A GUIDE TO MODERN RADIOLARIA

by

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SPECIAL PUBLICATION NO. 16

Cushman Foundation
for Foraminiferal Research

March 1979

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$30.00 Libraries

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INTRODUCTION

The taxonomic description and illustration of radiolarian species began in the early eighteen hundreds. Work on the taxonomy of Mesozoic and Cenozoic species florished in the late nineteenth century, and because these early studies were so impressive in size and scope, no such all-encompassing effort has been attempted since. Instead the emphasis over the last century has been more on the refinement of the taxonomy of certain forms, particularly those species and evolutionary lineages which have proven to be of interest to biostratigraphers.

In the last two decades there has been an increased interest in modern (extant) forms found as fossils in the surface sediment of the deep sea. Their usefulness as indicators of modern water masses has been demonstrated in the Atlantic, Antarctic and Pacific Oceans. These relationships have been used to interpret down-core changes through time. The past 10 years have seen an increased emphasis on establishing the statistical relationships between the distribution of species (or species groups) and quantitative measures of their environment. These quantitative approaches require a) that there be a large collection of surface sediment samples, and b) that the majority of the species preserved in these sediments are known. Although the requirement for a global coverage of surface sediment samples has been largely met, the requirement for a complete taxonomy of extant radiolarian species has not. Because of the inadequacies of the radiolarian taxonomy, researchers have used in some cases ill-defined and inadequately illustrated, poly-specific and even poly-generic "counting groups" in their studies of the relative abundance of assemblages. Such informal groupings can easily blur and confuse the distribution patterns and usually make it impossible for one researcher to duplicate or use the results of another.

Researchers working on the CLIMAP project have found the Radiolaria to be extremely useful indicators of Holocene and Pleistocene conditions; but as described above, these studies have suffered from the lack of a complete and uniform taxonomic guide. The taxonomic guide for Radiolaria presented here is not complete, but it is our first step toward providing a unified description and illustration of quantitatively important, extant Quaternary Radiolaria together with published information on their distributions.

ACKNOWLEDGEMENTS

This report was supported by the N.S.F. Offices of Climate Dynamics and International Decade of Ocean Exploration through grant OCE 75-20358-A01 made to the CLIMAP project at the University of Rhode Island.

We wish to acknowledge the excellent and enthusiastic cooperation of a number of radiolarian colleagues, namely, Richard Benson, Kjell Bjorklund, Robert Goll, James D. Hays, Stanley Kling, Gail Lombari, José Lozano, Adolpho Molina-Cruz, Joseph Morely, Maria Petrushevskaya, William Riedel (and his staff), James Robertson and Harvey Sachs. Our thanks also to Donna Mace, Joan Clark, and Beverly Koly for providing such an accurate typescript.

SYSTEMATICS

The primary purpose of this guide is to provide a standard taxonomic usage so that meaningful comparisons may be made between the counts and subsequent statistical analyses of various investigators. In many cases the taxonomy of Modern radiolarian species is well established. However, in some instances there are difficulties owing to misidentification, poor descriptions and or illustrations, or taxonomic problems which may be solved only by extensive investigation of lineages. It is not the purpose of the present paper to solve all these problems, but rather to standardize usage, to upgrade and coordinate descriptions and illustrations and to explain certain taxonomic difficulties.

Since this paper is meant only to be a guide, a conservative approach to taxonomy has been adopted and any changes are documented and explained in detail. Family level taxonomy is primarily that of Riedel (1967) with some emendations by Goll (1968), Foreman (1973) and Petrushevskaya (1975).

FORMAT

For each of the species included herein the following information is given:

1. Name and author.

2. References to the original description and the most important modern descriptions.

3. Description: most complete description available and additional comments by other authors.

4. Dimensions: most reliable dimensions available (usually from the same source as the description) with notation of any marked variations reported by other authors.

5. Remarks: notes concerning location of a more complete synonymy, other descriptions and taxonomic problems or errors.

6. Recent Distribution: a compilation of distribution data from a number of sources, primarily Riedel (1958), Hays (1965), Benson (1966), Nigrini (1967 , 1968, 1970), Lozano (1974), Molina-Cruz (1975), and Robertson (1975).

7. Photograph or Drawing: usually from the same source as the description with magnifications standardized to x 233 in most cases. Figures are purposely widely spaced to allow for subsequent additions to the guide.

GROSS CLASSIFICATION OF DESCRIBED SPECIES

SUBCLASS Radiolaria Muller 1858
ORDER Polycystina Ehrenberg 1838, emend. Riedel 1967
SUBORDER Spumellaria Ehrenberg 1875

1. FAMILY Collosphaeridae Muller 1858

GENUS Collosphaera Muller 1858
SPECIES Collosphaera tuberosa Haeckel, 1887

GENUS Disolenia Ehrenberg 1860
SPECIES Disolenia quadrata (Ehrenberg), 1872
Disolenia zanguebarica (Ehrenberg), 1872

GENUS Otosphaera Haeckel 1887, emend. Nigrini, 1967
SPECIES Otosphaera auriculata Haeckel, 1887
Otosphaera polymorpha Haeckel, 1887

GENUS Polysolenia Ehrenberg 1872, emend. Nigrini 1967
SPECIES Polysolenia arktios Nigrini, 1970
Polysolenia flammabunda (Haeckel), 1887
Polysolenia lappacea (Haeckel), 1887
Polysolenia murrayana (Haeckel), 1887
Polysolenia spinosa (Haeckel), 1860

GENUS Siphonosphaera Muller 1858
SPECIES Siphonosphaera polysiphonia Haeckel, 1887

2. FAMILY Actinommidae Haeckel 1862, emend. Riedel 1967

GENUS Actinomma Haeckel 1860, emend. Nigrini 1967
SPECIES Actinomma antarcticum (Haeckel), 1887
Actinomma arcadophorum Haeckel, 1887
Actinomma medianum Nigrini, 1967
Actinomma haysi Bjorklund, 1977
Actinomma leptodermum (Jorgensen), 1900

GENUS Anomalacantha Loeblich and Tappan 1961
SPECIES Anomalacantha dentata (Mast), 1910

GENUS Cenosphaera Ehrenberg 1854
SPECIES Cenosphaera coronata Haeckel, 1887
Cenosphaera cristata Haeckel ?, 1887
Cenosphaera spp.

GENUS *Hexacontium* Haeckel 1881
SPECIES *Hexacontium enthacantum* Jorgensen, 1899
Hexacontium laevigatum Haeckel, 1887

GENUS *Ommatartus* Haeckel 1881, *emend.* Riedel 1971
SPECIES *Ommatartus tetrathalamus tetrathalamus* (Haeckel), 1887
Ommatartus tetrathalamus coronatus (Haeckel), 1887

GENUS *Stylatractus* Haeckel 1887
SPECIES *Stylatractus* spp.

GENUS *Axoprunum* Haeckel 1887
SPECIES *Axoprunum stauraxonium* Haeckel, 1887

3. FAMILY *Sponguridae* Haeckel 1862, *emend.* Petrushevskaya 1975

GENUS *Ommatogramma* Ehrenberg 1860
SPECIES *Ommatogramma dumitricai* Petrushevskaya, 1975

GENUS *Spongurus* Haeckel 1860
SPECIES *Spongurus* cf. *elliptica* (Ehrenberg), 1872
Spongurus pylomaticus Riedel, 1958
Spongurus (?) sp.

GENUS *Spongocore* Haeckel 1887
SPECIES *Spongocore puella* Haeckel, 1887

GENUS *Styptosphaera* Haeckel 1887
SPECIES *Styptosphaera* (?) *spumacea* Haeckel, 1887

4. FAMILY *Phacodiscidae* Haeckel 1881

GENUS *Heliodiscus* Haeckel 1862, *emend.* Nigrini 1967
SPECIES *Heliodiscus asteriscus* Haeckel, 1887

5. FAMILY *Spongodiscidae* Haeckel 1862, *emend.* Riedel 1967

GENUS *Amphirhopalum* Haeckel 1881, *emend.* Nigrini, 1967
SPECIES *Amphirhopalum ypsilon* Haeckel, 1887

GENUS *Euchitonia* Ehrenberg 1860, *emend.* Nigrini, 1967
SPECIES *Euchitonia elegans* (Ehrenberg), 1872
Euchitonia furcata Ehrenberg, 1872

GENUS *Dictyocoryne* Ehrenberg 1860
SPECIES *Dictyocoryne profunda* Ehrenberg, 1860
Dictyocoryne truncatum (Ehrenberg), 1861

GENUS *Hymeniastrum* Ehrenberg 1847
SPECIES *Hymeniastrum euclidis* Haeckel, 1887

GENUS *Spongaster* Ehrenberg 1860
SPECIES *Spongaster tetras tetras* Ehrenberg, 1860
Spongaster tetras Ehrenberg *irregularis* Nigrini, 1967

GENUS *Stylodictya* Ehrenberg 1847, *emend*. Kozlova 1972
SPECIES *Stylodictya aculeata* Jorgensen, 1905
Stylodictya validispina Jorgensen, 1905

GENUS *Porodiscus* Haeckel 1881, *emend*. Kozlova 1972
SPECIES *Porodiscus* sp. A
Porodiscus (?) sp. B

GENUS *Stylochlamydium* Haeckel 1887
SPECIES *Stylochlamydium asteriscus* Haeckel, 1887

GENUS *Spongopyle* Dreyer 1889
SPECIES *Spongopyle osculosa* Dreyer, 1889

GENUS *Spongotrochus* Haeckel 1860
SPECIES *Spongotrochus glacialis* Popofsky-group, 1908
Spongotrochus (?) *venustum* (Bailey), 1856

6. FAMILY *Pyloniidae* Haeckel 1881

GENUS *Hexapyle* Haeckel 1881
SPECIES *Hexaplye* spp.

GENUS *Octopyle* Haeckel 1881
SPECIES *Octopyle stenozona* Haeckel, 1887

GENUS *Tetrapyle* Muller 1858
SPECIES *Tetrapyle octacantha* Muller, 1858

GENUS *Prunopyle* Dreyer 1889
SPECIES ? *Prunopyle antarctica* Dreyer, 1889

7. FAMILY *Litheliidae* Haeckel 1862

GENUS *Larcopyle* Dreyer 1889
SPECIES *Larcopyle butschlii* Dreyer, 1889

GENUS Larcospira Haeckel 1887
SPECIES Larcospira quadrangula Haeckel, 1887

GENUS Lithelius Haeckel 1862
SPECIES Lithelius minor Jorgensen, 1889
Lithelius nautiloides Popofsky, 1908

GENUS Pylospira Haeckel 1887
SPECIES ? Pylospira octopyle Haeckel, 1887

GENUS Spirema Haeckel 1881
SPECIES ? Spirema melonia Haeckel, 1887

SUBORDER Nassellaria Ehrenberg 1875

8. FAMILY Plagoniidae Haeckel 1881, emend. Riedel 1967

GENUS Antarctissa Petrushevskaya 1967
SPECIES Antarctissa denticulata (Ehrenberg), 1844
Antarctissa strelkovi Petrushevskaya, 1967

9. FAMILY Trissocyclidae Haeckel 1881, emend. Goll 1968
(= Acanthodesmiidae Haeckel 1862 in Riedel, 1971)

GENUS Ceratospyris Ehrenberg 1847
SPECIES Ceratospyris borealis Bailey, 1856

GENUS Giraffospyris Haeckel 1881, emend. Goll 1968
SPECIES Giraffospyris angulata (Haeckel), 1887

GENUS Liriospyris Haeckel 1881, emend. Goll 1968
SPECIES Liriospyris reticulata (Ehrenberg), 1872

GENUS Lophospyris Haeckel 1881, emend. Goll 1977
SPECIES Lophospyris pentagona pentagona (Ehrenberg) emend. Goll, 1977

GENUS Phormospyris Haeckel 1881, emend. Goll 1977
SPECIES Phormospyris stabilis (Goll) antarctica (Haecker) emend. Goll, 1977
Phormospyris stabilis (Goll) scaphipes (Haeckel) emend. Goll, 1977

GENUS Tholospyris Haeckel 1881, emend. Goll 1968
SPECIES Tholospyris procera Goll, 1969

GROSS CLASSIFICATION OF DESCRIBED SPECIES (cont)

10. FAMILY Carpocaniidae Haeckel 1881, emend. Riedel 1967

GENUS Carpocanistrum Haeckel 1887
SPECIES Carpocanistrum spp.
Carpocanistrum sp. A

GENUS Carpocanarium Haeckel 1887
SPECIES Carpocanarium papillosum (Ehrenberg) group, 1872

11. FAMILY Theoperidae Haeckel 1881, emend. Riedel 1967

GENUS Peripyramis Haeckel 1881, emend. Riedel 1958
SPECIES Peripyramis circumtexta Haeckel, 1887

GENUS Plectopyramis Haeckel 1881
SPECIES Plectopyramis dodecomma Haeckel, 1887

GENUS Dictyophimus Ehrenberg 1847, emend. Nigrini 1968
SPECIES Dictyophimus crisiae Ehrenberg, 1854
Dictyophimus hirundo (Haeckel) group, 1887
Dictyophimus infabricatus Nigrini, 1968

GENUS Pterocanium Ehrenberg 1847
SPECIES Pterocanium korotnevi (Dogiel), 1952
Pterocanium praetextum praetextum (Ehrenberg), 1872
Pterocanium praetextum (Ehrenberg) eucolpum Haeckel, 1887
Pterocanium trilobum (Haeckel), 1860
Pterocanium grandiporus Nigrini, 1968
Pterocanium sp.

GENUS Theocalyptra Haeckel 1887
SPECIES Theocalyptra bicornis (Popofsky), 1908
Theocalyptra davisiana (Ehrenberg), 1861

GENUS Eucyrtidium Ehrenberg 1847, emend. Nigrini 1967
SPECIES Eucyrtidium acuminatum (Ehrenberg), 1844
Eucyrtidium hexagonatum Haeckel, 1887

GENUS Lithocampe Ehrenberg 1838
SPECIES Lithocampe sp.

12. FAMILY Pterocoryidae Haeckel 1881, emend. Riedel 1967

GENUS Anthocyrtidium Haeckel 1881
SPECIES Anthocyrtidium ophirense (Ehrenberg), 1872
Anthocyrtidium zanguebaricum (Ehrenberg), 1872

GENUS Androcyclas Jorgensen 1905
SPECIES Androcyclas gamphonycha (Jorgensen), 1899

GENUS Lamprocyclas Haeckel 1881
SPECIES Lamprocyclas maritalis maritalis Haeckel, 1887
Lamprocyclas maritalis Haeckel polypora Nigrini, 1967
Lamprocyclas maritalis Haeckel ventricosa Nigrini, 1968

GENUS Lamprocyrtis Kling 1973
SPECIES Lamprocyrtis nigriniae (Caulet), 1971
Lamprocyrtis (?) hannai (Campbell and Clark), 1944

GENUS Pterocorys Haeckel 1881
SPECIES Pterocorys hertwigii (Haeckel), 1887
Pterocorys minythorax (Nigrini), 1968
Pterocorys zancleus (Muller), 1858

GENUS Stichopilium Haeckel 1881
SPECIES Stichopilium bicorne Haeckel, 1887

GENUS Theocorythium Haeckel 1887
SPECIES Theocorythium trachelium trachelium (Ehrenberg), 1872
Theocorythium trachelium (Ehrenberg) dianae (Haeckel), 1887

13. FAMILY Artostrobiidae Riedel 1967, emend. Foreman 1973

GENUS Botryostrobus Haeckel 1887, emend. Nigrini, 1977
SPECIES Botryostrobus aquilonaris (Bailey), 1856
Botryostrobus auritus / australis (Ehrenberg) group, 1844

GENUS Phormostichoartus Campbell 1951, emend. Nigrini, 1977
SPECIES Phormostichoartus corbula (Harting), 1863

14. FAMILY Cannobotryidae Haeckel 1881, emend. Riedel 1967

GENUS Botryocyrtis Ehrenberg 1860
SPECIES Botryocyrtis scutum (Harting), 1863

DESCRIPTION AND RECENT DISTRIBUTION OF SPECIES

SUBORDER *Spumellaria* Ehrenberg 1875

Collosphaera tuberosa Haeckel

Collosphaera tuberosa Haeckel, 1887, p. 97; Nigrini, 1971, p. 445, pl. 34.1, fig. 1

DESCRIPTION

"Shell is a smooth-surfaced, lumpy sphere, having numerous subcircular pores, irregular in size and distribution. Usually there is a rather larger pore where the shell indents." (from Nigrini, 1971).

DIMENSIONS

"Maximum shell diameter 103-159μ." (from Nigrini, 1971).

REMARKS

1. For a more complete synonymy and stratigraphy significance of this species, see Nigrini, 1971 and Knoll and Johnson, 1975.

Plate 1, figure 1

Collosphaera tuberosa Haeckel

RECENT DISTRIBUTION

1. Nigrini, 1970, fig. 2; belongs to a tropical assemblage derived by recurrent group analysis of North Pacific samples, but the species does range as far north as 40°N in the western Pacific.

2. Molina-Cruz, 1975, Code S-11; used in factor analysis of southeast Pacific assemblages; cf. Appendix 10 for percent S11 at each station.

3. Morley, 1977, fig. I-1; "This species loads highest in factor 4 (subtropical). At present it occurs most frequently in a very narrow latitudinal band between 20° and 28°N. This species was found in none of the 18,000 YBP samples probably because no samples with Radiolaria at 18,000 YBP were found in this narrow region."

Disolenia quadrata (Ehrenberg)

Tetrasolenia quadrata Ehrenberg, 1872a, p. 320; 1872b, p. 301, pl. x, fig. 20
Disolenia quadrata (Ehrenberg), Nigrini, 1967, p. 19, pl. 1, fig. 5

DESCRIPTION

"Shell smooth, thin-walled, subspherical, with numerous small irregular pores having no definite arrangement. Pored tubules, 3-8 (usually 5), approximately as long as broad or longer, 0.2-0.3 shell diameter. Tubules cylindrical or subcylindrical, sometimes slightly expanded distally; outer apertures truncated, smooth." (from Nigrini, 1967).

DIMENSIONS

"Diameter of shell 63-90μ. Maximum length of tubules 18-36μ; their maximum breadth 18-27μ." (from Nigrini, 1967).

REMARKS

1. For a more complete synonymy see Nigrini, 1967.

2. Benson's (1966) description and dimensions of this species (Disolenia cf. variabilis (Haeckel) in Benson, p. 123) are consistent with the above.

Plate 1, figure 2

Disolenia quadrata (Ehrenberg)

RECENT DISTRIBUTION

1. Benson, 1966 (Disolenia cf. varabilis); "In the Gulf of California this species is very rare and occurs only at 5 southern Gulf Stations... It is apparently a tropical oceanic form."

2. Nigrini, 1967, fig. 6; "Indian Ocean occurrences - D. quadrata is sparsely distributed in the eastern tropics, but increases in abundance (up to 6% of the described population) west of 75°E. The species is absent from middle latitude samples."

3. Molina-Cruz, 1975, Code S39; counted together with D. zanguebarica and used in factor analysis of southeast Pacific assemblages; cf. Appendix 10 for percent S39 at each station.

4. Morley, 1977 (Disolenia sp.), Fig. I-2; counted together with D. zanguebarica; "Both ... species seem to be found within the same habitat. D. zanguebarica occurs less frequently in most samples.

"These species load highest in factor 1 (tropical). At present they occur most frequently between the equator and 10°S, and are absent south of 35°S. At 18,000 YBP their abundance decreased drastically and they were absent in all samples south of 8°S."

Disolenia zanguebarica (Ehrenberg)

Trisolenia zanguebarica Ehrenberg, 1872a, p. 321; 1872b, p. 301, pl. x, fig. 11

Disolenia zanguebarica (Ehrenberg), Nigrini, 1967, p. 20, pl. 1, fig. 6

DESCRIPTION

"Similar to Disolenia quadrata, but tubules, of which there are 4-6 (usually 5), are broadly conical, narrowing distally; hence, there is no distinct break in shell contour at the bases of the tubules. Pores rather larger than those of D. quadrata." (from Nigrini, 1967).

DIMENSIONS

"Diameter of shell 90-146μ. Breadth of outer aperture of tubules 18-36μ." (from Nigrini, 1967).

REMARKS

1. For a more complete synonymy see Nigrini, 1967.

Plate 1, figure 3

Disolenia zanguebarica (Ehrenberg)

RECENT DISTRIBUTION

1. Nigrini, 1967, fig. 7; "Indian Ocean occurrences - D. zanguebarica is sparsely distributed in low latitudes and is absent from middle latitude samples. Maximum abundances (up to 3% of the described population) occur in the western tropics."

2. Molina-Cruz, 1975, Code S39; counted together with D. quadrata and used in factor analysis of southeast Pacific assemblages; cf. Appendix 10 for percent S39 at each station.

3. Morley, 1977 (Disolenia sp.); cf. D. quadrata.

Otosphaera auriculata Haeckel

Otosphaera auriculata Haeckel, 1887, p. 116, pl. 7, fig. 5; Nigrini, 1967, p. 22, pl. 1, fig. 7

DESCRIPTION

"Shell similar to, but generally rather smaller than, that of Disolenia quadrata. Two to four tubules, having a length 0.25-0.5 shell diameter. Species distinguished by 1 or 2 spines or a tooth on the outer aperture of each tubule. The spine is a single short solid projection, while the tooth is triangular in outline and bears a large triangular pore." (from Nigrini, 1967).

DIMENSIONS

"Diameter of shell 72-100μ. Maximum length of tubules (including spine or tooth) 9-36μ; their maximum breadth 18-27μ." (from Nigrini, 1967).

Plate 1, figure 4

Otosphaera auriculata Haeckel

RECENT DISTRIBUTION

1. Nigrini, 1967, fig. 8; "Indian Ocean occurrences - O. auriculata is sparsely distributed in the eastern tropics, but increases in abundance (up to 7% of the described population) west of 75°E. The species is absent from middle latitude samples."

2. Molina-Cruz, 1975, Code S39A; counted together with O. polymorpha but too rare for use in factor analysis of southeast Pacific assemblages; cf Appendix 10 for percent S39A at each station.

Otosphaera polymorpha Haeckel

Otosphaera polymorpha Haeckel, 1887, p. 116, pl. 7, fig. 6; Nigrini, 1967, p. 23, pl. 1, fig. 8

DESCRIPTION

"Shell smooth, thin-walled, subspherical, with numerous very small pores, much smaller than the bars. Tubules, 2-5, with rather larger pores, are truncated obliquely, one side prolonged into a prominent acute tooth. Length of tubules, including tooth, 0.25-0.3 shell diameter." (from Nigrini, 1967).

DIMENSIONS

"Diameter of shell 100-146μ. Maximum length of tubules (including tooth) 18-45μ; their maximum breadth 27-36μ." (from Nigrini, 1967).

Plate 1, figure 5

Otosphaera polymorpha Haeckel

RECENT DISTRIBUTION

1. Nigrini, 1967, fig. 9; "Indian Ocean occurrences - O. polymorpha is very sparsely distributed in low latitudes, never forming more than 1 percent of the described population, and is practically absent from middle latitude samples."

2. Molina-Cruz, 1975, Code S39A; counted together with O. auriculata, but too rare for use in factor analysis of southeast Pacific sediments; cf. Appendix 10 for percent S39A at each station.

Polysolenia arktios Nigrini

Polysolenia arktios Nigrini, 1970, p. 166, pl. 1, figs. 4,5

DESCRIPTION

"Shell smooth, spherical with numerous randomly arranged, subcircular and irregular pores of varying size. Shell very spiny, one or more poreless spines up to one-third the length of the shell diameter project outward from most pore margins. Spines may fork, or 2 or more spines arising from a single pore may meet at a point; they may be needle-like or flat, blunt projections. Rarely, specimens with an extra-cortical shell have been observed...

"This species appears to be closely related to P. spinosa, but its restricted distribution in Subarctic sediments seems to warrant a taxonomic distinction." (from Nigrini, 1970).

DIMENSIONS

"(based on 20 specimens). Shell diameter 103-238μ. Maximum length of spines 48μ." (from Nigrini, 1970).

REMARKS

1. This species is probably the Northern form of Polysolenia spp. in Sachs, (1973).

Plate 2, figure 1

Polysolenia arktios Nigrini

RECENT DISTRIBUTION

1. Nigrini, 1970, fig. 5; belongs to a subarctic assemblage derived by recurrent group analysis of North Pacific samples.

2. Ling et al., 1971; "... found only sparsely from the Bering Sea samples."

Polysolenia flammabunda (Haeckel)

Choenicosphaera flammabunda Haeckel, 1887, p. 103, pl. 8, fig. 5
Acrosphaera flammabunda (Haeckel), Popofsky, 1917, p. 253, text-figs. 14-16 (partim.)
Polysolenia flammabunda (Haeckel), Nigrini, 1967, pl. 15, pl. 1, fig. 2

DESCRIPTION

"Similar to Polysolenia spinosa, but with larger pores having a corona of up to 5 flat or conical spines. Single spines are also present on the margins of smaller pores, or may arise from pore clusters, or from between pores. Spines are narrower basally and generally longer than those of P. spinosa." (from Nigrini, 1967).

DIMENSIONS

"Diameter of shell 81-136μ." (from Nigrini, 1967).

Sachs (1973) considered several species of Polysolenia together and found the diameter of Northern forms to be 153± 9μ and of Southern forms 123± 2μ, based on measurements of 3 Northern and 12 Southern specimens. It seems likely that his Northern specimens were P. arktios.

Plate 2, figure 2

Polysolenia flammabunda (Haeckel)

RECENT DISTRIBUTION

1. Nigrini, 1967, fig. 3; "Indian Ocean occurrences - P. flammabunda never constitutes more than 3 percent of the described population. In low latitudes it usually forms about 1 percent and in middle latitudes it is practically absent."

2. Sachs, 1973, Code 21S; combined several species of Polysolenia in his counts, "Quite rare (<2% everywhere), but most abundant, although still patchy, in Southern portion of study area." Southern is south of about 45°N.

3. Molina-Cruz, 1975, Code S13A; not used in factor analysis of southeast Pacific assemblages; cf. Appendix 10 for percent S13A at each station.

4. Morley, 1977 (Polysolenia spp.)Fig. I-5; counted together with P. lappacea; "P. flammabunda is by far the less frequently occurring of these two species. These species load highest in factor 4 (subtropical). At present they are most abundant in the subtropical region between 20° and 31°S and are absent south of 35°S. Their very rare occurrence in the 18,000 YBP samples indicates a probable contraction in their distribution and a reduction in their abundance."

Polysolenia lappacea (Haeckel)

Xanthiosphaera lappacea Haeckel, 1887, p. 120, pl. 8, figs. 10, 11
Polysolenia lappacea (Haeckel) Nigrini, 1967, p. 16, pl. 1, figs. 3a,b

DESCRIPTION

"Similar to Polysolenia spinosa, but spines are often curved. At different distances from the shell some spines are joined by broad lateral branches which form an irregular and incomplete outer mesh." (from Nigrini, 1967).

DIMENSIONS

"Diameter of shell 81-109μ." (from Nigrini, 1967).

REMARKS

1. For a more complete synonymy see Nigrini, 1967.

Plate 2, figures 3a,b

Polysolenia lappacea (Haeckel)

RECENT DISTRIBUTION

1. Nigrini, 1967, fig. 4; "Indian Ocean occurrences - P. lappacea is sparsely distributed in low latitudes and is almost entirely absent from middle latitudes. Maximum abundances (6% and 10% of the described population) occur at the northern and southern limits respectively of tropical radiolarian distribution."

2. Molina-Cruz, 1975, Code S33; not used in factor analysis of southeast Pacific samples; cf. Appendix 10 for percent S33 at each station.

3. Morley, 1977 (Polysolenia spp.); cf. P. flammabunda.

Polysolenia murrayana (Haeckel)

Choenicosphaera murrayana Haeckel, 1887, p. 102, pl. 8, fig. 6
Polysolenia murrayana (Haeckel) Nigrini, 1968, p. 52, pl. 1, figs. 1a,b

DESCRIPTION

"Shell thin-walled, smooth, usually spherical but sometimes ellipsoidal, with numerous irregularly scattered, subcircular pores of variable size, their diameter up to 1/6 of shell diameter. Seven to ten pores on a half-equator. Most pores bear a corona of 2-6 (usually 3) short, pointed spines. No spines between pores." (from Nigrini, 1968).

DIMENSIONS

"Diameter of shell 127-184μ . Length of spines up to 22μ." (from Nigrini, 1968).

REMARKS

1. For a more complete synonymy see Nigrini, 1968.

2. Benson's (1966) description and dimensions of this species (Choenicosphaera murrayana Haeckel in Benson, p. 120) are consistent with the above.

Plate 2, figures 4a,b

Polysolenia murrayana (Haeckel)

RECENT DISTRIBUTION

1. Benson, 1966 (Choenicosphaera murrayana); "This species is rare in the Gulf [of California] but is the dominant member of the family Collosphaeridae ... apparently an oceanic species little influenced by local conditions of upwelling."

