



Lectotypification, emended description and distribution of *Planothidium distinctum* (Achnanthesiaceae, Bacillariophyceae)

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Abstract

The rare boreo-alpine, oligotraphenic diatom *Planothidium distinctum* (= *Achnanthes distincta*) was first described from the western Alps in 1954. *Achnanthes hirta*, a species described in 1970 from the Pyrenees, is regarded as a heterotypic synonym of *Planothidium distinctum* but almost all morphological details of *P. distinctum* are known from the type material of *Achnanthes hirta*. On the basis of reinvestigation of original samples typification and emended description of *P. distinctum* were carried out by means of LM and SEM. This study extends the distribution of *P. distinctum* to the Carpathians where occasional valves were found in the lateglacial (ca 15,000–14,000 cal yr BP) lacustrine sediment of a mountain lake (Retezat Mts, Southern Carpathians, Romania).

Key words: *Achnanthes*, Carpathians, oligotrophy, paleolimnology, *Planothidium*, Retezat Mountains, taxonomy

Introduction

Planothidium distinctum (Messikommer) Lange-Bertalot (1999: 281) was first described by Messikommer as *Achnanthes distincta* (Messikommer 1954: 32), who found it in three samples collected in the western part of the Alps (Urner Reusstales, Switzerland) at two localities, though not in any abundance. The three samples (material squeezed from mosses overgrowing rocks in an outflow from “Lauteren Seeli”) were included in the species protologue, along with a Latin diagnosis and two drawings illustrating raphe- and rapheless valves (Messikommer 1954: 32, pl. 1, figs 2a, 2b, reproduced here as Figs 1, 2). Since the designation of type material was not obligatory before 1958 (Jahn & Kusber 2009, McNeil *et al.* 2012), the description of *Achnanthes distincta* is valid.

Achnanthes hirta Carter (1970: 609) was described from material collected by J. Broadhead during the summer of 1966 and 1967 in Andorra (Carter 1970, Williams & Reid 2002). A detailed description of the “well defined form” (Carter 1970: 609) included drawings of both the raphe and rapheless valves (Carter 1970: pl. 1, figs 10, 11, reproduced here as Figs 3, 4). A holotype (BM 77780) was designated from “Sample No. 2 from a ditch near Llorts” (Carter 1970, Williams & Reid 2002).

The first micrographs of *Achnanthes hirta* were published by Lange-Bertalot and Krammer in their comprehensive monograph on *Achnanthes* (Lange-Bertalot & Krammer 1989: Pl. 31, figs 2, 3; pl. 40, figs 10–17). The only remark made by Lange-Bertalot and Krammer on the morphology of *A. hirta* refers to its striae structure, which is constructed of three rows of areolae near the valve edge, reducing to two rows towards the axial area (Lange-Bertalot & Krammer 1989: 65). Their description of *A. hirta* is accompanied by twelve light microscope (LM) and two scanning electron microscope (SEM) images. Four of the LM pictures were taken

from type material (BM 77780, Lange-Bertalot & Krammer 1989: pl. 40, figs 10, 10', 11, 12); two images are of specimens from the USA, appended with a reference to *Achnanthes stewartii* (Patrick 1945: 169) (Lange-Bertalot & Krammer 1989: pl. 40, figs 13, 13'); one image is from Iceland (Lange-Bertalot & Krammer 1989: pl. 40, fig. 14); and four images are from the Alps (Lange-Bertalot & Krammer 1989: pl. 40, figs 15–17). The SEM illustrations (Lange-Bertalot & Krammer 1989: pl. 31, figs 3, 4) show only the external view of a rapheless valve, which most probably originated from the type material, indicated in caption as “Leg. J. Carter”.

According to Krammer and Lange-Bertalot (1991: 32), *Achnanthes hirta* is a synonym of *A. distincta*, the latter having priority. *Achnanthes distincta* was illustrated, however, by type specimens of *A. hirta* (Krammer & Lange-Bertalot 1991: Plate 18: 1–4) and two valves from the Alps, of unknown origin (Krammer & Lange-Bertalot 1991: 18, figs 5, 6).

Later, *Achnanthes distincta* was invalidly transferred to the genus *Achnantheiopsis* Lange-Bertalot (1997: 200), but eventually transferred to *Planothidium* (Lange-Bertalot 1999: 281) where it is currently resides.

