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TYPIFICATION OF *NAVICULA AFFINIS* EHRENBERG: TYPE FOR THE NAME OF THE GENUS *NEIDIUM* PFITZER

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TYPIFICATION OF *NAVICULA AFFINIS* EHRENBERG: TYPE FOR THE NAME OF THE GENUS *NEIDIUM* PFITZER

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Samples from Christian Gottfried Ehrenberg's Collection were studied for the taxon *Navicula affinis* Ehrenberg. Since Ehrenberg did not designate a type for *Navicula affinis* at the place of its first description, eleven localities of his 1843 America publication had to be evaluated. Examination of the micas and samples from these localities, combined with the unpublished notations and original line drawings allowed us to verify that samples from the two localities, Newfoundland (Canada) and Bridgewater (Massachusetts, U.S.A.) contained *Navicula affinis*; a specimen from Ehrenberg's Newfoundland mica preparation was chosen to serve as lectotype. This study emends the description of the species *Neidium affine* (Ehrenberg) Pfitzer and the genus *Neidium* Pfitzer using its type species *Neidium affine*.

INTRODUCTION

The diatom genus *Neidium* was established in the late 1800's by Pfitzer (1871), when he separated a small group of taxa away from *Navicula* sensu lato based on cell contents, especially chloroplast structure. In this paper Pfitzer presents five species (*N. affine*, *N. amphigomphus*, *N. amphirhynchum*, *N. firmum*, *N. limosum*) belonging to the new genus but he did not designate which would be the type (Fourtanier & Kociolek 1999). Cleve (1894) used valve morphology, including the interesting proximal and distal raphe fissures, combined with unique areolae along the valve margins to further distinguish this genus with the addition of 10 more taxa. Prior to designation of a type species, an additional nine taxa were described or transferred to this genus by Hustedt (1922 in Schmidt 1874–1959) and Mereschkowsky (1906). Finally, in the late 1920's, Boyer (1927) selected *N. affine* (Ehrenberg) Pfitzer (basionym: *Navicula affinis* Ehrenberg) as the type species with its type locality somewhere in the America's. Since the work of Boyer, over 300 new taxa have been described or transferred into the genus *Neidium*. Significant treatises include Schmidt (1874–1959), Cleve-Euler (1955), Patrick & Reimer (1966), VanLandingham (1978) and Krammer & Lange-Bertalot (1986).

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Neidium affine sensu lato contains 22 infraspecific taxa, 13 varieties and 9 formae. Although little was known about the true *N. affine*, the descriptions for most of the infraspecific taxa are based primarily on differences in valve form and size. The wide diversity in valve morphology amongst these taxa illustrates the broad concept that authors maintained for the nominate form *N. affine*. Ehrenberg first described this species in his paper "das mikroskopischen Leben in Süd- und Nord-Amerika" (1843: 417). In this publication he cites its occurrence in 11 localities, and from seven of these he published figures. We searched his drawing sheets and the mica-preparations and decided to lectotypify this epithet with a specimen from Newfoundland, Canada.

MATERIAL AND METHODS

Eleven samples are cited for *Navicula affinis* by Ehrenberg (1843) which are deposited in the Ehrenberg Collection, Institute of Paleontology, Museum für Naturkunde, Humboldt University of Berlin (BHUPM):

1. Ehrenberg 1843, p. 307, pl. II: fig. II.7: "Surinam, 6°N 55°W, Erde von Landpflanzen aus dem Herbar Kunth". No sample, drawing no. 2054, Geographical Preparations 180601–180606.
2. Ehrenberg 1843, p. 310, pl. II: fig. III.2: "Caracas, Venezuela, 10°N 67°W, Kunth's Herbarium: Erdboden von Heteranthus". Sample no. 1176, drawing no. 2061, Geographical Preparations 190301, 190305, 190306.
3. Ehrenberg 1843, p. 311, pl. II: fig. V.4: "Guadeloupe, 16°20'N 42'W, Wurzel einer Cyperoidee aus Kunth's Herbar". Sample no. 0946, drawing no. 2032, Geographical Preparations 150801–150804, 150806, 150809–150812.
4. Ehrenberg 1843, p. 312, pl. III: fig. III:8: "Große Antillen, St. Domingo oder Haiti, 18°30'N 72°20'W, Meeressand, leg. Carl Ehrenberg 1830–33". Sample no. 0969, drawing no. 2031, Geographical Preparations 151003–151016.
5. Ehrenberg 1843, p. 317, pl. III: fig. III.8: "San Miguel bei Regla, Mexiko, 6666 Fuss über NN, Conferven, leg. Carl Ehrenberg 1830–33". Sample no. 1232, drawing no. 2067, Geographical Preparations 200405–200406.
6. Ehrenberg 1843, p. 319: "Puente de Dios, Mexiko, 5310 Fuss über NN, Conferven, leg. Carl Ehrenberg 1838". Sample no. 1230, drawing no. 2065, Geographical Preparations 200501–200508.
7. Ehrenberg 1843, p. 337: "Westpoint, New York, 40°N 74°W, lebende Probe aus Torf-Wasser, leg. Prof. Bailey". Sample no. 1755a, drawing no. 2073, Geographical Preparations 260101–260110.
8. Ehrenberg 1843, p. 350: "Bridgewater, Massachusetts, Torferde, leg. Prof. Hitchcock". Sample no. 1769, drawing no. 2241, Geographical Preparations 260601–260608.
9. Ehrenberg 1843, p. 358: "Neu-Fundland (Newfoundland), 47–51°N 53–59°W, Erde von *Scirpus ellipticus*". Sample no. 1778, drawing no. 2077, Geographical Preparations 271715–271716.
10. Ehrenberg 1843, p. 359, pl. IV: fig. II.6: "Okak auf Labrador, 57°N 63°W, Erde an Mooswurzeln, leg. Dr. Thienemann". Sample no. 1780, drawing no. 2078, Geographical Preparations 250509–250516.
11. Ehrenberg 1843, p. 363, pl. IV: fig. V.10: "Kotzebue's Sund, 67°N 164°W, an Wurzeln von *Parnassia kotzebui*, leg. Adalbert von Chamisso". No sample, drawing no. 1975, Geographical Preparations 271405–271408 & 271413–14.

