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DE GRUYTER Botanica Marina

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Journal:	*Botanica Marina*
Manuscript ID	Draft
Manuscript Type:	Research article
Date Submitted by the Author:	n/a
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Classifications:	5 Algal systematics/floristics/biogeography
Keywords:	brackish, diatoms, marine, taxonomic revision, taxonomy

Analysis of type material of *Opephora pacifica* (Grunow) P.Petit and emendation of the genus *Opephora* P.Petit (Bacillariophyta)

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Running title: Emendation of *Opephora*

Abstract

The genus *Opephora* currently contains 37 species and 27 infraspecific taxa. However, the existing literature reveals a wide morphological diversity and the need to establish defining characters to circumscribe the genus as a cohesive and, perhaps, monophyletic group. The type material of *Opephora pacifica*, the generitype, is analysed. We emend the description of both the species and the genus, the latter also based on published light and scanning electron microscopy observations of closely related species. After review of the available literature, we determined that currently only two species can be ascribed with 100% certainty to the genus *Opephora*: *O. pacifica* and *O. marina*. Based on available literature information, it is highly likely that *O. fragilarioides* also belongs to this genus. We present a table with all known species and infraspecific taxa and make comments regarding their recent transfer to other genera, their current accepted nomenclature, and the genus to which they should probably be ascribed pending the collection of further information.

Keywords: brackish; diatoms; marine; taxonomic revision; taxonomy.

Introduction

Over decades, the correct taxonomy of the genus *Opephora* P.Petit has been the subject of much controversy. One of the reasons is that the genus was traditionally composed of a heterogeneous mixture of small-sized araphid diatoms, difficult to identify using light microscopy (LM). The advent of scanning electron microscopy (SEM) confirmed a complex morphological variability, but despite some nomenclatural arrangements (e.g. Sabbe and Vyverman 1995) and guiding suggestions (Round et al. 1990, Morales 2002), the taxonomic boundaries of the genus have remained undefined.

The circumscription of *Opephora* through well-established distinguishing characters that clearly separate it from other, small-celled araphid diatoms lacking a rimoportula is important. The genus *Opephora* contains at present 37 species, 20 varieties and 7 forms (Guiry and Guiry 2020, Kociolek et al. 2020), many of them relatively common in brackish and marine habitats and appearing as frequent citations in floristic, taxonomic and ecological studies (e.g. Witkowski 1994, Ferreira et al. 2010, Witkowski et al. 2010, Koutsodendris et al. 2017, Siqueiros-Beltrones et al. 2017). Additionally, this genus appears represented in molecular phylogenies, but without clear definition of its identity at the morphological level, making it difficult to interpret its evolutionary associations with other taxa (Li et al. 2015, 2016, 2018).

Opephora was described in 1888 by Petit as having rectangular frustules, cuneiform valves, striae in the shape of buttonholes more or less elongated and located at the edge of the valves, and presenting a wide axial area. Petit (1888), however, did not describe any new species but transferred three taxa from other genera and placed them in his new genus: *Opephora pacifica* (Grunow) P.Petit (=*Sceptroneis pacifica* Grunow), *O. pinnata* (Ehrenberg) P.Petit (=*Fragilaria pinnata* Ehrenberg *pro parte*) and *O. marina* (W.Gregory) P.Petit (=*Meridion marinum* W.Gregory *pro parte*), but

without the designation of a generitype. Patrick in Patrick and Reimer (1966) designated a type for the genus choosing *O. pacifica* since the other two species had been erected based on parts of previously described species. The same authors also noted that Boyer's (1927) designation of *Opephora schwartzii* (Grunow) P.Petit ex Pelletan (=*Fragilaria schwartzii* Grunow) is incorrect since this taxon did not form part of the species originally considered by Petit (1888).

The original description of *O. pacifica* by Grunow (1862), as *Fragilaria pacifica*, was based on material collected from 'mari pacifico boreali'. Lange-Bertalot (1989) noted that the holotype slide is lost (see also Guiry and Guiry 2020), as is apparently also the case of the type material from the Pacific Ocean. To solve such a loss, Lange-Bertalot (1989, p. 95, pl. 7, figs 14 and 15) erected a neotype based on slide 790 of the Grunow Collection, W (Naturhistorisches Museum Wien, Austria, 790 Grunow, Flugsand der Kalkbai am Cap d.g. Hoff. Expedition Novara). A replica of slide 790 was deposited as slide VI-41-B10 in the Van Heurck Collection, at that time housed at AWH (Antwerp Scientific Collection, Belgium). This replica was studied in 1995 by Sabbe and Vyverman (1995, p. 239, figs 47, 52, 53), who referred to the slide as the "isotype". Since 2006, the entire Van Heurck diatom collection is part of Meise Botanic Garden (BR, Belgium). The above discussed slide, VI-41-B10, mentions on its label the "Kalkbay" locality and the Grunow number 790. Unmounted material used to prepare the slide was also found in the BR collection and is processed in this paper for further analysis.

Herein, we present the results of the LM and SEM analysis of slide VI-41-B10 and its unmounted material. With the aid of published information, we adjusted the differentiating features of *O. pacifica* and the genus *Opephora*, delimiting the number of

species contained in it through analysis of published information and making corresponding nomenclatural changes.

