

# UPPER DEVONIAN FORAMINIFERA FROM WESTERN AUSTRALIA

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ABSTRACT. Eight new species of arenaceous foraminifera are described from the Upper Devonian of the Pillara Range and Bugle Gap areas, Fitzroy Basin, Western Australia, giving the first record of authentic Devonian foraminifera in Australia. The species are *Rhabdammina virgata*, *Saccamina glenisteri*, *Sorosphaera adhaerens*, *Lagenammina ampullacea*, *Colonammina imparilis*, *Hyperammina devoniana*, *Tolypammina helina*, and *T. nexuosa*.

## INTRODUCTION

WHILE investigating the conodont fauna of the Devonian of Western Australia, Dr. B. F. Glenister of the University of Western Australia treated many limestones from the Upper Devonian of the Pillara Range and Bugle Gap areas, Fitzroy Basin, with weak acetic acid. The insoluble residues from these limestones contained not only abundant assemblages of conodonts but also numerous well-preserved radiolaria and arenaceous foraminifera. This discovery of authentic Devonian foraminifera in Australia was briefly recorded by Glenister and Crespin (1959).

Little literature is available on Devonian foraminifera. Good illustrations are scarce and at times it is difficult to study some of the described forms even generically. However, several Ordovician and Silurian foraminifera have been described and some of the figures are helpful at least generically. Workers on Devonian foraminifera include Miller and Carmer (1933), Bartenstein (1937), Rauzer-Chernousova (1938), Ireland (1939), Cushman and Stainbrook (1943), Stewart and Lampe (1947), Pokorný (1951), and Summerson (1958). Several papers on Devonian foraminifera of the U.S.S.R. are known to have been published and recently the writer received three of them from Dr. Bukova (1952, 1955, 1958).

In 1918 Chapman described and figured three genera and five species of what he considered to be foraminifera from thin sections of a limestone of Devonian age from the Nemingha area, Tamworth, northern New South Wales. However, Wood (1957) stated that these forms were 'oolite grains more or less affected by dolomitization and by mechanical distortion'. Parr (*in* Teichert and Talent 1958) reported poorly preserved arenaceous foraminifera from Devonian rocks in the Buchan area, east Gippsland, Victoria.

Eight new species and two unidentified species of foraminifera from the Upper Devonian of Western Australia are described in this paper. The tests of all forms are characterized by delicate wall structure and many are incomplete because of this. It is interesting to note the similarity of this assemblage from the Devonian with species described from the Silurian overseas.

All species described herein are housed in the Commonwealth Palaeontological Collection at Canberra, Australia.

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*Stratigraphical notes.* The stratigraphy of the Fitzroy Basin has been discussed at length by McWhae, Playford, Lindner, Glenister, and Balme (1958) and by Guppy, Lindner, Rattigan, and Casey (1958). The Devonian succession in the Pillara Range and Bugle



TEXT-FIG. 1. Locality map.

Gap areas, in which the present microfauna was found, was briefly mentioned by Glenister and Crespin (1959) and is included here.

<i>Epoch</i>	<i>Age</i>	<i>Pillara Range area</i>	<i>Bugle Gap area</i>
<i>Lower Permian</i>	<i>Sakmarian</i>	<i>Grant Formation</i>	<i>Grant Formation</i>
Upper Devonian	Famennian	Fairfield Beds	Fairfield Beds Bugle Gap Limestone
	Frasnian	Virgin Hills Formation Gogo Formation Sadler Formation Pillara Formation	Virgin Hills Formation Gogo Formation Sadler Formation Pillara Formation
Middle Devonian	Givetian		
		Precambrian	Ordovician

The localities from which the samples containing foraminifera were collected (see text-fig. 1) are:

1. Section at south-east end of Bugle Gap,  $18^{\circ} 44\frac{1}{2}'$  S.,  $126^{\circ} 05'$  E. This section probably starts in the Gogo Formation (0–22 feet) and continues in the Virgin Hills Formation.
2. Two hundred yards south of section 1, and an approximate continuation of it (Virgin Hills Formation).
3. Between Margaret River and Needle Eye Rocks. Base of section at  $18^{\circ} 16'$  S.,  $125^{\circ} 51'$  E. and top at  $18^{\circ} 16'$  S.,  $125^{\circ} 52'$  E. (Virgin Hills Formation).

*Notes on some of the Palaeozoic arenaceous genera.* The foraminifera so far found in the Ordovician, Silurian, and Devonian are all of the arenaceous type. All the forms from the Upper Devonian of Western Australia have delicate walls composed of medium to fine, angular quartz grains. Many previously described species have been referred to genera described from Recent material, such as *Bathysiphon*, *Hyperammina*, *Lagenammina*, *Psammospaera*, *Rhabdammina*, *Saccammina*, *Sorosphaera*, *Thurammina*, and *Webbinella*. Genera described from the Ordovician, Silurian, and Devonian include *Colonammina* Moreman (1930), *Arenosiphon* Grubbs (1939), *Ceratammina* Ireland (1939), *Fairiella* Summerson (1958), *Kerionammina* Moreman (1933), *Kettnerammina* Pokorný (1951), *Bifurcammina* Ireland (1939), *Moravammina* Pokorný (1951), *Sorosphaeroidea* Stewart and Lampe (1947), *Steganammina* Moreman (1930), *Webbinelloidea* Stewart and Lampe (1947), *Wiekkoella* Summerson (1958), and *Vašičekia* Pokorný (1951), and several others by Bukova (1952, 1955).

