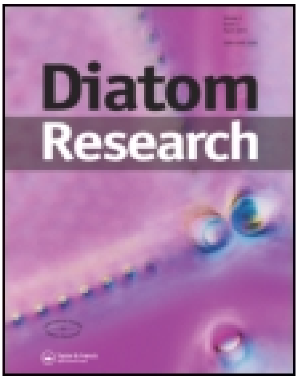

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GYROSIGMA SINENSE (EHRENBERG) DESIKACHARY: TYPIFICATION AND EMENDED SPECIES DESCRIPTION

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Ehrenberg's type specimen of *Navicula sinensis* is illustrated and discussed. The taxon was transferred to the genus *Gyrosigma* and assigned specific status as *G. sinense* in Desikachary (1988). Based on our examination of the type specimen we confirm this as correct. In particular, taxonomic studies on both the type and additional specimens from other habitats in marine localities lead us to reject the varietal status under *G. balticum* (Ehrenberg) Rabenhorst suggested in Cleve (1894). An emended species description is given and habitat information is added.

INTRODUCTION

C.G. Ehrenberg (1795–1876) described some large *Navicula* taxa which since then have been transferred to the genera *Gyrosigma* Hassall or *Pleurosigma* W.Smith. His most exotic species in relation to its geography, morphology and habitat is *Navicula sinensis,* which was subsequently transferred to *Pleurosigma* by Ralfs in Pritchard (1861) and then to *Gyrosigma* as a variety of *G. balticum* (Ehrenberg) Rabenhorst by Cleve (1894). This taxon, now verified to be a marine organism, was found and described by Ehrenberg (1847) from Chinese potting soil ("Blumenerde"). Ehrenberg himself wondered about this and concluded that the potting soil must have been made from brackish mud from the mouth of the Canton River because it contained other marine organisms as well.

Since we have found only a single valve in the original material, we have examined recent material from marine habitats to arrive at a realistic taxonomic definition of this species. Populations of organisms forming the best match available to us were found in samples taken from the coast of Cameroon and Guinea-Bissau, West Africa, and the coast of Brazil.

MATERIALS

The following materials were examined:

1). Ehrenberg Collection, Institut für Paläontologie, Museum für Naturkunde der Humboldt Universität zu Berlin (BHUPM): Mica-preparations of potting soil A from Canton, China, deposited in Kasten 7, Buch 2.

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2). Tempère et Peragallo Ed. 1, #538, "Cameroun"; slide in BRM (Friedrich Hustedt Arbeitsplatz für Diatomeenkunde at the Alfred-Wegener-Institut für Polarforschung, Bremerhaven). The set of slides is kept in many other collections as well. The catalogue of this set does not supply any other data, but the gathering presents a flora typical of littoral–marine shoals.

3). Sterrenburg #499 and #500, both: Geba Prabis, Guinea-Bissau, Jan. 6, 1993, leg. Bruno Ens. Intertidal mudflats on the coast of the Atlantic Ocean, West Africa. A slide of the material #500 has been deposited in B (Botanischer Garten und Botanisches Museum Berlin-Dahlem) and BRM.

4). Sterrenburg # 596, Itacorubi River, Santa Catarina, Brazil, leg. M.R. de Souza-Mosimann. Benthic estuarine material.

For morphological terminology see Sterrenburg (1991).

OBSERVATIONS

Ehrenberg's original material

Ehrenberg published the name and a Latin diagnosis in the monthly reports of the Berlin Academy of Sciences:

Navicula sinensis **Ehrenberg**

Ber. Bekanntm. Verh. Königl. Preuss. Akad. Wiss. Berlin 1847, p. 485 (1847).

The lectotype (designated here) is a single valve illustrated in Figs 2–4 on mica-preparation 070204 b white at BHUPM (see Fig. 5).

