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Description of the pseudocryptic species *Conticribra weissflogiopsis sp. nov.* (Thalassiosirales, Bacillariophyta) isolated from brackish waters in Korea, based on its cingulum structure and molecular analysis

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Abstract

We describe the new fultoportulate diatom species, *Conticribra weissflogiopsis*, isolated from brackish waters in Korea, based on morphological characters and molecular data. The new species is characterized by having areolae venation with internal (semi-) continuous cribra, a flat valve face, a single marginal rimoportula replacing a marginal fultoportula, a subcentral ring of the valve face fultoportulae, and a dextral pattern of cingulum structure. The overall valve structure of *C. weissflogiopsis* resembles that of *C. weissflogii*; however, the cingulum structure differs between the two species—*C. weissflogiopsis* has a dextral offset of band opening in the cingulum, whereas *C. weissflogii* has a sinistral offset. Phylogenetic analysis of the nuclear small subunit ribosomal DNA (SSU rDNA) revealed that *C. weissflogiopsis* is located in the *Conticribra* clade. Further, the pairwise genetic distance based on the SSU rDNA and the internal transcribed spacer 2 (ITS2) indicated that *C. weissflogiopsis* is a distinct *Conticribra* species. On the basis of the morphology and molecular phylogeny, we expand the hypothesis regarding the morphological evolution of *Conticribra* species.

Key words: brackish water, cingulum, *Conticribra*, *Conticribra weissflogiopsis*, diatoms, pseudocryptic species

Introduction

The fultoportula-bearing genus *Conticribra* Stachura-Suchoples et Williams (2009: 482) was recently established to accommodate *C. tricircularis* Stachura-Suchoples et Williams (2009: 479) and three species of *Thalassiosira* (Stachura-Suchoples & Williams 2009). The genus is characterized by the presence of loculate areolae with (semi-) continuous cribra; a non-plicate valve face; and the rimoportula located on the valve mantle, replacing a fultoportula (Stachura-Suchoples & Williams 2009). The genus *Conticribra* comprises four species, namely, two fossil species—*C. tricircularis* and *C. nevadica* (Khursevich et VanLandingham) Stachura-Suchoples et Williams (2009: 482; basionym: *Thalassiosira nevadica* Khursevich & VanLandingham 1993: 3902)—and two extant species—*C. guillardii* (Hasle) Stachura-Suchoples et Williams (2009: 482; basionym: *Thalassiosira guillardii* Hasle 1978: 274) and *C. weissflogii* (Grunow) Stachura-Suchoples et Williams (2009: 482; basionym: *Micropodiscus weissflogii* Grunow in Van Heurck 1885: 210[1]).

The presence of valve face fultoportulae constitutes the distinguishing character between living *Conticribra* species and fossil *Conticribra* species. The two living taxa are further distinguished by the number and distribution of the valve face fultoportulae. *Conticribra guillardii* has 0–4 randomly distributed valve face fultoportulae (Hasle 1978), whereas *C. weissflogii* has many valve face fultoportulae arranged in a slightly irregular ring pattern within the subcentral area (Fryxell & Hasle 1977). The number and position of the subcentral fultoportulae in *C. weissflogii* have been shown to vary according to the diameter of valve and salinity (e.g., Johansen & Theriot 1987) and also to various cultural conditions such as deficiency of nutrient (Kang *et al*. 1996). Nevertheless, the variation of valve face fultoportulae represents a distinguishing character for *C. weissflogii* (Fryxell & Hasle 1977), because no other species shows this pattern of fultoportulae.

Recently, the greater potential diversity of diatoms was recognized by the discovery of cryptic and pseudocryptic species belonging to genera such as *Pseudo-nitzschia* H. Peragallo (in H. & M. Peragallo 1900: 263; see Amato *et al.*

1 There are nomenclatural problems that require resolution with this genus, but these are beyond the scope of this paper.

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References

Alverson, A.J., Cannone, J.J., Gutell, R.R. & Theriot, E.C. (2006a) The evolution of elongate shape in diatoms. *Journal of Phycology* 42: 655–668.
http://dx.doi.org/10.1111/j.1529-8817.2006.00228.x

Alverson, A.J., Kang, S.H. & Theriot, E.C. (2006b) Cell wall morphology and systematic importance of *Thalassiosira ritscheri* (Hustedt) Hasle, with a description of *Shionodiscus* gen. nov. *Diatom Research* 21: 251–262.
http://dx.doi.org/10.1080/0269249x.2006.9705667

Alverson, A.J., Jansen, R.K. & Theriot, E.C. (2007) Bridging the Rubicon: Phylogenetic analysis reveals repeated colonizations of marine and fresh waters by thalassiosiroid diatoms. *Molecular Phylogenetics and Evolution* 45: 193–210.
http://dx.doi.org/10.1016/j.ympev.2007.03.024

