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REINSTATEMENT OF THE GENUS CERATONEIS EHRENBERG AND LECTOTYPIFICATION OF ITS TYPE SPECIMEN: *C. CLOSTERIUM* EHRENBERG

Regine Jahn^a & Wolf-Henning Kusber^a

^a Botanic Garden and Botanical Museum Berlin-Dahlem, Freie Universität Berlin, Königin-Luise-Str. 6-8, D-14191, Berlin, Germany

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REINSTATEMENT OF THE GENUS *CERATONEIS* EHRENBERG AND LECTOTYPIFICATION OF ITS TYPE SPECIMEN: *C. CLOSTERIUM* EHRENBERG

Regine Jahn* & Wolf-Henning Kusber

Botanic Garden and Botanical Museum Berlin-Dahlem, Freie Universität Berlin,
Königin-Luise-Str. 6–8, D–14191 Berlin, Germany

A preparation in the Ehrenberg Collection was designated as lectotype of *Ceratoneis closterium* Ehrenb., the type of the name of the genus *Ceratoneis*. The lectotype specimen was studied using the light microscopy and found to agree morphologically with recently studied material of taxa of the genus *Cylindrotheca* Rabenh. (1859) observed by Reimann & Lewin (1964). *Ceratoneis* Ehrenb., having priority over *Cylindrotheca* Rabenh., is reinstated and appropriate transfers are made.

INTRODUCTION

Ehrenberg (1839) described the genus *Ceratoneis* (ceratoneis = horned) from the marine habitat, North Sea Coast near the German Port Cuxhaven. He included two species in his original description of the genus: *Ceratoneis closterium* and *C. fasciola* without designating which one would be the genus type. Smith (1852) removed *C. fasciola* (\equiv *Gyrosigma fasciola*, for lectotypification see Jahn *et al.* 2005) from this genus. One year later, Smith (1853) also removed *C. closterium*, this time to the genus *Nitzschia*. From this time on and for more than one hundred years, the genus *Ceratoneis* and the species *C. closterium* have had two independent histories.

The species *Ceratoneis closterium* was included in the genus *Nitzschiella* which had been newly created by Rabenhorst (1864) to accommodate horned nitzschioid taxa. One hundred years later, with the development of the electron microscope, Hasle (1964), in her study of the *Nitzschia*, recognized *Nitzschiella* only as an unranked group in the genus *Nitzschia*, therefore supporting Smith's transfer of *C. closterium* to *Nitzschia*. At the same time, Reimann & Lewin (1964) and Reimann *et al.* (1965), when studying *C. closterium* and similar nitzschioid species came to a different conclusion. Reimann & Lewin (1964) revived and emended the genus *Cylindrotheca* which had been created by Rabenhorst (1859) with its only species *Cylindrotheca gerstenbergeri* Rabenhorst. From culture strains they studied *Ceratoneis closterium* Ehrenberg, re-combined it with *Cylindrotheca* and described further species from strains as well as from natural habitats. The freshwater species *Cylindrotheca gerstenbergeri* Rabenh. and *Ceratoneis gracilis* Bréb. ex Kütz. were documented from their original materials and their synonymization by Grunow was supported. The later species from lake "Neusiedler See" was also investigated with the scanning electron microscopy by Schmid (1976). The genus name problem *Nitzschia* or *Cylindrotheca* for *Ceratoneis closterium* is still seen today: A recent phylogenetic study (Damste *et al.* 2004) shows a small clade of *Cylindrotheca* strains including a *Nitzschia closterium*.

* e-mail: r.jahn@bgbm.org

The concept of the genus *Ceratoneis* shifted when Kützing (1844), Smith (1852, 1853), Rabenhorst (1859, 1864) and Grunow (1865), moved Ehrenberg's species out of *Ceratoneis* and fragilaroid and eunotioid taxa into Ehrenberg's genus (see Silva 1997). This culminated in the lectotype of the genus *Ceratoneis* by Boyer (1927) who designated the first species epithet in the alphabet of the *Ceratoneis* genus concept of his time which was *Navicula arcus* Ehrenb., currently known as *Hannaea arcus* (Ehrenb.) R.M. Patrick (see Bixby & Jahn 2005, and see Greuter *et al.* 2000, Art. 10.5a & b). As Patrick & Reimer (1966) and Fournanier & Kociolek (1999) pointed out, only originally included taxa are candidates for typification of a genus, which only are Ehrenberg's two new species of 1839. Finally, R. Ross in Farr *et al.* (1979) cleaned up this historical confusion by citing Smith (1852) and thus lectotypifying *Ceratoneis closterium* Ehrenb. as type of the genus *Ceratoneis* (Fournanier & Kociolek 1999).