The specimens labelled *Navicula affinis* were searched for on the drawing sheets; if there were no labels, the published drawings were consulted and compared. At the top of each individual drawing Ehrenberg wrote the number of the corresponding mica-preparation, i.e. 3δbl on the St. Domingo drawing (Fig. 4); 3 represents the no. of the mica-strip; δ/d is the 4th mica; bl is the blue ring. This means the specimen is in box 15 (Kasten 15), folder 10 (Buch 10), on the mica-strip no. 3, mica no. 4, blue ring (Lazarus & Jahn 1998); for datebase purposes this elaborate numbering has now been shortened to i.e. 151003-d blue (Jahn & Kusber 2004). Often there are labels with names in the books which aid in the identification of the corresponding specimen. The selected micas were examined and photomicrographs of the observed specimens (if present) were taken with an Olympus digital Camera DP 50 and BX 51, Objective: Olympus 80x: IC 80/0.75, 40x: UPlan Fl 40/0.75, 20x: UPlan Fl 20/0.50.

Subsamples were taken and cleaned from available material for LM and SEM examination. LM studies were conducted using a Leica DMR microscope with Phase, DIC and RIC optics: 40x: Plan Apo HCX 40/1.25 and 100x: Plan Apo HCX 100/1.35 objectives. Although RIC illumination was used in the study, no RIC images are presented. Samples for SEM study were filtered on either 8.0 or 0.8 μm filter papers and mounted on aluminium stubs using double sided carbon tape. The stubs were coated with 300–500 Å of gold and examined with an Environmental SEM (ESEM), FEI model 20 at 5–25 KV under high vacuum. Terminology used to describe morphological structures follows Stosch (1975), Ross *et al.* (1979), Krammer & Lange-Bertalot (1986) and Siver *et al.* (2003).

OBSERVATIONS on Ehrenberg's drawings and mica

1. Surinam (Figs 1, 11)

Ehrenberg's drawing could represent a *Neidium* but the corresponding specimen on the Geographical Preparation 180602-a blue is either a small *Navicula* or *Pinnularia*.

2. Caracas (Fig. 2)

Ehrenberg's drawing of this specimen is in girdle view. Since the corresponding specimen was not found on the Geographical Preparations and the preparations are without any label information, the identity of this specimen remains ambiguous.

3. Guadeloupe (Figs 3, 12)

Ehrenberg's drawing and the corresponding specimen on the Geographical Preparation 150802-e blue do not represent *Neidium affine*, but most probably a *Pinnularia*.

4. St. Domingo (Fig. 4)

Ehrenberg's drawing of this specimen is beautiful and could represent a *Neidium* but the labelled Geographical Preparation 151003-d blue is broken and covered with glue which makes it impossible to identify anything under the LM. Furthermore, this line drawing appears to show groups of areolae on the valve face, which is not typical for *Neidium* as described by Pfitzer (1871).

5. San Miguel (Figs 5, 13)

Ehrenberg's drawing and the corresponding specimen on the Geographical Preparation 200405-a blue is not a *Neidium*. In addition, the chloroplasts illustrated in the drawings are not of four distinct lobes or two bilobed chloroplasts typical of *Neidium*.

6. Puente de Dios (Figs 6, 14)

Ehrenberg's drawing and the corresponding specimen on the Geographical Preparation 200505-d blue are difficult to identify but do not look like a *Neidium*. The size, shape and striae pattern suggests this specimen is a *Cymbella* sensu lato or *Navicula*. The chloroplast illustrated in the line drawing is not a *Neidium* chloroplast.

7. Westpoint

Since Ehrenberg published no drawing, and there is neither a legend on the drawing sheet nor a legend on the Geographical Preparations, no identification of a specimen is possible.

8. Bridgewater (Fig. 7)

Ehrenberg's drawing and the corresponding specimen on the Geographical Preparation 260607-c blue is definitely a *Neidium* (photo not good). The line drawing (Fig. 7) illustrates a linear valve form with rostrate apices and distinct lines running along the valve margin, possibly representing longitudinal canals. We observed and photo-documented (CANA photomicrograph collection) many additional specimens of *N. affinis* on other Bridgewater mica preparations (260602-a white and blue; 260602-b orange and red; 260603-a white; 260603-c white, blue, and red; 260604-d red).

9. Newfoundland (Figs 8, 15)

Ehrenberg's drawing and the corresponding specimen on the Geographical Preparation 271715-d white is definitely a *Neidium*. The line drawing clearly presents additional lines along the valve margin (longitudinal canals) and the proximal and distal raphe endings in the drawing may indicate deflected proximal raphe fissures and a terminal lacinia.

