

## DIATOMS OF THE FAMILIES AMPHIPLEURACEAE AND BRACHYSIRACEAE FROM THE WYŻYNA KRAKOWSKO-CZĘSTOCHOWSKA UPLAND (S POLAND)

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**Abstract:** Diatom taxa representing the Amphipleuraceae and Brachysiraceae families are reported from Kobylanka Stream situated in the Wyżyna Krakowsko-Częstochowska upland (S Poland), and described based on light and scanning electron microscopy. Among the three recorded species, *Brachysira minor* (Krasske) Lange-Bert. is a new record for the flora of Europe, *B. microcephala* (Grun.) Compère is new to the study area, and *Frustulia vulgaris* (Thw.) De Toni is common in Poland. The morphological characteristics and ecological requirements of the species are briefly discussed, and maps of their distribution and photographic documentation are provided.

**Key words:** Bacillariophyceae, taxonomy, *Brachysira minor*, *B. microcephala*, *Frustulia vulgaris*, ecology, distribution

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### INTRODUCTION

The diatom flora of the Wyżyna Krakowsko-Częstochowska upland (Southern Poland) is relatively well investigated (e.g., Cabejszekówna 1935; Gumiński 1947; Siemińska 1947; Turoboyski 1962; Skalna 1969; Skalska 1966a, b; Kubik 1970, Hojda 1971; Wasylik 1985; Nawrat 1993). The specific conditions and differentiated habitats of this region favor the occurrence of various diatoms. Cosmopolitan species typical for calcareous terrain are reported most frequently, but numerous species rarely reported from Poland also occur here (e.g., Skalska 1966a, b; Hojda 1971; Kubik 1970; Wojtal 2001, 2003a, b).

Documentation is very important for accurate taxonomic identification of diatoms. Unlike other groups of organisms whose taxonomy is stable, photographic images and voucher specimens deposited in collections must be provided to support data on diatom taxa. Most of the floristic and ecological works on diatoms published in the 19<sup>th</sup> and 20<sup>th</sup> centuries were not supported and validated by adequate documentation and most frequently their value is very limited (Mann 2001; Kellogg & Kellogg 2002).

This paper presents the results of a floristic study of a stream, focused on taxa of the families Amphipleuraceae and Brachysiraceae, represented by three species of the genera *Frustulia* Rabenh. and *Brachysira* Bory in the material studied. Both genera comprise a relatively small number of taxa. The morphology of several species of *Frustulia* and *Brachysira* has been reinvestigated recently, and some of those studies have led to new taxonomic proposals and findings on phylogenetic relationships between particular species (Round & Mann 1981; Lange-Bertalot & Moser 1994; Wolfe & Kling 2002). Both genera are interesting in respect to their distribution and ecology. *Frustulia* and *Brachysira* species are commonly distributed in the Southern Hemisphere (Lange-Bertalot & Moser 1994, Metzeltin & Lange-Bertalot 1998, Kellogg & Kellogg 2001). Most *Frustulia* taxa known so far occur in habitats with low mineral content, acidic oligosaprobic waters or peat bogs. Similar environmental conditions (acidic oligosaprobic waters with low mineral content) are suitable for numerous *Brachysira* taxa (Lange-Bertalot & Moser 1994; Wolfe & Kling 2001).

## MATERIAL AND METHODS

Diatoms were intensively investigated in 1993–2002 in Kobylanka Stream, situated *ca* 30 km NW of Kraków. It is 7.3 km long, 0.4–1.2 m wide and 0.1–0.3 m deep, and possesses features typical for calcareous streams. During the study period the water temperature was 6.2°C–9.0°C (rarely higher), flow ranged from 10 to 18 cm/s<sup>-1</sup>, and conductivity was moderate, generally 360–480 µS/cm<sup>-1</sup>. The pH values usually varied from 6.1 to 8.0. The material was collected from mud, gravel and stones, filamentous algae (*Cladophora* sp., *Vaucheria* sp., and *Ulothrix* sp.) and submerged macrophytes. The material collected was preserved in 4% formaldehyde. The samples were treated with HCl, washed several times with distilled water, and boiled in concentrated H<sub>2</sub>O<sub>2</sub> with a small amount of KClO<sub>3</sub> in order to remove organic matter. After several rinses with distilled water, the material was air-dried on a coverglass and mounted in Naphrax. Observations employed a Nikon Optiphot microscope equipped with a Plan × 100 oil immersion lens (numerical aperture 1.25) and a Nikon FX-35 photomicroscopy unit. SEM observations of cleaned, gold-coated material employed a Philips XL 30ESEM instrument microscope.