Nevertheless, in the last decades this genus fell into oblivion and was not regarded as an accepted name by some scientists (e.g. Round *et al.* 1990) although it is in current use (Greuter *et al.* 1993) and nomenclaturally available. The reason could be that in contrast to the readily availability of Rabenhorst's exsiccatae, which served as basis for the emendation of the genus *Cylindrotheca* by Reimann & Lewin (1964), Ehrenberg's material was not easily available at the time of their study; during the Berlin Wall Era (1961–1989) scientists from West-Berlin, such as B. Reimann, were not allowed to work in the Ehrenberg Collection in East-Berlin. After the unification of Germany and Berlin and with the financial help within the *AlgaTerra* Project (Jahn & Kusber 2005) the Ehrenberg Collection has become more accessible and Ehrenberg's type specimen are now available for science.

Since the genus *Ceratoneis* has priority over *Cylindrotheca*, in this study we are focussing on the specimens of *C. closterium* on which Ehrenberg based the description of his genus *Ceratoneis* and are comparing it to the genus *Cylindrotheca* as it has been emended by Reimann & Lewin (1964). *Ceratoneis* Ehrenb. is reinstated and the appropriate transfers are made.

MATERIAL AND METHODS

From the Ehrenberg Collection at BHUPM the following material was investigated: Taxonomical Preparations (in a handwritten index at BHUPM as "Troockenpräparate II Polygastrica") No. 540032–3 [XXXII 3] and No. 540032–4 [XXXII 4], and Geographical Preparations (in the handwritten taxonomic index at BHUPM as Mikrogeologische Sammlung "Polygastern I") No. 360701–360801, as well as Ehrenberg's drawing No. 235 (partially reproduced here as Fig. 1).

Photographs were taken with an Olympus DP 50 and BX 51, Objective: Olympus 80x: SPlan 80/0.75, 40x UPlan F1 40/0.75, 20x: UPlan F1 20/0.50.

OBSERVATIONS

Ceratoneis Ehrenb. in Ber. Bekanntm. Verh. Königl. Preuss. Akad. Wiss. Berlin 1839: 157.

The generic description by Ehrenberg (1839: 157) reads: "Characteres Naviculae, sed apices in cornua longe attenuata, ab ovario non repleta, producti (aperturis 4?). Forma Closterii setacei". The term "Characteres Naviculae" is classification and habitus information as well. Ehrenberg described a new genus similar to the diatom genus *Navicula* with a rowing boat like valve, differentiated from the genus *Navicula* by its horn like rostra. The habitus was similar to the desmid *Closterium setacerum* Ehrenb. ex Ralfs, which Ehrenberg knew from freshwater samples between 1832 and 1835 in Berlin. Ehrenberg did not observe four apertures in *Ceratoneis*, but he drew several roundish structures in *C. fasciola* (\equiv *Gyrosigma fasciola* (Ehrenb.) J.W. Griffith & Henfr.), which he could not interpret.

Ceratoneis closterium Ehrenb. in Ber. Bekanntm. Verh. Königl. Preuss. Akad. Wiss. Berlin: 157. 1839.

Lectotype (designated here): Taxonomical Preparation No. 540032–3 in BHUPM, reproduced here as Fig. 5.

Locus typicus: “Nordsee bei Cuxhaven ... in dem zur Fluthzeit aus dem hohen Meere anströmenden Wasser” (Ehrenberg 1839) [North Sea, water of the rising tide, near Cuxhaven, Lat: 53 52 00 N, Long: 008 42 00 E, Germany].

Comment: The first published picture was on pl. 4: fig. 6 in Ehrenberg (1840) depicted from drawing No. 235 “Cuxhaven 21 Sept 1839” in BHUPM, reproduced here as Figs 1, 3.

