Lectotypes of type species of Agglutinated Foraminiferal Genera in the Collections of the Natural History Museum, London. Part 1. Astrorhizina and Saccamminina

MICHAEL A. KAMINSKI¹, CLAUDIA G. CETEAN² and ANDREW S. HENDERSON³

¹. Department of Earth Sciences, UCL, Gower Street, London, WC1E 6BT, U.K.
². Department of Geology, Babes-Bolyai University, str. Kogalniceanu 1, 400084 Cluj-Napoca, Romania
³. Department of Palaeontology, Natural History Museum, Cromwell Road, London, SW7 5BD, U.K.

ABSTRACT

We herein designate lectotypes for the type species of five genera belonging to the order Astrorhizina and seven genera of the suborder Saccamminina that are housed in the micropalaeontological collections of the Natural History Museum, London. These are the astrorhizids Diffusilina, Marsipella, Psammatoendron, Rhabdamminella, Sagenina and the saccamminids Aggerostramen, Sorosphaera, Cribrothalammina, Saccammina, Iridia, Masonella, and Pilulina. We also report on the status of type specimens (lectotypes and syntypes) of the type species of Halyphysema, Rhabdammina, Hippocrepinella, Schizammina, Technitella, Discobotellina and Thurammina and newly discovered syntypes of the type species of Thuramminopsis housed in the NHM collections.

INTRODUCTION

As part of a larger project to revise and update the Genera of Agglutinated Foraminifera, we have investigated the status of the type specimens of astrorhizid and saccamminid genera housed in the micropalaeontological collections of the Natural History Museum, London. This work is being carried out in order to underpin the generic taxonomy of the agglutinated foraminifera to serve as the basis for future taxonomic studies. As a first step towards the revision of the agglutinated foraminiferan genera, we here establish the status of the "generic types", designating lectotypes and when necessary, neotypes of the type species. Part of the task of lectotypification of generic types has already been accomplished during the taxonomic work for the "Treatise of Invertebrate Paleontology, part C" published by Loeblich & Tappan (1964). Our current goal is to complete the revision and lectotypification of generic types in a systematic manner.

METHODS

A number of classic foraminiferal collections are housed in the micropalaeontological collections of the Natural History Museum, London, including collections of Bowerbank, Norman, Carpenter, Jones, Brady, Heron-Allen & Earland, and Collins. The larger "Brady Collection" is of particular importance because H.B. Brady received syntypic specimens from his collaborators, including G.O. Sars and R. Haeusler. In some cases the original collections have been lost, and we were able to establish lectotypes from among the specimens sent to Brady. We examined these archived microscope slides in order to search for specimens that best fit the original descriptions and illustrations of the described genera. In many cases, we were able to identify the specimens that were illustrated by the original author, or by the first reviser. Specimens were photographed in reflected and transmitted light at the Natural History Museum. Images were produced using an Alicona Infinite Focus Microscope and a Zeiss Axiocam mounted on a Leica MZ16 microscope with Axiovision software.

SYSTEMATIC TAXONOMY

ASTORRHIZINA Lankester, 1885
ASTORRHIZACEA Brady, 1881

DIFFUSILINA Heron-Allen & Earland, 1924
Plate 1, figs 1-3

Type species. Diffusilina humilis Heron-Allen & Earland, 1924. Test attached, irregular in outline, up to 3 mm or more in diameter, flattened, interior with nonseptate ramifying cavity, producing a labyrinthic structure, filled with dark material. Wall agglutinated, consisting of silt grains and sponge spicules, with a floor against the attachment, outer surface smoothly finished. Apertures multiple, consisting of a few
scattered mammilale protuberances on the upper surface of the test, surrounded by raised rims constructed of quartz sand and mud particles similar to the rest of the wall but lacking cement. Holocene.

**Remarks.** Three slides of syntype specimens of *Diffusilina humilis* are housed in the collections of the NHM, London. The figured syntypes are from a sample of beach sand collected in the intertidal zone of Lord Howe Island, South Pacific, and are housed in slide 1955.1.20.23-26. This slide contains four specimens attached to fragments of calcareous algae, three of which are abraded and show the inner part of the chamber. The lectotype, 1955.1.20.26, designated herein, is the specimen illustrated by Heron-Allen & Earland, 1924 in pl. 35, fig. 13. It is the unbroken specimen preserved in the slide. Paralectotypes 1955.1.20.23 and 1955.1.20.24 are also illustrated.

The presence of evenly-spaced apertures in the shape of mammilale protuberances suggest an affinity to the genus *Thurammina*.

**HALYPHYSEMA** Bowerbank, 1862

*Type species.* *Haliphysema tumanowiczii* Bowerbank, 1862.

Test attached, with spreading and internally subdivided basal expansion, and later erect conical, clavate, tubular, or branching chamber. Wall agglutinated, that of basal expansion of finest particles, and may include fragments of sponge spicules, erect portion with sand, tests of other foraminifers, or sponge spicules that are oriented in the direction of test growth. Aperture terminal, rounded, may be obscured by a cluster of sponge spicules surrounding the opening. Pseudopodial network with pronounced granular streaming; multinucleate. Holocene; Atlantic; Caribbean; Pacific.

