

BARBARA KAWECKA

**Głony na sztucznym podłożu w Wielkim Stawie
w Dolinie Pięciu Stawów Polskich (Tatry Wysokie)**

**Algae on the artificial substratum in the Wielki Staw
in the Valley of the Five Polish Lakes
(High Tatra Mountains)**

Wpłynęło 29 listopada 1969 r.

Abstract — The algae species which during two seasons settled on artificial substratum suspended at the various depths in the lake are assembled.

The Valley of the Five Polish Lakes (Dolina Pięciu Stawów Polskich) lies in the Polish part of the High Tatra Mts and forms the upper stage of the Roztoka Valley. It is a wide valley with a bottom folded in tiers. The lake Wielki Staw, being the largest water body in the Tatra Mts., lies at the lowest stage, at an altitude of 1664 m. It is 988 m. long, 452 m. wide, its maximum depth amounting to 79.3 m. (Śliwierski 1935). The banks of the lake are covered with stones and scree, and partly overgrown with dwarf mountain pine and grass. The slope of the basin is very steep. The bottom is flat over a large area and covered for the most part with highly organic sediments (Pasternak 1965). The outlet (the stream Roztoka) is on the north-eastern side of the lake.

Wielki Staw is uncovered and exposed to the action of the wind. Owing to this, the process of water circulation reaches a considerable depth. Under appropriate atmospheric conditions there even occurs a full circulation, in spite of the immense mass of waters. The thermocline is maintained at the depth of 5 to 20 m. (Woźniczka 1965). The surface of the lake is free from ice for 3 to 5 months, the maximum temperature of the water at that time amounting to 14°C.

Wielki Staw is an oligotrophic lake. The total hardness amounts to 0.4—0.5 German degrees, the pH reaction to 6.2—6.8, and alkalinity to

0.1—0.15 mval (Pasternak 1965). The water is well saturated with oxygen which is uniformly distributed in the entire vertical water column. The transparency reaches about 24 m.

Within the framework of complex investigations of Tatra waters, organized in 1962 by Prof. Karol Starmach, Wielki Staw was the terrain of numerous studies. These were concerned with plant (Polek, 1964) and animal (Woźniczka 1965) plankton, with bottom fauna (Kownacka and Kownacki 1965), algae in bottom sediments (Wasyluk 1965), and with structure and chemical composition of bottom sediments (Pasternak 1965).

The present investigations deal with algae settled on an artificial substratum suspended in the depths of the lake. The substratum was built of styrofoam bricks 15×5×4 cm. in dimension with a glass slide mounted into one of the walls. The bricks were bound at an anchored sisal rope with a buoy on the surface of the water. Near the south-eastern bank of the lake, where the depth reaches 11 m., they were set at a depth of 1, 5, and 10 m., and in zone of open water in the layer of 0—73 m., at a depth of 2, 12, 32, 52, and 72 m.

The artificial substratum was set up in July 1964. The material was collected by cutting off the surface of the bricks and exchanging the slides, which were kept in 96 per cent alcohol.

The material was collected on 30th September and 14th November, 1964 from the two perpendiculars of the lake, and on the 29th July and 24th September, 1965 only from the perpendicular of 11 m. The high pressure prevailing in the deep parts of the lake deformed the bricks. Removed from the depth of 72 m, they were hard, reduced by a half, and bent.

The number of specimens was estimated using a 6-grade scale from + to — 5 (Kawecka 1965, 1966). The collected material was not abundant but fairly varied. The algae were not numerous on the smooth surface of the slide. They settled better on the porous wall of the bricks, forming a dark coating.

Altogether 109 forms of algae were determined. Dominant among them were *Bacillariophyceae*, representing 76.1 per cent of the total number, followed by *Chlorophyta* — 17.4 per cent, *Cyanophyta* and *Chrysophyceae* — 2.8 per cent, each and *Pyrrophyta* — 0.9 per cent. The list of these species is given in Table I, in which the depth at which they were found is marked.

Quantitatively, the algae developed poorly. They generally occurred in single specimens. Most frequently encountered were *Achnanthes microcephala*, *Melosira italica* var. *valida*, and *Tabellaria flocculosa*.

