

Emendation of the foraminiferal genus *Cribrostomoides* Cushman, 1910, and its taxonomic implications

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ABSTRACT

A review of the taxonomic history of the agglutinated (benthonic) foraminiferal genus *Cribrostomoides* Cushman, 1910 reveals much confusion concerning its type species, coiling mode and apertural characteristics. We believe the originally designated type species of *Cribrostomoides* Cushman, 1910, *C. bradyi* Cushman, 1910, to be no more than varietally (i.e. infra-subspecifically) distinct from, and therefore a junior synonym of, *Haplophragmoides subglobosus* Cushman, 1910. The coiling of *Cribrostomoides*, as typified by *C. subglobosus* (Cushman, 1910), is in the form of an involute streptospire characterised by a repeated alternation in axis. The aperture of the genus is equatorially or asymmetrically placed and interio-areal and single (in megalospheric and juvenile microspheric specimens) to areal and multiple (in microspheric adults). In order to stabilise the concept of *Cribrostomoides*, we have designated lectotypes for both *C. bradyi* and *H. subglobosus*, and have also emended the generic diagnosis of Loeblich and Tappan (1987). Criteria for the discrimination of *Cribrostomoides* emend. herein and allied genera are tabulated. *J. Micropalaeontol.* **12** (2): 181-193, December 1993.

INTRODUCTION

The lituolid (agglutinated benthonic foraminiferal) genus *Cribrostomoides* Cushman, 1910 is an ubiquitous component of modern deep-sea faunas. It has also been reported by numerous authors from "flysch-type" foraminiferal assemblages of Late Cretaceous to Oligocene age.

Unfortunately, this widely cited genus does not benefit from having a well-defined description. There is much confusion in the literature concerning its type-species, coiling mode and apertural characteristics. This is partly attributable to the poor quality of the original illustrations, and to the fact that the original description was based solely upon the external morphology of the test. The purpose of the present study is to stabilise the concept of *Cribrostomoides* based upon lectotypification of the type species (and emendation of the generic diagnosis). For this purpose we have illustrated type specimens from the collections of J.A. Cushman, H.B. Brady, and G.O. Sars, and have dissected specimens to reveal the mode of coiling and wall structure.

TAXONOMIC HISTORY OF THE GENUS CRIBROSTOMOIDES CUSHMAN, 1910

In his "North Pacific Monograph", Cushman (1910: 108-109) first described the new genus *Cribrostomoides*, with the new species *C. bradyi* as the type. The type description for *C.*

bradyi reads thus:

"Test free, planospiral, of several coils, chambered, the last-formed coil with several chambers progressively increasing in size, arenaceous wall, with much cement... , aperture in young specimens a simple elongate slit at the base of the apertural face, later subdivided by tooth-like processes, and in the adult represented by a linear series of distinct rounded [interio-areal or areal] openings." The type figures are reproduced in Fig. 1.1a-c.

In his subsequent "North Atlantic Monograph", Cushman (1920: 52-54) acknowledged the possibility that *Cribrostomoides bradyi* might be synonymous with *Haplophragmoides subglobosum* (Sars) (*sic*). However, he retained the two as separate species, stating that "*Cribrostomoides* may be easily distinguished in the adult by the row of pores forming the aperture, while the aperture of *H. subglobosum* is always simple."

In their studies of "Upper Cretaceous" [Palaeocene] material from the Lizard Springs Formation of Trinidad, Cushman & Jarvis (1927, 1932) applied the generic name *Cribrostomoides* to a species (*C. trinitatensis* Cushman & Jarvis, 1927) characterised by multiple interio-marginal rather than interio-areal openings, in so doing implicitly emended the concept of the genus. In fact, "*Cribrostomoides trinitatensis* appears distinct from *Cribrostomoides* s.s. in its