Materials and methods

For LM, slide VI-41-B10 of the Van Heurck Collection at BR (Figure 1) was analyzed using an Olympus® BX53 microscope (Olympus, Anvers, Belgique), equipped with Differential Interference Contrast (Nomarski) and an Olympus® UC30 digital camera (Olympus, Anvers, Belgique), and with a Leica® DMRX (Leica Microsystems AG, Wetzlar, Germany) with bright field equipped with a Leica® DC500 camera (Leica Camera AG, Wetzlar, Germany). For SEM analysis, a subsample of the Kalk Bay material (Grunow sample 790) from the BR collection was oxidized using 37% H_2O_2 and heating to 80°C for approximately 1h and subsequently rinsed with distilled water until neutrality. An aliquot of the material was rinsed with deionized water over 3 µm pore glass fiber filters. A subsample of the resulting cleaned material was coated with platinum using a BAL-TEC MED 020 Modular High Vacuum Coating System (Leica Camera AG, Wetzlar, Germany) for 30 s at 100 mA. The stub was analysed using a Hitachi SU-70 electron microscope (Hitachi High-Tech Corporation, Tokyo, Japan), operated at 5 kV and 10 mm working distance. All micrographs were digitally manipulated and plates containing LM and SEM pictures were mounted using CorelDraw X8® (Corel Corporation, Ottawa, Canada).

Morphological terminology follows Barber and Haworth (1981) for valve shape and stria pattern, Cox and Ross (1981) and Cox (2012) for lateral extensions (virgae) and cross bars (vimines and viminules), Williams and Round (1987) and Round et al. (1990) for areolar substructures, spines features, apical pore fields and girdle bands.

Results

The observed diatom flora in slide VI-41-B10 is rather diverse and composed of many species belonging to the genera *Biddulphia* and *Achnanthes*, *Eunotogramma frauenfeldii* (Grunow) Grunow, *Terpsinoë americana* (Bailey) Ralfs and *Fragilaria capensis* Grunow. The population of *Fragilaria pacifica* is rather small and represents less than 5% of the total diatom flora.

Redefinition of the genus *Opephora*

Opephora P.Petit emend. E.Morales, C.E.Wetzel, Van de Vijver *et* Ector

GENERITYPE: *Opephora pacifica* (Grunow) P.Petit

DESCRIPTION: Frustules rectangular in girdle view (Fig. 11), attached by mucilage stalks. Valves clavate in various degrees. Sternum of variable width and shape. Transition from valve face to mantle varying from abrupt (90°) to the formation of a transition zone. Striae composed of a single oval to elliptical areola running uninterruptedly from valve face to mantle. Internally, areolae opening into a single depression, running from valve face to mantle, occasionally becoming a chamber-like structure. Volae highly branched, usually in a dichotomous manner, arising from the virgae at different depths. Virgae flared at proximal and distal stria ends. Apical pore fields more or less developed, of the ocellulimbus type and composed of round poroids, present on both valve ends and internally sunken into apical depressions. Siliceous plaques present in the form of minute depositions arranged along the abvalvar edge of the valvocopula. Cingulum composed of a very large valvocopula, and few to many copulae. All girdle elements open, ligulated and lacking perforations.

Redefinition of *Opephora pacifica*

***Opephora pacifica* (Grunow) P.Petit emend. E.Morales, C.E.Wetzel, Van de Vijver *et* Ector**

Basionym: *Fragilaria pacifica* Grunow 1862, Verh. K.K. Zool.-Bot. Ges. Wien 12: 373, pl. VIII: fig. 19.

Homotypic synonyms: *Sceptroneis pacifica* (Grunow) Elmore 1921, Univ. Stud. Univ. Nebraska 21: 47. *Grunoviella pacifica* (Grunow) Mills 1934, An index to the genera and species of the Diatomaceae and their synonyms, Wheldon & Wesley Ltd. London, p. 822.

Microscopical study of Kalk Bay material: This manuscript, Figs 2–11 (LM); 12–25 (SEM).

Description: Frustules rectangular in girdle view (Figs 11, 13), attached by mucilage stalks. Valves clavate with broadly rounded apical pole and cuneate, acutely rounded foot pole (Figs 2–10). Valve dimensions (n=45): length 11–46 µm, width 6.5–8.5 µm, stria density 6–9 in 10 µm. Sternum narrow, linear, fusing without interruption with both valve poles (Figs 2–10, 12). Valve face convex and transition from valve face to mantle abrupt (Figs 12, 13, 18). Each stria composed of a single oval areola, bending and running without interruption from valve face to mantle (Figs 12–24). Internally, areolae opening into a single, unchambered depression (Figs 21–25). Volae robust and dichotomously anastomosing into a net-like occluding structure (Figs 12, 15–18, 21–25). Virgae flared at proximal and distal stria ends (Figs 12, 21). Apical pore fields composed of round pores, well-developed on both valves ends (Figs 12, 16, 17, 21), having approximately the same size, and internally sunken into apical and foot pole depressions (Figs 21, 22). Pores in apical pore field located at the valve apex rather simple and located on a more or less transapically elliptical pore plate (Figs 15, 17). Pores in foot-pole apical pore field lying in neatly arranged grooves, parallel to apical

valve axis, all within a transapically elliptical pore plate (Figs 13, 15). Cingulum composed of a very large and thick valvocopula (Figs 13, 14), and few to many slender, less silicified copulae (Fig. 14). All girdle elements open, ligulated, lacking perforations. Small silica plaques present along the abvalvar edge of the valvocopula, having the shape of blisters disorderly arranged in a single row (Figs 13, 14).