Recently, a few valves identified as *Planothidium distinctum* were found during an on-going paleolimnological survey carried out on a sediment core of Lake Lia in the Retezat Mountains, South Carpathians, Romania. To clarify the identity of this diatom, type material of *Achnanthes distincta* were studied by means of LM and SEM that resulted in the emended description herein.

Material and Methods

Material

The following material was examined:

1. Messikommer's type material of *Achnanthes distincta*. The species was reported from three samples (Messikommer 1954): Nr. 2, Nr. 4 and Nr. 5. For sample Nr. 2 specimens were rare (“spärlich”); for samples Nr. 4 and Nr. 5 specimens were not so rare (“nicht selten”).

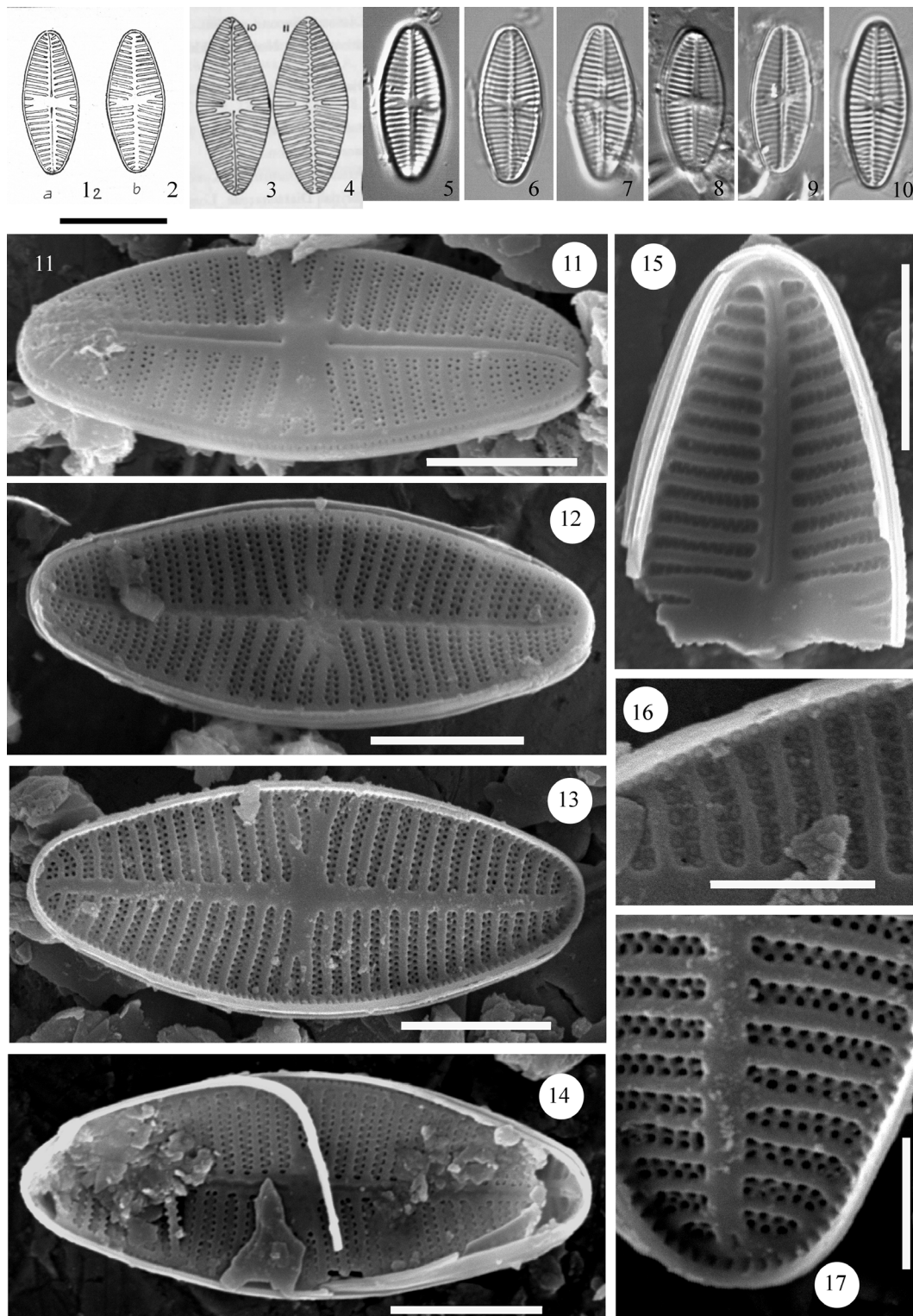
Sample Nr. 4: “Lauteres Seeli. Alt. 2250 m. Gewinnung von Ausquetschmaterial aus ins Gewässer hineinragenden Phanerogamenwurzeln am Kliff. Karbonathärte des Seewassers 2,5° (fr. H.), pH 6,9–7,0. Entnahmedatum wie oben, aber 14^h15“.