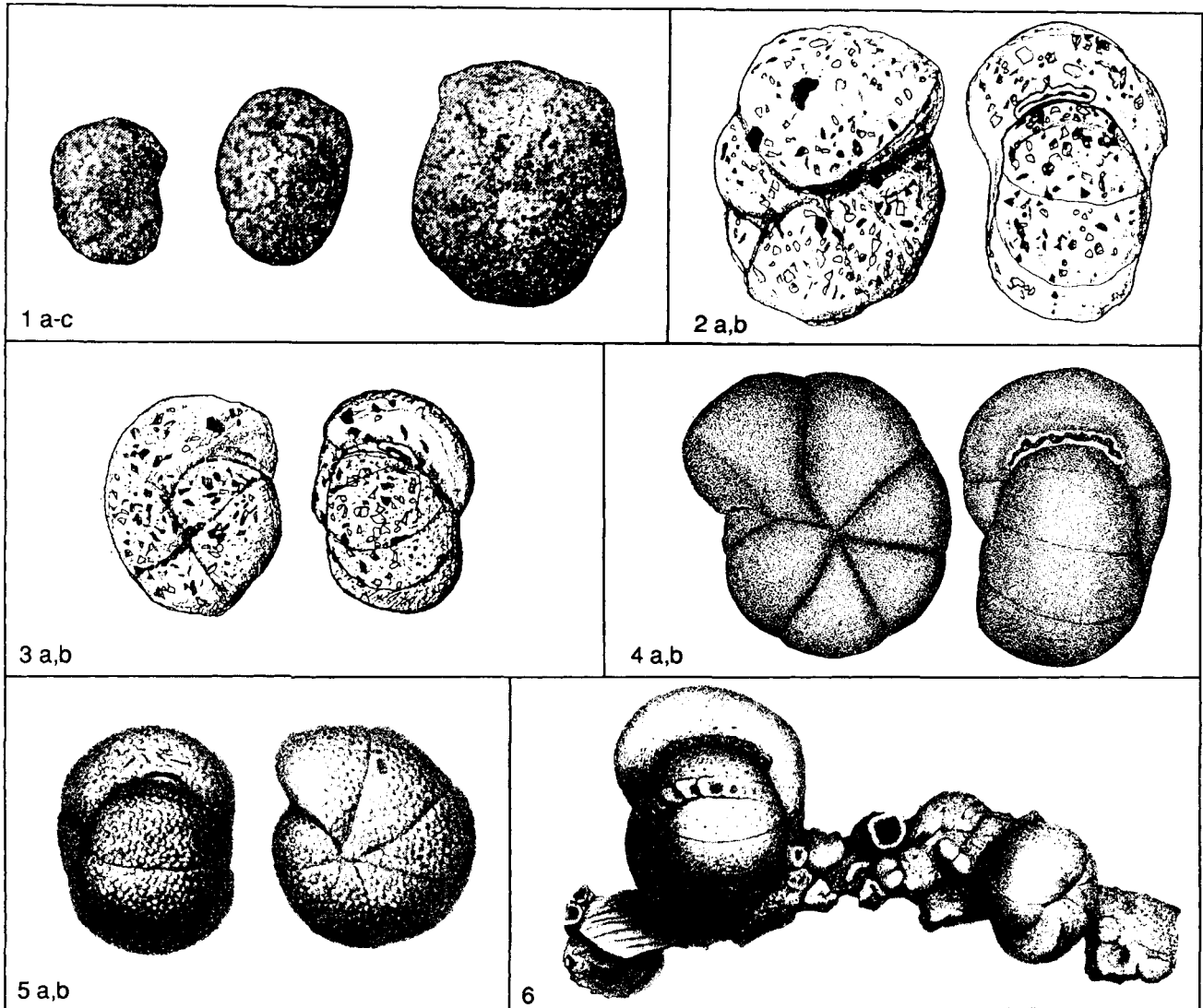


Fig. 1.1. *Cribrostomoides subglobosus* forma *subglobosus* (Cushman, 1910). x32. Reproduction of type figures of *Haplophragmoides subglobosus* Cushman, 1910, (Textfigs. 102-104). Textfig. 104 from Albatross Station D3603 (1771fm or 3241m). **Fig. 1.2.** *Cribrostomoides subglobosus* forma *subglobosus* (Cushman, 1910). x36. Lectotype of *Haplophragmoides subglobosus* Cushman, 1910 (herein designated). From Albatross Station D3603 (1771fm or 3241m). United States National Museum Registered Number USNM8219b. Specimen illustrated by Cushman (1910) as Textfig. 164. Compare with our Fig. 1.1. Also illustrated by SEM in Pl. 1, figs. 1a,b. **Fig. 1.3.** *Cribrostomoides subglobosus* forma *subglobosus* (Cushman, 1910). x36. Paralectotype of *Haplophragmoides subglobosus* Cushman, 1910 (herein designated). From Albatross Station D3603 (1771fm or 3241m), USNM8219b. Specimen illustrated by Cushman (1910) as Textfig. 162. **Fig. 1.4.** *Cribrostomoides subglobosus* forma *bradyi* (Cushman, 1910). x16. Reproduction of type figure of *Cribrostomoides bradyi* Cushman, 1910 (Textfig. 167). From Albatross Station D3346, North Pacific. **Fig. 1.5.** *Cribrostomoides subglobosus* forma *subglobosus* (Cushman, 1910). x20. Reproduction of Pl. 34, fig. 8 of Brady (1884) (identified as *Haplophragmium latidorsatum* (Bornemann)). From Challenger Station 24, off Culebra Island, West Indies (390 fm or 714 m). The Natural History Museum (BMNH) Registered Number ZF1542. Placed by Cushman (1910) in *Haplophragmoides subglobosus* G.O. Sars (sic). **Fig. 1.6.** *Cribrostomoides subglobosus* forma *bradyi* (Cushman, 1910). x15. Reproduction of Pl. 34, fig. 9 of Brady (1884) (identified as *Haplophragmium latidorsatum* (Bornemann)). From Challenger Station 246, North Pacific (2050fm or 3752m), BMNH ZF1543. Placed by Cushman (1910) in *Cribrostomoides bradyi* n. sp. For a modern SEM illustration see Fig. 2.3..

interio-marginal rather than interio-areal aperture (and from *Barkerina* Frizzell & Schwartz, 1950 (where it was placed by Frizzell & Schwartz (1950)) in its arenaceous rather than microgranular wall and in lacking internal partitions). We believe "*C. trinitatensis*" probably represents a separate genus.

Höglund (1947: 144-145) synonymised *Cribrostomoides* Cushman, 1910 with *Labrospira* n. gen., apparently rejecting it on the grounds of the inappropriateness of the name (observing a complete gradation from specimens with simple slit-like apertures ("*Labrospira*") to rare specimens with multiple apertures ("*Cribrostomoides*") and arguing that Cushman was "...in no way justified..." in "...singling out such specimens [as the latter] and setting them up ...as a... new genus"). In fact, Articles 18 and 23m of the International Code of Zoological Nomenclature (Ride *et al.*, 1985) state that the "inappropriateness" of a name does not affect its availability, and that no valid available name can be rejected on this or any other ground. Moreover, Höglund also synonymised the type-species of *Cribrostomoides* Cushman, 1910 (*C. bradyi* Cushman) with *Labrospira subglobosa* (G.O. Sars, 1871 (1872)) (*sic*), in so doing, automatically making *Labrospira* a junior synonym of *Cribrostomoides*.

Frizzell & Schwartz (1950: 3) emended *Cribrostomoides* on the basis of its apertural characteristics, citing as typical a simple "elliptical or crescent-shaped" slit, located "...slightly above..." the base of the septal face and "...completely surrounded by it...". They added that "provisionally, it seems advisable to regard *bradyi* and *subglobosa* as distinct species, each including variant individuals in which multiple apertures are developed".

Loeblich & Tappan (1964: C225) followed Höglund (1947) in synonymising *Cribrostomoides bradyi* Cushman, 1910 with *Lituola subglobosum* G.O. Sars, 1871 (1872) (*sic*), citing the latter as the type species of *Cribrostomoides* Cushman, 1910. They also synonymised *Labrospira* (see above) with *Cribrostomoides*. In their diagnosis of *Cribrostomoides* Cushman, 1910, they essentially reverted to the original, stating the chamber arrangement to be "similar to *Haplophragmoides*" [i.e. planispiral] and the aperture to be "areal" (single in "young" and dentate or multiple in "very large" individuals).

Subsequently, Loeblich & Tappan (1987: 65-66) reinstated *Labrospira* and quoted *bradyi* as the type species of *Cribrostomoides* without reference to *subglobosus*. In their revised diagnosis of the genus, they stated the coiling mode to be "slightly streptospiral" in early stages, later becoming "planispiral and symmetrical". They further stated the aperture to be "equatorial, just above the base of the final chamber face, ... a simple slit in the early chambers, later ... a linear series of irregular to rounded openings".

OBSERVATIONS ON THE GENUS *CRIBROSTOMOIDES* CUSHMAN, 1910

(1) On the type species

The type species (by original designation) of the genus *Cribrostomoides* Cushman, 1910 is unequivocally

Cribrostomoides bradyi Cushman, 1910. Confusion arises from the arguable synonymy of *C. bradyi* Cushman, 1910 and *C. subglobosus* auctt.

The earliest citations of *Lituola subglobosa* (M. Sars, 1868 (1869); G.O. Sars, 1871 (1872); Brady, 1881a,b) are unaccompanied by figures or descriptions, and are invalid. The next citation (Brady, 1884) synonymised *Lituola subglobosa* with the fossil species *Haplophragmium latidorsatum* Bornemann, which is herein regarded as distinct and referable to the genus *Haplophragmoides* Cushman, 1910. Interestingly, one of the slides in the Brady Collection in the Natural History Museum (BMNH) (which was evidently sent to Brady by Michael Sars) bears the pencilled inscription "*Lituola subglobosa*" crossed out and replaced by the inked inscription "*Haplophragmium latidorsatum*" (see our Fig. 2.3). It follows that if Brady had used Sars' designation instead of trying to synonymise it under Bornemann's species, he would have validated *subglobosa* in his Challenger Report.