**Remarks.** The type species of the genus was originally collected “from a sample of beach debris collected near Hastings, England” and described as a sponge. Loeblich (1958) designated a lectotype from the Heron Allen & Earland Collection. This specimen was originally separated out by Heron-Allen & Earland from the Bowerbank Collection, and is preserved in a small box labelled ZF 3652. Numerous paralectotypes are housed in slide 1972.3.29.12, and other material deposited in the NHM by Bowerbank is housed in boxes with the catalogue numbers 1957.2.18.1-4 and 1957.2.18.5-10. The specimens are attached to algae and Bryozoans.

**HIPPOCREPINELLA** Heron-Allen & Earland, 1932

*Type species.* *Hippocrepinella hirudinea* Heron Allen & Earland, 1932

Test free, up to 2 mm in length, irregularly cylindrical, straight to arcuate; wall thin, agglutinated, of very fine sand and mud, poorly cemented and flexible in life, although dried specimens become rigid and fragile, white to dark gray in color, smoothly finished, or may be transversely wrinkled; may have apertures at both ends of the test, one being much smaller than the other. Holocene, at 100 m to 346 m; S. Atlantic.

**Remarks.** The type species was listed by Heron-Allen & Earland (1932) from 14 stations off South Georgia Island, South Atlantic. The lectotype from the Heron Allen & Earland Collection designated by Loeblich & Tappan (1964) is from Discovery Sta. 45, 238-270 m, off West Cumberland Bay, South Georgia Island, and is preserved in slide ZF 3300, alongside several paralectotype specimens that were originally illustrated by Earland (1933). According to Loeblich & Tappan (1987), the much constricted openings possibly expand temporarily for the ingestion of food particles but are closed at gametogenesis. The tiny inequally biflagellate gametes escape from secondarily formed small pores of 15 µm to 20 µm diameter that are scattered over the test surface and then become free swimming.

**MARSIPELLA** Norman, 1878

*Type species.* *Marsipella elongata* Norman, 1878.

Test large, up to 6 mm in length, elongate, fusiform, tubular, cylindrical, or tapering and undivided, may be slightly twisted or sinusoidal. Wall thin, of agglutinated sand, sponge spicules or tests of other foraminifers, firmly cemented. Spicules, when present, are concentrated near the tapering ends of the tube. Apertures at the open ends of the tube. Holocene; cosmopolitan, from 108 m to 3,216 m.

**Remarks.** The lectotype specimen from the Norman Collection (ZF 5172), designated herein, and a single paralectotype specimen (ZF 5173) are from Porcupine Sta. 87 (59°35’N, 9°11’W; 767 fathoms) collected in 1869, and are preserved in the NHM, London (ex slide 1915.4.1.852). Twelve additional metatype specimens from Porcupine Sta. 42, 864 fathoms, are preserved in slide ZF 3300, alongside several paralectotype specimens that were originally illustrated by Earland (1933). According to Loeblich & Tappan (1987), the much constricted openings possibly expand temporarily for the ingestion of food particles but are closed at gametogenesis. The tiny inequally biflagellate gametes escape from secondarily formed small pores of 15 µm to 20 µm diameter that are scattered over the test surface and then become free swimming.

**PSAMMATODENDRON** Norman, in Brady, 1881

*Type species.* *Psammatodendron arborescens* Norman, in Brady, 1881.

Test attached, length about 5 mm, early chamber rounded and inflated as in *Lagenammina* but giving rise to an erect stage with repeatedly bifurcating tubular portion of constant diameter. Wall agglutinated, of compactly cemented fine sand, brownish in color. Apertures consist of irregular openings at the slightly constricted ends of the tubular branch-
es, bordered by slightly thickened lip. Holocene, at 60 m to 700 m: N. and S. Atlantic.

Remarks. Psammatomadron arborescens was first illustrated by Brady (1884, p. 263, textfig. 10) in the Challenger Report. Two slides containing type specimens are preserved in the NHM, London. The specimen illustrated by Brady (1884, pl. 28, figs 12, 13) is from the Norman Collection, collected from a station 20 fathoms deep off Holstenborg, Greenland. Unfortunately this specimen is broken. Three additional well-preserved specimens are preserved in the Brady Collection in slide 1964.2.8.760-762, from a station collected at 50 fathoms depth between Cumbrae and Bute. The specimen in the left-hand side of the slide (1964.2.8.760) is here designated the lectotype. This is the same specimen that was illustrated by Brady (1884) in his textfig. 10.

RHABDAMMINA Carpenter, 1869

Plate 3, fig. 1

Type species. Rhabdammina abyssorum Carpenter, 1869.

