



New species of the genus *Encyonema* (Cymbellales, Bacillariophyta) from the Descoberto River Basin, Central-western Brazil

WELITON JOSÉ DA SILVA¹ & MARIA DAS GRAÇAS MACHADO DE SOUZA²

¹Universidade Federal de Goiás, Instituto de Ciências Biológicas, Departamento de Botânica, Laboratório de Análises e Gerenciamento de Recursos Hídricos, Goiânia, Goiás, Brazil (welitondasilva@yahoo.com.br)

²Universidade de Brasília, Instituto de Biologia, Departamento de Botânica, Herbário da Universidade de Brasília, Brasília, Distrito Federal, Brazil

Abstract

Two new species of *Encyonema* are described from Central-western Brazil, bringing the total number of species in this genus recorded in Brazil to 45. *Encyonema menezesiae* has lanceolate valves with the ends subcapitate to rostrate-capitate, whereas *E. candangense* has linear valves with indistinct ends. The two species show deep alveoli, linear foramina, and densely areolate striae. These characteristics, together with the narrow valves, distinguish *E. menezesiae* and *E. candangense* from related taxa. The new species occurred in slightly acid and mostly oligotrophic waters. Similar aquatic environments in this region are being drastically affected by the use of biocides and fertilizers for agriculture. The description of these two species and their ecological preferences may provide useful information for the preservation of aquatic systems and their communities in Brazil.

Introduction

The taxonomy of *Encyonema* Kützing (1833: 589) has undergone many changes. In the original description, Kützing (1833) highlighted mainly colony features. His only reference to valvar characteristics was through the term “*cymbellas*”, indicating the dorsiventral aspect of the only representative of the genus, *E. paradoxum* Kützing (1833: 589), currently treated as a synonym of *E. leibleinii* (C.Agardh) W.Silva *et al.* (2013: 121).

Until the end of the last century, several representatives of *Encyonema* were treated in the genus *Cymbella* C.Agardh (1830: 1) *sensu* Heiberg (1863), since both groups have dorsiventral valves. In 1990, the genus *Encyonema* was resurrected and included in the order Cymbellales together with other genera such as *Cymbella*, *Gomphonema* Ehrenb. (1832: 87) *nom. cons.* and *Placoneis* Mereschk. (1903: 45) (Round *et al.* 1990). Subsequently, Krammer (1997a, 1997b) carried out an extensive revision of *Encyonema*, which culminated in a series of new species and combinations.

About 250 specific and infraspecific taxa of *Encyonema* are known from different aquatic systems worldwide (Kützing 1833, 1844, 1849, Rabenhorst 1853, Round *et al.* 1990, Krammer 1997a, 1997b, 2003, Metzeltin & Lange-Bertalot 1998, 2007, Rumrich *et al.* 2000, Metzeltin *et al.* 2005, Cantonati & Lange-Bertalot 2010, Vouilloud *et al.* 2010, Tremarin *et al.* 2011, Kulikovskiy *et al.* 2012a, 2012b, Bahls *et al.* 2013, da Silva *et al.* 2013, Winter & Bahls 2013, Rodionova *et al.* 2013), 86 of them occurring in South America, i.e., in French Guiana, Venezuela, Guyana, Brazil, Colombia, Peru, Bolivia, Chile, Argentina and Uruguay (Rusby 1888, Krasske 1948, Macchiavello & Díaz 1997, Krammer 1997a, 1997b, 2003, Metzeltin & Lange-Bertalot 1998, 2007, Torgan *et al.* 1999, Rumrich *et al.* 2000, Menezes & Dias 2001, Metzeltin *et al.* 2005, Morales & Vis 2007, Bauer *et al.* 2007, Montoya-M. *et al.* 2008, Ramírez C. & Plata-Díaz 2008, Villac *et al.* 2008, Morales *et al.* 2009, Tremarin *et al.* 2009, 2011, Pedraza-Garzón & Donato-Rondón 2011, Sosa *et al.* 2011, Canani *et al.* 2011, da Silva *et al.* 2011, Huber *et al.* 2011, Bes *et al.* 2012, Moreno & Aguirre R. 2013, Achem *et al.* 2014, Eskinazi-Leça *et al.* 2014, Tchilinguirian *et al.* 2014). *Encyonema minutum* (Hilse ex Rabenhorst) D.G.Mann and *E. silesiacum* (Bleisch) D.G.Mann has been the most common species of this genus recorded in this southern region. Only 43 taxa of *Encyonema* have been recorded in Brazil, 13 of them originally described from material collected in this country and 11 found only within its boundaries. However, the diversity of