Discussion

The measurements presented in the description of *O. pacifica* originated from Sabbe and Vyverman (1995), who analyzed slide VI-41-B10 from the Van Heurck collection (AWH, Belgium). A re-analysis of the same slide confirmed these data indicating that all observations made at the LM level agree well with those made by Sabbe and Vyverman (1995). The latter authors refer to slide VI-41-B10 as the "isotype", but there is no historical record of any type from the 'mari pacifico boreali' material used originally by Grunow (1862) to describe the species. Therefore, and since Lange-Bertalot (1989) erected a neotype based on Grunow 790 with slide VI-41-B10 being a replica of it, the latter should be considered as the isotype.

Populations of *Opephora pacifica* have been reported and illustrated several times in the past (Witkowski et al. 2000, 2010, Li et al. 2018). Using the current (new) morphological knowledge gathered in the present study, it is clear that most of these records actually belong to other (most likely undescribed) species. The *O. pacifica* population shown by Li et al. (2018, figs 324–329, SEM) differs from the *O. pacifica* type material by size (Li et al. 2018: length 4.5–10.5 µm, width 2.5–3.0 µm having a stria density of 11–14 in 10 µm), virgae being broader than the striae (contrary to the type that has virgae barely wider than the striae) and a smaller apical pore field at the head pole composed of only a few pores contrary to the type that presents a much larger

apical pore field. Witkowski et al. (2000, pl. 25, fig. 26, SEM) presented one specimen with slender striae, different from any other *Opephora* seen during our literature review. The authors identified this taxon as *O. pacifica*, but the structure and shape of the striae, much wider in the type specimens of *O. pacifica*, actually suggest that the taxon in Witkowski et al. (2000) is new and requires a proper description. Probably only some of the LM figures presented by Witkowski et al. (2000, pl. 25, figs 18–25) might belong to this new taxon (e.g. figs 22 and 23) and the remaining seem to belong to *O. pacifica*, but SEM analysis will be necessary to confirm this.

Based on the observations made in the current study, we now can indicate both exclusive, distinguishing morphological features of the genus *Opephora* and several other, typical but not exclusive characters.

Distinguishing characters of *Opephora*: Striae composed of one single, transapically elliptical areola. Volae arising from the virgae, forming intricate, intertwined, net-like structures and plaques located on the distal edge of the valvocopula. If it is considered that loss of characters can potentially be used as synapomorphies (D.G. Mann, pers. com.), then the complete lack of vimines, viminules, spines and flaps, all present in the morphologically closely related genus *Pseudostaurosira* D.M.Williams *et* Round (Morales et al. 2019), could be used as distinguishing features of *Opephora*.

Other salient but not unique features: Girdle composed of a much wider valvocopula and slender copulae. All girdle elements open, ligulate, the latter feature also observed in *Staurosirella* D.M.Williams *et* Round (Morales and Manoylov 2006), but in this latter genus the valvocopula is always fimbriate, and mantle plaques always absent. *Pseudostaurosira* also has a well-developed valvocopula and slender copulae (Morales

et al. 2012, 2015), but the valvocopula in the latter is much less developed than in *Opephora* and mantle plaques are absent from the girdle elements.

Internally, the areolae open up into depressions, a feature also present in *Pseudostaurosira*. However, in *Pseudostaurosira*, the striae are composed of more than one areola (Morales et al. 2015) and occasionally, if only a single areola is present (as in *Pseudostaurosira varisterna* (Chunlian Li, Ashworth *et* Witkowski) E.Morales (Morales et al. 2019), spines develop along the stria at the valve face-mantle transition. As stated before, spines are always lacking in all *Opephora* species.

In the past a fairly large number of species have been included within the genus *Opephora* since the exact morphology of the generitype was not fully known. Table 1 contains all the names currently associated to *Opephora*, including varieties and forms. Most of them were already transferred to other genera. Witkowski et al. (2010) already indicated this based on the description and illustration in Round et al. (1990) stating that the actual number of true *Opephora* taxa has been reduced to a few marine forms whereas most other taxa were transferred to other araphid genera. Only two taxa can currently be ascribed with certainty to this genus, *Opephora marina* (type material studied by Andrén in 1997) and *Opephora pacifica* (neotype material studied herein). A third taxon, *Opephora fragilarioides* H.Kobayasi, is most likely also a member of the genus *Opephora* considering the morphological details given by Kobayasi et al. (1977), showing single-slit striae, absence of vimines and spines, and the interpretation given by Witkowski et al. (2000) based on SEM observations. However, until the type population of *O. fragilarioides* is studied in detail, the transfer cannot be made with certainty.