Test with two, three, or less commonly four to five, radiating tubes of nearly constant diameter, cavity in central area globular, that of branches narrow, about one-third the diameter of the branches; wall thick, of firmly cemented coarse sand grains, exterior rough but cavity interior smooth; apertures at the open ends of the tubular rays. Holocene, in deep water, from 700 m to 4,800 m; cosmopolitan.

Remarks. M. Sars (1868) listed Rhabdammina abyssorum from a sample collected from 450 fathoms depth off the coast of Norway. However, Sars’s name is nomen nudum, as no description or illustration was given. The authorship of the genus is sometimes listed as ‘M. Sars, 1869’ or as ‘M. Sars, in Carpenter, 1869’; however, the genus was first validly described in the paper published by Carpenter (1869), who listed R. abyssorum as the type species. There is no indication in Carpenter’s paper that he quoted correspondence from Sars, and likewise there are no specimens of Rhabdammina preserved in the Carpenter collection that are from Sars’ locality. All the specimens in the Carpenter collection are from the Porcupine and Lightning dredge stations collected by Carpenter, and should be considered syntypic. Slide 1886.1.16.12 from the Carpenter collection is the only slide containing a single, isolated specimen collected from Porcupine Sta. 47 (540 fathoms, 59°34’N, 7°18’W, NW of Scotland) therefore we designate this four-rayed specimen (1886.1.16.12) as the lectotype for R. abyssorum. Three-rayed paralecotypes specimens from this station are preserved in slide 86.1.16.13, and smaller 4-rayed paralecotypes and one 5-rayed specimen are housed in slide 86.1.16.11. Some of the specimens from this station were illustrated by Brady (1884, pl. 21).

RHABDAMMINELLA de Folin, 1887

Plate 3, figs 3-5

Type species. Rhabdamminella prismagicinososa de Folin, 1887 = Marsipella cylindrica Brady, in Tizard & Murray, 1882. Test an elongate slender tube of constant diameter, may be slightly arcuate, up to 6 mm or 7 mm in length; wall constructed of firmly cemented acicular sponge spicules, aligned parallel to the sides of the test in more or less irregular overlapping tiers; aperture at the open ends of the tube. Holocene, from 278 m to 3,750 m depth; N. and S. Atlantic; North Sea; Caribbean; S. Pacific.

Remarks. Twelve specimens of ‘Marsipella’ cylindrica, including the specimens figured by Brady (1884) are preserved in the Brady Collection in the NHM, London, in slide ZF 1811. The lectotype, ZF 5176 (ex slide ZF 1811) designated herein, is the fourth specimen from the left and corresponds to the specimen figured by Brady (1884, pl. 24, fig. 21). Paralecotypes ZF 5177 and ZF 5178 (both ex slide ZF 1811) are also illustrated.

SAGENINA Chapman, 1900

Plate 4, figs 2-5

Type species. Sagenella frondescens Brady, 1879.

Test attached throughout, consisting of dichotomously or irregularly branching and occasionally anastomosing tubes lying against the substrate. Tubular chamber has a floor, and may decrease in diameter with successive bifurcations. Wall finely agglutinated, brownish in colour. Apertures rounded, constricted, at the tips of each of the tubular branches. Holocene; N. and S. Pacific.

Remarks. Two slides (ZF 2343; and 1959.5.11.364-368) containing 12 syntypes of Sagenella frondescens are preserved in the Brady Collection in the NHM, London. These are both from Challenger Sta. 218A, 16-25 fathoms, Admiralty Islands. The lectotype ZF 5182 (ex slide ZF 2343), designated herein is the fourth specimen from the left and corresponds to the specimen illustrated by Brady (1879, pl. 5, fig. 1) the other remaining specimens are therefore paralecotypes, three of which are illustrated (ZF 5181, ZF 5183, both ex slide ZF 2343 and 1959.5.11.366). Branching is mostly dichotomous, but trichotomous and irregular branching also occurs. In places where the tubes anastomose, they may form pentagonal or hexagonal cells, as in the trace fossil Paleodictyon. The tips of the branches occasionally rise up off the substrate, and possess constricted apertural openings.

SCHIZAMMINA Heron-Allen & Earland, 1929

Plate 3, figs 6-8; Plate 4, fig. 1

Type species. Schizammina labyrinthica Heron-Allen & Earland, 1929
Test free, a nonseptate dichotomously branching tube of large dimensions. Wall thick, finely agglutinated, with interior labyrinthic layer and thin imperforate epidermal layer, with both exterior and interior surface smoothly finished between openings of the labyrinth cavities. Exterior with occasional transverse wrinkles. Apertures at the open ends of the tube. Holocene; Atlantic: off French Equatorial Africa.

Remarks. Three slides containing Schizammina labyrinthica are preserved in the "Discovery" Collection in the NHM. The lectotype ZF 3653 designated by Loeblich & Tappan (1964) and two paralectotype specimens ZF 5179 and ZF 5180 (both ex slide ZF 3653) were collected from Discovery Sta. 279, 58-67 fathoms off "French Equatorial Africa". The specimens are brown in colour, with white tips of the branches. Branching is mostly in a single plane.