tral side; striae with deep alveoli, parallel, larger close to margins, 8–13 striae in 10 µm; small stubs under intercostal ribs; areolae with linear foramina externally and internally, foramen lips inconspicuous or absent; 47–51 areolae in 10 µm; isolated pores absent.

Etymology:—The epithet *candangense* derivate from “candango” (Portuguese), designation given to the people that came in 1950s from Northeastern Brazil to Central-western Brazil to build the city of Brasília.

Material analyzed:—UB 01496, UB 01497.

Ecology:—The taxon occurred in two samples, and only during the dry season. The pH of the water was 6.37–6.48, turbidity 2.8–3.6 µT and conductivity 27.5–38.9 mS.cm⁻¹. Dissolved oxygen was 7.68–7.90 mg.L⁻¹ and COD 5.6–10.8 mg.L⁻¹. *E. candangense* occurred in environments with low concentrations of ammonium (0.07–0.17 mg.L⁻¹), nitrate (0.2 mg.L⁻¹) and nitrite (0.001–0.004 mg.L⁻¹).

Discussion

Encyonema menezesiae is similar to *E. gaeumannii*, described from material collected in the Swiss Alps (Krammer 1997b), but in *E. gaeumannii* the ends are more protracted and capitate. Moreover, the striae in *E. menezesiae* are larger and more widely distributed on the valves (8–13 vs. 15–18 striae in 10 µm) and these striae are more delicately areolate (44–53 vs. 38–42 areolae in 10 µm), with linear foramina (Figs 9–16). *E. gaeumannii* differs by having narrow, rounded foramina (Krammer 1997b, Figs 142: 22, 23).

The specimens of *E. menezesiae* observed in the Descoberto River Basin are also very similar to *Cymbella perpusilla* A. Cleve (1895: 19) identified by Ludwig (1996) in São Paulo. This species was originally described from material from Sweden. Cleve (1895) recorded one specimen, 17 µm in length, 3 µm in breadth, with slightly rostrate ends, and 15 striae in 10 µm. The type material of *E. perpusillum* (A.Cleve) D.G. Mann in Round *et al.* (1990: 667) [≡ *C. perpusilla*] is unknown (Krammer 1997b). In his Plate I, Fig. 3, Cleve (1895) represented *C. perpusilla* with a different outline from that of *E. menezesiae*. Based on the representation of *C. perpusilla* and description of the taxa, Krammer (1997b) identified specimens of *E. perpusillum* with outlines and density of puncta which are also different from the specimens found in the Descoberto River. Therefore it is possible that the specimens recorded by Ludwig (1996) in São Paulo may be conspecific with *E. menezesiae*, but it is clearly not *E. perpusillum*.

The outline of *E. menezesiae* is also very similar to *Cymbellopsis krammeri* Lange-Bertalot & Wydrzycka in Rumrich *et al.* (2000: 105), which has a length of 17–22 µm, breadth 3.8–4.2 µm, maximum length/breadth ratio 5.2, 9–11 striae in 10 µm and 28–32 areolae in 10 µm (Rumrich *et al.* 2000, Krammer 2003). However, *C. krammeri* has the areolae and foramina irregularly arranged and the alveoli divided into several parts (Krammer 2003, Pl. 161, Figs 12, 13), differing from *E. menezesiae*, in which the alveoli are continuous (Figs 15, 16). Moreover, in *E. menezesiae* the striae are more densely punctate than in *C. krammeri* (44–53 versus 28–32 areolae in 10 µm, respectively).