Data on the distribution of particular species were obtained from the literature and from the Iconotheca of Algae of the Department of Phycology, W. Szafer Institute of Botany, Polish Academy of Sciences, Kraków.

The material studied is deposited in the collection of the Department of Phycology, W. Szafer Institute of Botany, Polish Academy of Sciences, Kraków.

## RESULTS AND DISCUSSION

### *Frustulia vulgaris* (Thw.) De Toni

(Figs 1 & 2a–d)

*Schizonema vulgare* Thw.

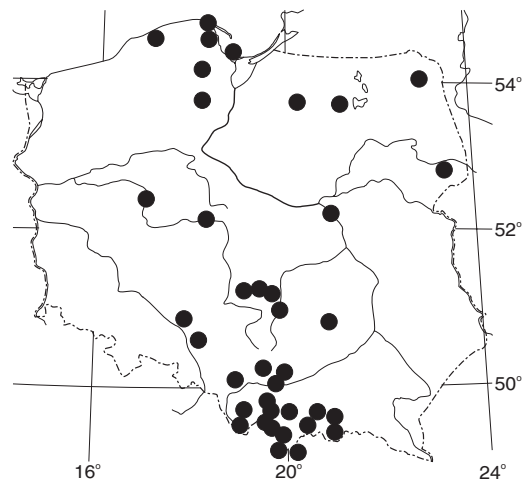
Ref. Krammer & Lange-Bertalot 1986 (Fig. 97: 1–6); Lange-Bertalot 2001 (Fig. 134: 1–7).

Valves with flat valve face, linear-lanceolate, 53.0–63.5 µm long and 10–12 µm wide. Striae around central area moderately radial, becoming parallel and very slightly convergent at ends, uniseriate, 30 per 10 µm. Raphe system slightly biarcuate. Internally, raphe branches accompanied by prominent axial ribs interrupted in the central