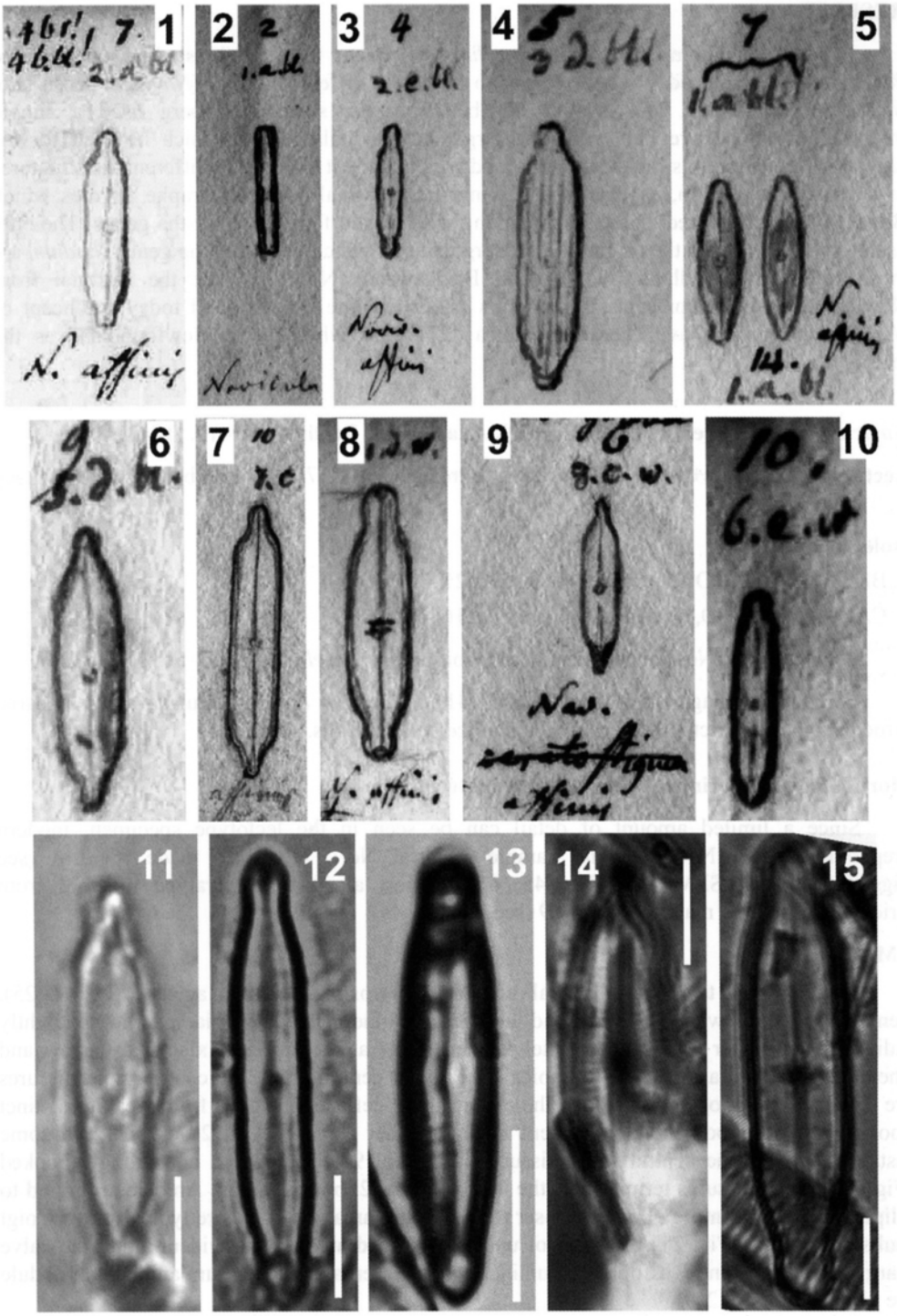
10. Labrador (Fig. 9)

Ehrenberg's drawing and the corresponding specimen on the Geographical Preparation 250516-c white is a *Pinnularia*.

11. Kotzebue's Sund (Fig. 10)

Ehrenberg's drawing and the corresponding specimen on the Geographical Preparation 271406-e white is a *Pinnularia*. Also note that no labels were present underneath the micas stripes.

Figs 1–15. Ehrenberg's *Navicula affine* specimens from paratype localities. **Figs 1–10.** Ehrenberg's original line drawings; each drawing is a small cut out from a composite drawing sheet. **Figs 11–15**. LM micrographs from mica-preparations with Ehrenberg's circled specimens. We present the best specimen within the circle that matches Ehrenberg's original line drawing. **Figs 1, 11**. Surinam: specimen from drawing sheet 2054 and from mica-preparation 180602-a blue. **Fig. 2**. Caracas (Venezuela): Girdle view of specimen from drawing sheet 2061. **Figs 3, 12**. Guadeloupe (Mexico): specimen from drawing sheet 2032 and from mica-preparation 150802-e blue. **Fig. 4**. St. Domingo (Dominican Republic): specimen from drawing sheet 2031. **Figs 5, 13**. San Miguel (Mexico): specimen from drawing sheet 2067 and from mica-preparation 200405-a blue. **Figs 6, 14.** Puento de Dios (Mexico): specimen from drawing sheet 2065 and from mica-preparation 200505-d blue. **Fig. 7**. Bridgewater (Massachusetts, USA): specimen from drawing sheet 2241. **Figs 8, 15**. Newfoundland (Canada): specimen from drawing sheet 2077 and Lectotype for *N. affinis* (= *Neidium affine*) from mica-preparation 271715-d white below. **Fig. 9**. Labrador (Canada): specimen drawing from drawing sheet 2078. **Fig. 10**. Kotzebue's Sound (Alaska, USA): Specimen from drawing sheet 1975. Scale bars = 10 µm.



RESULTS

Except two, Ehrenberg's *Navicula affinis* specimens from the 11 studied localities are different taxa which today would belong to at least 3 different genera (*Navicula* sensu lato, *Neidium*, *Pinnularia*). This should not be surprising since Ehrenberg used a simple microscope which gave him a 300x enlargement, an enlargement which he used for his drawings throughout his life (Jahn 1995) and which made it difficult to differentiate structures in detail below 10 µm, especially observing the proximal and distal raphe fissures which Boyer (1927) considered characteristic, along with plastid formation, for the genus. The only usable specimens from the original Ehrenberg material which belong to the genus *Neidium* are those from Newfoundland (No. 9) and Bridgewater (No. 8). Since the material from Newfoundland best represents Ehrenberg's published line drawing and today's concept of *Neidium affine*, we have chosen the mica "271715-d white" from Newfoundland as the lectotype:

***Navicula affinis* Ehrenb. in Abh. Königl. Akad. Wiss. Berlin 1841:417. (1843).**

Lectotype (designate+d here): Geographical Preparation 271715-d white below, BHUPM (see Fig. 15).

Isolectotypes

1. BHUPM slide ECO 15, circled valve (Figs 21–22).
2. CANA slide 53340, circled valve (see Figs 16–18).

Locus typicus: Newfoundland, Canada, soil on *Scirpus ellipticus*, 47–51°N 53–59°W.

Ehrenberg's diagnosis is short (1843: 417): *Navicula affinis*, testula a dorso linearis, utroque apice constricto obtuso. *Pinnularia dicephalae* affinis. Icon!"

