On the identity of *Gyrosigma prolongatum* var. *closterioides* (Grunow) Cleve

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Abstract

*Gyrosigma prolongatum* var. *closterioides* is raised to specific status as *G. closterioides* (Grunow) G. Reid stat. nov. The ultra-structure of *G. closterioides*, *G. fasciola* (Ehrenb.) J.W. Griff. & Henfr., *G. prolongatum* (W.Sm.) J.W. Griff. & Henfr. and *G. macrum* (W.Sm.) J.W. Griff. & Henfr. is investigated using light and electron microscopy.

Key index words: *Gyrosigma*, taxonomy, ultra-structure

Introduction

The genus *Pleurosigma* W.Sm. was established (Smith 1852) to encompass the naviculoid diatoms that were sigmoid in valve outline. A taxon named *Pleurosigma prolongatum* var. *closterioides* was first described by Grunow (1884). Morphologically it appeared quite distinct from other members of *Pleurosigma* in that its poles appeared to be curved in the same direction rather than in opposite directions as in other members of the genus resembling those, as Grunow noted, of *Toxonidea* Donkin. Similarities to *Toxonidea* were also noted by Peragallo (1891: 26) and Reid (1998: 363). The genus *Toxonidea* is quite distinct from other members of the Pleurosigmales in that both of its poles are curved in the same direction. *Toxonidea* was established by Donkin (1858: 9) to accommodate species that resembled *Pleurosigma*, but had apices curving in the same direction rather than opposite directions as in *Pleurosigma*.

The genus *Pleurosigma* was later divided into two genera *Pleurosigma* and *Gyrosigma* Hassall on the basis of the striae arrangement, transverse and oblique and transverse and longitudinal respectively by Cleve (1894). He transferred the taxon to *Gyrosigma* under the name *G. prolongatum* var. *closterioides* due to it having transverse and longitudinal striae (Cleve 1894: 117). It was later transferred as a variety of *G. fasciola* by Proshkina-Lavrenko (1950: 249) (as with her interpretation of *G. prolongatum*) due to the shape of the valve outline, in that the extremities were sharply drawn out as in *G. fasciola*. This combination was agreed by Cardinal et al. (1986: 175) as they saw the valve outline with ends being abruptly drawn out as in *G. fasciola* rather than gradually drawn out as in *G. prolongatum*.

Hendey (1964: 249) recognised *closterioides* as a variety of *G. prolongatum* describing it as ‘valves as the type, but the produced apices turned in the same direction.’

Von Quillfeldt (2000: 229) interpreted Sterrenburg (1991) as having invalidated var. *closterioides* as a taxon stating ‘Sterrenburg (1991) pointed out for the first time that the ‘var. *closterioides*’ is a spurious taxon based on an artefact: one tip of the valve flips over because the ‘neck’ is thin and flexible.’ On referring back to Sterrenburg (1991: 385) this is not the case as he says ‘The remarkable feature of ends curving in the same direction that has lead to the distinction of *G. prolongatum* var. *closterioides* is at variance with valve and raphe sternal morphology in the genus as a whole. I have seen numerous valves with such raphe sternal shape, but this was always due to twisting (not bending) from mechanical causes, without fracture. This artefact should be excluded by examination of the type before *G. prolongatum* var. *closterioides* is confirmed a valid taxon.’

This paper investigates the morphology of *G.
prolongatum var. closterioides with light and electron microscopy and compares it with its nominate varieties; G. prolongatum (W.Sm.) J.W.Griff. & Henfr. and G. fasciola (Ehrenb.) J.W.Griff. & Henfr. Also investigated is G. macrum (W.Sm.) J.W.Griff. & Henfr. which has a very similar valve shape that G. prolongatum var. closterioides could easily be mistaken for. It explores Sterrenburg (1991: 385) and Von Quillfeldt (2000) suggestion that the appearance of G. prolongatum var. closterioides is due to an artefact.

Materials and methods

Slides were examined using a Reichert microscope. For photomicroscopy, specimens were examined on a Carl Zeiss microscope, with differential interference contrast, using plan apochromat objectives and tri colour green filter. Photos were taken using medium format Kodak Tmax 100 film. Cleaned specimens were strewn on aluminium stubs for SEM examination. The specimens were sputter coated with gold-palladium and observed using a Hitachi S800 and Phillips XL30 field electron microscope. All slides, negatives and SEM stubs of the specimens are housed in the herbarium of The Natural History Museum, London (BM) except those indicated (WEIN) for The Natural History Museum, Vienna.

Terminology for the siliceous parts of the diatom frustule follows that of Anonymous (1975) and Ross et al. (1979).

Species descriptions

Gyrosigma closterioides (Grunow) G.Reid stat. nov. Figs 1–13
Basionym: Pleurosigma prolongatum var. closterioides Grunow 1884: 105, Taf. A, Fig. 58.

