DIATOMS FROM THE COLOMBIAN LOWLAND WATERS: THE GENUS BRACHYSIRA (NAVICULALES, BACILLARIOPHYCEAE).

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ABSTRACT

This paper is part of an integrated analysis of the diatom flora from Colombia and is focused on the genus Brachysira from lowland waters. Plankton an periphytom samples were collected in lentic an lotic waterbodies from different Amazonian basins and in the Ayapel Swamp System at the Northern Atlantic plain of Colombia. Materials were analysed with light and scanning electron microscopy.

Brachysira aff. brebissonii**,** B. manfredii, B. microcephala and B. subrostrata are discussed and three new species B. guarrerai, B. huitotarum and Brachysira rafaelii are described.

In the study area the genus was found both in lotic and lentic waterbodies. All of the sites where the species were registered are oligotrophic, with acid to circumneutral pH, very low to low conductivity, turbid waters and high temperatures.

This study allowed us to clarify problems related with Colombian materials but also to point out other taxonomic problems within the genus that still need solution.

Key words: Bacillariophyceae, Brachysira, Brachysira guarrerai, Brachysira huitotarum, Brachysira rafaelii, Colombia, diatom, neotropical

INTRODUCTION

This paper is part of an integrated analysis of the diatom flora from Colombia (Sala et al. 1999, 2002 a, b and 2008 a,b, Sala & Ramírez 2008, Vouilloud et al. 2010, Montoya-Moreno et al. 2011). These studies show important differences between Andean and Amazonian regions that could be attributed to altitudinal gradients (Sala et al. 2008b).

This paper is focused on the genus Brachysira from lowland waters of the Amazonian region and of Ayapel, a system of swamps from the Northern Atlanthic plain of Colombia (Fig. 1). In a preliminary analysis to compare diatom flora from different regions of the country, only 16 % of the 450 registered taxa were present in at least two of the five the studied systems that comprised low and highland waters. Amazonia waterbodies and Ayapel system were those more closely related in the performed analysis (Sala et al. 2010, unplublished data).

The genus Brachysira was erected by Kützing in 1836, based on a unique marine species B. aponina Kützing. Nevertheless, the same author afterwards transferred it to the genus Navicula Bory, this criterion was followed a posteriori by other authors until 1981, when Round & Mann analyzed the type of the genus -Brachysira aponina- and redefined the genus. They also compare it with Anomoeoneis and Navicula and transferred several species from Anomoeoneis.

Brachysira species are not usually dominant but could be abundant in acid oligotrophic lakes, generally asociated to Frustulia and Eunotia species (Shayler & Siver 2004b).

Round & Mann (1981), based on the type of the genus, defined as distinctive characters: 1) raphe between two prominent longitudinal ribs 2) a prominent marginal rib at the valve face and mantle union 3) another siliceous longitudinal rib that divides the hemivalve in two parts located between the marginal rib and the raphe, 4) a row of elongate areolae on the mantle that continuous on the valve apices. Besides, they point

out that the valve face is plain, has transapically elongated areolae closed by internal hymens with tiny pores of 5 nm in diameter irregularly arranged. The external proximal raphe ends are expanded and terminal fissure absent. The internal raphe fissures are proximately separated by a siliceus longitudinal thickening and end in small helictoglossae. Lange-Bertalot & Moser (1994) analyzed the genus in detail, described 67 taxa, of which more than one third was new for science. These authors studied many specimens from Venezuela, Brazil and Colombia documenting neotropical taxa. Afterwards, more new species and varieties were described and at present the genus comprises more than 80 taxa (Metzeltin & Lange-Bertalot 1998, 2007, Wolfe & Kling, 2001 and Shayler & Siver 2004a,b).

Round et al. (1990) and Shayler & Siver (2004a) mentioned as other general features the presence of accessory longitudinal ribs or hyaline areas; external terminal raphe ends T- shaped and the internal distal ends finishing in rudimentary helictoglossae. Shayler & Siver (2004a), studing Brachysira species from oligotrophic lakes in Florida, found difficulties in identification of some species frequently mentioned as cosmopolitan. They held an exhaustive revision of the genus, and discussed taxonomic and nomenclatural problems. They point out that other taxonomic characters are important as the number of areolae per striae, the proportion of the valve length with striae composed by only one areola, the areola length and the papilae present on the interstriae.

Although all this research have solved many taxonomic problems there is still a great confusion in relation to species identification, e.g. B. brebissonii Ross, B. neoexilis Lange Bertalot and B. microcephala (Grunow) Compère.

On the other hand, in tropical habitats of South America Metzeltin & Lange-Bertalot (1998, 2007) mentioned several taxa as Brachysira sp. that indicates that there are still

many undescribed taxa in the region. In Colombia Lange-Bertalot and Moser (1994) and Metzeltin & Lange-Bertalot (1998) reported various species. Also there are records of Anomoeoneis (Vélez et al. 2005) that need revision to establish if they belong to Brachysira. In the Amazon there are several records in the Brazilian sector (Lange-Bertalot & Moser, 1994; de Melo & Huszar, 2000; Alencar et al. 2001).

When the analyzed materials were compared with those described in the literature at least 11 taxa were recognized. Some correspond to described taxa while others could not be determined. Whith the aim of enlarging knowledge about tropical Brachysira their fine valve morphology was studied and compared with the species described in the literature.

MATERIALS AND METHODS

Samples for the analysis were collected during February 1991 and November 2003 in Colombian Amazon basins and during May 2006 and January 2009 in the Ayapel swamp system (Fig. 1).

Horizontal and vertical tows were made with a plankton net (mesh size = 24 µm) at different depths of the photic zone, and benthic diatoms were sampled by scraping. At each sampling station were measured temperature, water transparency (Secchi disc), pH, dissolved oxygen, and conductivity (Table 1).

Samples were fixed with 6-8 % formaline or lugol ($KI-I_2$) al 10% and treated to eliminate organic matter following different methods: Hasle & Fryxell (1970), CEN/TC 230 (2002) and/or in a muffle furnace at 500 °C during 10 minutes. Samples for light microscopy (LM) were mounted in permanent slides with Naphrax® and for scanning electron microscopy (SEM) were mounted on glass stubs and then metalized with gold-

palladium. Observations were carried on with a Wild M20 and a Leica DM 2500 LM and a Jeol TM 100 SEM. Terminology used follows Anonymous (1975) and Ross et al. (1979).

Unclean and clean samples and permanent slides are deposited at the Herbarium of the División Científica Ficología, Museo de Ciencias Naturales de La Plata, Argentina (LPC).

1. LPC 5512: Amauri Creek, Departamento del Amazonas, Colombia. 11-1994. Periphyton. 1°10'50.19"N, 69°48'21.80"W. Collected by Santiago R. Duque.

2. LPC 5575: Porvenir River, Departamento del Amazonas, Colombia. 06-2001. Phytoplankton. 2º29'54"S, 70º11'14"W. Collected by Marcela Núñez-Avellaneda.

3. LPC 5608: Temporal Swamp La Turbia, Departamento de Caquetá, Colombia. 11-2003. Periphyton. 1°28'55.769"N, 75°35'19.806" W. Collected by Marcela Núñez-Avellaneda.

4. LPC 5610: Inundated forest creek, Departamento de Caquetá, Colombia. 11-2003. Periphyton. 1°38'01.46"N, 75°28'45.98"W. Collected by Marcela Núñez-Avellaneda.

5. LPC 9939: Permanent Swamp Escobillitas, Departamento de Córdoba, Colombia. 01-2009. 08° 17' 18" N y 75° 05' 38.9" W. Collected by Yimmy Montoya-Moreno.

6. LPC 9942: Permanent Swamp Escobillitas, Departamento de Córdoba, Colombia. 04-2007. 08° 17' 18" N y 75° 05' 38.9" W. Collected by Yimmy Montoya-Moreno.

7. LPC 9943: Permanent Swamp Ayapel, Departamento de Córdoba, Colombia. 09-2006. 08° 18' 55.2" N y 74° 59' 52 " W. Collected by Yimmy Montoya-Moreno.

8. LPC 9947: Quebradona River, Departamento de Córdoba, Colombia. 05-2007. 08° 17' 31" N y 75° 9' 3.7" W. Collected by Yimmy Montoya-Moreno.

9. LPC 9966: Permanent Swamp Escobillitas, Departamento de Córdoba, Colombia. 01-2009. 08° 17' 18" N y 75° 05' 38,9" Wº. Collected by Yimmy Montoya-Moreno.

10. LPC 9969: Permanent Swamp Ayapel, Departamento de Córdoba, Colombia. 01-2008. 08° 18' 55.2" N y 74° 59' 52 " W. Collected by Yimmy Montoya-Moreno.

11. LPC 9975: Barro River, Departamento de Córdoba, Colombia. 09-2006. 08° 16' 13.3" N y 75° 02' 55" W. Collected by Yimmy Montoya-Moreno.

12. LPC 9980. Quebradona River, Departamento de Córdoba, Colombia. 05-2007. 08° 17' 31" N y 75° 9' 3.7" W. Collected by Yimmy Montoya-Moreno.

13. LPC 9982. Permanent Swamp Escobillas, Departamento de Córdoba, Colombia. 01-2009. 08° 16' 49.1" N y 75° 5' 0.8" W. Collected by Yimmy Montoya-Moreno.

14. LPC 9984. Permanent Swamp Ayapel, Departamento de Córdoba, Colombia. 01-2009. 08° 18' 55.2" N y 74° 59' 52 " W. Collected by Yimmy Montoya-Moreno.

15. LPC 9992. Permanent Swamp Hoyo Los Bagres, Departamento de Córdoba, Colombia. 01-2009. 08° 17' 33.1" N y 75° 6' 13.9" W. Collected by Yimmy Montoya-Moreno.

16. LPC 9999. Barro River, Departamento de Córdoba, Colombia. 01-2009. 08° 16' 13.3" N y 75° 02' 55" W. Collected by Yimmy Montoya-Moreno.

