

Typification of *Sigmatella subrecta* Brébisson and its transfer to the genus *Gyrosigma* (Naviculaceae, Bacillariophyta)

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The genus *Sigmatella* Kützing, *nom. rej.* (Kützing 1833: 2) was based on *S. nitzschii* Kützing, an illegitimate name for *Bacillaria sigmoidea* Nitzsch (Kützing 1833: 3). The genus name was rejected in favour of the genus name *Nitzschia* Hassall (Wiersema & al. 2018+). A handful of species, however, was described in the genus *Sigmatella*, most of them now transferred to the genera *Nitzschia* or *Gyrosigma* Hassall. There are, however, still a few taxa that await further taxonomic treatment, most likely because an analysis of their type material has not been carried out at present.

One of these taxa is *Sigmatella subrecta* Brébisson, described in 1838 from the “Côte du Calvados” (Normandy, France) in the “Corrections et Additions” of his 1838 paper “Considérations sur les Diatomées” (Brébisson 1838a, b). Brébisson (1838b : 149) described the species as “*Elle ressemble à l’acuminata, mais elle est plus étroite, plus obtuse et moins courbée à ses extrémités.*” [She resembles the *acuminata*, but she is narrower, more obtuse and less curved towards its apices.]. With ‘*acuminata*’, Brébisson most likely meant *Sigmatella acuminata* (Kützing) Brébisson & Godey, a new combination he had made in 1835 for *Frustulia acuminata* Kützing, a species now transferred to the genus *Gyrosigma* as *G. acuminata* (Kützing) Rabenhorst (Brébisson & Godey 1835). *Sigmatella acuminata* was found to be a marine species as Brébisson added “*Elle se trouve sur la couche de vase qui enduit les rochers marins qui sont découverts à chaque marée.*” [She is found on the mud layer that surrounds the rocks in the sea and that exposed at every low tide.] Kützing (1844: 104) considered *S. subrecta* to be a synonym for his *Amphipleura rigida* Kützing (1844: 104) together with *Frustulia scalaris* Brébisson (1838: 19). *Frustulia scalaris* was transferred to the genus *Climaconeis* Grunow as *C. scalaris* (Brébisson) E.J.Cox by Cox (1982: 166). Kützing (1849: 88) retained *A. rigida* and included *F. scalaris* as a synonym but omitted the name *S. subrecta*.

Amphipleura rigida was later first transferred to the genus *Nitzschia* by Grunow (in Van Heurck 1881: pl. 66: fig. 2) as *Nitzschia sigma* var. *rigida* (Kützing) Grunow. Peragallo & Peragallo (1900: 291, pl. 74: figs 8–9) treated the taxon as *Nitzschia rigida* (Kützing) H.Peragallo & M.Peragallo. De Toni (1892: 531) included *S. subrecta* as a synonym for *N. sigma* var. *rigida*, together with the name *F. scalaris*, but expressed his doubts for both synonyms by adding a ‘?’ for each. Frenguelli (1926: 66, pl. 7: fig. 3) included the taxon as *Sigmatella sigma* var. *rigida* (Kützing) Frenguelli.

As *Amphipleura rigida* Kützing (1844: 104, pl. 4: fig. XXX) represented an unwarranted name change for *Sigmatella subrecta*, which Kützing included in synonymy, it should be considered illegitimate. The later H.Peragallo & M.Peragallo name *Nitzschia rigida* is most likely valid but superfluous.

Analysis of type material from Arromanches collected by de Brébisson and retrieved from the Van Heurck collection (**BR**, Meise Botanic Garden, Belgium), showed that this taxon does not belong to the genus *Nitzschia*. Light microscopical analysis of the samples labelled “*Sigmatella subrecta*” showed that almost all valves in the sample belong to a species showing all morphological features

of the genus *Gyrosigma* Hassall, *nom. cons.* (e.g. Round & al. 1990; Figs 1–13). As Brébisson (1838: 142) had indicated, the species resembles a miniature version of *G. acuminata* and therefore we propose to transfer *Sigmatella subrecta* to the genus *Gyrosigma*, according to the provisions of the ICN (Turland & al. 2018: Art. 56. Note 1). Material from Arromanches prepared as a slide is here designated as lectotype.