SACCAMMINININA Lankester, 1885
PSAMMOSPHAERACEA Haeckel, 1894

AGGEROSTRAMEN Loeblich & Tappan, 1985
Plate 5, figs 1-3
Type species. Psammosphaera rustica Heron-Allen & Earland, 1912, p. 383; OD.
Description. Test in the early stage with a few angular, tetrahedral, or conical chambers attached to other foraminifers, later chambers are less angular and may be rounded or fusiform, and the test may lie free on the substrate, early chambers may be closely appressed and form a straight uniserial series but later are somewhat irregular in arrangement and interconnected by distinct tubular stolons, up to five such stolons may project from an individual chamber and result in an irregularly branching test. Wall consisting largely of a pavement of sponge spicules aligned in parallel groups or with smaller grains of quartz in the interstices, commonly with some long spicules that project beyond the chamber itself and may connect to adjacent chambers or to the substrate. Aperture in the early stage a simple opening, in the later chambers at the end of the stolonlike necks. Holocene; Atlantic; Caribbean.
Remarks. The figured syntypes of Psammosphaera rustica are preserved in the Earland Collection in slide 1957.11.14.272-273. These specimens are from Goldseeker Sta. 145 in the North Sea, 330 m. The 3-chambered syntype illustrated by Heron-Allen & Earland (1912) is preserved in slide 1957.11.14.235. This specimen is from Goldseeker Sta. 228, west of Scotland, 1,600 m, and is here designated the lectotype.

SOROSPHAERA Brady, 1879
Plate 5, figs 4-5
Type species. Sorosphaera confusa Brady, 1879, OD(M).
Description. Test free, a series of subglobular chambers without definite arrangement. Wall agglutinated, of loosely cemented coarse particles. No distinct aperture, but interstitial pores probably allow communication with the exterior. Silurian to Holocene; cosmopolitan.
Remarks. The specimen figured by Brady (1879, pl. 4, fig. 18), 1959.5.11.402 is from Porcupine Sta. 23, 630 fathoms, 56°7’N, 14°19’W off NW Ireland, and is herein designated the lectotype. The specimen figured by Loeblich & Tappan (1964), ZF 2364, is from Porcupine Sta. 47, 540 fathoms, NW of Scotland. The wall of the type specimens is only about two grains thick. Agglutinated particles consist mainly of quartz, but may include calcareous fragments and sponge spicules.

SACCAMMINACEA Brady, 1884

CRIBROTHALAMMINA Goldstein & Barker, 1988
Plate 5, figs 6-9
Type species. Hippocrepinella alba Heron-Allen & Earland, 1932, OD(M).
Description. Test free, finely agglutinated, flexible in living individuals, composed of agglutinated materials, organic cement and an inner organic lining. Test ovoid to fusiform. Aperture single, simple, at end of a short neck, may have an external agglutinated collar. Pores form in a regular array over the entire gamontic test during gametogenesis. Holocene, Georgia USA, South Georgia, California, Scandinavia, marsh to deep water.
Remarks. Five type specimens of Cribrothalammina alba Heron-Allen & Earland are preserved in the Heron-Allen Collection at the NHM, London in slide ZF 3298. The most elongated specimen ZF 5184 in this slide is herein designated the lectotype. Three paralectotype specimens, ZF 5185, ZF 5186 and ZF 5187 (all ex slide ZF 3298) are illustrated. All specimens are from Discovery Sta. WS154, 160 metres off South Georgia. Some of the type specimens show a short apical spine. The genus Cribrothalammina is distinguished by the presence of pores that form a regular array over the entire gamontic test during gametogenesis (Goldstein & Barker, 1988). This feature is not apparent on Heron-Allen’s type specimens. Specimens preserved in balsam in the Heron-Allen Collection from Discovery Sta. 144 clearly show the brown inner organic lining.

DISCOBOTELLINA Collins, 1958
Plate 6, figs 1-3
Type species. Discobotellina biperforata Collins, 1958; OD.
Description. Test discoidal to ellipsoidal, up to 2.3 cm in diameter, with two different forms that may represent alternate generations, one discoidal with
inflated center, the other of more elliptical outline and with two eccentric slotlike perforations through the test that appear to migrate outward with test growth by resorption and regrowth at the margins of the holes. Wall agglutinated, with thick coarse-grained and poorly cemented inner layer and thinner, fine-grained and well-cemented outer layer, imperforate except at periphery. Aperture consists of interstitial spaces at the disk periphery that communicate with the chamber interior. Holocene, at 8 m to 74 m; Australia: Moreton Bay, S. Queensland, and Great Barrier Reef off E. Queensland.