2. Nigrini, 1968, text-fig. 3; "Abundant to few in the regions of the North and South Equatorial and Peru Currents, but rare or absent in the region of the Equatorial Countercurrent."

3. Molina-Cruz, 1975, Code S34; used in factor analysis of southeast Pacific assemblages; cf. Appendix 10 for percent S34 at each station; mostly abundant in areas of coastal upwelling.

4. Morley, 1977 (note erroneous spelling in text) Fig. I-3; "This species loads highest in factor 1 (tropical). Samples containing high percentages of this species are located between 15° and 30°S. This species does not occur today south of 35°S. At 18,000 YBP this species does not appear to occur south of 25°S."

Polysolenia spinosa (Haeckel)

Collosphaera spinosa Haeckel, 1860b, p. 845; 1862, p.536, pl.34, figs.12,13
Polysolenia spinosa (Haeckel), Nigrini, 1967, p. 14, pl. 1, fig. 1

DESCRIPTION

"Shell thin-walled, smooth, spherical, with numerous, irregularly scattered, subcircular pores of variable size, 1-4 times as broad as the bars. Short spines, usually mounted on conical elevations, project randomly over the shell surface, either singly from pore margins or from between the pores. Spines are usually conical, but may be quite sharp; often they are fenestrate near the shell and sometimes arise from a cluster of small pores rather than from a single pore. Probably these pore clusters form when a single pore is divided by a growing spine." (from Nigrini, 1967).

DIMENSIONS

"Diameter of shell 81-164μ (usually 81-128μ)." (from Nigrini, 1967).

REMARKS

1. For a more complete synonymy see Nigrini, 1967.

Plate 2, figure 5

Polysolenia spinosa (Haeckel)

RECENT DISTRIBUTION

1. Nigrini, 1967, fig. 2; "Indian Ocean occurrences - P. spinosa is sparsely distributed in both low and middle latitudes. It forms a high percentage (17%) of the described population in a sample near the African coast (SERPENT(?) 9); and in two samples near the southern limit of tropical radiolarian distribution (VEMA 18-201, 21°02'S; and LSDA 119G, 22°02'S) the species constitutes 12 percent and 10 percent respectively of the described population."

2. Molina-Cruz, 1975, Code S13; used in factor analysis of southeast Pacific assemblages; cf. Appendix 10 for percent S13 at each station.

3. Morley, 1977; Fig. I-4; "This species loads highest in factor 4 (subtropical). At present its maximum abundance is centered in the middle of the Subtropical Gyre. Although no samples at the 18,000 year level contained Radiolaria from the region where this species is most abundant, the similarity in percentages in peripheral areas would indicate that at 18,000 YBP there may have not been much variation in the abundance of this species."

Siphonosphaera polysiphonia Haeckel

Siphonosphaera polysiphonia Haeckel, 1887, p. 106; Nigrini, 1967, p. 18, pl. 1, figs. 4a, b.

DESCRIPTION

"Shell spherical, rather thick-walled with somewhat rough or pitted surface and numerous small subcircular pores, irregularly scattered. Four to ten poreless tubules, thin-walled, cylindrical, having no definite arrangement. Tubules usually as long as broad, about 0.2 shell radius, but may be longer, up to 0.25 shell radius; smoothly truncated tangentially, or sometimes obliquely to the sphere." (from Nigrini, 1967).

DIMENSIONS

"Diameter of shell 81-119μ. Maximum length of tubules 9-27μ; their maximum breadth 9-18μ." (from Nigrini, 1967).

REMARKS

1. Benson's (1966) description and dimensions of this species (Siphonosphaera cf. socialis Haeckel in Benson, p. 121) are consistent with the above.

Plate 1, figures 6a,b

Siphonosphaera polysiphonia Haeckel

RECENT DISTRIBUTION

1. Benson, 1966 (Siphonosphaera cf. socialis); "...appears to be a tropical oceanic form. In the Gulf [of California]. It is very rare... It is apparently not influenced by upwelling."

2. Nigrini, 1967, fig. 5; "Indian Ocean occurrences - S. polysiphonia is rather sparsely distributed in low latitudes and is practically absent from middle latitude samples. Maximum abundance occurs in a sample near Africa (SERPENT (?) 9, 10% of the described population)."

3. Molina-Cruz, 1975, Code S37; used in factor analysis of southeast Pacific assemblages; cf. Appendix 10 for percent S37 at each station.

4. Morley, 1977, fig. 1-6; "This species loads highest in factor 4 (subtropical). At present it is most abundant in central and western South Atlantic subtropical and tropical waters and absent south of 40^{0}S. It is difficult to determine the difference in abundance between 18,000 YBP and today because of the absence of samples at the 18,000 year level in the region where this species is presently most common."

Notes on the Genus *Actinomma*

The taxonomy proposed by Bjorklund (1977) is followed herein, i.e.:

Family Actinommidae (note that Bjorklund incorrectly uses the name Astrosphaeridae)

Genus *Actinomma* Haeckel 1860 *emend*. Bjorklund 1977

Actinomma Haeckel 1860a, p. 815 (note erroneous date in Bjorklund,1977).
Cromyomma Haeckel 1862, p. 446
Echinomma Haeckel 1881, p. 452
Cromyechinus Haeckel 1881, p. 453

Diagnosis: Actinommid "possessing three or four lattice spheres and 10-20 unbranched spines of either uniform or irregular length." (from Bjorklund, 1977)

In addition, the outer medullary shell is irregular in shape, i.e., not a perfect sphere (Bjorklund, personal communication).

Species included: *Actinomma antarcticum* (Haeckel)
Actinomma medianum Nigrini
Actinomma arcadophorum Haeckel

(Note: It is the opinion of Bjorklund (personal communication) and Nigrini that the above species, described by Nigrini (1967), can remain in the genus *Actinomma*. Petrushevskaya (1975) equates *Actinomma sensu*. Nigrini, 1967, with *Actinometta* Haeckel, 1887.).

Actinomma haysi Bjorklund
Actinomma leptodermum (Jorgensen)

see also ? *Prunopyle antarctica* Dreyer

Actinomma antarcticum (Haeckel)

Spongoplegma antarcticum Haeckel, 1887, p. 90
Cladococcus aquaticus Popofsky, 1908, p. 214, pl. 23, figs. 3,4
Actinomma antarcticum (Haeckel), Nigrini, 1967, p. 26, pl. 2, figs. 1a-d.

Diploplegma (?) aquatica (Popofsky), Petrushevskaya, 1967, p. 18, fig. 9, I-III, fig. 10, I-IV

DESCRIPTION

"Cortical shell large, spherical, with a rough surface. Shell thickness varies from a single lattice plate with subcircular to subangular pores of different sizes to a thick spongy meshwork; intervening bars heavy.

"Numerous radial beams join the cortical shell to a superficially completely spongy medullary meshwork. However, by breaking open this meshwork a central subspherical shell having 2.5-3 subcircular pores on a half-equator can be seen.

"According to Hays (1965) the medullary meshwork is not always present, but from his extensive examination of Antarctic material he has concluded that forms with and without a central meshwork are conspecific." (from Nigrini,1967).

"Cortical shell large; spherical, spongy surface rough, varying greatly in thickness from a single mesh to a spongy network equaling one-quarter of the radius. In spite of spongy texture, pores usually well-defined, rounded, irregular in size and shape, ranging in diameter from 1 to 10 times the width of bars, 15 - 30 across diameter. Bars vary in thickness but tend to be rather heavy, about 8-15 wide, bearing very short thorns on each node. Some specimens show the development of a second and sometimes a third cortical shell. Texture of these inner shells similar to the outer cortical shell, but generally the bars are thinner.

"Cortical shell or shells connected to a loose, subspherical, spongy medullary meshwork without a central cavity by numerous radial rodlike beams (as many as 40) branching distally as they join spongy cortical shell.

"The medullary meshwork is not present in all specimens but the association of forms with and without this central meshwork in the same sample suggests that both are the same species. Also, numerous specimens have been observed without the medullary shell but with rodlike spines projecting radially from the inner surface of the cortical shell. Many of these spines show no evidence of breakage, which suggests that the medullary meshwork may develop later in the life cycle of the animal than the cortical shell." (from Hays, 1967, p. 165).

Plate 3, figures 1a,b,

2a,b, 3

Actinomma antarcticum (Haeckel)

A. antarcticum "may have one, two or three cortical shells. The most common form in our area is that with two cortical shells. These cortical shells may be very close to each other giving the appearance of a single thick shell, or the distance between the two shells may be as much as one-third of the radius of the outer shell. A few specimens were observed in which the medullary mesh is replaced by spongy tissue, in others it is poorly developed but generally it is clearly defined. Nigrini described the presence of a medullary capsule with a central cavity. This was not observed in the southern specimens but is present in specimens under subantarctic waters.

"Sometimes the medullary mesh is found without showing signs of being broken. Specimens with bars and the beginning of the cortical shell were also observed suggesting that growth of the shell proceeds from the central part to the cortical shell. Forms like the last two mentioned above may constitute a significant part of the total radiolarian fauna (2.6 percent in cores RC12-291 and RC15-96).

"North of about 45^{o}S, forms which fit better Nigrini's description of A. medianum become predominant. Generally they have a single cortical shell but sometimes they have a delicate extracortical shell, as Nigrini referred to it. In A. antarcticum the two cortical shells are equally well developed. According to Nigrini (1967), in A. medianum, the radial beams which extend from the outer surface of the medullary meshwork to the cortical shell, sometimes extend externally. These spines are better developed in specimens from cores RC11-117 to RC11-120 east of the Crozet basin. Specimens as small as 140 microns in diameter were observed. It is suggested here that the forms described by Nigrini as A. antarcticum and A. medianum are morhpological variants of the same species. Moore (1974) believes the same is true for A. medianum and A. arcadophorum. A more detailed study is necessary to reach a more definitive conclusion." (from Lozano, 1974).

DIMENSIONS

"Diameter of cortical shell 225-375μ of medullary shell 100-130μ" (from Hays, 1965).

REMARKS

1. For a more complete synonymy see Nigrini, 1967. The fact that this species can have up to three cortical shells may require some taxonomic revision. Petrushevskaya (1975, p. 571) places this species in the genus Rhizosphaera Haeckel emend. Holland and Enjumet, but she does not specify the placement of its two close relatives, A. medianum and A. arcadophorum. Therefore, all three species are left herein in the genus Actinomma until a more complete taxonomic revision can be made.

Actinomma antarcticum (Haeckel)

RECENT DISTRIBUTION

1. Hays, 1965, fig. 4; "Spongoplegma antarcticum is one of the most abundant species in the Antarctic fauna and in several samples constitutes over 50% of the species counted. Although the sampling in this area is not sufficient to be certain, there seems to be a tendency for this species to reach its greatest relative abundance in the vicinity of the Polar Front. Farther to the south Helotholus histricosa is apt to be the dominant species and to the north the Antarctic fauna is replaced by a warmer-water fauna. This situation is best illustrated in the series of cores V-16-57 through V-16-66 south and east of Africa. Exceptions to this pattern are also present, e.g., V-14-58, which lies well south of the Front and contains a relative abundance of S. antarcticum of over 50%.

"The stratigraphic range of this species is not known but in the Antarctic it occurs in zone ø; however, it may extend back as far as the Miocene if Plegmosphaera churchi and/or Rhodosphaera nipponica are synonymous with S. antarcticum."

2. Lozano, 1974, fig. IV-15; "This species accounts for 1 to 6 percent of the Radiolarian in samples south of the average position of the APF. It reaches relatively high values along the APF and immediately to the north (13.5 percent in RC8-44). In the Atlantic it is found only south of 40^{0}S except for the samples in the northwestern part of the Argentine Basin. It is generally present under subantarctic waters in the Indian Ocean sector. It reaches maximum abundance in core V14-64A (18.9 percent) under southern subantarctic waters. In the Indian Ocean it is found in some samples north of the subtropical convergence but invariably they can be interpreted as being transported by bottom currents or as intermediate forms which could be classified as Actinoma medianum, according to Nigrini (1967). The transported specimens can be distinguished by the presence of two equally developed cortical shells.

"Except for cores RC14-12A (1.7 percent) and RC11-104 (2.2 percent) with typical Antarctic forms, it is not found in proportions over one percent under August surface temperatures over 8^{0}C. Maximum August temperature under which it is found is 14^{0}C in the Indian Ocean (RC8-36) and over 15^{0}C in the Argentine basin (V18-155)."

Actinomma arcadophorum Haeckel

Actinomma arcadophorum Haeckel, 1887, p. 225, pl. 29, figs. 7,8; Nigrini, 1967, p. 29, pl. 2, fig. 3

DESCRIPTION

"Similar to Actinomma medianum, but cortical shell is generally larger and much more delicate with many more pores and thinner bars. Radial spines more numerous, occasionally supporting an extracortical shell.

"Medullary shell and meshwork as in A. medianum and A. antarcticum but more delicate." (from Nigrini, 1967).

DIMENSIONS

"Diameter of cortical shell 191-236μ of medullary meshwork 81-100μ. Inner medullary capsule approximately one-third the diameter of the medullary meshwork." (from Nigrini, 1967).

Plate 3, figure 4

Actinomma arcadophorum Haeckel

RECENT DISTRIBUTION

1. Nigrini, 1967, fig. 12; "Indian Ocean occurrences - A. arcadophorum is sparsely distributed in low latitudes and does not occur in middle latitude samples. Though rather rare in Recent sediments, it appears to be a useful member of the low latitude assemblage."

2. Nigrini, 1970, fig. 10; belongs to a tropical assemblage derived by recurrent group analysis of North Pacific samples, but the species does range as far north as 40°N in the western Pacific.

3. Molina-Cruz, 1975; "It is assumed that this species is a morphological variant of A. medianum and is grouped with this species in the counts."

Actinomma medianum Nigrini

Actinomma medianum Nigrini, 1967, p. 27, pl. 2, figs. 2a, b.

DESCRIPTION

"Cortical shell a somewhat irregular sphere, thin-walled, with 9-12 subcircular to subangular pores on a half-equator.

"Medullary meshwork irregular, more delicate than, but otherwise similar to, that of Actinomma antarcticum, with an internal shell having 2.5-3 subcircular pores on a half-equator.

"Numerous radial beams extend from the outer surface of the medullary meshwork to the cortical shell and sometimes extend externally. Additional, more delicate spines, originating on the cortical surface, are present in some specimens. Occasionally, these spines support a delicate extracortical shell.

"... the species exhibits characters intermediate between A. antarcticum and A. arcadophorum. It may be distinguished from the former by its simply latticed cortical shell and more delicate medullary meshwork, and from the latter by its larger cortical pores and heavier medullary meshwork." (from Nigrini, 1967).

DIMENSIONS

"Diameter of cortical shell 164-227μ; of medullary shell 81-100μ. Inner medullary capsule approximately one-third the diameter of the medullary meshwork." (from Nigrini, 1967).

"cortical shell diameter, 221± 32μ; diameter of spongy medullary structure, 101± 5μ; (based on measurements of 11 specimens)" (from Sachs, 1973).

REMARKS

1. Benson's (1966) description and dimensions of this species (Diplopleгma banzare Riedel in Benson, p. 134) are consistent with the above.

2. "Nigrini (1967) described this species as having characteristics intermediate between Actinomma antarcticum (Haeckel) and Actinomma arcadophorum Haeckel. All three species were encountered in this study. Nigrini's differentiation between these species can be extended to the South Atlantic. A. antarctica usually has two heavy cortical shells, where A. medianum has only one cortical shell. A. arcadophorum is distinguished in the study area by its large, delicate cortical shell containing many small pores." (from Morley, 1977).

Plate 3, figures 5,6

Actinomma medianum Nigrini

RECENT DISTRIBUTION

1. Benson, 1966 (Diploplegma banzare);"This species has a much greater occurrence in the northern Gulf than in the central or southern parts [which] may reflect its tolerance of higher salinity and temperature.

2. Nigrini, 1967, fig. 11; "Distribution of A. medianum in the Indian Ocean is also intermediate between that of A. antarcticum and A. arcadophorum. A. antarcticum is found in cold (Antarctic) water, A. medianum in cool (middle latitude) water and A. arcadophorum in warm (low latitude) water."

"Indian Ocean occurrences - A. medianum is almost completely absent from low latitudes, but forms 6 percent to 12 percent of the described population in middle latitude samples. The species is present in high latitudes, but is far out-numbered by A. antarcticum. A. medianum appears to be a reliable and potentially useful member of the middle latitude assemblage."

3. Nigrini, 1970, fig. 9; belongs to a transitional assemblage derived by recurrent group analysis of North Pacific samples, although it does occur rarely in tropical sediments.

4. Sachs, 1973, Code 8S + 22S, figs. 2A; "Occurs to 7% of total fauna, and exhibits strong Southern (Transitional Factor) preferences." Southern is south of about 45°N.

5. Molina-Cruz, 1975, Code S3; counted together with A. arcadophorum and used in factor analysis of southeast Pacific assemblages; cf. Appendix 10 for percent S3 at each station.

6. Robertson, 1975; "The medullary shell of A. medianum is frequently encountered and is included in the counts of this species... This species loads most heavily in factor 3 (transitional). At the present it occurs most frequently between 35° and 43°N. At 18,000 YBP higher abundances are found farther to the south."

7. Morley, 1977; Fig. I-7; "This species loads highest in factor 3 (gyre margin). Although it appears to have a somewhat cosmopolitan distribution, this species is most common in samples between 45° and 52°S at present. Lower abundances in most areas are characteristic of this species' distribution 18,000 YBP."

Actinomma haysi Bjorklund

Echinomma leptodermum Jorgensen, Hays, 1965, p. 169, pl. 1, fig. 2
Hexacontium cf. heteracantha (Popofsky), Benson, 1966, p. 156, pl. 4, figs. 6-7.
Hexacontium cf. hericliti (Haeckel), Benson, 1966, p. 158, pl. 4 figs. 8-10.
Echinomma sp. Bjorklund, 1973 (in table).
Actinomma sp. group aff. Hexacontium arachnoidale Hollande and Enjumet, Petrushevskaya and Kozlova, 1972, p. 515, pl.9, figs. 4-7.
Not Echinomma leptodermum Jorgensen, 1900, p. 57., Jorgensen, 1905, p. 116, pl. 8, fig. 33a-c.

DESCRIPTION:

"An actinommatin characterized by a heavy, spiny third cortical shell furnished with needle-shaped by-spines. 8-15 radial main spines, usually about 10....

"Skeleton consists of three, occasionally four concentric shells. Outermost (fourth) shell very rarely completely developed, in most cases only indicated as transverse processes on the spines. The cortical (third) shell is spherical, 130-240μ, thick-walled, rarely thin-walled, pores very unequal in size, 5-30μ, commonly circular to oval but also polygonal pores may occur. On the bars, where the pores join, small nodes extend, often armed with short thorn-like to needle-shaped by-spines, in some specimens half the length of the main spines. The middle (second) shell is thin-walled, 44-68μ, irregular in outline, pores circular to subcircular, almost equal in size, 5-7μ. Surface smooth with scattered needle-shaped by-spines. Main spines start out from the middle shell, about 8-15 in number, three-bladed, about half the diameter of the third shell of equal breadth between the cortical and the middle shell. At the base where they pierce the cortical shell, they are two to three times broader than between the cortical and middle shells. Innermost (first) shell spherical, 20-27μ, thin-walled, with large polygonal pores. The innermost shell connected to the middle shell by thin radial beams, which are more numerous than the radial beams that connect the middle and the cortical shell; the latter beams continue outside the cortical shell as main spines". (from Bjorklund, 1977).

DIMENSIONS:

"cortical shell 209μ, middle shell 57μ, and innermost shell 22μ". (from Bjorklund, 1977).

REMARKS: 1. For further taxonomic notes see Bjorklund, 1977.

cf. Bjorklund, 1977
for illustrations

Actinomma haysi Bjorklund

RECENT DISTRIBUTION

1. Hays, 1965, fig. 15 (Echinomma leptodermum): "It has not been observed in the tops of cores taken from south of the Polar Front. In surface sediments from north of the Polar Front Echinomma leptodermum together with Axoprunum stauraxonium frequently constitute the major part of the radiolarian fauna."

2. Bjorklund, 1977; see text-figure 2 and text for Atlantic Ocean occurrences and significance of size variation.

3. Morley, 1977; "This species loads highest in factor 4 (subtropical). At present it occurs most frequently in the central southern portion of the Subtropical Gyre and is absent in most samples south of 47°S. At 18,000 YBP this species is absent in all samples south of 39°S and appears to be slightly more abundant in tropical samples when compared to today's values."

Actinomma leptodermum (Jorgensen)

Echinomma leptodermum Jorgensen, 1900, p. 57; 1905, p. 116, pl. 8, figs. 33a-c.
Actinomma sp., Benson, 1966, p. 164 (partim.), pl. 5, fig. 6 (only)

DESCRIPTION AND DIMENSIONS

"The outer ball thinwalled (the walls broader than they are thick). The pores polygonally roundish oval, very uneven in size, 7-25 μ, with intermediate walls (2-4μ broad), which are much broader towards the corners (lumen rounded off).

"The middle shell moderately thick (the intermediate walls being as thick as they are wide, about 1½ μ), rather angular and irregular, a little larger than in Hexacontium enthacanthum; diameter about 40μ. The pores somewhat uneven, roundish, 4-7μ. The intermediate walls solid, not particularly broader in the corners.

"It is difficult to see the inmost shell, which possesses solid beams (about equal in thickness to those of the middle shell), but rather few polygonal, mostly pentagonal or hexagonal pores, about 8 μ. The diameter of the inmost shell about 15μ (or a little more).

"About 15 main spines, about equally broad inside as outside of the outmost shell, not long. They seldom protrude farther than to a length equal to the distance between the two outer shells, often less, and vary in development. Between the two inner shells, the radial spines are very narrow and in fact hardly wider than the beams of the inmost shell.

"The byspines on the outside shell are in appearance like the main spines, but not radially lengthened inwards, with a wide base on the outer shell (like the main spines) and very unevenly developed in size, although generally protruding less than the main spines. Variable in number; although, as a rule, not many, far from being developed in all the corners, only here and there.

"The number of the main spines is variable often only about 10, though oftenest about 15. They are 3-edged....there are forms without outer shells, but there is generally a trace of these in transverse processus on the main spines. These may, however, also be entirely absent...

"This species also varies a good deal. When the outside shell is thin-walled, the pores and intermediate walls are of a more uneven size. The byspines are in such cases slightly developed or (as yet) wanting.

"It is likely that these divergences may be accounted for by a difference in age. A more important difference is the number of main spines, which seems to be able to vary from 10 to 16." (from Jorgensen, 1905).

Plate 3, figure 7

Actinomma leptodermum (Jorgensen)

RECENT DISTRIBUTION

1. Benson, 1966 (Actinomma sp.); rare or absent in all Gulf of California stations.

2. Sachs, 1973,Code 7S (Actinomma sp.); "Occurs preferentially in Southern samples, with maximum frequency 3%. Anomalous indication (2%) at Northern count [024] due to an uncorrected error: Specimens of another species, probably Hexacontium enthacanthum were incorrectly included with the present species, although the former has significantly fewer spines (5-6 vs. 10-12)." Southern is south of about 45°N.

3. Molina-Cruz, 1975, Code S4 (Actinomma sp.); not used in factor analysis of southeast Pacific assemblages; cf. Appendix 10 for percent S4 at each station.

4. Robertson, 1975 (Actinomma spp.); "This group loads most heavily in factor 3 (transitional). At the present it occurs most frequently in the northwest Pacific north of 35°N. At 18,000 Y.B.P. there is no discernible shift in its distribution."

5. Morely, 1977 (Actinomma spp.1); "This taxonomic group loads highest in factor 3 (gyre margin). At present it occurs most frequently in samples located between 25° and 45°S. At 18,000 Y.B.P. its over-all abundance decreased and the region of its maximum concentration shifted 5° to 10° northward."

NOTE: There is considerable variation between authors concerning the limits of this species. Comparison of distributional data should be made with caution.

Anomalacantha dentata (Mast)

Heteracantha dentata Mast, 1910, p. 157, Nigrini, 1970, p. 167, pl. 1, fig. 9

Cladococcus lychnosphaera Hollande and Enjumet, 1960, p. 115, pl. 55, figs. 1, 2

Anomalacantha dentata (Mast), Benson, 1966, p. 170, pl. 5, figs. 10, 11

DESCRIPTION

"Small, spherical, latticed shell from which originate 8-12 or more long, broad, regularly arranged, three-bladed radial spines, each with thorns or lateral branches originating from the blades at 2-5 or more verticels. Pores of shell circular, of equal size, 5-6 on half the shell circumference, surrounded by well defined, hexagonal frames. Surface of shell either smooth, thorny, or with thin, conical, often distally forked, secondary spines of variable length (up to 25μ), all originating singly from the nodes of the intervening bars. In fully developed tests a verticel of long, arborescently branched lateral spines is present on each main spine. All verticels at a common distance from the center of the test. The lateral, arborescent branches do not anastomose with those of adjacent main spines; therefore, an outer shell is not developed." (from Benson, 1966).

DIMENSIONS

"Based on 30 specimens: diameter of shell 53-69μ; length of radial spines 166-246μ, breadth at their bases 6-12μ." (from Benson, 1966).

REMARKS

1. The generic name Anomalacantha was proposed by Loeblich and Tappan (1961) because they found the name Heteracantha to be previously occupied.

Plate 4, figure 4

Anomalacantha dentata (Mast)

RECENT DISTRIBUTION

1. Benson, 1966; "... nearly cosmopolitan in the Gulf [of California] and undergoes a marked increase in frequency in the northern half of the Gulf."

2. Nigrini, 1970, fig. 8; "according to Benson (1966), this species is widespread in Holocene tropical seas. This was not found to be the case by the author." Belongs to a transitional assemblage derived by recurrent group analysis of North Pacific samples.

3. Sachs, 1973, Code 19S; "The species is always rare (less than 3%), and consequently is patchily distributed. It loads on the Transition (Southernmost) factor."

4. Robertson, 1975; "This species loads most heavily in factor 3 (transitional). At the present its highest abundances are in a small region centered at 40^{o}N and east of 155^{o}W. It is absent north of about 46^{o}N except for rare occurrences in three samples. At 18,000 YBP it is essentially absent north of about 40^{o}N."

Cenosphaera coronata Haeckel

Cenosphaera coronata Haeckel, 1887, p. 67, pl.26, fig. 11

DESCRIPTION:

Shell consists of a single, rough thick-walled latticed sphere. Pores irregular in size, shape and distribution. Each pore surrounded by a characteristic raised frame. (Gail Lombari, unpublished data).

DIMENSIONS:

Based on 10 specimens. Shell diameter 186-192μ. (Gail Lombari, unpublished data).

Plate 4, figure 1

Cenosphaera coronata Haeckel

RECENT DISTRIBUTION:

1. Molina-Cruz, 1975, Code S21; used in factor analysis of southeast Pacific sediments; cf. Appendix 10 for percent S21 at each station.

Cenosphaera cristata Haeckel?

Cenosphaera cristata Haeckel, 1887, p. 66; Riedel, 1958, p. 223, pl. 1, figs. 1, 2

DESCRIPTION

"Spherical shell thick-walled, thorny. Pores subcircular or circular, variable in size, 10-24 on the half-equator, as wide to five times as wide as the intervening bars. Pores surrounded by raised polygonal frames bearing short thorns at the corners - in rare specimens the polygonal frames are absent but the thorns present... a large number of species of Cenosphaera have been described, in many instances inadequately, from both high and low latitudes, and the pattern of distribution of members of this group cannot be determined until the relationships between the various species are more satisfactorily understood." (from Riedel, 1958).

See also Petrushevskaya (1967) for further discussion of specific variability.

DIMENSIONS

"Diameter of shell 115-230μ" (from Riedel, 1958).

REMARKS

1. For a more complete synonymy see Petrushevskaya (1975).

Plate 4, figures 2a,b

Cenosphaera cristata Haeckel?

RECENT DISTRIBUTION

1. Molina-Cruz, 1975,Code S5 ; not used in factor analysis of southeast Pacific assemblages; cf. Appendix 10 for percent S5 at each station.

2. Robertson, 1975; "This species loads most heavily in factor 3 (transitional). At the present this species is most abundant in a band between about 40^{o} and 45^{o}N. It is absent in the extreme northern and southern portions of the study area. At 18,000 YBP it is absent north of about 43^{o}N and is restricted to a narrow band centered at 40^{o}N except for two samples to the west."

Cenosphaera spp.

DESCRIPTION AND DIMENSIONS

"The specimens included in this group are several forms which all have spherical shells lacking any internal stucture or spines. The pores are rounded to subrounded and regularly disposed with 8-14 on a diameter; most specimens are thick-walled. The shell itself is quite smooth and lacks marked ridges between the pores. Only those specimens greater than 90µ in diameter were counted." (from Robertson, 1975).