A complete revision of all *Opephora* names falls beyond the scope of the present paper and should be the focus of a thorough morphological study based on type analysis of all

species, preferably with the underlying support of molecular results. However, based on information and illustrations available in the literature, the following new combinations can be presented.

Neofragilaria burchardtiae **(Witkowski, Metzeltin *et* Lange-Bertalot) E.Morales comb. nov.**

Basionym: *Opephora burchardtiae* Witkowski, Metzeltin *et* Lange-Bertalot in Moser, Lange-Bertalot and Metzeltin 1998. Bibliotheca Diatomologica 38: 355–356, pl. 71, fig. 2, pl. 78, figs 1–13.

This species should be placed within the genus *Neofragilaria* based on the presence of vimines at the valve face/mantle junction and the presence of spines (Desikachary and Prema 1987, Li et al. 2015). The virgae are doubly flared and the areolae are very wide, approximately rectangular to square in shape. The striae open internally into depressions. The volae originate from inner areolar perimeter and intertwine to form a complex, flat, net-like pattern covering the entire areolar opening. This latter feature distinguishes the genus from *Pseudostaurosira* in which the volae are not as complex, and there are also flaps as additional areolar coverings.

Pseudostaurosira minuta **(Cleve-Euler) E.Morales, C.E.Wetzel, Van de Vijver *et* Ector stat. nov. comb. nov.**

Basionym: *Opephora marina* var. *minuta* Cleve-Euler 1953, Kongl. Svenska Vetensk.-Akad. Handl., ser. 4, p. 16, fig. 314e.

This taxon, as presented in Witkowski et al. (2000) is a member of *Pseudostaurosira* since it has wide and short vimines (Morales et al. 2019). Additionally, spines interrupting the striae are present. The latter are composed of two areolae, one on the

valve face and another on the valve mantle. The virgae are doubly flared. The small size of the valve face areolae leaves a wide, lanceolate sternum. Apical pore fields are present on both valve ends.

Acknowledgements

This work was co-funded by the European Union through the European Regional Development Fund, framed within the Operational Programme Competitiveness and Internationalization, COMPETE 2020 through the ICT project (UID/GEO/04683/2013) with reference POCI-01-0145-FEDER-007690 and the Agencia Portuguesa do Ambiente, APA-000004DFIN.AALP/2017 integrated within the Operational Program for Sustainability and Efficiency in the Use of Resources 2014-20, POSEUR-03-2013-FC-000001. Funding for this research was also partly provided in the framework of the DIATOMS project (LIST-Luxembourg Institute of Science and Technology).

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Figures 1–12. *Opephora pacifica* from Kal Bay (isotype).

(1) Grunow slide no. 790 containing material collected from Flugsand an der Kalkbai, Kap der Guten Hoffnung. (2–11) LM photographs. (11) Girdle view. (12). SEM image showing the external features of the valve: single-slit striae bearing well-developed, dichotomously-branched volae and well-developed apical pore fields.

Figures 13–20. SEM images of external features of *Opephora pacifica* from Kalk Bay (isotype) material. (13, 14) Girdle views showing relatively shallow valves, wide valvocopulae bearing small depositions on their distal edge, and the much slender copulae. (15–17) Detail of the valve apices showing the apical pore fields, sometimes occluded by extra siliceous material as in (15). (18) Detail in girdle view showing the single-slit areolae and the degree of development of the volae. (19–20) Two other specimens found in Kalk Bay (isotype) material depicted in valve view, showing variability in valve outline.

Figures 21–25. SEM images of internal features of *Opephora pacifica* from Kalk Bay (isotype) material. (21) Internal view of whole valve. Notice lack of chambered areolae and the degree of entanglement of the volae. The internal side of the apical pore field can be seen in the upper left side of the image. (22–25) Various shots depicting the high degree of entanglement of the volae, anastomosed and forming a net-like pattern.

Table 1. Taxa ascribed to *Opephora* and taxonomic status after the present revision. Rows in gray depict confirmed or possible true members of *Opephora*.

Taxon	Current taxonomic position	Reference	Comments
Opephora americana Peragallo	Unknown		
Opephora angusta Cholnoky	Unknown		Probably conspecific with *Neofragilaria stylus* Krzywda, Witkowski *et* Chunlian Li in Li et al. (2015)
Opephora anomala Giffen	Unknown		Probably a *Neofragilaria* Desikachary, A.K.S.Prasad *et* Prema in Desikachary & Prema (1987)
Opephora ansata M.H.Hohn *et* Hellerman	Unknown		Probably a *Staurosirella* following the drawing in Patrick and Reimer (1966)
Opephora bituminosa (Pantocsek) Cleve-Euler	Unknown	This manuscript	Probably a *Pseudostaurosira* following the