Sample Nr. 5. “Dito. Entnahme von Grundschlammmaterial. Entnahmededingungen wie oben“.

A small, dried quantity of material from sample Nr. 4 and Nr. 5 donated to BP (Hungarian Natural History Museum, Budapest) from Z (Universität Zürich, Institut für Systematische Botanik, Messikommer collection). Samples numbered: BP 2013/18 and BP 2013/19, slides BP 2208 and BP 2215.

2. Lake Lia, core samples between 748 and 721 cm: Material and permanent slides BP 2012/275–2012/289.

Site description: Lake Lia is a shallow mountain lake (max. water–depth 4.3 meter, volume ca. 16,000 m³, perimeter 512 m) with a surface area of 1.3 ha (Onciu & Radu 2006, Straškrábová *et al.* 2006) in the Retezat Mountains, South Carpathians, Romania (45°35'30"N, 22°87'87"E). The triangle-shaped Lake Lia is the lowest (1910 m a.s.l.) amongst the lakes of the Bucura cirque. The lake conductivity is low (13 µS cm⁻¹); alkalinity is 36 µeq l⁻¹; dissolved organic carbon (DOC) 0.61 mg l⁻¹, dissolved nitrogen 335 µg l⁻¹, dissolved phosphorous 3.8 µg l⁻¹. (Straškrábová *et al.* 2006). The pH varies between 6.4–6.7 (János Korponai pers. com.)



FIGURES 1–17: Original drawings of *Planothidium distinctum* and *Achnanthes hirta*, LM and SEM images from specimens in Messikommer's sample. Fig 5, designated here as lectotype (BP 2210). **Figs 1, 2.** Reproduction of Messikommer's drawings (1954: 32, pl. 1, figs 2a, 2b). **Figs 3, 4.** Reproduction of Carter's drawings of *Achnanthes hirta* (Carter 1970: 609, pl. 1, figs 10, 11). **Figs 5, 7–9.** Raphid valves in LM. **Figs 6, 10.** Raphidless valve of *Planothidium distinctum* in LM. Scale bar = 10 μm . Figs 5 and 6 are of the same specimen each at a different focus. **Fig. 11.** External view of raphid valve, note the hardly expanded proximal raphe endings. **Fig. 12.** External view of raphidless valve, note three rows of areolae becoming biseriate towards axial area. **Fig. 13.** Internal view of raphidless valve. **Fig. 14.** Whole frustule, external view of raphidless valve. **Fig. 15.** Internal view of raphid valve. **Fig. 16.** Details of internal view of valve with poroids on internal edge of mantle; number is exactly 3 x number of striae. **Fig. 17.** Internal view of raphidless valve with poroids. Note slightly curved valve end. Scale bars = 5 μm for figs 11–15, 2 μm for figs 16, 17.

Methods

The 875-cm long sediment core was taken from Lake Lia with a modified Livingstone piston corer (7-cm diameter) in July 2008. The core was sub-sampled at every 2 cm for diatom analysis. For analyses of the siliceous algae, samples were prepared using standard digestion procedures (Battarbee 1986). Approximately 350 valves were counted from each sample using a light microscope (LEICA DM LB2 with 100 HCX PLAN APO objective). The cleaned sample was air-dried on an aluminium stub, sputter-coated with gold-palladium and studied in a Hitachi S-26000N scanning electron microscope.

Morphological terminology follows Hendey (1964), Barber & Haworth (1981) and Round *et al.* (1990).