Gyrosigma subrectum (Brébisson) Van de Vijver & Kusber, *comb. nov.* (Figs 1–17)

Basionym: *Sigmatella subrecta* Brébisson, *Mémoires de la Société Académique, Agricole, Industrielle et d'Instruction de l'Arrondissement de Falaise*, Vol. 1: 249, 1838.

Lectotype (here designated): BR-4761, slide prepared from sample from Arromanches [Arromanches-les-Bains], Calvados, Normandy, France, leg. A. de Brébisson, *sine numero*. labelled *Sigmatella subrecta*, material conserved at BR. The lectotype is represented by Fig. 3.

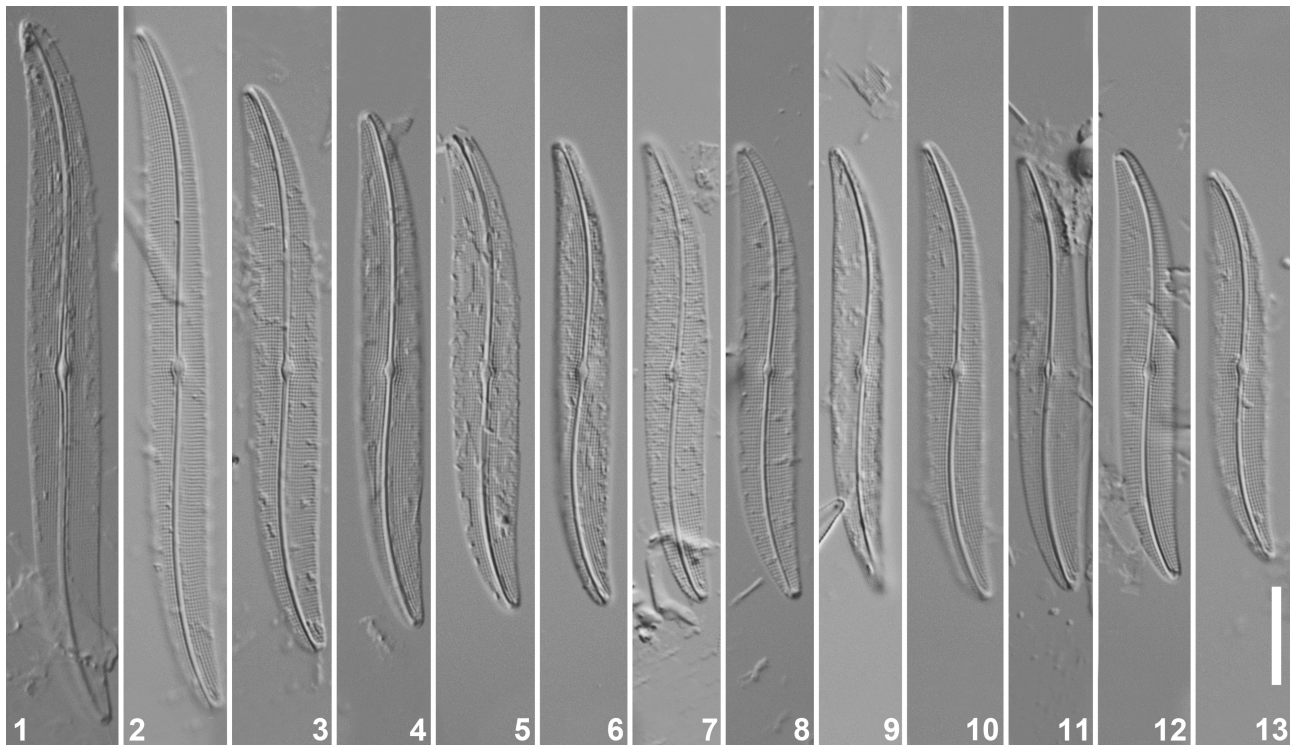
PhycoBank registrations: <http://phycoBank.org/103399> (name), <http://phycoBank.org/103402> (type)