"The species composing this group all have spherical shells with no apparent internal structure or spines. The description of this group given by Robertson (1975) is followed except that all species in the study contained round pores regularly disposed, with 10-14 on a diameter. The shell in all cases was smooth with no ridges between the pores. Only specimens between 90µ and 150µ in diameter were counted." (from Morley, 1977).

Plate 4, figures 3a-d

Cenosphaera spp.

RECENT DISTRIBUTION

1. Robertson, 1975; "This group loads most heavily in factor 2 (subtropical). Its present distribution is almost cosmopolitan with lowest abundances in the Sea of Okhotsk and Bering Sea. At 18,000 YBP higher abundances are restricted to the south except for an unexplained extension to the north at about 160°E."

2. Morley, 1977; Fig. I-12; "This group loads highest in factor 3 (gyre margin). At present this generally cosmopolitan group is found most frequently in samples under subantarctic and southern subtropical waters. In addition to a general decrease in abundance at 18,000 YBP, the maximum area of concentration of this group is displaced northward by approximately 7°."

Hexacontium enthacanthum Jorgensen

Hexacontium enthacanthus Jorgensen, 1899, p. 52, pl. 2, fig. 14, pl. 4, fig. 20
Hexacontium entacanthum Jorgensen, Benson, 1966, p. 149, pl. 3, figs. 13, 14, pl. 4, figs: 1-3.

DESCRIPTION

"Cortical shell generally spherical but varies from subspherical to sub-octahedral and in a few specimens has a subquadrate outline; surface ranges from completely smooth to generally one with thorns or thin conical by-spines which arise at the nodes of intervening bars as well as along the bars; in one specimen the by-spines branch and anastomose distally at a common distance from the cortical shell to form a secondary outer shell; pores subcircular or subelliptical, subpolygonal, or in a few tests with irregular shapes, subequal in size in most tests but in a few with unequal size, with subregular (hex-agonal) to irregular arrangement, with or without polygonal frames, in most specimens 8-9 on the half circumference but ranging from 7-13. Second shell spherical to subspherical, thin-walled, with surface ranging from smooth to one with scattered thorns or thin conical spines which in a few specimens join with the cortical shell to form thin secondary beams; pores subpolygonal to polygonal, unequal to subequal in size, with irregular to subregular arrange-ment, generally 6-8 on the half circumference but ranging from 5-10. First shell thin-walled, subspherical to suboctahedral, with 2-3 relatively large polygonal pores on the half-circumference. Each of the six mutually perpen-dicular radial beams arise from the corners of the suboctahedral inner shell, remain thin and cylindrical until they pierce the second shell after which they are relatively heavy and three-bladed in section. Beams continue beyond cortical shell as relatively heavy and in several specimens very long three-bladed spines, all six nearly of equal length and breadth. In several speci-mens not all beams and spines are mutually perpendicular; some specimens have seven or eight beams, the extra beams representing either bifurcations of one or more of the six primary beams at the level of either the first or second shell or separate beams arising from the first shell and with no regular rela-tionship to the six primary beams; a few specimens observed with only five of the six primary beams present." (from Benson, 1966).

DIMENSIONS

"diameter of cortical shell 74-154μ, of second shell 30-50μ, of first shell 12-22μ; average length of main spines per specimen 9-112μ." (from Benson, 1966).

REMARKS:

1. Erroneous spelling in Benson (1966) has been repeated by numerous subsequent investigators.

Plate 5, figures 1a,b

Hexacontium enthacanthum Jorgensen

RECENT DISTRIBUTION

1. Benson, 1966; "This species is present at all stations in the Gulf [of California] except 214. It is one of the most abundant spumelline species found in the Gulf sediments... Its rare or nearly rare occurrence in the southern Gulf and its general increase northward indicates that it is a normal member of the tropical Pacific oceanic fauna and that it inhabits water masses with slightly higher salinity and temperature."

2. Sachs, 1973, Code 6S (Hexacontium spp.); "Forms enountered in the present study generally fitted Benson's descriptions of H. enthacanthum and H. laevigatum, but were not divided. Shell spherical to subquadrate, smooth to hexagonally-framed pores, generally six mutually perpendicular spines, but a seventh occasionally present. Spines variably developed, but about a length of outer shell radium...

"Strongly Southern [south of about 45°N] , with maximum frequency to 5%. (There is also a Northern Hexacontium, which was mixed with Actinomma sp. in this study)."

3. Molina-Cruz, 1975, Code S17; used in factor analysis of southeast Pacific assemblages; cf. Appendix 10 for percent S17 at each station.

4. Robertson, 1975 (Hexacontium spp.);

"The description of this genus as given by Benson (1966) was followed but the innermost shell was frequently very difficult to discern. All forms in this genus are counted except those forms in which the outer shell was subquadrate rather than spherical.

"This genus loads most heavily in factor 3 (transitional). At present its higher abundances generally occur south of 45°N. At 18,000 YBP comparable abundances are found south of about 40°N."

Hexacontium laevigatum Haeckel

Hexacontium laevigatum Haeckel, 1887, p. 193, pl. 24, fig. 6; Benson, 1966, p. 154, pl. 4, figs. 4,5

DESCRIPTION

"Cortical shell generally spherical to subspherical but ovoid or ellipsoidal or with subquadrate outline in several specimens; surface generally smooth except in several specimens with a concentration of short, thin, conical by-spines around one of the six main spines, the larger spine in those tests with one spine larger than the remaining five; pores circular to subcircular, small, equal, as wide as or slightly less than the width of intervening bars, with generally regular hexagonal arrangement, without polygonal frames, 12-16 on the half circumference. Second shell spherical to subspherical, surface smooth to slightly thorny, with subcircular to subpolygonal, subequal pores with subregular arrangement 6-8 on the half circumference. First shell subspherical to subpolyhedral, thin-walled, barely visible in many specimens, with 2-3 large polygonal pores on its half circumference. Six, rarely five or seven, mutually perpendicular radial beams that arise from the surface of the inner shell are heavy and three-bladed between the second and third shell and extend beyond the cortical shell as three-bladed, in a few tests conical, spines or thorns. In most specimens the six spines are of nearly equal length, but in several one spine is longer (up to 30μ) and heavier, located at one of the poles of the major axis if the cortical shell is ellipsoidal or ovoid, and surrounded by numerous thin conical by-spines, the remaining five main spines being shorter (as short as 8μ) or present as short thorns. In a few tests one or more of the beams and/or spines are not mutually perpendicular to the others.

..."This species differs from H. entacanthum Jorgensen by its generally smooth surface, it's smaller diameter, the presence of more numerous and smaller, more nearly equal circular pores of the cortical shell, the presence of numerous thin by-spines concentrated at one pole of the shell, and in the presence of unequal main spines in numerous specimens." (from Benson, 1966).

DIMENSIONS

"diameter of cortical shell (including average of larger and smaller diameters of ovoid or ellipsoidal shells) 77-103μ of second shell 30-46μ, of first shell 12-17μ; length of main spines 10-65μ." (from Benson, 1966).

Plate 5, figures 2a,b

Hexacontium laevigatum Haeckel

RECENT DISTRIBUTION

1. Benson, 1966; rare or absent in Gulf of California sediments.

2. Molina-Cruz, 1975, Code S17A ; not used in factor analysis of southeast Pacific assemblages; cf. Appendix 10 for percent S17A at each station.

3. Robertson, 1975; cf. *Hexacontium enthacanthum* .

Ommatartus tetrathalamus tetrathalamus (Haeckel)

Panartus tetrathalamus Haeckel, 1887, p. 378, pl. 40, fig. 3; Nigrini, 1967, p. 30, pl. 2, figs. 4a-4d.
Panartus tetrathalamus tetrathalamus Haeckel, Nigrini, 1970, p. 168, pl. 1, fig. 12

DESCRIPTION

"Terminology is that proposed by Riedel (1957, p. 76). Cortical twin-shell constricted equatorially, with subcircular to subangular pores, having no definite arrangement, sometimes hexagonally framed; surface usually rough, spiny. Polar caps, when present, hemispherical to conical, approximately the same breadth as cortical twin-shell, supported by about 12 spines. Caps generally more delicate than twin-shell, with smaller pores and smoother surface. There are approximately equal numbers of specimens with and without single polar caps; rarely, completely or incipiently double-capped specimens are found. A few specimens have a delicate lateral meshwork supported by numerous rods, usually around the twin-shell, but sometimes extending around the caps. There is a tendency for middle latitude forms to develop rather stout unbranched spines, either on the distal ends of the cortical twin-shell or on the polar caps. Such forms are rare in low latitudes.

"Outer medullary shell lenticular, inner one spherical; radial beams connect outer medullary to twin-shell at the equatorial constriction." (from Nigrini, 1967).

DIMENSIONS

"Length of cortical twin-shell 90-136μ; of polar caps 36-63μ. Maximum breadth of cortical twin-shell 72-109μ." (from Nigrini, 1967).

"cortical length 116± 12μ, cortical minimum width 83 ± 5μ, width at constriction 67 ± 12μ(based on 15 specimens)" (from Sachs, 1973).

REMARKS

1. For a more complete synonymy see Nigrini, 1967. The nominate subspecies permits distinction from O. tetrathalamus coronatus (see below). See Riedel (1971) for explanation of change in generic assignment.

2. Benson's (1966) description and detailed dimensions of this species (Zygocampe chrysalidium Haeckel in Benson, p. 193) are consistent with the above.

Plate 6, figures 1a-d

Ommatartus tetrathalamus tetrathalamus (Haeckel)

RECENT DISTRIBUTION

1. Benson, 1966 (*Zygocampe chrysalidium*); "In the Gulf [of California] this species is cosmopolitan... It is rare in all stations except 90 (7.4%), 92 (2.4%), 184 (2.2%), 194 (7.5%) and 206 (3.0%)... In general, its frequency in the southern Gulf is slightly greater than that in the northern Gulf..."

2. Nigrini, 1967, fig. 13; "Indian Ocean occurrences - *P. tetrathalamus* is abundant in low latitudes, forming up to 29 percent (usually 9% to 22%) of the described population. South of 35°S only a very few specimens have been observed. The species appears to be a reliable and potentially useful member of the low latitude assemblage."

3. Nigrini, 1968, text fig. 12; "Common to abundant throughout most of the equatorial region of the study area, decreasing in abundance to the north in the region of the North Equatorial Current and also in the 2 southernmost samples examined."

4. Nigrini, 1970, fig. 11; belongs to a tropical assemblage derived by recurrent group analysis of North Pacific samples, but ranges as far north as 40°N right across the Pacific.

5. Sachs, 1973, Code 28I; counted together with *O. tetrathalamus coronatus*; "this species is essentially absent in the extreme Southeast, and is only significant (2.8%) at count [042], from RC12:403:TW:0-2.

6. Lozano, 1974, Fig. IV-6; "It reaches a maximum of 2.4 percent of the total radiolarian fauna in cores V29-80 and V27-191 under subtropical waters. It is found under the northernmost reaches of the subantarctic waters and in the eastern samples of the Atlantic Ocean, probably due to the Agulhas current influence.

"Minimum February sea surface temperature under which it is found is 8°C (core RC11-67).

"West of 0°C longitude, it may constitute more than one percent of the total radiolarian fauna only under February sea surface temperatures greater than 21°C. East of 0° longitude it may account for more than one percent of the fauna only under February sea surface temperatures greater than 17°C."

7. Molina-Cruz, 1975, Code S23; counted together with *O. tetrathalamus coronatus* and used in factor analysis of southeast Pacific assemblages; cf. Appendix 10 for percent S23 at each station.

Ommatartus tetrathalamus tetrathalamus (Haeckel)

8. Robertson, 1975; counted together with O. tetrathalamus coronatus; "This species loads most heavily in factor 2 (subtropical 25° to 35°N). At present, its greatest abundances are found to the extreme south and at 18,000 YBP comparable abundances are shifted about 5° to the south."

9. Morley, 1977, Fig. I-13; counted together with O. tetrathalamus coronatus; "This species loads highest in factor 1 (tropical). At present this species occurs most frequently in samples from the central and western tropical and subtropical South Atlantic. It is absent in samples south of 35°S. Although the 0% contour does not appear to be displaced northward at 18,000 YBP, the lack of samples in the subtropical and western tropical regions make it difficult to assess any possible changes in distribution pattern at this level."

Ommatartus tetrathalamus coronatus (Haeckel)

Cyphinidium coronatum Haeckel, 1887, p. 372.
Panartus tetrathalamus coronatus Haeckel, Nigrini, 1970, p. 168, pl. 1, figs. 13, 14

DESCRIPTION

"This subspecies is identical in all respects to *P. tetrathalamus tetrathalamus*, except for the development of a corona of stout, unbranched, 3-bladed spines on the distal ends of the cortical twin-shell and/or on the polar caps. When polar caps are present, the spines commonly extend without interruption beyond the point of junction with the cap. There may be as many as 9 or 10 spines on each end of the cortical twin-shell which is, in general, smaller than that of *P. tetrathalamus tetrathalamus*." (from Nigrini, 1970).

DIMENSIONS

"(based on 20 specimens). Length of cortical twin-shell 96 to 119μ. Maximum breadth of cortical twin-shell 64 to 88μ. Maximum length of polar spines 56μ." (from Nigrini, 1970).

Plate 6, figures 2 a,b

Ommatartus tetrathalamus coronatus (Haeckel)

RECENT DISTRIBUTION

1. Nigrini, 1970, fig. 12; belongs to a transitional assemblage derived by recurrent group analysis of North Pacific samples.

2. Sachs (1973), Moore (1974), Molinz-Cruz (1975) and Robertson (1975) all combined this species with *O. tetrathalamus tetrathalamus* in their counts.

Stylatractus spp.

? Stylatractus neptunus Haeckel, 1887, p. 328, pl. 17, fig. 6; Riedel, 1958, p. 226, pl.1, fig. 9.

? Stylatractus sp. Petrushevskaya, 1967, p. 27, fig. 15, I-IV.

DESCRIPTION:

"Shell ellipsoidal, consisting of three concentric lattice shells and two unequal polar spines. Innermost shell spherical or subspherical, thin-walled, with numerous circular or subcircular pores, joined to the second shell by few radial beams. Second lattice-shell somewhat ellipsoidal, usually thick-walled, with large subcircular or angular pores, joined to the outermost lattice-shell by numerous radial beams. Outermost lattice shell ellipsoidal, thick-walled, thorny, with irregular pores (7-16 on a half-equator) which are large when a few in number, and are in many specimens subdivided by centripetal ingrowths from the pore-walls to form numerous smaller pores. Polar spines heavy, usually cylindro-conical and fluted at the base, rarely weakly three-bladed." (from Riedel, 1958).

DIMENSIONS:

Based on 21 specimens. "Major diameter of outermost lattice-shell 130-150μ, its minor diameter 115-140μ. Major diameter of second lattice-shell 75-85μ, of innermost lattice-shell 30-40μ. Length of longer polar spine 55-95μ, of shorter polar spine 30-75μ." (from Riedel, 1958).

Eleven specimens from about 25°N in the Eastern Pacific were found to be generally smaller than those measured by Riedel in the Antarctic (Gail Lombari, personal communication).

REMARKS:

1. Benson (1966) described 2 similar species, i.e., Xiphatractus cronos (Haeckel) and Xiphatractus pluto (= S. neptunus Haeckel according to Benson): X. cronos "differs from [X. pluto] in the thinner wall of the cortical shell (3-5μ), the lack of small, circular, secondary pores filling the spaces of the larger pores of the cortical shell, and in generally less robust polar spines."

2. "The North Pacific form is robust, with markedly elliptical cortical shells. "Rosettes" occasionally developed in cortical shell pores. Polar spines almost aways coaxial....A second form marked by a smaller, lighter, cortical shell with large open pores and polar spines consider-

Plate 7, figures 1 a,b

Stylatractus spp.

REMARKS:

ably longer than the cortical shell diameter is also present, but is not included with this species. It is considerably less abundant." (from Sachs, 1973).

3. According to Molina-Cruz (1975) "this species group is distinguished from Stylosphaera lithatractus by its generally smaller size and strongly bladed polar spines."

4. "The internal characteristics and variations in spine dimensions in the species which compose this group vary widely." (from Morley, 1977).

RECENT DISTRIBUTION

1. Riedel, 1959; "Specimens closely resembling those from the Antarctic have been found in the northern Pacific, and in the tropical parts of the Pacific and Indian oceans....it may thus be a cosmopolitan species."

2. Sachs, 1973, Code 13S; "Widely distributed, to 5% of fauna, and concentrated in Polar (Northermost) and bottom-influenced factors."

3. Molina-Cruz, 1975, Code S51; used in factor analysis of southeast Pacific assemblages; cf. Appendix 10 for percent S51 at each station.

4. Robertson, 1975; "The shape of the spines and degree to which the internal structure of these forms could be distinguished is highly variable.... This species loads most heavily in factor 1 (subpolar). Its greatest abundances both at the present and 18,000 YPB are found north of about 45^{0}N. There is evidence for a slight southern shift of the zone of highest abundance from the present to 18,000 YBP".

5. Morley, 1977, fig. I-15; "This group of species loads highest in factor 4 (subtropical). This species has a general cosmopolitan distribution at present and 18,000 YBP. No major changes in distribution pattern appear to occur between today and 18,000 YBP."

Axoprunum stauraxonium Haeckel

Axoprunum stauraxonium Haeckel, 1887, p. 298, pl. 48, fig. 4;
Hays, 1965, p. 170, pl. 1, fig. 3

DESCRIPTION

"Shell ellipsoidal, showing considerable variation in thickness, the thicker individuals having rougher surfaces. Pores evenly spaced, circular to subcircular, in some specimens pores have double edges, pores 4-6 times bar width, 12-18 along major axis, 8-12 across minor axis. Shell bears 2 unequal polar spines, cylindrical to conical, weakly three-bladed at base. Medullary shell thin-walled, subspherical, occasionally double, more commonly single, pores subcircular, 6 across equatorial diameter, shell supported by internal extensions of polar spines plus 6 radial beams lying in or near the equatorial plane. Radial beams thin, but thicken at each end. Often the medullary shell is missing, especially in thin-shelled individuals; however, the radial beams are almost always present."(from Hays, 1965).

"Heavy shelled specimens sometimes are similar to Druppatractus acquilonaris but A. stauraxonium is smaller in size (>165μ along the major axis" (from Robertson, 1975).

DIMENSIONS

"Length of major axis 145-165, of minor axis 125-145, of long polar spine 55-80, of short spine 40-60. Diameter of medullary shell 30-45." (from Hays, 1965).

REMARKS

1. According to Petrushevskaya (1975, p. 570) this genus may be distinguished from Stylosphaera by the position of the rods joining the medullary and cortical shells. In Axoprunum, except for the polar spines, they all lie approximately in the equatorial plane. It differs from the genus Stylatractus (which Petrushevskaya, 1975, synonymized with Amphisphaera) by having polar spines longer than the major axis of the cortical shell. This latter distinction is questionable since the polar spines of the type species (cf Haeckel, 1887, pl. 48, fig. 4) are shorter than the major axis of the cortical shell.

Plate 7, figures 2,3

Axoprunum stauraxonium

RECENT DISTRIBUTION

1. Hays, 1965 (Fig. 13); "A. stauraxonium is one of the most abundant and widespread of those species found in the tops of cores north of the South Polar Front. Its presence in the lower part of V-16-66 (zone ø) indicates that it extends back in time at least as far as the time represented by this zone. It does not occur, however, in the other cores containing the red clay fauna; thus it seems that in the past, as today, it was excluded from the colder southern waters of the area."

2. Molina-Cruz, 1975, Code S50; counted together with Stylosphaera lithatractus Haeckel and used in factor analysis of southeast Pacific assemblages; cf. Appendix 10 for percent S50 at each station.

3. Robertson, 1975; "This species loads in factor 2 (subtropical). At the present its occurrence is limited to the region southeast of a line running from 35°N, 145°E to 50°N, 180°. At 18,000 YBP it is absent north of about 38°N, except for a small occurrence in V20-119 which may be an incorrect identification."

4. Morely, 1977 (Axoprunum spp.), Fig. I-11; "The description of this species given by Haeckel (1877) is followed. Haeckel did not include a spherical medullary shell in this original description. Although this species is probably identical to A. stauraxonium, it is referred to in this study as Axoprunum spp. This species loads highest in factor 4 (subtropical). At present this species is absent in almost all samples south of 40°S. Because of the absence of samples in the subtropical region at 18,000 YPB, it is difficult to ascertain variations in distribution of this species at this level."

Notes on the Genera Ommatogramma, Spongurus and Spongocore

According to Haeckelian systematics the genus Ommatogramma belongs to the Family Euchitoniidae and has a central structure composed of concentric rings. However, Ehrenberg's (1872b)illustration of the type species, O. naviculare, does not show such a structure. Therefore, Petrushevskaya (1975) has correctly moved the genus to the Family Sponguridae. She also synonymized it with Spongurus, Spongocore and Spongocorisca. However, in the same publication, Petrushevskaya noted that Spongurus pylomaticus seems sufficiently different from Ommatogramma dumitricai as to require a "special (new) genus", and so she retained the designation S. pylomaticus.

Spongurus (?) sp. (herein) had been placed in the genus Spongurus as a matter of convenience (cf. Petrushevskaya, 1967 and Ling et al., 1971), but has a distinctive spiral structure.

Spongocore puella has quite a different shell outline from O. dumitricai, but a similar spongy construction.

Since none of the above mentioned species has been studied in the context of their relationship to each other, it seems unwise to change generic assignments mechanically. Hence, Petrushevskaya's generic synonymy is not used forthe time being and familiar terminology is retained herein.

Ommatogramma dumitricai Petrushevskaya

Ommatogramma dumitrica Petrushevskaya, 1975, p. 577, pl. 7, fig. 3; pl. 37, figs. 4,5

DESCRIPTION AND DIMENSIONS

"The main skeleton body is about 50μ broad in its central part, about 75μ broad in its arms and 200-250μ long. The central part of the skeleton and the base of the arms are surrounded by a patagium (as by a muff), about 100μ-150μ long. The outlines of the main body of the skeleton and the layers of the patagium are X-shaped. The radial spines are weak. The pylomeis in one of the arms. Gown with small pores covers only the patagium. Differs from Spongurus pylomaticus Riedel. . . by: smaller dimensions, the outline of the skeleton, the more delicate gown, and the presence of patagium. The intermediate species (?), similar to the species in question and to S. pylomaticus was illustrated by Kruglikova (1969). O. dumitrikii differs from Spongocore puella Haeckel, Spongocore lata Campbell and Clark and some other similar species by not having a thickened central part of the main skeletal body, and thus having a different skeletal outline." (from Petrushevskaya, 1975).

REMARKS

1. Note inconsistent spelling of the specific name in Petrushevskaya (1975); "dumitricai" is thought to be correct.

2. Petrushevskaya (1975) considers this species to be so different from Spongurus pylomaticus as to require a separate genus. However, in counting specimens it may not be possible to readily distinguish between the two.

Plate 8, figure 1

Ommatogramma dumitricai Petrushevskaya

RECENT DISTRIBUTION

1. Petrushevskaya, 1975; DSDP Site 278 (56°33.42'S, 160°04.29'E).

Spongurus cf. elliptica (Ehrenberg)

?Acanthosphaera elliptica Ehrenberg, 1872a, p. 301; 1872b, pl. 7, fig. 4
Spongurus cf. elliptica (Ehrenberg), Benson, 1966, p. 189, pl. 8, figs. 4,5

DESCRIPTION

"Large ellipsoidal, spongy-appearing test with numerous (50-200 or more) short, stout, conical to three-bladed radial spines arising from its surface. Test not spongy but consists of numerous (5-12 or more) closely and equally spaced ellipsoidal shells that are joined by beams originating from the nodes of the intervening bars of each shell. Innermost shell small, spherical to ellipsoidal, indistinct. Pores of each shell small, subpolygonal, of subequal size, with subregular arrangement. Radial spines not traceable inwards as distinct beams piercing all shells. In several specimens additional but incomplete concentric shells are present at each pole of the major shell axis, giving the test a three-jointed appearance." (from Benson, 1966).

DIMENSIONS

"length of test (major axis) 86-107μ ; minor diameter 70-127μ ; length of radial spines 6-74μ." (from Benson, 1966).

Plate 8, figure 2

Spongurus cf. elliptica (Ehrenberg)

RECENT DISTRIBUTION

1. Benson, 1966; "This species is very rare in the Gulf [of California]. It is, therefore, of oceanic affinity but is rare in the tropical Pacific assemblage. It does have a slightly greater frequency in the southern Gulf."

2. Moore, 1974, Code S1; "This form was not separated from Spongurus sp. in the counts (although morphologic differences in well preserved specimens are apparent). It is found only in the temperate and tropical region while Spongurus sp. is most abundant in the cooler waters."

3. Molina-Cruz, 1975, Code S1A; "It was found only in the equatorial and subtropical regions, and it is not common in this study." Not used in factor analysis of southeast Pacific assemblages; cf. Appendix 10 for percent S1A at each station.

Spongurus pylomaticus Riedel

Spongurus pylomaticus Riedel, 1958, p. 226, pl. 1, figs. 10,11; Petrushevskaya, 1967, p. 32, fig. 16, I-II; Ling et al., 1971, p. 711, pl. 1, fig. 5

Spongurus (?) pylomaticus Riedel, Petrushevskaya, 1975, p. 577, pl. 7 fig. 4; pl. 37, fig. 7

DESCRIPTION

"Shell subcylindrical or elongate ellipsoidal, approximately twice as long as broad. An inner densely spongy core is surrounded by a narrow mantle of less dense meshwork. Entire surface usually sparsely covered with bristle-like spines, which in many specimens tend to be longer at the two poles of the main axis. At one pole is a pylome, usually surrounded by short, irregular teeth." (from Riedel, 1958).

"... the Bering Sea specimens sometimes show that the side of the dense inner spongy shell core is slightly concave outward rather than straight. Also there is a range of intraspecific variation on length vs. width (or breadth) ratio." (from Ling et al., 1971).

DIMENSIONS

"Length 150-255μ, breadth 78-125μ. Length of surface spines 5-10μ (usually broken off)." (from Riedel, 1958).

"Length 180-250μ, width 75-100μ." (from Ling et al., 1971).

REMARKS

1. Petrushevskaya (1975) considers this species to be so different from Ommatogramma dumitricai as to require a separate genus. However, in counting specimens, it may not be possible to readily distinguish between the two.

Plate 8, figures 3a,b

Spongurus pylomaticus Riedel

RECENT DISTRIBUTION

1. Ling et al., 1971; "This is the first record for occurrence of the present species, though found only rarely, from the Bering Sea. We have also noticed the presence of the species from the eastern and central subarctic North Pacific deep-sea sediments, which are currently under intensive examination. By combining the previous information of RIEDEL and PETRUSHEVSKAYA from the Antarctic, KRUGLIKOVA from the northern Pacific, and the present study, S. pylomaticus can be considered as one of the cold-water and bipolar forms."

2. Sachs, 1973, Code 18I; counted together with Spongurus (?) sp.; "The maximum abundance of the two Spongurus species is less than 4%, but together they are widespread, favoring higher latitudes. They load preferentially on the northernmost (Polar) factor, with a decreased intermediate (Subarctic) influence."

3. Lozano, 1974; Fig. IV-21, counted together with Spongurus (?) sp.; "It has the distribution typical of the Antarctic assemblage. It reaches a maximum relative abundance of 5.5 percent in core RC13-268 which is located at the edge of the winter ice. The presence of well developed forms with mantle north of about 40°S... is an indcation of northern transport by bottom currents, reworking or non-Recent sediments.

"As the other Antarctic species, its distribution is affected by bottom transport in the Argentine and Crozet basins. S. pylomaticus is found in sediments under August sea surface temperatures between 16°C and -1.7°C reaching its maximum relative abundance at -1.7°C."

4. Molina-Cruz, 1975, Code S41; not used in factor analysis of southeast Pacific assemblages; cf. Appendix 10 for percent S41 at each station.

5. Robertson, 1975; "This species loads most heavily in factor 3 (transitional). At present its greatest abundances are in the northwest Pacific north of 40°N. Abundances are low in the Sea of Okhotsk and through most of the Bering Sea. At 18,000 YBP the region of higher abundances is significantly smaller and further to the east."

6. Morley, 1977 (Spongurus spp.), Fig. I-14; S. pylomaticus and Spongurus (?) sp counted together; "S. pylomaticus is most common in polar waters. Spongurus (?) sp. is found only in tropical, subtropical, and subantarctic waters... This taxonomic group loads highest in factor 2 (polar). At present this group is found most frequently south of 45°S. At 18,000 YBP the 1% contour is displaced northward by 15° to 20° of latitude."

Spongurus (?) sp.

Spongurus (?) sp. Petrushevskaya, 1967, p. 33, fig. 16, III; fig. 26, I; Ling et al., 1971, p. 711, pl. 1, fig. 6

DESCRIPTION

"Shells somewhat different from Spongurus pylomaticus often encountered in same samples. These shells ellipsoidal and not cylindrical. Spongy tissue far looser and spaces far larger; in optical section their spiral arrangement can be seen. Specimens with developed mantle and pylome could not be detected...