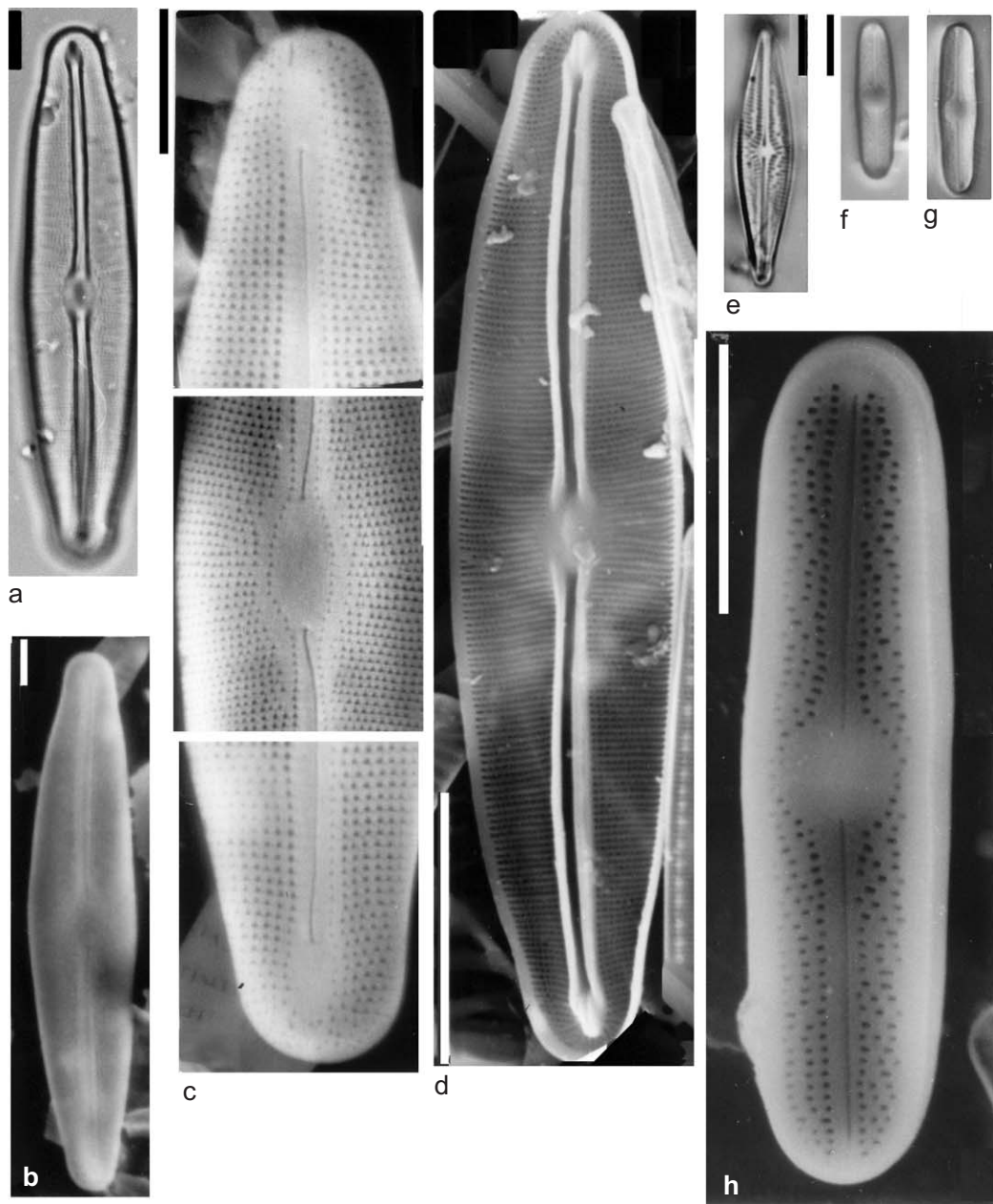
area, hence forming no continual axial system including the central nodule. At the poles, ribs closely associated to the helictoglossae. Central internal raphe endings simple. Outer raphe endings central and terminal Y-shaped.

**ECOLOGY.** It is a tube-dwelling species occurring in fresh or brackish waters, known also from aerophytic habitats (Krammer & Lange-Bertalot 1986; Lange-Bertalot 2001). According to Lange-Bertalot (2001) it possesses an extraordinarily wide ecological spectrum. High oxygen content seems to be the factor most important to the viability of the species. *Frustulia vulgaris* belongs to the group of diatoms not endangered and even becoming more common (Lange-Bertalot 1996). In Kobylanka Stream it was present during the whole study period. It was observed most frequently among filamentous thalli of *Vaucheria* sp., where it was living in mucilage tubes. It was also frequent in mud samples.

**DISTRIBUTION.** *Frustulia vulgaris* is considered a common, cosmopolitan species (Krammer & Lange-Bertalot 1986; Lange-Bertalot 2001). It is reported from 58 localities in Poland (Fig. 1), but only a few of them could be confirmed because of the lack of any documentation



**Fig. 1.** Distribution of *Frustulia vulgaris* (Thw.) De Toni in Poland. One dot may represent more than one locality.



**Fig. 2.** a–d – *Frustulia vulgaris* (Thw.) De Toni; e – *Brachysira microcephala* (Grun.) Compère; f–h – *B. minor* (Krasske) Lange-Bert. a, e–g – LM, b–c, h – SEM (external valve view); d – LM (internal valve view). Scale bars = 5  $\mu$ m.