Cushman (1910) was the first to validate the specific name *subglobosus*, though at the time of writing he was evidently unaware of this. This is noted on an undated addendum slip in the Natural History Museum's edition of the Ellis & Messina Catalogue of Foraminifera (1940 *et seq.*) (the full text of which states that "although Cushman credited the specific name [*Haplophragmoides (sic) subglobosus*] to G.O. Sars it should be credited to Cushman since Sars was responsible for the name alone and not for the description or figures [ICZN, Article 21]").

Both *Cribrostomoides bradyi* Cushman, 1910 and *Haplophragmoides subglobosus* Cushman, 1910 were validated in the same publication (Cushman, 1910), the former species on p. 108 and the latter on p. 105.

The microfossil collections in the United States National Museum of Natural History, Smithsonian Institution, house about six trays of slides labelled "*Cribrostomoides bradyi*" and "*Haplophragmoides subglobosus*" from Albatross and Nero stations studied by Cushman (1910, 1920, 1921). The bulk of this material is from the North Atlantic (Cushman, 1920), but some is also from the North Pacific (Cushman, 1910) and some from the Philippines (Cushman, 1921). All of the Pacific specimens of both "species" are considered cotypic (syntypic).

Based partly on a study of syntypic suites of both "species", we believe *Cribrostomoides bradyi* Cushman, 1910 (see our Fig. 1.4,6; Fig. 2. and Pl. 3) and *Haplophragmoides subglobosus* Cushman, 1910 (see our Fig. 1. 1-3, 5 and Pls. 1,2) to be no more than infra-subspecifically distinct and therefore for practical purposes synonymous (Lukina (1980) reached a similar conclusion). Forma *bradyi* differs from forma *subglobosus* essentially only in its size (being larger), and in its wall texture (being finer) and composition (apparently being selective in its use of mafic particles). These differences are interpreted as due to differences in substrate rather than genetic effects (i.e. phenotypic rather than genotypic).

Article 24 of the ICZN (Ride *et al.*, 1985) (the "Principle of the First Reviser") states that "If two ... names are published

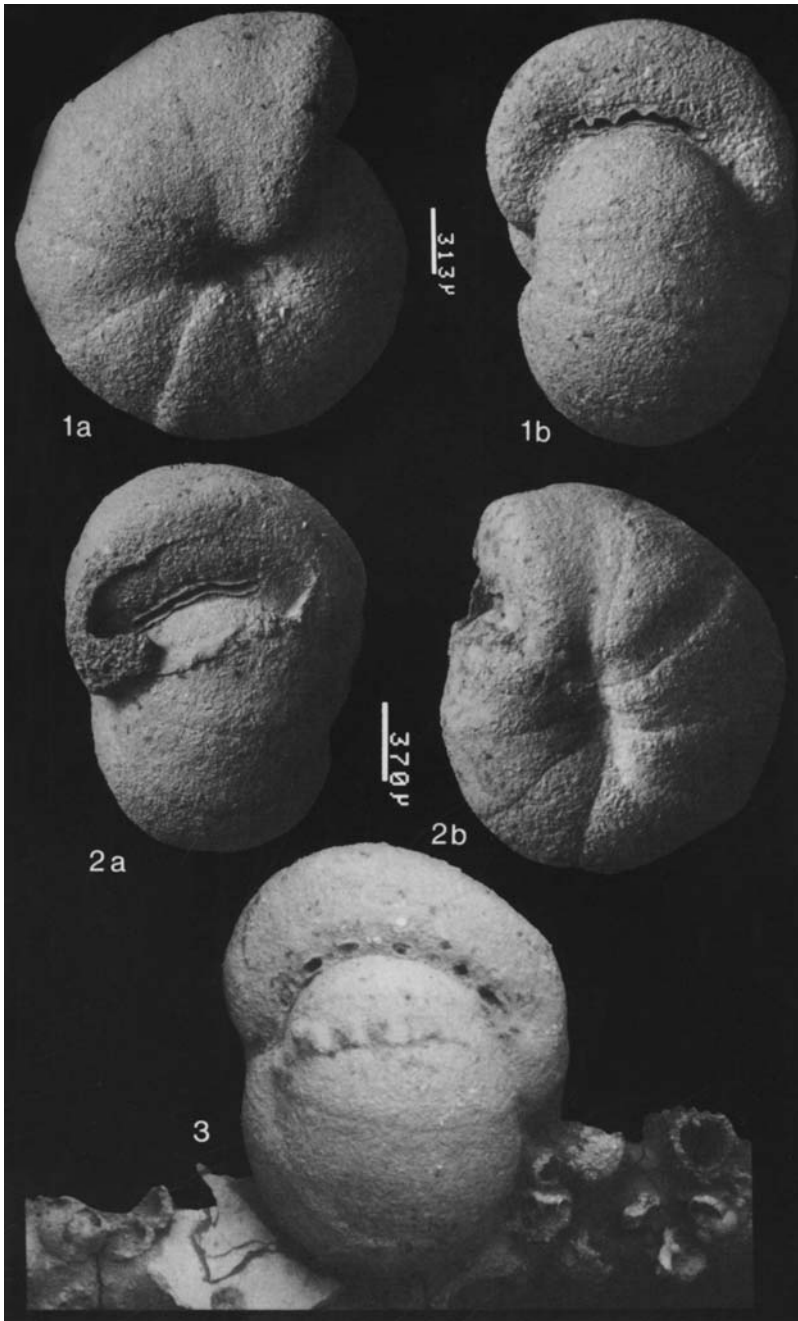
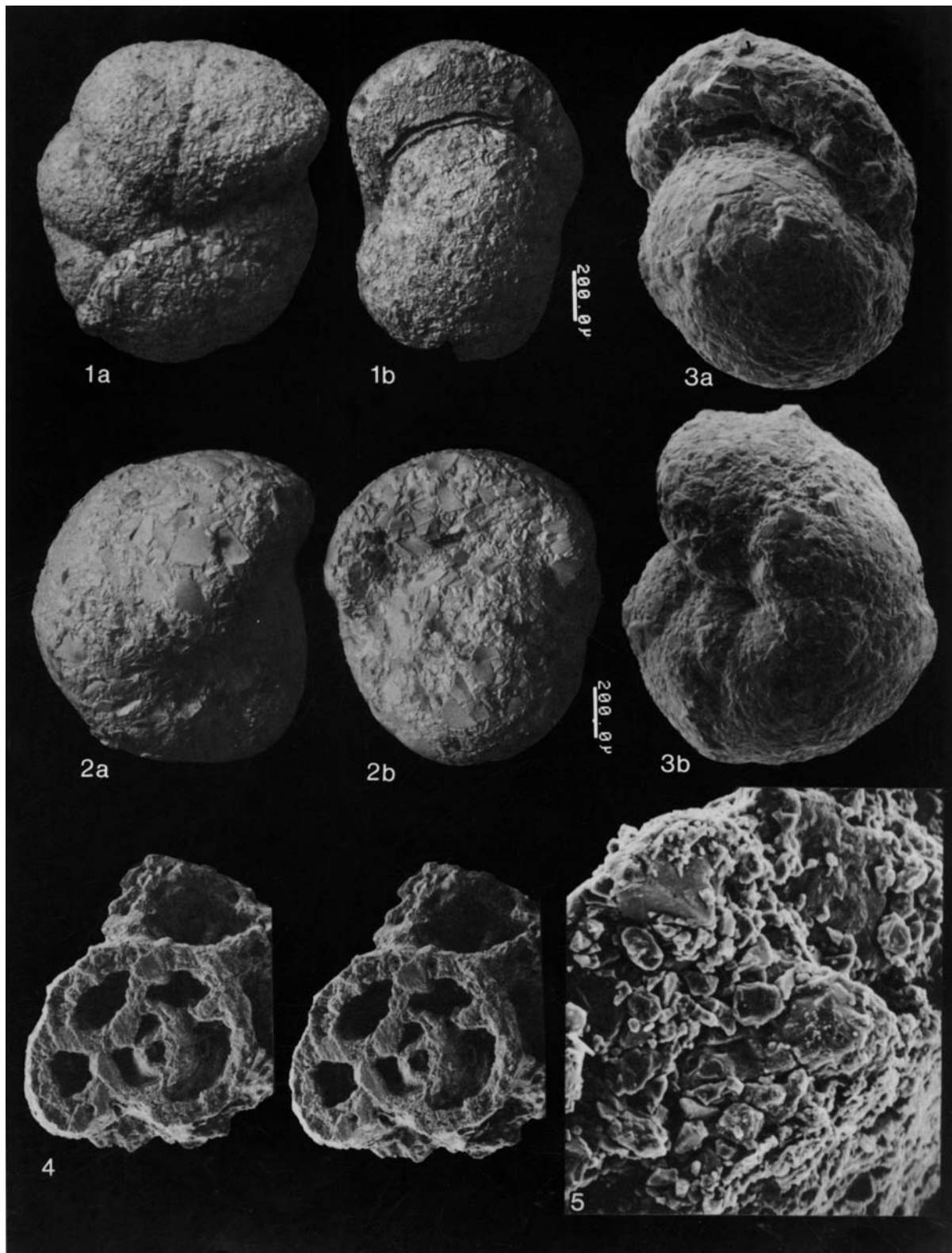