Taxonomic results

Planothidium distinctum (Messik.) Lange-Bert. (1999: 281) emend. Buczkó, Wojtal & Magyari (Figs 5–17; Figs 19–32)

Basionym: *Achnanthes distincta* Messikommer (1954: 32, plate 1, figs 2a, 2b)

Synonyms: *Achnantheiopsis distincta* (Messik.) Lange-Bert. (1997: 206)

Achnanthes hirta J.R. Carter (1970: 609, plate 1, figs 10, 11)

Type:—SWITZERLAND: “Lauteres Seeli. Alt. 2250 m. Gewinnung von Ausquetschmaterial aus ins Gewässer hineinragenden Phanerogamenwurzeln am Kliff”; (BP slide 2210!, lectotype, designed here, illustrated in fig. 5; Messikommer’s original material sample Nr. 4, see above for further details; lectotype specimen located using England Finder H30/3 (Fig. 18) or at co-ordinates 30.8 and 108 with a Leica DM LB2 light microscope).

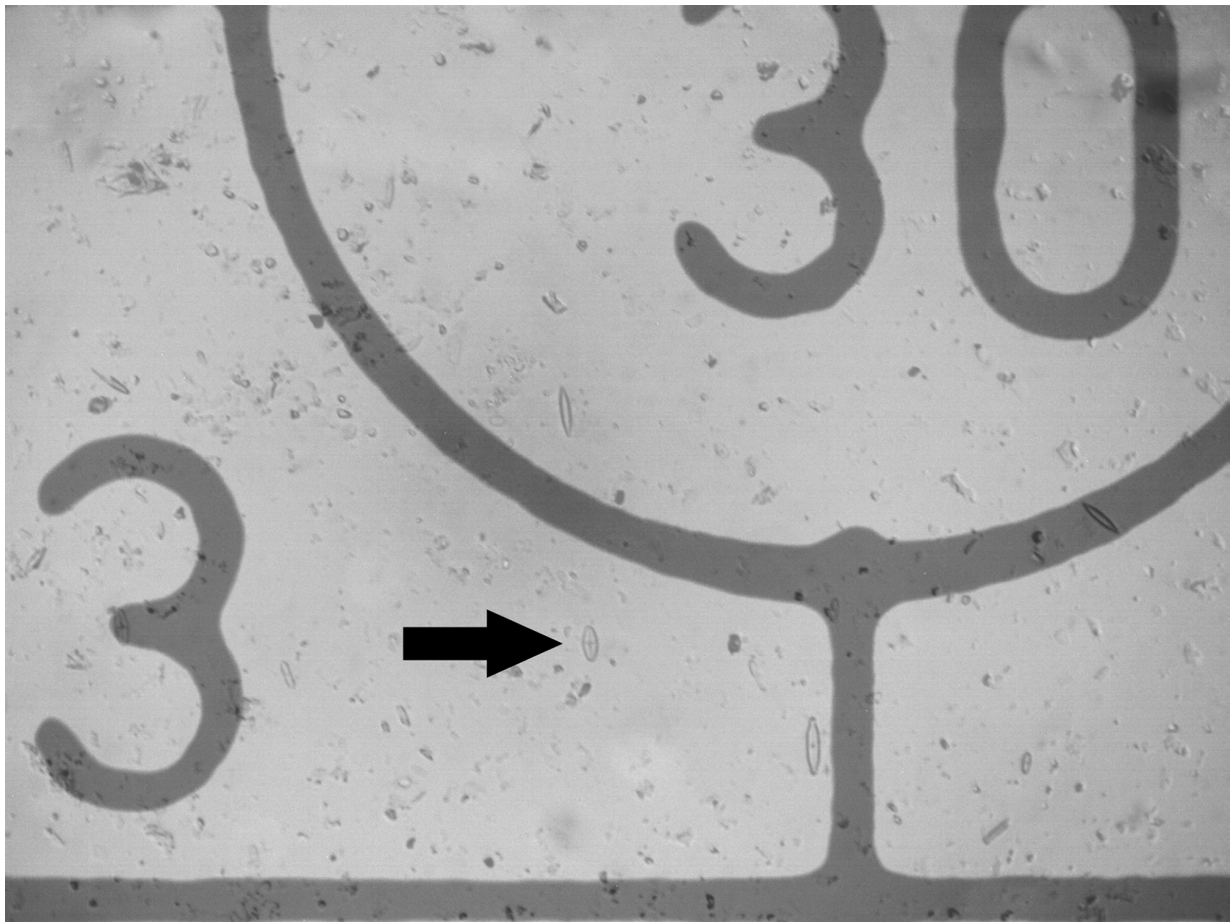
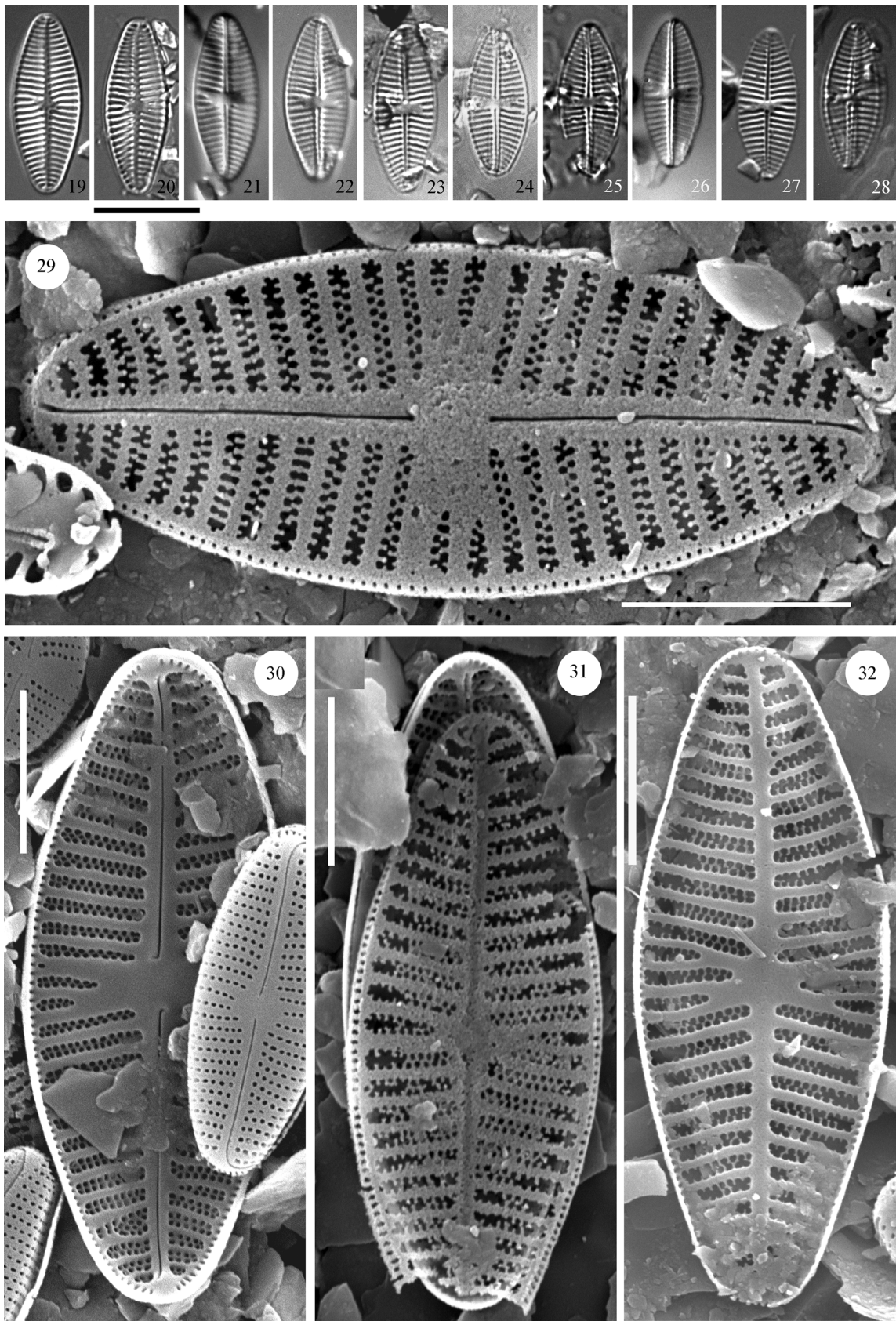


FIGURE 18: Position of lectotype specimen of *Planothidium distinctum* on BP 2210, England Finder H30/3.