in the form of photographic images, morphological descriptions or at least references to original descriptions or illustrations in most source publi-

cations. From the Wyżyna Krakowsko-Częstochowska upland it was reported from the Biała Przemsza River (Cabejszekówna 1935), Młynów-

ka Stream (Gumiński (1947), ponds in Mydlniki (Siemińska 1947), Wisła River (Turoboyski 1962), springs of Kobylanka Stream (Skalna 1969) and Będkówka Stream (Kubik 1970), Sanka Stream (Hojda 1971), and Kluczwoda Stream (Nawrat 1993). Only two localities could be confirmed from the Wyżyna Krakowsko-Częstochowska upland: springs of Kobylanka Stream by slides deposited in the collection of the W. Szafer Institute of Botany, Kraków, studied by Skalna (1969), and of Kluczwoda Stream, by photographic documentation given by Nawrat (1993).

REMARKS. The genus *Frustulia*, described by Rabenhorst in 1853, is represented in European flora by 18 species (Lange-Bertalot 2001). Most of them occur in electrolyte-poor, acidic and oligotrophic waters, but a few taxa are alkaliphilous (Lange-Bertalot 2001).

The second representative of the family Amphipleuraceae known from the Wyżyna Krakowsko-Częstochowska upland, *Amphipleura pellucida* Kütz., has been reported only once, by Hojda (1970), but its occurrence could not be confirmed.

***Brachysira microcephala* (Grun.) Compère**  
(Figs 2e & 3)

*Navicula microcephala* Grun., *Anomoeoneis exilis* (Grun.) Cl. p.p., excl. type, *A. vitrea* (Grun.) Ross p.p., excl. type, *Brachysira exilis* (Kütz.) Round et D.G. Mann p.p., excl. type, *B. neoexilis* Lange-Bert.

Ref. Lange-Bertalot & Moser 1994 (Figs 5: 1–9, 17: 7–11, 32: 27–29, 46: 19–22); Wolfe & Kling 2001 (Figs 14–22).

Valves lanceolate, 17–31 µm long, 5–6 µm wide. Valve face flat, ornamented with longitudinal ribs and siliceous warts on external surface of valve face (e.g., Wolfe & Kling 2001). Transapical striae lineate, uniseriate, composed of simple areolae around central area, 19–25 per 10 µm, irregularly spaced. Axial area narrow. Central area relatively small and circular.

ECOLOGY. This species occurs in oligosaprobic, oligo- to mesotrophic waters with a wide range of pH and electrolyte concentrations (Lange-Bertalot & Moser 1994). According to

Wolfe & Kling (2001) it is circumneutral to slightly acidophilous. In the material studied a few specimens were recorded amongst filamentous thalli of *Cladophora* sp.

DISTRIBUTION. It is one of a few *Brachysira* species thought to be cosmopolitan (Lange-Bertalot & Moser 1994; Wolfe & Kling 2001), widespread in Europe. In Poland it is reported from several scattered localities (Fig. 3), but only two are properly documented by descriptions and/or illustrations (Starmach 1973; Kawecka 1981). It has not been reported from the Wyżyna Krakowsko-Częstochowska upland so far.

REMARKS. *Brachysira microcephala* is reported from numerous freshwater habitats worldwide, and according to Wolfe & Kling (2001) is

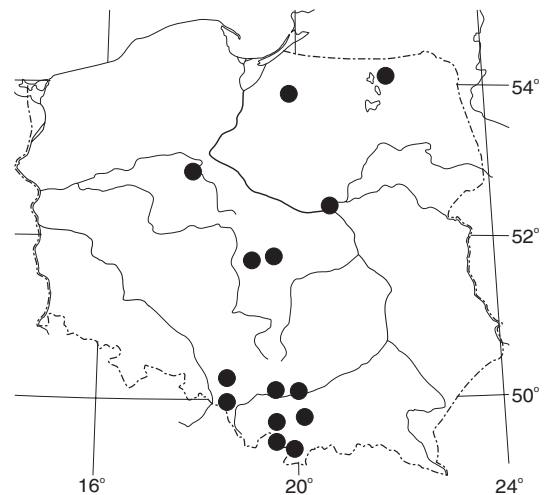


Fig. 3. Distribution of *Brachysira microcephala* (Grun.) Compère in Poland. One dot may represent more than one locality.

one of the most abundant taxa in boreal and arctic lakes occurring in differentiated environmental conditions. Thus the species should be easily identifiable. However, the representatives of this species are considered to be highly polymorphic in respect to valve shape, suggesting complex variability and the need for further detailed investigations.