OBSERVATIONS

Brachysira aff. brebissonii Ross in Hartley (Figs. 2-6)

Synonyms: Navicula brachysira Brébisson in Rabenhorst 1853

Anomoeoneis brachysira (Brébisson) Cleve 1895

Anomoeoneis serians var. brachysira (Brébisson) Hustedt 1959

Valves lanceolate, valve face flat with rounded ends. Striae uniseriate, mostly radial, only at the apices the 2-3 last striae are parallel, the major part of them built of 2 transapically elongated areolae, sometimes 3, at the valve ends the last 5-6 striae have only one areola. Areolae well spaced, delimiting a wide hyaline and ondulated longitudinal area visible with LM and without anastomosed lines. The Voigt fault is evidenced by a stria with small round areolae. Interstriae with irregularly spaced spines, 2-3 spines per interstriae at the center. Raphe simple, filiform, slightly sinuous externally, proximal and distal ends sligthly curved to the primary side of the valve. Proximal ends simple; terminal fissure T-shaped with curved branches. Central area rounded asymetric. Axial area straight and very narrow. Mantle without spines. Dimensions: length: 17-20 µm; width: 4.5-5 µm; l/w: 3.8-4; 27-30 striae/10 µm; D(pre) (distance between the proximal raphe ends): 1.5 µm.

Studied materials: LPC 5512, 5608 and 5610 (Amazonia); LPC 9975 and 9992 (Ayapel).

Remarks: Wolfe & Kling (2001) studied the isotype of Navicula brachysira Brèbisson ex Rabenhorst (basionym of B. brebissonii) with LM. The authors only mentioned that the specimens have striae strongly radial at the valve center but do not include a description. In the photographs it is only possible to see the valve outline and l/w relationship while other features of the type material, like striae density (see table 2), shape of the central area and raphe details can not be seen. That is why we consider that this information is insufficient to state if our specimens and those described and illustrated in the literature, unequivocally correspond to B. brebissonii.

Our material coincides with the description of B. brebissonii morphotype brebissonii in Lange-Bertalot & Moser (1994), and especially with the specimens from Colombia illustrated in Fig. 44:1-10. These authors were widely followed to determine Brachysira materials.

Distribution: B. brebissonii, reported in the literature as cosmopolitan, was recorded in Colombia by Lange-Bertalot & Moser (1994) and as Anomoeoneis brachysira in Lakes El Piñal and Carimagua in the Llanos Orientales (Vélez et al. 2005). Considering the confusion in relation to this species the records of A. brachysira, must be revised to be sure about the distribution of the species in the country.

Brachysira guarrerai nov. spec. (Figs. 7-11)

Syn: Brachysira cf. garrensis (Lange-Bertalot & Krammer) Lange-Bertalot in Lange Bertalot & Moser (1994, Plate 47: Figs. 21-29)

Type locality: Río Porvenir, Putumayo River Basin, Colombia.

Holotype: slide LPC 5575, División Científica Ficología, Facultad de Ciencias Naturales y Museo (UNLP), La Plata, Argentina.

Etymology: the species is dedicated to Dr. Sebastián A. Guarrera, Professor Emeritus at the Universidad Nacional de La Plata, Argentina, pioneer of the studies of freshwater algae in South America.

Descriptio: Valvae lanceolatae, paulo asymmetrica axis transapical; apicibus rostratis ad subcapitado. Superficie plana valvar. Striae uniseriatae parallela centrum valvae radialis sulci apices versus leviter. Areolis irregulariter distincta. Definiens areolas duas lineas

quae ad apicem anastomosed. Absens interstria papillae. Raphe filiformis recta extremis centralibus externis cum poris, fissuris distalibus T-formis. Area centralis elliptica paulo asymmetrica. Area axialis angusta recta.

Longitudo: 20-38.5 µm; latitudo: 5.5-7 µm; longitudo/latitudo: 3.7-5.4; raphe distantia extrema proximal: 0.8 µm.

Valves lanceolated, slightly asymmetric respect the transapical axis with rostrated to subcapitated ends. Valve face flat. Uniseriate striae, parallel at valve center and sligthly radial on the rest of the valve face. Striae with 2 transapically elongated areolae, to the ends the striae have 2-3 areolae and the last 10-12 have only one elongated areola. The areolae delimiting the central area are longer on the primary valve side. Areolae irregularly spaced, delimiting 1-2 longitudinal undulated and anastomosing hyaline lines visible with LM. Interstriae without warts or spines. Raphe simple, filiform and straight, limitaded by siliceus ribs slightly thickened. Proximal ends straight, slightly expanded; terminal fissure T-shaped, with curved branches. Central area elliptic, asimetryc, more developed on the primary valve side. Axial area narrow and straight. Dimensions: length: 20-38 µm; width: 5.5-7 µm; l/w: 3.7-5.4; 26-32 striae/ 10 µm; D(pre): 0.8 µm.

Studied materials: the species was only registered in the type locality.

Remarks: The specimens collected in Venezuela and mentioned as B. cf. garrensis in Lange- Bertalot & Moser (1994), belong to this new species (see table 3).

The studied material coincides with the type material of Anomoeoneis garrensis Lange-Bertalot & Krammer (Basionym of B. garrensis in Krammer & Lange-Bertalot 1985, Pl.

1 Figs. 1-5) in axial and marginal costae slightly prominent and in the absense of warts, but differs in valve outline rhombic to lanceolate with undifferentiated to slightly protracted ends, striae radiate at valve center and more densely arranged.

Brachysira huitotarum nov. sp. (Figs. 12-26)

Type locality: Temporal Swamp La Turbia, Caquetá River Basin, Colombia.

Holotype: slide LPC 5608, División Científica Ficología, Facultad de Ciencias Naturales y Museo (UNLP), La Plata, Argentina.

Etymology: the specific epithet huitotarum is dedicated to the "Huitoto" community that lives in the River Caquetá Basin.

Descriptio: Valvae late lanceolatae- rhombicae, apicibus late rotundatis ad parum rostratis. Striae uniseriatae, in media fortius radiantis et interpositae, modice radiantis ad apices. Areolis irregulariter distincta. Lines hyalinis longitudinalibus anastomosantibus ad apices. Areolae internum clauditur hymens. Voigt patet saltum grandior an interstria abest areola. Papillae interstria parvis irregulariter dispositas 5-6 per interstria centrum valvae. Raphe simplex filiformis extremis centralibus externis simplex, fissuris distalibus T-formis.

Area centralis rhombica paulo asymmetrica. Area axialis angusta recta. 4 copulae, cum valvocopula poroides seriem.

Longitudo: 17-28.5 µm; latitudo: 5.2-7.5 µm; longitudo/latitudo: 2.7-3.8; 25-30 striae/ 10 µm; raphe distantia extrema proximal: 0.9-1.15 µm; 30 poroides/10µm in valvocopulae.

Valves broadly lanceolated to rhombic, valve face flat, rounded to subrostrated apices. Striae uniseriated, strongly radial at the centre with an interposed stria at each side, moderately radial in the rest of the valve. Each stria comprises 2-3 elongated areolae irregularly spaced while 4-7 apical striae have only one areola. The striae delimiting the central area have two areolae, towards the apices the striae have 3 areolae (the central one shorter) intersposed with striae with 2 areolae. The distribution of the areolae delimits sinuous hyaline longitudinal lines, one at the valve center that divides in two towards the apices and then anastomose at the very end. Areolae closed with internal hymens. Voigt fault evidenced by a greater separation of the striae or by irregular areolae. Interstriae with little warts irregularly spaced, 5-6 warts per interstriae at the centre. Raphe simple, filiform, externally slightly sinuous, proximal and distal ends slightly curved to the primary valve side at the valve center and the ends. Proximal raphe ends simple; terminal fissure T- shape with curved branches; internally proximal ends are curved to the valve primary side; distal ends straight, helictoglossae very small, near the apices. Central area rhombic slightly irregular and asymmetric. Axial area narrow, straight, narrower on the primary valve side. The mantle is inclined respect the valve face, so in valve view it is visible the row of elongated areolae coincident with each striae, mantle with warts. Girdle with 4 copulae, valvocopula with a row of small poroids.

Dimensions: length: 17-28.5 µm; width: 5.2-7.5 µm; l/w: 2.7-3.8; 25-30 striae/ 10 µm; copulae with 30 poroids/10µm; D(pre) 0.9-1.15 µm.

Studied material: LPC 5608 (Amazonia); LPC 9947 and 9966 (Ayapel).

Remarks: the described specimens fit within the range of dimensions of Brachysira brebissonii Ross sensu lato in Lange-Bertalot & Moser (1994) (see table 4). These authors point out that B. brebissonii show a great variation in valve outline, l/w relationship, length, width and striae density and they defined eight morphotypes. B. huitotarum is similar to the B. brebissoni morphotypes latior and major in Lange Bertalot & Moser (1994) but Wolfe & Kling (2001) point out that these morphotypes correspond to a new species named B. arctoborealis Wolfe & Kling. B. huitotarum and B. arctoborealis coincide in l/w relationship and valve outline but clearly differ in that B. arctoborealis has striae with round areolae to the median valve line, slightly elongated to elongated at the margins, also the species has a lower striae density (19-25/10 µm). Besides, none of the studied materials present the occluded areolae similar to a stigmoid present in B. arctoborealis.

The studied materials are also similar to the lectotype of B. microcephala (Grunow) Compére analyzed by Compére (1988) but in the latter the central area is rounded, proximal raphe ends are more distant, the striae have 3-4 areolae irregularly elongated and the central striae are moderately radial and are more densely arranged than in B. huitotarum.