The shape of the foramina of *E. candangense* is similar to *E. indistinctum*, recorded in the Essequibo River, Guyana, and *E. caronianum*, from the Caroni River, Venezuela. However, *E. candangense* has a linear outline, with the ends inconspicuously distinct from the middle of the valvae. The ends of *E. indistinctum* and *E. caronianum* are clearly narrower than the middle of the valve, giving both species a semilanceolate outline. Moreover, *E. candangense* is narrower than *E. indistinctum* (2–4 vs. 4.5–5.5 µm) and *E. caronianum* (2–4 vs. 4.1–5.5 µm), and is more densely areolate than the latter two species (47–51 vs. 34–37 and 40–42 areolae in 10 µm, respectively).

Acknowledgments

W.J. da Silva thanks Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES) for a postdoctoral fellowship.

References

- Achem, A.L.G., Seeligmann, C. & Alderete, M. (2014) Variaciones espacio-temporales de la flora diatomologica en Laguna de Los Pozuelos (Jujuy, Argentina). *Boletín de la Sociedad Argentina Botánica* 49: 177–193.

- Agardh, C.A. (1830) *Conspectus criticus diatomacearum*. Literis Berlingianus, Lundae [Lund], 16 pp.
- American Public Health Association (1998) *Standard methods for the examination of water and wastewater*. 20th ed. APHA, Washington, DC., CD-ROM.
- Bahlsm, L., Pierce, J., Apfelbeck, R. & Olsen, L. (2013) *Encyonema droseraphilum* sp. nov. (Bacillariophyta) and other rare diatoms from undisturbed floating-mat fens in the northern Rocky Mountains, USA. *Phytotaxa* 127: 32–48.
<http://dx.doi.org/10.11646/phytotaxa.127.1.7>
- Bauer, D.E., Gómez, N. & Hualde, P.R. (2007) Biofilms coating *Schoenoplectus californicus* as indicators of water quality in the Río de la Plata Estuary (Argentina). *Environmental monitoring and assessment* 133: 309–320.
<http://dx.doi.org/10.1007/s10661-006-9586-x>
- Bes, D., Ector, L., Torgan, L.C. & Lobo, E.A. (2012) Composition of the epilithic diatom flora from a subtropical river, Southern Brazil. *Iheringia, Série Botânica* 67: 93–125.
- Canani, L.G.C., Menezes, M. & Torgan, L.C. (2011) Diatomáceas epilíticas de águas oligotróficas e ácidas do Sudeste do Brasil. *Acta Botanica Brasilica* 25: 130–140.
- Cantonati, M. & Lange-Bertalot, H. (2010) Diatom biodiversity of springs in the Berchtesgaden National Park (North-Eastern Alps, Germany), with the ecological and morphological characterization of two species new to science. *Diatom Research* 25: 251–280.
<http://dx.doi.org/10.1080/0269249x.2010.9705849>
- Cleve, A. (1895) On recent freshwater diatoms from Lule Lappmark in Sweden. *Bihang till Kongliga Svenska Vetenskaps-Akademiens Handlingar* 21: 1–45.
- da Silva, W.J., Jahn, R., Ludwig, T.A.V. & Menezes, M. (2013) Typification of seven species of *Encyonema* and characterization of *Encyonema leibleinii* comb. nov. *Fottea* 13: 119–132.
- da Silva, W.J., Nogueira, I.S. & Souza, M.G.M. (2011) Catálogo de diatomáceas da região Centro-Oeste brasileira. *Iheringia, Série Botânica* 66: 61–86.