**Remarks.** The holotype of *Discobotellina bipерforata*, 1958.11.7.810, is from Moreton Bay, Queensland, Australia, a station at 4-6 fathoms, and is preserved in the W.J. Parr Collection at the NHM, London. An additional specimen is from a dredge station on Linden Bank, 38 fathoms, collected during the Great Barrier Reef Expedition of 1928/29, and preserved in slide 1958.11.7.811. Sections of *Discobotellina* made by Stephenson (e.g., pl. 6, fig. 3, 1964.10.8.1) reveal that the organism agglutinates well-sorted mineral grains and uses dark (mafic) grains that are concentrated at the test surface. A paratype specimen (1958.11.7.812) is also figured.

**SACCAMMINA** Carpenter, 1869

Plate 7, figs 1-4

**Type species.** *Saccammina sphaerica* Brady, 1871, p. 183; SD Cushman, 1928, p. 72.

**Description.** Test free, a single globular chamber up to 3.5 mm in diameter; wall firm, with inner proteinaceous layer covered by fine agglutinated quartz particles held in an organic cement; aperture rounded, may be nearly flush or produced on a short neck, inner organic wall layer modified in living specimens to an oral apparatus or entosolenian tube around the opening. M. Silurian; USA: Ohio, Oklahoma; to Holocene: N. Atlantic, at 346 m to 2,886 m, off Norway; Ireland; Arctic Ocean, at 178 m to 290 m; N. Pacific, at 4,100 m; Antarctic, at 2,600 m.

**Remarks.** The authorship of the genus is commonly credited to Sars or to "Sars in Carpenter", but both the genus and species names of Sars (1869) were originally *nomina nuda*. The authorship of the genus should be credited to Carpenter (1869), and the type species *S. sphaerica* credited to Brady (1871) as discussed by Loeblich & Tappan (1961, pp. 79-80). Brady received sample material from Prof. G.O. Sars, and two slides with specimens of *S. sphaerica* (labeled "ex coll. G.O. Sars") are preserved in the Brady collection in the NHM. These specimens, some of which were illustrated in the Challenger Report (pl. 18, figs. 11, 13, 15), may be considered syntypes. These specimens are from two localities: "Hardanger Fjord, 400-500 fathoms" (slide 1959.5.11.351-363) and "North Atlantic, deep water" (slide ZF 2340). Specimen ZF 5202 (ex slide ZF 2340), which also corresponds to Brady’s illustration in the Challenger Report (pl. 18, fig. 11) is herein designated the lectotype.

**IRIDIA** Heron-Allen & Earland, 1914

Plate 7, figs 7-11

**Type species.** *Iridia diaphana* Heron-Allen & Earland, 1914; OD.

**Description.** Test attached, a hemispherical, elongated, or irregular chamber with short tubular to branching projections. Wall proteinaceous in early stage of life cycle, later coarsely agglutinated, consisting of a fibrillar lamina propria, formed by endoplasm, and an outer periplanina produced by the ectoplasm and pseudopodia, containing agglutinated particles. Chamber interior is floored by a clear organic sheath. Apertures at the ends of tubular projections. Pseudopodia elongate, bifurcating, and arising from a stomostyle or pseudopodial trunk; during asexual reproduction young embryos become temporarily pelagic and have radiating, nonanastomosing pseudopodia, later the pseudopodia are with drawn, the embryo attaches to the substrate and forms an agglutinated test. During sexual reproduction gametes with two laterally attached unequal flagella unite to form a diploid schizont that is morphologically like the gamont. Holocene; Africa: Kerimba Archipelago; Caribbean; Mediterranean.

**Remarks.** The lectotype of *Iridia diaphana*, ZF 3630, from Station 3 in Mtundo Bay (6 fathoms), Kerimba Archipelago, East Africa is preserved in the collections of the NHM, London. This specimen was designated the lectotype by Loeblich & Tappan, but was not illustrated in their "treatise". Its shape is irregularly stellate, with a wall consisting of a well-sorted mosaic of coarse mineral grains, shell fragments, and tests of other foraminifera. Several additional specimens from the Heron-Allen Collection are in slide 1914.11.4.4. These specimens vary from hemispherical to oval, or irregular. The clear organic sheath that floors the chambers is clearly visible in detached specimens. Four paralectotypes ZF 5188, ZF 5189, ZF 5190 and ZF 5191 (all specimens ex slide 1914.11.4.4) are illustrated here.

**MASONELLA** Brady, 1889

Plate 6, figs 4-5

**Type species.** *Masonella planulata* Brady, 1889; SD Cushman, 1927, p. 188.

**Description.** Test discoidal, compressed, up to 10 mm in diameter; central cavity reflected externally by a swollen area and leads into fine radiating tubules that may bifurcate near the periphery. Wall agglutinated in little cement, of light coloured quartz sand and sponge spicules, Apertures at the open ends of the radial tubules. Holocene, at 500 m to 530 m; Indian Ocean: Bay of Bengal.
Remarks. Brady (1889) originally described two species of Masonella from two different stations in the Bay of Bengal. Two syntype specimens of the type species M. planulata (1955.5.5.891 and 1955.5.5.892) that conform to the type description and illustration are preserved in the Brady Collection in the NHM, London. The lectotype, designated herein, is specimen 1955.5.5.892. Unfortunately the specimen illustrated by Brady (1889, textfig. 1) could not be found. These specimens, preserved in balsam, are from a station north of Sentinel Island, Bay of Bengal, 250 fathoms. The test wall of these specimens between the radiating tubes consists nearly entirely of a mat of fine sponge spicules.