Morphology of specimens from original material

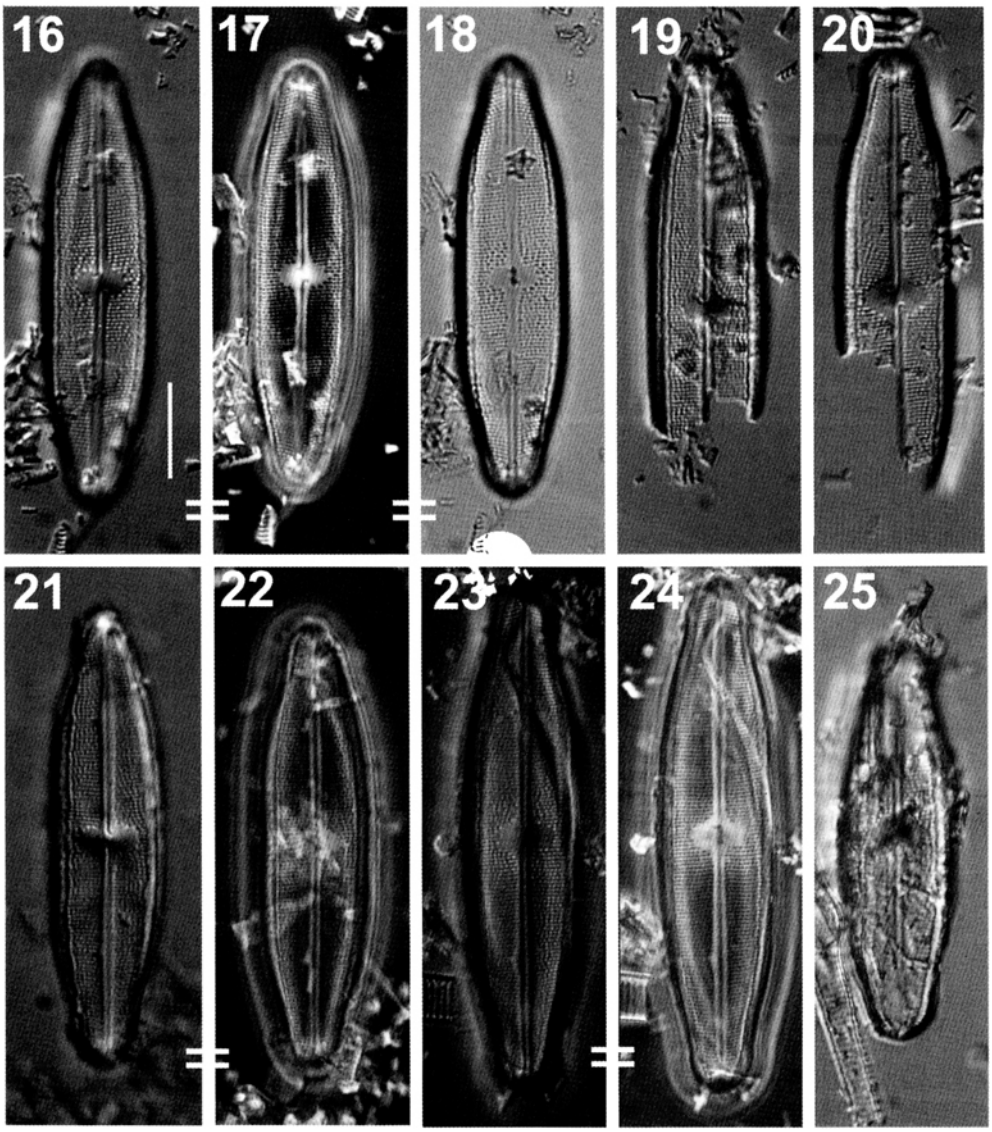
Since a limited amount of detail can be seen in the lectotype specimen, modern preparations from Newfoundland sample material No. 1778 were made for LM (see Figs 16–32) and SEM (see Figs 45, 47) studies, along with paratype material from Bridgewater sample material No. 1769 (see Figs 33–44).

LM:

Valves linear to linear–elliptical with distinct rostrate-rounded apices (Figs 16–25). Length 39–60 µm, width 8–13 µm and with 25–26 striae in 10 µm. Striae parallel to slightly radiate at the center becoming parallel to convergent at the apices. Axial area narrow and linear opening into a round to transapically elliptical central area. The central raphe fissures are deflected in opposite directions. The extent of the deflections varies from weak to distinct hooks, with one hook more prominent than the other (Figs 16, 19, 20, 21, 23). In some instances, one of the central raphe fissures is bent at 90 degrees and not strongly hooked (Fig. 21). Distal fissures terminate at the lacinia (Fig. 22, bottom apex). Areolae are round to elliptical appearing more elliptical closer to the central area. One or more typically two Voigt faults are present (Fig. 21). A series of unevenly spaced areolae are evident along the valve margin. With DIC and RIC optical illuminations, an internal axial sternum and central nodule are visible (Figs 16, 21).