It is unfortunate that many genera and species of foraminifera described and figured from the Ordovician, Silurian, and Devonian are difficult to study. This is especially the case with regard to the Recent genus *Sorosphaera* Brady 1879, of which several species are described from older rocks, and the Devonian genus *Sorosphaeroidea* Stewart and Lampe 1947. Species of both these polythalamous genera are figured by Stewart and Lampe (1947, pl. 78) and the difference between them is difficult to detect. They indicate that in *Sorosphaeroidea* the chambers are more intimately joined and are arranged more nearly in a plane than in *Sorosphaera*. Neither of these features seems consistent enough in the many specimens available for study in the Western Australian material to justify their reference to *Sorosphaeroidea* rather than *Sorosphaera*. Summerson (1958) uses the genus *Sorosphaeroidea* for his Middle Devonian specimens and described two species of the genus. However, the variation within a species as shown by the Western Australian specimens suggests that these two species may be synonymous.

I am in agreement with Grubbs (1939, p. 544) who, when discussing his species *Sorosphaera irregularis*, stated that 'several species have been erected on which the determination apparently was based on the number of cells, but from the material at hand, it is evident that a rupture of some of the composite individuals would obviously produce several new ones having variable numbers of chambers. Thus a specific description would possibly apply to only a single individual. Forms of such variable attributes are here grouped into one species.' Gutschick and Treckman (1959, p. 232), discussing their Pennsylvanian species *Sorosphaera papilla*, express agreement with Grubbs and add that 'it seems superfluous to attempt to split this form into several species based on material in the collection'. The variation within *Sorosphaera adhaerens* sp. nov. is illustrated on Pl. 66.

Some of the specimens from the Ordovician, Silurian, and Devonian referred to the

genus *Bathysiphon* Sars 1878 require generic revision. Cushman (1950), Galloway (1933), and Glaessner (1945) refer to Sars's definition of *Bathysiphon* as having a thick wall and being typically composed of broken sponge spicules overlain by fine-grained arenaceous material. Grubbs (1939) introduced a new genus *Arenosiphon* for a cylindrical, commonly tapering test composed of quartz grains of nearly uniform size and with apertures at either end of the test. He considered that several small Silurian forms previously referred to *Bathysiphon* should be included in this genus. Ireland (1939), in describing his species *Bathysiphon rugosus* from the Silurian of Oklahoma, states that the wall is composed of well-cemented medium-sized sand grains and continues 'the rough exterior of this form and the large size of the sand grains show it (*B. rugosus*) to be different from all other described species of *Bathysiphon*'.

It is most probable that these specimens with walls composed of angular quartz grains and included under *Bathysiphon* and *Arenosiphon* should be included in the genus *Rhabdammina* Sars 1869. Species of this genus have been described from the Ordovician and Silurian. The chitinous inner layer of the tests and the outer wall of sand grains suggest that the specimens from the Virgin Hills Formation belong to the family Astorhizidae and are most probably referable to the genus *Rhabdammina* rather than to *Bathysiphon* as suggested in Glenister and Crespin (1959). Ireland's Silurian species *Bathysiphon rugosus* referred to in the previous paragraph closely resembles Glaessner's Paleocene species *Rhabdammina cylindrica*.

Specimens referable to the genus *Colonammina* Moreman 1930, a small attached *Lagenammina*-like form from the Silurian of Oklahoma, have been recognized in the assemblage from the Virgin Hills Formation.

Future investigations on the wall structure of numerous specimens from the Ordovician, Silurian, and Devonian may prove that these early primitive forms now referred to Recent genera are generically distinct from the Recent ones, and that some of the names now erected for them are valid. However, extensive collections are necessary for such work. The present work is based on a small collection only.

#### SYSTEMATIC DESCRIPTIONS

##### Family ASTORRHIZIDAE

##### Genus RHABDAMMINA M. Sars 1869

##### *Rhabdammina virgata* sp. nov.

Plate 64, figs. 7-10; Plate 65, figs. 1, 2

*Occurrence.* Holotype (C.P.C. No. 394) and paratypes B and C (C.P.C. Nos. 396, 397) from locality between Margaret River and Needle Eye Rocks, Virgin Hills Formation. Paratypes A, D, and E (C.P.C. Nos. 395, 398, 399) from section south-east end of Bugle Gap, 44-66 feet above base, Virgin Hills Formation.

*Dimensions.* Length of tube—holotype, 1.51 mm.; paratype A, 1.03 mm.; paratype B, 2.60 mm.; paratype C, 1.63 mm.; paratype D, 0.97 mm.; paratype E, 1.16 mm. Width of inner chitinous tube of paratype A, 0.11 mm.

