnicze, Zeszyt Botaniczny* **2**: 65.

PIĄTEK J. & PIĄTEK M. 2005. Chrysophyte stomatocysts of the sulphuric salt marsh in the Owczary Reserve (central Poland). *Polish Bot. J.* **50**(1): 97–106.

PIECH K. 1934. *Bupleurum tenuissimum* L., neu für Flora von Polen. *Spraw. Komis. Fizjogr. PAU* **68**: 91–98 (in Polish with German summary).

RAJCHEL L., RAJCHEL J. & WOŁOWSKI K. 2002. Microorganisms in selected sulphuric springs of the Polish Carpathians. *Geological Quarterly* **46**(2): 189–198.

RIETH A. 1978. Beiträge zur Kenntnis der Vaucheriaceae. XXI. Monözie und Diözie im Formenkreis von *Vaucheria dichotoma* (L.) Agardh und die Art *Vaucheria starmachii* Kadłubowska. *Archiv. Protistenk.* **120**: 409–419.

RIETH A. 1980. Xanthophyceae. **2**. In: H. ETTL, J. GERLOFF & H. HEYNIG (eds), *Süßwasserflora von Mitteleuropa*. **4**. VEB G. Fischer, Jena.

SIEMIŃSKA J. & WOŁOWSKI K. 2003. Catalogue of Polish prokaryotic and eukaryotic algae. W. Szafer Institute of Botany, Polish Academy of Sciences, Kraków.

STARMACH K. 1972. Chlorophyta III. Zielenice nitkowate: Ulotrichales, Ulvales, Prasiolales, Sphaeropleales, Cladophorales, Chaetophorales, Trentephorales, Siphonales, Dichotomosiphonales. In: K. STARMACH & J. SIEMIŃSKA (eds), *Flora Słodkowodna Polski* **10**. Państwowe Wydawnictwo Naukowe, Warszawa–Kraków (in Polish).

TOPIŃSKA-LUCHTER A. 1951. Problems concerning the relations between the microflora and the chemism of the waters in sulphuric sources. *Prace Komisji Nauk Farmaceutycznych* **3**: 225–266 (in Polish with English summary).

TRZCIŃSKA-TACIK H. 1988. Halophytes in the lower Nida basin (southern Poland). *Zesz. Nauk. Uniw. Jagiell.* **872**, *Prace Bot.* **17**: 133–154 (in Polish with English summary).

TRZCIŃSKA-TACIK H. 1995. Monitoring of halophytes in the Lower Nida Basin. In: Z. MIREK & J. J. WÓJCICKI (eds), *The vegetation of Poland in the process of changes. Proceedings of the 50 Congress of the Polish Botanical*

Society, Kraków 26.06.–01.07.1995, p. 419. Polskie Towarzystwo Botaniczne, Oddział Krakowski & Instytut Botaniki im. W. Szafera, Polska Akademia Nauk, Kraków (in Polish).

WÓYCICKI Z. 1915. Compte-rendu des voyages floristiques effectués dans les regions de Pinczów et de Busk pendant l'année 1914. *Sprawozdania z Posiedzeń Towarzystwa Naukowego Warszawskiego* **8**(5): 275–285 (in Polish with French summary).

ŻELAZNA-WIECZOREK J. 2002. *Vaucheria* species from selected regions in Poland. *Acta Soc. Bot. Poloniae* **71**(2): 129–139.

Received 9 March 2005