Description: Valve slightly sigmoid, linear with parallel margins at the valve centre. Apices acutely rounded, not protracted. Valve dimensions (n=20): valve length 40–80 µm, valve width 6–8 µm. Raphe sternum narrow, distinctly sigmoid. Internally raphe sternum bordered by two thick ridges running from the central area to the terminal raphe endings, the latter terminating on small helictoglossae. First row of areolae on both sides of the sternum different, on one side composed of two small areolae, on the other side with two areolae fused to form one large, irregular one. Central area externally small, rounded. Internally, formed by elliptical central nodule bordered on each side by short, hemi-circular ridge. External central raphe endings hooked into opposite directions, internally short T-shaped, terminating onto the central nodule. External terminal raphe fissures deflected into opposite directions, long, continuing until the valve face/mantle junction, terminating into weakly inflated terminal pores. Striae uniseriate, parallel at the central area, becoming radiate towards the apices. External areola foramina apically elongated, almost touching forming longitudinal lines across the striae, 26–27 in 10 µm. Internally, rounded at the axial area, becoming more elongated-elliptical towards the valve mantle. Areola more densely placed near the margins.

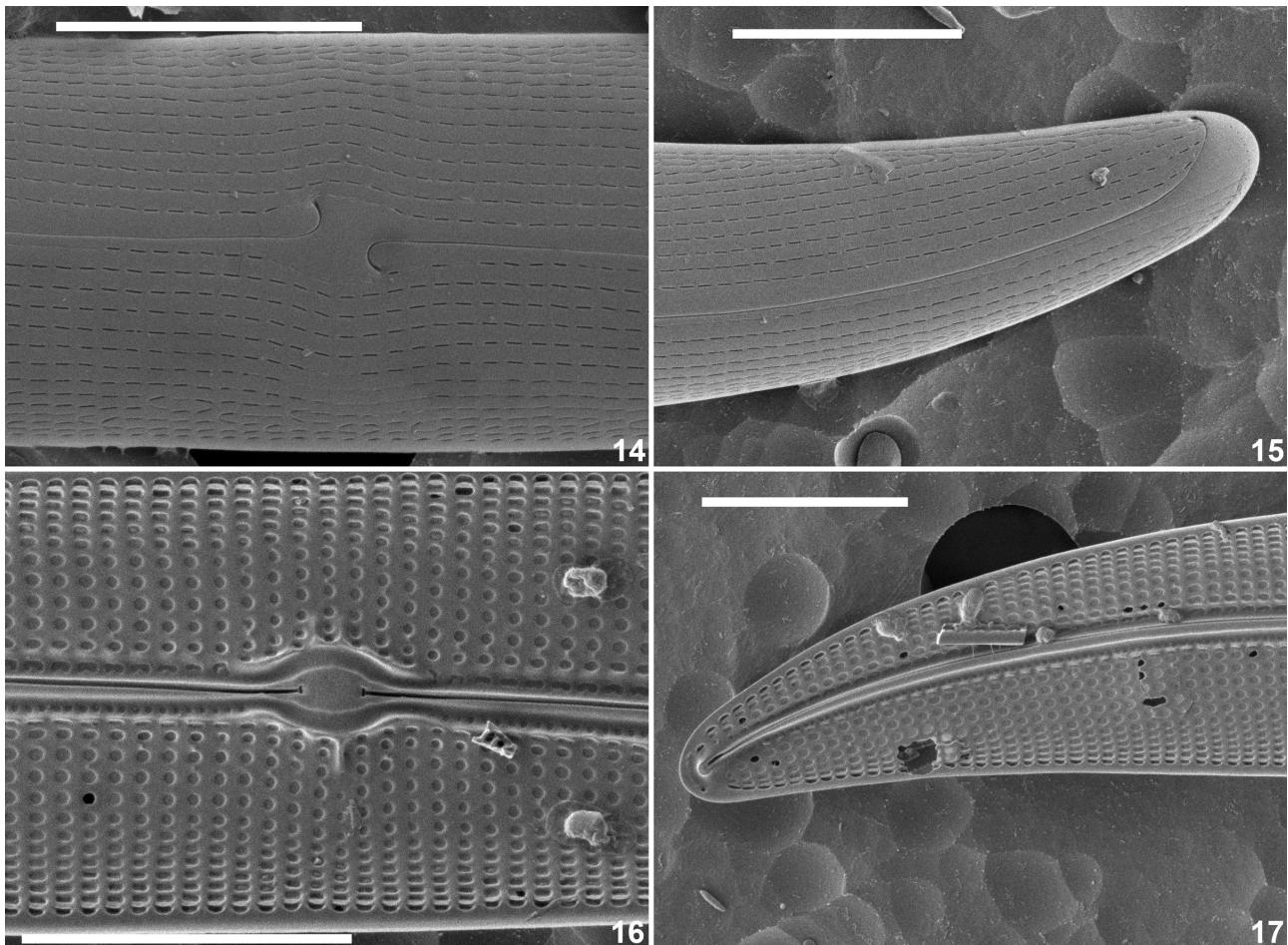
Note: It appears that after the publication of Brébisson's (1838a) *Considerations sur les diatomées...* a note by Brébisson was published in the first volume of *Mémoires de la Société Académique, Agricole, Industrielle et d'Instruction de l'Arrondissement de Falais* under the title “*Corrections et additions au mémoire sur les diatomées*” on pp. 148 and 149 (Brébisson 1938b). These pages were apparently distributed separately (as pp. 141 and 142) and often bound with the original or perhaps included as additional pp. 21 and 22. However, it is clear from the publication of the note in the journal that “*Corrections et additions...*” did not form part of the original publication.