FIGURES 19–32: *Planothidium distinctum* LM and SEM images of specimens from Lake Lia lacustrine sediment. **Figs 19–20.** LM of rapheless valves. **Figs 21–28.** LM of raphid valves. **Fig. 29.** External view of raphid valve. Note straight, simple raphe endings. **Fig. 30.** Internal view of raphe valve, note central raphe endings deflected in opposite directions. **Fig. 31.** Whole frustule, external view of rapheless valve. Valve and mantle, latter bears row of poroids with number exactly 3 x that of striae. **Fig. 32.** Internal view of rapheless valve. Scale bars = 10 μm for figs 19–28, 5 μm for figs 29–32.

Emended description of type material (Figs 5–17): Valves lanceolate with broadly protracted, rounded apices (Figs 5–10); valve length $18.3 \pm 1.4 \mu\text{m}$ (min = $16.1 \mu\text{m}$, max = $20.3 \mu\text{m}$), width $7.2 \pm 0.3 \mu\text{m}$; (min = $5.8 \mu\text{m}$ max = $7.9 \mu\text{m}$) (n = 18). Rapheless valve with very narrow with linear axial area. Central area small, transversely rectangular, asymmetrical (2–3 central striae usually slightly shortened). Striae radiate throughout valve, 12–14 in $10 \mu\text{m}$. Raphe straight, filiform, terminal fissures turned in opposite directions. Axial area narrow, linear. Central area small, transversely rectangular asymmetrical. Striae radiate throughout valve, 15–16 in $10 \mu\text{m}$. Areolae not resolvable in LM.

In SEM: externally, terminal raphe fissures very slightly curved in opposite directions (Fig. 11). Proximal raphe endings straight, slightly expanded, (hardly ‘drop-like’) relatively distant from each other (Fig. 11). Distance between central pores on outer surface shorter than inner surface, $1.0\text{--}1.3 \mu\text{m}$ and $1.5\text{--}1.6$, respectively (Figs 11, 15). Mantle bears a row of poroids, exactly 3 x number of striae (Figs 11, 13, 16, 17). Internally, central raphe endings deflected in opposite directions. Transapical striae usually composed of two rows of alternating small, round areolae ($42\text{--}46$ in $10 \mu\text{m}$), sometimes three, becoming biseriate towards axial area (Fig. 12). In central area, 1–3 asymmetrically shortened striae present. Rapheless valves with narrow, linear axial area and narrow, transversely rectangular, asymmetrical central area of variable size, dependent on length shortened striae. Valve slightly curved in girdle view (Figs 11, 12, 15, 17).

Notes:—Messikommer’s sample Nr. 4 contained a few valves of *Planothidium distinctum*, while none occurred in sample Nr. 5, hence the choice of lectotype. According to Messikommer (1954), the most frequent diatoms in this sample were *Achnanthes austriaca* var. *helvetica* Hustedt (1933: 385), *Achnanthes linearis* (W. Smith) Grunow in Cleve & Grunow (1880: 23), *Cymbella ventricosa* Kützing (1844: 80), *Gomphonema intricatum* var. *pumilum* Grunow (in Van Heurck 1880: pl. 24, figs 35, 36), *Navicula schmassmannii* Hustedt (1943: 400), and *Nitzschia fonticola* (Grunow) Grunow in Van Heurck (1881: pl. 69, fig.15–20).

Description of material from Lake Lia, Retezat Mountains (Figs 19–32): Valve length $19.8 \pm 1.4 \mu\text{m}$ (min = $17.6 \mu\text{m}$, max = $22.5 \mu\text{m}$), width $7.6 \pm 0.1 \mu\text{m}$; (min = $7.2 \mu\text{m}$, max = $8.3 \mu\text{m}$) (n = 27). Striae are radiate throughout valve, 13–14 in $10 \mu\text{m}$ (n = 27). In SEM, externally, terminal raphe fissures slightly curved in opposite directions (Fig. 29). Proximal raphe endings straight, simple, not expanded, relatively distant from each other (Fig. 11). Distance between central pores on outer surface shorter than inner surface, $1.0\text{--}1.3 \mu\text{m}$ and $1.5\text{--}1.6$, respectively (Figs 29, 30). Mantle bears a row of poroids, exactly 3 x number of striae (Figs 29–32). Internally, central raphe endings deflected in opposite directions (Fig. 30). Transapical striae always composed of two rows of alternating small, round areolae ($42\text{--}46$ in $10 \mu\text{m}$). In central area, 1–3 asymmetrically shortened striae present. Rapheless valves narrow, linear axial area and narrow, transversely rectangular, asymmetrical central area of variable size, dependent on length of shortened striae. Valve plain, not curved in girdle view.