*Diagnosis.* This species has a free, elongate tube which may be curved, sinuous, straight, or tapering, and with apertures at both ends of the tube. The outer wall is thin and com-

posed of angular quartz grains of varying sizes, giving a rough surface; the inner wall is a thin chitinous layer.

*Holotype.* Test free, an elongate tube, slightly curved, chiefly uniform in width but with occasional constrictions. Wall thin, composed of medium and fine angular quartz grains, finely cemented. Surface rough. Inner wall smooth, composed of thin chitinous material. Apertures at both ends of test.

*Paratype A.* Specimen with portion of outer wall of quartz grains in siliceous cement removed and exposing the thin, smooth, chitinous inner layer.

*Paratype B.* Specimen long, showing sinuous character of tube, outer surface rough with wall composed of moderately large quartz grains; chitinous inner wall showing at one end of tube.

*Paratype C.* Similar to holotype.

*Paratype D.* Tube coiled in early portion then becoming almost erect. Surface rough with several large quartz grains in cement.

*Paratype E.* Tube tapering rather rapidly, with smooth chitinous layer of inner wall showing at one end.

*Observations.* *R. virgata* is one of the commonest species in the Virgin Hills Formation assemblage, being especially numerous in the residue from the locality between Margaret River and Needle Eye Rocks. All specimens from this locality are white in colour; at the south-east end of Bugle Gap they are brown with considerable limonitic replacement. Comments on the genus *Rhabdammina* are given in the previous section. The species name is taken from the Latin *virgatus*—rodlike.

Family RHIZAMMINIDAE

Genus MARSIPELLA Norman 1878

*Marsipella* sp.

Plate 65, fig. 9

*Occurrence.* Figured specimen (C.P.C. No. 400) from section between Margaret River and Needle Eye Rocks, Virgin Hills Formation.

*Dimensions.* Length of figured specimen, 0.49 mm.

*Observations.* A fragment of an elongate tubular test with an outer wall composed of coarse, angular, quartz grains and an inner one with a roughened surface suggests the genus *Marsipella*. The present specimen closely resembles *M. aggregata* Moreman (1933) from the Silurian of Oklahoma.

Family SACCAMMINIDAE

Genus SACCAMMINA M. Sars 1869

*Saccamina glenisteri* sp. nov.

Plate 65, figs. 3-7

*Occurrence.* Holotype (C.P.C. No. 401) and paratypes A and B (C.P.C. Nos. 402, 403) from south-east end of Bugle Gap, 66-88 feet above base of section, Virgin Hills Formation. Paratype D (C.P.C.

No. 405) from same locality as above but 0–22 feet above base of section and probably Gogo Formation. Paratype C (C.P.C. No. 404) section between Margaret River and Needle Eye Rocks, Virgin Hills Formation.

*Dimensions.* Maximum width of holotype, 0.37 mm.; paratype A, 0.39 mm.; paratype B, 0.42 mm.; paratype C, 0.34 mm. Thickness of wall of paratype C, 0.04 mm.

*Diagnosis.* This species has a small, more or less sphaerical test, usually free but occasionally lightly attached, and composed of small angular quartz grains cemented together. An apertural opening is usually present.

*Holotype.* Test free, almost sphaerical, small. Wall thin, composed of medium to small angular quartz grains in fine siliceous cement. Surface rough. Aperture a small elongated slit-like opening in centre of test.

*Paratype A.* Test less regularly sphaeroidal in shape than holotype. Surface rough but grains more even in size. Aperture elongate and slightly more open than in holotype.

*Paratype B.* Test irregularly sphaeroidal with rough surface as angular edges of quartz grains protrude from cement. Wall thin. Aperture circular.

*Paratype C.* Test broken showing hollow central cavity, thin wall of test and roughened inner wall.

*Paratype D.* Two sphaeroidal tests gently attached to fragment of *Rhabdammina*.

*Observations.* Some species of *Saccamina* described from the Ordovician, Silurian, and Devonian have apertural openings at the end of a slightly protruding neck but this feature is not essential to the determination of the genus. The present species, *S. glenisteri*, has a small aperture which may be slit-like or rounded and it does not protrude beyond the surface of the test. *S. ingloria* Bukova (1952) from the Devonian of the Ural region resembles *S. glenisteri* in the composition of the wall which is made up of angular quartz grains closely cemented, the angular grains also forming a rough surface to the inner wall. It differs, however, in its short neck for the apertural opening.

The species is named after Dr. B. F. Glenister who discovered the present microfauna in the Upper Devonian rocks of Western Australia.

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EXPLANATION OF PLATE 64

Figs. 1–6. *Hyperammina devoniana* sp. nov. 1, Holotype. Showing globular proloculus and long, narrow, tubular second chamber. 2, Paratype A. Large globular proloculus followed by delicate tubular second chamber. 3, Paratype E. Showing thin wall of sinuous tubular second chamber. 4, Paratype B. Globular proloculus followed by tubular second chamber gradually decreasing in size. 5, Paratype D. Showing globular proloculus and sinuous tubular second chamber. 6, Paratype C. Showing proloculus followed by straight tubular second chamber.