			interpretation of Ognjanova-Rumenova et al. (1994)
Opephora burchardtiae Witkowski	*Neofragilaria burchardtiae* (Witkowski) E.Morales comb. nov.	This manuscript	
Opephora cantalense Héribaud	Unknown		
Opephora cantalense var. *capitata* Héribaud	Unknown		
Opephora cantalense var. *obesa* Héribaud	Unknown		
Opephora cantalense var. *obesa* Tempère *et* H.Peragallo	Unknown		
Opephora cantalense var. *obtusa* Tempère *et* H.Peragallo	Unknown		
Opephora fragilarioides H.Kobayasi	Unknown		Probably a true *Opephora* following the original drawing by Kobayasi et al. (1977), and SEM illustration in Witkowski et al. (2000, pl. 25, fig. 26

			as *O. pacifica*)
Opephora gemmata (Grunow) Hustedt	Unknown		
Opephora gemmata f. *minor* Jurilj	Unknown		
Opephora giffenii Schoeman	Unknown		Probably a *Neofragilaria*
Opephora glangeaudii Héribaud	Unknown		
Opephora guenter-grassii (Witkowski *et* Lange-Bertalot) Sabbe *et* Vyverman	*Staurosirella guenter-grassii* (Witkowski *et* Lange-Bertalot) E.Morales, C.E.Wetzel *et* Ector	Morales et al. (2019)	
Opephora hachiroensis H.Kobayasi	Unknown		Original pictures not clear, but probably a *Stauroforma*
Opephora horstiana Witkowski	*Sarcophagodes mutabilis* (Grunow) E.Morales	Morales et al. (2019)	
Opephora kittonii Cleve-Euler	Unknown		Probably a *Neofragilaria*
Opephora krumbeinii Witkowski, Witak *et* Stachura apud Lange-Bertalot *et* Genkal	*Nanofrustulum krumbeinii* (Witkowski, Witak *et* Stachura) E.Morales	Morales et al. (2019)	

Opephora lanceolata Lohman	Unknown		
Opephora linearis J.W.Sherman *et* R.M.Patrick	Unknown		
Opephora lineata Edsbagge	Unknown		
Opephora lineata Giffen	Unknown		Probably a *Pseudostaurosira*
Opephora marina (W.Gregory) P.Petit	Current	Andrén (1997)	Type analyzed
Opephora marina var. *genuina* Cleve-Euler	Unknown		
Opephora marina var. *minuta* Cleve-Euler	*Pseudostaurosira minuta* (Cleve-Euler) E.Morales, C.E.Wetzel, Van de Vijver *et* Ector stat. nov. comb. nov.	This manuscript	Witkowski et al. (2000) present LM and SEM images of this taxon as *Opephora minuta*
Opephora marina var. *perminuta* (Grunow) Proschkina-Lavrenko	*Pseudostaurosira perminuta* (Grunow) Sabbe *et* Wyverman	Sabbe and Vyverman (1995)	
Opephora marina var. *pontica* Tarnavschi *et* Oltean	Unknown		
Opephora martyi Héribaud	*Staurosirella martyi* (Héribaud) E.Morales *et* Manoylov	Morales and Manoylov (2006)	

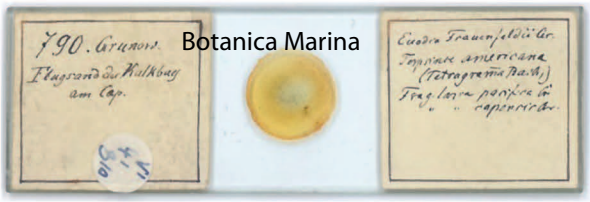
Opephora martyi f. *anomala* Héribaud	Unknown		*Opephora martyi* is now in *Staurosirella*, this forma should be revised
Opephora martyi f. *elliptica* Komarenko	Unknown		*Opephora martyi* is now in *Staurosirella*, this forma should be revised
Opephora martyi f. *intermedia* Komarenko	Unknown		*Opephora martyi* is now in *Staurosirella*, this forma should be revised
Opephora martyi f. *semirostrata* Tinny	Unknown		*Opephora martyi* is now in *Staurosirella*, this forma should be revised
Opephora martyi f. *vinaninkarenae* Manguin	Unknown		*Opephora martyi* is now in *Staurosirella*, this forma should be revised
Opephora martyi var. *amphioxys* V.S.Poretzky	Unknown		*Opephora martyi* is now in *Staurosirella*, this