**TECHNITELLA** Norman, 1878

*Type species*. Technitella legumen Norman, 1878; SD Cushman, 1910, p. 47.

**Description.** Test free, elongate, oval, fusiform or cylindrical, up to 3 mm in length. Wall thin, of agglutinated longitudinally aligned sponge spicules and fine quartz grains, or other biogenic particles such as echinoderm plates. Aperture terminal, rounded, constricted, may be slightly produced on a neck or have a thickened border. Oligocene to Holocene; N. and S. Atlantic; Pacific; Antarctic; Europe; South America; Australia.

**Remarks.** The lectotype of Technitella legumen, ZF 3628, designated by Loeblich & Tappan from the Norman Collection is preserved in the NHM, London, in a slide erroneously labelled "holotype". This specimen is from a station 30 miles west of Valenta, 112 fathoms. As noted by Heron-Allen & Earland (1912), the sponge spicules comprising the wall of the type species *T. legumen* are aligned in two layers. Externally, the spicules are aligned longitudinally but internally the spicules are positioned at right angles, forming a "fabric", a feature that is clearly visible in specimens preserved in balsam. This fabric can be seen in a specimen (1957.11.14.650) from the Earland Collection, Goldseeker Haul. 141, 260m, Hilte Fjord, Norway. (Plate 5, Figure 11) Another species of Technitella (*T. thompsoni* Heron-Allen & Earland) has a wall constructed entirely of hexagonal echinoderm plates.

**THURAMMINA** Brady, 1879

*Type species*. Thurammina papillata Brady, 1879; SD Cushman, 1910, p. 571.

**Description.** Test globular to subglobular, with many short conical protuberances. Wall agglutinated, very thin, of a single layer of fine quartz grains, dark brown in colour. Aperture a small opening at the summit of each protuberance, the apertural rim of cement only, without included grains. M. Silurian to Pennsylvanian: USA; Czechoslovakia; Holocene; N. and S. Atlantic, from 218 m to 3,800 m; North Sea; N. and S. Pacific, from 48 m to 6,250 m; Antarctic, to 5,200 m.

**Remarks.** The syntypes in the Brady Collection are preserved in slide ZF 2483. These are from Porcupine Sta. 23, 630 fathoms NW of Ireland. These are the specimens that Heron-Allen & Earland (1917) regarded as "typical" for the species. Five specimens are illustrated herein (ZF 5192, ZF 5193, ZF 5194, ZF 5195 and ZF 5196 all ex slide ZF 2483). We examined the preserved specimens but refrained from selecting a lectotype pending further revision of the genus.

**PILULINA** Carpenter, 1870

*Type species*. Pilulina jeffysii Carpenter, 1875, p. 532; SD(SM).

**Description.** Test free, globular, up to 3.5 mm in diameter; wall relatively thick but flexible, agglutinated of loosely aggregated sand and long sponge spicules felted together in a ground mass of finer sand and broken spicules, surface smoothly finished; aperture an elongate narrow curved or sigmoid slit, elevated on a low ridge. Holocene; N. Atlantic.

**Remarks.** Syntype specimens from the Brady Collection (labelled ex. Carpenter Collection) are preserved in the NHM, London in slides 1958.10.7.728-730 and 1958.5.5.960. These specimens are from Porcupine Station 21, West of Ireland, 1476 fathoms. The specimen 1958.5.5.960 was re-illustrated by Loeblich & Tappan (1964; fig. 112-9) and is here designated the lectotype. Four additional whole and partial specimens from Porcupine Station 28, NW of Ireland, 1215 fathoms, are housed in slide ZF 2089.

**THURAMMINOPSIS** Haeusler, 1883

*Type species*. Thuramminopsis canaliculata Haeusler, 1883; OD(M).

**Description.** Test subsphaerical, cylindrical, or irregular chamber with numerous subglobular to conical protrusions from the surface. The interior surface of the chamber is partially subdivided by raised invaginations of the wall that form a rectangular pattern in larger specimens. Wall agglutinated, thin, imperforate, comprised of fine quartz grains. No definite aperture but large pores are present in the grooves between adjacent papillae. U. Jurassic (Malm); Switzerland; Germany.