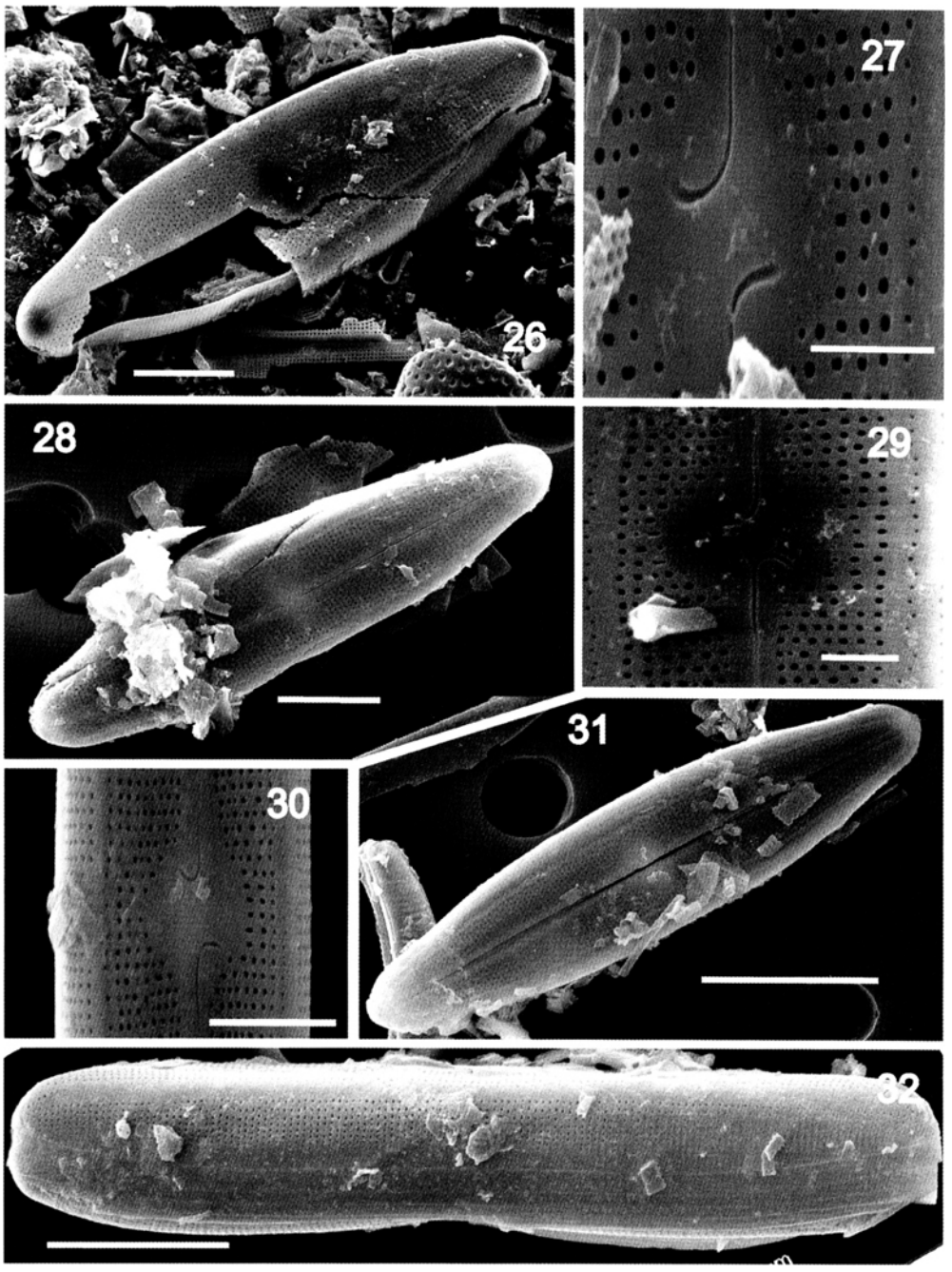
SEM:

Observed valves are 42–69 µm long, 8–15 µm with 24–26 striae in 10 µm. Striae parallel to slightly oblique at the center becoming parallel to slightly radiate at the apices. Two or



Figs 16–25. *Neidium affine*. LM micrographs of modern preparations from original material of the lectotype locality Newfoundland (sample 1778). **Figs 16–18, 19, 20**. DIC, phase contrast and bright field optical illumination for circled specimens on CANA slide 53340. **Figs 21–22, 23–24, 25**. DIC and phase contrast optical illumination for circled specimens on isolectotype slide ECO 15 at BHUPM.
Scale bars = 10 μm.

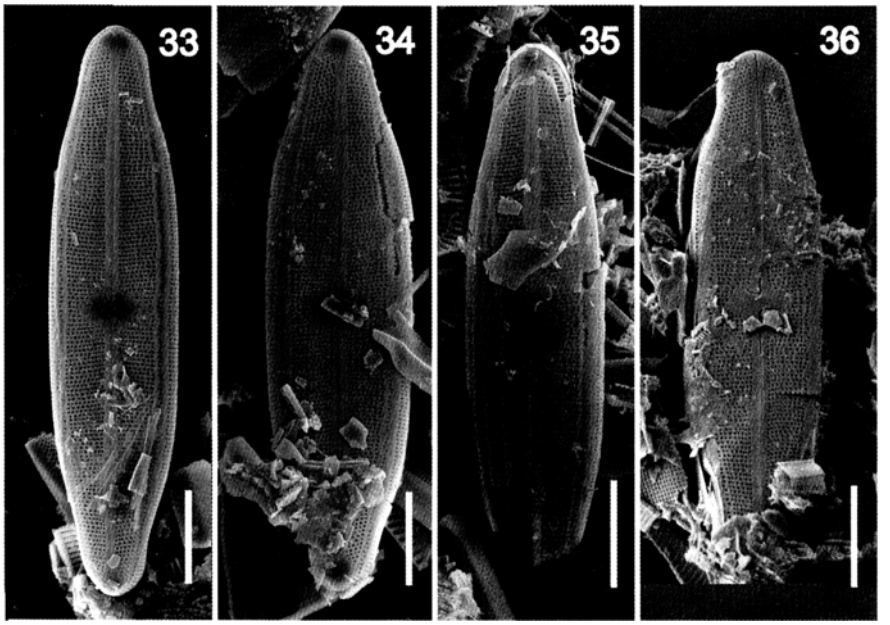
three longitudinal canals (one large, one or two small) are present along each margin of the valve, identified by two rows of punctae separated from the striae (Figs 26, 28, 30, 31, 37, 39). Axial area narrow and linear, central area is circular to a transapically expanded ellipse (Figs 26–31). The central area maybe slightly elevated on the external surface. The terminal area is broad, extending down the mantle. Raphe linear, ending with oppositely deflected