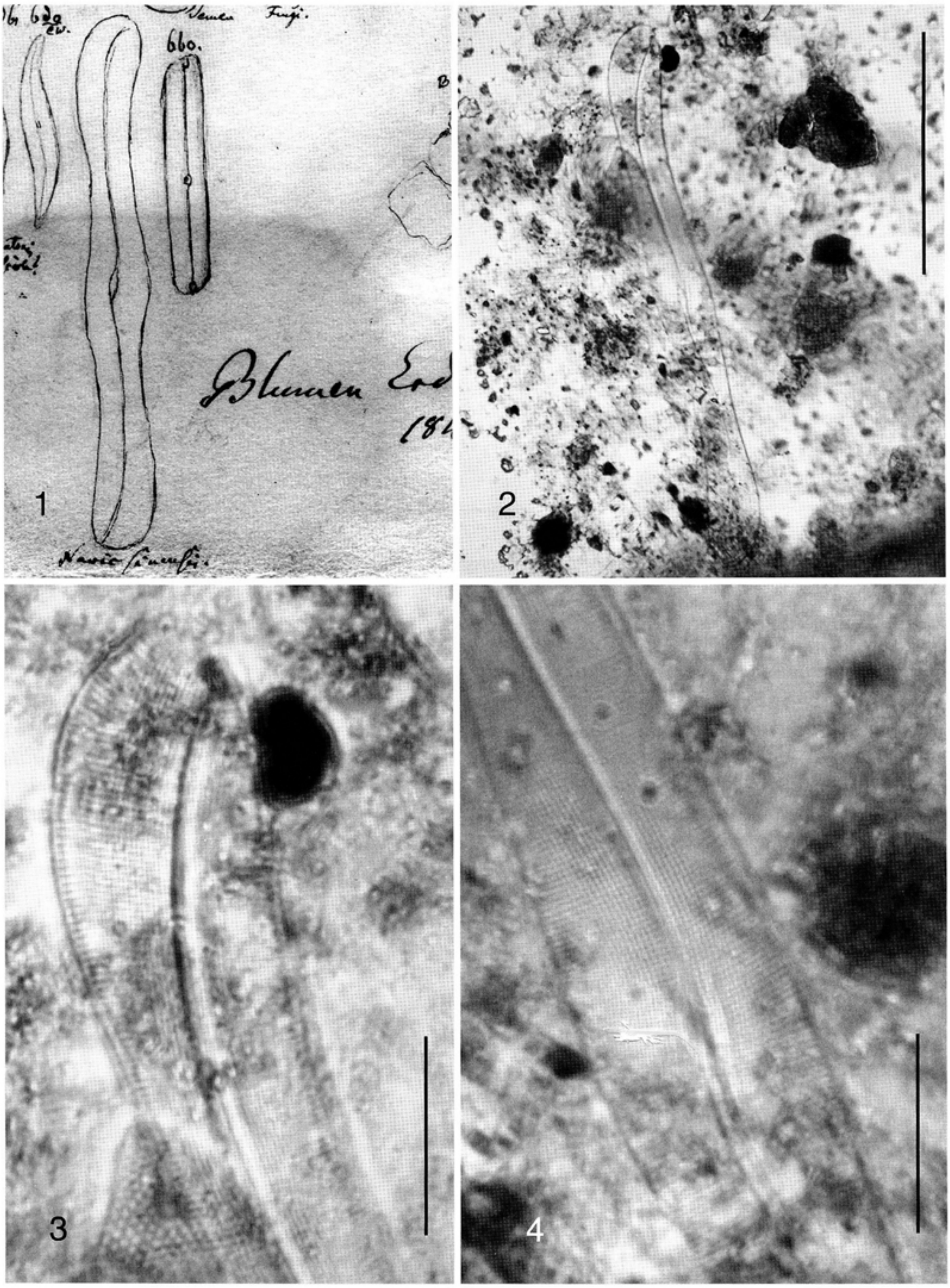
Original illustrations: Zeichenblatt No. 841 and No. 1996 (part of drawing sheet No. 1996 is reproduced here as Fig. 1).