Notes:—Preservation of the valves was poor with several corroded forms detected. In the Lake Lia, Retezat Mountains material *Planothidium distinctum* co-occurred with *Navicula digitulus* Hustedt (1943: 162), *Staurosira venter* (Ehrenberg) Grunow (1882: 139), *Achnantheidium minutissimum* (Kützing) Czarnecki (1994: 157), *Diatoma mesodon* (Ehrenberg) Kützing (1844: 47) and *Diademesmis perpusilla* (Grunow) D.G. Mann in Round, Crawford & Mann (1990: 666).

Discussion

These detailed morphological and morphometric studies reveal differences between the specimens found in the populations from type material and specimens found from the Lake Lia material. Namely, (1) dimensions (2) striae pattern (3) shape of central raphe endings, and (4) shape of valves in girdle view.

(1) *Dimensions*: valves in the type material are noticeably smaller than in material from Lake Lia (Table 1, fig. 33). In the protologue for *Achnanthes distincta*, Messikommer (1954) provided dimensions for one valve only, which was length $17.5 \mu\text{m}$, width $7.5 \mu\text{m}$. Further examination of specimens from type material extended these sizes: $16\text{--}20 \mu\text{m}$ in length and $5.8\text{--}7.9 \mu\text{m}$ in width (Table 1, fig. 33). The dimensions given in

Messikommer's protologue (length 17.5 μm , width 7.5 μm) are close to the mean population values. Specimens from the Retezat Mts. have larger valves, but the dimensions of the two populations overlap.

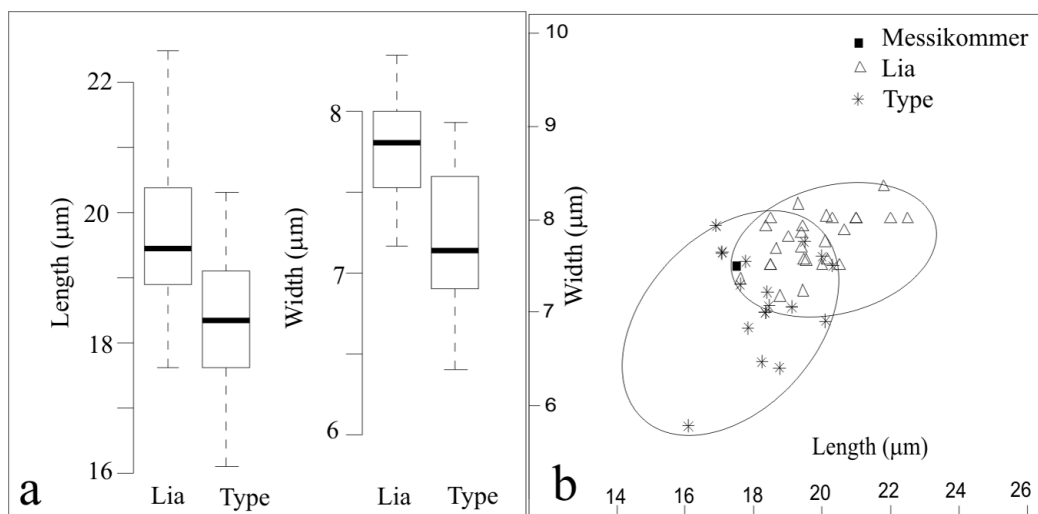


FIGURE 33. Boxplots (a) of length and width of valves in type and Lake Lia populations, and length-width scatterplot (b) of *Planothidium distinctum*.

(2) *Striae morphology*: The striae are always biseriate in the specimens from Lake Lia but, in some cases, multiseriata in specimens from type material. Occasionally three rows of areolae can be detected close to the valve edge that becomes biseriate towards the axial area. These features can be found in type material and were illustrated on valves from Andorra by Lange-Bertalot and Krammer (1989).