Description of the specimens:

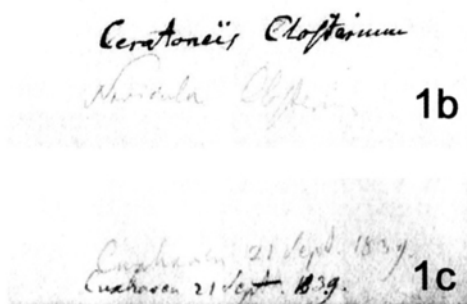
Ehrenberg (1839) gave a short diagnosis, an emended description was given in Ehrenberg (1840). The main focus was on the living cell, “im mittleren vierseitigen Körper, welcher 2 in der Mitte getrennte Massen bildet” refers to two chloroplasts, drawn by Ehrenberg and still visible in his preparations (Figs 1, 2). “Die Bewegung ist sehr deutlich und lebhaft” refers to the vigorous moving of the cells.

The main problem for an unequivocal identification of Ehrenberg’s taxon was the lack of information on the raphe, its orientation, and the number of fibulae. Table 1 gives measurements from the lectotype preparation as well as from other original materials from the Ehrenberg Collection and from Reimann & Lewin (1964). The frustules in the lectotype preparation are not twisted in the central part, which can be clearly seen by two parallel raphe. But in the rostrate ends of the frustules the two raphe are clearly twisted (see Figs 5, 7). The number of fibulae in 10 µm is difficult to count because of the low quality of mica-preparations from dried alive material. With the risk of underestimation, we counted 9–12 fibulae in 10 µm (Figs 5–6) in the lectotype preparation. Two single cells from another sampling of Ehrenberg’s original material 360714–a (not marked) had 14–18 fibulae in 10 µm (see Fig. 7). These light microscope observations fit into the main concept published by Reimann & Lewin (1964) studying modern specimens with an outline similar to those published by Ehrenberg (1840). The number of fibulae in Ehrenberg’s material is quite low in contrast to some of the strains (Table 1, 6 & 7) and merged data from different literature sources in Reimann & Lewin (1964; see our Table 1). The arrangement of fibulae is irregular, an interrupted fissure, as described by Reimann & Lewin (1964) by electron microscopy is not clearly seen in the original material.

DISCUSSION

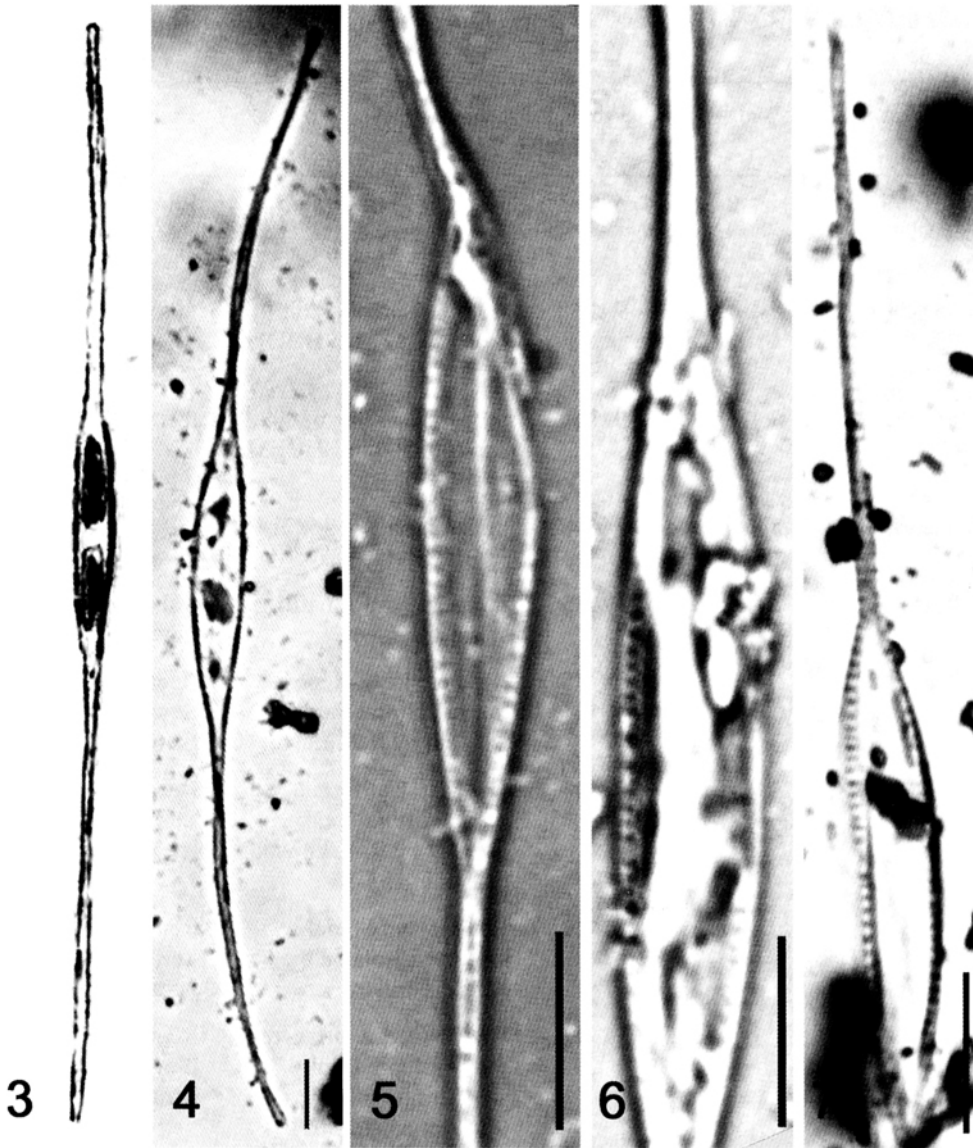
As a result of our investigation of Ehrenberg’s original material by light microscopy, most of the studied cultured material published by Reimann & Lewin (1964) sub “*Cylindrotheca closterium* var. *closterium*.”, is likely to be conspecific with Ehrenberg’s *Ceratoneis closterium*. However, the entire data set provided by Reimann & Lewin (1964), cited here in Table 1, seems to show a wider species concept than we understand today.