Amato, A., Kooistra, W.H.C.F., Levialdi Ghiron, J.H., Mann, D.G., Pröshold, T. & Montresor, M. (2007) Reproductive isolation among sympatric cryptic species in marine diatoms. *Protist* 158: 193–207.
http://dx.doi.org/10.1016/j.protis.2006.10.001

Beszteri, B., John, U. & Medlin, L.K. (2007) An assessment of cryptic diversity within the *Cyclotella meneghiniana* species complex (Bacillariophyta) based on nuclear and plastid genes, and amplified fragment length polymorphisms. *European Journal of Phycology* 42: 47–60.
http://dx.doi.org/10.1080/09670260601044068

Brébisson, A. de (1838) *Considérations sur les Diatomées et essai d'une classification des genres et des espèces appurtenant à cette famille.* Breé l'Ainé Imprimeur-Libraire, 22 pp.
http://dx.doi.org/10.5962/bhl.title.64353

von Dassow, P., Chepurnov, V.A. & Ambrust, E.V. (2006) Relationships between growth rate, cell size, and induction of spermatogenesis in the centric diatom *Thalassiosira weissflogii* (Bacillariophyta). *Journal of Phycology* 42: 887–899.
http://dx.doi.org/10.1111/j.1529-8817.2006.00250.x

Evans, K.M. & Mann, D.G. (2009) A proposed protocol for nomenclaturally effective DNA barcoding of microalgae. *Phycologia* 48: 70–74.
http://dx.doi.org/10.2216/08-70.1

Fryxell, G.A. & Hasle, G.R. (1977) The genus *Thalassiosira*: Some species with a modified ring of central strutted processes. *Beihft zur Nova Hedwigia* 54: 67–89.

Fryxell, G.A., Hubbard, G.F. & Villareal, T.A. (1981) The genus *Thalassiosira*: variations of the cingulum. *Bacillaria* 4: 41–63.

Greville, R.K. (1865) Descriptions of new and rare diatoms. Series XVI. *Transactions of the Microscopical Society, New Series, London* 13: 43–57.

Hasle, G.R. (1978) Some freshwater and brackish water species of the diatom genus *Thalassiosira* Cleve. *Phycologia* 17: 263–292.
http://dx.doi.org/10.2216/i0031-8884-17-3-263.1

Hamsher, S., Evans, K., Mann, D.G., Poulickova, A. & Saunders, G.W. (2011) Barcoding Diatoms: Exploring, alternatives to CO1-5P. *Protist* 162: 405–422.
http://dx.doi.org/10.1016/j.protis.2010.09.005

Huelsenbeck, J.P. & Ronquist, F. (2001) MRBAYES: Bayesian inference of phylogenetic trees. *Bioinformatics* 17: 754–755.
http://dx.doi.org/10.1093/bioinformatics/17.8.754

Johansen, J.R. & Theriot, E.C. (1987) The relationship between valve diameter and number of central fultoportulae in *Thalassiosira weissflogii* (Bacillariophyceae). *Journal of Phycology* 23: 663–665.
http://dx.doi.org/10.1111/j.1529-8817.1987.tb04221.x

Kaczmarska, I., Beaton, M., Benoit, A.C. & Medlin, L.K. (2006) Molecular phylogeny of selected members of the order Thalassiosirales (Bacillariophyta) and evolution of the fultoportula. *Journal of Phycology* 42: 121–138.
http://dx.doi.org/10.1111/j.1529-8817.2006.00161.x

Kang, J.S., Kim, H.-S. & Lee, J.H. (1996) Morphological variations of the marine diatom *Thalassiosira weissflogii* under culture conditions. *Algae* 11: 23–24.

Khursevich, G.K. & VanLandingham, S.L. (1993) Frustular morphology of some centric diatom species from Miocene freshwater sedimentary rocks of western U.S.A. and Canada. *Nova Hedwigia* 56:389–400.

Luddington, I.A., Kaczmarska, I. & Lovejoy, C. (2012) Distance and character-based evaluation of the V4 region of the 18S rRNA gene for the identification of diatoms (Bacillariophyceae). *PLoS One* 7: e45664. http://dx.doi.org/10.1371/journal.pone.0045664

Mann, D.G. & Evans, K.M. (2007) Molecular genetics and the neglected art of diatomics, in: Brodie, J. & Lewis, J. (eds.). *Unravelling the algae: The past, present and future of algal systematics.* CRC Press, Boca Raton, Florida, pp. 231–265.