Figs. 7–10. *Rhabdammina virgata* sp. nov. 7, Holotype. Showing openings at either end of tube, rough outer surface and inner chitinous wall. 8, Paratype B. Showing sinuous character of tube. 9, Paratype E. Showing rapidly tapering test with smooth chitinous inner wall. 10, Paratype A. Portion of outer wall removed to show smooth chitinous inner layer.

All figures  $\times 92$

Genus *SOROSPHAERA* Brady 1879*Sorosphaera adhaerens* sp. nov.

Plate 66, figs. 1-6

*Occurrence.* Holotype (C.P.C. No. 406) and paratypes A, B, C, and D (C.P.C. Nos. 407, 408, 409, 410) from section south-east end of Bugle Gap, Virgin Hills Formation, between 66 and 88 feet above base of section.

*Dimensions.* Average width of chamber—holotype, 0.37 mm.; paratype A, 0.28 mm.; paratype B 0.34 mm.; paratype C, 0.30 mm.; paratype D, 0.47 mm.

*Diagnosis.* Test arenaceous consisting of an aggregate of two or more chambers intimately attached to one another around a central chamber or in linear arrangement. The chambers are rounded on dorsal surface, flattened on ventral side indicating attachment. The wall is thin and the aperture, when observed, is central.

*Holotype.* Test arenaceous, medium sized, consisting of an aggregate of eight chambers attached in irregular linear arrangement along a fragment of *Tolypammina*. Each chamber rounded on dorsal surface and flattened on ventral one. Chambers almost uniform in size and firmly attached to one another, line of attachment being slightly polygonal in outline. Wall thin, composed of quartz grains which are large for size of chamber and set in fine siliceous cement. Surface rough. Aperture a minute rounded opening in centre of rounded portion of chamber, the area around this opening slightly constricted in one of the chambers.

*Paratype A.* Test consisting of six chambers arranged in branching fashion, all strongly attached to one another. Two attached chambers in stem and two in each branch. Wall composed of coarse quartz grains with little visible cement. Surface very rough. Aperture observed in only one chamber.

*Paratype B.* Test consisting of three rounded chambers attached to one another in a linear direction, with suggested polygonal outline at point of attachment and flattened on lower surface. Dorsal surface very rough, wall on both surfaces composed of coarse, angular, quartz grains. Minute aperture present in middle chamber, close to line of attachment between chambers.

*Paratype C.* Test consisting of two chambers strongly attached to one another and also attached to fragment of *Tolypammina*. Aperture in one chamber near line of attachment, and in second chamber it appears as an opening in short neck composed of quartz grains.

*Paratype D.* Single chamber strongly attached to fragment of *Tolypammina*. Wall thin, composed of coarse quartz grains. Aperture almost rounded opening.

*Observations.* Many moderately well-preserved specimens of *Sorosphaera adhaerens* were available for study in one sample and it seems certain that the variation in the number of chambers present in the different specimens is comparable with the habit of growth of other polythalamous foraminifera. The persistent uniformity of composition of the chambers' walls, which includes the size of the component quartz grains, and the persistent delicate wall structure indicate that the variation in the number of chambers is all within the one species.

*S. adhaerens* shows some similarity with *S. pentachora* and *S. trichora* of Summerson (1958) from the Middle Devonian of Ohio, in the shape of the chambers and the pentagonal lines of attachment of chambers. However, in the Western Australian form the chambers appear to be more intimately attached.

Genus PROTEONINA Williamson 1858

*Proteonina* sp.

Plate 65, fig. 8

*Occurrence.* Figured specimen (C.P.C. No. 411) from south-east end of Bugle Gap, between 0–22 feet above base of section, probably Gogo Formation.

*Dimensions.* Maximum width of figured specimen, 0.43 mm.; length, 0.58 mm.

*Observations.* The test of this form is very compressed, with a short apertural neck situated to one side of the test. The wall is coarsely arenaceous and the aperture is at the end of a compressed tubular neck. Only one specimen has been found. Its shape resembles that of *P. pseudospiralis* Cushman and Stainbrook (1943) from the Devonian of Iowa.

Genus LAGENAMMINA Rhumbler 1911

*Lagenammina ampullacea* sp. nov.

Plate 66, figs. 6–8

*Occurrence.* Holotype (C.P.C. No. 412) and paratypes A and B (C.P.C. Nos. 413, 414) from section south-east of Bugle Gap, 66–88 feet above base of section, Virgin Hills Formation.

*Dimensions.* Length of test, including neck—holotype, 0.44 mm.; paratype A, 0.41 mm.; paratype B, 0.49 mm. Maximum diameter of holotype, 0.41 mm.; paratype A, 0.35 mm.; paratype B, 0.37 mm.

*Diagnosis.* The species is almost spherical in shape with a short protruding neck. The

EXPLANATION OF PLATE 65

Figs. 1, 2. *Rhabdammina virgata* sp. nov. 1, Paratype C. Showing openings at both ends of slightly curved tubular chamber. 2, Paratype D. Early portion of tubular chamber coiled, later being almost straight.