Two groups distinguished themselves in the vertical distribution. The first was represented by numerous diatoms, *Cyanophyceae*, and single *Chlorophyceae*, occurring in the entire vertical water column. The other

Tabela I. Lista gatunków; cyfry oznaczają średnie ilości z okresu badań szacowane wg skali (Kawecka 1965, 1966)

Table I. List of species; the figures denote the mean quantities from the period of investigations estimated according to the scale (Kawecka 1965, 1966)

Umiejscowienie substratu Location of the substratum	Litoral Littoral zone			Pelagial Pelagic zone				
	1	5	10	2	12	32	52	72
Głębokość = m Depth in m.								
Cyanophyta								
<i>Merismopedia glauca</i> (Ehrenb.) Nægeli		+	+		+	+		
<i>Lyngbya</i> sp.	1	1	1		+	+	+	+
<i>Phormidium</i> sp.	1	1	+	+	1	+	+	+
Pyrrophyta								
<i>Peridinium</i> sp.	+	+	+		+	+		
Chrysophyceae								
<i>Chrysoococcus</i> sp.	+	+	+	+	+		+	+
<i>Dinobryon</i> sp.	+	1	+	+				
cysty	+	+	1	+	+		+	+
Bacillariophyceae								
<i>Achnanthes flexella</i> (Kütz.) Brun.	+	+	1	+	+	+	+	+
- <i>lanceolata</i> (Bréb.) Grun.	+							
- <i>lapidosa</i> Krasske	+							
- <i>lapponica</i> Hust.	+	+		+				
- <i>laterostrata</i> Hust.	+				+			
- <i>microcephala</i> (Kütz.) Grun.	2	3	3	1	2	1	1	2
- <i>minutissima</i> Kütz.	1		+	+			+	+
- <i>pyrenaica</i> Hust.	+							
<i>Amphora ovalis</i> Kütz.	+	+	+					+
<i>Anomoeoneis exilis</i> (Kütz.) Cl.	+	+	+	+	+			
- <i>serians</i> (Bréb.) Cl. var. <i>brachysira</i> (Bréb.) Hust.	+	1	+	+	+			+
<i>Caloneis silicula</i> (Ehr.) Cl. var. <i>ventricosa</i> (Ehr.) Donk.	+	+						
<i>Ceratoneis arcus</i> (Ehr.) Kütz.	+	+	+	+	+	+	+	+
<i>Cocconeis plecentula</i> Ehr. var. <i>euglypta</i> (Ehr.) Cl.	+	+	+		+	+	+	
- var. <i>intermedia</i> (Herib. et Parag.) Cl.	+							
<i>Cymbella affinis</i> Kütz.	+			+	+		+	
- <i>Cesatii</i> (Rabh.) Grun.	+							
- <i>cistula</i> (Hemp.) Grun.	+							
- <i>cymbiformis</i> (Ag.?Kütz.) V.H.					+			
- <i>helvetica</i> Kütz.	+	+	+					+
- <i>lanceolata</i> (Ehr.) V.H.	+	+						
- <i>ventricosa</i> Kütz.	+	+	1	+	+	+	+	+
<i>Cymbella</i> sp.			+					
<i>Denticula tenuis</i> Kütz.		+						
- var. <i>crassula</i> (Næg.) Hust.	+	+	+	+	+	+	+	+
<i>Diatoma hiemale</i> (Lyngb.) Heib.	+	+	+		+	+	+	+
- var. <i>mesodon</i> (Ehr.) Grun.	+	+	+	+	1	+	+	+
- <i>vulgare</i> Bory	+	+					+	
- var. <i>capitulatum</i> Grun.	+	+	+		+		+	+
- var. <i>Ehrenbergii</i> (Kütz.) Grun.	+	+	+	+	+		+	+
<i>Epithemia zebra</i> (Ehr.) Kütz.	+						+	
<i> Eunotia bigibba</i> Kütz.						+	+	
- <i>exigua</i> (Bréb.) Rabh.	+	+	+	+	+		+	+
- <i>flexuosa</i> (Bréb.) Kütz.	+	+						
- <i>pectinalis</i> (Dillw.?Kütz.) Rabh. var. <i>minor</i> (Kütz.) Rabh.	+	+	+					
- <i>valida</i> Hust.	+	+	+	+	+	+	+	+
<i>Fragilaria capucina</i> Desm.	+	+	+		+			+
- <i>intermedia</i> Grun.			+			+	+	
<i>Frustulia rhomboidea</i> (Ehr.) De Toni var. <i>saxonica</i> (Rabh.) De Toni	+	+	+		+			
<i>Gomphonema acuminatum</i> Ehr.	+		+		+			+
- var. <i>Brebissonii</i> (Kütz.) Cl.	+							
- <i>angustatum</i> (Kütz.) Rabh.			+	+				+