Fig. 2. Syntypes of "*Cribrostomoides bradyi*" from the Cushman Collection. **Fig. 2. 1a,b.** *Cribrostomoides subglobosus* forma *bradyi* (Cushman, 1910). Lectotype (designated herein) of "*Cribrostomoides bradyi*", North Pacific, Albatross Station D3346, specimen displays crenulated lip, x28. **Fig. 2. 2a,b.** *Cribrostomoides subglobosus* forma *bradyi*. Paralectotype (designated herein) of "*Cribrostomoides bradyi*", North Pacific, Albatross Station D3346, specimen without crenulated lip, x28. **Fig. 2.3.** *Cribrostomoides subglobosus* forma *bradyi*. Brady's specimen of "*Haplophragmium latidorsatum*", from Challenger Station 246, North Pacific. This specimen was placed by Cushman (1910) in "*Cribrostomoides bradyi*". BM(NH) ZF1543, x10.

Explanation of Plate 1

Type specimens of "*Cribrostomoides subglobosus*". **Fig. 1a,b.** *Cribrostomoides subglobosus* forma *subglobosus* (Cushman, 1910). Lectotype (designated herein) of "*Cribrostomoides subglobosus*", North Pacific, Albatross Station D3603, 1771 fathoms, USNM 8219b. Specimen illustrated by Cushman (1910) in Textfig. 104. x45. **Fig. 2a,b.** *Cribrostomoides subglobosus* forma *subglobosus*. Paralectotype (designated herein) of "*Cribrostomoides subglobosus*", North Pacific, NERO Station 160, 1907 fathoms, USNM 8219a, x45. **Fig. 3a,b.** *Cribrostomoides subglobosus* forma *subglobosus*. Lofoten Islands, Norway "very deep water". Specimen was sent to H.B. Brady from the collection of G.O. Sars. Brady Collection, BMNH 1958:11:3:7-12. x63. **Fig. 4.** *Cribrostomoides subglobosus* forma *subglobosus*. Stereo-pair of a specimen sectioned to show involute streptospiral coiling ALBATROSS Station D2572. Slide labelled "*Cribrostomoides bradyi*" from the Cushman Collection, donated to the British Museum (Natural History). BMNH 1961:1:9:77. **Fig. 5.** Detail of wall, showing non-canalliculate wall structure, x615.



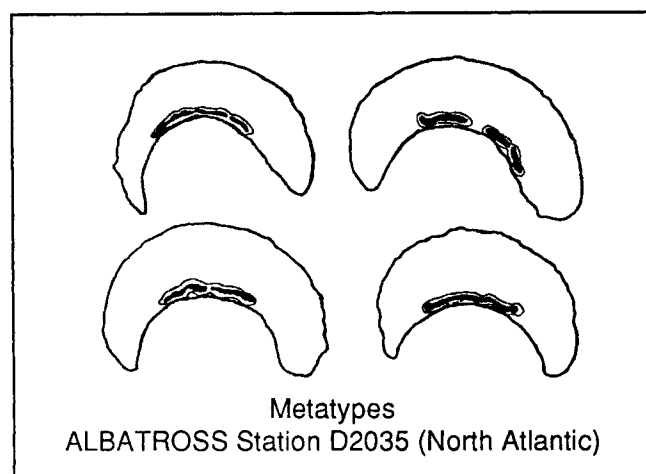
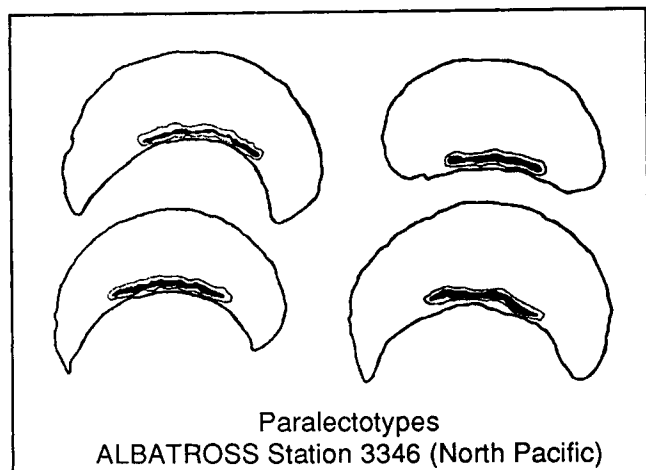


Fig. 3. Apertural characteristics of adult specimens of "*Cribrostomoides bradyi*". All specimens are from the Cushman Collection (USNM), camera lucida drawings. The paralectotypes have broad apertures with crenulate lips, whereas Atlantic specimens display a greater tendency to possess true multiple apertures. All specimens drawn to the same size.

on the same date, ... in the same or different works, ... by the same or different authors, ... and ... subsequently considered to be synonyms ..., their relative precedence is determined by the first reviser".