Figs. 3–7. *Saccammina glenisteri* sp. nov. 3, Holotype. Almost spherical test showing slit-like aperture. 4, Paratype C. Test broken to show thin wall and central cavity. 5, Paratype A. Showing rough surface of test. 6, Paratype B. Irregular-shaped test attached to fragment of *Rhabdammina*. 7, Paratype D. Two spherical tests attached to fragment of *Rhabdammina*.

Fig. 8. *Proteonina* sp. Showing compressed test with short apertural neck.

Fig. 9. *Marsipella* sp. Broken specimen showing roughened surface of inner wall.

Figs. 10–13. *Colonammina imparilis* sp. nov. 10, Holotype. Showing roughened surface of unattached surface and groove with smooth surface indicating area of attachment. 11, Paratype B. Showing smooth flat area of attachment. 12, Paratype A. Area of attachment flattened and smooth, and protruding neck of horny material. 13, Paratype C. Area of attachment near lower portion of test.

All figures  $\times 92$



wall is moderately thin and composed of angular quartz grains. The surface is rough. The aperture is circular at the end of the neck.

*Holotype.* Test free, almost sphaerical in shape with a short protruding neck. Wall moderately thin, composed of quartz grains of varying sizes in a siliceous cement. Surface rough. Aperture circular at the end of short neck.

*Paratype A.* Test irregularly sphaerical, with surface rougher than holotype.

*Paratype B.* Test with neck incomplete, but measuring at least a third of the length of the entire test; coarse quartz grains in wall of neck.

*Observations.* *L. ampullacea* appears to be the first record of the genus *Lagenammina* in the Devonian. Several species have been described from the Silurian. *L. ampullacea* differs from the two species *L. sphaerica* and *L. cucurbita* described by Moreman (1930; 1933) from the Silurian of Oklahoma, in its shorter neck; this character, however, shows some resemblance to *L. bulbosa* Dunn (1942) and *L. cornuta* Grubbs (1939), both from the Silurian.

The species name is derived from the Latin *ampullaceus*, flask-like.

#### Genus COLONAMMINA Moreman 1930

##### *Colonammina imparilis* sp. nov.

Plate 65, figs. 10-13

*Occurrence.* Holotype (C.P.C. No. 415) and paratypes A, B, and C (C.P.C. Nos. 416, 417, 418) from section south-east end of Bugle Gap, 66-88 feet above base of section, Virgin Hills Formation.

*Dimensions.* Length of test including neck—holotype, 0.57 mm.; paratype A, 0.43 mm.; paratype B, 0.50 mm.; paratype C, 0.45 mm. Maximum width of holotype, 0.50 mm.

*Diagnosis.* The test is attached and is irregularly sphaerical in shape on the unattached side. It has a protruding neck on the convex surface and the wall is composed of well-cemented angular quartz grains.

*Holotype.* Test attached, medium sized, subsphaerical with a protruding erect neck. Wall moderately thin, composed of medium to fine angular quartz grains well cemented. Surface rough. On one side of test immediately below neck where it protrudes from the rounded test is a groove indicating attachment. This groove reveals a wall of fine siliceous material. The neck is composed of chitinous material. Aperture is a small rounded opening at end of the neck.

*Paratype A.* Test smaller than holotype and more irregular in shape and with a long, protruding, erect neck of horny material. Area of attachment flattened and smooth. Wall of convex surface thinner than holotype and composed of angular quartz grains.

*Paratype B.* Test irregular in shape, somewhat flattened on one side. Wall thin composed of quartz grains of varying sizes which also cover the protruding neck. Neck slightly curved.

*Paratype C.* Test almost sphaerical, but with smooth area of attachment on one side of lower portion of test. Neck protruding, erect, composed of chitinous material.

*Observations.* Several specimens of *Colonammina imparilis* are present at the type locality. All show variation in shape and position of area of attachment and the protruding neck composed of horny-like material. This genus was originally described by Moreman (1930) from the Silurian of Oklahoma. Although Moreman has described two species, *C. verruca* and *C. conea*, the variation in shape found in the specimens from Western Australia suggests that probably these should be referred to one species only.

The specific name is derived from the Latin *imparilis*, unequal.

Family HYPERAMMINIDAE

Genus HYPERAMMINA H. B. Brady 1878

*Hyperammina devoniana* sp. nov.

Plate 64, figs. 1-6

*Occurrence.* Holotype (C.P.C. No. 419) and paratypes A, B, C, D, E (C.P.C. Nos. 420, 421, 422, 423, 424) from section south-east end of Bugle Gap, 66-88 feet above base of section, Virgin Hills Formation.

*Dimensions.* Length of incomplete test of holotype, 0.82 mm.; diameter of globular proloculus, 0.16 mm.

*Diagnosis.* The species has an elongate test composed of a globular proloculus followed by a tubular second chamber which may be straight or sinuous. The wall is thin and composed of very fine quartz grains.

*Holotype.* Test free, delicate, elongate, incomplete, consisting of a small but prominent globular proloculus followed by a long, rather narrow, tubular second chamber. Wall thin, composed of small quartz grains in siliceous cement. External surface rough, internal wall smooth. Aperture at open end of tube.