The genus *Gyrosigma* was intensively studied by the late Frithjof A.S. Sterrenburg (1934–2016) who analysed based on both LM and SEM observations many *Gyrosigma* species (e.g. Sterrenburg 1991, 1992, Sterrenburg & Tiffany 2004), collected from the marine and the freshwater habitats. Although the central area was repeatedly examined in detail, the typical structure in the valve interior of the double areolae on one side of the axial area and one large areola on the other, was not found, making *G. subrectum* almost unique among the smaller *Gyrosigma* species. Additionally, the valve exterior with longitudinal lines running across the striae, has not been observed so far in many species. An exception is *Gyrosigma tubicola* F.A.S. Sterrenburg & M.A. Tiffany (2004: 278 ‘*tubicolum*’) showing a similar external striation pattern but the latter possesses a different internal central nodule and lacks the asymmetrical bordering of the axial area.

- Brébisson, [L.] A. de (1838a). *Considerations sur les diatomées et essai d'une classification des genres et des espèces appartenant à cette famille*, par A. de Brébisson, auteur de la Flore de Normandie, etc. pp. [i], [1]-20 [error pages bound with it]. Falaise & Paris: Brée l'Aînée Imprimeur-Libraire; Meilhac.
- Brébisson, [L. A.] de (1838b). Corrections et additions au mémoire sur les diatomées. *Mémoires de la Société Académique, Agricole, Industrielle et d'Instruction de l'Arrondissements de Falaise* 1: 148-149.
- Brébisson, L.A. de & Godey, L.L. (1835 '1836'). Algues des environs de Falaise, décrites et dessinées par MM. de Brébisson et Godey. *Mémoires de la Société Académique des Sciences, Artes et Belles-Lettres de Falaise* 1835: 1-62, 256-269 [corrections], pls I-VIII.
- Cox, E.J. (1982). Taxonomic studies on the diatom genus *Navicula* Bory. IV. *Climaconeis* Grun., a genus including *Okedenia inflexia* (Bréb.) Eulens. ex De Toni and members of *Navicula* sect. *Johnsonieae* sensu Hustedt. *British Phycological Journal* 17: 147-168.
- De Toni, G.B. (1892). *Sylloge algarum omnium hucusque cognitarum. Vol. II. Sylloge Bacillariarum. Sectio II. Pseudoraphideae*. pp. [i-v], 491-817. Padova [Padua]: Sumptibus auctoris.
- Frenguelli, J. (1926). Diatomeas fósiles del Prebelgranense de Miramar (Contribución IV). *Boletín de la Academia Nacional de Ciencias en Córdoba* 29: 5-89, 9 pls.
- Kützing, F.T. (1833). *Algarum aquae dulcis germanicarum* Decas I. pp. [1-24]. Halis Saxonum [Halle]: in commissis C.A. Schwetschkii et fil.
- Kützing, F.T. (1844). *Die Kieselschaligen Bacillarien oder Diatomeen*. pp. [i-vii], [1]-152, pls 1-30. Nordhausen.
- Kützing, F.T. (1849). *Species algarum*. pp. [i]-vi, [1]-922. Lipsiae [Leipzig]: F.A. Brockhaus.
- Peragallo, H. & Peragallo, M. (1900). *Diatomées marines de France et des districts maritimes voisins*. Atlas. pp. pls 73-80. Grez-sur Loing (S.-et-M.): J. Tempère, Micrographe-Editeur.