We accordingly assign precedence to *Haplophragmoides subglobosus* Cushman, 1910. This is the more widely used name and the one whose retention would best maintain nomenclatorial stability. It also has "position precedence" (defined as that "given to the the nominal species cited first in the work, page or line"). Recommendation 69B(II) of the ICZN suggests that this be recognised in the event of "all other things being equal" (Ride *et al.*, 1985).

(2) On the coiling mode

The widely-held belief (e.g. of Cushman, 1910, Frizzell and Schwartz, 1950, and Loeblich & Tappan, 1964) that the chamber arrangement in the genus *Cribrostomoides* is planispiral is in our opinion untenable. This was first called into question by the work of Höglund 1947: 144-145), who noted that *Labrospira subglobosa* (G.O. Sars) (*sic*) (which he regarded as a senior synonym of *Cribrostomoides bradyi* Cushman) "is not formed as a completely flat spiral", that "this is frequently plainly visible in the last volution, which is more or less twisted" and that "the irregularity is particularly noticeable in the initial portion, where the arrangement of the chambers is difficult to determine in a section". Höglund's figured section (Textfigure 126) seems to indicate that later whorls are arranged more or less at right angles to earlier ones. This kind of coiling conforms to that which Banner & Blow (1967) defined (in the case of the planktonic genus *Pulleniatina* Cushman) as "streptospiral".

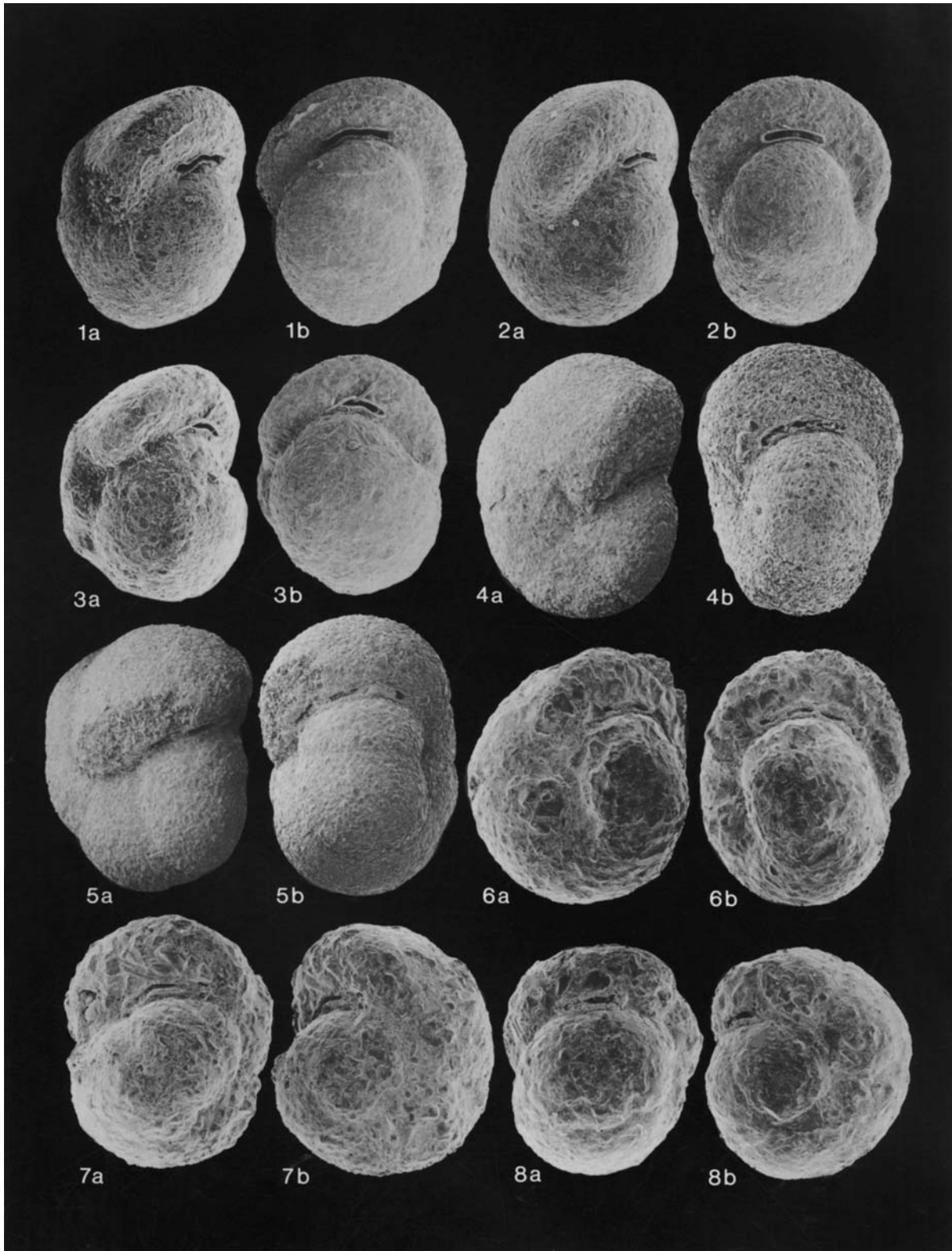
Hofker (1976: 54-55) also observed of *Cribrostomoides bradyi* Cushman that "especially the early chambers are streptospirally arranged, so that in a section transverse to the last formed coil the whole spiral is seen, whereas in sections in the plane of the last formed coil, several chambers of the first coils are sectioned transversely". He erroneously added that Höglund's *subglobosa* "does not show" the streptospiral initial part.

In contrast, Loeblich & Tappan (1964: C225) regarded *Cribrostomoides* as essentially planispiral. In this work, they defined "streptospiral" genera somewhat imprecisely as "coiled like a ball of twine". Later (1987: 65-66), they came to regard *Cribrostomoides* as "slightly streptospiral" in early stages, later becoming "planispiral and symmetrical". In this later work they defined streptospiral genera still somewhat imprecisely as "coiled ... in continually changing planes" (p. 741).

Our dissected specimen of *Cribrostomoides subglobosus* forma *subglobosus* from the Cushman Collection (Pl. 1, fig. 4) confirms the suspected involute streptospiral coiling mode, characterised by a (repeated) alternation in axis. This is manifest by regular intersections by the plane of section of

Explanation of Plate 2

Metatypes of "*Cribrostomoides bradyi*" (specimens identified as such by J.A. Cushman). All specimens are from the Cushman Collection, USNM. **Fig. 1a-3b.** *Cribrostomoides subglobosus* forma *bradyi*. Albatross Station D5613 (42°00'S, 121°44'W), South China Sea, 752 fathoms. USNM 12657. **1a,b-** large specimen with crenulated aperture, x29; **2a,b-** x42; **3a,b-** small specimen displaying streptospiral coiling and oval aperture, x57. **Fig. 4a-5b.** *Cribrostomoides subglobosus* forma *bradyi*. Albatross Station D2035 (39°26'N, 70°02'W), North Atlantic, 1362 fathoms. USNM 10359, **4a,b-** x27; **5a,b-** x26. **Fig. 6a-8b.** *Cribrostomoides subglobosus* forma *subglobosus*. Goldseeker Station in the Faeroe-Shetland Channel (61°03'N, 02°20'W), 1418 m. Cushman Collection (unregistered slide). **6a,b-** large specimen with crenulated apertural lips, x46; **7a-8b-** small specimens displaying streptospiral coiling, **7a,b-** x43; **8a,b-** x54.