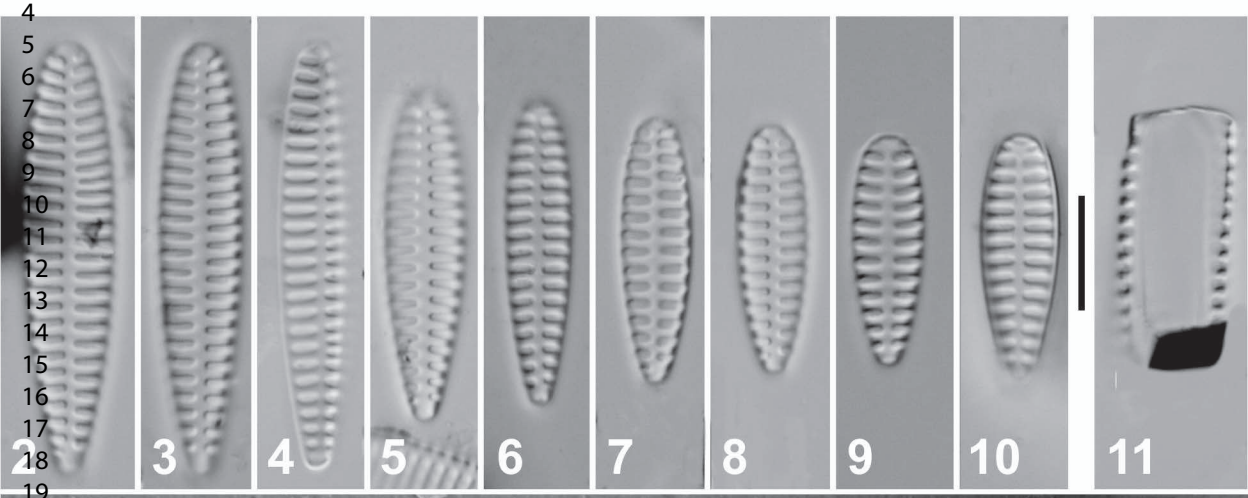
			variety should be revised
Opephora martyi var. *baicalensis* Skvortzov	Unknown		*Opephora martyi* is now in *Staurosirella*, this variety should be revised
Opephora martyi var. *capitata* Héribaud	Unknown		*Opephora martyi* is now in *Staurosirella*, this variety should be revised
Opephora martyi var. *elongata* Skvortzow	Unknown		*Opephora martyi* is now in *Staurosirella*, this variety should be revised
Opephora martyi var. *minor* Héribaud	Unknown		*Opephora martyi* is now in *Staurosirella*, this variety should be revised
Opephora martyi var. *okadae* (Skvortzow) Okuno	Unknown		*Opephora martyi* is now in *Staurosirella*, this variety should be revised

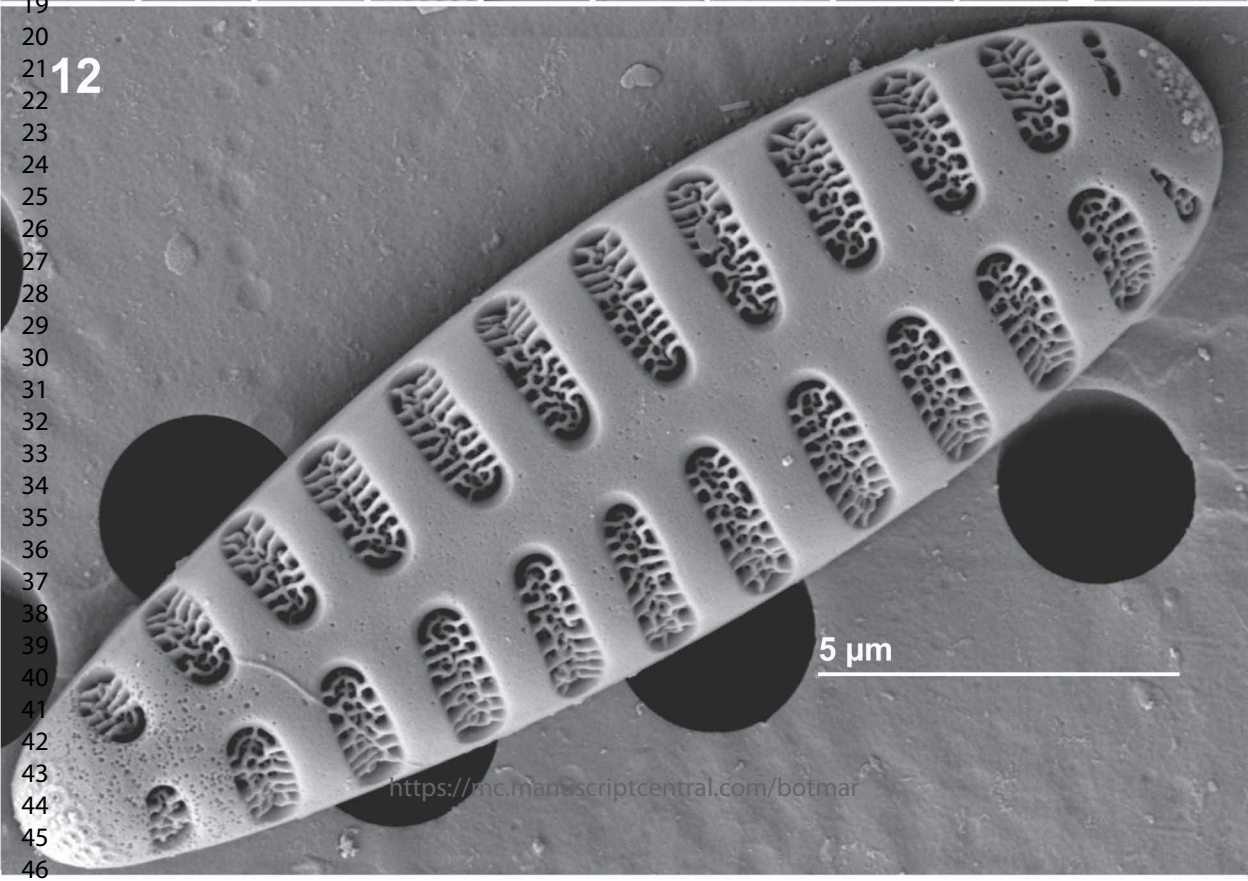
Opephora martyi var. *polymorpha* (Jouravleva) Proschkina-Lavrenko	Unknown		*Opephora martyi* is now in *Staurosirella*, this variety should be revised
Opephora martyi var. *robusta* Héribaud	Unknown		*Opephora martyi* is now in *Staurosirella*, this variety should be revised
Opephora martyi var. *robusta* Skvortzow	Unknown		*Opephora martyi* is now in *Staurosirella*, this variety should be revised
Opephora minuta (Cleve-Euler) Witkowski, Lange-Bertalot *et* Metzeltin	*Pseudostaurosira minuta* (Cleve-Euler) E.Morales, C.E.Wetzel, Van de Vijver *et* Ector stat nov. & comb. nov.	This manuscript	Witkowski et al. (2000) present LM and SEM images of this taxon
Opephora mutabilis (Grunow) Sabbe *et* Wyverman	*Sarcophagodes mutabilis* (Grunow) E.Morales	Morales et al. (2019)	
Opephora naveana Le Cohu	*Pseudostaurosira naveana* (Le Cohu) E.Morales *et* Edlund	Morales and Edlund (2003)	