*Paratypes A, B, C, D, E.* These specimens illustrate the variation within the species of the shape of the tubular second chamber, paratype E especially exhibiting the sinuous character of that chamber. This specimen also shows the delicate character of the wall, with its smooth inner surface.

*Observations.* Although the genus *Hyperammina* is recorded from the Devonian by Cushman and Stainbrook (1943) and Bartenstein (1937), no species have been described as far as the author can discover. However, species are described from the Ordovician and Silurian. *H. devoniana* shows some resemblance to *H. hastula* Moreman (1933)

EXPLANATION OF PLATE 66

Figs. 1-5. *Sorosphaera adhaerens* sp. nov. 1, Holotype. Aggregate of eight chambers firmly attached to one another in an irregular linear direction along fragment of *Tolypammina*. 2, Paratype A. Six chambers arranged in branching fashion. 3, Paratype B. Three chambers attached to one another in linear direction. Surface rough. 4, Paratype D. Single chamber attached to *Tolypammina*. 5, Paratype C. Two chambers strongly attached to one another and to fragment of *Tolypammina*.

Figs. 6-8. *Lagenammina ampullacea* sp. nov. 6, Holotype. Showing almost spherical test with short protruding neck. 7, Paratype A. Showing rough surface and short neck. 8, Paratype B. Showing long, incomplete, neck with coarse quartz grains in wall of neck.

All figures  $\times 92$

from the Silurian of Oklahoma, but differs from that species in its more delicate tubular second chamber which at times becomes sinuous. This latter character is shown in *H. baltica* Eisenack (1954) from the Silurian. The prominent globular proloculus is characteristic of all specimens figured from the Ordovician, Silurian, and Devonian. *H. gracilentata* Gutschick and Treckman (1959), from the Pennsylvanian of Indiana, closely resembles *H. devoniana* in its prominent globular proloculus followed by a delicate tubular chamber.

## Family AMMODISCIDAE

## Genus TOLYPAMMINA Rhumbler 1895

*Tolypammina helina* sp. nov.

Plate 67, figs. 1-5

*Occurrence.* Holotype (C.P.C. No. 425) and paratypes A and B (C.P.C. Nos. 484, 485) from section 200 yards south of Bugle Gap, south-east end, 88-100 feet above base of section, Virgin Hills Formation.

*Dimensions.* Width of tubular second chamber near spiral portion of proloculus—holotype, 0.13 mm.; paratype A, 0.11 mm. Maximum width of spiral portion—holotype, 0.39 mm.; paratype A, 0.41 mm.

*Diagnosis.* The proloculus of this species is followed by a tubular second chamber which is coiled for about two whorls, then becoming erect or somewhat irregular in direction. The wall is very thin.

*Holotype.* Test attached throughout length, consisting of proloculus followed by a tubular second chamber which is coiled for at least two whorls, then becoming erect. This chamber is narrow near the proloculus then gradually increases in width. Wall very thin, as shown by fracture of attached surface, and composed of fine quartz grains in siliceous cement. Surface rough. Aperture not observed but probably at open end of tube.

*Paratype A.* Tubular second chamber more loosely coiled than in holotype and very gradually increasing in width. Wall as seen on attached surface, very thin, composed of fine quartz grains of varying sizes. Surface rather rough.

*Paratype B.* Tubular chamber irregularly and loosely coiled, and then winding in different directions.

*Observations.* *Tolypammina helina* cannot be compared with any described species from the Ordovician or Silurian and it appears that no species has been described from the Devonian. It differs from *T. nexuosa* sp. nov. in its coiled portion of the tubular chamber and in the tendency in some tests for the chamber to be erect rather than sinuous as in that species.

The species name is derived from the Greek *helinos*, tendril.

*Tolypammina nexuosa* sp. nov.

Plate 67, figs. 6-8

*Occurrence.* Holotype (C.P.C. No. 486) and paratype A (C.P.C. No. 487) from south-east of Bugle Gap, 66-88 feet above base of section, Virgin Hills Formation. Paratype B (C.P.C. No. 488) 200 yards south of south-east end of Bugle Gap, 44-66 feet above base of section.

*Dimensions.* Maximum length of test—holotype, 1.15 mm.; paratype A, 0.73 mm.; paratype B, 1.33 mm. Maximum width of tube—holotype, 0.15 mm.; paratype A, 0.13 mm.

*Diagnosis.* This attached species consists of a proloculus followed by a long second tubular chamber which winds loosely in irregular directions with the proloculus and the end of the tube at times becoming attached. The wall is thin and the surface smooth.

*Holotype.* Test attached, consisting of a spherical proloculus followed by a long tubular second chamber which is loosely coiled in the early portion, then becoming sinuous and at times curling back on itself and becoming attached to the proloculus. Wall thin, composed of fine quartz grains well cemented, and with occasional coarser grains. Unattached surface smooth and at times polished. Attached surface where broken shows roughened inner wall. Aperture not visible and is probably attached to outside wall of sinuous chamber.

*Paratype A.* Proloculus broken, tubular second chamber gradually increasing in size as it winds around to form an irregular circle. Wall thin. Surface smooth, at times polished.

*Paratype B.* Sinuous tubular second chamber gradually increasing in width.