(3) *Shape of central raphe endings*: The central pores are simple in specimens from Lake Lia, but expanded in the type material. Messikommer illustrated a large, symmetrical central area on the raphe valve, with well marked central pores, while specimens illustrated by Carter (1970), as well as valves from Lake Lia, have a small, asymmetrical central area and the central raphe ends are simple.

(4) *The shapes of valves in girdle view*: All specimens from the Lake Lia population have valve that are not curved when seen in girdle view, while some slightly curved valves were found in specimens from the type population.

Specimens from type material and from Lake Lia have prominent poroids on valve mantle, with exactly three times the number of striae. According to Round and Bukhtiyarova (1996), species in *Planothidium* have a valve mantle with rather an inconspicuous ring of mantle pores.

Achnanthes stewartii, a species similar to *Planothidium distinctum*, according to Lange-Bertalot and Krammer (1989: 31), was described by Patrick for specimens from Lake Wallenpaupach, USA (Patrick 1945: 169, Plate 2, figs 1–3). Morphological similarities between *Achnanthes stewartii* and *A. distincta* were noted by Krammer and Lange-Bertalot (1991, 2004: 32, 33) and *A. stewartii* was transferred to *Planothidium* as *Planothidium stewartii* (Patrick) Lange-Bertalot (in Krammer & Lange-Bertalot 2004: 437). Later *Planothidium stewartii* was transferred to *Platessa* (Potapova *et al.* 2012: 38) based on its raphe morphology, which, along with some other morphological features, clearly distinguishes it from *Planothidium distinctum*.

Published records for *P. distinctum* began with specimens recorded from mountain areas: the Pyrenees, the Alps, Scandinavia, and the Rocky Mountains, USA. The specimens recorded in Lake Lia extend its occurrence to the Southern Carpathians in the late glacial period. Known records mainly concern lakes (Messikommer 1954, Carter 1970, Krammer & Lange-Bertalot 1991, Juggins 2001), although it is known from habitats threatened by temporal desiccation, such as ditches (Carter 1970), or rocks overgrown by mosses near lake outflow (Messikommer 1954). The tolerance of temporal water deficiency is also suggested by the abundant presence of *Diadesmis perpusilla* in the samples from Lake Lia.

TABLE 1. Morphological characters of *Planothidium distinctum* and *Platessa stewartii* RV = raphe valve; RL = rapheless valve; (*) = values after original description

Taxon/ morphological character	<i>Planothidium distinctum</i>			<i>Platessa stewartii</i>	
Data source	published data from Alps by Messikommer	type population (present study)	Lake Lia (present study)	published data of <i>Achnanthes hirta</i>	published data
valve length (µm)	17.5	16–20	18–22	16–22	11–16
valve width (µm)	7.5	5.8–7.9	7.2–8.3	6–8	5.7–7.0
valve outline	rhombic-elliptic	rhombic-elliptic	lanceolate	lanceolate	elliptic
valve apices	rounded	rounded	rounded	rounded	rounded
number of striae (in 10 µm)	13.0–13.5* RV: 14 RL: 12–16	15 RV: 13–14 RL: 14–16	14 RV: 13–14 RL: 12–14	14 RV: 13–14 RL: 14	14–18*
striation pattern	radiate	radiate	radiate	radiate	radiate
number of areolae (in 10 µm)	unknown	42–46	40	c.a. 38–40	36–44
poroids on mantle	unknown	three poroids per striae	three poroids per striae	unknown	corresponds to the number of striae
striae structure	unknown	three rows of areolae becoming biseriate towards axial area	biseriate	three rows of areolae becoming biseriate towards axial area	biseriate
ecology	*calcium poor, circumneutral, cold- water	*calcium poor, circumneutral, cold-water	weakly acidic	no data	low calcium content
time window	recent	recent	lateglacial 15–13,000 cal year BP	recent	recent
distribution	Alps Switzerland	Alps	Retezat Romania	Andorra	North America

Planothidium distinctum is a rare boreo-alpine diatom with a distribution limited to the least human impacted environments. These areas should be protected, since they are inhabited by threatened, oligotraphenic species, which may be the best biogeographical markers because of their narrow tolerance ranges and peculiar ecological requirements.

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