- Delgado, S.M. & Souza, M.G.M. (2007) Diatomoflórula Perifítica do rio Descoberto – DF e GO, Brasil, Naviculales (Bacillariophyceae): Diploneidinae e Sellaphorineae. *Acta botanica brasilica* 21: 767–776.
<http://dx.doi.org/10.1590/s0102-33062007000400002>
- Ehrenberg, C.G. (1832) Über die Entwicklung und Lebensdauer der Infusionsthier; nebst fernerer Beiträgen zu einer Vergleichung ihrer organischen Systeme. *Abhandlungen der Königl. Akademie Wissenschaften zu Berlin, Physikalische Klasse* 1831: 1–154.
- Eskinazi-Leça, E., Cunha, M.G.G.S., Santiago, M.F., Borges, G.C.P., Lima, J.C., Silva, M.H., Ferreira, L.C., Aquino, E., da Silva, W.J. & Menezes, M. (2014) Bacillariophyceae. In: *Lista de Espécies da Flora do Brasil*. Jardim Botânico do Rio de Janeiro, Rio de Janeiro. Available from: <http://www.floradobrasil.jbrj.gov.br/jabot/floradobrasil/FB97964> (accessed 27 November 2014).
- Heiberg, P.A.C. (1863) *Conspectus criticus Diatomacearum danicarum. Kritisk oversigt over de danske Diatomeer*. Wilhelm Priors Forlag, Kjøbenhavn, 135 pp.
<http://dx.doi.org/10.5962/bhl.title.68738>
- Huber, M.P., Novoa, M.D. & Fabricius, A.L.M. (2011). Fitoplancton de una laguna endorreica de uso recreacional (Córdoba, Argentina). *Biológicas* 13: 24–33.
- Krammer, K. (1982) Valve morphology in the genus *Cymbella* C. A. Agardh. In: Helmcke, J.-G. & Krammer, K. (Eds.) *Micromorphology of Diatom Valves* 11: 1024–1148.
- Krammer, K. (1997a) Die cymbelloiden Diatomeen, eine Monographie der weltweit bekannten Taxa. Teil 1. Allgemeines und *Encyonema* Part. In: Lange-Bertalot, L. & Kociolek, P. (Eds.) *Bibliotheca Diatomologica* 36: 1–382. J.
- Krammer, K. (1997b) Die cymbelloiden Diatomeen, eine Monographie der weltweit bekannten Taxa. Teil 2. *Encyonema* Part., *Encyonopsis* and *Cymbellopsis*. In: Lange-Bertalot, L. & Kociolek, P. (Eds.) *Bibliotheca Diatomologica* 37: 1–469.
- Krammer, K. (2003) Diatoms of the European inland waters and comparable habitats. *Cymbopleura, Delicata, Navicymbula, Gomphocymbellopsis, Afrocybella*. In: Lange-Bertalot, H. (Ed.) *Diatoms of Europe* 4. A.R.G. Gantner Verlag K.G., Ruggel, pp. 1–529
- Krasske, G. (1948) Diatomeen Tropischer Moorsrasen. *Svensk Botanisk Tidskrift* 42: 405–443.
- Kulikovskiy, M.S., Lange-Bertalot, H., Metzeltin, D. & Witkowski, A. (2012a) Lake Baikal: hotspot of endemic diatoms I. In: Lange-Bertalot, H. (Ed.) *Iconographia Diatomologica* 23. A.R.G. Gantner Verlag K.G., Ruggel, pp. 7–608.
- Kulikovskiy, M.S., Witkowski, A. & Khursevich, G.K. (2012b) *Encyonema horstii* sp. nov., a species of unusual valve outline from Pleistocene deposits of Lake Baikal. *Nova Hedwigia, Beiheft* 141: 365–374.
- Kützing, F.T. (1833) Synopsis Diatomacearum oder Versuch einer systematischen Zusammenstellung der Diatomeen. *Linnaea* 8: 529–620.
<http://dx.doi.org/10.5962/bhl.title.65634>
- Kützing, F.T. (1844) *Die kieselschaligen Bacillarien oder Diatomeen*. Annals and Magazine of Natural History 15, Nordhausen, 152 pp.
<http://dx.doi.org/10.1080/037454809495289>