Umiejscowienie substratu Location of the substratum	Litoral Littoral zone			Pelagial Pelagic zone				
	1	5	10	2	12	32	52	72
Głębokość w m Depth in m.								
<i>Gomphonema constrictum</i> Ehr.	+	+	+					+
- var. <i>capitatum</i> Ehr.	+	+	+			+		
- <i>intricatum</i> Kütz. var. <i>pumilum</i> Grun.	+	+	+	+	+		+	+
- <i>longiceps</i> Ehr. var. <i>montanum</i> (Schum.) Cl.	+	+	+	+	+	+	+	+
- <i>olivaceum</i> (Lyngb.) Kütz. var. <i>calcareum</i> Cl.	+							
- <i>parvulum</i> (Kütz.) Grun. var. <i>micropus</i> (Kütz.) Cl.	+							
<i>Gyrosigma</i> sp.								+
<i>Melosira distans</i> (Ehr.) Kütz. var. <i>alpigena</i> Grun.	+		+					
- <i>italica</i> (Ehr.) Kütz. var. <i>valida</i> (Grun.) Hust.	2	1	2	2	2	1	1	+
<i>Meridion circulare</i> Ag.	+	+	+		+	+	+	+
- var. <i>constricta</i> (Ralfs) V.H.	+	+						
<i>Navicula cryptocephala</i> Kütz.			+				+	
- var. <i>intermedia</i> Grun.	+		+				+	+
- var. <i>veneta</i> (Kütz.) Grun.					+			
- <i>perpusilla</i> Grun.	+							
- <i>radiosa</i> Kütz.	+				+	+	+	
- <i>Rotaeana</i> (Rabb.) Grun.	+	+	+	+	+			
<i>Neidium affine</i> (Ehr.) Cl.	+							
- <i>bisulcatum</i> (Lagerst.) Cl.	+	+	+	+	+			
<i>Neidium</i> sp.	+	+	+					
<i>Nitzschia angustata</i> (W.Sm.) Grun. var. <i>acuta</i> Grun.	+					+		+
- <i>dissipata</i> (Kütz.) Grun.	+	+	+					
- <i>Hantzschiana</i> Rabb.		+						
- <i>sublinearis</i> Hust.						+	+	
<i>Pinnularia borealis</i> Ehr.	+	+	+					
- <i>episcopalis</i> Cl.	+	+	+					+
- <i>gibba</i> Ehr.	+	+	+	+	+			
- <i>maior</i> (Kütz.) Cl.	+	+						
- <i>microstauron</i> (Ehr.) Cl.	+	+	+	+				
- <i>subcapitata</i> Greg. var. <i>Hilseana</i> (Janisch.) O.Müll	+							
- <i>viridis</i> (Nitzsch.) Ehr.	+		+					
- var. <i>sudetica</i> (Hilse) Hust.		+						
<i>Stauroneis anceps</i> Ehr.	+			+	+	+		
- <i>phoenicentron</i> Ehr.		+			+			
<i>Synedra amphicephala</i> Kütz.	+	+					+	
- <i>ulna</i> (Nitzsch.) Ehr.	+	+	+	+	+	+	+	+
- <i>rumpens</i> Kütz.	+	+		+	+			
<i>Synedra</i> sp.	1	+	+	+	+			+
<i>Surirella linearis</i> W. Sm.			+					
- <i>ovata</i> Kütz.	+							
<i>Tabellaria flocculosa</i> (Roth) Kütz.	2	1	1	1	+	+	+	+
Chlorophyta								
<i>Pediastrum</i> sp.				+				
<i>Scenedesmus</i> sp.		+	+	+				
<i>Hormidium</i> sp.	+	+	+	+		+		
<i>Cylindrocapsa Brebissonii</i> Menegh.	1	+	+	+	+			
<i>Spirogyra</i> sp.					+			
<i>Mougeotia</i> sp.	+	+						
<i>Gonatozygon monotaenium</i> De Bary? Bréb.	+	+				+		
<i>Closterium abruptum</i> W. West		+						
<i>Coenarium vexatum</i> West		+						
- <i>subcrenatum</i> Hantzsch.	+	+	+	+		+		
- <i>tenuis</i> Arch.	+	+	+					+
<i>Coenarium</i> sp.	+	+		+				
<i>Arthrodesmus</i> sp.	+	+	+	+	+	+	+	+
<i>Staurestrum punctulatum</i> Bréb.					+			+
<i>Euastrum bidentatum</i> Næg.	+							
<i>Euastrum</i> sp.		+						
<i>Tetmemorus laevis</i> Ralfs			+					
<i>Sphaerosoma excavatum</i> Ralfs		+	+	+				