Synonyms: Gyrosigma prolongatum var. closterioides (Grunow) Cleve 1894: 117. Gyrosigma fasciola var. closterioides (Grunow) Proshk.-Lavr. 1950: 249, Tab. 82, Fig. 6.

Lectotype (designated here): WEIN 2781a, Dawlish Warren, W. Arnott 557.


Description: Valves lanceolate with long slender drawn out apices occasionally curved in opposite directions (Figs 1, 4), but more frequently with apices appearing to curve in the same direction (Figs 5–7). Raphe central, straight in the main body of the valve, only curving to fit into the beak (Figs 1, 4–7). External central raphe fissures overlapping (Fig. 3). Internal central bars divided (Fig. 2). Apices often appear to be pointing in the same direction (Figs 5–7) this is due to the valve twisting in the narrow beak (Figs 9, 12). Length 120–170 μm, breadth 7–10 μm, beak length 30–50 μm. Transverse striae 22–23 per 10 μm, longitudinal striae 40? per 10 μm.

Ecology: Marine.

Gyrosigma prolongatum (W.Sm.) J.W.Griff. & Henfr. 1856:303, Pl. 11 Fig. 23.

Figs 14–22
Basionym: Pleurosigma prolongatum W. Sm. 1852: 9, Fig. 7.

Synonyms: Pleurosigma fasciola var. prolongatum (W.Sm.) Van Heurck 1896: 259.

Type locality: Poole Bay, 1849.

Type slide (lectotype designated here): BM 23709 W. Sm. Shoreham 1852. The lectotype was chosen from Shoreham as no Poole Bay material was available and Shoreham was the additional locality Smith gave later in his 1853 description.
Non: Gyrosigma fasciola var. prolongata (W. Sm.) Proshk.-Lavr. 1950: 249 Tab. 82 Fig. 5. Proshkina-Lavrenko appear to have inverted their descriptions of G. prolongatum and G. macrum. The species they give as G. prolongatum is in fact G. macrum.

Gyrosigma prolongatum sensu Von Quillfeldt 2000: 231, Figs 16–17. Von Quillfeldt gave four images identified as G. prolongatum only Figures 14 & 15 are of G. prolongatum, Figs 16 & 17 resemble either G. closterioides or G. macrum. The images are not of the same specimen and only details of one pole is available in each case so exact determination is not possible as the other salient features for identification are not in focus.

Material Studied: UK: England: Teignmouth: BM 19518; Shoreham Sussex: BM 23708; BM 23709; The following slide is marked WS 212 indicating William Smith Fig. 212. This may be interpreted as the locality of the slide being either Poole Oct 1849 or Shoreham Sept 1852 as these are the only two localities cited by Smith (1853: 67) BM 20724 WS 212; Scotland: Arran: BM 20374; Cumbrae: BM 25433; BM 48475. Sweden: Lysekil: BM 12896.

Description: Valves lanceolate, gradually drawn out into long beaks curved in opposite directions (Figs 14–17). Length 110–180 μm, breadth 7–15 μm. Raphe central, straight in the main body of the valve, only curving to fit into the beak (Figs 14–18). Transverse and longitudinal striae 21–22 per 10 μm. Central area small, central bars smooth, continuous with the primary side of the raphe (Fig. 20). Central fissures curved in the same direction (Fig. 28). Length 60–150 μm, breadth 12–24 μm, beak length 10–20 μm, beak width 1.5–2 μm. Pore at the end just above the raphe ending modified into a horseshoe shape (Fig. 23).

Ecology: Marine.

Gyrosigma fasciola (Ehrenb.) J.W.Griff. & Henfr. 1856: 303. Figs 23–30. Basionym: Ceratoneis fasciola Ehrenb. 1839: 157; 1839 (1849): 144, Pl. 4 Fig. 6a–c. Synonym: Pleurosigma fasciola W.Sm. 1853: 67 Supp. Pl. 31 Fig. 276.

Synonym: Gyrosigma fasciola var. prolongata (W. Sm.) Proshk.-Lavr. 1950: 249 Tab. 82 Fig. 5.


Type slide (lectotype designated here): BM 23707, Iford, Sussex, Oct. 1852.

Material Studied: UK: England: Iford Sussex: BM 23706; BM 23707; Stoneferry, Hull BM 20722; BM 1898; BM 20777; BM 21904; BM 20777.
Figs 23–30. *Gyrosigma fasciola* from Hastings 1851 BM W. Smith material (excluding Fig. 27 from Hastings 1993). Fig. 23. SEM of internal polar region. Fig. 24. SEM of external polar region. Figs 25, 26. Light micrograph of valve. Fig. 27. Light micrograph of live specimen showing chloroplast arrangement. Fig. 28. SEM of external central area. Fig. 29. SEM of internal central area. Fig. 30. SEM of internal valve. Scale bars: Figs 25–27 = 10 µm; Figs 24 & 29 = 2 µm; Figs 23 & 28 = 1.5 µm; Fig. 30 = 43 µm.
Description: Valves lanceolate, apices abruptly drawn-out into long beaks which are curved in the opposite directions (Figs 31, 35). Raphe central, straight in the main body of the valve, only becoming sigmoid at the apices curving to fit into the beak (Figs 31–35). Length 160–270 μm, breadth 10–13 μm, beak length 35–55 μm. Longitudinal striae 30 per 10 μm, transverse striae 27–28 per 10 μm. No central bars as such (Fig. 38) just silica ridges with undulating outer edges, surrounded by small hyaline area. External central raphe fissures nearly straight, deflected very slightly in the same direction (Fig. 37). At apices a series of pores are situated directly above the raphe ending (Figs 36, 39). Internally these pores are elongate (Fig. 39) and pass directly through to the outside of the valve (Fig. 36).