Brachysira manfredii Lange-Bertalot in Lange-Bertalot & Moser (Figs. 27-34)

Valves rhombic-lanceolated with rounded ends. L/W relationship lower in the smaller specimens. Striae uniseriated, sligthly radial at the valve center with 1-2 interposed striae at each side, slightly radial on the rest of the valve. At the centre the striae have 3 transapically elongated areolae, those that delimit the central are longer; away from the center the striae have 4-5 areolae and at the ends the number of areolae is reduced and

the last 10-12 striae have only one areola. The areolae have diferent size and are irregularly spaced, so the longitudinal lines are not well delimited, instead at LM are visible short, undulated and anastomosed lines. Interstriae with irregularly spaced warts, 4-5 per interstriae at the valve centre. Raphe simple, filiform, externaly sligthly sinuous, proximal raphe ends straight and simple, raphe fissure T- shaped with curved branches. Internally, proximal raphe ends straight and simple and terminal ones end in small helictoglossae. Central area elliptical slightly asymmetric. Axial area narrow and straight. The mantle has a row of elongated areolae, without warts. Girdle with 4 copulae, the valvocopula with a row of big poroids and the other copulae with tiny pores at the apices.

Dimensions: length: 31-37 µm; width: 4.5-6 µm; l/w: 5.7-6.8; 30-35 striae/ 10 µm; copulae with 40 poroids/ 10 µm; D(pre): 1.7-2.1 µm.

Studied material: LPC 9939, 9942 and 9984 (Ayapel).

Remarks: the studied material coincides with that illustrated in Lange-Bertalot & Moser (1994) in Fig. 48.9. Dimensions given by the authors for B. manfredii are l: 23-40, w: 5-6, striae 24.5-26.5, our specimens only have a higher stria density. Nevertheless it is important to point out that the authors illustrate the type material with two photographs (Fig. 48.8-9) that seem to correspond to different taxa. To clarify this problem it is necessary to analyse more materials form the type locality.

B. manfredii Lange-Bertalot from the study area coincides with that illustrated in Lange-Bertalot & Moser (1994) in Fig. 48.9 and only have a higher striae density. Nevertheless, it is necessary to point out that the authors illustrate the type material with two SEM photographs (Fig. 48.8-9) that seem to correspond to different taxa. This

problem exceeds the limits of this paper but it is necessary to point out that it would be necessary to analyze more specimens from the type locality to clarify it.

Our specimens also could be confused in LM with B. ocalanensis Shayler & Siver but this species differs from B. manfredii in the valve outline slightly heteropolar and in the striae densely arranged, 33-43/ 10 µm (Shayler & Siver 2004a). Also, the central area is poorly developed, fusiform and raphe terminal fissures are T-shaped with straight branches.

Distribution: B. manfredii reported in tropical environments of Australia, Africa and America, was citated from Sierra Nevada, Colombia (Lange-Bertalot & Moser 1994).

Brachysira microcephala (Grunow) Compère (Figs. 35-40)

Bas.: Navicula microcephala Grunow

Valves broadly rhombic-lanceolated, valve face flat with rounded to rostrated ends. Striae uniseriated, radial throughout the valve, with one interposed stria at each side at the valve center. Striae with 3 transapically elongated areolae, 2 through the poles and at the apices the last 10-12 ones have only one elongated areola. Areolae irregularly spaced, delimiting a hyaline longitudinal line that follows the outline of the axial and central areas and 1-2 undulated and anastomosed short lines at valve center visible with LM. Interstriae with spines irregularly spaced, 4-5 at the center of each interstriae. Raphe simple, filiform, externally slightly sinuous, proximal ends sligthly curved, simple; raphe fissure T-shaped with curved branches. Central area small irregular, very asymmetric. Axial area narrow and straigth. Mantle without warts.

Dimensions: length: 20-28 µm; width: 5-7 µm; l/w: 4-4.3; 28-35 striae/ 10 µm; D(pre): 1.2-1.8 µm.

Studied material: LPC 9939, 9947 and 9992 (Ayapel).

Remarks: the studied specimens coincide with the lectotype of B. microcephala described and illustrated in Compère (1988), except in the lower striae density and width that can be broader (see table 5). Wolfe & Kling (2001) pointed out that B. microcephala is the right name of B. neoexilis Lange-Bertalot and that also is synonym of B. vitrea (Grunow) Ross in Hartley. Also Siver et al. (2005) discussed the confusion related to this taxon and point out that B. neoexilis is a posterior synonym as Lange-Bertalot & Moser (1994) erected it without considering the lectotype given by Compère. However, Siver et al. (op.cit.) distinguish two morphotypes in B. microcephala, one with valves slightly capitated living in acid waters and the other capitated. They considered that the latter is synonym of Anomoeoneis vitrea sensu Patrick & Reimer 1966.

Although dimensions are similar in the three species they differ in valve outline and fine valve morphology so from our point of view there are enough evidences that B. microcephala and B. vitrea are not conspecific. And B. neoxilis still needs a carefull revision.

Distribution: this species, considered cosmopolitan, is recorded in Colombia for the first time.

Brachysira rafaelii nov. spec. (Figs. 41-48)

Type locality: Temporal Swamp La Turbia , Caquetá, Colombia.

Holotype: slide LPC 5608, División Científica Ficología, Facultad de Ciencias Naturales y Museo (UNLP), La Plata, Argentina.

Etymology: the species is dedicated to Lic. Rafael Urrejola, from the SEM Service, Facultad de Ciencias Naturales y Museo, Universidad Nacional de La Plata, Argentina who conducts with us the SEM analysis of the Colombian materials since 1995.

Descriptio: Valvae lanceolatae apicibus subcapitatis vel capitatis. Superficie plana valvar.

Striae uniseriatae, in media radiantis et interpositae, moderate fulgens parallela ad apices. Voigt saltum insignis. Areolae roduntatis vel elongatis irregulariter distincta. Lines hyalinis longitudinalibus anastomosantibus ad apices.Papillae interstria parvis irregulariter dispositas 3-5 per interstria centrum valvae. Raphe simplex filiformis leniter sinuosa extremis centralibus externis recta simplex, fissuris distalibus T-formis. Area centralis rotundatis asymmetrica. 4 copulae, cum valvocopula poroides seriem. Longitudo: 20-27 µm; latitudo: 4.5-5 µm; longitudo/latitudo: 4.3-5.4; striae in 10 µm: 32-34; raphe distantia extrema proximal: 1-1.7 µm.

Valves lanceolated with capitated end, valve face flat. Mantle with one row of elongated areolae, aligned with the valve face striae. Striae uniseriated, slightly radial at valve center with 1-2 interposed striae at each side; slightly radial towards the ends where they are parallel. Voigt fault evident with a short striae that marks off the change of striae position at the secondary valve side. Striae with round to transapically elongated areolae, irregularly spaced, frequently 2 areolae per stria at valve center, then 3-4

smaller and to the apices 2 and finally, one elongated areola at the last 8-10 striae. With LM are visible sinuos and anastomosed hyaline longitudinal lines. Interstria with irregular spaced spines or warts, 3-5 at valve center. Raphe simple, sligthly sinuous, proximal ends straight and simple, distal end T-shaped. Central area rounded, asymmetric, delimited by areolae longuer that the others in the same stria; axial area narrow, straight, narrower at the secondary valve side. Girdle with 4 copulae, valvocopula with a row of poroids, and the other copula with tiny pores at the apices. Dimensions: length: 20-27 µm; width: 4.5-5 µm, l/w: 4.3-5.4; 32-34 striae in 10 µm; D(pre): 1-1.7 µm; copulae with 21-23 poroids/10 µm.

Studied materials: LPC 5512 and 5608 (Amazonia).

Remarks**:** Brachysira rafaelii is similar to Brachysira neoexilis Lange-Bertalot in Lange-Bertalot & Moser (1994) in dimensions but it is difficult to make comparisons as the latter needs further revision to evaluate if it is a valid species. B. neoexilis shows a great variation in valve outline, shape of the central area, striae distribution, among other details of the valve morphology even in the type population (PL. 5: 1-35).

Brachysira subrostrata Lange-Bertalot in Lange-Bertalot & Moser (Figs. 49-58)

Bas.: Anomoeoneis serians var. rostrata Krasske 1948 pro parte (excluding lectotype).

Valves rhombic with rostrated ends. Mantle with one row of elongated areolae aligned with the striae. Striae uniseriated, strongly radial at the valve center with 2-3 interposed striae and moderately radial throughout the rest of the valve. Areolae rounded to transapically elongated, more or less irregularly spaced, internally closed by hymens.

Striae with 4-6 areolae at valve center. Interstria without warts. Voigt fault evident by the absence of one areola towards each secondary hemivalve. Hyaline longitudinal elevated costae parallel to the axial and central areas, 3 at valve center and 1 at the valve ends. Central area small, rhomboidal, irregular; axial area moderately broad, straight. Externally, raphe straight, bordered by two hyaline costae poorly developed near the proximal ends and prominent towards the apices; central and distal raphe ends gently curved to the primary valve side; central raphe ends simple, terminal fissures T-shape with curved branches. Internally, raphe straight with proximal ends simple and straight and distal ones ending in small helictoglossae placed at some distance from the apices. Mantle with a row of elongated areolae interrupted near the ends and continued at the poles by 3 areolae and without warts. Girdle bands without pores.
Dimensions: length: 47.5-53.5 µm, width: 9.5-11.5 µm, l/w: 4.4-5.2; 21-24 striae in 10 µm; D(pre): 1.2-1.4 µm (externally) and 2.2 µm (internaly).

Studied material: LPC 5608 and 5610 (Amazonia); LPC 9992 and 9999 (Ayapel).