group was composed of algae occurring to the depth of 12 m. The majority of *Chlorophyceae* were found here, as well as numerous diatoms and *Dinobryon* sp. The algae developed most intensely from September to November. The number of taxonomic units and species increased during this period.

The following are some remarks on those algae deserving fuller description.

1. *Melosira distans* (Ehr.) Kütz. var. *alpigena* Grun. (fig. 5). Encountered in small numbers in the littoral zone of the reservoir; frequently occurs in the lake Morskie Oko (Wasylik 1965, Kaweck a 1966). Is also known from streams of the High Tatras (Kaweck a 1965). Classed among stenothermal species inhabiting cold waters.

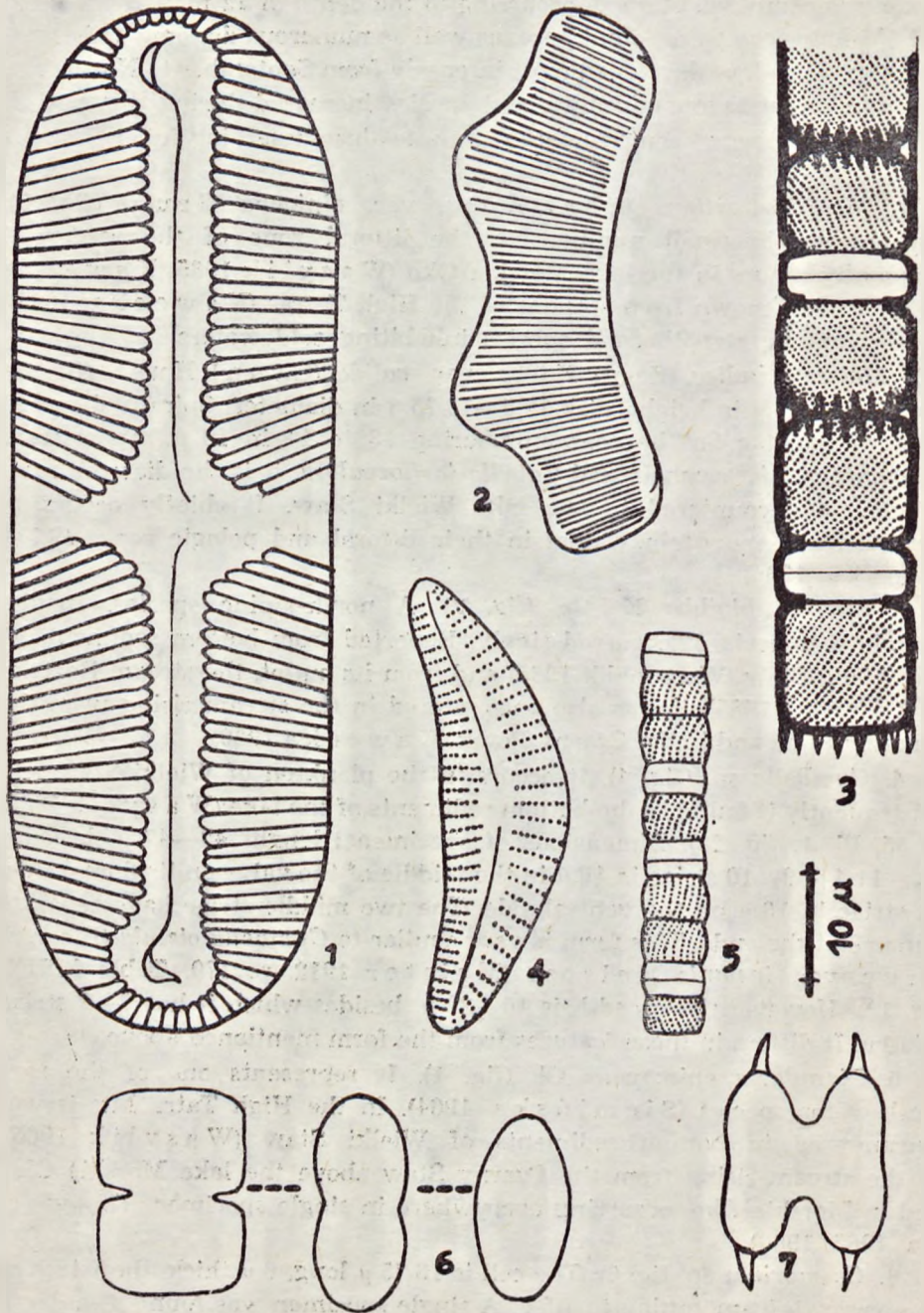
2. *Melosira italica* (Ehr.) Kütz. var. *valida* (Grun.) Hust. (fig. 3). Valves 10—15 μ in height, disk 12.5—13.75 μ in diameter. Spirally disposed rows of punctae on the coat, numbering 13 to 14 in 10 μ . Apart from *Achnanthes microcephala* and *Tabellaria flocculosa*, it is the diatoms most frequently encountered in the lake Wielki Staw. It chiefly occurs in northern and mountain waters in their littoral and pelagic zones (Siemińska 1964).