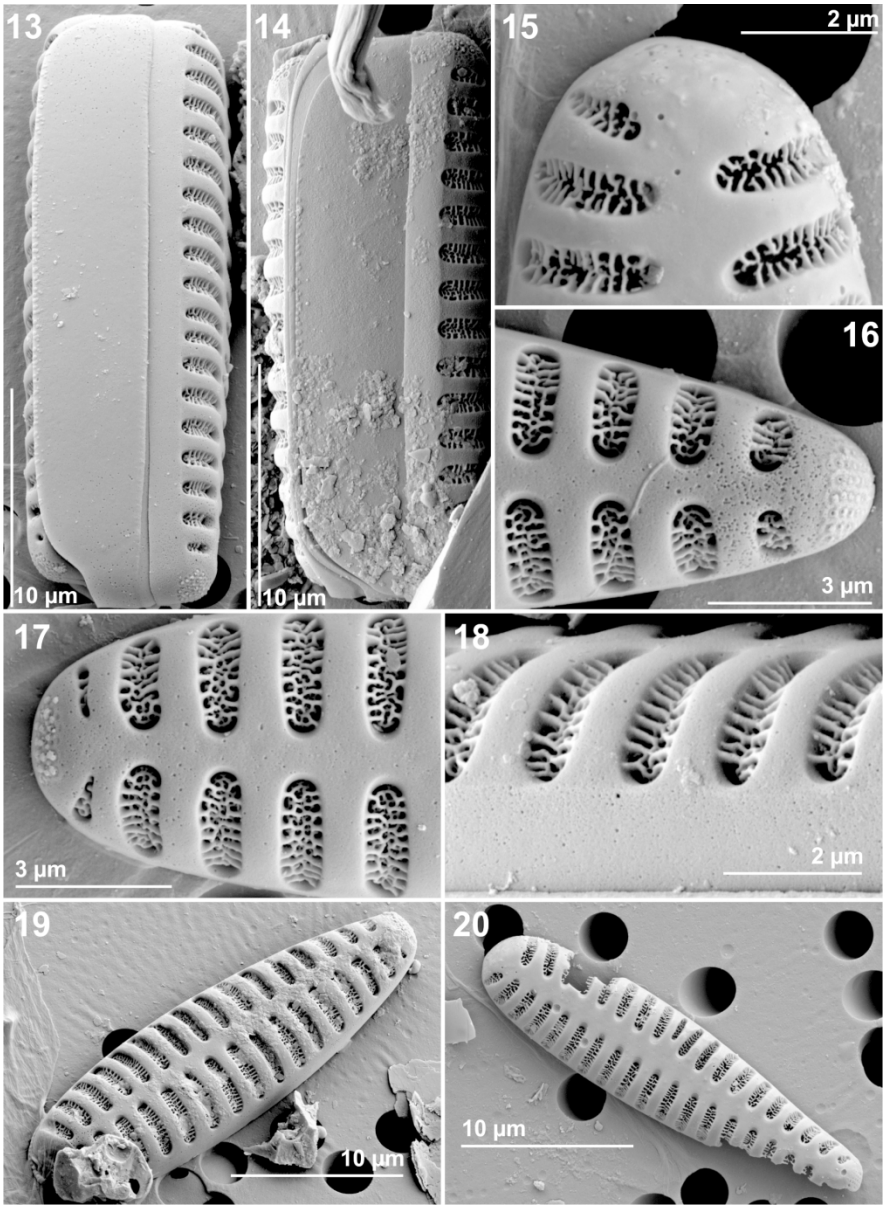
Opephora neoelliptica (Witkowski) Witkowski, Metzeltin *et* Lange-Bertalot	*Pseudostaurosira neoelliptica* (Witkowski) E.Morales	Morales (2002)	
Opephora okadae Skvortzow	Unknown		Syn.: *Opephora martyi* var. *okadae* (Skvortzow) Okuno. Placement in *Staurosirella* should be assessed.
Opephora olsenii M.Møller	*Pseudostaurosira perminuta* (Grunow) Sabbe *et* Wyverman	Sabbe and Vyverman (1995)	
Opephora pacifica (Grunow) P.Petit	Current	This manuscript	Isotype material analyzed in this manuscript
Opephora pacifica f. *parva* Mereschkowski	Unknown		
Opephora pacifica var. *trigona* Héribaud	Unknown		
Opephora parva (Grunow) Krasske	Unknown		Probably a member of *Sarcophagodes* following SEM illustrations in Witkowski (1994)
Opephora perlonga Giffen	Unknown		