Ecology: Marine and brackish water. Predominantly found in brackish water.

Discussion

From examination of the type material (Figs 1–13) *G. prolongatum* var. *closterioides* is shown to have its valve endings curved in the same direction. The appearance of valves having ends pointing in the same direction is due to a twisting of the end of the valve (Figs 9 & 12). If the twist were forcibly straightened out i.e. unfolded, the valve would be sigmoid as in Fig. 4. This twisting is not an artefact of the valve drying on the coverslip because when specimens are observed live they hold the same position.

A similar position is observed in valves of *Gyrosigma spathulatum* Ricard, from Tahiti. This is a species with long drawn out apices which then become inflated giving the appearance of spoons (spathulate). Ricard showed in SEM that the curvature of the apices in the same direction as opposed to the normal sigmoid shape was caused by a twist in one of the apices of 180° (Ricard 1975: Figs 42–43). He commented on the similarity of his species to that of *Pleurosigma naja* (Ricard 1975: 209), but noted the difference in the striation and size of the species. Sterrenburg (2000: 302) synonymised *P. naja* E.Meister and *G. spathulatum* under the new combination *G. naja* as he saw no differences in the morphology of the species. Sterrenburg (2000 : 302) stated in this case that the rotation of the valve ending was due ‘mechanical stress' and ‘even the slightest stress causes the ‘spoons’ to flip over' and the ‘undistorted configuration’ was with poles curving in opposite directions as opposed to curving in the same direction which is the case in *G. prolongatum* var. *closterioides*.

*Gyrosigma prolongatum* var. *closterioides* is here raised to specific status as it is quite distinct from the other taxa it has previously been associated with or could be confused with.

*Gyrosigma prolongatum* has quite a different valve outline with its apices gradually being drawn out into short beaks (Figs 14–17) whereas *G. closterioides* has very long delicate apices (Figs 1, 4–12). The two taxa do possess a number of ultrastructural similarities with both taxa having external central fissures that overlap (Figs 3 & 22) and internal central bars that are divided (Figs 2 & 20). However the difference in valve outlines are quite distinct.

*Gyrosigma fasciola* has very short curved apices (Figs 25–27, 30) with central fissures straight (Fig. 28) and smooth central bars (Fig. 29) when compared to the very long delicate apices in *G. closterioides* (Figs 1, 4–12) coupled with overlapping central fissures and divided central bars (Figs 2–3).

*Gyrosigma macrum* has a very similar valve outline to *G. closterioides* with very delicate drawn out apices (Figs 1 & 4 compared with Figs 31 & 35), however in this species the poles do not appear to twist as in *G. closterioides* (Figs 5–7, 9, 12). This is quite a significant difference as when studying a population of *G. closterioides* the majority of the population has its apices appearing to be turned in the same direction whereas in *G. macrum*, which is of the same shape, this does not occur. The poles in the two species have very similar dimensions so the mechanism that causes *G. closterioides* to
twist and fold over itself is quite distinct. However their ultrastructure is also quite different. G. macrum has reduced central bars (Fig. 38), its central fissures deflected slightly to one side (Fig. 37) and a series of elongate apical pores above the raphe (Fig. 39), whereas in G. closterioides there are overlapping central fissures, divided central bars and no series of elongate apical pores (Figs 2, 3, 8).

As it is shown to be quite distinct from the other species it has been named as a variety of I shall raise it to specific status as G. closterioides stat. nov. The appearance of the valve apices is not an artefact as suggested by Sterrenburg (1991) and Von Quillefeldt (2000) and is a real phenomenon.

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References


Figs 31–39. Gyrosigma macrum from Ilford, Sussex, Oct. 1852 BM W. Smith material. (Figs 31–35 BM 23707). Fig. 31. Light micrograph of valve. Figs 32, 33. Light micrograph of polar region. Fig. 34. Light micrograph of central region. Fig. 35. Light micrograph of valve. Fig. 36. SEM of polar region. Fig. 37. External SEM of central area. Fig. 38. Internal SEM of central area. Fig. 39. Internal SEM of polar region. Scale bars: Figs 31–35 = 10 μm; Figs 36–38 = 2 μm; Fig. 39 = 1 μm.


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