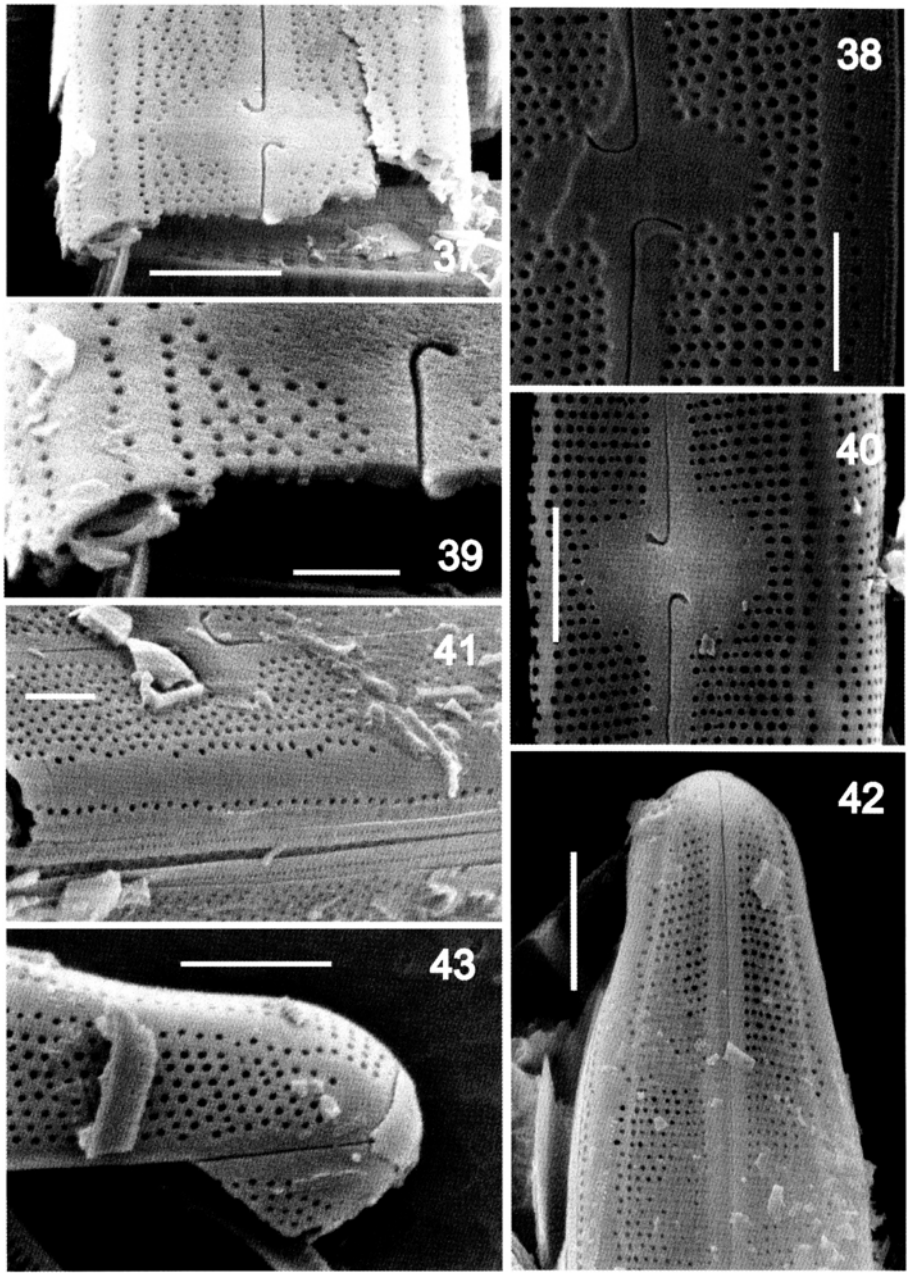
Figs 26–32. *Neidium affine* from original material of the lectotype locality Newfoundland (sample 1778). SEM external views. **Figs 26, 28, 31**. Whole valves illustrating typical valve form. **Figs 27, 29, 30.** Variations in central area formation and degree of deflected proximal raphe fissures are presented. **Fig. 32**. Girdle view of frustule showing a mild central depression. Four–five copulae with one–two rows or linear pores form the cingulum. Scale bars = 20 μm (Fig. 31), 10 μm (Figs 26, 28, 32), 5μm (Fig. 30), 2 μm (Figs 27, 29).

proximal raphe fissures and a simple poroid terminal fissure covered with a lacinia (Figs 26–31, 42, 43). The proximal fissures may vary from weakly to distinctly hooked, although sometimes one of the fissures may only be bent at 90 degrees (Figs 27, 29, 30, 33–38, 40). The lacinia originates at the base of the mantle and extends up to cover the terminal raphe fissure on the valve face (Fig. 43). Areolae are chambered, opening externally as round to elliptical pores that are not occluded (Figs 27, 29, 30, 39). On the internal side of the valve, the areolae open as pores which are of equal size or smaller than the external openings and are covered by a hymen (Figs 27, 39, 45–47). Within the valve matrix, the areolae are chambers which interconnect to surrounding areolate-chambers, especially in the transapical direction. This morphology is similar to *N. hitchcockii* (Ehrenberg) Cleve and *N. gracile* Hustedt (Hamilton *et al.* 1995, Siver *et al.* 2003). On the internal valve surface, renilimbi are associated with the hymen and surround the areolae. These renilimbi are typically observed on areolae adjacent to the axial area and on either side of the large longitudinal canal (Figs 45–46). The proximal and distal fissures of the raphe terminate in a helictoglossa. The two helictoglossa positioned on the elevated central nodule are interconnected to form a compound structure (Fig. 45). The larger longitudinal canal is inflated on the internal side of the valve forming a bulge at the internal valve margin (Figs 44–47). When the hymen is removed, the larger longitudinal canal is a solid structure which opens internally through a row of elliptical pores aligned with the striae (Fig. 44). The smaller canals have internal pores similar in form and size to the adjacent areolae. The cingulum comprises an advalvar band (valvocopula) and three pleurae (Fig. 32). Each pleura contains two rows of pores on the pars exterior (Figs 32, 41, 44).