"Spongurus (?) sp. outwardly similar to early stages of S. pylomaticus and at first glance differs only by spindle shape of shell. However, these species are essentially different in the structure of the spongy tissue." (from Petrushevskaya, 1967).

"This ellipsoidal, spiral spongy shell has been reported from the Antarctic by PETRUSHEVSKAYA (1967). Although the generic diagnosis given by HAECKEL (1862) for Spongurus does not encompass such forms with a spiral structure, we believe it seems the best to be considered here within the present classification scheme." (from Ling et al., 1971).

DIMENSIONS

"Length 110-130μ, width 65-80μ" (from Ling et al., 1971).

"Length, 107 ± 7μ; width, 68 ± 3μ; based on measurements of 11 specimens." (from Sachs, 1973)

Plate 8, figure 4

Spongurus (?) sp.

RECENT DISTRIBUTION

1. Ling et al., 1971; "PETRUSHEVSKAYA (1967) indicated that the present form is rather common in the temperate as well as tropical region of the Antarctic. We have noticed its occurrence in the central and eastern North Pacific sediments. Thus with the present finding from the Bering Sea sediments, even though sparse, it can be concluded that the present species has wide geographic distribution."

2. Sachs, 1973, Code not assigned; counted together with Spongurus pylomaticus.

3. Lozano, 1974; cf. Spongurus pylomaticus.

4. Molina-Cruz, 1975, Code S1; "It is most abundant in coastal and cool waters"; used in factor analysis of southeast Pacific assemblages; cf. Appendix 10 for percent S1 at each station.

Spongocore puella Haeckel

Spongocore puella Haeckel, 1887, p. 347, pl. 48, fig. 6; Benson, 1966, p. 187, pl. 8, figs. 1-3; Nigrini, 1970, p. 168, pl. 2, fig. 3

DESCRIPTION

"Fully developed forms consisting of a cylindrical, solid, spongy-appearing test with three joints separated by two constrictions, the middle joint ranging from 1-2 times the lengths of the terminal joints; with numerous, thin, conical, radial spines arising from the surface of all three joints; with the middle joint covered by a spindle-shaped, relatively smooth, thin walled lattice-mantle having small, unequal, irregular pores; mantle supported by numerous radial spines that arise from the middle joint. Mantle absent or rudimentary in most tests, but a complete gradation exists between the incomplete and complete forms. A few tests with radial spines absent or rudimentary. Solid, "spongy" appearing part of test not spongy but consists of closely spaced concentric shells, at least in the middle joint and possibly in the terminal joints as well; in one specimen the test is bent into a gentle curve." (from Benson, 1966).

DIMENSIONS

"based on 30 specimens from stations 27 and 34: length of test 188-363μ; diameter of middle joint 37-71μ, of terminal joints 30-68μ; length of lattice mantle 123-191μ, maximum breadth 74-111μ; length of radial spines 2-25μ." (from Benson, 1966).

REMARKS

1. For a more complete synonymy see Benson, 1966.

2. Renz (1976) used the name Spongocore diplocylindrica Haeckel for apparently the same species.

Plate 8, figures 5a-c

Spongocore puella Haeckel

RECENT DISTRIBUTION

1. Benson, 1966; "... greater frequency in the southern half of the Gulf [of California] and its gradual decrease to the north suggests that it has a greater affinity for normal oceanic water masses but is also, to some extent, tolerant of slightly greater salinity and temperature."

2. Nigrini, 1970, fig. 15; belongs to a tropical assemblage derived by recurrent group analysis of North Pacific sediments, but the species ranges too far north to be useful in downcore analysis.

3. Molina-Cruz, 1975, Code S42; not used in factor analysis of southeast Pacific assemblages; cf. Appendix 10 for percent S42 at each station.

Styptosphaera (?) spumacea Haeckel

?Styptosphaera spumacea Haeckel, 1887, p. 87; Nigrini, 1970, p. 167, pl. 1, figs. 7,8.

DESCRIPTION

"Shell spherical, composed entirely of loose, irregular spongy meshwork. Pores are subcircular and of varying size. No central cavity or radial spines. Surface rough, but without thorns." (from Nigrini, 1970).

"The appearance is of a densely interwoven mesh-work ball, without protruding spines or thorns." (from Sachs, 1973).

DIMENSIONS

"(based on 20 specimens). Diameter of shell 119 to 167μ." (from Nigrini, 1970).

"diameter 166± 16μ. (based on 15 measurements)" (from Sachs, 1973).

REMARKS

1. "S. spumacea was described, but not illustrated, by Haeckel (1887) from "Challenger" station 236 (34°58'N, 139°29'E), but no specimen of this general form could be found in topotypic material examined by the author. Haeckel's unillustrated description appears to fit the form found in the North Pacific during this study. However, the shell diameter given by Haeckel is almost twice that of the North Pacific specimens which are, therefore, only tentatively assigned to S. spumacea." (from Nigrini, 1970).

Plate 8. figures 6a,b

Styptosphaera (?) spumacea Haeckel

RECENT DISTRIBUTION

1. Nigrini, 1970, fig. 7; belongs to a subarctic assemblage derived by recurrent group analysis of North Pacific samples.

2. Sachs, 1973 Code 9S, fig. 2B; "General aspect is Southern, [i.e., south of about 45°N], but greatest abundance is slightly North of the Southernmost stations."

3. Robertson, 1975; "This species loads heavily in factor 3 (transitional). At present this species is most abundant in a band between 37° and 45°N. To the extreme north and south it is absent. The area where it is absent at 18,000 YBP is poorly defined but may show a shift to the south in the western part of the northwest Pacific."

Heliodiscus asteriscus Haeckel

Heliodiscus asteriscus Haeckel, 1887, p. 445, pl. 33, fig. 8; Hays, 1965, p. 171, pl. II, fig. 7; Nigrini, 1967, p. 32, pl. 3, figs. 1a,b

DESCRIPTION

"Cortical shell forms a discoidal biconvex lens. Pores circular to subcircular, sometimes hexagonally framed, fairly regularly arranged over most of the smooth shell surface, but irregular in size, shape, and arrangement near the center of the disc; 7 or 8 (sometimes to 10) pores on a radius.

"Medullary shell spherical to ellipsoidal with a diameter approximately 0.3 that of cortical shell. Pores numerous, small, and irregular. Radial beams, 12-16, extend from the medullary shell to the central region of the discoidal surface of the cortical shell. Inner medullary shell delicate, always held eccentrically within outer one by numerous radial beams... Pores large, subcircular, and irregular.

"Radial spines 8-12, well developed, straight, 3-bladed near the disc, becoming cylindrical distally, placed more or less regularly around the margin of the cortical shell. Spines up to 0.5 or 0.75 cortical shell diameter; rarely forked. Usually a few short slender marginal by-spines present." (from Nigrini, 1967).

DIMENSIONS

"Diameter of cortical shell 136-191; of outer medullary shell 45-63μ; of inner medullary shell approximately 9-18μ." (from Nigrini, 1967).

REMARKS

1. Benson's (1966) description and dimensions of this species (p. 200) are consistent with the above.

Heliodiscus asteriscus Haeckel

RECENT DISTRIBUTION

1. Hays, 1965, fig. 15; "It has not been observed from core tops south of the Polar Front and is rarely an important constituent of samples from north of it.

"Heliodiscus asteriscus occurs regularly in the samples from core V-16-66 below 720 cm, indicating a range at least as far back as zone ϕ. Like Axoprunum stauraxonium, it does not occur in the ϕ zone from cores taken south of the Polar Front."

2. Benson, 1966; "This species is of cosmopolitan but rare occurrence in the Gulf [of California] . It is ... common (3.0%) only at station 194... In the absence of known upwelling near station 194, it must be concluded that the increase in this species at this station is due to its tolerance of waters with slightly higher than average temperature and salinity... It has a slightly greater abundance in the southern Gulf."

3. Nigrini, 1967, fig. 14; "Indian Ocean occurrences - H. asteriscus is found in both low and middle latitudes, forming 1 percent to 7 percent of the described population. It was present in all counted samples."

4. Nigrini, 1970, fig. 13; belongs to a tropical assemblage derived by recurrent group analysis of North Pacific samples, but the species ranges too far north to be useful in down-core analysis.

5. Lozano, 1974, Fig. IV-7; "Generally present in samples from the Atlantic and practically always found in samples from the Indian Ocean under subtropical waters where it reaches a maximum of 0.7 percent of the total radiolarian fauna.

"The minimum February sea surface temperature under which it is found is $9^{o}C$ in the Atlantic and $6^{o}C$ in the Indian Ocean."

6. Molina-Cruz, 1975, Code S14; used in factor analysis of southeast Pacific assemblages; cf. Appendix 10 for percent S14 at each station.

7. Morley, 1977 (Heliodiscus spp.), Fig. I-16; counted together with H. echiniscus; "The present author belives that H. echiniscus is probably a morphological variant of H. astericus... This taxonomic group loads highest in factor 4 (subtropical). At present this group of species is absent in samples south of $46^{o}S$. At 18,000 YBP the 0% contour is shifted northward by approximately 2^{o} of latitude to $44^{o}S$."

Amphirhopalum ypsilon Haeckel

Amphirhopalum ypsilon Haeckel, 1887, p. 522; Nigrini, 1967, p. 35, pl. 3, figs. 3a-3d.

DESCRIPTION

"Shell with 2 opposite, chambered arms, one of which is forked distally. Arms arise from a central structure composed of 2 inner spherical shells and an outer oblate spheroidal shell, all quite smooth and connected by numerous, discontinuous, radial beams. In addition, there is an outer ring of mesh in the plane of the shell which is normally oriented perpendicular to the microscope axis. This orientation makes the central structure appear as a "central, concentrically annulated disc" (cf. Haeckel, 1887, p. 516, Subfamily Euchitonida), because the spheroidal shell has its minor axis along the microscope axis and the external ring, or rings, are in the plane of the slide.

"In cross section arms are elliptical with their shortest dimension normally oriented along the microscope axis. Unforked arm is narrow proximally, expands distally to a maximum breadth about two-thirds of the way along its length, then decreases slightly in breadth to a blunt termination. Usually 4-9 distinct chambers, convex distally, can be seen; however, shell may become spongy over the distal one-third of the arm. Similarly, the forked arm expands distally and branches where its breadth reaches a maximum. Usually 5-9 distinct chambers, including those on the branches, convex distally; chambers on branches sometimes obscured by spongy meshwork.

"Internal spines form a basic framework which is covered by a lattice of small circular to subcircular pores.

"In some specimens a patagium is present around the central structure and arms, sometimes with 4 or 5 chambered rows, concave inwards; sometimes simply a spongy mass. It seems probable that a complete patagium (i.e., on a fully developed specimen) might surround the whole basic shell structure, but in all specimens examined the patagium had developed only between the 2 main arms and around the central structure. Patagium generally more delicate than the main shell." (from Nigrini, 1967).

"Specimens from the upper parts of the cores examined average four or five proximal chambers on the forked arm before it bifurcates. Lower down in the cores this number decreases, and forms with two or three (sometimes one) such chambers predominate. The decrease coincides approximately with an increase in abundance." (from Nigrini, 1971).

Plate 10, figures 1a-e

Amphirhopalum ypsilon Haeckel

DIMENSIONS

"Total length 236-307μ. Radius of simple arm 119-155μ; of forked arm 119-155μ. Maximum breadth of simple arm 63-119μ; of branches on forked arm 36-63μ." (from Nigrini, 1967).

REMARKS

1. For a more complete synonymy see Nigrini, 1967.

2. "Dumitrica (1973, p. 835) described a species called Amphirhopalum wirchowii (Haeckel). There is a minor spelling error and the name should be A. virchowii. This species is very likely the ancestor of A. ypsilon, and differs from it in having smoother, more distinct and more rounded chambers. It has previously been observed by the present author in Upper Pliocene sediments and there is a transition from A. virchowii to A. ypsilon near the Plio-Pleistocene boundary. A. ypsilon then evolves in the manner described by Nigrini (1971, p. 447). The specimens figured by Dumitrica (1973, pl. 11, fig. 6) and by Haeckel (1862, pl. 30, fig. 4) are good examples of A. virchowii. The arms are somewhat narrower than those illustrated by Haeckel (1862, pl. 30, figs. 1, 2). Specimens figured by Nigrini (1971, pl. 1, figs. 7b, 7c) and referred to by Dumitrica (1973) are good examples of early A. ypsilon. A. virchowii is a convenient name for the species in question, but without examining type material, it is difficult to say whether Haeckel was looking at the Pliocene form or early A. ypsilon." (from Nigrini, 1974).

3. Benson's (1966) description and dimensions of this species (Amphicraspedum wyvilleanum Haeckel in Benson, p. 221) are consistent with the above.

4. Note spelling error in Moore (1974) and Molina-Cruz (1975).

Amphirhopalum ypsilon Haeckel

RECENT DISTRIBUTION

1. Benson, 1966 (Amphicraspedium wyvilleanum); "This species is cosmopolitan in the Gulf [of California] , being absent only at stations 203, and 214. It is rare at all stations but is present in slightly greater numbers at stations located in the axial portion of the Gulf. Its average frequency is slightly greater in the southern half of the Gulf; therefore, it is a more nearly oceanic species. It undergoes no marked increase at stations located within regions of upwelling."

2. Nigrini, 1967, fig. 16; "Indian Ocean occurrences - A. ypsilon is sparsely distributed in low latitudes and is absent from samples south of 35°S. Though rather rare in Recent sediments, it appears to be a useful member of the low latitude assemblage."

3. Nigrini, 1968, text-fig. 13; "Few in the regions of the North and South Equatorial Currents, but decreasing in abundance westward and in the region of the Equatorial Countercurrent."

4. Nigrini, 1970, fig. 14; belongs to a tropical assemblage derived by recurrent group analysis of North Pacific samples, but the species does range as far north as 40°N in the western Pacific.

5. Molina-Cruz, 1975, Code S9; not used in factor analysis of southeast Pacific samples; cf. Appendix 10 for percent S9 at each station.

Notes on the Genera Euchitonia, Dictyocoryne and Hymeniastrum

Petrushevskaya and Kozlova (1972, p. 528) made the following taxonomic changes for part of the Family Spongodiscidae:

Genus RHOPALASTRUM Ehrenberg

Rhopalastrum Ehrenberg, 1847a, chart to p.385: Haeckel, 1887, p.526

Rhopalodictyum Ehrenberg, 1860b, p. 832: Haeckel, 1887, p. 589

Dictyocoryne Ehrenberg, 1860b, p. 830: Haeckel, 1887, p. 592

Dictyastrum Ehrenberg, 1860b, p. 830: Haeckel, 1887, p. 524

Euchitonia Ehrenberg, 1860b, p. 831: Haeckel, 1887, p. 532

Pteractis Ehrenberg, 1872a, p. 277

"Spongodiscidae with thin spongy central disc (where chambered rings may be sometimes seen), with three spongy arms and patagium between them."

It is not clear why the genus Hymeniastrum Ehrenberg was excluded from Petrushevskaya and Kozlova's synonymy.

It has already been noted by Ling (1966), Ling and Anikouchine (1967) and Nigrini (1967) that presence or absence of a patagium is of no generic or specific consequence. Ling (1972) is of the opinion that "the concerntric spongy disc bears the taxonomic value for these spumellarians."

It is the present authors' opinion that:

1. Patagium is of no consequence taxonomically.

2. All the forms of this general type possess some degree of central spheroidal and/or discoidal structure, but this may be obscured by spongy material. The degree of visibility of the central structure may be of generic significance.

3. Some forms exhibit bilateral symmetry while others have equiangular displacement between arms and this feature may be of generic significance.

Notes on the Genera Euchitonia, Dictyocoryne and Hymeniastrum (cont.)

4. Species with bifurcating arms should be placed in different genera from those having simple arms.

For these reasons and because major taxonomic revision should involve a stratigraphic study, the following taxonomy, more conservative than that of Petrushevskaya and Kozlova (1972) is proposed.

Family Spongodiscidae Haeckel 1862, emend. Riedel, 1967

"Emended definition: Discoidal, spongy or finely-chambered skeleton, with or without surficial pore-plate, often with radiating arms or marginal spines, and without a large central phacoid shell." (from Riedel, 1971)

GENUS Euchitonia Ehrenberg, emend. Nigrini, 1967

Euchitonia Ehrenberg, 1860b, p. 831; sens. emend. Haeckel, 1887, p. 532.

"Euchitoniidae with three simple, undivided, chambered (proximally, at least) arms, with or without terminal spines; triangular shell, bilateral, one unpaired and two paired arms. Patagium may or may not be present. The definition of this genus is emended herein to include forms with and without (1) terminal spines; and (2) a patagium." (from Nigrini, 1967)

The genus Rhopalastrum Ehrenberg, 1847, is similar to the above but has spongy rather than chambered arms and for that reason is not included. Species included:

1. Euchitonia elegans (Ehrenberg)
2. Euchitonia furcata Ehrenberg
3. Euchitonia sp. includes immature or broken specimens of the above, distinguishable by a strong and clearly visible central structure of 3 or 4 concentric spheroidal shells and strong bilateral symmetry. Species of Euchitonia possess a much coarser lattice than other genera.
4. Euchitonia cf. echinata - see remarks for Dictyocoryne truncatum.

GENUS Dictyocoryne Ehrenberg

Dictyocoryne Ehrenberg, 1860b, p. 830

Rhopalodictyum Ehrenberg, 1860b, p. 832

Spongodiscidae with three simple, undivided, spongy arms, with or without terminal spines, equally to bilaterally disposed. Patagium may or may not be present. Central structure often obscured by spongy meshwork, but consisting

Notes on the Genera *Euchitonia*, *Dictyocoryne* and *Hymeniastrum* (cont.)

of 5 to 10 or more concentric discoidal shells. Species included:

1. *Dictyocoryne profunda* Ehrenberg
2. *Dictyocoryne truncatum* (Ehrenberg)

GENUS *Hymeniastrum* Ehrenberg

Hymeniastrum Ehrenberg, 1847b, p. 54

Dictyastrum Ehrenberg, 1860b, p. 830

Spongodiscidae with three simple, undivided, chambered arms, with or without terminal spines; triangular shell, equiangular displacement between arms. Patagium may or may not be present. Central structure often obscured by spongy meshwork, but consisting of 4 to 5 concentric discoidal shells.

Species included: 1. *Hymeniastrum euclidis* Haeckel

NOTE: 1. It is entirely possible that *Dictyocoryne* and *Hymeniastrum* are cogeneric.

2. Riedel (1971) places *Hymeniastrum* in the Family Coccodiscidae.

Euchitonia elegans (Ehrenberg)

Pteractis elegans Ehrenberg, 1872a, p. 319; 1872b, p. 299, pl. VIII, fig. 3
Euchitonia elegans (Ehrenberg), Nigrini, 1967, p. 39, pl. 4, figs. 2a,b

DESCRIPTION

"Similar to Euchitonia furcata, but differing in the shape of its arms. Arms slender, tapering distally, and sometimes terminating in 1 or 2 short, fairly stout spines. Angle between paired arms of E. elegans generally smaller than that of E. furcata.

"A patagium may or may not be present. When well developed it forms a delicate meshwork around the central structure and between each of the 3 arms (generally less well developed between paired arms). Meshwork forms rows of chambers, convex outwards in larger angles, concave between paired arms, and thickens towards its outer edge. Sometimes patagium shows partial development or, often, only a few initial branches are present. In other specimens there is no indication of a pagatium forming...

"It is usually difficult, if not impossible, to distinguish between E. elegans and E. furcata . These species are differentiated by the shape of the arms of fairly complete and well-developed specimens. However, the majority of specimens found are either broken or not completely developed, making it impossible to identify them to species. One is tempted to make E. elegans and E. furcata and the indeterminant forms conspecific, but the difference between end members of such a series is sufficiently great to indicate that two species are, in fact, involved. Thus, a few specimens definitely belonging to each species and a large number of unidentifiable fragments were present in the samples examined." (from Nigrini, 1967).

DIMENSIONS

"Average length of arms (measured from center of innermost sphere) 146-289μ (usually 200-289μ). Maximum breadth of arms 36-63μ. Angle between paired arms 54^{o}-75^{o}." (from Nigrini, 1967).

REMARKS

1. For a more complete synonymy see Nigrini, 1967 and Ling and Anikouchine, 1967.

2. Benson's (1966) description and dimensions of this species (p. 230) are not consistent with the above.

Plate 11, figures 1a,b

Euchitonia elegans (Ehrenberg)

RECENT DISTRIBUTION

1. Nigrini, 1967, fig. 18, 19; "Indian Ocean occurrences - Recognizable specimens of E. elegans (fig. 18) very sparsely distributed in low latitudes and do not occur in middle latitude samples ...

"Euchitonia sp. (fig. 19) is fairly abundant (4% to 12% of the described population) in low latitudes, but like E. elegans it is absent from samples taken south of 35°S. The three forms appear to be reliable and potentially useful members of the low latitude assemblage."

2. Nigrini, 1968, text-fig. 14; Euchitonia spp. is "Rare in the northernmost sample examined, few in the region of the Peru Current, generally several along the coast of Central America and in the region of the South Equatorial Current, common to abundant in the western part of the study area."

3. Nigrini, 1970, fig. 18; belongs to a tropical assemblage derived by recurrent group analysis of North Pacific samples, but the species does range as far north as 40°N in the western Pacific.

4. Sachs, 1973, Code 22I; Euchitonia spp. (counted together with E. furcata); "their distributions are all Southern (Transitional) and they are all rare." Southern is south of about 45°N.

5. Molina-Cruz, 1975, Code S12; counted together with E. furcata and used in factor analysis of southeast Pacific assemblages; cf. Appendix 10 for percent S12 at each station.

6. Robertson, 1975; counted together with E. furcata; "E. elegans is by far the less frequently occurring of these two species....

"These species load most heavily in factor 2 (subtropical). At the present they are absent north of about 45°N but to the east of 165°E they occur only rarely south of 45°N. At 18,000 YBP they occur only rarely north of 35°N."

7. Morley, 1977 (Euchitonia spp.); Fig. I-17 counted together with E. furcata; "Although these two species are placed in one taxonomic group for this study, E. furcata was much more abundant in all samples than E. elegans... These species load highest in factor 1 (tropical). Today they are most frequently found in samples from tropical regions and are absent from all samples south of 35°S. At 18,000 YBP they occur only rarely in the eastern equatorial samples and are absent south of 15°S."

Euchitonia furcata Ehrenberg

Euchitonia furcata Ehrenberg 1872a, p. 308; 1872b, p. 289, pl. IV (iii), fig. 6; Ling and Anikouchine, 1967, p. 1484, pl. 189, 190, figs. 1-2,5-7.

Euchitonia mulleri Haeckel, Nigrini, 1967, p. 37, pl. 4, figs. 1a,b

DESCRIPTION

"Shell bilaterally symmetrical with 3 arms of approximately equal length, elliptical in cross section. Arms arise from a central structure composed of 2 inner spherical shells and an outer oblate spheroidal shell, all quite smooth and connected by numerous, discontinuous, radial beams. In addition, there is an outer ring of mesh in the plane of the shell which is normally oriented perpendicular to the microscope axis. This central structure is the same as that of Amphirhopalum ypsilon.

"Arms fairly heavy, increasing in breadth distally and having a blunt or irregularly rounded termination; sometimes with 1-3 slender terminal spines. Proximally arms appear chambered, but a rather dense mesh of subcircular pores generally obscures distal chambers, and gives arms a spongy appearance. Paired arms form the smaller angle opposite odd arm and often curve slightly towards each other.

"A patagium may or may not be present. Specimens having a well-developed patagium are rare, and examination of it has not been sufficiently extensive to warrant any general conclusions. Usually, patagium shows partial development or, often, only a few initial branches are present. In other specimens there is no indication of a patagium forming." (from Nigrini, 1967).

DIMENSIONS

"Average length of arms (measured from center of innermost sphere) 164-298μ. Maximum breadth of arms 54-90μ. Angle between paired arms 59°-94°." (from Nigrini, 1967).

REMARKS

1. For a more complete synonymy and taxonomic discussion see Nigrini, 1967 and Ling and Anikouchine, 1967.

2. Benson's (1966) descriptions and dimensions of E. cf. furcata Ehrenberg (p. 228) and E. mulleri Haeckel (p. 232) are not consistent with the above.

Plate 11, figures 2a,b

Euchitonia furcata Ehrenberg

RECENT DISTRIBUTION

1. Nigrini, 1967, fig. 17; "Indian Ocean occurrences - Recognizable specimens of E. furcata are sparsely distributed in low latitudes, and are absent from samples taken south of 35°S."

See also discussion of recent distribution for E. elegans herein.

2. Nigrini, 1968, text. fig. 14; cf. E. elegans herein;

3. Nigrini, 1970, fig. 17; belongs to a tropical assemblage derived by recurrent group analysis of North Pacific samples, but the species does range as far north as 40°N in the western Pacific.

4. Molina-Cruz, 1975, Code S12; cf. E. elegans herein.

5. Robertson, 1975; cf. E. elegans herein.

Dictyocoryne profunda Ehrenberg

Dictyocoryne profunda Ehrenberg, 1860a, p. 767, 1872a, p. 307, 1872b, p. 288, pl. 7, fig. 23; Haeckel, 1887, p. 592; Martin, 1904, p. 454, pl. 80, figs. 11-13; Ling and Anikouchine, 1967, p. 1489, pls. 191, 192, fig. 6; non Renz, 1976, pl. 3, fig. 1

DESCRIPTION

"... Arms approximately of equal size and equidistant, club-shaped, from 2½ to 3 times as broad at the ends as in the narrowest part, broadest part twice the diameter of the central disk, length 2½ to 3 times the diameter of the central disk; central disk with three or four concentric rings; patagium reaching almost or quite to the ends of the arms.

"The forms here referred to this species show considerable variation within themselves, and if they all remain here will make it necessary to broaden the descriptions given by Ehrenberg and by Haeckel. With the material now at hand it seems better to broaden the species than to describe new ones. The three figures show the range of variation observed in the Maryland forms.

"It may be seen from the figures that the arms are not absolutely equidistant as they are supposed to always be in this genus. The maximum variation in this respect is shown in Fig. 11 where the angles between the arms are 105^{o}, 122^{o} and 133^{o}. This does not invalidate the reference of this form to Dictyocoryne for Ehrenberg's figure of the type of the genus shows the arms as being at angles of 113^{o}, 123^{o}, and 124^{o}." (from Martin, 1904).

DIMENSIONS

Based on 10 specimens; length of arms from geometric centre to distal end 130-150μ; maximum breadth of arms 80-120μ." (from Ling and Anikouchine, 1967).

REMARKS

1. Benson (1966, p. 225) has described another species Hymeniastrum koellikeri Haeckel, but the distinctions between it and D. profunda are not pronounced. It appears that Benson's illustrated specimens could be assigned to D. truncatum (pl. 12, fig. 4) and D. profunda (pl. 12, figs. 5, 6).

Plate 12, figure 1

Dictyocoryne profunda Ehrenberg

RECENT DISTRIBUTION

1. Molina-Cruz, 1975, Code S36A; not used in factor analysis of southeast Pacific assemblages; cf. Appendix 10 for percent S36A at each station.

Dictyocoryne truncatum (Ehrenberg)

Rhopalodictyum truncatum Ehrenberg, 1861, p. 301, Haeckel, 1887, p. 589
Dictyocoryne cf. truncatum (Ehrenberg), Benson, 1966, p. 235, pl. 15, fig. 1
?Dictyocoryne sp. Ling and Anikouchine, 1967, p. 1489, pls. 191, 192, fig. 4,5
?Dictyastrum angulatum Ehrenberg, 1872b, pl. 8, fig. 17
?Euchitonia mulleri Haeckel (?), Popofsky, 1912, p. 137, text. fig. 52 only

DESCRIPTION

(modified from Benson, 1966) Test with three, broad, spongy arms, equally to bilaterally disposed, generally with but in several specimens without a spongy patagium between them. Central region consisting of 5-10 or more concentric latticed discoidal shells; these shells are frequently concealed by a fine spongy lattice. Arms narrow proximally for a short distance, becoming broad and thick, elliptical in section distally. In specimens without a patagium the arms have a definite margin; in those with a patagium margin of arms indefinite, often appearing to merge with patagium; in several specimens arms appear only as triangular dark areas.

DIMENSIONS

"based on 30 specimens from stations 46, 56, 60, 71 and 81; angle A 112^{o}-139^{o}, mean 126^{o}; angle B 92^{o}-116^{o}, mean 108^{o}; angle C 114^{o}-144^{o}, mean 127^{o}; ratio of angle A to B 1.03-1.43, mean 1.17, of angle C to B 1.07-1.43, mean 1.18; diameter of outermost concentric shell of central region (11 specimens with number of shells ranging from 5-10) 68-117μ; maximum breadth of arms 86-153μ; length of base of triangular test 172-343μ, of altitude 177-348μ." (from Benson, 1966).