*Observations.* *T. nexuosa* is common in some residues. It winds in many irregular directions and for the most part is attached. The species closely resembles *T. tortuosa* Dunn (1942) from the Silurian of the Mississippi Basin. It differs from that species in its smooth and at times polished surface of the unattached side. As with *T. tortuosa*, although many specimens of *T. nexuosa* are available, no two are exactly alike. It also resembles *T. polyverta* Ireland (1958) from the Pennsylvanian of Kansas.

The species name is derived from the Latin *nexuosus*, complicated.

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#### EXPLANATION OF PLATE 67

Figs. 1-5. *Tolypammmina helicina* sp. nov. 1, Holotype. Unattached surface of test with smooth wall, minute proloculus, followed by coiled tubular chamber which later becomes erect. 2, Attached surface of holotype. 3, Paratype A. Unattached surface with loosely and irregularly coiled tubular chamber. 4, Attached surface of Paratype A. 5, Paratype B. Loosely and irregularly coiled tubular chamber later becoming sinuous. Unattached surface.

Figs. 6-8. *Tolypammmina nexuosa* sp. nov. 6, Holotype. Unattached surface with smooth wall, long sinuous tubular second chamber curling back on itself. 7, Paratype A. Tubular chamber gradually increasing in size and winding around to form an irregular circle. Unattached surface. 8, Paratype B. Smooth sinuous tubular chamber gradually increasing in size.

All figures  $\times 92$

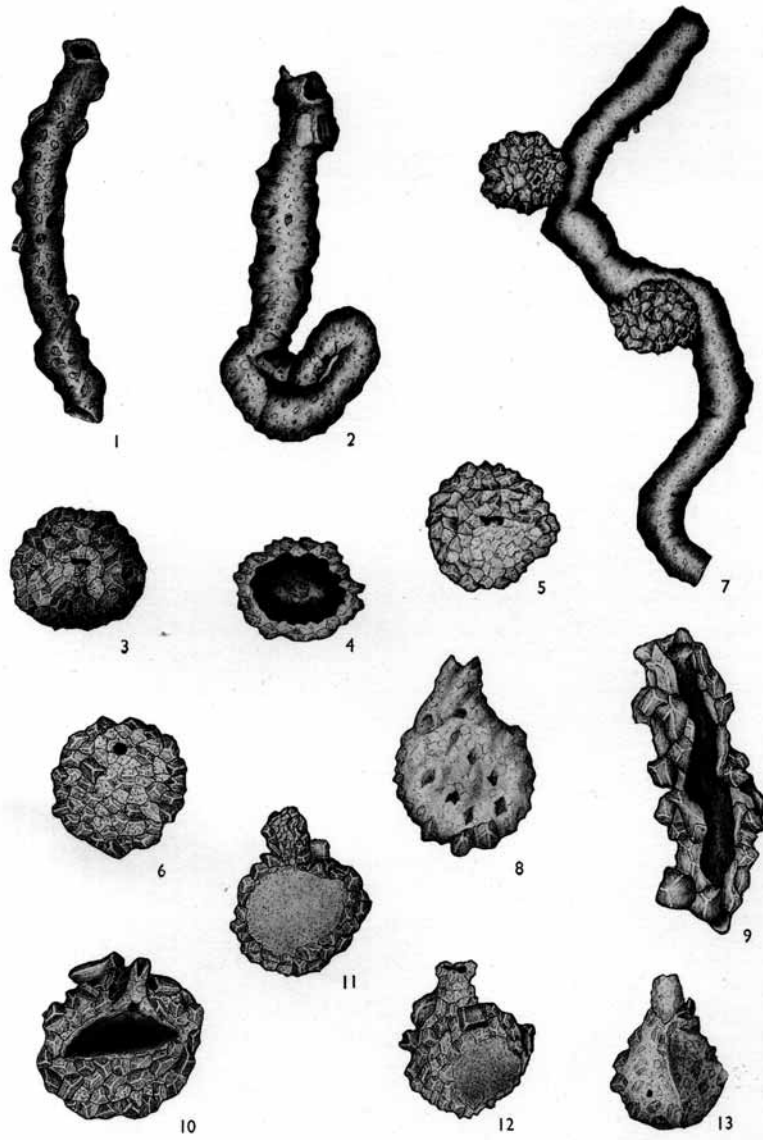
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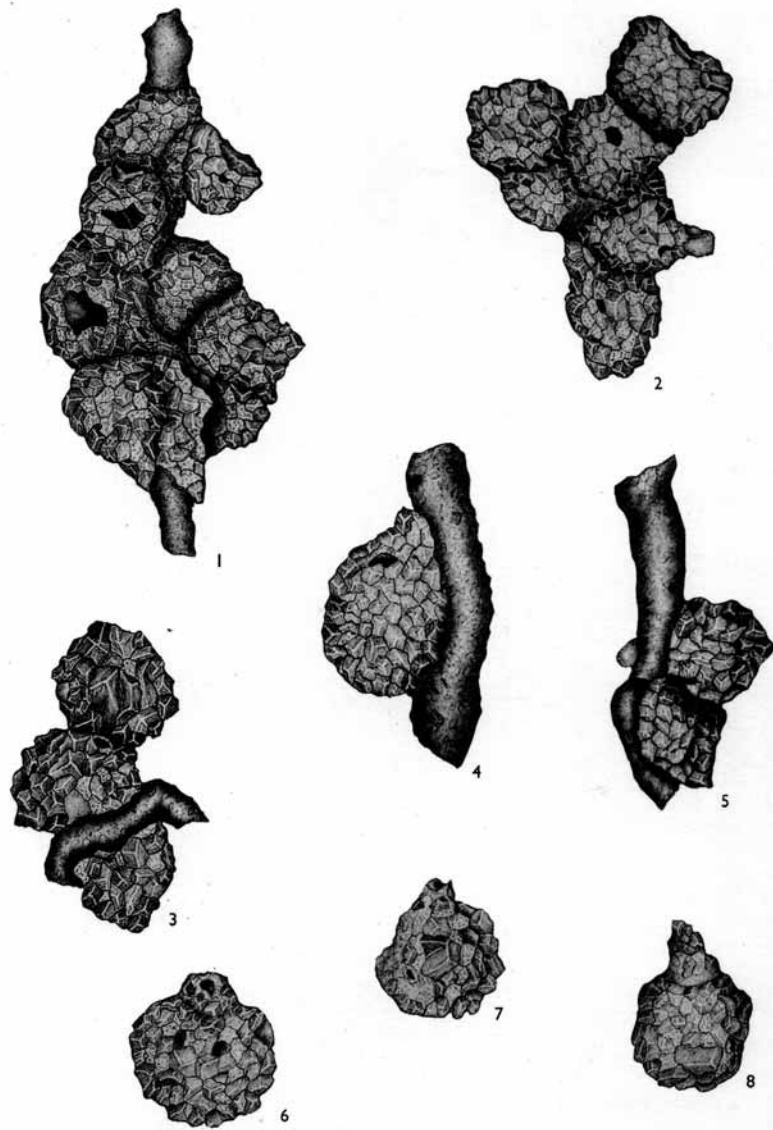
Manuscript received 28 August 1959