**Remarks.** Haeusler (1883) originally described *Thuramminopsis canaliculata* from spongial limestones of the *transversarius* and *bimammatus* zones in Switzerland. Three faunal slides containing specimens are preserved in the Brady Collection in the
Lectotypes of Astrorhizina and Saccaminina in the NHM

Acknowledgements

The revision of agglutinated foraminiferal genera is supported by a consortium of petroleum companies and micropalaeontological consultancies (BP, Saudi Aramco, Shell, Total, PDVSA, RPS Energy, Fugro Robertson Ltd., Petronas). This research received support from the SYNTHESIS Project (www.synthesis.info), which is financed by European Community Research Infrastructure Action under FP6 “Structuring the European Research Area” Programme. We thank Milena Pika-Biolzi (ETH Zurich) for checking the status of Thuramminopsis in the Haeusler Collection, and Clive Jones and John Whittaker (NHM) for reviewing the manuscript. This is contribution nr. 83 of the Deep-Water Agglutinated Foraminiferal Project.

References


Plate 1. 1. Lectotype specimen of *Diffusilina humilis* Heron-Allen & Earland, 1924, from the Heron-Allen & Earland Collection, 1955.1.20.26; maximum width = 2mm. 2–3. Paralectotype specimens of *Diffusilina humilis* Heron-Allen & Earland, 1924, from the Heron-Allen & Earland Collection; 2. 1955.1.20.24, max. width = 1.72 mm. 3. 1955.1.20.23, max. width = 3.6 mm. 4–7. Type specimens of *Halyphysema tumanowiczii* Bowerbank, 1862, from the Bowerbank Collection. 4. Specimens from the Bowerbank collection, from a pillbox labelled 1957.2.18.7; length of complete specimen, bottom left = 0.6 mm. 5. Paralectotypes, from a slide labelled 1972.3.29.12, width across seaweed = 2 mm. 6. Lectotype designated by Loeblich (1958), in a small box labelled ZF 3652; L = 1.04 mm. 7. A loose paralectotype in slide 1972.3.29.12, L = 1.1 mm. 8. Lectotype specimen of *Hippocrepinella hirudinea* Heron-Allen & Earland, 1932, from the Heron-Allen & Earland Collection, slide ZF 3300; L=3.0 mm. 9–13. Paralectotype specimens of *Hippocrepinella hirudinea* Heron-Allen & Earland, 1932, from the Heron-Allen & Earland Collection, slide ZF 3300. 9–11. Lateral views, 9=2.06 mm. 10=2.10 mm. 11= 1.94 mm. 12,13. Apertural views; 12. W= 0.44 mm, 13. W=0.28 mm.
Plate 2. 1. Lectotype of *Marsipella elongata* Norman, 1878, from the Norman Collection, ZF 5172, ex slide 1915.4.1.852; L= 2.8 mm. 2. Paralectotype specimen of *Marsipella elongata* Norman, 1878, from the Norman Collection, ZF 5173, ex slide 1915.4.1.852; L=3.1 mm. 3–4. Metatype specimens of *Marsipella elongata* Norman, 1878, from the Norman Collection, ex slide 1915.4.1.849; 3. ZF 5174, L= 3.3 mm. 4. ZF 5175, L= 2.4 mm. 5–7. *Psammatodendron arborescens* Norman in Brady, 1881, from the Brady Collection, slide 1964.2.8.760-762. 5–6. 1964.2.8.762 and 1964.2.8.761 paralectotype specimens, scale bars = 1mm. 7. Lectotype, 1964.2.8.760, scale bar = 1 mm.
Plate 3. 1. Lectotype of *Rhabdammina abyssorum* Carpenter, 1869, from the Carpenter Collection, 86.1.16.12; scale bar = 2 mm. 2. Paralectotype of *Rhabdammina abyssorum* Carpenter, 1869, from the Carpenter Collection, ZF 5201 ex slide 86.1.16.13; scale bar = 2 mm. 3. Lectotype specimen (ZF 5176) of *Rhabdamminella cylindrica* Brady, in Tizard & Murray, 1882, from the Brady Collection, ex slide ZF 1811; L= 5.4 mm. 4–5. Paralectotype specimens of *Rhabdamminella cylindrica* Brady, in Tizard & Murray, 1882, from the Brady Collection, ex slide ZF 1811; 4. ZF 5177, L= 2.5 mm. 5. ZF 5178, L= 3.6 mm. 6. Lectotype of *Schizammina labyrinthica* Heron-Allen & Earland, 1929, from the Heron-Allen & Earland Collection, ZF 3653. 7–8. Paralectotype specimens of *Schizammina labyrinthica* Heron-Allen & Earland, 1929, ex slide ZF 3653, (6, ZF 5179; 7, ZF 5180), scale bar = 5 mm.