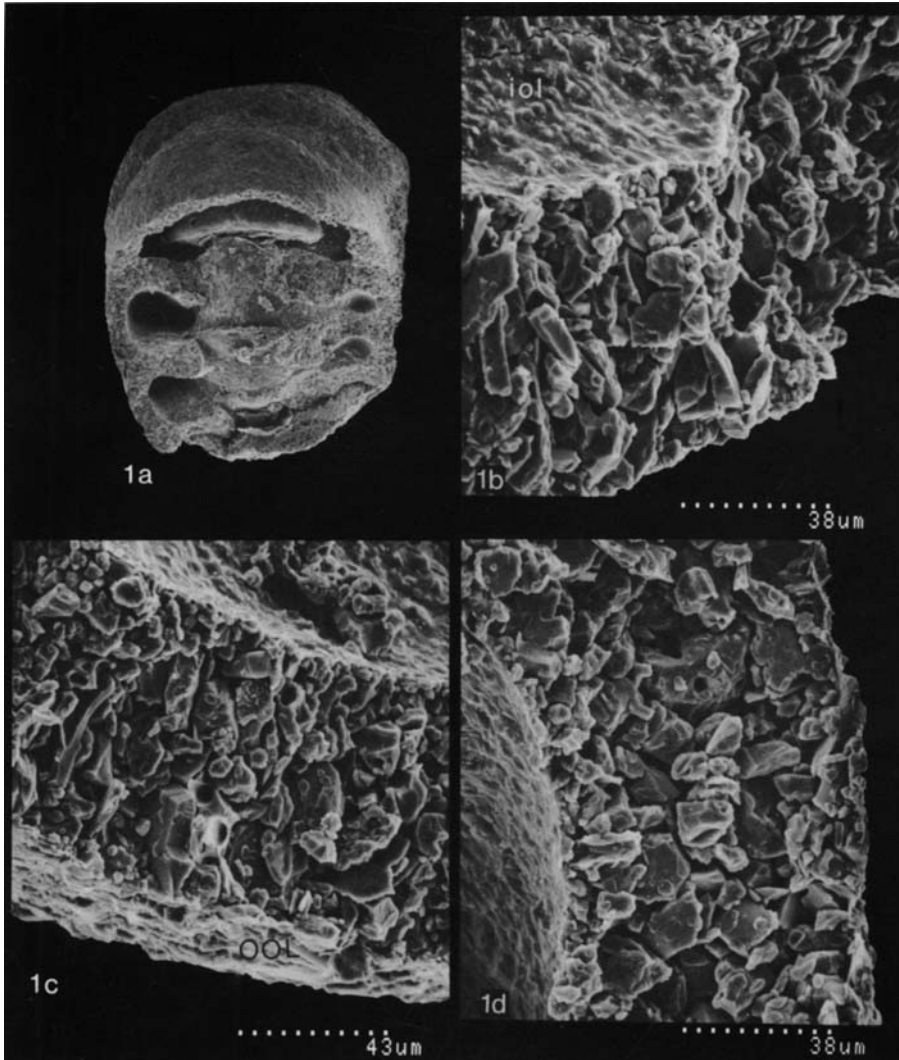


Fig. 4. Wall structure of *Cribrostomoides subglobosus* forma *bradyi*. **fig. 4.1** *Cribrostomoides subglobosus* forma *bradyi*. **1a-** Paralectotype sectioned to reveal wall structure x30; **1b-** Detail of wall, showing the inner organic layer (iol), x510; **1c-** wall consists of both biogenic (siliceous) and lithogenic particles with long axes oriented normal to the inner and outer surfaces, (OOL= outer organic layer), x510; **1d-** Larger particles appear to be concentrated near the centre of the wall, while small particles are placed beneath the IOL and OOL. Undifferentiated organic cement is visible at grain contacts, x510.

the line of communication between successive intercameral foramina and the primary aperture.

(3) On the apertural characteristics

Hofker (1976: 54-55) associated variation in apertural form with alternation of generations in *Cribrostomoides bradyi*

subglobosus forma *bradyi*, both the exterior and interior test surfaces are finely agglutinated and smoothly finished, and coarser particles are concentrated within the chamber wall. In *C. subglobosus* forma *subglobosus*, the coarser grains may project outward as well as into the chamber lumen resulting in rough test surfaces. Sectioned, imperforate chamber walls

Cushman (sic). He has demonstrated that morphotypes characterised by single interio-areal apertures represent the megalospheric generation and that those with multiple areal apertures ("with lips which approach each other in several places even to separate the slit into areal openings") are microspheric adults (see also our Fig. 3). The former have a proloculus diameter of 33µ and an overall test diameter of 1.5 - 2 mm (A1 generation) or a proloculus diameter of 46µ and an overall test diameter of 0.8 - 1.6 mm (A2 generation). The latter have a proloculus diameter of 10 - 18µ and an overall test diameter of 2 - 3 mm.

Multiple areal apertures have only been observed in Recent individuals (though this could be a preservational phenomenon or artifact of our sampling). In a few individuals with single elongate apertures the lower lip may be very narrow, giving the impression of an interio-marginal slit. This is also true with the specimen drawn in Brady's (1884) Pl. 34, fig. 7b. A close-up of the aperture reveals the interio-areal position.