Remarks**:** Brachysira subrostrata was erected by Lange-Bertalot & Moser in 1994. The species is based on Anomoeoneis serians var. rostrata Krasske collected in a bog from Brazil (Krasske Collection). Although the type material was not analyzed with SEM we consider that our specimens correspond to this taxon as all characters visible with LM coincide with the description given by Lange-Bertalot & Moser (1994). Nevertheless, Metzeltin & Lange-Bertalot (2007) emend the original description of B. subrostrata but the illustrations they give do not coincide with Lange-Bertalot & Moser (1994). The specimens illustrated in Metzeltin & Lange-Bertalot to broaden the specific limits have striae slightly radial at the centre, without interposed striae and straight distal raphe

ends; in the SEM picture (PL.177, Fig. 3) the apical raphe ends are curved and the striae pattern is also different. Although this problem steel needs revision, our determination was done considering only the original description based on Krasske's materials. On the other hand, B. subrostrata is hardly distinguishable from B. neoacuta, the most notorious difference is that it is thinner than B. subrostrata and present very small papilae. The studied material is also similar to B. serians (Bréb.) Round & Mann, but it can be distinguished from our material in the different position of the striae at valve center, moderately radial without interposed striae and straight distal raphe ends.

B. subrostrata also differ from B. rostrata Metzeltin & Lange-Bertalot in valve outline more rostrated and in the areolae less elongated. The type materials of both species have marked longitudinal lines, which correspond to the elevated costa observed in our material.

Besides, the species is hardly distinguishable from B. neoacuta Lange-Bertalot whose basionym is Anomoeoneis serians var. acuta Hustedt. The most notorious difference between these taxa is that B. neoacuta is thinner than B. subrostrata and present very small papilae. Lange-Bertalot & Moser (1994) do not compare this two species but it is important to establish differences.

Distribution: the species that was previously registered in tropical environments of America, it is cited in Colombia for the first time.

DISCUSSION AND CONCLUSIONS

During the revision of plankton and periphyton samples of lentic and lotic waterbodies of the Colombian Amazon region and from a system of shallow swamps located at the

north eastern part of Colombia at least 11 taxa of the genus Brachysira were registered. In this paper we include B. aff. brebissonii, B. manfredii, B. microcephala and B. subrostrata, and describe three new species B. guarrerai, B. huitotarum and B. rafaelii. The others could not be assigned to any known taxon but as they were very scarce they will not be treated until more material can be examined.

Brachysira brebissonii is one of the most widely distributed and problematic taxa of the genus. Although Wolfe & Kling (2001) studied the isoptype of Navicula brachysira Brébisson -basionym of B. brebissonii- the taxonomic limits of the species are still confusing. Shayler & Siver (2004a) held a detailed nomenclatural analysis of the species from Navicula brachysira and its synonymy to B. brebissonii but to identify their materials from Ocala National Forest the authors compared them with the description in Lange-Bertalot & Moser (1994), without considering the isotype studied in Wolfe & Kling (2001). Siver et al. (2005) also identificated B. brebissonii in materials of Cape Cod (USA) and give interesting comments about taxonomic problems, but also comparing their materials with the morphotype brebissonii in Lange-Bertalot & Moser (1994).

B. microcephala is other taxon mentioned as cosmopolitan in the literature and recorded in varying environments. Unlike B. brebissoni the type material of this taxon has been studied in detail by Compère (1988). On the basis of the comparisson with the type material it seems that many records should be considered erroneous and from our point of view only the those specimens that coincide with the type should be named B. microcephala.

To avoid more confusion within the genus we based our discussions on the comparison of the studied specimens with illustrations of the types given in the literature, but this was not possible in all cases as types are sometimes mounted in inappropriate mounting

medium and /or are poorly illustrated -e.g. B. brebissonii-. This study allowed us to clarify problems related with Colombian materials but also to point out other taxonomic problems within the genus that still need solution.

The specimens of B. aff. brebissonii, B. huitotarum, and B. microcephala observed in this study, could be easily confused with LM but they differ in the shape of the central area, shape and number of areolae per stria, characteristics of the central striae and longitudinal lines (compare figs. 2-5; 12-15, 21; 35-37, 39). B. guarrerai and B. rafaelii are similar at LM in valve outline but the former is broader, it has more acute apices and parallel central striae.

Although Round et al. (1990), Compère (1988), Lange-Bertalot & Moser (1994) Wolfe & Kling (2001) and Shayler & Siver (2004a,b) broaden the limits of the genus and clarified many problems through the study and discussion of the type materials, all above discussed evidences that there is still a great confusion among the known species, especially in the case of those mentioned as widely distributed. This should be particularly related to the morphological similitude of the species when analyzed with LM so other morphological characters to differentiate Brachysira species are proposed. As Round & Mann (1981) defined the genus based on B. aponina some of the characters that they considered are not valid for all the species that the genus comprises today. The authors pointed out that between the marginal costa and the raphe there is another costa that divides de hemivalve in two parts, this is characteristic of B. aponina but in some species there are more than one longitudinal line and others have 2-3 anastomosed lines. On the other hand, the authors mention that the girdle is composed by several copulae without pores and at least B. huitotarum and B. rafaelii have a row of pores in the valvocopula and tinny pores at the ends of the other copulae. Shayler & Siver (2004a,b) pointed out that it is important to take into account the number of

areolae per striae, the areolae size and the presence of warts or spines besides valve outline, length, width, l/w, and striae density. We consider that the central part of the valve is also important, particularly the distribution, size and shape of the striae that delimit the central area and the distance between proximal raphe ends. On the other hand it is necessary to analyze with SEM the external valve face to distinguish taxa as the inside view is very similar in all analyzed species.

In the study area the genus was found both in lotic and lentic waterbodies. All sites where the species were registered are oligotrophic, with acid to circumneutral pH, very low to low conductivity, turbid waters and high temperatures.

While Brachysira brebisonii and B. microcephala are described as cosmopolitan B. manfredii was collected in Australia, Africa and America and B. subrostrata only in the neotropics. As in other diatom species we wonder if the cosmopolitan distribution of some Brachysira species is due mainly attributable to misidentifications and the lack of morphologic and comparative studies of populations from distant areas, this has been probed in studies of other freshwater species even in the same country (Sala et al. 1993, 1998). Although molecular tools can give more precise answers to these questions there is too many work to do in this sense comparing American and other parts of the world populations.

B. brebissonii seems to have a wide distribution in Colombia as it was previously reported by Lange-Bertalot & Moser (1994) and as Anomoeoneis brachysira in Lakes El Piñal and Carimagua in the Llanos Orientales (Vélez et al. 2005) but considering the confusion in relation to this species these records must be revised. In the studied areas Brachysira guarrerai and B. rafaelii were found only in the Amazon region while B. manfredii and B. microcephala were only registered in Ayapel System. B. aff. brebissonii, B. huitotarum and B. subrostrata were found at both geographic areas.

Although the studied sites have similar characteristics in pH, conductivity, differences in diatom flora between the two studied regions had been also observed in a study that considered diatoms geographic distribution in the country (Sala et al. 2010 unpublished data). At present we held coordinated taxonomic and ecological studies in high and lowlands waters of Colombia that will allow explaining these differences.

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REFERENCES

ALENCAR, Y.B., VEIGA LUDWIG, T.A., SOARES, C. & HAMADA, N. (2001). Stomach content analices of Simulium perflavum Roubard 1906 (Dipterae: Simulidae) larvae from streams in Central Amazônia, Brazil. - Mem. Inst. Oswaldo Cruz, 96, 561-576.

ANONYMUS (1975). Proposals for a standardization of diatom terminologyh and diagnosis. Nova Hedwigia, Beih. 53, 323-354.

CEN (2003). Water quality - Guidance standard for the routine sampling and pretreatment of benthic diatoms from rivers. – EN 13946, 2003; Comité European de Normalisation, Geneva.

COMPERE, P. (1988). Brachysira microcephala (Grunow) Compère nom correct de "Navicula exilis" Grunow 1860 non Kutzing 1844. Memoires de la Société Royale de Botanique de Belgique 10: 9-11

DE MELO, S. & HUSZAR, V. L. M. (2000). Phytoplankton in an Amazonian flood-plain lake (Lago Batata, Brasil): diel variation and species strategies. Journal of Plankton Research, 22, 63–76.

KRAMMER, K. & LANGE-BERTALOT, H. (1985). Naviculaceae. Neue und wenig bekannte Taxa, neue Kombinationen und Synonyme sowie Bemerkungen zu einigen Gattungen. Bibliotheca Diatomologica Band 9. J.Cramer. Berlin-Stuttgart. 230 pp.

LANGE-BERTALOT, H. & MOSER, G. (1994). Brachysira. Monographie der Gattung. Wichtige Indikator- Species für das Gewässer-Monitoring und Naviculadicta nov. gen. Bibliotheca Diatomologica Band 29, 212 pp. J. Cramer, Stuttgart.

LANGE-BERTALOT, H., KÜLBST, K., LAUSER, T., NÖRPEL-SCHEMPP, M. & WILLMANN, M. (1996). Diatom Taxa introduced by Georg Krasske. Documentation and revision. Iconographia Diatomologica 3, 358 pp. Koeltz Scientific Books. Königstein.

METZELTIN, D. & LANGE-BERTALOT, H. (1998). Tropical diatoms of south America I. In: Lange-Bertalot. H. (Ed.). Iconographia Diatomologica 5, 695 pp. Koeltz Scientific Books.

METZELTIN, D. & LANGE-BERTALOT, H. (2007). Tropical diatoms of the South America II. Iconographia Diatomologica 18, 877 pp.A.R.G. Gantner Verlag K.G. Koenigstein.

MONTOYA-MORENO, Y., SALA, S., VOUILLOUD, A.A., AGUIRRE, N. (2011). Capartogramma crucicula (Grunow ex Cleve) Ross, un nuevo registro del género para Colombia. Universitas Scientiarum, 16, 70-76.

ROSS, R., COX, E.J., KARAYEVA, D.G.¸ MANN, D.G., PADDOCK, T.B., SIMONSEN, R. & SIMS, P.A. (1979). An emended terminology for the siliceous components of the diatom cell. Nova Hedwigia, 64, 513-533.

ROUND, F. E., CRAWFORD, R. M. & MANN, R. M. (1990). The Diatoms. Biology and Morphology of the Genera. 747 pp., Cambridge University Press, Cambridge.