- Round, F.E., Crawford, R.M. & Mann, D.G. (1990). *The diatoms biology and morphology of the genera*. pp. [i-ix], 1-747. Cambridge: Cambridge University Press.
- Sterrenburg, F.A.S. (1991). Studies on the genera *Gyrosigma* and *Pleurosigma* (Bacillariophyceae). Light-microscopical criteria for taxonomy. *Diatom Research* 6: 367-389.
- Sterrenburg, F.A.S. (1992). Studies on the genera *Gyrosigma* and *Pleurosigma* (Bacillariophyceae). The type of the genus *Gyrosigma* and other *Attenuati* sensu Peragallo. *Diatom Research* 7: 137-155.
- Sterrenburg, F.A.S. & Tiffany, M.A. (2004). Studies on the genera *Gyrosigma* and *Pleurosigma* (Bacillariophyceae). Two new species from the Red Sea: *Gyrosigma schmidianum* nov. sp. and *Gyrosigma tubicolum* nov. sp. *Diatom Research* 19(2): 275-281.
- Turland, N.J., Wiersema, J.H., Barrie, F.R., Greuter, W., Hawksworth, D.L., Herendeen, P.S., Knapp, S., Kusber, W.-H., Li, D.-Z., Marhold, K., May, T.W., McNeill, J., Monro, A.M., Prado, J., Price, M.J. & Smith, G.F., editors (2018). International Code of Nomenclature for algae, fungi, and plants (Shenzhen Code) adopted by the Nineteenth International Botanical Congress Shenzhen, China, July 2017. *Regnum Vegetabile*, Vol. 159. pp. [i]-xxxviii, 1-253. Glashütten: Koeltz Botanical Books.
- Van Heurck, H. (1881). Synopsis des Diatomées de Belgique Atlas. pls XXXI-LXXVII [pls 31-77]. Anvers: Ducaju et Cie.
- Wiersema, J.H., Turland, N.J., Barrie, F.R., Greuter, W., Hawksworth, D.L., Herendeen, P.S., Knapp, S., Kusber, W.-H., Li, D.-Z., Marhold, K., May, T.W., McNeill, J., Monro, A.M., Prado, J., Price, M.J. & Smith, G.F. (eds.) 2018+ [continuously updated]: International Code of Nomenclature for algae, fungi, and plants (Shenzhen Code) adopted by the Nineteenth International Botanical Congress Shenzhen, China, July 2017: Appendices I-VII. Online at <https://naturalhistory2.si.edu/botany/codes-proposals/> [accessed 21 October 2022].



Figs 1–13. *Gyrosigma subrecta* (Brébisson) Van de Vijver & Kusber, *comb. nov.* LM pictures taken from the lectotype material (**BR-4761**, Arromanches, Calvados, France, de Brébisson original sample s.n.). LM pictures of valves in decreasing length series. Scale bar = 10 μm .



Figs 14–17. *Gyrosigma subrecta* (Brébisson) Van de Vijver & Kusber, *comb. nov.* SEM pictures taken from the lectotype material (**BR-4761**, Arromanches, Calvados, France, de Brébisson original sample s.n.). **Fig. 14.** External SEM detail of the central area showing the hooked central raphe endings. **Fig. 15.** External SEM detail of the valve apex with the terminal raphe fissures. **Fig. 16.** Internal SEM detail of the central area. Note the asymmetrical areolae bordering the sternum ridges. **Fig. 17.** Internal SEM detail of the valve apex with the helictoglossa. Scale bars = 5 μm .