Mann, D.G., McDonald, S.M., Bayer, M.M., Droop, S.J.M., Chepurnov, V.A., Loke, R.E., Ciobanu, A. & du Buf, J.M.H. (2004) Morphometric analysis, ultrastructure and mating data provide evidence for five new species of *Sellaphora* (Bacillariophyceae). *Phycologia* 43: 459–482. http://dx.doi.org/10.2216/i0031-8884-43-4-459.1

Mereschkowsky, C. (1902) On *Sellaphora*, a new genus of diatoms. [series 7] *Annnals and Magazine of Natural History* 9: 185–195.

Medlin, L.K., Elwood, H.J., Stickel, S. & Sogin, M.L. (1988) The characterization of enzymatically amplified eukaryotic 16S-like rRNA-coding regions. *Gene* 71: 491–499. http://dx.doi.org/10.1016/0378-1119(88)90066-2

Moniz, M.B.J. & Kaczmarska, I. (2009) Barcoding diatoms: Is there a good marker? *Molecular Ecology Resources* 9: 65–74. http://dx.doi.org/10.1111/j.1755-0998.2009.02633.x

Orsini, L., Sarno, D., Procaccini, G., Poletti, R., Dahlmann, J. & Montresor, M. (2002) Toxic *Pseudo-nitzschia multistriata* (Bacillariophyceae) from the Gulf of Naples: morphology, toxin analysis and phylogenetic relationships with other *Pseudo-nitzschia* species. *European Journal of Phycology* 37: 247–257. http://dx.doi.org/10.1017/S0967026202003608

Peragallo, H. & Peragallo, M. (1897–1908) *Diatomées Marines de France et des Districts Maritimes Voisins.* Micrographe-Editeur, à Grez-sur-Loing (S.-et-M.), 491 pp. http://dx.doi.org/10.5962/bhl.title.13501

Ross, R., Cox, E.J., Karayeva, N.I., Mann, D.G., Paddock, T.B.B., Simonsen, R. & Sims, P.A. (1979) An amended terminology for the siliceous components of the diatom cell. *Beihft zur Nova Hedwigia* 64: 513–533.

Round, F.E., Crawford, R.M. & Mann, D.G. (1990) *The diatoms: biology and morphology of the genera.* Cambridge University Press, Cambridge, 747 pp.

Sarno, D., Kooistra, W.H.C.F., Medlin, L.K., Percopo, I. & Zingone, A. (2005) Diversity in the genus *Skeletonema* (Bacillariophyceae). II. An assessment of the taxonomy of *S. costatum*-like species with the description of four new species. *Journal of Phycology* 41: 151–176. http://dx.doi.org/10.1111/j.1529-8817.2005.04067.x

Schneider, C.A., Rasband, W.S. & Eliceiri, K.W. (2012) NIH Image to ImageJ: 25 years of image analysis. *Nature Methods* 9: 671–675.

Stachura-Suchoples, K. & Williams, D.M. (2009) Description of *Conticribra tricircularis*, a new genus and species of Thalassiosirales, with a discussion on its relationship to other continuous cribra species of *Thalassiosira* Cleve (Bacillariophyta) and its freshwater origin. *European Journal of Phycology* 44: 477–486. http://dx.doi.org/10.1080/09670260903225431

von Stosch, H. (1975) An amended terminology of the diatom girdle. *Beihft zur Nova Hedwigia* 53: 1–35.

Tamura, K., Stecher, G., Peterson, D., Filipski, A. & Kumar, S. (2013) MEGA6: Molecular Evolutionary Genetics Analysis version 6.0. *Molecular Biology and Evolution* 30: 2725–2729. http://dx.doi.org/10.1093/molbev/mst197

Theriot, E.C. & Serieyssol, K. (1994) Phylogenetic systematics as a guide to understanding features and potential morphological characters of the centric diatom family Thalassiosiraceae. *Diatom Research* 9: 429–450. http://dx.doi.org/10.1080/0269249x.1994.9705318

Thompson, J.D., Higgins, D.G. & Gibson, T.J. (1994) CLUSTAL W: improving the sensitivity of progressive multiple sequence alignment through sequence weighting, positions-specific gap penalties and weight matrix choice. *Nucleic Acids Research* 22: 4673–4680.

Van Heurck, H. (1885) *Synopsis des Diatomées de Belgique. Texte.* Martin Brouwers & Co., Anvers, 235 pp.

Zimmermann, J., Jahn, R. & Gemeinholzer, B. (2011) Barcoding diatoms: evaluation of the V4 subregion on the 18S rRNA gene, including new primers and protocols. *Organisms Diversity & Evolution* 11: 173–192. http://dx.doi.org/10.1007/s13127-011-0050-6