ROUND, F.E. & MANN, D.G. (1981). The Diatom Genus Brachysira 1. Typification and Separation from Anomoeoneis. Archive für Protistenkunde, 124, 221-231.

SALA, S., DUQUE, S.R., NÚÑEZ-AVELLANEDA, M. & LAMARO, A.A. (1999). Nuevos registros de diatomeas (Bacillariophyceae) de la Amazonia Colombiana. Caldasia 21, 26-37.

SALA, S., DUQUE, S.R., NÚÑEZ-AVELLANEDA, M.& LAMARO, A.A. (2002a). Diatoms from the Colombian Amazonia. Cryptogamie, Algologie, 23, 75-99.

SALA, S., DUQUE, S.R., NÚÑEZ-AVELLANEDA, M.& LAMARO, A.A. (2002b), Diatoms from the Colombian Amazon: some species of the genus Eunotia (Bacillaryophyceae). - Acta Amazonica, 32, 589-603 (also available on-line: http://acta.inpa.gov.br/fasciculos/32-4/PDF/v32n4a05.pdf).

SALA, S.E., SAR, S.E. & FERRARIO, M.E. (1998). Review of the materials mentioned in

Argentina as Amphora coffeaeformis. Diatom Research 13, 323-336.

SALA, S.E.,GUERRERO, J.M. & FERRARIO; M.E. (1993). Redefinition of Reimeria sinuata and recognition of Reimeria uniseriata nov. spec. Diatom Research 8, 439-446.

SALA, S.E., NÚÑEZ-AVELLANEDA, M. & VOUILLOUD, A.A. (2008a). Ultrastructure of the frustule of Urosolenia species from the colombian and peruvian amazon: U. delicatissima nov. spec., U. amazonica nov. spec. and U. braunii (Hustedt). Diatom Research 23, 159-169.

SALA, S.E., RAMIREZ, J.J. (2008). Cyclotella katiana nov. sp. (Bacillariophyceae) from La Reina Swamp, Parque Nacional los Katíos, Colombia. Diatom Research 23, 147-157.

SALA, S.E., RAMIREZ, J.J. & PLATA DIAZ, Y. (2008b). Diatoms from lentic and lotic systems in Antioquia, Chocó and Santander Departments in Colombia. Revista de Biología Tropical/International Journal of Tropical Biology 56, 1159-1178.

SHAYLER, H.A. & SIVER, P.A. (2004a). Biodiversity of the genus Brachysira in the Ocala National Forest, Florida, U.S.A. Proceedings of the Seventeenth International Diatom. Symposium Ottawa, Canada, 25th – 31st August 2002 (M. Poulin, ed.), Biopress limited, Bristol, 309-333.

SHAYLER, H.A. & SIVER, P.A. (2004b). Description of a new species of the diatom genus Brachysira (Bacillariophyta), Brachysira gravida sp. nov. from the Ocala National Forest, Florida, U.S.A. Nova Hedwigia 78, 399-409.

SIMONSEN, P. (1987). Atlas and catalogue of the diatom types of Friedrich Hustedt. 1. Catalogue. 525 pp. 2-3. Atlas, Taf. 1-722. J. Cramer. Stuttgart.

SIVER, P.A., HAMILTON, P.B., STACHURA-SUCHOPLES, K. & KOCIOLEK, J.P. (2005). Diatoms of North America. The freshwater Flora of Cape Cod. Iconographia Diatomologica 14, 463 pp. A.R.G. Gantner Verlag K.G. Koenigstein.

VÉLEZ, M. I.,WILLIE, M., HOOGHIEMSTRA, H. & METCALFE, S. (2005). Integrated diatom-polIen based Holocene environmental reconstruction of Lake Las Margaritas, eastern savannas of Colombia. The Holocene 15, 1184-1198.

VOUILLOUD, A.A., SALA, S.E., NÚÑEZ-AVELLANEDA, M. & DUQUE, S.R. (2010). Diatoms from the Colombian and Peruvian Amazon: the genera Encyonema, Encyonopsis and Gomphonema (Cymbellales, Bacillariophyceae). Revista de Biología Tropical/International Journal of Tropical Biology 58, 45-62.

WOLFE, A.P. & KLING, H.J. (2001). A consideration of some North American soft-water Brachysira taxa and description of B. arctoborealis sp. nov. In: R. Jahn, J.P. Kociolek, A. Witkowski, and P. Compère: Lange-Bertalot-Festschrift: Studies on Diatoms. Koeltz, Koenigstein, 243-264.

FIGURE LEGENDS

Fig. 1. Location of the study sites in Colombian Amazon basins and Ayapel swamp system (Colombia).

Figs. 2-6. Brachysira aff. brebissonii Ross. 2-3. LM. Frustules of different size. 4-6. SEM. 4. External valve view. 5-6. Details of the same specimen showing small warts in interstria and T-shaped distal raphe end. 2. Specimen of Barro River (Ayapel); 3. Specimen of Temporal Swamp La Turbia (Amazonia); 4. Specimen of Amauri Creek (Amazonia).

7-11. Brachysira guarrerai nov. spec. 7-9. LM. Frustules showing size range variation. 10-11. SEM. 10. External valve view. 11. Detail of valve face; note the ribs slighty

prominent, the ausence of warts and T-shaped distal raphe end. 7-11. Holotype material of Porvernir River (Amazonia).

Scale bars: 2-4, 7-10: 5 μm; 5,11: 2 μm; 6: 1 μm.

Figs. 12-26. Brachysira huitotarum nov. spec. 12-15. LM. Frustules showing size range variation. 16-26. SEM. 16-17. External valve view, note the prominent axial and marginal ribs and the warts. 18. Frustule in external view showing the cingulum. 19. Detail of the cingulum showing the valvocopulae with poroids (arrows). 20. External view valve end, note T-shaped distal raphe end and Voigt fault (arrow). 21. External view of the valve center. 22-23. Internal valves view. 24-25. Internal view of the valve center. 26. Internal view of valve end. 12-14, 16-26. Holotype material from Temporal Swamp La Turbia (Amazonia). 15. Specimen from Quebradona River (Ayapel).

Scale bars: 12-18, 22-23: 5 μm; 19: 2 μm; 20-21; 24-26: 1 μm.

Figs. 27-34. Brachysira manfredii Lange-Bertalot. 27-28. LM. Frustules of different size. 29-34. SEM. 29. External valve view; note the ribs slightly prominent, the presence of warts and T-shaped distal raphe end. 30. Frustule in external valve view, showing the cingulum and partially internal view. 31. Detail of the copulae showing pores (arrows). 32. External view of the valve center. 33. External view of the valve end . 34. Internal view of the valve center. 27. Specimen of Permanent Swamp Ayapel; 28. Specimen of Barro River; 29-34. Specimens of Permanent Swamp Escobillitas.

Scale bars: 27-30: 10 μm; 31-34: 2 μm.

Figs. 35-40. Brachysira microcephala (Grunow) Compère. 35-36. LM. Frustules of different size. 37-40. SEM. 37. External valve view. 38. Frustule in external view; note

the ribs slightly prominent, the presence of warts and T-shaped distal raphe end. 39. External view of the valve center. 40. External view of the valve end. 35, 37. Specimens of Permanent Swamp Escobillitas; 36, 38-40. Specimens of Permanent Swamp Ayapel. Scale bars: 35-38: 5 μm; 39-40: 2 μm.

Figs. 41-48. Brachysira rafaelii nov. spec. 41-42. LM. Frustules of different size. 43-48. SEM. 43. Frustule in external view. 44. Valve in internal view. 45. Detail of the frustule showing the Voigt fault (arrow black) and the copulae with poroids (little white arrows). 46. External view of the valve center showing the small rhomboidal central area and the warts on the interstria. 47. External view of the valve end. 48. Internal valve view showing the proximal raphe end and terminal ending in small helictoglossae. 41-48. Holotype material Temporal Swamp La Turbia.
Scale bars: 41-45: 5 μm; 46, 48: 2 μm; 47:1 μm.

Figs. 49-58. Brachysira subrostrata Lange-Bertalot. 49-50. LM. Frustules of different size, the arrow shows the Voigt fault. 51-58. SEM. 51. External valve view; note the ribs slightly prominent, the absence of warts and the Voigt fault (arrow). 52. Frustule in external valve view, showing the cingulum. 53. Internal valve view, note the Voigt fault (arrow). 54. External view of the frustule center, note the longitudinal elevated costae parallel to the axial and central areas. 55. External view of the valve center, central raphe ends simple and costae poorly developed. 56. Detail of valve end showing the T-shaped raphe end and the row of areolae in the mantle interrupted near the ends and continued at the poles by 3 areolae, note the Voigt fault (arrow). 57. Internal view of the valve end; note the distal ends in small helictoglossae placed at some distance from the

apices. 58. Detail of internal view of valve center showing the proximal raphe ends. 49-58. Specimens of Temporal Swamp La Turbia (Amazonia).

Scales bars: 49-53: 10 μm; 54-58: 2 μm.

Table 1. Physical and chemical parameters in sampling stations.