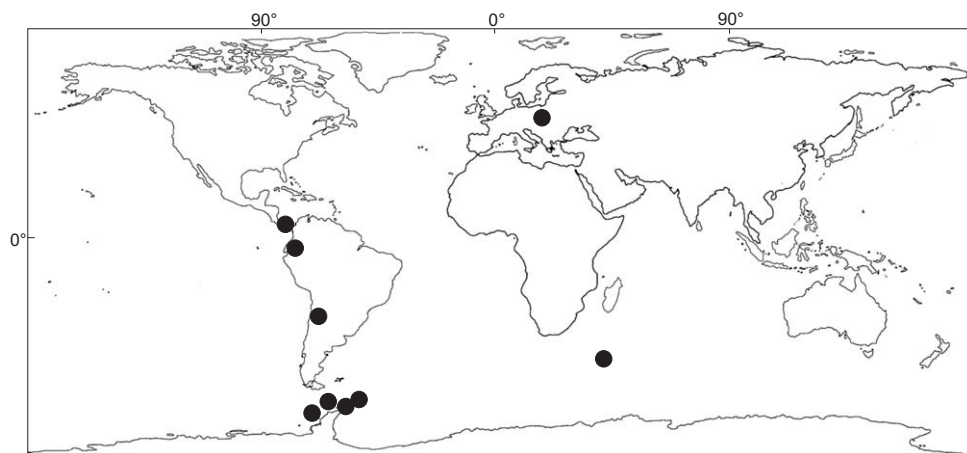


Fig. 4. World distribution of *Brachysira minor* (Kraske) Lange-Bert.

***Brachysira minor*** (Kraske) Lange-Bert.  
(Figs 2f–h & 4)

*Anomoeoneis minor* Kraske

Ref. Lange-Bertalot & Moser 1994 (Fig. 47: 1–8);  
Lange-Bertalot *et al.* 1996 (Fig. 8: 8–12).

Valves linear-elliptic, 12.0–19.5  $\mu\text{m}$  long and 3–4  $\mu\text{m}$  wide, with broadly rounded ends. Valve face flat, without longitudinal ribs surrounding the raphe and without siliceous ‘warts’. Raphe straight, central and terminal raphe endings simple. Transapical striae parallel or very slightly radial, composed of simple areolae, 40–42 per 10  $\mu\text{m}$ . Central area large, circular.

**ECOLOGY.** *Brachysira minor* has been reported so far from electrolyte-poor acidic waters with high oxygen concentration and from periodically wet mosses (Lange-Bertalot & Moser 1994; Van de Vijer & Beyens 1997). It has also been recorded in soil samples (Van de Vijer & Beyens 1998). In the material studied it occurred amongst filamentous thalli of *Cladophora* sp. and moist mosses. From the present study it is clear that the ecological spectrum of *B. minor* is wider and extends to circumneutral or slightly alkaline habitats.

**DISTRIBUTION.** *Brachysira minor* was known until now only from Costa Rica (Wydrzycka & Lange-Bertalot 2001), Chile (Lange-Bertalot *et al.*

1996; Rumrich *et al.* 2000), Ecuador (Rumrich *et al.* 2000), and Antarctic and subantarctic regions (Lange-Bertalot & Moser 1994; Van de Vijer & Beyens 1997, 1998; Kellogg & Kellogg 2002). It is a new record for the flora of Europe. (Fig. 4)

**REMARKS.** *Brachysira minor* lacks the marginal ridge or other longitudinal ribs and siliceous ‘warts’ on the external surface of the valve face. Such a plain valve surface is characteristic also for the genus *Anomoeoneis*. However, it possesses a set of features typical for *Brachysira* such as a straight raphe ending centrally in straight fissures and distally in the absence of fissures.