REMARKS

1. Dictyocoryne sp. (in Ling and Anikouchine, 1967) is tentatively included in the synonymy of this species. The arms of their figured specimens are clearly chalice-shaped, but it is not clear whether this characteristic is sufficient to erect a separate species or whether it is an allowable morphological variation of D. truncatum.

2. There is another very similar form, Euchitonia triangulum (Ehrenberg) with the following synonymy:

Stylactis triangulum Ehrenberg, 1872a, p. 320; 1872b, pl. 8, fig. 9, Stohr, 1880, p. 113, pl. 6, fig. 2
Euchitonia triangulum (Ehrenberg) Haeckel, 1887, p. 533.
Euchitonia cf. E. triangulum (Ehrenberg) Ling and Anikouchine, 1967, p. 1487, pls. 189,190, figs.8,9.

Plate 12, figures 2a,b

Dictyocorne truncatum (Ehrenberg)

This species closely resembles D. truncatum (cf. Ling and Anikouchine, 1967) except that the arms are not equidistant and the central region is not spongy. These features were not found to be particularly distinctive and it is suggested herein that there is only one species of this general type. The species is never as markedly bilateral as Euchitonia elegans or Euchitonia furcata.

Benson (1966) described a third species Euchitonia cf. echinata which may be valid. His description is as follows:

> "Arms distinctly bilaterally disposed, an odd arm generally distinguishable. Central region circular, consisting of 5-8 concentric discoidal shells; arms generally broad proximally with broader but blunt, thicker terminations, characteristically with 1-5 or more (generally 12) conical to pyramidal terminal spines, continuous inwards as beams, lying in the plane of the disc, variable in length (4-31μ). Internal structure of arms with distinct, regular, equally spaced, concentric, latticed rings, traceable from arm to arm, 6-20 per arm; terminations of arms appear spongy, suggestive of a structure similar to the central region, i.e., concentric shells. Test covered by a distinct latticed sheath as in the preceding species. A spongy, layered patagium between the arms generally absent or only rudimentary, thinner and more delicate proximally."

DIMENSIONS

(based on 30 specimens) "diameter of outer concentric shell of central region 68-107μ; length of odd arm 37-129μ, of each of the two similar arms 43-112μ and 41-116μ; minimum breadth of odd arm 49-79μ, of each of the two similar arms 44-79μ and 41-80μ; maximum breadth of odd arm 69-135μ, of each of the two similar arms 54-119μ and 55-121μ; length of base of triangular test 146-265μ, of altitude 151-276μ." (from Benson, 1966).

The distinctive features of this species are the concentric rings which may be traced from arm to arm and the consistent and well-developed terminal spines. However, the concentric ring structure of the arms is quite different from the type of chambering observed in Euchitonia furcata and Euchitonia elegans and for this reason it might be more properly assigned to another genus.

RECENT DISTRIBUTION

1. Benson, 1966; "...cosmopolitan in the Gulf [of California] but is rare at all stations where it is present... some tolerance for waters of higher than average salinity and temperature."

2. Molina-Cruz, 1975, Code S36; used in factor analysis of southeast Pacific assemblages; cf. Appendix 10 for percent S36 at each station.

Hymeniastrum euclidis Haeckel

Hymeniastrum euclidis Haeckel, 1887, p. 531, pl. 43, fig. 13; Benson, 1966, p. 222, pl. 12, figs. 1-3
?Cyclastrum? sp., Ling and Anikouchine, 1967, p. 1487, pls. 191, 192, figs. 1,2

DESCRIPTION

"Discoidal test with three arms of nearly equal size and similar shape, elliptical in section, separated by nearly equal angles; a layered spongy patagium generally present but rudimentary or absent in several specimens, thicker distally along its margin than proximally where it is thin and delicate, when fully developed subtriangular in shape. Central region of test circular to subtriangular in outline, consisting of 4-5 concentric discoidal latticed shells, therefore, biconvex in side view. Arms very narrow proximally, increasing only gradually in breadth for most of their length, terminating in broad bulbous tips, a few of which were observed with 3-4 internal concentric shells or rings. Internal structure of arms consisting of numerous (13-25) concentric, irregular, partial rings, subequally spaced, more or less perpendicular to the outer latticed cover of the arm. In most specimens the internal structure of the test is not distinct and the center as well as the arms appear spongy. The arms and center covered with a generally distinguishable, small-pored latticed sheath. Several specimens were observed with 1-3 terminal spines on one or more of the arms, 4-31μ in length." (from Benson, 1966).

DIMENSIONS

"based on 30 specimens from stations 27, 34, 46, 56, 60, 64, 71, and 81: angle A 111^{o}-142^{o}, mean 126^{o}; angle B 95^{o}-126^{o}, mean 111^{o}; angle C 111^{o}-133^{o}, mean 123^{o}; ratio of angle A to angle B 0.98-1.49, mean 1.13; ratio of angle C to angle B 0.88-1.29, mean 1.11; diameter of outer concentric shell of central region 55-84μ; length of odd arm (if not distinguishable an arm was chosen at random) 96-209μ , of each of the two similar arms 96-205μ, and 101-197μ, minimum breadth of odd arm 27-48μ, of each of the two similar arms 27-47μ and 26-48μ; maximum breadth of bulbous tip of odd arm 50-112μ, of each of the two similar arms 48-123μ and 49-114μ; length of base of triangular test 218-411μ, of altitude 203-369μ." (from Benson, 1966).

REMARKS

1. For a more complete synonymy see Nigrini, 1970.

2. The specimens figured by Benson (1966) are larger than that shown by Nigrini (1970). For additional illustrations see Benson (1966).

Plate 12, figure 3

Hymeniastrum euclidis Haeckel

RECENT DISTRIBUTION

1. Benson, 1966; "This species is cosmopolitan but rare in the Gulf [of California]... It has a higher than average frequency in the southern Gulf with highest frequency (1.4%) at station 64 located in a region of upwelling. It does not increase, however, at other stations located within areas of upwelling. Its general decrease northward in the Gulf suggests its greater affinity for oceanic water masses."

2. Nigrini, 1970, fig. 16; belongs to a tropical assemblage derived by recurrent group analysis of North Pacific samples, but the species ranges too far north to be useful in down-core analysis.

3. Molina-Cruz, 1975, Code S18; not used in factor analysis of southeast Pacific assemblages; cf. Appendix 10 for percent S18 at each station.

Spongaster tetras tetras Ehrenberg

Spongaster tetras Ehrenberg, 1860b, p. 833; 1872b, p. 299, pl. IV(iii), fig. 8
Spongaster tetras tetras Ehrenberg, Nigrini, 1967, p. 41, pl. 5, figs. 1a,b

DESCRIPTION

"Shell is a square with rounded corners. Four spongy, pear-shaped "arms" approximately at right angles, are regularly placed in one plane around 5 concentric lattice spheres. A completely enveloping patagium usually makes the central spheres difficult to see, and, at best, 5 concentric rings can be recognized; the "arms" appear merely as dark patches.

"Patagium is, for the most part, a dense irregular spongy meshwork with small subcircular pores, but around the "arms" bars become thicker and 3-bladed. In some specimens radial beams apparently form a basis for the patagium which will then have a radially striated border. Patagium may be depressed slightly around the central structure, but at its periphery its thickness is approximately 0.25 the length of the sides of the square." (from Nigrini, 1967).

DIMENSIONS

"Distance between sides 150-302μ (usually 150-276μ);diagonal 187-369μ (usually 187-316μ)." (from Nigrini, 1967).

REMARKS

1. For a more complete synonymy see Nigrini, 1967.

2. Benson's (1966) description of this species (p. 238) is consistent with the above, but his dimensions are generally smaller (e.g., length of diagonal 127-196μ) which may reflect lack of affinity for restricted water masses such as the Gulf of California .

Plate 13, figure 1

Spongaster tetras tetras Ehrenberg

RECENT DISTRIBUTION

1. Benson, 1966; "This species is rare at all Gulf [of California] stations where it is present ... Because it is present at only four stations in the northern half of the Gulf, its greater affinity for oceanic water masses is indicated."

2. Nigrini, 1967, fig. 20; "Indian Ocean occurrences - S. tetras tetras is fairly abundant in the western tropics, but decreases in abundance east of 85°E, and is absent from middle latitude samples. It appears to be a reliable and potentially useful member of the low latitude assemblage."

3. Nigrini, 1968, text-fig. 15; "Absent from the northernmost sample examined, rare or absent in the region of the Peru Current, few in the regions of the North and part of the South Equatorial Currents; common in a broad region which includes the Equatorial Countercurrent and part of the South Equatorial Current."

4. Nigrini, 1970, fig. 19; belongs to a tropical assemblage derived by recurrent group analysis of North Pacific sediments, but the species does range as far north as 40°N in the western Pacific.

5. Molina-Cruz, 1975, Code S40; used in factor analysis of southeast Pacific assemblages; cf. Appendix 10 for percent S40 at each station.

6. Morley, 1977; Fig. I-18; "This species loads highest in factor 1 (tropical). At present the species is most abundant in the tropical waters of the western Atlantic. The position of the 0% contour at 18,000 YBP would seem to indicate a similar distribution pattern when compared to today's values."

Spongaster tetras Ehrenberg *irregularis* Nigrini

Spongaster tetras Ehrenberg *irregularis* Nigrini, 1967, p. 43, pl. 5, fig. 2

DESCRIPTION

"Shell roughly rectangular, usually irregular, spongy. Basically similar to *Spongaster tetras tetras*, with 4 or 5 central concentric lattice spheres, but differing from it by the shape of the patagium and angle between the "arms". "Arms" generally indistinct at 65°-79° to each other, forming an oblique cross; rarely, this angle may be as low as 59° or as high as 84°." (from Nigrini, 1967).

DIMENSIONS

"Length of longer side 136-263μ; of shorter side 100-191μ. Average radius of arms (measured from center of innermost sphere) 80-132μ." (from Nigrini, 1967).

Plate 13, figure 2

Spongaster tetras Ehrenberg irregularis Nigrini

RECENT DISTRIBUTION

1. Nigrini, 1967, fig. 21; "Indian Ocean occurrences - S. tetras irregularis is absent from low latitudes. In middle latitudes it is sparsely distributed. Though rare in Recent sediments, it appears to be a useful member of the middle latitude assemblage."

2. Nigrini, 1970, fig. 20; belongs to a transitional assemblage derived by recurrent group analysis of North Pacific samples.

Notes on the Genera *Stylodictya*, *Porodiscus* and *Stylochlamydium*.

The following species are abundant, but their identification is difficult. Their morphological characteristics are frequently gradational and incomplete specimens are numerous. According to some classification schemes rotation of the specimen is necessary to confirm the specific identification; clearly this is impossible when counting specimens in a fixed slide.

Kozlova (in Petrushevskaya and Kozlova, 1972) presented a useful generic revision based primarily on the nature of the central structure. Her taxonomy is used herein where possible. In some instances familiar specific names are retained even if they are technically questionable. Species are illustrated and described from "ideal" specimens and in practice might have to be combined for counting purposes. Incomplete specimens may have to be grouped as gen. sp. indeterminate.

Genus Stylodictya Ehrenberg 1847, emend, Koslova, 1972

"Stylodictya Ehrenberg, 1847b. p.54 (part.); Porodiscus Haeckel, 1881, p. 491 (part); Staurodictya Haeckel 1881, p. 506 (part.); Stylodictya Haeckel, 1881, p. 509 (part.) Type species Stylodictya gracilis Ehrenberg, 1854a, p.246.

Skeleton is flat or slightly concave with round outline; consists of equatorial and sagittal girdles (frontal girdle is not developed), wings of the rings are displaced at 45^0 in relation to the main axes; at their merging point they do not envelope each other and thus form girdles or regular round or scalloped form, especially distinctive in the first systems. The first system is close to Tholostaurus (cupolas do not overlap each other), diameter $\sim$30-40μ, not submerged into the skeleton; the distance between systems is greater than or equal to the diameter of the central chamber.

"The main and additional spines are well developed and often extend as external spines. Rim of the disc is smooth with 4, 8, or more spines.

"Differs from Tholodiscus new gen. by the annular character of the wing connection, by the absence of the zig-zag radial lines in the plane of the disc, and by its more regular round outline.

Eocene-Recent". (from Petrushevskaya and Kozlova, 1972).

Note: central structure clearly visible

Species included: Stylodictya aculeata Jorgensen

Stylodictya validispina Jorgensen

Stylodictya aculeata Jorgensen

Stylodictya aculeata Jorgensen, 1905, p. 119, pl. 10, fig. 41; Petrushevskaya, 1967, p. 35, pl. 17, figs. 1-3.

DESCRIPTION

"Species very similar to [S. validispina]. Differentiated by greater irregularity of structure of shell, which has effect upon disposition of chambers, radial cross-pieces, needles, and pores. In addition, in S. aculeata width of chambers increases more markedly towards periphery of disk than in previous species. S. aculeata differs from S. validispina also in larger number of pores lying across width of one chamber (4-5.5)."

"Species S. validispina and S. aculeata are very similar to each other. Their morphological differences may prove to be due only to different hydrological conditions and that these are two subspecies of one polymorphic genus. The two species are very similar to S. gracilis Ehrenberg, 1854 (the type species of genus Stylodictya Ehrenberg, 1847), but differ from it by their finer, less frequent, less regularly disposed radial needles." (translated from Petrushevskaya, 1967).

DIMENSIONS

"Diameter of middle chamber 15-17 μ, diameter of first ring 30-35 μ, of second about 55 μ, of third about 80 μ, of fourth 110-120 μ, diameter of disk with five rings about 150 μ." (translated from Petrushevskaya, 1967).

Stylodictya aculeata Jorgensen

RECENT DISTRIBUTION

1. Benson, 1966; see S. validispina.

2. Sachs, 1973; this form was recognized as having "a much smaller number of rows of chambers and consequently...wider chamber rows than characterize typical S. validispina"; not counted by Sachs.

Stylodictya validispina Jorgensen

Stylodictya validispina Jorgensen, 1905, p. 119, pl.10, fig. 40; Petrushevskaya, 1967, p.33, fig. 17, IV-V

DESCRIPTION

"Skeleton in form of flat disk not thickened in middle. Central round chamber distinctly visible; around it four chambers of approximately equal dimensions arranged in form of cross. These surrounded by others, usually larger in dimensions, disposed in more or less regular concentric rings . . .; sometimes arrangement of chambers somewhat disturbed and zigzag seam present that may be regarded as proof of their spiral growth. Concentric rings of chambers number 5-6; their width hardly increases to periphery of disk. Pores on walls of chambers irregular, usually 2-2.5 pores located at width of one ring (i.e., third pore disposed in middle of seam between chambers of neighboring rings). Pores on peripheral rings somewhat larger than those on central. Growth of shell proceeds by successive growth of chambers around margin of disk. Adjacent rings pierced by radial pieces, some of which extend from margin of disks as radial needles. Apart from these, radial needles not connected with the radial pieces arise around margin of disk. Radial needles arranged very irregularly, number 12-16 along periphery of disk with five rings (most frequently broken off to base)." (translated from Petrushevskaya, 1967).

"The four central chambers so characteristic of this species were found to be less distinctive in the downcore study of RC14-105". (from Robertson, 1975).

DIMENSIONS

"Diameter of central chamber 12-15μ, diameter of first ring 30-35μ, diameter of second ring 55-60μ, of third 80-85μ, of fourth 110-115μ, diameter of disk with five rings about 140μ." (translated from Petrushevskaya, 1967)

These dimensions are in good agreement with those reported by Benson (1966) and Sachs (1973).

REMARKS

1. Petrushevskaya (1975) placed this species in synonymy with Stylodictya stellata Bailey. However, Bailey's illustration (1856, pl. 1, fig. 20) does not show the characteristic central girdles and for that reason the synonymy is rejected.

Plate 13, figures 5a,b

<u>Stylodictya</u> <u>validispina</u> Jorgensen

<u>RECENT</u> <u>DISTRIBUTION</u>

1. Benson, 1966; considered together with <u>S.</u> <u>aculeata</u>; ". . . rare at all stations in the Gulf [of California] except at 64 where it is common (2.0%)".

2. Sachs, 1973, Code 13I; "Very widespread to 9% of the total fauna, but prefers Northern (Polar factor) conditions".

3. Molina-Cruz, 1975, Code S47; used in factor analysis of southeast Pacific assemblages; cf. Appendix 10 for percent S47 at each station.

4. Robertson, 1975; "The species loads most heavily in factor 3 (transitional) but also loads in factor 1 (subpolar). The greatest abundances for this species are to the north of 40° N at both the present and 18,000 YBP. There is not a marked shift in the abundance pattern from the present to 18,000 YBP but at 18,000 YBP abundances are higher north of 40° N".

Genus Porodiscus Haeckel, 1881, emend. Kozlova, 1972

"Flustrella Ehrenberg, 1838, p. 122; Porodiscus Haeckel, 1887, p. 491 (part.); Flustrella Campell, 1954, p. 89 (part.); Stylodictya Campbell, 1954, p. 92 (part) Type species Porodiscus concentrica (Ehrenberg) 1838, p. 132.*

"The skeleton is flat or slightly concave in its center, has a rounded outline and is composed of annular equatorial rings (the rest is not developed); first system is of the Archidiscus type (central chamber and one ring), $d \approx 30$, very rarely submerged in the skeleton; distance between the annular rings is less than or equal to the diameter of the initial chamber. Main spines are indistinct and as a rule cannot be distinguished from the secondary spines, the number of which in the latter systems exceeds fifty. The rim of the skeleton is either smooth or covered by numerous spines.

Remarks: Rings in Porodiscus sometimes merge into a spiral. Differs from the genus Stylodictya by the absence of cupola-shaped chambers in the first system and by the more or less constant width of the rings. "Early Cretaceous-Recent." (from Petrushevskaya and Kozlova, 1972).

NOTE:

"...Although genus Porodiscus Haeckel, 1887, combining genera Trematodiscus Haeckel, 1862, and Discospira Haeckel, 1862, is a synonym of Ehrenberg's genus Flustrella Ehrenberg, 1838, still, as Haeckel himself wrote (1862), the generic name Flustrella has by mistake come to be used for representatives of the Bryozoa, and this usage has taken such firm root that there is no sense in changing it and re-establishing the name Flustrella for radiolarians, as Campbell and Moore (1954) suggest". (translated from Petrushevskaya, 1967).

Species included: Porodiscus sp. A
Porodiscus (?) sp. B

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*"Porodiscus Haeckel, 1881, p. 459
Frizzell (1951, p. 24) designates Trematodiscus orbiculatus Haeckel in Haeckel, 1862 as the type species of Porodiscus; Campbell (1954, p. D89) designates Flustrella concentrica Ehrenberg, 1838. However, these seem inappropriate as neither species was among those first subsequently assigned to Porodiscus. Species first subsequently assigned to Porodiscus are: Porodiscus communis Rüst, 1885; P. nuesslinii Rüst, 1885; P. simplex Rüst, 1885." (from Foreman and Riedel, in press).

S106

Porodiscus sp. A

Ommatodiscus sp. Benson, p. 210, pl. 10, fig. 3 (only).
Stylodictya sp. Petrushevskaya, 1967, p. 32, fig. 18, I, II.

DESCRIPTION

"Skeleton in form of disk thickened in central part and therefore opaque. Second and third rings are first to be seen distinctly. Usually chambers often disposed in spiral turns rather than in concentric rings... Width of chambers not increasing to periphery of disk. Pores irregular; usually three pores lying on width of chamber. Pores of approximately uniform dimensions on central and peripheral chambers....Radial needles seen extending from margin of shell; owing to apophyses of these needles the following chambers form....

"In the Pacific Ocean sector [of the Antarctic Ocean]....several other forms are encountered. Differ from above usually in greater number of rings (7-8) observed), and therefore in the greater size of the disk. Disposition of pores somewhat more regular, pores are larger, and only 2.5 of them are located on the width of one chamber (i.e., one pore usually lies on the seam between the chambers of neighboring rings). Chambers of various rings, as in the typical variety described above, of uniform width about 10 , not expanding toward periphery of the disk. The margins of the disk in all specimens were unfortunately broken down". (translated from Petrusevskaya, 1967).

DIMENSIONS

"diameter of central opaque part of shell 25-40μ, width of one row of chambers about 10μ, diameter of shell with 4-5 marked turns 110-125μ". (translated from Petrushevskaya, 1967).

RECENT DISTRIBUTION:

1. Sachs, 1973, Code 121 (Ommatodiscus sp.): Sachs apparently follows Benson's (1966) concept of this species which includes a number of different forms. Therefore, his distributional information may be inaccurate for the species here described, i.e., "This form strongly favors southern (Transitional) waters".

Plate 14, figures 1, 2a,b

Porodiscus sp. A

2. Lozano, 1974, Fig. IV-II (Ommatodiscus sp.): "There are several closely related species which have been classified in various ways by different authors and are difficult to distinguish from one another in permanent slides. We restrict our counts to three variants which are included by Benson (1966) within his definition of Ommatodiscus sp. characterized by having concentric, latticed, discoidal shells in the central region of the text so that inside view of the central region of the test is biconvex. We limited our counts to those forms which in plain view are seen as made of concentric or spiral rings, the width of the rings increasing very little outwardly. In some specimens the first two or three rings cannot be resolved....Other specimens have the first two concentric rings followed by a spire of two or three whorls....In other forms all rings can be distinguished and are concentric from the first to the last one....Other specimens in which the central part can be resolved have a continuous spiral shape....We did not include in our counts other types of Ommatodiscus which have irregular rings. We differentiated Ommatodiscus sp. from Stylodictya validispina Jörgensen (Benson, 1966) because in the latter one the first and second and sometimes the third ring have a quadrate outline and the second ring consists of four separated chambers....However, it is possible that we may have included in our counts some of the latter in which the quadrate outline of the inner rings was not apparent.

"It is present at all locations within the studied area constituting less than 0.1 percent only in core V29-87. It is more abundant under subtropical waters where it generally accounts for over 2.5 percent of the total radiolarian fauna reaching a maximum in cores RC13-244, V24-202 (7.1 percent), and V18-188 (7.0 percent). Under subantarctic waters it generally accounts for 0.5 to 2.5 percent of the total Radiolaria. Under Antarctic waters it is found in abundances of 0.1 to 0.9 percent. The maximum values (7 percent) correspond to sea surface temperatures of 18° to 21°C in February and about 15°C in August. Present in proportions over 2 percent only under waters warmer than 12° in February and 7°C in August. It consitituеs less than 1 percent of the total Radiolaria under waters with temperatures below 6°C in February and 2°C in August."

3. Molina-Cruz, 1975, Code S45 (Ommatodiscus sp. A); used in factor analysis of southeast Pacific assemblages; cf. Appendix 10 for percent S45 at each station.

4. Robertson, 1975; counted together with Porodiscus (?) sp. B. "This species loads heavily in factor 2 (subtropical). At present this species is most abundant to the south. At 18,000 YBP there is a marked southern shift of the regions of highest abundance."

Porodiscus (?) sp. B

Ommatodiscus sp., Benson, 1966, p. 210, pl. 10, fig. 4 (only).

DESCRIPTION

Shell is an irregular disc, becoming thinner toward the periphery. Central structure a single lattice sphere obscurred by some spongy meshwork (hence the questionable inclusion of this species in Porodiscus). Concentric latticed chambers irregular, appearing as discontinuous, "wobbly" rings. Pores numerous, subcircular, becoming smaller toward shell margin. (Gail Lombari, unpublished data).

DIMENSIONS

Based on 15 specimens. Shell diameter 147-196μ. (Gail Lombari, unpublished data).

Plate 14, figures 3,4

Porodiscus (?) sp. B

RECENT DISTRIBUTION

1. Molina-Cruz, 1975, Code S48 (*Ommatodiscus* sp. B); "This species is distinguished by the irregular discontinuous internal rings". Used in factor analysis of southeast Pacific assemblages; cf. Appendix 10 for percent S48 at each station.

2. Robertson, 1975; see *Porodiscus* sp. A.

Genus Stylochlamydium Haeckel 1881

Stylochlamydium Haeckel 1881, p. 460; 1887, p. 514.

"Porodiscida with numerous (five or more, commonly eight to twelve) solid radial spines, regularly or irregularly disposed on the margin of the circular or polygonal disk; margin of the disk surrounded by a thin, porous (but not chambered), equatorial girdle." (from Haeckel, 1887).

Type species: Stylochlamydium asteriscus Haeckel, 1887, p. 514, pl. 41, fig. 10.

REMARKS:

1. It seems likely that the generic definition should be emended as follows:

   a. Central structure consists of concentric rings.
   b. Spines may or may not pierce the equatorial girdle.

2. There has been some confusion between this genus and the genus Perichlamydium. However, the type species of Perichlamydium, P. praetextum Ehrenberg (1847b), has a polar opening of pylome and, therefore, in Haeckelian taxonomy is quite different from Stylochlamydium asteriscus Haeckel (1887), the type species of Stylochlamydium. For further discussion see Petrushevskaya (1967) and Ling et al., (1971).

Stylochlamydium asteriscus Haeckel

Stylochlamydium asteriscus Haeckel, 1887, p. 514, pl. 41, fig. 10

DESCRIPTION

Circular disc with centre somewhat thickened. Concentric rings surround a central chamber separating shell into a system of 4 to 7 pored bands increasing in breadth toward shell margin. Pores are subcircular, approximately the same size and evenly spaced, 1-3 per ring. Marginal band is a thin, porous equatorial girdle. Characteristically, radial, needle-like spines (up to 10) extend from the centre to the periphery and beyond, subdividing the concentric bands into chambers. Central structure may be clearly visible or obscured by spongy lattice. (Gail Lombari, unpublished data).

DIMENSIONS

Based on 20 specimens; diameter of central shell 10-12μ; diameter of shell with 5 bands 94-110μ. Breadth of second band 5-7μ, of third band 7-9μ, of fourth band 9-12μ, of fifth band 12-16μ, of sixth band 15μ (3 specimens) of seventh band 17μ (1 specimen). (Gail Lombari, unpublished data).

Plate 14, figure 5

Stylochlamydium asteriscus Haeckel

RECENT DISTRIBUTION

1. Molina-Cruz, 1975, Code S30. "This species presented three variants. Thus, it was divided into three categories: (1) S30, (2) S30A, and (3) S30B. S30 has an opaque center and is mostly abundant in the equatorial region. S30A has a clear and concentric center but it is in the form of a spiral. S30B was not common in this study."

S30 and S30A used in factor analysis of southeast Pacific assemblages; S30B not used; cf. Appendix 10 for percent S30, S30A and S30B at each station.

Spongopyle osculosa Dreyer

Spongopyle osculosa Dreyer, 1889, p. 42, pl. 11, figs. 99, 100,
Riedel, 1958, p. 226, pl. 1, fig. 12
Spongodiscus (?) osculosus (Dreyer), Petrushevskaya, 1967, p. 42
figs. 20-22

DESCRIPTION

"Spongy shell in form of biconvex lens. Its shape varies: approximates to a more or less regular circle. Spongy tissue fine; central thickened part of shell constructed of denser spongy mass than marginal. Entire surface of shell in adult specimens covered by mantle similar to that of Spongurus pylomaticus. Because of mantle shell has clear contours. Radial pieces pass among cross-pieces of spongy tissue in form of indistinct radial striation . . . do not emerge to the outside, and shells devoid of radial needles. Distinct pylome characteristic. This is not a simple funnel in spongy tissue. . . but specialized formation in form of porous tubule with notches at end." (translated from Petrushevskaya, 1967).

"Well preserved specimens with mantle and pylome are easily distinguished from other species. When badly preserved or not well developed (?) and the mantle and pylome are not well preserved, it is difficult to differentiate from some variants of Spongotrochus glacialis. As described by Dreyer, Riedel and Petrushevskaya the shell has the shape of a biconvex lens. The central thickened part is made of a denser spongy mass. The entire surface of the shell in adult specimens is covered with a mantle so the shell has a well defined coutour. It is also characterized by the presence of a tubular pylome . . . However, under subantarctic and subtropical waters a variant is found which has flat sides in lateral view acquiring a subhexagonal outline . . . and some specimens are difficult to differentiate from a variant of [Spongotrochus glacialis]." (from Lozano, 1974).

DIMENSIONS

"Diameter of disk of adult specimen - 190 - 270 μ" (translated from Petrushevskaya, 1967).

REMARKS

1. Petrushevskaya (1975) synonymized the genera Spongodiscus Ehrenberg, 1854 (type species = Spongodiscus resurgens Ehrenberg, 1854, pl. 35B, IV, fig. 16) and Spongopyle Dreyer, 1889 (type species = Spongopyle setosa Dreyer, p. 119, pl. 11, figs. 97, 98). This synonymy is based on the belief that a pylome may or may not be present.