Opephora perlonga var. *clavata* Giffen	Unknown		
Opephora perminuta (Grunow) Frenguelli	*Pseudostaurosira perminuta* (Grunow) Sabbe *et* Wyverman	Sabbe and Vyverman (1995)	
Opephora pinnata (Ehrenberg) P.Petit	*Nanofrustulum shiloi* Round, Hallsteinsen *et* Paasche	Round et al. (1999)	
Opephora pinnata var. *lanceolata* C.S.Boyer	Unknown		
Opephora polymorpha Jouravleva	Unknown		
Opephora schulzii (C.Brockmann) Simonsen	*Stauroforma schulzii* (C.Brockmann) Gogorev	Gogorev and Lange (2014)	
Opephora schwartzii (Grunow) P.Petit ex Pelletan	Unknown		
Opephora taiaensis J.R.Carter *et* Denny	Unknown		









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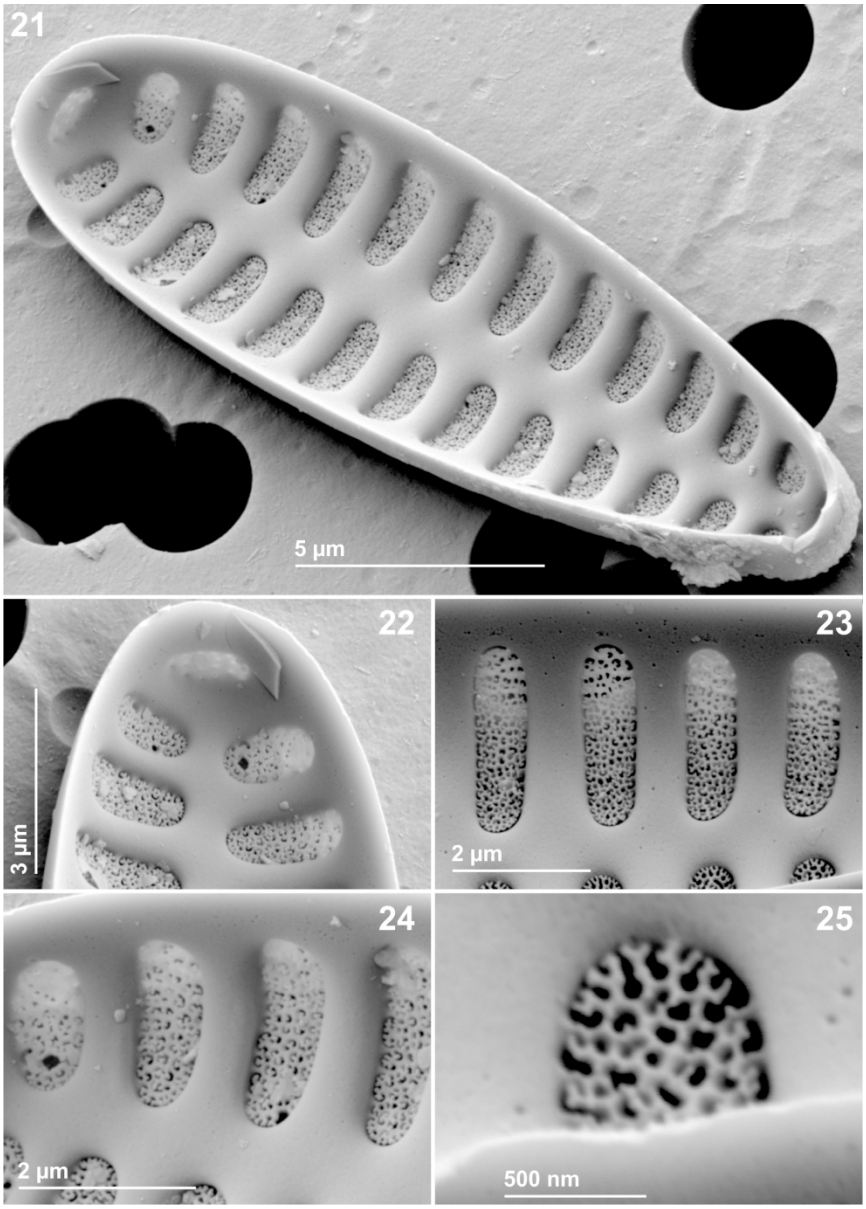

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