Our results show clearly that Ehrenberg did not see the rapheless and hence effectively stationary *Psammosynedra closterioides* (Grunow) Round, which is very similar in outline, and therefore often misidentified as Ehrenberg’s taxon as Round (1993) pointed out.



Figs 1, 2. Original materials of *Ceratoneis closterium* Ehrenb. in BHUPM. **Fig. 1.** Drawing sheet No. 235. **1a.** Seven specimens, drawn by C.G. Ehrenberg; see the chloroplasts of the living cells. **1b.** Ehrenberg's handwriting "Cuxhaven 21 Sept 1839", evidence of being original material. **1c.** Ehrenberg's handwriting "*Ceratoneis Closterium*" in clean copy, the draft (in pencil) "*Navicula Closterium*" was not implemented in Ehrenberg (1839, 1840). **Fig. 2.** Dried cells on preparation No. 540032-3, see remains of two chloroplasts. Scale bar = 10 μ m.

With the lectotypification of *Ceratoneis closterium* as the type of the name of the genus *Ceratoneis* by R. Ross in Farr *et al.* (1979), its recombination with *Cylindrotheca* by Reimann & Lewin (1964) places the current concept of *Cylindrotheca* into synonymy with *Ceratoneis*. We would have liked to honour the thorough and careful work with cultures and EM of Reimann & Lewin (1964) and Reimann *et al.* (1965) by retaining their author names.



Figs 3–7. Single specimens of *Ceratoneis closterium* Ehrenb. in BHUPM. **Fig. 3.** Drawn specimen “b” from Drawing sheet No. 235. **Fig. 4.** Specimen on preparation No. 540032–3, see remains of two chloroplasts. **Fig. 5.** Lectotype-specimen, preparation No. 540032–3; see fibulae and twisted upper rostrum. **Fig. 6.** Further cell on preparation No. 540032–3. **Fig. 7.** Specimen with dense fibulae on preparation 360714-a. Scale bars = 10 μ m.

We carefully weighted the pros and cons on priority versus stability. Since the genus *Cylindrotheca* is not based on a currently well known taxon, *C. gerstenbergeri*, which was found in a freshwater habitat and, in addition, is considered to be a later synonym of *Ceratoneis gracilis* which was not included in the original description of Rabenhorst’s *Cylindrotheca* but in his later described *Nitzschiella* (Rabenhorst 1859, 1864), we refrained from the ordeal of conserving the superfluous generic name *Cylindrotheca*.

Table 1. Dimensions of *Ceratoneis closterium* Ehrenb. from different sources.