Spongopyle osculosa Dreyer

At this time, there appears to be so much difficulty in distinguishing and defining Spongopyle osculosa, Spongopyle setosa and Spongotrochus glacialis (see Lozano, 1974) as well as some less well known species of this general form, that the present authors prefer to retain familiar names until generic and specific revisions can be made simultaneously. Petrushevskaya's synonymy has the disadvantage of giving us Ehrenberg's poorly illustrated type species (only half a specimen is shown) rather than Dreyer's excellent illustration.

RECENT DISTRIBUTION

1. Benson, 1966; ". . . rare but cosmopolitan in the Gulf [of California] ."

2. Lozano, 1974 (fig. IV-13); "It is found in all but three samples from subtropical water where it is generally less abundant but without displaying a preferred distribution pattern. It reaches a maximum of 3.5 percent in core RC12-292. Because of the difficulty of differentiating between some specimens of S. osculosa and S. glacialis . . . they were combined for the factor analysis. Figure IV-4 shows the percent distribution of S. glacialis plus S. osculosa. Due to the almost constant and comparatively low abundance of S. osculosa the characteristics of the distribution for both of them are essentially the same as for S. glacialis alone."

3. Molina-Cruz, 1975, Code S44; mistakenly counted together with Spongotrochus glacialis and Stylochlamydium venustum. It now appears that each of these species has a defined distribution. Therefore, this category was not used in factor analysis of southeast Pacific assemblages.

4. Morley, 1977, fig. I-19 "Since it is difficult to differentiate this species from Spongotrochus glacialis without its characteristic mantle and pylome, only specimens with a distinguishable mantle and/or pylome were counted. . .

"This species loads highest in factor 3 (gyre margin). At present this species is most abundant under subantarctic waters. While keeping approximately the same southern boundary at 18,000 YBP, this species appears to slightly increase in abundance in sampling along the western coast of Africa."

Spongotrochus glacialis Popofsky group

Spongotrochus glacialis Popofsky, 1908, p. 228, pl. 26, fig. 8, pl. 27, fig. 1, pl. 28, fig. 2; Riedel, 1958, p. 227, pl. 2, figs. 1, 2, text-fig. 1

Spongotrochus glacialis Popofsky group, Petrushevskaya, 1975, p. 575, pl. 5, fig. 8, pl. 35, figs. 1-6

DESCRIPTION

"Shell biconvex-discoidal, consisting of a spiny disc of spongy structure which is in some (fully developed ?) individuals surrounded by a lenticular lattice-shell. Spongy disc thickened in its central portion (a quarter to a half of its total diameter), with numerous acicular or acutely conical spines of different lengths around its circumference and in most specimens also on the two surfaces, particularly on the thickened central portion. When present, the enclosing lenticular lattice-shell is apparently in contact with the spongy disc at or near its circumference, but is separated by a distinct space from its two surfaces. In most specimens, the spines arising from the thickened central part of the spongy disc penetrate the lattice-shell. The lattice-shell has an uneven surface, with subcircular or circular pores of varying sizes, the diameters of which are a half to ten times as great as the breadth of the intervening bars." (from Riedel, 1958).

DIMENSIONS

"Diameter of shell 195-465μ. Length of free parts of spines on circumference 5-170μ (often about 70μ)." (from Riedel, 1958).

REMARKS

1. For further synonymy and taxonomic discussion see Petrushevskaya (1967, 1975) and Lozano (1974).

Plate 15, figures 2a-d

Spongotrochus glacialis Popofsky group

RECENT DISTRIBUTION

1. Benson, 1966; "... rare but cosmopolitan in the Gulf [of California]." However, it is not certain if Benson's specimens belong to the same species as Riedel's Antarctic specimens.

2. Lozano, 1974, Fig. IV-12; "It is an important constituent of the radiolarian fauna in all of our samples. The higher percentage values are generally found under subantarctic waters where, with few exceptions, it constitutes over 10 percent of the total Radiolaria reaching a maximum value of 28.4 percent in core RC11-81.

"The 10 percent isopleth nearly coincides with the average position of the Antarctic Polar Front (APF). To the north only our samples between 35°W and 25°W and north of 40°S have less than 10 percent of S. glacialis.

"The southern boundary of the area with more than 10 percent S. glacialis, being coincident with the average position of the APF, correlates well with the 5°C February and 2°C August sea surface isotherms. The northern limit of the area with over 10 percent S. glacialis cuts the isotherms and separates the subtropical Atlantic fauna with less than 10 percent S. glacialis from that of the subtropical Indian Ocean where it generally constitutes over 10 percent of the total Radiolaria."

3. Molina-Cruz, 1975, Code S44; mistakenly grouped with Spongopyle osculosa and Stylochlamydium venustum. It appears now that each of these species has a defined distribution. Therefore, this category was not used in factor analysis of southeast Pacific assemblages.

Spongotrochus (?) venustum (Bailey)

Perichlamydium venustum Bailey, 1856, p.5, pl. 1, figs. 16, 17

Stylochlamydium venustum (Bailey), Haeckel, 1887, p. 515

DESCRIPTION

Shell is a spongy, biconvex, circular disc; surface rough. Central structure probably a single lattice sphere, but generally obscured by spongy meshwork. In well-preserved specimens, broken concentric rings visible and a pored equatorial girdle. Cylindrical radial spines, probably originating from central capsule, lie on the equatorial plane (or nearly so) and extend beyond the marginal girdle. (Gail Lombari, unpublished data).

DIMENSIONS

Based on 20 specimens; shell diameter 120-192μ for all specimens; shell diameter of complete specimens 175-192μ (Gail Lombari, unpublished data).

REMARKS

1. Most recent radiolarian workers have followed Haeckel's taxonomy with regard to this species, i.e., Stylochlamydium venustum (Bailey). However, because the species is composed of a spongy framework and does not have a porous sieve plate, the genus Stylochlamydium is unacceptable. The genus Spongotrochus has been suggested herein because of the apparently close relationship between this species and Spongotrochus glacialis.

2. According to Renz (1976), "in most specimens the concentric rings appear "broken" in a spongy meashwork; and the equatorial girdle is present."

Plate 15, figures 3a,b

S120

Spongotrochus (?) venustum (Bailey)

RECENT DISTRIBUTION

1. Sachs, 1973, Code 17I (Stylochlamydium venustum) Fig. 2c;

"In the present study, two forms corresponding approximately to Stylochlamydium venustum or Spongotrochus ? glacialis were separately tabulated. The former generally includes forms lacking a pylome, but often with protruding spines on the periphery. The latter always showed a marked pylome, but generally lacked spines...These two categories have been combined in the results reported here. Because of the abundance of these forms, more detailed resolution of taxa is potentially most valuable. However, it has not yet been possible to recognize more detailed divisions in all specimen orientations, which is required for the counting undertaken in this study...

"Ubiquitous and very abundant, but most strongly associated with the Subarctic Factor (Factor 2), which reaches its maximum expression at intermediate latitudes."

2. Molina-Cruz, 1975, Code S44 (Stylochlamydium venustum); mistakenly grouped with Spongopyle osculosa and Spongotrochus glacialis. It appears now that each of these species has a defined distribution. Therefore, this category was not used in factor analysis of southeast Pacific assemblages.

3. Robertson, 1975, includes Spongotrochus (?) glacialis Popofsky, Riedel, 1958, Stylochlamydium sp. Petrushevskaya, 1967 and Spongodiscus (?) setosus (Dreyer), Petrushevskaya, 1967; "This species loads very heavily in factor 1 (subpolar) and also loads to a lesser degree in factor 2 (subtropical). This species occurs in high abundances throughout the study area but occurs most abundantly in the northernmost part of the northwest Pacific and in the Bering Sea. Low abundances characteristic of the Sea of Okhotsk today extend over the area north of 45^{o}N at 18,000 YBP."

Hexapyle spp.

Hexapyle dodecantha Haeckel, 1887, p. 569, pl. 48, fig. 16; Benson, 1966, p. 275, pl. 18, figs. 14-16, text-fig. 20

DESCRIPTION

"Test consisting of a double pylodiscid shell; with outer shell larger than that of [Discopyle? sp] but with similar arrangement of twelve radial spines and, in several specimens, with one, two, or three radial beams each extending across the tubular spaces through the shell; with or without a large but irregularly-pored lattice covering the surfaces of the outer shell. Latticed covering, when present, with numerous (50 or more) radial spines arising from its surface and branching at a common level; in a few specimens, the branches of these spines anastomose to form part of an outer triangular or ellipsoidal latticed shell which was never observed fully developed; completely developed tests, therefore, not discoidal. Innermost structure within first pylodiscid shell not observed but may consist of a central node from which radiate the three radial beams mentioned above." (from Benson, 1966).

DIMENSIONS

"length of base of inner triangular pylodiscid shell 18-43μ, of outer pylodiscid shell 80-137μ, of altitude of inner shell 20-42μ, of outer shell 74-128μ; length of base of outer triangular shell covering double pylodiscid shell 113-185μ, of altitude 122-154μ." (from Benson, 1966).

Plate 16, figures 1a-c

Hexapyle spp.

RECENT DISTRIBUTION

1. Benson, 1966; (Hexapyle dodecantha); identification of this species frequently depends on orientation.

"Numerous, relatively large ellipsoidal shells were counted as a group designated as Litheliacea unidentified if some indication of inner latticed girdles were observed. ... This group is common to rare at all stations in the Gulf except 203 and 214 where it is absent. It occurs in greater numbers in the southern Gulf; thus it is parallel to the distribution of the members comprising it."

2. Molina-Cruz, 1975, Code S53; used in factor analysis of southeast Pacific assemblages; cf. Appendix 10 for percent S53 at each station.

Octopyle stenozona Haeckel

Octopyle stenozona Haeckel, 1887, p. 652, pl. 9, fig. 11; Benson, 1966, p. 251, pl. 16, figs. 3-4

DESCRIPTION

"Test subquadrate in outline, with one complete system of inner dimensive girdles with elliptical outline in frontal view and with the second transverse girdle complete as well as most of the second lateral girdle; the lateral girdle has short spines or thorns, parallel to the sagittal axis extending from it in the region of the poles of the principal axis, suggestive of a rudimentary second sagittal girdle; however, no specimens from the Gulf were observed with this girdle. Second transverse and lateral girdles very narrow, with large unequal pores separated by heavy intervening bars; surface of both girdles with short, stout spines or thorns, unbranched distally. Test typically with a pair of heavy, cylindrical beams, oppositely placed, coaxial with the principal axis of the test, each arising from the surface of the innermost ellipsoidal shell and joining with the second lateral girdle distally; the presence of the beams gives the test the appearance of having eight subcircular gates, four on each side of the test, whereas there are only four true gates, two each on the dorsal and ventral surfaces of the test.

"... this species is easily distinguished from Tetrapyle octacantha by its very narrow second transverse and lateral girdles, very short sagittal axis relative to the principal and transverse axes, its generally quadrangular outline, and by the presence of the two heavy polar beams which occupy the principal axis and give the test the appearance of having eight gates instead of four." (from Benson, 1966).

DIMENSIONS

"length of P_1 axis 15-18μ, of P_2 axis 43-52μ, of P_3 axis 123-191μ, of T_1 axis 11-14μ, of T_2 axis 34-41μ, of T_3 axis 119-154μ." (from Benson, 1966).

REMARKS

1. Note erroneous spelling in Moore (1974) and Molina-Cruz (1975).

Plate 16, figures 2a,b

Octopyle stenozona Haeckel

RECENT DISTRIBUTION

1. Benson, 1966; "... very rare in the Gulf [of California]... present only in the southern half..."

2. Goll and Bjorklund, text-fig. 7; "A small number or species are present in sediments underlying the Equatorial, Gulf Stream and Canary Currents comprising the central gyre of the North Atlantic, and these species may occupy the corresponding gyre system of the South Atlantic as well. The distribution of Octopyle stenozona Haeckel, 1887 is illustrated in text-figure 7. This species may possibly live in the Sargasso Sea, but its skeletons are not preserved in the underlying sediments. Octopyle stenozona is analogous in its distribution to foraminifera such as Globigerinoides conglobatus and Globoquadrina dutertrei (Bé and Hamlin, 1967, text-figs. 17,22)".

3. Molina-Cruz, 1975; counted together with Tetrapyle octacantha but observed to be much less abundant; used in factor analysis of southeast Pacific assemblages; cf. Appendix 10 for percent S54 at each station.

Tetrapyle octacantha Muller

Tetrapyle octacantha Muller, 1858, p. 33, pl. 2, figs. 12, 13, pl. 3, figs. 1-12; Benson, 1966, p. 245, pl. 15, figs. 3-10, pl. 16, fig. 1, text-fig. 18

DESCRIPTION

"Complete tests consisting of two well-defined systems of latticed dimensive girdles, with few, if any radial beams, and a third outer system of poorly-defined girdles supported by numerous short beams of approximately equal length that arise from the nodes of the intervening bars of the latticed girdles of the second system. Most tests incomplete, consisting either of all or a portion of the second girdle system (transverse and lateral girdles with rudimentary, sagittal girdle), but in several tests with some indication of the third girdle system in the form of numerous branched spines or incomplete outer girdles, generally representing the rudimentary, third transverse girdle. Pores of the latticed girdles relatively large, unequal, irregular to subregular in arrangement, generally subcircular to subpolygonal. Surface of complete specimens irregular, rough or spinose; surface of second girdle system relatively smooth to highly spinose. Outline of second lateral girdle generally ellipsoidal (major diameter the principal of P axis) but variable from subcircular to subquadrate. Gates defined by the transverse and lateral girdles of the second system generally elliptical to kidney-shaped, in a few specimens with beams lying in their plane and joining the transverse girdle with the rudimentary second sagittal girdle. Radial beams absent in many tests but when present generally lie in the axes of the test (P, T, or S), although in a few specimens they extend from the pole of the inner system of girdles at an acute angle with the axis. Beams arise from the inner ellipsoidal shell or ring but do not penetrate beyond the second girdle system as free spines; number of coaxial beams variable but generally six when present; a few specimens were observed with only one of a pair of opposite polar beams extending through the inner tubular space between gates; rarely more than one beam observed at each pole; tests without beams generally with short polar spines or thorns representing rudimentary beams. Specimens with eight diagonal spines, each originating from one of the eight edges of the second transverse girdle (Tetrapyle octacantha Muller) rare, with or without polar beams." (from Benson, 1966).

DIMENSIONS

"range in length of dimensive axes of each girdle system (cf. fig. 18):

	Range (μ)		Range (μ)		Range (μ)
P_1	14-18	T_1	9-12	S_1	5-9
P_2	39-65	T_2	31-48	S_2	15-25
P_3	93-194	T_3	70-156	S_3	55-95
P_4	215-246	T_4	172-221	S_4	121-221"

(from Benson, 1966).

Plate 16, figures 3a,b

Tetrapyle octacantha Muller

"outermost girdle length: $120 \pm 24\mu$, width: $83 \pm 22\mu$, next-to-outermost girdle length $42 \pm 7\mu$; width: $26 \pm 8\mu$" (from Sachs, 1973).

REMARKS

1. Benson (1966) suggests a lengthy synonymy based on the belief that many described species are in fact incomplete specimens or orientations are other than frontal.

RECENT DISTRIBUTION

1. Benson, 1966; "...a predominant member of the Gulf [of California] assemblage. It occurs in greatest abundance in the southern part..."

2. Sachs, 1973 (Code 5I); "An important (to 18%) constituent of the Southern [south of about 45°N] fauna; loads on the Transitional (Southernmost) factor."

3. Molina-Cruz, 1975, Code S54 ; counted together with Octopyle stenozona Haeckel and used in factor analysis of southeast Pacific assemblages; cf. Appendix 10 for percent S54 at each station.

4. Robertson, 1975; "This species loads quite heavily in factor 2 (subtropical). Its highest abundances are to the south at present. The region in which it is absent at present is significantly further to the south at 18,000 YBP."

? Prunopyle antarctica Dreyer

Prunopyle antarctica Dreyer, 1889, p. 24, pl. 5, fig. 75; Riedel, 1958, p. 225, pl. 1, figs. 7, 8.
Cromyechinus antarctica (Dreyer), Petrushevskaya, 1967, p. 25, pl. 3, figs. 5 I-VI, pl. 14, figs. I-VII.

DESCRIPTION

"Skeleton consisting of four concentric shells connected by numerous radial bars. The three inner shells are spherical, or approximately so, while the fourth is ovate. The two inner and the two outer shells lie rather close together, and a larger space separates the second shell from the third. Pores of the second shell (counting outward) subcircular, separated by relatively thin bars. Pores of the fourth (outermost) shell small, circular or subcircular, in mann specimens arranged in groups over the pores of the third shell in such a manner that 2-8 pores of the fourth shell overlie one larger pore of the third shell. Fourth shell apparently rather thick, with smooth or ridged surface, in some individuals partially united with the third shell. Short, thorn-like spines are sparsely distributed over the shell surface; those surrounding the large pylome are longer and stronger, and some specimens have a group of large spines also on the aboral pole." (from Riedel, 1958).

The connecting bars are 3-bladed and pierce the outermost shell. In complete specimens there is one spine longer than the others on the long axis of the fourth shell. Fourth shell often incomplete, but is always indicated by transverse processes on the radial spines. (Gail Lombari, personal communication).

DIMENSIONS

"Diameter of the innermost shell approximately 15-17μ, of second shell 35-12μ (occasionally to 61μ?), of third shell 75-98μ, of fourth shell (major axis) 115-160μ, (minor axis) 105-110μ.

"Emended description differing principally in the ranges of variation of the shell diameters, based on 15 specimens from Sta. 91. Although Dreyer stated that the diameter of the second shell is approximately 61μ, the present author has found no specimen in which it exceeds 42μ." (from Riedel, 1958).

Based on 20 specimens from the North Pacific, near the Oregon coast. Diameter of inner medullary 12-14μ; outer medullary 26-39μ; third shell 66-84μ; long axis of fourth shell 89-126μ; short axis of fourth shell 84-120μ. Length of principle spine 26-40μ. (Gail Lombari, unpublished data).

Plate 16, figure 4

? Prunopyle antarctica Dreyer

The above dimensions are generally smaller than those found by Riedel (1958) in Antarctic sediments. This difference supports Bjorklund's (1974) conclusion that there are two forms of this general type i.e., one boreal-arctic and one antiboreal-antarctic. See Remarks 2 below.

REMARKS

1. Petrushevskaya (1975) and Bjorklund (1977) believe that forms of this general type with 3 concentric shells are growth stages of similar forms having a fourth spherical or ellipsoidal shell with an opening at one pole. Bjorklund (personal communication) is in favor of making such forms cogeneric (Actinomma) and dividing them at the species level. This is certainly a useful approach for the purpose of counting mophologically distinct entities and for that reason it is followed herein, for the most part. However, forms with a pylome presently belong to the Family Prunoidea rather than the Family Actinommidae and it would be inappropriate to make major, undocumented taxonomic changes herein. There is a further difficulty in moving this particular species to the genus Actinomma in that the specific name antarcticum is preoccupied.

2. Bjorklund (1974) concludes that there is a boreal-arctic form of this general type (Cromyechinus borealis) and an antiboreal-antarctic form (Cromyechinus antarctica in Bjorklund's paper).

Prunopyle antarctica Dreyer

RECENT DISTRIBUTION

1. Riedel, 1958; "This species, first described from the southern Indian Ocean, occurs in both the American and Indian Ocean sectors of antarctic waters. A rather similar form, which may belong to the same species, occurs in the northern Pacific- the material at present available is however insufficient for accurate identification of the northern form. No form resembling P. antarctica has been found in the tropical parts of the Pacific or Indian Oceans. Thus this species may possibly be restricted to high northern and southern latitudes."

2. Benson, 1966 (Sphaeropyle langii Dreyer, p. 166); "...rare at all stations where it is present...". It is uncertain whether or not this species is conspecific with P. antarctica.

3. Sachs, 1973, Code 3I; "Infrequent and very patchy, loads on Polar factor."

4. Molina-Cruz, 1975, Code S8 (Cromyechinus antarctica); used in factor analysis of southeast Pacific assemblages; cf. Appendix 10 for percent S8 at each station.

5. Robertson, 1975; "Only those specimens which were ellipsoidal and had an outermost shell with a pylome were counted. The descriptions of Riedel (1958) and Petrushevskaya (1967) were followed although additional work is needed to determine if the forms described by Petrushevskaya which have spines should be included in this species..."This species loads most heavily in factors 3 (transitional) and 1 (subpolar). Its greatest abundances at the present and 18,000 Y.B.P. are in the northernmost part of the northwest Pacific."

Larcopyle butschlii Dreyer

Larcopyle butschlii Dreyer,1889, p. 124, pl. 10, fig. 70; Benson, 1966, p. 280, pl. 19, figs. 3-5

DESCRIPTION

"Large ellipsoidal shell when fully developed with regular outline; surface with scattered short (5-25μ) conical spines or thorns continuous inward as beams; pores unequal, irregular, larger than those of preceding species; at one pole in a few specimens a cluster of short (5-12μ) conical spines but without definite opening or pylome. Internal structure consists of irregular but generally recognizable latticed lamellae joined by numerous radial beams, in several specimens with an identifiable pylonid structure of concentric trizonal shells or spirals, particularly apparent in those with outer shell not fully developed. Those specimens with a recognizable internal triangular pylodiscid shell were placed within Discopyle ? sp." (from Benson, 1966).

DIMENSIONS

"based on 30 specimens... major diameter of test 135-246μ, minor diameter 81-172μ; length of axes of internal trizonal shells (8 specimens): P_1 18-33μ, P_2 59-95μ, T_1 14-18μ, T_2 39-74μ." (from Benson, 1966).

REMARKS

1. Benson (1966, p. 279) also described a similar form, Larcopyle sp., which may be distinguished from L. butschlii "by its relatively smaller size, its smooth surface without radial spines, and the presence of secondary pores filling the spaces of the large pores of the outer shell." Moore (personal communication) noted that the smaller form is more abundant, but he counted it together with the larger form.

Plate 17, figures 1a,b

Larcopyle butschlii Dreyer

RECENT DISTRIBUTION

1. Benson, 1966; "rare but cosmopolitan in the Gulf [of California]... its distribution in local areas may be favored by upwelling."

2. Sachs, 1973, fig. 2D, Code 30I; the dimensions given by Sachs suggest that he was counting Larcopyle sp., not L. butschlii; "This form is rather strongly southern in its preferences, loading on the transitional factor. With the exception of an anomalous occurrence (9%) in sample 026, which may be a counting error, the maximum abundance is less than 5% in the surface study. The form is encountered in almost all samples south of 43^{O}N."

3. Morley, 1977, fig. I-20; "This species loads highest in factor 3 (gyre margin). At present it is most frequently found in samples from the subantarctic region. Although the abundance of this species decreases at 18,000 YBP, the region of maximum concentration is comparable to that for the present-day."

Larcospira quadrangula Haeckel

Larcospira quadrangula Haeckel, 1887, p. 696, pl. 49, fig. 3; Benson, 1966, p. 266, pl. 18, figs. 7-8

DESCRIPTION

"Fully developed tests subquadrangular in outline but with a sagittal constriction. Structure consisting of a double spiral representing a turning of two diagonally opposite wings of the second transverse girdle around the principal axis of the test; the other two wings of this girdle are absent. The wings are attached proximally two oppositely placed, cylindrical, polar (coaxial with principal shell axis) beams, each of which arises from the innermost ellipsoidal shell from which is developed the inner trizonal shell surrounding it; the two spiral wings of the second transverse girdle arise from the trizonal shell. Each of the two wings are elongated parallel to the principal axis and form half-cylindroidal chambers whose openings face in opposite directions. Wings (chambers) supported by several thin, cylindrical, radial beams which arise from the surface of the inner trizonal shell. Lattice of test with subequal to unequal, subpolygonal pores, subregularly arranged, separated by thin intervening bars. Surface of test with scattered thorns or short, thin, conical spines." (from Benson, 1966).

DIMENSIONS

"based on 13 specimens...length of P_1 axis (innermost shell) 31-36μ, of P_2 axis (inner trizonal shell) 68-82μ, of P_3 axis (sagittal constriction of fully developed forms) 135-209μ, of T_1 axis 18-27μ, of T_2 axis 43-64μ, of T_3 axis (maximum breadth of fully developed tests) 125-246μ." (from Benson, 1966).

Plate 17, figure 2

Larcospira quadrangula Haeckel

RECENT DISTRIBUTION

1. Benson, 1966; "This species is rare in the Gulf [of California] ... Its near absence in the northern half of the Gulf indicates that it is an oceanic species."

2. Nigrini, 1970, fig. 21; belongs to a tropical assemblage derived by recurrent group analysis of North Pacific samples, but ranges too far north to be meaningful in down-core analysis.

3. Sachs, 1973, Code 201; "The species has a maximum abudnance of less than 5% of sample, and is exclusively Southern in its distribution, loading on the Transitional Fauna." Southern is south of about 45^{0}N.

Lithelius minor Jorgensen

Lithelius minor Jorgensen, 1899, p. 65, pl. 5, fig. 24; Benson, 1966, p. 262, pl. 17, figs. 9-10

DESCRIPTION

"Ellipsoidal to spherical test consisting of 3-7 or more concentric trizonal shells, separated by approximately equal distances (6-25μ); in certain orientations internal structure appears as a double spiral. Shells supported by thin radial beams which arise from the nodes of the intervening bars of the lattice, therefore, several hundred in number; outermost shell with thorns or thin conical spines (incipient beams for support of an additional shell) arising from the nodes of the intervening bars; spines generally short (5-20μ), but long (up to 40μ) in a few specimens. Pores of all shells of nearly the same size, with regular to subregular arrangement, subcircular to subpolygonal, 9-15 on half the minor circumference of the outermost shell." (from Benson, 1966).

"As noted by Benson, forms may exhibit either doubly spiral shells or concentric shells, depending on their orientation. In either case, there are generally less than four whorls or shells. The form is one of the most heavily constructed encountered in this study." (from Sachs, 1973).

"In general the specimens found north of the subtropical convergence have more shells, four to seven, most frequently four to five, whereas under southern subantarctic waters specimens with three to four shells are most common. Small specimens 80 microns in diameter are found together with the largest ones (140 microns). As noted by Benson (1966) when specimens are turned under the microscope the internal structure appears as distinct concentric shells..., or as a double spiral ..., and in certain oblique positions as a single spiral. The position in which it appears as a single spiral is very unstable, it is very difficult to photograph and it never adopts this orientation in permanent slides." (from Lozano, 1974).

DIMENSIONS

"major diameter of test 79-148μ, minor diameter 70-132μ." (from Benson, 1966).

"major diameter: 103 ± 17μ; minor diameter 90 ± 14μ." (from Sachs, 1973).

REMARKS

1. For a more complete synonymy see Benson (1966).

Plate 17, figures 3,4a,b

Lithelius minor Jorgensen

RECENT DISTRIBUTION

1. Benson, 1966; "... cosmopolitan in the Gulf [of California]..."

2. Sachs, 1973, Code 8I; "Almost ubiquitous, and important (to 9% of fauna). Concentrated in southernmost (Transitional) and bottom-influenced factors."

3. Lozano, 1974, Fig. IV-10; "Generally absent south of the APF, when present it constitutes less than one percent of the total Radiolaria. It is always found in samples under subantarctic and subtropical waters in proportions varying from 0.1 to a maximum of 8.0 in core V29-80.

"As could be expected from its morphological variability, it does not show a clear pattern of latitudinal distribution within the subantarctic and subtropical waters."

4. Molina-Cruz, 1975, Code S24; "This species appeared very cosmopolitan. It probably needs a taxonomic review, since the specimens may represent more than one species with markedly different ecological responses."; used in factor analysis of southeast Pacific assemblages; cf. Appendix 10 for percent S24 at each station.

Lithelius nautiloides Popofsky

Lithelius nautiloides Popofsky, 1908, p. 230, pl. 27, fig. 4 (only); Riedel, 1958, p. 228, pl. 2, fig. 3 (only), text-fig. 2; Petrushevskaya, 1967, p. 53, figs. 27; 28, I; 29, I

DESCRIPTION

"Shell subspherical, consisting of a small, spherical medullary shell surrounded by a completely involute spiral of approximately four or five whorls. The whorls of the spiral increase in width outward, and are penetrated by numerous radial bars which extend as radial spines on the shell surface. Radial spines mostly broken off in the examples from the sediments, but according to Popofsky they are approximately as long as the shell radius or shorter, needle-like, and of varying thickness. Shell wall of moderate thickness, with rounded pores of different sizes." (from Riedel, 1958).

DIMENSIONS

"Diameter of medullary shell 10-15μ, of entire shell of approximately four to five whorls 110-220μ" (from Riedel, 1958).

REMARKS

1. Petrushevskaya (1967) suggested that only one of Popofsky's illustrations is *L. nautiloides*. She refers the other specimens which have only 2 or 3 whorls, rather than 5 or 6, to *Lithelius* sp.

2. According to Petrushevskaya, there is some doubt about the generic placement of this species since the type species (*L. spiralis* Haeckel, 1860) has a double spiral rather than a single one. However, Benson (1966) and the present authors agree that *L. spiralis* has a single spiral and, therefore, the generic assignment is acceptable.