Locus typicus: Blumenerde Canton A aus China (Potting soil A from Canton, China).

In this paper Ehrenberg reported on three samples from China: one from the Canton River and two from potting soils, one of them of a lighter colour (A), from which he described *N. sinensis*, and one of a darker colour (B). He writes (p. 483): "In beiden Erdarten sind die vorherrschenden kleinsten Organismen Süßwassergebilde, aber in beiden sind auch viele Schalen von Seethierchen. Daraus ist mit Sicherheit zu schließen, dass die Mischungstheile im Bereiche der Ebbe und Flut des Meeres genommen wurden. Es ist nicht eine aus dem tiefen Innern des Landes kommende, keine Süßwassererde, sondern eine im oberen Fluthgebiete des Canton-River entnommene oder bereitete brakische Erde." (Translation: In both soils most micro-organisms are from freshwater but in both there are also many valves of sea-animals. From this it can be concluded with certainty that the components of the soil mix came from the zone affected by the ocean's tides. The soil is therefore not from a freshwater area deep inland but is a brackish soil collected or prepared from the upper tidal area of the Canton River.)

Ehrenberg's diagnosis (p.485): "N. flexuosa sigmoides, major, laevissima, apicibus late rotundatis cum media parte dilatatis. Longit. -1/15'''. (A large sigmoid flexed *Navicula*, with very smooth shape, with broadly rounded apices and inflated middle portion. Length up to 150 µm).

In contrast to Ehrenberg's measurements the type specimen is 225 µm long and 25 µm wide. Although some details in the type specimen are barely visible, a double raphe curvature, a rhombic rotated central area and strongly laterally displaced terminal areas are verifiable with certainty. It has just been possible to measure the stria densities: the transverse are clearly coarser (circa 15½ in 10 µm)



Figs 1–4. *Gyrosigma sinense* specimen in the Ehrenberg Collection. **Fig. 1**. Ehrenberg's drawing, part of Zeichenblatt 1996. Figs 2–4. Type specimen. **Fig. 2**. Entire frustule. **Fig. 3**. Detail of apex. **Fig. 4**. Detail of central portion. Scale bars: Fig. 2 = 100 μm; Figs 3, 4 = 20 μm.

than the longitudinal (circa 17½ in 10 µm). This is an important character, placing the species in the section Strigiles sensu Peragallo (1890–91).