Plate 4. 1. Detail of lectotype of *Schizammina labyrinthica* Heron Allen & Earland, 1929, ZF 3653. 2. Paralectotype specimen (ZF 5181) of *Sagenina frondescens* (Brady, 1879), from Brady Collection, ex slide ZF 2343. 3–4. Lectotype (ZF 5182) of *Sagenina frondescens* (Brady, 1879), from Brady Collection, ex slide ZF 2343. 3. Detail. 4. Whole specimen. 5–6. Paralectotype specimens of *Sagenina frondescens* (Brady, 1879), from Brady Collection. 5. ZF 5183 ex slide ZF 2343, 6. 1959.5.11.366. All scale bars = 1.00 mm.
Plate 5. 1. Lectotype of *Aggerostamen rustica* (Heron-Allen & Earland, 1912), 1957.11.14.235, preserved in Canada balsam; scale bar = 250 µm. 2–3. Paralectotype specimens of *Aggerostamen rustica* (Heron-Allen & Earland, 1912); 2. 1957.11.14.272, scale bar = 237 µm; 3. 1957.11.14.273 scale bar = 246 µm. 4. Lectotype of *Sorosphaera confusa* Brady, 1879, from Brady Collection, 1959.5.11.402, Scale bar = 671 µm. 5. Metatype specimen of *Sorosphaera confusa* Brady, 1879, from Brady Collection, ZF 2364, Scale bar = 346 µm. 6. Lectotype of *Cribrothalammina alba* (Heron-Allen & Earland, 1932), ZF 5184 (ex ZF 3298) from Heron-Allen & Earland Collection, Scale bar = 253 µm. 7–9. Paralectotype specimens of *Cribrothalammina alba* (Heron-Allen & Earland, 1932), from Heron-Allen & Earland Collection, all ex slide ZF 3298; 7. ZF 5185, scale bar = 250 µm; 8. ZF 5186, scale bar = 248 µm; 9. ZF 5187, scale bar = 243 µm. 10. Lectotype of *Technitella legumen* Norman, 1878, from Norman Collection, ZF 3628 (slide labeled “Holotype”), Scale bar = 241 µm. 11. Specimen of *Technitella legumen* from Earland Collection, preserved in Canada balsam, slide 1957.11.14.650, scale bar = 294 µm.
Plate 6. 1. Holotype specimen of *Discobotellina biperforata* Collins, 1958, W.J. Parr collection at the NHM, Moreton Bay, Queensland, 4-6 fathoms, 1958.11.7.810, Scale bar = 6.34 mm. 2. Paratype specimen of *Discobotellina biperforata* Collins, 1958, W.J. Parr collection at the NHM, 1958.11.7.812, Scale bar = 2.5 mm. 3. Topotype specimen of *Discobotellina biperforata* Collins, 1958, Stevenson collection at the NHM, equatorial section of partial test preserved in Canada balsam, 1964.10.8.1, Scale bar = 2.5 mm. 4. Paralectotype specimen of *Masonella planulata* Brady, 1889, from Brady Collection, 1955.5.5.891, Scale bar = 1 mm. 5. Lectotype specimen of *Masonella planulata* Brady, 1889, from Brady Collection, 1955.5.5.892, Scale bar = 1 mm.
Plate 7. 1–4. Syntype specimens of *Saccammina sphaerica* Brady, 1871, from Brady Collection (ex. Collection of G.O. Sars), 1. Lectotype, ZF 5202 ex slide ZF 2340, Scale bar = 500 µm, 2. Paralectotype, ZF 5203 ex slide ZF 2340, Scale bar = 500 µm, 3. Metatype, 1959.5.11.351, Scale bar = 442 µm, 4. Metatype, 1959.5.11.352, Scale bar = 488 µm. 5. Lectotype of *Pilulina jeffeysii* Carpenter, 1875, from Brady Collection (ex. Collection of P.H. Carpenter), 1958.5.5.960, Scale bar = 537 µm. 6. Paralectotype specimen of *Pilulina jeffeysii* Carpenter, 1875, 1958.10.7.728, Scale bar = 627 µm. 7. Lectotype of *Iridia diaphana* Heron-Allen & Earland, 1914, from Heron-Allen & Earland Collection, ZF 3630, Scale bar = 429 µm. 8–11. Paralectotype specimens of *Iridia diaphana* Heron-Allen & Earland, 1914, all specimens ex slide 1914.11.4.4; 8. ZF 5188, Scale bar = 125 µm, 9. ZF 5189, Scale bar = 516 µm, 10. ZF 5190, Scale bar = 564 µm, 11. ZF 5191, Scale bar = 300 µm.
Plate 8. 1–5. Paralectotype specimens of *Thurammina papillata* Brady, 1879, from Brady Collection, all specimens ex slide ZF 2483. 1. ZF 5192, Scale bar = 233 µm. 2. ZF 5193, Scale bar = 241 µm; 3. ZF 5194, Scale bar = 238 µm; 4. ZF 5195, Scale bar = 227 µm; 5. ZF 5196, Scale bar = 170 µm. 6–9. Syntype specimens of *Thuraminopsis canaliculata* Haeusler, 1883, from Brady collection (ex Haeusler Collection). 6. ZF 5197, Scale bar = 125 µm; 7. ZF 5198, Scale bar = 125 µm; 8. ZF 5199, Scale bar = 125 µm; 9. ZF 5200, Scale bar = 112 µm.