3. *Eunotia bigibba* Kütz. (fig. 2). A north-alpine species. In the examined material it occurred singly. Reported from bottom sediments of the Wielki Staw (Wasylik 1965) and from its outlet, the stream Roztoka (Kaweck a 1965), it was also encountered in the stream rising from the Zmarzły Staw and in the Czarny Potok (Kaweck a 1969).

4. *Cymbella* sp. (fig. 4). It occurs in the plankton of Wielki Staw and consequently it found in the bottom sediments of the lake (Wasylik 1965, p. 55, Pl. 1, fig. 23). Dimensions of specimens: length 42—47 μ , breadth 9.6—11.4 μ , 9—10 striae in 10 μ in the middle of the valve on its dorsal side, 10 striae in 10 μ on the ventral side. The two middle striae have separate punctae at the ends. This form is very similar to *Cymbella cistula* (Hemp) Grun. var. *insignis* Meister (Meister 1912, p. 179, Table XXIX, fig. 12). However, its breadth is 16—22 μ , besides which it has 7—9 striae in 10 μ . It differs in these features from the form mentioned above.

5. *Pinnularia episcopalis* Cl. (fig. 1). It represents one of the rare fresh-water species (Siemińska 1964). In the High Tatra Mts it was encountered in bottom sediments of Wielki Staw (Wasylik 1965), in the stream rising from the Czarny Staw above the lake Morskie Oko, and in Morskie Oko, occurring everywhere in single specimens (Kaweck a 1965, 1966).

6. *Cosmarium* sp. fig. 6). The cell is 13.75 μ long, 6 μ thick, the width of the narrowing amounting to 7.5 μ . A single specimen was found at a depth of 1 m. in November 1964. It is probably *C. pseudoprotuberans* Kirchn. var. *pygmaeum* Gutw. Both the habit and dimensions correspond to Messikommer's (1942, p. 147, Table V, fig. 7) description. A similar *Cosmarium* was reported by Bybniček (1958, p. 112, Table II, figs. 26



Ryc. 1-7.

Figs. 1-7: 1. *Pinnularia episcopalis*, 2. *Eunotia bigibba*, 3. *Melosira italica* var. *valida*, 4. *Cymbella* sp. 5. *Melosira distans* var. *alpigena*, 6. *Cosmarium* sp., 7. *Arthrodesmus* sp.

and 27). This author suggested that it is *C. pseudoprotuberans* Kirchn. var. *pygmaeum* Gutw. sensu Messikommer (1942), or *C. kaiseri* Messik., observing, however, that it ought to be carefully examined on a rich material. This observation should also be referred to the form examined here, in order to determine its specific name.

7. *Arthrodesmus* sp. (fig. 7). The length of the cell ranges from 15 to 18.75 μ , its width from 15 to 16.25 μ , the width of the narrowing from 6.25 to 7.5 μ , the length of the spines amounting to about 4 μ . This green alga is most similar to *A. incus* (Bréb.) Hass var. *Ralfsii* W. G. S. West form of subhexagon (West 1905, Table IV, p. 96, Plate CXIV, fig. 6). In the Wielki Staw it occurred in single specimens, some of which were slightly damaged. However, its specific appurtenance ought to be determined on a larger material.