CRESPIN, Upper Devonian Foraminifera, W. Australia

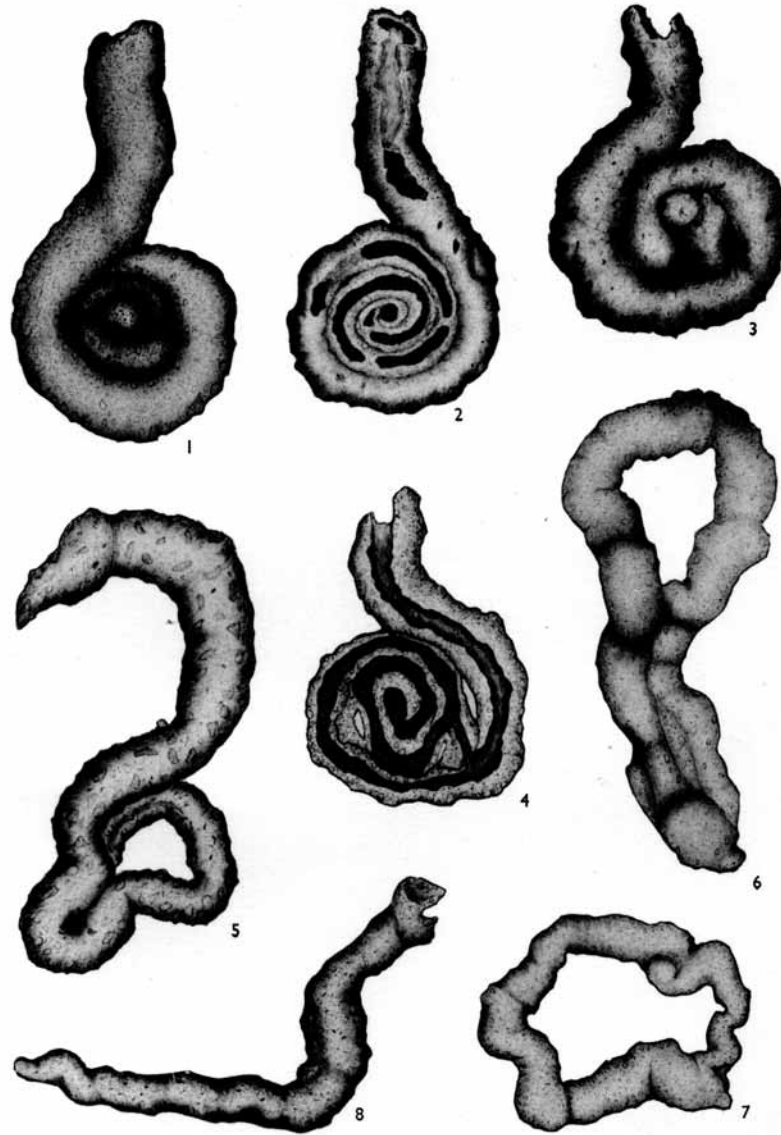


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