Length (μm)	Width (μm)	Fibulae in 10 μm	Source	Data by
94.0–125.3 [cit.: 1/24 – 1/18" (Paris lines)]		not seen	material from Cuxhaven and/or Wismar	Ehrenberg (1840)
130.8–156.0– 174.0	5.4–6.6–7.8	9–12	lectotype preparation No. 540032–3 in BHUPM (n=20)	this study, Figs 4–6
130.8–158.1– 174.0	5.4–6.5–8.4	9–12	preparations No. 540032–3 & 540032–4 in BHUPM (n=40)	this study
not measurable	5–6	14–18	preparation No. 360714–a in BHUPM (n=2)	this study, cp. Fig. 7
25.0–180.0	1.5–8.0	12–25	merged data from different sources	Reimann & Lewin (1964)
44.0–49.0		20–25	Sapelo Island, Georgia, marine littoral mud; isolated by R.A. Lewin	Reimann & Lewin (1964) [strain No. 8]
27.0–30.0		24–25	Del Mar, California, marine littoral mud; isolated by R.A. Lewin; his strain 155–M	Reimann & Lewin (1964) [strain No. 9]
33.0–35.0		14–19	Long Island Sound, seawater; isolated by R.R.L. Guillard	Reimann & Lewin (1964) [strain No. 10]
70.0–79.0		15–17	Pacific Ocean, offshore water sample from southern tip of Baja California; isolated by Anne Dodson, her strain Baja 62–1	Reimann & Lewin (1964) [strain No. 11]

The few taxa which fit into the generic circumscription provided by Reimann & Lewin (1964) for the genus *Cylindrotheca*, are herewith recombined into the reinstated genus *Ceratoneis*. The following list provides the correct names under *Ceratoneis* Ehrenb. according to the ICBN (Greuter *et al.* 2000). Taxonomical, ecological, and molecular data provided by and since Reimann & Lewin (1964) for the synonymized taxa can thus be linked to the correct names.

Reinstatements and new combinations

***Ceratoneis* Ehrenb. in Ber. Bekanntm. Verh. Königl. Preuss. Akad. Wiss. Berlin 1839: 157. 1839.**

= *Cylindrotheca* Rabenh., Algen Sachsens, No. 801. 1859; as emended by Reimann & Lewin (1964); the type of its name *Cylindrotheca gerstenbergeri* Rabenh. (by monotypy) has been synonymized with *Ceratoneis gracilis* Bréb. ex Kütz.

Type of the name of the genus *Ceratoneis* is *C. closterium* (R. Ross in Farr *et al.* 1979):

***Ceratoneis closterium* Ehrenb. in Ber. Bekanntm. Verh. Königl. Preuss. Akad. Wiss. Berlin: 157. 1839.**

≡ *Nitzschia closterium* (Ehrenb.) W. Sm., Syn. Brit. Diat. 1: 42. 1853.

≡ *Nitzschiella closterium* (Ehrenb.) Rabenh., Fl. Eur. Alg. 1: 16, 163. 1864.

≡ *Cylindrotheca closterium* (Ehrenb.) Reimann et J.C. Lewin in J. Roy. Microscop. Soc. 83: 288. 1964.

***Ceratoneis gracilis* Bréb. ex Kütz., Spec. Alg.: 89. 1849.**

≡ *Cylindrotheca gracilis* (Bréb. ex Kütz.) Gunow in Van Heurck, Syn. Diat. Belg., pl. 80: fig. 2 (caption). 1882.

≡ *Nitzschia taenia* W. Sm., Syn. Brit. Diat. 1: 43, pl. 15: fig. 123. 1853, nom. illeg. (Greuter *et al.* 2000, Art. 52).

≡ *Nitzschiella gracilis* (Bréb. ex Kütz.) Rabenh., Fl. Eur. Alg. 1: 16, 163. 1864.

Locus typicus: “In aqua dulci circa Falaise, Gallica”.

According to Grunow in Van Heurck (1882), *Cylindrotheca gerstenbergeri* Rabenh. is a (heterotypic) synonym of *Ceratoneis gracilis*. Although Grunow in Van Heurck (1882) did not check original material and *Ceratoneis gracilis* originally was described without a figure, Kützing (1849) had a specimen of Brébisson in his hand, when describing the taxon. Smith (1853: 43) checked the specimen or asked Brébisson concerning this. Rabenhorst (1864) was not aware of the synonymy, because he was not able to re-evaluate his original material by means of modern microscopy as done by Reimann & Lewin (1964). If Rabenhorst (1864) had reexamined his preparation he would have seen that his published drawings differed from his specimens.

***Ceratoneis gracilis* var. *major* (Grunow) R. Jahn & Kusber, comb. nov.**

Basionym: *Cylindrotheca gracilis* var. *major* Grunow in Van Heurck, Syn. Diat. Belg.: pl. 80: fig. 1 (1882).