LPC	Location	Date	Sampling Type of community	Temperature (C°)	pH	Conductivity (µS cm-1)	Transparency (m)
5512	Amauri Creek, La Pedrera	11/94	Periphyton	26	4.8	10	0.60
5575	Porvenir River	6/01	Periphyton	27..5	6.3	10.5	0.62
5608	Temporal Swamp La Turbia	11/03	Periphyton	29.8	5.3	12	0.40
5610	Inundated forest creek	11/03	Periphyton	26.5	5.1	8.0	0.45
9939	Permanent Swamp Escobillitas	01/09	Epiphyton on E. azurea	30	6.16	47.9	0.80
9942	Permanent Swamp Escobillitas	04/07	Epiphyton on E. azurea	29.9	6.81	13.8	1.17
9943	Permanent Swamp Ayapel	09/06	Epiphyton on Paspalum sp.	31.9	6.65	21.2	0.60
9947	Quebradona River	05/07	Epiphyton on E. azurea	30.8	6.57	25.8	0.21
9966	Permanent Swamp Escobillitas	05/06	Epiphyton on grass	29.4	6.15	33.2	0.57
9969	Permanent Swamp Ayapel	01/08	Epiphyton on E. crassipes	31.2	7.44	129.6	0.60
9975	Barro River	09/06	Epiphyton on E. heterospermum	30.2	6.3	30	0.57
9980	Quebradona River	01/09	Epiphyton on E. azurea	32	6.2	86.3	0.70
9982	Permanent Swamp Escobillas	01/09	Epiphyton on E. azurea	29.5	6.3	23.9	0.65
9984	Permanent Swamp Ayapel	01/09	Epiphyton on E. azurea	32	6.2	89.5	0.75
9992	Permanent Swamp Hoyo Los Bagres	01/09	Epiphyton on E. azurea	32	5.9	86.2	0.65
9999	Barro River	01/09	Epiphyton on Ludwigia sp.	30	6.71	101.7	0.18

Table 2. Comparison of B.aff. brebissonii and allied taxa. Dimensions in bold correspond to type materials. -: means no data and * measured from the illustrations of the publication.

Taxon	Reference	length	width	l/w	striae/10 µm	D (pre) µm
B. aff. brebissonii Ross	This study	17-20	4.5-5	3.9-4.1	27-30	1.5
B. brebissonii Ross	Wolfe & Kling (2001)	**24-28.5***	**5.8-6.7***	**4.1-4.7***	-	-
		14-23	5-7	3.2-4.4	19-25	1-1.2
B. brebissonii Ross morph. brebissonii	Lange-Bertalot & Moser (1994)	12-45	4.5-8	2.3-5.8*	24-27	0.6-1.5*

Table 3. Comparison of Brachysira guarrerai with other related taxa. D(pre)Dimensions in bold correspond to type materials. -: means no data and * measured from the illustrations of the publication.

Taxon	**Author**	length (µm)	width (µm)	l/w	striae/10µm	D(pre) µm
Brachysira guarrerai	This study	**20-38**	**5.5-7**	**3.7-5.4**	**26-32**	**0.8**
Anomoeoneis garrensis Krammer & Lange-Bertalot	Krammer & Lange-Bertalot 1985	**8.3-32**	**3-6.5**	**-**	**36-40**	-
B. garrensis (Krammer & Lange-Bertalot) Lange-Bertalot & Moser	Lange-Bertalot & Moser 1994	8.3-32	3-6.5	2.2-5.5	36-40	0.75*
B. cf. garrensis (Lange-Bertalot & Krammer) Lange-Bertalot	Lange-Bertalot & Moser 1994	20*	5*	3.2-5.2*	34*	0.9*

Table 4. Comparison of B. huitotarum and allied taxa. Dimensions in bold correspond to type materials. -: means no data and * measured from the illustrations of the publication.

Taxon	Reference	length (µm)	width (µm)	l/w	striae/10 µm	D (pre) µm
B. huitotarum	This study	**17-28.5**	**5.2-7.5**	**2.7-3.8**	**25-30**	**0.9-1.15**
B. brebissonii morph. latior	Lange-Bertalot & Moser (1994, Pl. 42, Figs 1-18)	19-27.5*	6.5-8*	2.9-3.8*	24-28*	1.5-2*
B. brebissonii morph. major	Lange-Bertalot & Moser (1994, Pl. 42, Figs 1-18)	27-43*	7-9*	2.4-5.2*	20-24*	0.6-1.7*
B. arctoborealis Wolfe & Kling	Wolfe & Kling (2001)	**17-31**	**7-10**	**2.8-3.7***	**19-25**	**1-1.6***
B. microcephala (Grunow) Compère	This study	20-28	5-7	4-4.3*	28-35	1.2-1.8*
	Compère (1988)	**13-28**	**4-5.2**	**3.3-5.8***	**35-39**	**1-1.5***

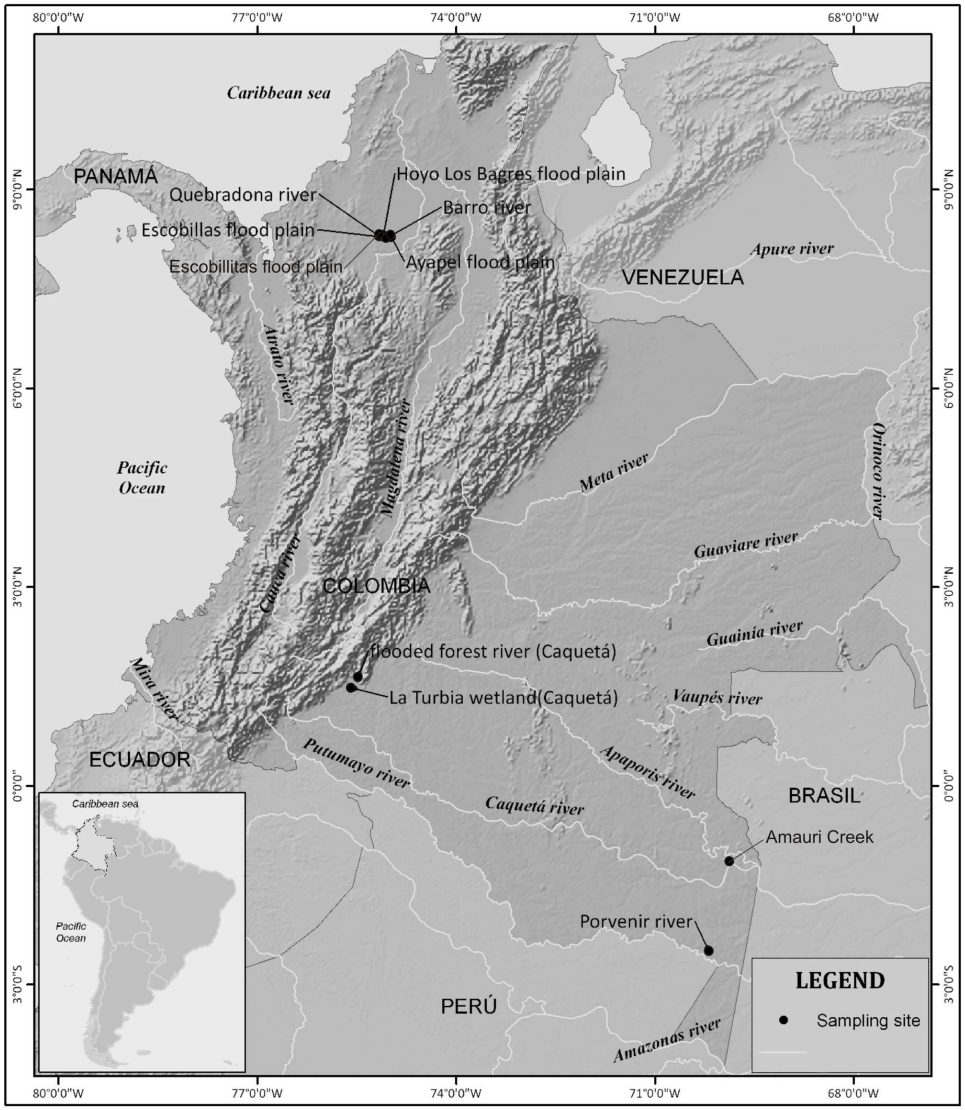
Table 5. Comparison of B. microcephala with other related taxa. Dimensions in bold correspond to type materials. -: means no data and * measured from the illustrations of the publication.

Taxon	Author	length (µm)	width (µm)	striae/10 µm	D(pre) µm
B. microcephala (Grunow) Compère	This study	20-28	5-7	28-35	1.2-1.8
	Compère (1988)	**13-28**	**4-5-2**	**35-39**	**1-1.5***
	Wolfe & Kling (2001)	14-36	4,6	30-35	1.5*
B. neoexilis Lange-Bertalot	Lange-Bertalot & Moser (1994)	**12-34**	**2.9-6.4**	**30-36**	**0.8-2.2***
B. vitrea (Grunow) Ross	Lange-Bertalot & Moser (1994)	16-40	5-5-9	30-35	1-1.5*

Table 6. Comparison of B. subrostrata and allied taxa. Dimensions in bold correspond to type materials. -: means no data and * meassured from the ilustrations of the publication.

Taxon	Materials	Length	width	l/w	striae/10 µ	D(pre) µm
B. subrostrata Lange-Bertalot	This study	47.5-53.5	9.5-11.5	4.4-5.2	21-24	1.2-1.4
	Lange-Bertalot & Moser (1994)	**35-67**	**9-14**	**3.8-5.1***	**19-23**	**1.2-1.3***
	Metzeltin & Lange-Bertalot (2007)	35-130	9.5-20	-4.5-6-8	19-23	1.3-2*
Anomoeoneis serians var. rostrata Krasske	Lange-Bertalot et al. (1996, Pl. 8, fig. 7, typus of B. subrostrata Lange-Bertalot)	**36***	**10***	**3.6***	**24***	**1.3***
Brachysira sp.	Metzeltin & Lange-Bertalot (2007, pl. 167, figs. 5-9)	59-67*	12-13*	4.6-5.1*	22-25*	1.3-1.6*
B. serians (Breb) Round & Mann	Lange-Bertalot & Moser (1994)	35-115	10-21	3.6-5.5	19-23	1.6-2*
B. serians var. rostrata (Krasske) Lange-Bertalot & Moser	Lange-Bertalot & Moser (1994)	38-57*	9-13*	4-4.6*	21-23*	1.3-1.6*
Anomoeoneis serians var. rostrata Krasske	Lange-Bertalot et al. (1996, Pl. 8, figs- 3-6, type of B. rostrata (Krasske) Lange-Bertalot & Moser	**38-60***	**8-13***	**3.9-4.5***	**21-22***	**1.3-2***