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#### REFERENCES

- CABEJSZEKÓWNA I. 1935. Contribution à la connaissance des Diatomées de la rivière Biała Przemsza et son bassin dans le terrain de Pustynia Błędowska (“Desert de Błędów”). *Arch. Hydrobiol. Rybactwa* 9: 170–184 (in Polish with French summary).

- GUMIŃSKI S. 1947. Recherches sur le seston de la rivière Młynówka à Mydlniki près de Cracovie. *Acta Soc. Bot. Polon.* **18**(2): 155–178 (in Polish with French summary).
- HOJDA K. 1971. Diatoms of the upper course of the stream Sanka (Cracow-Częstochowa Upland). *Fragm. Flor. Geobot.* **17**(3): 445–454 (in Polish with English summary).
- KAWECKA B. 1981. Sessile algae in European mountain streams. 2. Taxonomy and autecology. *Acta Hydrobiol.* **22**: 361–420.
- KELLOGG T. B. & KELLOGG D. E. 2002. Non-marine and littoral diatoms from Antarctic and Subantarctic Regions. Distribution and updated taxonomy. In: A. WITKOWSKI (ed.), *Diatom monographs* **1**. A. R. G. Gantner Verlag K. G., Vaduz.
- KUBIK B. 1970. The occurrence of Bacillariophyceae in three springs of Będkówka stream (Cracow-Częstochowa Jurassic region), Southern Poland. *Fragm. Flor. Geobot.* **16**(4): 549–561.
- KRAMMER K. & LANGE-BERTALOT H. 1986. Bacillariophyceae. 1. Naviculaceae. – In: H. Ettl, J. Gerloff, H. Heyning & D. Mollenhauer (eds), *Stißwasserflora von Mitteleuropa*. **2**(1). Gustav Fischer Verlag, Stuttgart – New York.
- LANGE-BERTALOT H. 1996. Rote Liste der limnischen Kieselalgen (Bacillariophyceae) Deutschlands. *Schrittenreihe für Vegetationskunde* **28**: 633–677.
- LANGE-BERTALOT H. 2001. *Navicula* sensu stricto, 10 genera separated from *Navicula* sensu lato, *Frustulia*. In: H. Lange-Bertalot (ed.), *Diatoms of Europe. Diatoms of the European inland waters and comparable habitats*. **2**: 1–526. A. R. G. Gantner Verlag K. G., Königstein.
- LANGE-BERTALOT H., KÜELBS T., LAUSER T., NÖRPEL-SCHEMPP M. & WILLMANN M. 1996. Dokumentation und Revision der von G. Krasske beschriebenen Taxa. In: H. Lange-Bertalot (ed.), *Iconographia Diatomologica. Annotated Diatom Iconographs* **3**: 1–347. Koeltz Scientific Books, Königstein.
- LANGE-BERTALOT H. & MOSER G. 1994. *Brachysira*. Monographie der Gattung. *Bibliotheca Diatomologica* **29**. J. Cramer, Berlin – Stuttgart.
- MANN D. G. 2001. The systematics of the *Sellaphora pupula* complex: typification of *S. pupula*. In: R. Jahn, J. P. Kociolek, A. Witkowski & P. Compère (eds), *Lange-Bertalot-Festschrift*, pp. 225–241. A. R. G. Gantner Verlag K. G., Ruggell.
- METZELTIN D. & LANGE-BERTALOT H. 1998. Tropical Diatoms of South America I. About 700 predominantly rarely known or new taxa representative of the neotropical flora. In: H. Lange-Bertalot (ed.), *Iconographia Diatomologica. Annotated Diatom Iconographs* **5**: 1–695. Koeltz Scientific Books, Königstein.
- NAWRAT B. 1993. Autumn-winter diatoms attached to *Vaucheria* filaments in Kluczwoźda streams near Cracow. *Fragm. Flor. Geobot.* **38**(2): 715–736 (in Polish with English summary).
- RABENHORST L. 1853. Die Süßwasser-Diatomaceen (Bacillarien) für Freunde der Mikroskopie. E. Kummer, Leipzig.