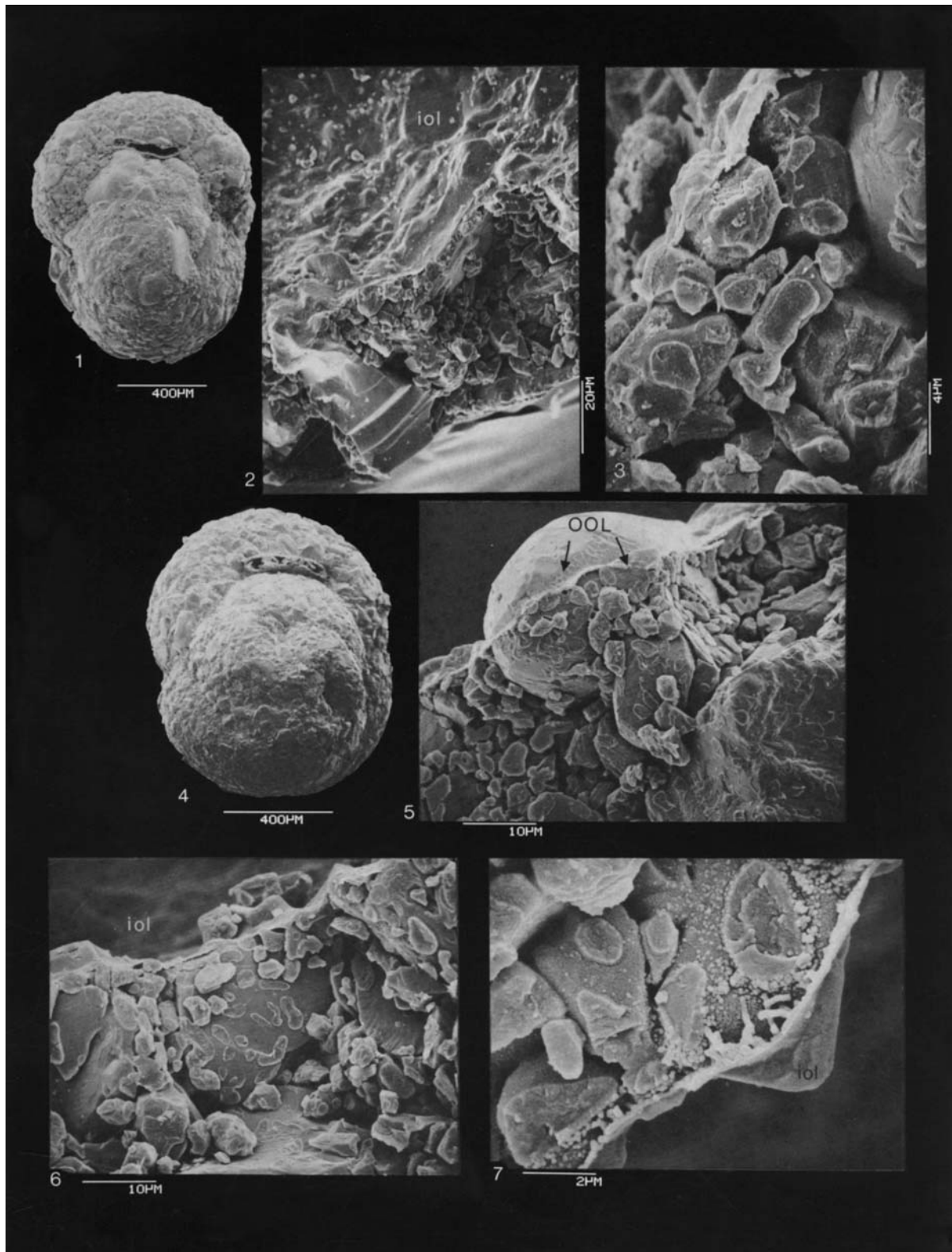
(4) On the wall structure

Both *C. subglobosus* forma *bradyi* (Fig. 4) and forma *subglobosus* (Pl. 3) possess a typically tripartate trochamminacean wall structure with a thick agglutinated layer bounded by inner and outer organic layers. The chamber walls of forma *bradyi* and forma *subglobosus* are several grains thick with coarse quartz and other mineral particles in a fine-grained ground mass. In *C.*

Explanation of Plate 3

Wall structure of *Cribrostomoides subglobosus* forma *subglobosus*. **Fig. 1-3** Norwegian-Greenland Sea, Sample 21697-1 (73°45.1'N/10°28.5' W), 3062 m, **1-** x40; **2-** detail of wall showing inner organic layer (iol), x635; **3-** detail of wall showing undifferentiated organic cement at particle contacts, x3180. **Fig. 4.** Ivory Coast, Sample 16802-1 (4°30.2'N/6°28.0'W), 691 m., x48.

Fig. 5-7 Offshore Ghana, Sample 16838-1A, 4°39.0'N/1°11.0'E, 3736 m. **5-** Cross section of wall showing outer organic layer (OOL), x1270; **6-** Detail of wall showing inner organic layer and undifferentiated organic cement at particle contacts, x1270; **7-** Detail of wall showing inner organic layer with net-like organic cement beneath, x6515.



GENUS	TYPE SPECIES	COILING MODE	APERTURAL CHARACTERISTICS
<i>Cribrostomoides</i> Cushman, 1910	<i>C. bradyi</i> Cushman, 1910 = <i>Haplophragmoides subglobosus</i> Cushman, 1910, O.D.	Involute streptospiral	Interio-areal (megalo.) areal, multiple (micro.)
<i>Cribrostomellus</i> Saidova, 1970	<i>C. apertus</i> Saidova, 1970, O.D.	Evolute streptospiral	Areal, large, multiple, irregular openings
<i>Haplophragmoides</i> Cushman, 1910	<i>Nonionina canariensis</i> d'Orbigny, 1839, O.D.	Involute planispiral	Interio-marginal
<i>Recurvoides</i> Earland, 1934	<i>Recurvoides contortus</i> Earland, 1934, O.D.	Evolute streptospiral	Interio-areal
<i>Conglophragmium</i> Bermúdez & Rivero, 1963	<i>Trochammina conglobata</i> Brady, 1884, = <i>T. coronata</i> Brady, 1879, O.D.	Evolute streptospiral (irregular, inflated)	Interio-marginal
<i>Budashevaella</i> Loeblich & Tappan, 1964	<i>Circus multicameratus</i> Voloshinova & Budasheva 1961, O.D.	Evolute streptospiral (regular, compact)	Interio-marginal
<i>Evolutinella</i> Myatlyuk, 1971	<i>E. subevoluta</i> Nikitina & Myatlyuk, in Myatlyuk, 1971, O.D.	Evolute planispiral	Interio-marginal
<i>Veleroninoides</i> Saidova, 1981	<i>Haplophragmoides veleronis</i> Cushman & McCulloch, 1939, O.D.	Evolute planispiral	Interio-areal
<i>Buzasina</i> Loeblich & Tappan, 1985	<i>Trochammina ringens</i> Brady, 1879, O.D.	Involute planispiral	Interio-areal

Table 1. Criteria for discriminating *Cribrostomoides* from a number of allied genera.

of well-preserved specimens show an inner organic layer as well as a thin outer organic layer (Fig. 4.1b-d; Pl. 3, figs. 2,3, 5-7). In both formae all agglutinated particles are organically enveloped and firmly glued together with organic cement. In the distal parts of the chamber wall the cement is developed as morphologically undifferentiated substance which joins particles at their points of contact Fig. 4.1d, Pl. 3, figs. 3, 5, 6), while in proximal parts of the wall it may have a net-like appearance (Pl. 3, fig. 7). The organic nets are especially found in contact with the inner organic layer, although they may be incomplete in some chamber wall areas.

DESIGNATION OF LECTOTYPE FOR HAPLOPHRAGMOIDES SUBGLOBOSUS CUSHMAN, 1910

The specimen designated as lectotype of *Haplophragmoides subglobosus* Cushman, 1910 (United States National Museum of Natural History [USNM] Registered Number USNM8219b) has been chosen from the original syntypic suite of that species. The specimen (Pl. 1, fig. 1a,b) is from Albatross Station D3603 in the North Pacific (1771fm or 3241m), material from which was certainly available to Cushman at the time he was working on his "Monograph of the Foraminifera of the North Pacific Ocean" (1910). The lectotypification is therefore in accordance with Article 74(a) of the ICZN (Ride *et al.*, 1985), which states that "If a type series contains more than one specimen and a holotype has not been designated, any author may designate one of the syntypes as a lectotype...".