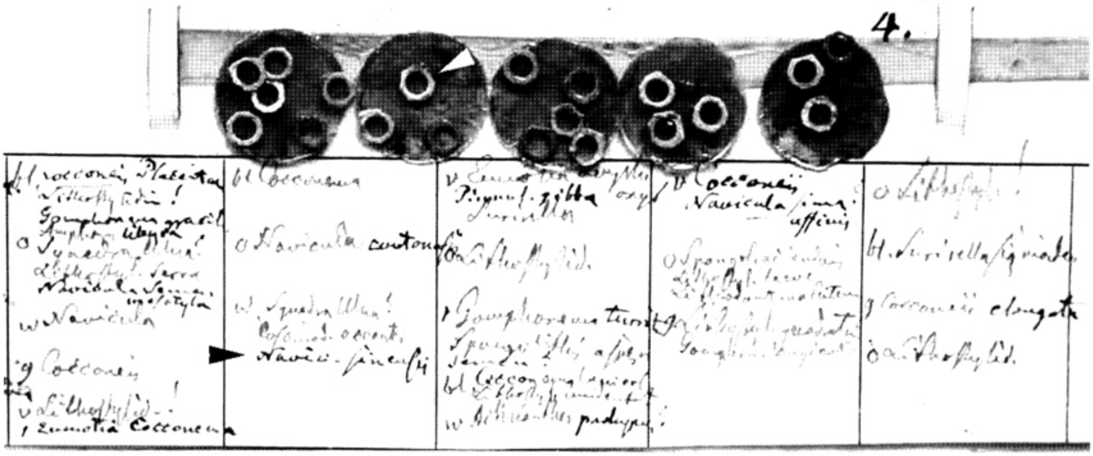


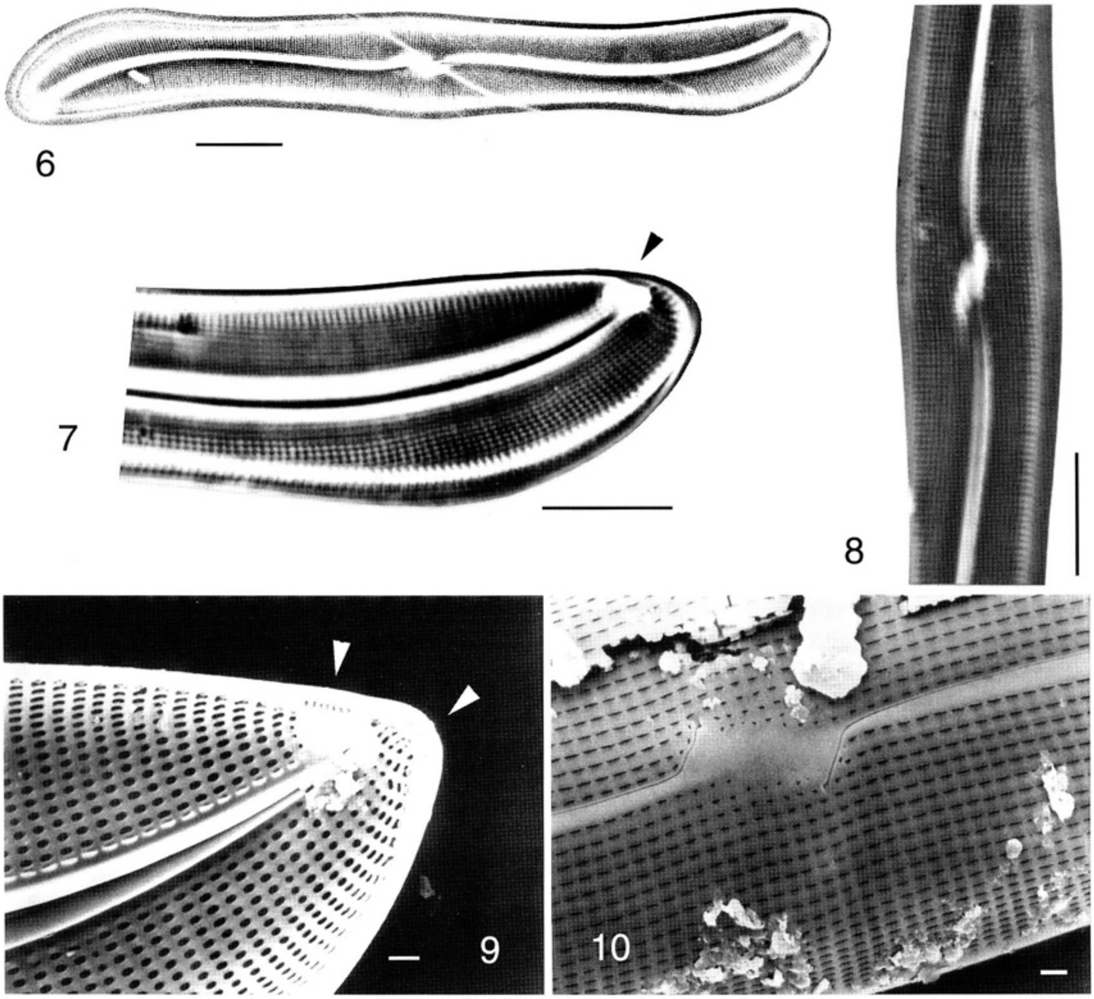
Fig. 5. Ehrenberg Collection, preparations of "Blumenerde von Canton A": Mica-strip No. 4 in Kasten 7, Buch 2. The lectotype specimen of *Navicula sinensis* is in the white ring on the 2[nd] mica (b) (white arrow head), the protocol below gives the name (black arrow head).