Plate 17, figure 5

Lithelius nautiloides Popofsky

RECENT DISTRIBUTION

1. Lozano, 1974(Fig. IV-20); "This species seems to be slightly more restricted in its distribution than other Antarctic species; it is always present under Antarctic waters and generally present under southern sub-antarctic waters. When found close to or north of the subtropical convergence it is generally as a product of reworking or northern transport by bottom waters.

"It reaches a maximum abundance of 1.58 percent of the total Radiolaria in core V14-64A.

"It also shows a good correlation with topography when found more than 2^{o} north of the APF indicating northward transport by bottom currents. It generally constitutes less than 1.0 percent of the total Radiolaria except for two cores (V14-64A and RC13-253). Maximum August temperature under which it is found is $15^{o}C$ but specimens are in place probably under surface waters below $8^{o}C$."

<u>Pylospira</u> <u>octopyle</u> Haeckel?

<u>Pylospira</u> <u>octopyle</u> Haeckel, 1887, p. 698, pl. 49, fig. 4

DESCRIPTION:

Shell ellipsoidal in outline, composed of a series of spiralling chambers supported by numerous cylindrical radial beams which piece the outer shell margin. Outer shell thorny, bearing subcircular pores, irregular in size, shape and distribution. (Gail Lombari, unpublished data).

DIMENSIONS:

Based on 10 specimens; length of major axis 101-122μ, of minor axis 79-106μ. (Gail Lombari, unpublished data).

REMARKS:

1. The specimen illustrated by Benson (1966, pl. 17, fig. 2) as <u>Phorticium</u> <u>pylonium</u> is probably conspecific.

2. "The identification of this species is questionable because the test illustrated by Haeckel is much more regular than the forms observed in this study" (from Molina-Cruz, 1975).

3. <u>Tholospira</u> (?) sp. 2 in Sachs (1973) is thought to be conspecific although the dimensions given by him are rather larger.

Plate 17, figures 6a-c

Pylospira octoplye Haeckel?

RECENT DISTRIBUTION:

1. Sachs, 1973, Code 34I (*Tholospira* (?) sp. 2); "...widely distributed, but always less than 6% of the fauna of the surface study... loads most heavily on the bottom - influenced factor."
2. Molina-Cruz, 1975, Code S27; used in factor analysis of southeast Pacific assemblages; cf. Appendix 10 for percent S27 at each station.
3. Robertson, 1975, included this species in the synonymy of *Phorticium pylonium* which he found "loads heavily in factors 3 (transitional). At present it is most abundant in a zone east of about 155°E and between 44° and 50°N. There is a significant southern shift of the zone of highest abundances from the present to 18,000 YBP".

Spirema melonia Haeckel?

Spirema melonia Haeckel, 1887, p. 692, pl.49, fig. 1

DESCRIPTION:

Shell smooth-walled, ellipsoidal or subspherical depending on orientation. In the elliptical view, shell displays spiral convolutions, often a double spiral. In the subspherical view rings appear to be concentric. Radial beams do not pierce outer shell. Pore small subcircular, arranged irregularly. (Gail Lombari, unpublished data).

DIMENSIONS:

Based on 12 specimens; elliptical view: major axis 88-98μ, minor axis 74-94μ; spherical view, diameter 78-84μ. (Gail Lombari, unpublished data).

REMARKS:

1. Tholospira (?) sp. 3 in Sachs (1973) is thought to be conspecific although the dimensions given by him are much larger.

Plate 17, figure 7

Spirema melonia Haeckel?

RECENT DISTRIBUTION

1. Sachs, 1973, Code 33I (Tholospira (?) sp. 3); "The form is widely distributed, to less than 5% of total fauna.
   ... loads most on the bottom-influenced factor, with a lesser Southern (Transitional) influence [than Tholospira (?) sp. 2]."
   Southern is south of about 45°N.

2. Molina-Cruz, 1975, Code S28; not used in factor analysis of south-east Pacific assemblages; cf. Appendix 10 for percent S28 at each station.

3. Robertson, 1975; "The species loads most heavily in factor 3 (transitional). It is widely distributed with low abundances throughout the study area at the present but is absent in the Bering Sea and Sea of Okhotsk. There may be an expansion of the region where it is absent at 18,000 YBP but the area is poorly defined".

SUBORDER *Nassellaria* Ehrenberg 1887

Antarctissa denticulata (Ehrenberg)

Lithobotrys? denticulata Ehrenberg, 1844b, p.203.
Antarctissa denticulata (Ehrenberg), Petrushevskaya, 1967, p. 87, fig. 49, I-IV

DESCRIPTION

"The skeleton is massive, has a characteristic equilateral triangular outline. The first segment is small, deeply submerged into the widened second segment.

"The width of the second segment has a ratio of 1.5 - 1.8 : 1 to the width of the first segment. The widest part of the shell is at the lower part of the second segment. The "thorax" is closed below by a flat plate, perforated by pores. The pores on the shell are oval, randomly arranged, somewhat larger on the second segment. The shell walls are very thick and consequently the pores form in them a structure, which has a morphology reminiscent of funnels. The shell surface is rough, with thorns. The longer thorns are situated on the lower edge of the shell. The spines of the inner skeleton, A, Vert, D, Lr and Lj, are very tightly connected to the shell walls. Their extensions are almost unnoticeable on the outside of the shell." (from Petrushevskaya, 1967; translation courtesy W.R. Riedel).

DIMENSIONS

"Length of the first segment (externally) 35μ - 50μ, width 65μ - 80μ, length of the second segment 70μ - 90μ, width 90μ - 150μ." (from Petrushevskaya, 1967; translation courtesy W.R. Riedel).

REMARKS

1. For further synonymy and description of 3 additional varities see Petrushevskaya (1967).

2. "A form with three segments. . . is present but only a few specimens were observed in all the samples. Evidently it is closely related to A. denticulata but because it has three segments it would have to be classified in another genus or the definition of the genus would have to be expanded to include forms with three segments." (from Lozano, 1974).

Plate 18, figures 1a,b

Antarctissa denticulata (Ehrenberg)

RECENT DISTRIBUTION

1. Riedel, 1958 (Peromelissa denticulata); ". . . occurs in both the American and Indian Ocean sectors of Antractic waters, and no form closely resembling it has been found at any other locality. Thus it appears to be an exclusively southern cold-water species."

2. Hays, 1965, Fig. 5 (Peromelissa denticulata); "The distribution of Peromelissa denticulata is nearly identical to that of Helotholus histricosa . . . P. denticulata is usually less abundant; however, there is one striking exception to this generalization that may be of some significance. The two Deep Freeze samples located in the Ross Sea and the Russian sample Ob-282 have an assemblage in which Peromelissa denticulata is dominant. Since the number of individuals in these samples is not great and only three samples from the shelf were examined, no conclusions can be drawn; however, it may be that this species is more tolerant of near-ice conditions than the other members of the Arctic fauna.

"Peromelissa denticulata has not been reported from outside the Antarctic and, with the exception of cores raised from the Argentine basin, was not encountered in this study north of the mixed zone. It ranges back to zone ϕ, but its occurrence there is rare."

3. Lozano, 1974, fig. IV-17; the typical form and three varities described by Petrushevskaya (1967) were counted together.

"It is more abundant under Antarctic waters reaching a maximum of 26.4 percent in core V15-133. Values over 10 percent are found south of the APF and as far north as 45^{o}S in the Atlnatic Ocean. Its abundance decreases under sub-antarctic waters and it is practically absent at the average position of the subtropical convergence, except in the northern part of the Argentine and Crozet Basins.

"In the Argentine basin the correlation of percentage of A. denticulata and the 5000 m water depth is striking. North of 47^{o}S sediments from water depths greater than 5000 m have percentages generally greater than 5 and as high as 15.8 whereas samples shallower than 5000 m have values generally under one percent. It is also evident (Fig IV-17) that the values are generally higher in the western side of the basin. This pattern of distribution is best explained by bottom transport of this species by Antarctic Bottom Water in the Argentine Basin. . .

"The distribution of A. denticulata indicates that north of 47^{o}S the bottom currents are strong enough to transport Radiolaria only at water depths greater than 5000 m. In the western margin of the basin

Antarctissa denticulata (Ehrenberg)

the influence of the bottom current is evident at shallower depths (Lloyd Burckle, personal commumication). We have only one sample at 4401 m (V18-153 at 35°S in which *A. denticulata* accounts for 4.7 percent of the total Radiolaria. A similar pattern is discerned in the Crozet basin. Here the percentage values are lower than in the Argentine basin and the influence of bottom transport is felt at depths shallower than 5000 m in the western part of the basin where pratically all out cores are located. There is also evidence of northward tranpsort in the Aguhlas basin.

"Outside the Argentine and Crozet basins, *A. denticulata* is never found in proportions larger than one percent under August sea surface temperatures over 8°C. It is occasionally found in small proportions under the warmer waters in the Indian Ocean but it is absent in the three samples east of the Crozet basin.

"In the Atlantic Ocean, east of 30°W it is practically absent under August sea surface temperatures over 10°C.

4. Morley, 1977; see *Antarctissa strelkovi* .

N4

Antarctissa strelkovi Petrushevskaya

Antarctissa strelkovi Petrushevskaya, 1967, p. 89, fig. 51, III-VI

DESCRIPTION

"This species has a structure typical for the genus. The first segment is separated from the second by a slight constriction. The ratio of "cephalis" width to "thorax" width is 1: 1.5 - 2. Pores on both segments are rounded, randomly distributed; their sizes vary greatly. The shell walls are comparatively thin. On the surface there are thorns and even long secondary spines. These spines arise at the first segment, extend laterally along the sides of the second segment and project downward at its lower edge (in sediment specimens, the spines are usually broken off in the vicinty of the base). The elements of the inner skeleton are much thinner than in A. denticulata and their outward extensions are more distinct....differs from [A. denticulata] in the presence of long secondary spines on its surface, general form of the shell and thinner, transparent wall" (from Petrushevskaya, 1967; translation courtesy W.R. Riedel).

DIMENSIONS

"Length of the first segment (externally) 45μ - 55μ, its width 60μ - 65μ, length of the second segment 70μ - 90μ, width 70μ - 110μ, overall length of the shell is up to 150μ." (from Petrushevskaya, 1967; translation courtesy W.R. Riedel).

REMARKS

1. "When counting, many specimens are found which are difficult to assign to [A. denticulata or A. strelkovi]. A. denticulata is characterized by the smooth outline of the shell due to filling of the contriction between the cephalis and the thorax. This contriction is well defined in typical specimens of A. strelkovi.

"Several varieties of A. strelkovi can be distinguished but it seems that there are specimens with characteristics which are intermediate between each one of these varieties and one of the varieties of A. denticulata". (from Lozano, 1974). See Lozano (1974) for further discussion of specific gradations.

Plate 18, figures 2a,b

Antarctissa strelkovi Petrushevskaya

RECENT DISTRIBUTION

1. Hays, 1965, Fig. 3 (Helothus histricosa);

"... generally restricted to sediments south of the Polar Front except in the Argentine basin where it occurs in some abundance, often associated with warm-water species...H. histricosa occurs in zone ø but is a much less important component of this assemblage than it is of the typical Antarctic assemblage found in the overlying diatomite facies.

"H. histricosa is probably the most abundant and ubiquitous radiolarian species in the Antarctic, and if this fauna were to be characterized by any one species, H. histricosa would be a good choice. Its dominance in the fauna is frequently replaced near the Polar Front by Spongoplegma antarcticum Haeckel.

"With the exception of several samples, particularly those near the ice in the Ross Sea where Peromelissa denticulata is the dominant species, no other Antarctic species seriously threatens the dominance of Helotholus histricosa."

2. Lozano, 1974, Fig. IV-18; "It has a similar pattern of distribution as A. denticulata but some important differences can be noted.

"It is more abundant south of the APF varying between 12.2 and 36.8 percent (RC13-263) except in core V15-133) where it accounts for only 6.8 percent of the total Radiolaria. It reaches values of over 3 percent close to the Subtropical Convergence being generally more abundant at the same latitudes in the Indian than in the Atlantic Ocean. As A. denticulata it is more abundant in the sediments of the Argentine, Crozet, and Aguhlas basins, but unlike A. denticulata it is more abundant in the Crozet basin than in the Argentine basin North of 40^{o}S and to the east of 30^{o}W it is practically absent in the Atlantic sector but it is found in a few cores in the Indian Ocean. It is also absent in the three cores east of the Crozet basin. The northward transport by bottom currents in the Argentine, Aguhlas and Crozet basins is as evident as for A. denticulata.

"It is never found in proportions over one percent outside of the Argentine and Crozet basins beneath August surface temperatures over 12°C. Outside the Argentine basin, in the Atlantic Ocean it is practically absent under waters warmer than 10°C. Under Antarctic waters it seems to increase in relative abundance from west to east reaching higher values between 15°W and 20°E and apparently decreasing again toward the east but the number of samples is not enough to show a clear pattern.

Antarctissa strelkovi Petrushevskaya

"As A. denticulata and A. strelkovi appear to intergrade we combined them in the factor analysis (Fig. IV-19). All the samples south of the APF and west of 20°E have values of over 30 percent reaching a maximum of 51.9 percent in core RC13-263. Only one of the five samples east of 20°E has a value of over 30 percent. Values of 30 percent are not found north of 2° north of the average position of the APF which is within the limits of seasonal fluctuation for the APF (Gordon, 1971).

"The distribution of A. denticulata plus A. strelkovi seems to have a more uniform pattern. It seems that one takes the place of the other as if they were varieties of the same species or at least species with a common ancestor (see section on taxonomic notes). The addition of the two species only emphasizes the features described for each one of them."

3. Morley, 1977, counted together with A. denticulata and its varieties; "This group loads highest in factor 2 (polar). At present this group occurs most frequently in the polar regions. Although its maximum concentration is reduced at 18,000 YBP, the 20% contour is positioned at approximately the same latitude as today."

N8

Ceratospyris borealis Bailey

The taxonomic position of this species is completely uncertain. Dr. Robert Goll (personal communication) is presently reviewing Recent Spyroids and will, hopefully, provide a basis for the placement of this species through observations of the Spyroids as a group. This species is common in high northern latitudes and has been well illustrated, but poorly described, by a number of workers under a variety of names. Bailey's (1856) description and illustration of Ceratospyris borealis are both poor. However, since he was describing commonly occurring Recent North Pacific radiolarians, it is not unlikely that he indeed saw the species now under discussion. Therefore, the name Ceratospyris borealis Bailey is used herein with the understanding that it is used purely as a matter of convenience. The species has been variously presented under the following names:

Ceratospyris borealis Bailey, 1856, p. 31, pl. 1, fig. 3; Kruglikova, 1969, fig. 4-15
Tholospyris ?sp, Kruglikova, 1969, fig. 4-13
Tristylospyris sp. Nigrini, 1970, p. 170, pl. 3, figs. 3-6
Triceraspyris ?sp. Ling et al., p. 713, pl. 2, figs. 1-3
Tholospyris spinosus Kruglikova, 1974, p. 193, pl. 2, figs. 10-11

DESCRIPTION

"The two forms of radiolarian shell with a sagittal ring recovered from the Bering Sea surface sediments are grouped here.

"The first form is similar to Ceratospyris borealis originally proposed by BAILEY (1856, p. 3, pl. 1 fig. 3) and is illustrated by KRUGLIKOVA (1969, fig. 4-15). NIGRINI [1970] discussed it under the name of Tristylospyris sp.

"The second form has skeletal elements similar to the first, but has more lattice bars on the lattice shell and consequently smaller and more circular, lattice pores; has short projections at the junctions of lattice bars; and has slightly longer and distinct basal spines. Judging from the illustration, KRUGLIKOVA (1969, fig. 4-13) encountered the form and it is illustrated under the name of Tholospyris (?) sp.

"The joint occurrence of these two forms was also noticed by the senior author in his study of eastern and central subarctic surface sediments. An Antarctic species, Triceraspyris antarctica (RIEDEL 1958; PETRUSHEVSKAYA 1964, 1967) also seems closely related to the present forms but it differs by possessing much longer and distinct basal spines, and no such specimens were found during the present study.

"Thus samples from the Antarctic region must be examined before a relationship between the forms of both hemispheres is resolved, or before these two forms found in the Bering Sea should be considered as a separate taxon." (from Ling et al., 1971).

Plate 19, figures 1a-d

Ceratospyris borealis Bailey

Kruglikova (1974) described Tholospyris spinosus n.sp. with the following diagnosis:

"Differs from Tholospyris borealis in having more numerous and smaller pores. The spinosity of the skeleton is well expressed. The skeleton is slightly narrowing toward the basal part. The terminal legs are better developed and frequently porous. The measurements of the skeleton are usually smaller than in T. borealis."

DIMENSIONS

"Width of lattice shell 120-190μ, height of sagittal ring 90-140μ" (from Ling et al., 1971).

"Width 135±16μ; height, 108±12μ; based on 15 specimens" (from Sachs, 1973).

RECENT DISTRIBUTION

1. Nigrini, 1970, fig. 23; belongs to a subarctic assemblage derived by recurrent group analysis of North Pacific samples.

2. Ling et al., 1971, fig. 7; "found frequently in most of the samples" [from the Bering Sea]. Also "noticed... in... eastern and central [Pacific] subarctic surface sediments".

3. Sachs, 1973, Code 26N, fig. 2F; "...an important species (to 25%) in Northern stations, and loads heavily on the Polar Factor".

4. Robertson, 1975; "Two forms of this species are described by Ling and others (1971). However, only the first form described by them is included in the counts for this species in this study. This form is similar to Ceratospyris borealis Bailey and is characterized by its well-exposed sagittal rings, few lattice bars, and open lattice structure.

"This species loads most heavily in factor 1 (subpolar). At both the present and 18,000 YBP higher abundances are found in the more northern part of the study area. At 18,000 YBP some of the more southern samples have higher percentages than at the present."

Giraffospyris angulata (Haeckel)

Eucoronis angulata Haeckel, 1887, p. 978, pl. 82, fig. 3
Giraffospyris angulata (Haeckel), Goll, 1969, p. 331, pl. 59, figs. 4, 6, 7, 9

DESCRIPTION AND DIMENSIONS

"Sagittal ring 'D-shaped'; 60 to 93μ high; 51 to 93μ thick. Apical, axial, and frontal spines short; vertical spine short, mounted close to base of sagittal ring; no sagittal-ring tubercles; variable number of sagittal-ring spines. Some specimens have no lattice shell or connector bars; primary and secondary-lateral spines are present. In a few skeletons, lattice shell consists solely of basal ring; primary-lateral bars or primary-lateral spines; three to six pairs of sagittal-ring spines between apical and vertical spines.

"Basal ring oval, indented sagittally; 67 to 133μ wide; 32 to 67μ thick; joined directly to front and back of sagittal ring; irregularly spinous; encloses two or four basal pores. In addition to the basal ring, most specimens have lattice shell 120 to 270μ wide, strongly constricted sagittally, and does not extend below basal ring. The lattice shell consist of a sparse trellis of spinous lattice bars. One lattice bar joined to each side of basal ring; one to five lattice bars joined to sagittal ring between apical and vertical spines. Lattice pores large and polygonal; no vertical, sternal, or frontal pores...

"Representatives of Giraffospyris angulata differ from those of G. annulispina, n. sp., and G. circumflexa, n. sp., in having no sagittal-ring tubercles and from those of G. laterispina, n. sp., in having lattice spines. Skeletons of the type-species of Giraffospyris, G. didiceros, have two lattice spines and no axial spine." (from Goll, 1969).

REMARKS

1. For a more complete synonymy see Goll, 1969.

Plate 19, figures 2a-d, 3a,b

Giraffospyris angulata (Haeckel)

RECENT DISTRIBUTION

1. Goll , 1969; "Representatives of *Giraffospyris angulata* are in all the samples between AMPH 102P [3°52'S, 155°43'W] , 482-484 cm. (upper Miocene) and DWBG 147B [1°27'N, 116°13'W] 4-7 cm. (Quaternary).

Liriospyris reticulata (Ehrenberg)

Dictyospyris reticulata Ehrenberg, 1872a, p. 307; 1872b, pl. 10, fig. 19
Amphispyris reticulata (Ehrenberg), Nigrini, 1967, p. 44, pl. 5, fig. 3
Amphispyris costata Haeckel, Nigrini, 1967, p. 45, pl. 5, fig. 4
Liriospyris reticulata (Ehrenberg), Goll, 1968, p. 1429, pl. 176, figs. 9,11,13

DESCRIPTION AND DIMENSIONS

"Sagittal ring "D-shaped"; 60 to 77μ high; 53 to 84μ thick. Four to six pairs of sagittal-ring tubercles; one pair adjacent to a short vertical spine that projects from midpoint of sagittal ring. No frontal or axial spines. A few specimens have very short apical spine. In most skeletons, apical spine is absent. Some specimens have no lattice shell or connector bars; pairs of sagittal-ring spines project from tubercles. In skeletons having lattice shell, a pair of connector bars projects horizontally from slightly below top of front of sagittal ring; another pair of horizontal connector bars is adjacent to vertical spine. Very few specimens have primary-lateral bars; most skeletons have short primary-lateral spines; no other basal connector bars.

"No basal ring. Lattice shell suboval in basal view; 180 to 210μ wide; 90 to 186μ thick; smooth; surrounds front and back of sagittal ring. Four massive lattice bars, circular in cross section, and parallel to lateral axis; two of them joined to tubercles at front and back of base of sagittal ring, and two to tubercles at front and back of apex of sagittal ring. Laterally, these lattice bars reticulate to form short horizontal band of lattice shell perforated by subpolygonal lattice pores 5 to 17μ in diameter. Two pairs of sagittal-lattice pores are a maximum of 55μ in diameter...

"Representatives of Liriospyris reticulata differ from those of L. ovalis n. sp. in having four lattice bars that are joined to the sagittal ring; from skeletons of L. globosa n. sp. in having paired sagittal-ring tubercles; and from specimens of L. mutuaria n. sp. and Tholospyris devexa (Goll, 1969) in having connector bars on the front and back of the sagittal ring. In skeletons of the type-species of Liriospyris, L. clathrata, the lattice shell is joined directly to the front and back of the sagittal ring, and sternal bars and sternal pores are lacking.

"On specimens of Liriospyris reticulata, the two lattice bars that are joined to the base of the sagittal ring are considered to be the homologues of the front and back of the basal ring of skeletons of L. globosa.

"Species included in the synonymy are distinguished on the basis of variations in the lateral portions of the lattice shell or the absence of a lattice shell. I consider that most of these species represent various growth stages of Liriospyris reticulata." (from Goll, 1968).

Plate 19, figures 4a,b

Liriospyris reticulata (Ehrenberg)

REMARKS

1. For a more complete synonymy see Goll, 1968. Goll (personal communication) regards A. costata (in Nigrini, 1967) as a growth stage or more complete preservation of A. reticulata.

RECENT DISTRIBUTION

1. Nigrini, 1967, fig. 22; "Indian Ocean occurrences - A. reticulata is sparsely distributed in low latitudes, and is almost entirely absent from middle latitudes. Maximum abundances (up to 3% of the described population) occur in the western tropics."

fig. 23; "Indian Ocean occurrences - A. costata is very sparsely distributed in low latitudes and is absent from samples taken south of 35°S.

2. Goll, 1968; "... in all but one of the samples between WRTR 11 High [Trinidad] (middle Miocene) and DWBG 147 B, [1°27'N, 116°13'W], 4-7cm. (Quaternary).

Lophospyris pentagona pentagona (Ehrenberg) emend. Goll

Ceratospyris pentagona Ehrenberg, 1872a, p. 303; 1872b, pl. 15, fig. 15
Ceratospyris polygona Benson, 1966, p. 321, pl. 22, figs. 15, 16 (partim.)
Ceratospyris sp., Nigrini, 1967, p. 48, pl. 5, fig. 6
Dorcadospyris pentagona (Ehrenberg), Goll, 1969, p. 338, pl. 59, figs. 1-3, 5 (not 8-10, 12); Goll, 1972, p. 964, pl. 58, figs. 1-3, pl. 88.
Lophospyris pentagona pentagona (Ehrenberg), Goll, 1977, p. 398, pl. 10, figs. 1-7, pl. 11, figs. 1-3, 5.

DESCRIPTION AND DIMENSIONS

"Sagittal ring polygonal; 54 to 90μ high; 28- 67μ thick; joined to front, apex, and back of lattice shell. Apical and frontal spines of variable length; vertical spine very short; no axial spine. Primary-lateral bars joined to basal ring; no other connector bars.

"Basal ring polygonal; 43 to 85μ wide; 28 to 60μ thick; joined directly to front and back of sagittal ring; encloses four basal pores. Basal ring, lattice bars, lattice spines, and basal spines tribladed in cross section, having blades arranged like the letter T. Six lattice bars, arranged in three symmetrical pairs, are joined to basal ring at points of angularity; two pairs of lattice bars in front of primary-lateral bars; one pair of lattice bars in back of primary-lateral bars. Nine basal spines, 6 to 58μ long, project from basal ring. Frontal spine is shortest basal spine. Remaining basal spines arranged in four symmetrical pairs of approximately equal length; one basal spine is adjacent to each of the lattice bars and primary-lateral bars that are joined to basal ring. Two of the three blades of basal spines are parallel to basal ring; whereas the third perpendicular blade is on the exterior of basal spines adjacent to lattice bars and on the interior of basal spines adjacent to sagittal ring and primary-lateral bars. Lattice shell 78 to 155μ wide; slightly constricted sagittally; does not extend below basal ring; perforated by subcircular to subpolygonal lattice pores 4 to 30μ in diameter. Four lattice bars joined to sagittal ring; one junction at proximal end of apical spine; one junction between apical and frontal spines; two junctions between apical and vertical spines. Lattice spines, 4 to 32μ long, project from junctions of lattice bars. Five pairs of sagittal-lattice pores; no vertical, frontal, or sternal pores." (from Goll, 1969).

REMARKS

1. "... Specimens assignable to this species demonstrate a substantial size range. Small individuals... are polygonal in outline and overlap the size range of Lophospyris pentagona quadriforis [see Goll, 1977, p. 398]... Large individuals... are inflated and subspherical in outline." (from Goll, 1977).

<u>Lophospyris</u> <u>pentagona</u> <u>pentagona</u> (Ehrenberg) <u>emend</u>. Goll

RECENT DISTRIBUTION

1. Benson, 1966 (<u>Ceratospyris</u> <u>polygona</u>); "... cosmopolitan in the Gulf [of California] but rare at all stations where it occurs except 115 where it is common (2.6%). It has a greater frequency in the axial portion of the Gulf and does not appear to respond to upwelling..."

2. Nigrini, 1967, fig. 25; "<u>Indian Ocean occurrences</u> - <u>C</u>. sp. is sparsely distributed in the western tropics, but forms up to 6 percent of the described population in the eastern tropics. The species is practically absent from middle latitudes."

3. Goll, 1977; "... panoceanic, warm cosmopolitan subspecies..."

Phormospyris stabilis (Goll) antarctica (Haecker)

Phormospyris antarctica Haecker, 1907, p. 124, fig. 9
Triceraspyris antarctica Haecker, Riedel, 1958, p. 230, text-figs. 3-5, pl. 2, figs. 6-7; Chen. 1975, p. 456, pl. 15, fig. 6; Petrushevskaya, 1975, p. 593, pl. 8, fig. 1.
Triceraspyris (?) antarctica Petrushevskaya, 1967, p. 62, text-fig. 37.
Triospyris antarctica Goll and Bjorklund, 1974, text-fig. 8
Desmospyris (?) haysi Petrushevskaya, 1975, p. 593, pl. 27, figs. 4-6 (in part).

DESCRIPTION

"Shell of rather heavy construction, nut-shaped, with unequal rounded pores, generally smooth surface, and slight or pronounced sagittal constriction. Four large basal pores. Usually three basal feet, circular or three-bladed in section, of approximately the same length as the cephalis: of these, the unpaired one is usually simply latticed proximally, and in many specimens all three are forked distally. In a few specimens, secondary spines or a small amount of lattice-work are developed between the proximal parts of these basal feet. Sagittal ring approximately D-shaped, from which a short, free apical spine arises subapically, and a thorn-like vertical spine arises from the more curved part of the ring near the basal pores. In most specimens, two more thorn-like spines are present, one to either side of the apical part of the sagittal ring, and in some specimens several more thorns are scattered over the apical surface." (from Riedel, 1958).

DIMENSIONS

"Height of sagittal ring 63-90 μ; maximum breadth of bilocular cephalis 80-125 μ." (from Riedel, 1958).

REMARKS

1. For further synonymy see Riedel, 1958 and Chen, 1975.

2. For further taxonomic discussion and illustrations see Goll, 1977.

Phormospyris stabilis (Goll) antarctica (Haecker)

RECENT DISTRIBUTION

1. Riedel, 1958 (Triceraspyris antarctica); "This species occurs in both the American and Indian Ocean sectors of antarctic waters, and no form resembling it has been found at any other locality. Thus it appears to be an exclusively southern cold-water species."