B. neoacuta Lange- Bertalot	Lange-Bertalot & Moser (1994)	40-65	6-9	6.1-7.7	24-26	1.5*
Anomoeoneis serians var. acuta Hustedt	Simonsen (1987, figs. 36-38) Lectotype	37-46*	8-9*	4.6-5.3*	22-24*	-



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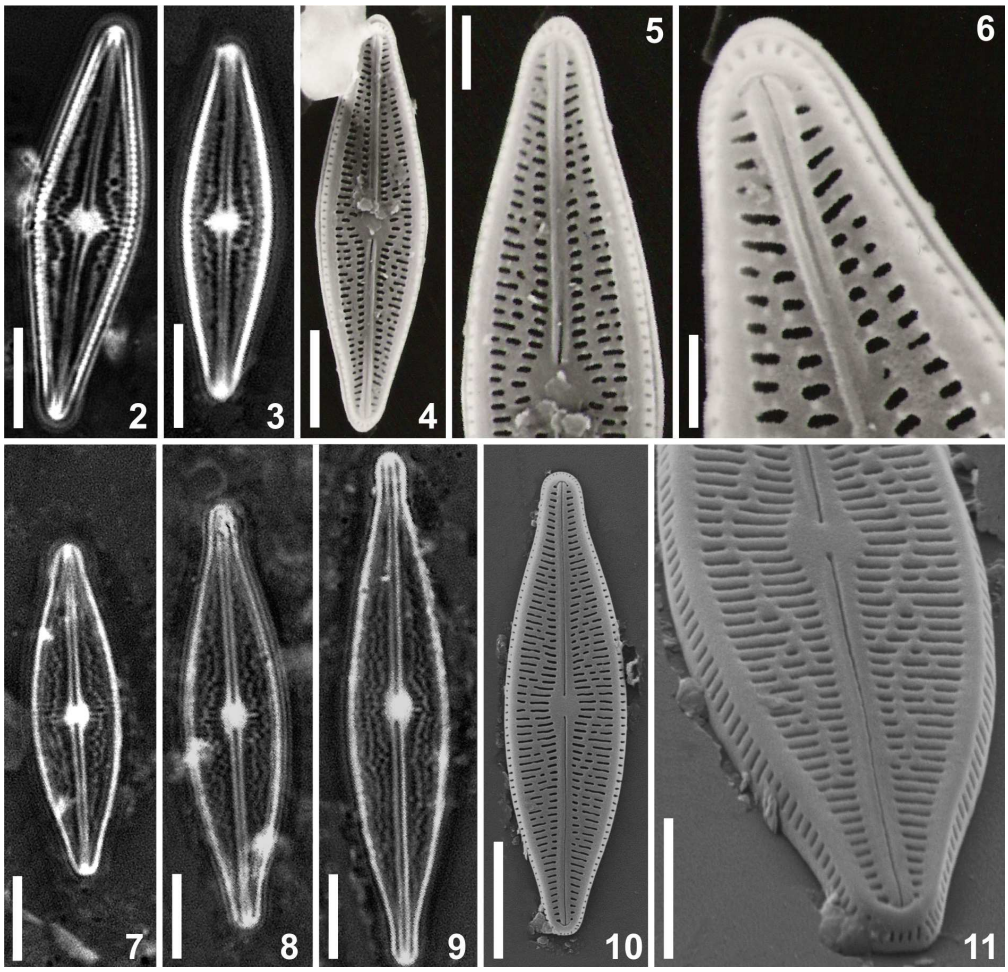

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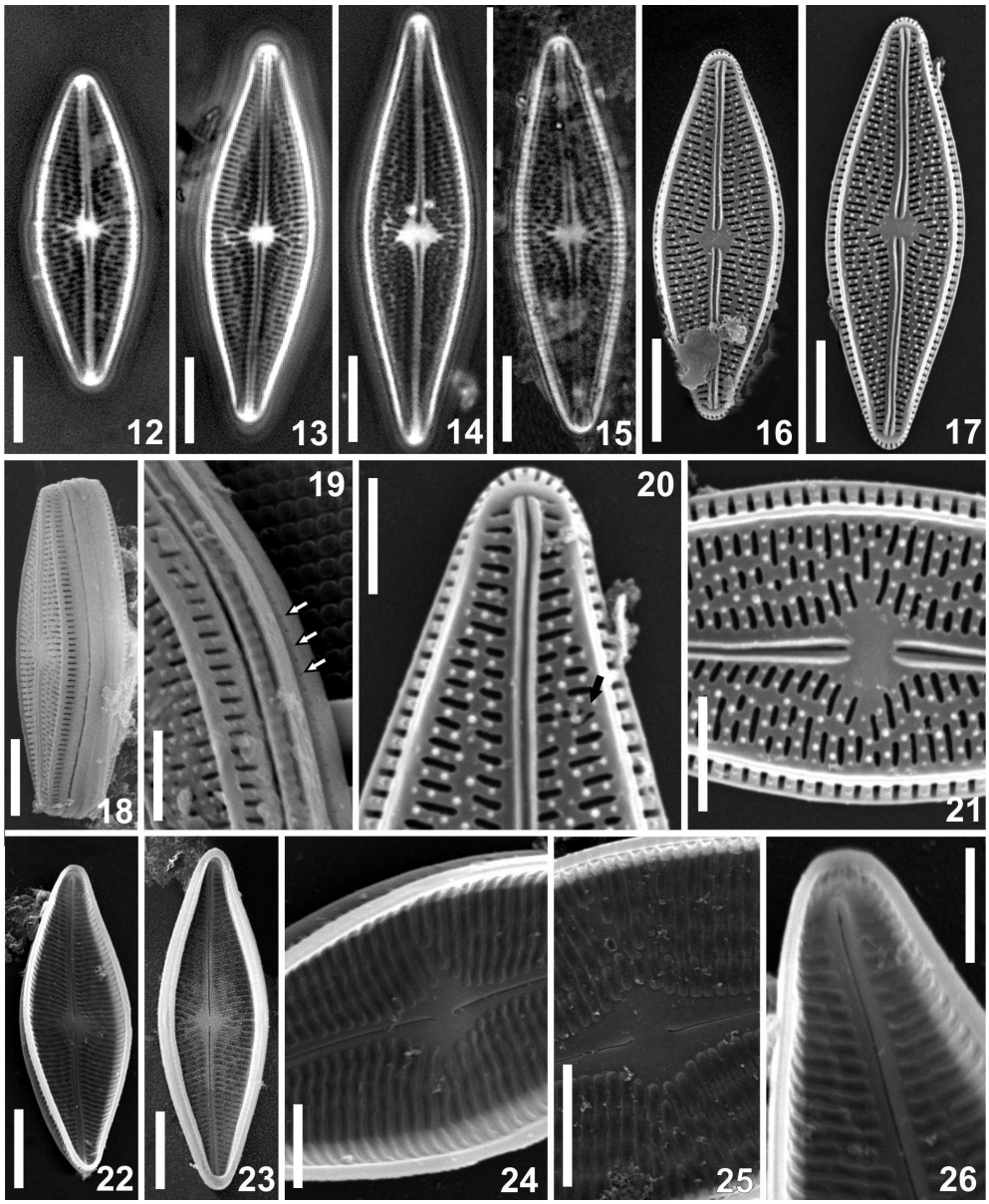

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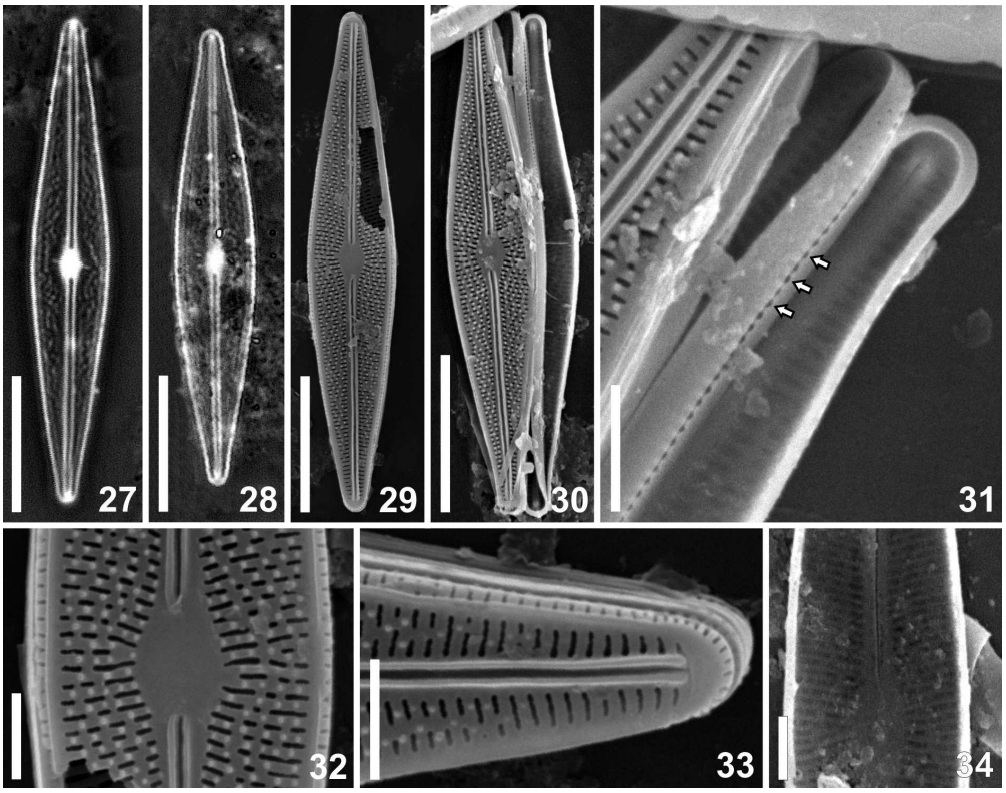