Additional materials:

In the additional materials (2–4, see under "Materials") examined, many specimens were observed that fully matched the data now determined for Ehrenberg's type specimen in the ***qualitative*** sense (e.g. double raphe sternum curvature, Strigilis-type stria ratio, lateral position of terminal areas, rhombic shape of central area). These additional specimens permitted an extension of the range of ***quantitative*** data (e.g. size, stria densities) to realistic values, leading to the extended species description given below. One of these materials, deposited as a 'paradigm' for this species in the collections "B" and "BRM", was used for study by SEM. The central external raphe fissures (Fig. 10) show the abrupt 'hook-like' deflection typical of the *Gyrosigma* species with an isomorphic raphe fissure deflection pattern. In *G. sinense* they end in a small more or less triangular depression of the valve and cross the striae. The apical structure, which is at the very limit of the optical performance of the LM (see arrow in Fig. 7), consists (via SEM) of a long microforamina crescent situated on the convex side of the raphe sternum and another, separate, short segment situated on its concave side and lying within the terminal area – see arrows in Fig. 9.

DISCUSSION

Although there is only a single specimen and the nature of Ehrenberg's materials precludes visualization of fine detail, several decisive morphological characters of the type specimen could be determined that had not been described before. These, in turn, permitted identification of additional specimens in our own materials, extending the range of data and permitting selection of specimens for examination in SEM. Thus we are convinced that the morphological details we describe are also present – although not visible – in the type specimen. This is a situation unavoidable for many of the type materials from the 19th century, viz. in those cases where no additional original herbarium material can be retrieved.



Figs 6–10. *Gyrosigma sinense* specimens from Guinea-Bissau. Figs 6–8. LM. **Fig. 6**. General aspect of valve. **Fig. 7**. Apex, note tiny apical micropore segment in terminal area (arrow). The longer apical micropore segment on the opposite side of the raphe sternum is not visible here. **Fig. 8**. Central portion. Figs 9–10. SEM. **Fig. 9**. Apex, arrows indicate two separate apical micropore segments. **Fig. 10**. Central portion. Note that raphe fissures cross the striae and end in a small ± triangular depression. Scale bars: Fig. 6 = 20 µm; Fig. 7 = 10 µm. Figs 9, 10 = 1 µm.

The decisive morphological characters of the type specimen now verified, include the double raphe curvature, rhombic rotated central area, the strongly displaced terminal areas and Strigilis-type stria ratio. The strongly displaced terminal areas and Strigilis-type striation by themselves preclude assignment of varietal status under *G. balticum* and therefore we agree with Desikachary's (1988) assignment of specific status. In particular, specific status is also supported by the very different apical structure in comparison with *G. balticum* (see Sterrenburg 1995). Evidently Ehrenberg's specimen is particularly long, the largest specimen we have personally observed in other materials so far was 205 µm long.

Desikachary (1988) recorded such a diatom for the Indian Ocean and recombined it as a separate species, *G. sinense*. However, no comparison was made with Ehrenberg's original material, so that the conspecifity of these two organisms was not assured. Also, Desikachary (1988) supplied no taxonomic arguments for such assignment of specific status, rather than a varietal one under *G. balticum*, as suggested by Cleve. In our view, both type studies and critical morphological evaluation in LM and SEM, are necessary before such reassignment is done, especially because of the existence of "simulacrum species" in the *G. balticum* complex (Sterrenburg 1995). Desikachary's specimens appear to agree with those we have seen, although the taxonomically decisive apical micropore segments cannot be observed in his illustrations and the text does not discuss the organism's morphology.