The lectotype is housed in a slide bearing annotations to the effect that it is a "plesiotype" probably representing the

specimen figured as Textfig. 164 on p. 106 of the "North Pacific Monograph" (Cushman, 1910) (a plesiotype is a figured specimen used subsequently to the original description). The lectotypification is therefore also in accordance with Recommendation 74B of the ICZN, which states that "other things being equal, an author who designates a lectotype should give preference to a syntype of which an illustration has been published".

The remaining former syntypes of *H. subglobosus* Cushman, 1910 become paralectotypes in accordance with Article 74a(iv) of the ICZN, which states that "The valid designation of a lectotype permanently deprives all specimens that were formerly syntypes ... of the status of syntype [Art. 73b(ii)]; those species become paralectotypes [Rec. 74F]".

DESIGNATION OF LECTOTYPE FOR CRIBROSTOMOIDES BRADYI CUSHMAN, 1910

The specimen designated as lectotype of *Cribrostomoides bradyi* Cushman, 1910 (hitherto unregistered by the USNM) has also been chosen from the original syntypic suite of that species. The specimen (Fig. 2. 1a,b) is from Albatross Station D3346 in the North Pacific, material from which was certainly available to Cushman at the time he was working on his "North Pacific Monograph" (Cushman, 1910). The lectotypification is therefore in accordance with Article 74(a) of the ICZN (Ride *et al.*, 1985; see also above). The remaining former syntypes of *C. bradyi* Cushman, 1910 become paralectotypes in accordance with Article 74a(iv) of the ICZN.

EMENDED DIAGNOSIS OF THE GENUS CRIBROSTOMOIDES

Cribrostomoides Cushman, 1910, pps. 108-109 [*C. bradyi* Cushman, 1910, pps. 108-109 = *Haplophragmoides subglobosus* Cushman, 1910: 105-106 (herein lectotypified); O.D.] [= *Lituola auctt.*, non Lamarck, 1804; *Haplophragmium auctt.*, non Reuss, 1860; *Haplophragmoides* Cushman, 1910: 99 (*pars*); *Cribrostomoides* Cushman, 1910: 108-109; *Labrospira* Höglund, 1947]. Test free, coiled in an involute streptospire, characterised by a (repeated) alternation in axis (usually of ninety degrees); wall agglutinated, solid, imperforate, consisting of a multiple layer of mineral particles covered by an inner and outer organic lining, cement organic, aperture equatorial or slightly asymmetrically placed, interio-areal and single to areal and multiple, surrounded by lips.

Geographical Distribution

The geographical distribution of *Cribrostomoides* appears to be worldwide based on the following records: Arctic, Brady (1881a,b), Vilks (1969), Jones (1984, MS); Atlantic (including Caribbean and Gulf of Mexico) and borderlands, Brady (1884), Flint (1899), Cushman (1910, 1920), Höglund (1947), Galhano (1963), Leroy & Hodgkinson (1975), Hofker (1976), Pflum & Frerichs (1976), Pearce (1980, MS), Lutze (1980), Cole (1981), Culver & Buzas (1982), Schafer & Cole (1982), Schafer et al. (1983), Jones (1984, MS), Murray & Taplin (1984) (after Carpenter (1868)), Mackensen et al. (1985); Pacific and borderlands, Brady (1884), Cushman (1910), Theyer (1971), Smith (1973), Saidova (1975), Zheng (1988), Zheng and Fu (1988), Mackensen & Douglas (1989); Southern Ocean and Antarctic, Brady (1884), Herb (1971), Anderson (1975), Lindenberg & Auras (1984), Mackensen & Douglas (1989), Mackensen et al. (1990).

The majority of occurrences are either in comparatively shallow (shelf to upper bathyal) depths in high latitudes or comparatively deep (middle bathyal to abyssal) depths in low to moderate latitudes. The inference is that it is a stenothermal, cryophilic genus. Recent evidence suggests that it might be infaunal in habit (Mackensen & Douglas, 1989).

Stratigraphic Range

The stratigraphic range of *Cribrostomoides* appears to extend from the Late Cretaceous to the Recent based on the following records: Late Cretaceous - Early Tertiary, Labrador Sea, Miller et al. (1982); Maastrichtian - Palaeogene, Labrador and North Seas, Gradstein & Berggren (1981); Santonian - Palaeocene, Central North Sea, Charnock & Jones (1990); Late Pleistocene, Denmark Strait, Norwegian-Greenland Sea and Iberian Abyssal Plain, Jones (1984, MS); late Quaternary, Norwegian Sea, Sen Gupta (1984).

TAXONOMIC IMPLICATIONS

Our emendation of *Cribrostomoides* Cushman, 1910 affects the interpretation of its relationship to a number of allied genera. *Cribrostomoides* Cushman, 1910, as emended herein, is distinguished from *Haplophragmoides* Cushman, 1910, emend. Höglund, 1947 and *Evolutinella* Myatlyuk, 1971 on

the basis of its streptospiral rather than planispiral coiling and interio-areal rather than interio-marginal aperture, respectively; from *Recurvoides* Earland, 1934, emend. Uchio, 1960 on the basis of its involute rather than evolute streptospiral coiling and inflated rather than compressed test; from *Conglophragmium* Bermúdez & Rivero, 1963 in its well-formed chambers; from *Martyschiella* Myatlyuk, 1966 and *Thalmanorecurvoides* Sandulescu, 1971 on the basis of its involute rather than evolute streptospiral coiling and interio-areal rather than interio-marginal aperture, respectively; from *Budashevaella* Loeblich & Tappan, 1964 on the basis of its involute rather than evolute streptospiral coiling, interio-areal rather than interio-marginal aperture and inflated rather than compressed test; from *Veleroninoides* Saidova, 1981 on the basis of its involute streptospiral rather than evolute planispiral coiling; from *Cribrostomellus* Saidova, 1970 on the basis of its organic rather than calcareous cement, and from *Buzasina* Loeblich & Tappan, 1985 (and its synonym *Cystamminella* Lukina, 1980, non Myatlyuk, 1966) on the basis of its streptospiral rather than planispiral coiling. Criteria for the discrimination of the aforementioned genera are summarised on Table 1.

Labrospira Höglund, 1947 is automatically a synonym of *Cribrostomoides* Cushman, 1910 because Höglund included the type species of the latter genus in his description of the former. In our opinion, evolute planispiral species with interio-areal apertures previously erroneously included in *Labrospira* Höglund, 1947 should now be transferred to *Veleroninoides* Saidova, 1981. We are currently reviewing the genus *Recurvoidella* Uchio, 1960 partly in order to elucidate the nature of its relationship with *Cribrostomoides* Cushman, 1910.

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