- Kützing, F.T. (1849) *Species Algarum*. Lipsiae: F. A. Brockhaus, Leipzig, 922 pp.
<http://dx.doi.org/10.5962/bhl.title.60464>
- Ludwig, T.A.V. (1996) *Levantamento florístico dos gêneros Cymbella e Gomphonema do estado de São Paulo*. Universidade Estadual Paulista Júlio de Mesquita Filho, São Paulo, 235 pp.
- Macchiavello, J.C.M. & Díaz, L. (1997) Diatomeas (Chrysophyta, Bacillariophyceae) de un perfil de una turbera de Milluyoc, Provincia de Jujuy, Argentina. *Insula* 26: 29–44.
- Menezes, M. & Dias, I.C.A. (2001) *Biodiversidade de algas continentais do estado do Rio de Janeiro*. Museu Nacional, Rio de Janeiro, 256 p.
- Mereschkowsky, C. (1903) Über *Placoneis*, ein neues Diatomeen-Genus. *Beihefte zum Botanischen Centralblatt* 15: 1–29.
- 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: Lange-Bertalot, H. (ed.) *Iconographia Diatomologica* 5. Koeltz Scientific Books, Königstein, pp. 1–695.
- Metzeltin, D. & Lange-Bertalot, H. (2007) Tropical Diatoms of South America II. Special remarks on biogeography disjunction. In: Lange-Bertalot, H. (ed.) *Iconographia Diatomologica* 18. A.R.G. Gantner Verlag K.G., Ruggel, pp. 1–877.
- Metzeltin, D., Lange-bertalot, H. & García-Rodríguez, F. (2005) Diatoms of Uruguay. In: Lange-Bertalot, H. (Ed.) *Iconographia Diatomologica* 15. A. R. G. Gantner Verlag K. G., Ruggel, pp. 1–736.
- Montoya-M., Y., Ramírez-Restrepo, J.J. & Segecin-Moro, R. (2008) Diatomeas perifíticas de la zona de ritral del río medellín (Antioquia), Colombia. *Actualidades Biológicas* 30: 181–192.
- Morales, E.A. & Vis, M.L. (2007) Epilithic diatoms (Bacillariophyceae) from cloud forest and alpine streams in Bolivia, South America. *Proceedings of the Academy of Natural Sciences of Philadelphia* 156: 123–155.
[http://dx.doi.org/10.1635/0097-3157\(2007\)156\[123:edbfcf\]2.0.co;2](http://dx.doi.org/10.1635/0097-3157(2007)156[123:edbfcf]2.0.co;2)
- Morales, E.A., Fernández, E. & Kociolek, P.J. (2009) Epilithic diatoms (Bacillariophyta) from cloud forest and alpine streams in Bolivia, South America 3: diatoms from Sehucenas, Carrasco National Park, Department of Cochabamba. *Acta Botanica Croatica* 68: 263–283.
- Moreira-Filho, H. & Valente-Moreira, I.M. (1981) Avaliação taxonômica e ecológica das diatomáceas (Bacillariophyceae) epífitas em algas pluricelulares obtidas nos litorais dos estados do Paraná, Santa Catarina e São Paulo. *Boletim Museu Botânico Municipal* 47: 1–17.
- Moreno, Y.M. & Aguirre, R.N. (2013) Estado del arte del conocimiento sobre perifiton en Colombia. *Gestión y ambiente* 16: 91–117.
- Pedraza-Garzón, E. & Donato-Rondón, J. (2011) Diversidad y distribución de diatomeas en un arroyo de Montaña de los Andes Colombianos. *Limnología* 33: 177–191.
- Rabenhorst, L. (1853) *Die Süßwasser-Diatomeen (Bacillarien) für Freunde der Mikroskopie*. Eduard Kumer, Leipzig, 72 pp.
<http://dx.doi.org/10.5962/bhl.title.8348>
- Ramírez, C.A.M. & Plata-Díaz, Y. (2008) Diatomeas perifíticas en diferentes tramos de dos sistemas lóticos de Alta Montaña (Páramo de Santurbán, Norte de Santander, Colombia) y su relación con las variables ambientales. *Acta biológica colombiana* 13: 199–216.
- Rodionova, Y.V., Pomazkina, G.V. & Makarevich, O.Y. (2013) *Encyonema mirabilis*, *Cymbella olgae* and *C. cognata*: new diatom species from Lake Baikal. *Diatom Research* 28: 487–502.
<http://dx.doi.org/10.1080/0269249x.2013.851120>
- Round, F.E. (1991) Use of diatoms for monitoring rivers. In: Whitton, B.A., Rott, E. & Friedrich, G. (Eds.) *Use of Algae for Monitoring Rivers. Proceeding of an International Symposium*. Landesamt für Wasser und Abfall Nordrhein-Westfalen, Düsseldorf, pp. 25–32.
- Round, F.E., Crawford, R.M. & Mann D.G. (1990) *The diatoms: biology and morphology of the genera*. Cambridge University Press, United Kindow, 747 pp.
- Rumrich, U., Lange-Bertalot, H. & Rumrich, M. (2000) Diatomeen der Anden. Von Venezuela bis Patagonien/Feuerland. In: Lange-Bertalot, H. (Ed.) *Iconographia Diatomologica* 9. Koeltz Scientific Books, Ruggel, pp. 1–649.
- Rusby, H.H. (1888) An enumeration of the plants collected by Dr. H. H. Rusby in South America, 1885-1886. *Bulletin of the Torrey Botanical Club* 15: 177–184.
<http://dx.doi.org/10.2307/2476382>
- Simonsen, R. (1974) The diatom plankton of the indian ocean expedition of R/V “Meteor”. *Meteor-forschungsbericht Reihe D. Biol* 19: 1–66.
- Sosa, M.L., Novoa, M.D. & Fabricius, A.L.M. (2011) Ficoflora de la cuenca endorreica fluvio-lacustre Chucul (Córdoba, Argentina). *Biológicas* 13: 14–23.
- Tchilinguirian, P., Morales, M.R., Oxman, B., Lupo, L.C., Olivera, D.E. & Yacobaccio, H.D. (2014) Early to Middle Holocene transition in the Pastos Chicos record, dry Puna of Argentina. *Quaternary International* 330: 171–182.
<http://dx.doi.org/10.1016/j.quaint.2012.03.006>
- Torgan, L.C., Becker, V. & Prates, H.M. (1999) Checklist das diatomáceas (Bacillariophyceae) de ambientes de águas continentais e