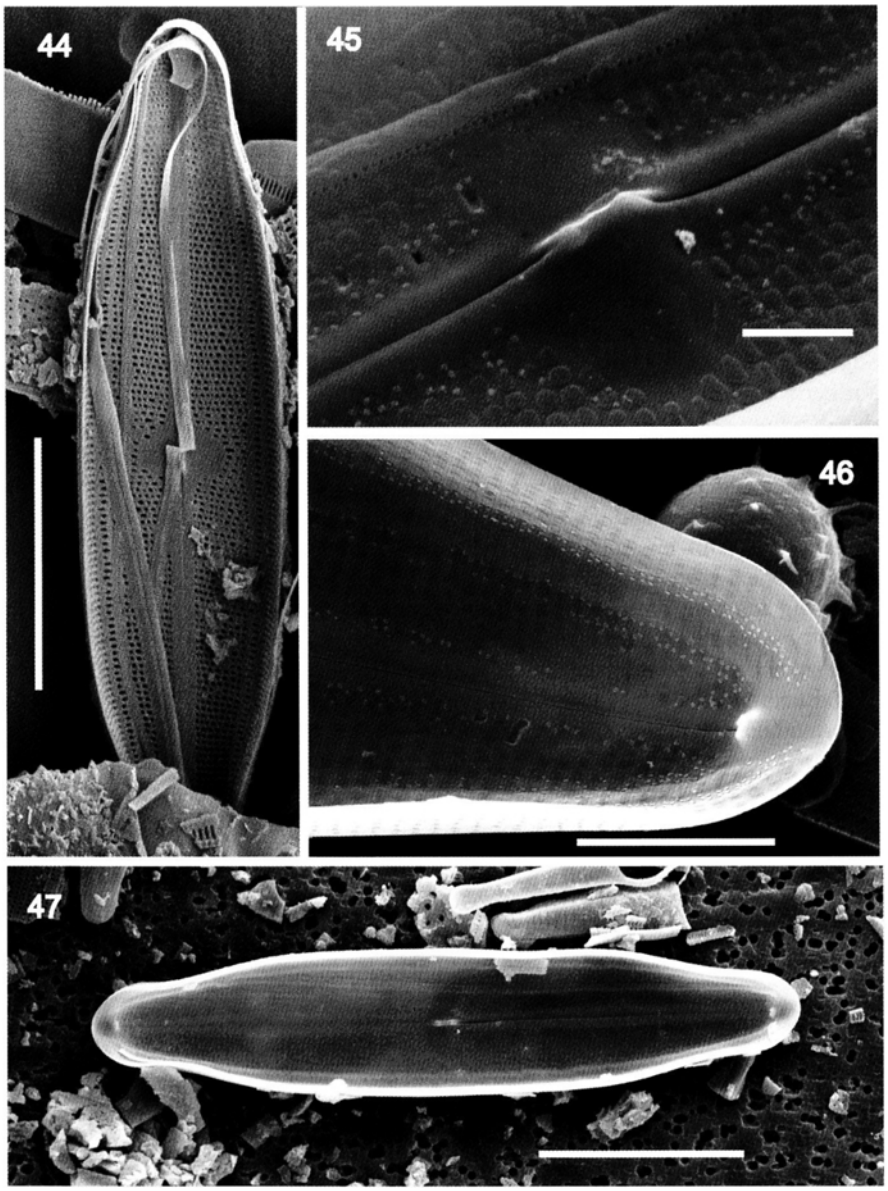
Specimens from Bridgewater were more abundant and variable in outline and size. The apices ranged from subrostrate to rostrate and length varied from 47 μm to 69 μm.



Figs 33–36. *Neidium affine* from original material of the paratype locality Bridgewater (sample 1769). SEM external views. Whole valves illustrating the linear elliptical to elliptical valve form with rostrate apices. **Fig. 33**. Proximal raphe fissures hooked, one more pronounced than the other and the lacina extends down the mantle. **Fig. 35**. Proximal raphe fissures both mildly hooked. **Figs 34, 36**. One proximal raphe fissure bent at a 90 degree angle and the other hooked. Scale bars = 10 μm.



Figs 37–43. *Neidium affine* from original material of the paratype locality Bridgewater (sample 1769). SEM external views. **Figs 37, 39**. Fractured valves highlighting one large marginal canal with two small adjacent canals. Areolae are chambers within the matrix of the valve, formed by nodules on the external and internal valve surface. **Figs 38, 40**. Proximal fissures and central areas. Areolae vary from round to elliptical and from small to large. Surface depression (ghost striae) are typically observed in and around the central area. **Fig 41**. Frustule margin with 3 visible copulae. Copulae have one or two rows of pores. **Figs 42, 43**. Valve apices showing the termination of the larger longitudinal canals and the presence of a triangular lacinia which extends down the mantle. Scale bars = 5 μm (Figs 37, 38, 40, 42, 43), 2 μm (Figs 39, 41).



Figs 44–47. *Neidium affine* from Newfoundland (Figs 45, 47) and Bridgewater (Fig. 44), Type and paratype material respectively, and Fig. 46 from Ryder Pond (Cape Cod). SEM internal views. **Fig. 44**.Whole valve missing the hymen. Collapsed copulae contain one row of prominent pores and beneath this a row of smaller pores. A row of enlarged, elliptical areolae on the longitudinal canal. **Fig. 45**. Central area on a mound with bimodal helictoglossa central fissures. Renilimbi situated around the areolae on the first (sometimes second) row adjacent to the central axial area. Hymens covering the areolae are elevated from the internal valve face. **Fig. 46**. Apex, with a small elevated terminal helictoglossa, in a region devoid of areolae. Longitudinal canals terminal at the beginning of the apex. Renilimbi are positioned around areolae on either side of the large longitudinal canal, terminate on the mantle surface at the apex, while becoming continuous and connected with renilimbi adjacent to the axial area. **Fig. 47**. Whole valve highlighting the projection of the large longitudinal canals along each margin and areolae covered by a hymen. Scale bars = 20 μm (Figs 44, 47), 5 μm (Fig. 46), 2 μm (Fig. 45).