- ROUND F. E. & MANN D. G. 1981. The Diatom Genus *Brachysira*. I. Typification and separation from *Anomooneis*. *Arch. Protistenk.* **124**: 221–231.
- ROUND F. E., CRAWFORD R. M. & MANN D. G. 1990. The diatoms, biology and morphology of the genera. Cambridge University Press, Cambridge.
- RUMRICH, U., LANGE-BERTALOT H. & RUMRICH M. 2000. Diatoms of the Andes. From Venezuela to Patagonia/Tierra del Fuego and two additional contributions. In: H. Lange-Bertalot (ed.), *Iconographia Diatomologica. Annotated Diatom Iconographs* **9**: 1–649. Koeltz Scientific Books. A. R. G. Gantner Verlag K. G., Königstein.
- SIEMIŃSKA J. 1947. The winter flora of diatoms in the ponds of the Fishery Experimental Station of the Jagiellonian University at Mydlniki by Cracow. *Arch. Hydrobiol. Rybactwa* **13**: 181–220 (in Polish with English summary).
- SKALNA E. 1969. The occurrence of Bacillariophyceae in three springs of Kobylanka stream (Cracow-Częstochowa Jurassic region). *Fragm. Flor. Geobot.* **15**(2): 245–254 (in Polish with English summary).
- SKALSKA T. 1966a. The occurrence of Bacillariophyceae in a spring at Dubie. *Acta Hydrobiol., Suppl.* **1**: 311–319 (in Polish with English summary).
- SKALSKA T. 1966b. Bacillariophyceae occurring in winter in a spring at Dubie near Kraków. *Fragm. Flor. Geobot.* **12**(2): 233–240 (in Polish).
- STARMACH K. 1973. Bottom algae in Lake Wielki Staw in the Five Polish Lakes Valley in the Tatra Mts. *Fragm. Flor. Geobot.* **19**(4): 481–511 (in Polish with English summary).
- TUROBOYSKI L. 1962. Einführende Untersuchungen über das Vorkommen von Kieselalgen in der Wisła in Kraków. *Ekol. Polska, Ser. A* **10**(9): 273–284 (in Polish with German summary).
- VAN DE VIER B. & BEYENS L. 1997. The epiphytic diatom flora of mosses from Strømness Bay area, South Georgia. *Polar Biology* **17**(6): 492–501.
- VAN DE VIER B. & BEYENS L. 1998. A preliminary study of the soil diatom assemblages from Ile de la Possession (Crozet, Subantarctica). *Eur. J. Soil Biol.* **34**: 133–142.
- WASYLIK K. 1985. Diatom communities in pure and polluted waters in the Biała Przemsza river basin (Southern Poland). *Acta Hydrobiol.* **25/26**(3/4): 287–315.

- WOJTAL A. 2001. New or rare species of the genus *Navicula* (Bacillariophyceae) in the diatom flora of Poland. *Polish Bot. J.* **46**(2): 161–167.
- WOJTAL A. 2003a. Diatoms of the genus *Gomphonema* from karstic stream in the Kraków-Częstochowa Upland. *Acta Soc. Bot. Polon.* **72**(3): 213–220.
- WOJTAL A. 2003b. New locality of *Diademsis tabellariaeformis* (Krasske) Lange-Bertalot et Wojtal (Bacillariophyceae) in Europe. *Algol. Studies* (in press).
- WOLFE A. P. & KLING H. J. 2001. A consideration of some North American soft-water *Brachysira* taxa and description of *B. arctoborealis* sp. nova. In: R. JAHN, J. P. KOCIOLEK, A. WITKOWSKI & P. COMPÈRE (eds), *Lange-Bertalot-Festschrift*, pp. 243–264. A. R. G. Gantner Verlag K. G., Ruggell.
- WYDRZYCKA U. & LANGE-BERTALOT H. 2001. Las diatomeas (Bacillariophyceae) acidófilas del río Agrio y sitios vinculados con su cuenca, volcan Poás, Costa Rica. *Brenesia* **55–56**: 1–67.

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