- costeiras do estado do Rio Grande do Sul, Brasil. *Iheringia, Série Botânica* 52: 89–144.
- Tremarin, P.I., Wetzel, C.E., Ludwig, T.A.V. & Ector, L. (2011) *Encyonema exuberans* sp. nov. (Bacillariophyceae) from southern Brazilian lotic systems. *Nova Hedwigia* 92: 107–120.
<http://dx.doi.org/10.1127/0029-5035/2011/0092-0107>
- Tremarin, P.I., Freire, E.G., Bertolli, L.M. & Ludwig, T.A.V. (2009) Catálogo das diatomáceas (Ochrophyta - Diatomeae) continentais do estado do Paraná. *Iheringia, Série Botânica* 64: 79–107.
- Villac, M.C., Cabral-Noronha, V.A.P. & Pinto, T.O. (2008) The phytoplankton biodiversity of the coast of the state of São Paulo, Brazil. *Biota Neotropica* 8: 151–173.
<http://dx.doi.org/10.1590/s1676-06032008000300015>
- Vouilloud, A.A., Sala, S.E., Avellaneda, M.N. & Duque, S.R. (2010) Diatoms from the Colombian and Peruvian Amazon: the genera *Encyonema*, *Encyonopsis* and *Gomphonema* (Cymbellales: Bacillariophyceae). *Revista de biología tropical* 58: 45–62.
<http://dx.doi.org/10.15517/rbt.v58i1.5193>
- Winter, D. & Bahls, L. (2013) *Encyonema hamsherae*, a new diatom species from the Northern Rocky Mountains, USA. *Phytotaxa* 127: 58–65.
<http://dx.doi.org/10.11646/phytotaxa.127.1.9>