DISCUSSION

In the treatise Diatoms of Sardinia (Lange-Bertalot *et al.* 2003), two new species *Neidium sardiniense* Lange-Bertalot, Cavacini, Tagliaventi & Alfinito and *Neidium paraffine* Lange-Bertalot, Cavacini, Tagliaventi & Alfinito were created and are very similar to *Neidium affine*. In the discussion Lange-Bertalot correctly points out that many authors had different concepts for *N. affine*. The linear and wide valves with rostrate apices in Patrick & Reimer (1966, fig. 35:2) and Germain (1981, figs 58: 3, 6–8) match the valve outline observed from Newfoundland, while the more lanceolate forms with rounded apices depicted by Schmidt (1877, figs 49: 20–22) and Cleve-Euler (1955, fig. 1164) were not illustrated by Ehrenberg in the original publication and do not belong to our lectotype-concept of *N. affine*. It is interesting to note that we have observed both these outline forms in both the Newfoundland and Bridgwater material, and specimens with the lanceolate form represent a new taxon which needs further study. In the protologue for *Neidium paraffine* Lange-Bertalot states "it is very likely that *Neidium paraffine* corresponds to the concept of *Neidium affine* of several authors" and we agree. *Neidium paraffine* is synonymous with *Neidium affine*, while *N. sardiniense* is typically smaller, has more pronounced proximal raphe fissures and from what we can see, only has one longitudinal canal. *Neidium decens* (Pantocsek) Stoermer 1963 is similar in valve outline but larger, with less striae and based on the line drawing probably has more than 3 canals, all of equal size.

Following the line drawings and descriptions for the varieties and forms, only one, *N. affine* var. *ceylonica* (Skvortzow) Reimer is similar in valve and apices shape, with more than one canal and hooked proximal raphe fissures. However, this taxon is much larger. Other infraspecific taxa with possibly more than one canal, as presented in the type line drawings, are either triundulate in shape (e.g. *N. affine* var. *hankensis* (Skvortzow) Reimer, *N. affine* var. *ranomafensis* Manguin) or have round to apiculate apices (e.g. *N. affine* var. *linearis* Foged, *N. affine* var. *humerus* Reimer). The majority of the infraspecific taxa (ca. 11) based on the type line drawing appear to have only one longitudinal canal and are different in valve outline (e.g. *N. affine* f. *koreana* (Skvortzow) Skvortzow & Noda, *N. affine* var. *capitatum* Ross, *N. affine* var. *constrictum* Messikommer). It is currently our opinion that the majority of these infraspecific taxa do not belong to *N. affine*. Although given the plasticity shown within the genus it is anticipated that varietal forms do exist.

Neidium affine (Ehrenberg) Pfitzer, emended description

Syn. *Neidium paraffine* Lange-Bertalot, Cavacini, Tagliaventi & Alfinito, Diatoms of Sardinia, p. 89, pl. 76: 5–9. 2003.

Valves linear to linear-elliptical with rostrate apices. Length 39–68 μm, width 8–16 μm, striae 22–26 in 10 μm and 21–26 areolae in 10 μm. Each valve with two (sometimes three) longitudinal canals along each margin. Larger canal positioned between the smaller canals. Axial area narrow and linear with a slight elevation at the central area. Raphe linear, ending proximally with oppositely deflected raphe fissures. Proximal fissures either both hooked or one hooked and one deflected. Terminal fissures covered with a lacinia. Striae parallel to slightly oblique at the center, sometimes becoming slightly convergent at the apices. One or two Voigt faults present on each valve. Areolae round to elliptical, not occluded externally, and open internally through a fine poroid hymen. Renilimbi positioned on the hymen around areolae. Renilimbi observed on areolae adjacent to the sternum and on areolae on each side on the larger longitudinal canal. Areolae chambered within the valve wall, formed by costae and associated silica nodules connected to the costae. Cingulum comprises an advalvar band (valvocopula) and three pleurae. Each pleura contains two rows of pores on the pars exterior.

One row of pores elongated and the other is smaller and round. *Neidium affine* exhibits allogamous reproduction, gametes anisogamous. Active gametes move to the gametangium through unique fusion canals (Mann 1984). The perizonium containing the auxospore is linear with broadly rounded apices composed of two siliceous caps held together with numerous perizonial bands.

Neidium Pfitzer, emended genus description

(Type of the name of the genus: *Neidium affine* (Ehrenberg) Pfitzer, see emended species description above)

Cells solitary, freshwater forms predominately benthic. Frustules isovalvar, isopolar and biraphid. In girdle view, frustules rectangular with girdle depth less than or equal to valve width. Valves linear to elliptical "naviculoid", and contain marginal longitudinal canals. Canals vary from one rudimentary subapical structure (*N. rudimentarum* Reimer) to >12 marginal canals (*N. tumescens* (Grunow) Cleve). The internal formation of the longitudinal canal may vary from a series of siliceous ribs covered with a velum (e.g. *N. holstii*, Hamilton et al. 1993) to a more elaborate solid structure maintained within the valve matrix (e.g. *N. affine*). Raphe a key and slot formation. Proximal fissures may or may not deflect in opposite directions and a lacinia may or may not be present covering the terminal fissures. Internally, the terminal and proximal raphe fissures end in helictoglossae. Striae uniseriate with areolae ranging from simple pores between costate interstriae to chambers within the valve matrix. All the taxa we have observed maintain hymens covering the internal areolae openings and renilimbi associated with the hymen are positioned around the edge of the areolae. Externally, areolae may or may not be occluded with volae. Voigt faults present. Cingulum composed of a valvocopula with a series of 3–5(?) pleurae. Chromatophores four single lobes or two bilobed plastids positioned close to the cingulum on either side of the central area. *Neidium* taxa allogamous with paired gametangia giving rise to two auxospores sensu De Bary (*teste* Pfitzer 1871; see Mann 1984 for summary).

Taxa within the genus *Neidiopsis* Lange-Bertalot & Genkal (1999) differ from those taxa in the genus *Neidium* primarily by the absence of longitudinal canals and the unilaterally deflected proximal and distal raphe fissures. *Neidiopsis* also lack renilimbi which is consistently observed in *Neidium* species.

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