I wish to express here my sincere gratitude to Dr K. Wasyluk for his help in the determination of algae.

STRESZCZENIE

Badania prowadzono w latach 1964 i 1965 w Wielkim Stawie położonym w Tatrach Wysokich w Dolinie Pięciu Stawów Polskich (wys. 1664,6 m n.p.m., maks. głębokość 79,3 m., powierzchnia 34,14 km²).

Zbadano gatunki glonów, osiadłych na sztucznym podłożu zawieszonym na różnych głębokościach jeziora. W strefie przybrzeżnej na głębokości 1,5, 10 m oraz w strefie otwartej wody na 2, 12, 32, 52 i 72 m głębokości. *Bacillariophyceae* stanowiły 76,1%, *Chlorophyta* 17,4%, *Cyanophyta* i *Chrysophyceae* po 2,8%, *Pyrrophyta* 0,9%, całości oznaczonych glonów. Rozwój ilościowy glonów był słaby, najintensywniejszy pomiędzy 1 a 12 m głębokości, zwłaszcza w strefie przybrzeżnej jeziora. Wiele form glonów, w tym większość zielenic, nie spotykano głębiej. Glony przeważnie występowały w pojedynczych egzemplarzach, a wyższe liczebności osiągnęły tylko: *Achnanthes microcephala*, *Melosira italica* var. *valida*, *Tabellaria flocculosa*. Okres pomiędzy wrześniem a listopadem był najdogodniejszy dla rozwoju glonów. Wzrastała wtedy liczba jednostek taksonomicznych jak i ilość komórek.

REFERENCES

- Kawecka B., 1965. Communities of benthic algae in the river Białka and in its Tatra tributaries the Rybi Potok and Roztoka. Komitet Zagospod. Ziem Górskich PAN, zeszyt nr 11, s. 113—127.
- Kawecka B., 1966. Glony osiadłe na *Potamogenton* sp. w Morskim Oku. Acta Hydrobiol. 8, 3—4, s. 321—328.
- Kawecka B., 1969. Zbiorowiska glonów w potokach Tatr Wysokich (in manuscript).
- Kownacka M. A. Kownacki 1965. The bottom fauna of the lakes Morskie Oko and Wielki Staw in the Polish Tatra Mountains. Komitet Zagospod. Ziem Górskich PAN, zeszyt nr 11, Kraków s. 33—38.
- Meister F., 1912. Die Kieselalgen der Schweiz. Beitr. zur Kryptogamenfl. der Schweiz IV, 1, 1—254 + 48 Pl.

- Messikomer E., 1942. Beitrag zur Kenntnis der Algenflora und Algenvegetation des Hochgebirges um Davos. Beitrage zur geobotan. Landesaufnahme der Schweiz, Heft 24.
- Pasternak K., 1965. The chemical composition of sediments in some Tatra lakes. Komitet Zagosp. Ziem Górskich PAN, zeszyt nr 11, s. 59—73.
- Polek T., 1964. Zimowy plankton roślinny trzech jezior tatrzańskich (in manuscript).
- Sliwerski K., 1935. Zmienność poziomu wód i repery jeziorne. Wiadomości Służby Geograficznej T. 9, zeszyt 1-2, s. 295—310.
- Siemińska J., 1964. *Bacillariophyceae*. Flora Ślaskowodna Polski, T. 6, Warszawa.
- Rybniček K., 1958. Krásivky pramenné oblasti Branné v Hrubem Jeseníku. Přírodovědecký Sborník Ostravskeno Kraje XIX-1.
- Wasyluk K., 1965. Remnants of algae in bottom sediments of the lakes Wielki Staw and Morskie Oko in the Tatra mountains. Komitet Zagospod. Ziem Górskich PAN, zeszyt nr 11, s. 39—58.
- West W., 1905—1923. British *Desmidiaceae*, vol. II—V, London.
- Woźniczka K., 1965. The zooplankton of the Valley of Five Polish Lakes in the Tatra mountains. Komitet Zagospod. Ziem Górskich PAN, zeszyt nr 11, s. 19—31.

Adres autorki — Author's address

dr Barbara Kawecka

Zakład Biologii Wód, Polska Akademia Nauk, Kraków, ul. Sławkowska 17