Jin Dexiang *et al.* (1985) recorded "*Gyrosigma balticum var. sinensis*" from Xiamen, Pingtan and Sandu Bay, China, "from the intertidal areas or the digestive guts of *Strongylocentrotus pulcherrimus*" (a sea-urchin). The data supplied agree with our findings, but again, the apical micropore segments are not illustrated or even mentioned.

From the data supplied, *G. balticum var. sinicum* Chin et Liu in Jin Dexiang *et al.* (1985) does not appear to differ from a large specimen of *G. sinense*. Assuming that the illustration was at 1000x (the text says "100 x") it is about as long as Ehrenberg's specimen.

G. turgida Stidolph (1988) also has inflated distal valve portions but its terminal areas are in apical position and it has a peculiar central raphe fissure morphology – confirmed by our own examination of its type material. Thus, it cannot be confused with *G. sinense.*

The data for *G. exoticum* in Cholnoky (1960) fully match our data for *G. sinense* except for a small round central area, according to the drawing accompanying the protologue. Because older authors, e.g. Hustedt, have consistently drawn the internal central raphe **node** (whose shape is unspecific) instead of the (specific) central **area**, the final decision whether *G. exoticum* is a synonym of *G. sinense* must await examination of the former's type material. *G. exoticum* was described from littoral benthos of the Sta. Lucia lagoon and from the Umlalazi River estuary, Natal, South Africa.

By examination of the type specimen and re-evaluation of the findings of other authors we are able to present nomenclatural and taxonomic synonyms and an emended species description:

Gyrosigma sinense (Ehrenberg) Desikachary emend. Sterrenburg et R. Jahn

Gyrosigma sinense ["*sinensis*"] (Ehrenberg) Desikachary, Atlas of the Diatoms 5, p. 11, Pl. 592, figs 1–11.

Basionym: ≡ *Navicula sinensis* Ehrenberg, Ber. Bekanntm. Verh. Königl. Preuss. Akad. Wiss. Berlin 1847, p. 485 (1847).

Synonyms:

⊟ *Pleurosigma sinensis* (Ehrenberg) Ralfs in Pritchard (1861, p. 916–917)

≡ *Gyrosigma balticum* var. *sinensis* (Ehrenberg) Cleve (1894, p. 119)

? = *Gyrosigma exoticum* Cholnoky (1960, p. 47–48, Pl. 4, figs 145–146)

? = *Gyrosigma balticum var. sinicum* Chin et Liu in Jin Dexiang *et al.* (1985, p. 82, Pl. 25, fig. 196).

Emended species description (see Figs 6–10):

(Values in brackets are for the single type specimen)

Valve linear-sigmoid, with inflated central and distal portions 150–225 (225) µm long, 20–25 (25) µm wide. Colour in resin and standardized darkfield bright blue. Raphe sternum with double curvature and rotated internal central raphe node, strongly eccentric at the ends, where it is markedly displaced to its **concavity**. Raphe angle +2 to +6°. Central area rhombic, rotated. Terminal areas triangular, strongly displaced away from the apices so that they are in completely lateral position. Central external raphe fissures with isomorphic deflection pattern, crossing the striae. Striae: transverse 15–18 (circa 15½) in 10 µm, longitudinal 17–20 (circa 17½) in 10 µm (section Strigiles sensu Peragallo). Apical structure (SEM): one very long and one short apical microforamina segment on opposite sides of the raphe sternum.

Habitat and distribution:

Littoral–marine species, so far personally observed from Guinea-Bissau and Brazil. Taken together with Ehrenberg's specimen, the findings of Desikachary, Jin Dexiang *et al.* and the probable synonymy of *G. exoticum* this would indicate a wide distribution in warmer waters. The species inhabits the environment typical of related large linear *Gyrosigma* species: shallow waters in estuaries or littoral–marine mudflats.

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