Original material: pl. 80: fig. 1 in Van Heurck (1882).

Locus typicus: “Helgoland”, according to caption of pl. 80: fig. 1 in Van Heurck (1882), Germany.

***Ceratoneis closterium* var. *californica* (Mereschk.) R. Jahn & Kusber, comb. nov.**

Basionym: *Nitzschiella californica* Mereschk. in Ann. Mag. Nat. Hist., ser. 7, 7: 479, pl. 4: fig. 18–20. 1901.

≡ *Cylindrotheca closterium* var. *californica* (Mereschk.) Reimann & J.C. Lewin in J. Roy. Microscop. Soc. 83: 289. 1964.

Locus typicus: Redondo Beach, California, U.S.A.

Comment: Reimann & Lewin (1964) studied two strains from the Pacific Ocean.

***Ceratoneis fusiformis* R. Jahn & Kusber, sp. nov.**

Cylindrotheca fusiformis Reimann & J.C. Lewin in J. Roy. Microscop. Soc. 83: 288. 1964., nom. inval. (Greuter *et al.* 2000, Art. 37.3).

Holotype: pl. 121: fig. 4 and 122: fig. 1 from Woods Hole, Massachusetts, U.S.A., in Reimann & Lewin (1964) as “strain 4”, isolated September 1957 by S. Watson; “his strain 13”.

Locus typicus: Woods Hole, Massachusetts, U.S.A., marine littoral.

Reimann & Lewin (1964) thoroughly and correctly discussed the designation of figures as types (see Greuter *et al.* 2000, Art. 37.4) but the inclusion of figures of six different gatherings from different sampling sites, violates Art. 37.3. making the name invalid. For valid publication, we excluded all gatherings from the intended type, except for the Woods Hole material, because it fits the description, and a living culture strain is still available. The authentic strain (see Jahn *et al.* 2004) of the original material of *Cylindrotheca fusiformis* was deposited by J.C. Lewin as CCMP strain No. 343. In addition, detailed information on cell wall formation was based on this material (Reimann *et al.* 1965).

Reimann & Lewin (1964) provided a Latin diagnosis to make the name available for use. Since the diagnosis is split between the diagnosis of the species and the nominate variety, the complete diagnosis by Reimann & Lewin (1964: 288) is quoted here: “Pars centralis cellularum fusiformis. Frustulae circiter semel terve contortae circum axem apicalem. Valvae non siliceofactae praeter raphe. Raphe ex tenoribus duobus fissurae adiacentibus, cohaesitis fibulis arcuatis, 20–35 in 10 μ . Raphe lateraliter comitata a tenoribus singulis siliceofactis. Fissura media in valva interrupta. Longitudo cellularum circiter 25–125 μ , latitudo circiter 3–7 μ .”

We adopt these protologue data, but we do not accept the classification within the genus *Cylindrotheca*.

***Ceratoneis fusiformis* var. *enodis* R. Jahn & Kusber, var. nov.**

Cylindrotheca fusiformis var. *enodis* Reimann & J.C. Lewin in J. Roy. Microscop. Soc. 83: 289. 1964., nom. inval. (Greuter *et al.* 2000, Art. 43.1).

Holotype: pl. 121: fig. 7 and pl. 122: fig. 5, 6 in Reimann & Lewin (1964) taken from strain 7, isolated by R.A. Lewin (“his strain 54-M”) from San Diego, California, marine littoral mud.

Locus typicus: San Diego, California, marine littoral mud, U.S.A.

Since the name by Reimann & Lewin (1964) was originally classified within an invalidly published species, it is also invalid. Reimann & Lewin (1964: 289) provided a Latin diagnosis (“Fissura non interrupta in media parte valve. Longitudo 18–36 μ , latitudo 1.5–3 μ , numerus fibularum 26–29 in 10 μ .”) to make the name available for use. We adopt these protologue data, but we do not accept the classification within the genus *Cylindrotheca*.

***Ceratoneis signata* (Reimann & J.C. Lewin) R. Jahn & Kusber, comb. nov.**

Basionym: *Cylindrotheca signata* Reimann & J.C. Lewin in J. Roy. Microscop. Soc. 83: 290. 1964.

Holotype: pl. 127: fig. 2, pl. 128: fig. 4, pl. 129: fig. 4 in Reimann & Lewin (1964), taken from a sample by R. Williams.

Locus typicus: Sapelo Island, Georgia, U.S.A.

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