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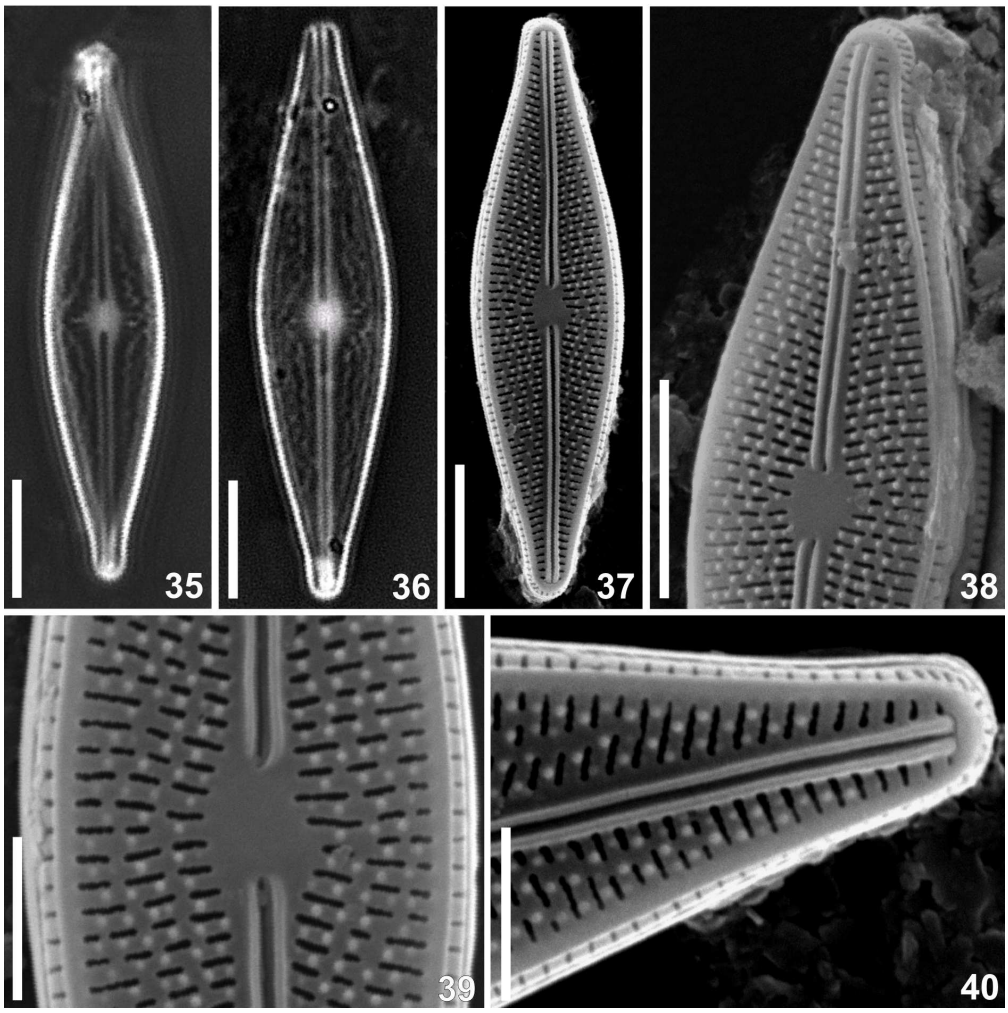

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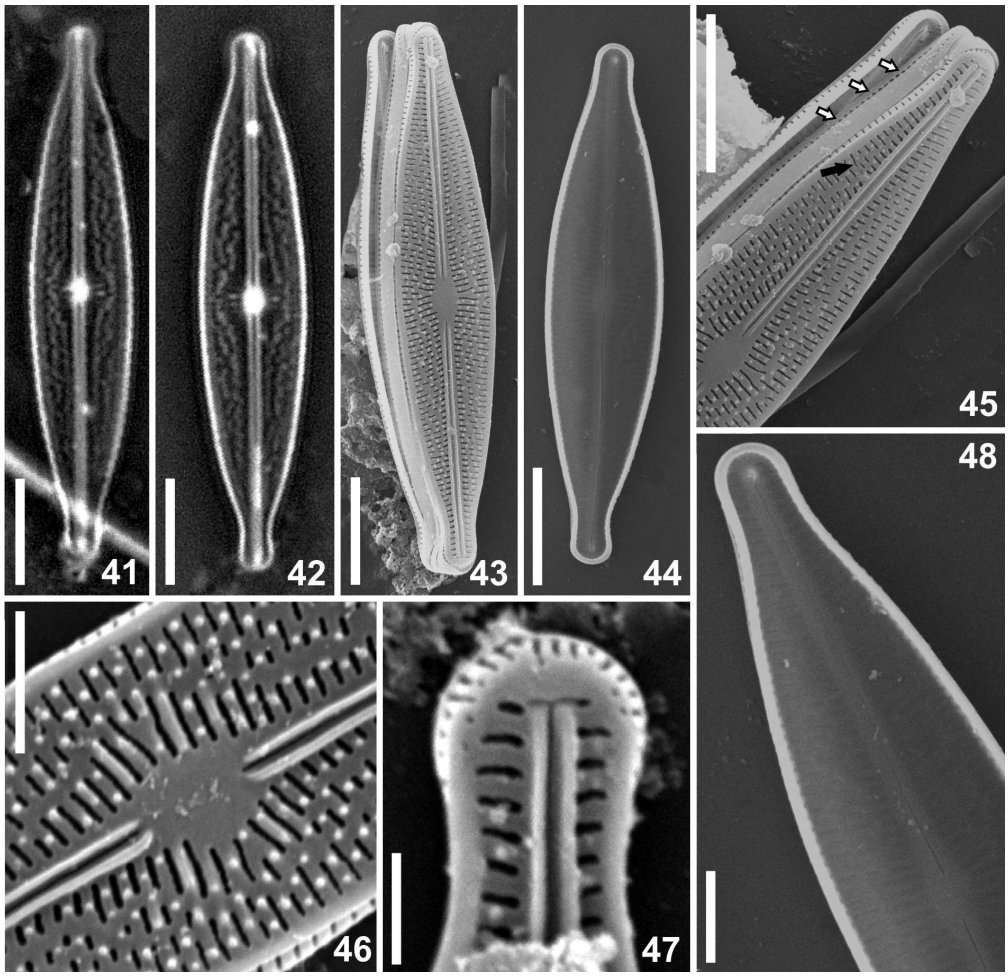

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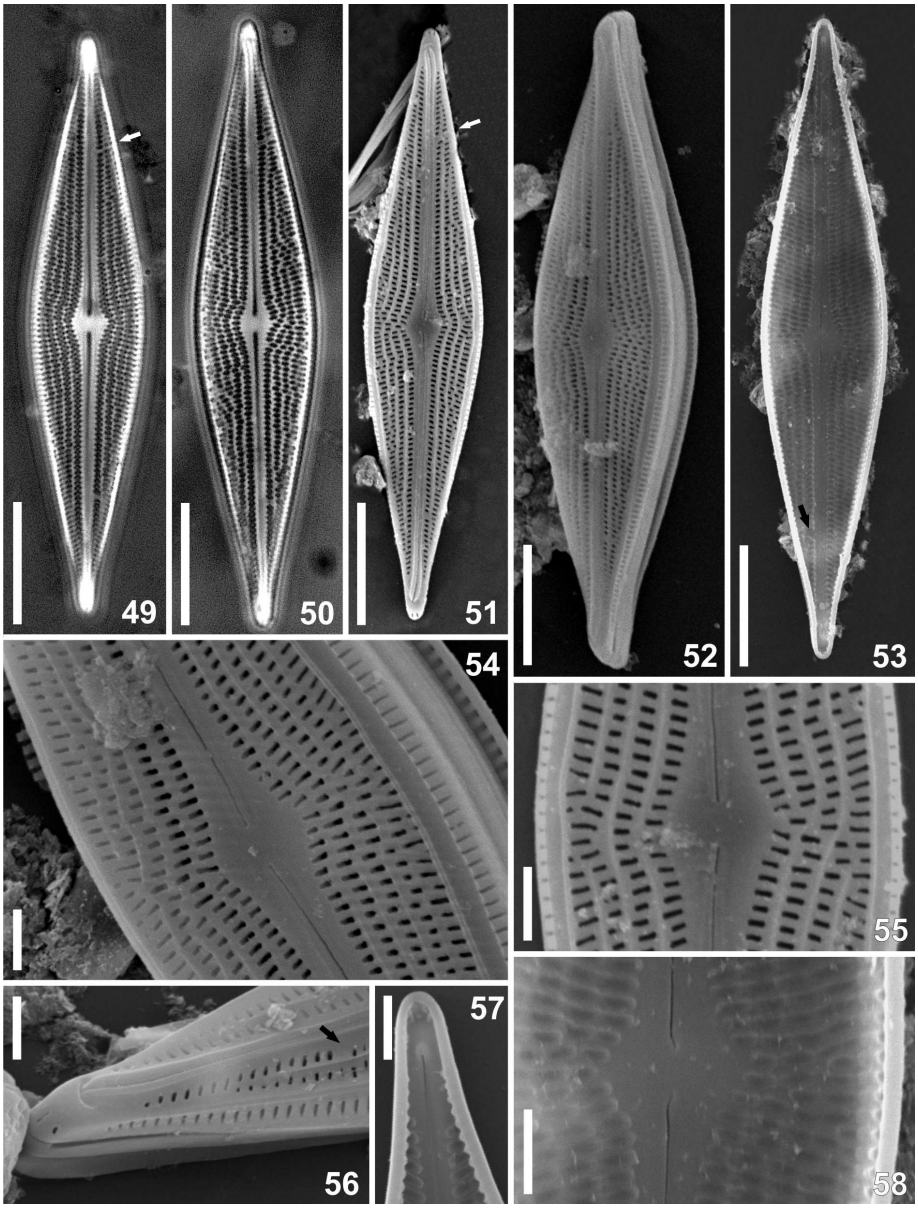

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