2. Lozano, 1974 (Triceraspyris antarctica), Fig. IV-16; "It has the distribution which is characteristic for the Antarctic assemblage being generally present south of about 42°S in the Atlantic sector, west of 35°W and south of the average position of the Subtropical Convergence in the Indian Ocean Sector. It is found north of these latitudes only in deep cores, notably in samples from the Crozet and Argentine basins indicating that it is transported by bottom waters. T. antarctica reaches a maximum abundance of 3.5 percent in core RC15-92 at the average position of the APF. It is found in abundances over 1.5 percent under August sea surface temperatures lower than 10° in the Indian Ocean. The maximum August sea surface temperature under which it is found is over 20°C but specimens not transported by bottom currents are probably found only under August sea surface temperatures of about 10°C."

3. Morley, 1977 (Triceraspyris antarctica), Fig. I-24; "This species loads highest in factor 2 (polar). At present it is most abundant under polar waters south of 45°S. At 18,000 YBP the 1% contour shifts slightly northward and the maximum abundance of this species increases in samples south of 50°S."

4. Goll, 1977; "... common constituent of sediments south of the southern Subtropical Convergence. Moreover, it has low frequencies in Argentine Basin sediments as well as sporadic occurrences in sediments of the Brazil Basin..."

Phormospyris stabilis (Goll) scaphipes (Haeckel)

Tristylospyris scaphipes Haeckel, 1887, p. 1033, pl. 84, fig. 13
Tholospyris scaphipes (Haeckel), Goll, 1969, p. 328, pl. 58, figs. 1-6 (in part); Goll, 1972, p. 969, pl. 82, figs. 1-4, pl. 83, fig. 1.
Tristylospyris scaphipes Haeckel, Benson, 1966, p. 316, pl. 22, figs. 7, 9-10.
Ceratospyris angulata (Popofsky), Petrushevskaya, 1971, pl. 127, figs. 13-14, 16.
Acanthodesmiidae, gen. et spp. indet. Kling, 1973, pl. 8, fig. 23.

DESCRIPTION AND DIMENSIONS

"Sagittal ring subcircular; 37 to 76μ high; 25 to 50μ thick; joined to front, apex, and back of lattice shell. Apical spine short; vertical spine very short; frontal spine long; no axial spine. Primary-lateral bars joined to basal ring; no other connector bars.

"Basal ring oval; indented laterally and sagitally; 31 to 58μ wide; 23 to 40μ thick; joined directly to front and back of sagittal ring; encloses four basal pores. Three equal basal spines, 20 to 46μ long, project downward from basal ring and taper to simple joint; one of them is frontal spine; two of them are adjacent to primary-lateral bars. In some skeletons, basal spines circular in cross section. Other specimens have basal spines that are tri-bladed or cruciform in cross section; frontal spine tribladed, having two parallel blades tangent to basal ring and third perpendicular blade projecting inward; basal spines adjacent to primary-lateral bars are cruciform, having two parallel blades tangent to basal ring and two blades parallel to primary-lateral bar. Most specimens possessing bladed basal spines have narrow median rib on outer surface of back of basal ring between primary-lateral bars. Lattice shell smooth; 58 to 89μ thick; strongly constricted sagittally; has appearance of thin sheet perforated by circular, widely spaced lattice pores 1 to 23μ in diameter. In some specimens, lattice shell extends below basal ring, is completely closed basally, and is joined to proximal portions of basal spines; in other skeletons, lattice shell ends at basal ring. Variable number of lattice bars joined to basal ring or sagittal ring. Four to nine pairs of sagittal-lattice pores. No vertical, sternal, or frontal pores." (from Goll, 1969).

"The emended description presented by Goll (1969) is correct in all aspects except one. It is necessary further to restrict the name scaphipes only to specimens bearing a well-developed ridge on the outer margin of the back of the basal ring. Thus defined, the specimen illustrated by Goll (1969, pl. 58, figs. 7-8, 13-14) is clearly not a member of this subspecies... Phormospyris stabilis scaphipes shares the general structural configuration of a deeply constricted, simple lattice shell and three basal lattice spines with numerous other trissocyclid morphs, many of which are unnamed, but it is readily distinguished by its small size, thin, finely perforated lattice shell, and triblade on the back of the basal ring." (from Goll, 1977).

Plate 20, figures 2a-d

Phormospyris stabilis (Goll) scaphipes (Haeckel)

REMARKS

1. For a more complete synonymy and additional illustrations see Goll, 1969.

RECENT DISTRIBUTION

1. Goll and Bjorklund, 1971 (Tholospyris scaphipes), text-fig. 6; "In the Atlantic Ocean other Radiolaria are restricted to the southern equatorial regions. Tholospyris scaphipes (Haeckel) Goll, 1969, has a distribution similar to but more restricted than the equatorial occurrences of Ceratospyris hyperborea (text-figure 7). Tholospyris scaphipes is also abundant north of the Antarctic Convergence and is absent north of latitude 15°N. Anthocyrtidium ophirense (Ehrenberg) Nigrini, 1967, has a surface sediment distribution similar to that of T. scaphipes in our samples."

2. Goll, 1977; "Phormospyris stabilis scaphipes is scarce to common in sediments underlying the transition provinces and eastern equatorial provinces of the Pacific and southern Atlantic Oceans. In addition, the subspecies is present in low frequencies in biosiliceous sediments of the subtropical and equatorial Indian Ocean.

Tholospyris procera Goll

Tholospyris procera Goll, 1969, p. 328, pl. 59, fig. 8, 10-12

DESCRIPTION AND DIMENSIONS

"A species of Tholospyris characterized by sagittal-ring tubercles and a lattice shell that surrounds the apex of the sagittal ring and extends below the basal ring. . .

"Sagittal ring subrectangular; 75 to 85μ high; 45 to 70μ thick; joined directly to front and back of lattice shell. No axial or apical spines. Some skeletons have very short vertical spine projecting from lower third of sagittal ring; on other skeletons, vertical spine is absent. Some skeletons have frontal spine, whereas other skeletons have frontal bar. No connector bars; primary-lateral spines short.

"Basal ring oval; 54 to 105μ wide; 24 to 57μ thick; joined directly to front and back of sagittal ring; encloses two basal pores. Lattice shell 105 to 150μ wide; 116 to 182μ high; surrounds apex of sagittal ring; composed of irregular meshwork of massive lattice bars that are sub-circular in cross section and frame subpolygonal lattice pores 4 to 50μ in diameter. In some skeletons, lattice shell extends below basal ring and has large basal opening. In other specimens, lattice shell ends at basal ring; variable number of irregularly spaced and irregularly shaped basal spines project from basal ring. Four laterally oriented lattice bars joined to sagittal ring. Paired tubercles located at the junctions of these lattice bars and the sagittal ring. Apical portion of the lattice shell joined to front and back of apex of sagittal ring ...

"Representatives of Tholospyris procera n. sp., differ from those of T. kantiana in having no primary-lateral bars and from those of T. devexa n. sp., in having no sagittal-ring spines at the proximal end of the frontal spine. Skeletons of the type-species of Tholospyris, T. cortinisca, have primary-lateral bars and three basal spines that project from the basal ring; the lattice shell does not extend below the basal ring". (from Goll, 1969).

REMARKS

1. Goll (personal communication) prefers not to include Amphispyris subquadrata Haeckel (1887, p. 1097, pl. 88, Fig. 5) in the synonymy of T. procera because the figured specimen lacks tubercules on the sagittal ring. For the same reason Semantis sigillum Hacckel (1887, p. 957, pl. 92, Fig. 1) is only tentatively regarded as a synonym in Goll, 1969.

2. Benson (1966, p. 297) describes and illustrates a species which he calls Amphispyris subquadrata Haeckel. Goll (personal communication) considers Benson's specimens to be the same as his T. procera

Plate 20, figures 3a,b

Tholospyris procera Goll

RECENT DISTRIBUTION

1. Goll, 1969. "Representatives of Tholospyris procera are in all the samples between JYN V 38P, 397-399 cm. (lower Miocene) and DWBG 147G, 4-7 cm. (Quaternary)".

2. Molina-Cruz, 1975, Code N1A; the distinction between this species and A. subquadrata recognized by Goll was not made by Molina-Cruz; not used in factor analysis of southeast Pacific sediments; cf. Appendix 10 for percent N1A at each station.

Carpocanistrum spp.

Carpocanium petalospyris in Benson, 1966, p. 434, pl. 29, figs. 9, 10; Fig. 25
Carpocanium spp., Nigrini, 1970, p. 171, pl. 4, figs. 4-6
Carpocanistrum spp., Riedel and Sanfilippo, 1971, p. 1596, pl. 1G, figs. 1-6, 8-13; pl. 2F, figs. 5-6, pl. 3D, figs. 1, 2, 6, 7, 9

DESCRIPTION

"Included under this name are most of the forms commonly thought of as typical carpocaniids - with cephalis not markedly distinguished in contour from the ovate thorax, pores often longitudinally aligned, and a somewhat constricted peristome often bearing numerous teeth." (from Riedel and Sanfilippo, 1971).

"Test consisting of a cap-shaped cephalis and a thorax; cephalis hidden at top of thorax, in a few specimens separated from thorax by slight constriction but generally indistinguishable; with an internal collar ring consisting of four collar pores (cardinals and cervicals) at its base; collar ring joined to inner wall of thorax by the primary lateral and dorsal bars, which extend as ribs coincident with furrows in the thoracic wall and by a few accessory bars that arise from the collar ring and join the inner thoracic wall but do extend as ribs. Thorax variable in shape from nearly cylindrical with constricted mouth to greatly inflated, nearly subspherical, with constricted mouth. Pores of thorax equal, small, the same size as those of cephalis, arranged hexagonally in longitudinal rows (15-22 rows on the half circumference), subcircular to hexagonal; surface of intervening bars variable from smooth to one with hexagonal frames surrounding pores. Mouth constricted, in most specimens surrounded by a hyaline peristome (4-16μ in length), peristome absent in a few tests. Peristome surmounted by tooth-like, lamellar to pyramidal, triangular to rectangular, terminal spines or teeth, variable in number from 0-16 or more. Teeth of some specimens triangular, converging inward, of others lamellar or rectangular, extending vertically downward. A few specimens with a few adjacent teeth fused together. One specimen observed with all teeth fused together to form a vertical, lamellar, hyaline extension of the peristome. Another specimen observed with similar peristomal extension but not hyaline, instead with pores similar to those of the thorax giving the appearance of a rudimentary abdomen separated from the thorax by a hyaline septal ring." (from Benson, 1966).

DIMENSIONS

"length of test (not including terminal teeth) 80-107μ, of cephalis (when visible) 15-20μ; breadth of thorax 59-98μ; length of peristomal teeth 5-33μ." (from Benson, 1966).

"overall length 90± 7μ; maximum width 71± 6μ, based on 17 specimens" (from Sachs, 1973).

Plate 21, figures 1a-c

Carpocanistrum spp.

RECENT DISTRIBUTION

1. Benson, 1966 (Carpocanium petalospyris); "confined to the southern two-thirds of the Gulf [of California]. It is rare at all stations where present but has a slightly greater frequency in the southern half of its range."

2. Nigrini, 1970, fig. 31; "For the purposes of the present study, all specimens of the Carpocanium-Carpocanistrum form were considered together except for the distinctive Carpocanium sp. A. (Nigrini, 1968 p. 55, Pl. 1, fig. 5)."

Belongs to a tropical assemblage derived by recurrent group analysis of North Pacific samples, but ranges too far north to be meaningful in down-core analysis.

3. Sachs, 1973, Code 29N (Carpocanium spp.); "rare (to about 2%), but exhibits markedly Southern preferences."

4. Molina-Cruz, 1975, Code N4 (Carpocanium spp.); used in factor analysis of southeast Pacific assemblages; cf. Appendix 10 for percent N4 at each station. Note that Molina-Cruz includes Carpocanistrum sp. A. in his counts.

5. Robertson, 1975 (Carpocanium spp.); "This species loads most heavily in factor 2 (subtropical). Its highest abundances are in the southeastern part of the study area at the present. At 18,000 YBP similar abundances are shifted about 5^{o} further to the south, but only in the east."

Note that Robertson does not include Carpocanistrum sp. A. in his counts.

Carpocanistrum sp. A

Carpocanium sp. A, Nigrini, 1968, p. 55, pl. 1, fig. 4

DESCRIPTION

"Shell elongate, subcylindrical, smooth, with completely hidden spherical cephalis. Primary lateral and dorsal spines extend to the thoracic wall and draw it inwards, thus making the upper part of the shell trilobate.

"Thoracic pores subcircular to circular, approximately equal in size over most of the segment but smaller over the cephalic end, usually arranged in longitudinal rows, 9-13 in a vertical series, 7-10 on a half-equator. Mouth slightly constricted and sometimes surrounded by a well-developed, poreless, hyaline peristome. Terminal teeth, up to 14 on well-developed individuals, flat, usually truncate, parallel, as broad as, or broader than, the intervening spaces. Peristome may be smoothly terminated, or absent and termination ragged." (from Nigrini, 1968).

This species differs from other members of the genus by its elongate, subcylindrical thorax.

DIMENSIONS

"Length of thorax 81-137μ; of peristome and terminal teeth up to 45μ (usually up to 18μ). Maximum breadth of thorax 63-81μ." (from Nigrini, 1968).

REMARKS

1. Benson's (1966) description and dimensions of this species (Carpocanium sp. in Benson, p. 438) are consistent with the above.

Plate 21, figure 2

Carpocanistrum sp. A

RECENT DISTRIBUTION

1. Benson, 1966 (_Carpocanium_ sp.); "confined to southern two-thirds of Gulf [of California] ... rare at all stations where it occurs, but it has a slightly greater frequency in the southern half of its range."

2. Nigrini, 1968, text-fig. 5; "Few in the region of the North Equatorial Current and in one equatorial sample near the coast of South America, most abundant in the northern part of the study area, rare or absent in all other samples examined."

Carpocanarium papillosum (Ehrenberg) group

Eucyrtidium papillosum Ehrenberg, 1872a, p. 310; 1872b, pl. 7, fig. 10.
Dictyocephalus papillosus (Ehrenberg), Haeckel, 1887, p. 1307; Riedel, 1958, p. 236, pl. 3, fig. 10, text-fig. 8
Dictyocryphalus papillosus (Ehrenberg), Nigrini, 1967, p. 63, pl. 6, fig. 6.
Carpocanium calycothes Stohr, 1880, p. 96, pl. 3, fig. 8.
Dictyocephalus bergontianus Carnevale, 1908, p. 32, pl. 4, fig. 20.

DESCRIPTION

"The designation 'Carpocanarium spp.' is here used for forms with hemispherical cephalis, distinct collar stricture, ovate thorax with rather few, rather large pores and occasionally three short spine-like wings in its proximal half, and a poreless subcylindrical peristome which in some specimens is irregularly terminated to give the impression of a corona of teeth. These forms include the type species of Carpocanarium Haeckel (Carpocanium calycothes Stohr), and are not closely related to the type species of Dictyocryphalus (Cornutella obtusa Ehrenberg, 1844a, p. 77; 1854b, pl. 22, fig. 40), to which genus the best-known member of this group of species (Eucyrtidium papillosum Ehrenberg) has recently been assigned." (from Riedel and Sanfilippo, 1971).

Description of D. papillosus from Riedel, 1958:

"Cephalis approximately hemispherical, with small subcircular pores in a hyaline shell-wall, set off from thorax by a pronounced change in contour. Many specimens have a small, inconspicuous lateral tubule projecting slightly from the cephalis near its junction with the thorax, and a short, acute apical horn. Thorax ovate, usually with a rough surface, and with a conspicuous subcylindrical or flared peristome surrounding the mouth which is approximately one-half to two-thirds as broad as the thorax. Thoracic pores subcircular to circular, usually of different sizes and without regular arrangement, separated by rather wide and often thick intervening bars. In the upper part of the thoracic wall are three, usually conspicuous longitudinal ribs, which in many specimens terminate in three short, solid, triangular lateral wings at or above the level at which the thorax reaches its maximum breadth."

DIMENSIONS

"Length of cephalis 18-25μ, of thorax (including peristome) 60-90μ. Maximum breadth of thorax 58-70μ." (from Riedel, 1958).

Plate 21, figure 3

Carpocanarium papillosum (Ehrenberg) group

REMARKS

1. For further synonymy see Nigrini (1967); for further taxonomic discussion see Riedel and Sanfilippo (1971); for further morphology see Riedel (1958).

RECENT DISTRIBUTION

1. Nigrini, 1967, fig. 33; "Indian Ocean occurrences - D. papillosus is very sparsely distributed in both low and middle latitudes, never forming more than 1 percent of the described population."

2. Molina-Cruz, 1975, Code N8 [Dictyocryphalus papillosus (Ehrenberg)]; used in factor analysis of southeast Pacific assemblages; cf. Appendix 10 for percent N8 at each station.

Peripyramis circumtexta Haeckel

Peripyramis circumtexta Haeckel, 1887, p. 1162, pl. 54, fig. 5; Riedel 1958, p. 231, pl. 2, figs. 8,9; Petrushevskaya, 1967, p. 111, fig. 64, I-II, fig. 65, I-II

DESCRIPTION

"Cephalis small, ovate, hyaline, bearing a short, excentric, vertical apical spine. Collar stricture slight, with four collar pores in the one specimen which could be examined from the apex. In some specimens, one to three (?) short, downwardly-directed spines penetrate the thoracic wall near the collar stricture. Thorax rather acutely conical, in some specimens subcylindrical below, consisting principally of 8-11 longitudinal rods joined by transverse bars which are usually not continuous around a circumference. Thoracic pores thus formed are rounded-quadrangular, increasing in size distally. From the longitudinal and transverse skeletal bars of the thorax arise numerous short, forked spines; the terminations of these spines are in some specimens joined by delicate siliceous threads which thus form a loose, irregular, incomplete network surrounding the main surface of the thorax." (from Riedel, 1958).

DIMENSIONS

"Total length usually 100-270μ (to 320μ according to Haeckel); maximum breadth 85-150μ." (from Riedel, 1958).

REMARKS

1. Benson's (1966) description and dimensions of this species (p. 426) are consistent with the above.

Plate 21, figures 4a,b

Peripyramis circumtexta Haeckel

RECENT DISTRIBUTION

1. Benson, 1966; "very rare in the Gulf [of California]."

2. Molina-Cruz, 1975, Code N23; counted together with Plectopyramis dodecomma Haeckel, but not used in factor analysis of southeast Pacific assemblages; cf. Appendix 10 for percent N23 at each station.

Plectopyramis dodecomma Haeckel

Plectopyramis dodecomma Haeckel, 1887, p. 1258, pl. 54, fig. 6; Benson, 1966, p. 424, pl. 29, fig. 3

DESCRIPTION

"Test consisting of a small sub-hemispherical, poreless cephalis, with or without apical horn or spine, and smooth, long, conical thorax, broad at the base, consisting of 8-11 heavy, longitudinal bars or ribs, circular in section, and joined by transverse bars, likewise circular in section, that are continuous around the circumference, straight not curved between adjacent longitudinal ribs. Thoracic pores subrectangular, increasing in size toward the base; in the proximal one third of the thorax the pores are either infilled by silica or by a thin, reticulate, secondary meshwork. Collar pores not observed in all tests, but at least three are present and four if vertical bar is developed. Apical spine variable from absent, to a short spine, to a heavy, conical horn either straight or curved. Vertical spine not observed but may be present in some specimens. One specimen observed with a raised thoracic rib corresponding to one of the primary basal spines and extending for about one-third the length of the thorax...

"This species differs from Peripyramis circumtexta Haeckel in the absence of branched spines arising from the thorax and in the presence of transverse bars that are continuous around the circumference." (from Benson, 1966).

DIMENSIONS

"maximum length of test 160-277μ; maximum breadth of thorax 117-178μ; length of cephalis 10-16μ; breadth of cephalis 11-17μ; length of apical spine or horn 0-37μ." (from Benson, 1966).

REMARKS

1. For further synonymy see Benson (1966).

Plate 21, figure 5

Plectopyramis dodecomma Haeckel

RECENT DISTRIBUTION

1. Benson, 1966; "very rare in the Gulf [of California] but occurs as far north as station 184. It is relatively more abundant in the southern Gulf."

2. Molina-Cruz, 1975, Code N23; counted together with Peripyramis circumtexta Haeckel, but not used in factor analysis of southeast Pacific assemblages; cf. Appendix 10 for percent N23 at each station.

Dictyophimus crisiae Ehrenberg

Dictyophimus crisiae Ehrenberg, 1854a, p. 241
Dictyophimus crisiae Ehrenberg, Nigrini, 1967, p. 66, pl. 6, figs. 7a,b
?Pterocorys (?) hirundo Haeckel, Petrushevskaya, 1967, p. 115, fig. 67, IV-V (partim.)
Pterocorys hirundo Haeckel, Ling et al., 1971, p. 715, pl. 2, figs. 8,9 (partim.)

DESCRIPTION

"Cephalis hemispherical with small closely spaced pores or pits (probably representing infilled pores). Inside cephalis, both apical and vertical spines are free of the shell wall. Externally, apical spine forms a cylindroconical horn which may be up to 3 times the length of the cephalis; vertical spine forms a short, much more delicate horn. In some specimens the dorsal spine is also external, and usually additional by-spines occur on the cephalis and upper thorax. Collar stricture indistinct.

"Thorax conical, rather thick-walled, with large subcircular to subangular pores increasing in size distally; bars relatively narrow. Strong thoracic ribs become external just above the lumbar stricture and are prolonged into 3 solid cylindrical or 3-bladed wings as long to 3 times as long as thorax, tapering to a point distally. Wings diverge freely, forming an extension of the conic line of the thorax.

"Abdomen thinner-walled, cylindrical, varying in state of development, and having pores similar to those on thorax. No definite termination." (from Nigrini, 1967).

DIMENSIONS

"Length of apical horn 18-72μ; of cephalis 18-27μ; of thorax 45-63μ; of abdomen up to 81μ. Maximum breadth of cephalis 23-32μ; of thorax 63-100μ." (from Nigrini, 1967).

REMARKS

1. For a more complete synonymy see Nigrini, 1967.

2. There has been some confusion between this species and a form referred to as Pterocorys hirundo Haeckel. The form here described as Dictyophimus crisiae Ehrenberg is unusually robust. Even incomplete specimens are thick-walled. The appendages are definitely wings, not feet and project from the thorax above the lumbar stricture.

Plate 22, figures 1a,b

Dictyophimus crisiae Ehrenberg

RECENT DISTRIBUTION

1. Nigrini, 1967, fig. 34;"Indian Ocean occurrences - D. crisiae is sparsely distributed in both low and middle latitudes, being slightly more abundant in the latter (up to 5% of the described population)."

2. Ling, et al., 1971; The specimens shown in plate 2, figures 8 and 9 belong to D. crisiae. The specimen in plate, figure 10 may belong to D. hirundo. Ling et al. found these species to be sparsely distributed in the Bering Sea.

3. Sachs, 1973, Code 6N (Pterocorys hirundo); "In the surface study, this species was ubiquitous but did not account for more than 2% of the fauna, except for two SE stations: strewn sample [005] from V21-175, and samples [026] (strewn) and [044] (settled) - from RC11-185."

4. Molina-Cruz, 1975, Code N29 (Pterocorys hirundo); used in factor analysis of southeast Pacific assemblages; cf. Appendix 10 for percent N29 at each station.

Dictyophimus hirundo (Haeckel) group

Pterocorys hirundo Haeckel, 1887, p. 1318, pl. 71, fig. 4; Riedel, 1958, p. 238, pl. 3, fig. 11, pl. 4, fig. 1, text-fig. 9

?Pterocorys (?) hirundo Haeckel, Petrushevskaya, 1967, p. 115, fig. 67, I-III (partim.)

Dictyophimus sp. aff. D. hirundo (Haeckel), Petrushevskaya and Kozlova, 1972, p. 553, pl. 27, figs. 16, 17

Dictyophimus hirundo (Haeckel) group, Petrushevskaya, 1975, p. 583 (partim.)

DESCRIPTION

"Cephalis subglobular, with smooth or slightly spiny surface, and numerous small pores which in some specimens are secondarily closed by siliceous lamellae. Apical horn thin, acute, vertical, eccentrically situated, usually approximately as long as the cephalis. In some specimens the "vertical spine" element of the primary spicular skeleton extends beyond the cephalis surface as a second, oblique cephalic horn. Thorax truncate-conical to campanulate, with rather large subcircular or circular pores, its surface usually bearing short, thorn-like spines. Abdomen short, narrower than widest part of thorax, in many specimens rudimentary or consisting of only one or two rows of subcircular pores separated by narrow intervening bars, with no distinct peristome. In the wall of the thorax are three ribs, continuous with the three three-bladed, acute, divergent, straight or slightly curved feet which arise subterminally from the thorax. At the collar stricture are two pairs of large collar pores separated by the primary lateral spines (L,L), and it is often possible to distinguish also a pair of smaller pores, enclosed by the dorsal (D) and the secondary lateral (l,l) spines in front of the origin of the apical spine." (from Riedel, 1958).

DIMENSIONS

"Length of apical horn 7-36μ, of cephalis 16-27μ, of thorax 30-70μ, of feet 35-125μ. Breadth of thorax 50-90μ." (from Riedel, 1958).

REMARKS

1. The present authors are doubtful that the specimens from Petrushevskaya and Kozlova (1972), illustrated on Pl. 22, figs. 3a,b herein, belong to the D. hirundo group.

Plate 22, figures 2, 3a,b, 4

Dictyophimus hirundo (Haeckel) group

RECENT DISTRIBUTION

1. Riedel, 1958; "This species occurs in both the American and Indian Ocean sectors of Antarctic waters, in the tropical parts of the Pacific and Indian Oceans, and in the northern Pacific. It may thus be cosmopolitan."

Dictyophimus infabricatus Nigrini

Dictyophimus infabricatus Nigrini, 1968, p. 56, pl. 1, fig. 6

DESCRIPTION

"Shell thin-walled, smooth, conical to inflated conical. Cephalis simple, spherical, with numerical small subcircular pores. Apical horn usually 1 to 2 times the cephalic length (rarely longer), either 3-bladed or cylindrical; vertical horn present, usually shorter than apical horn, but sometimes equally developed. Both apical and vertical spines free of shell wall. Thin by-spines present on cephalis and upper thorax. Collar stricture distinct.

"Thorax tetrahedral with 3 strong, 3-bladed or cylindrical ribs, corresponding to primary lateral and dorsal spines; ribs either divergent or bowed, tapering distally, and extending beyond the thoracic lattice, which is usually attached to the ribs for its entire length. Pores subcircular to subangular, aligned longitudinally and increasing in size distally. Termination invariably ragged." (from Nigrini, 1968).

DIMENSIONS

"Length of cephalis 14-27μ, of thorax 72-156μ , of ribs 127-230μ . Maximum breadth of cephalis 18-27μ , of thorax 72-156μ ." (from Nigrini, 1968).

Plate 22, figure 5

Dictyophimus infabricatus Nigrini

RECENT DISTRIBUTION

1. Nigrini, 1968, text-fig. 7; "Few along the coast of Central and South America, except from 0^o to 10^oN; rare or absent in all other samples examined."

2. Molina-Cruz, 1975, Code N24; used in factor analysis of southeast Pacific assemblages; cf. Appendix 10 for percent N24 at each station. It is not certain whether or not Molina-Cruz's concept of the species is the same as that of Nigrini (1968) or if he includes forms ascribed by Moore (1974) to the species, but described herein as Pterocanium sp.

Pterocanium korotnevi (Dogiel)

Pterocorys korotnevi Dogiel, Dogiel and Reshetnyak, 1952, p. 17, fig. 11
Pterocanium korotnevi (Dogiel), Nigrini, 1970, p. 170, pl. 3, figs. 10,11

DESCRIPTION

"Thorax in the form of a cupola or a perforated pot with rounded, small pores of uneven size. Three massive, faceted and slightly convex (outward) basal spines extending from the lower rim of the cupola. The spines extend from the rim of the cupola at an angle of 120^{o} to each other. The length of the basal spines somewhat exceeds the combined length of the cupola and the apical spine. The surface of the cupola is nodose with short conical protrusions. From the lower margin of the thorax to the base of the cephalis, there are 5-6 horizontal rows of pores; these pores decreasing in size in the direction of the mouth aperture. The cephalis has the form of a small dome-like, reticulate superstructure above the cupola of the thorax. This superstructure consists of pores which are larger than those on the thorax; they are triangular or tetragonal instead of rounded, with narrow bars between them. The number of pores on the cephalis is small, obviously not over 6-8. From the apex of the cephalis arises an apical spine; it is smooth, massive and somewhat shorter than the basal spines. Height 0.26, width 0.09mm. We found one specimen in a sample from a depth of 500-200m.

"Remark. While further studying the material from the Bering Sea, this species was encountered at the same depths, from 500 to 200m. In many of the discovered specimens the ventral section, i.e. the abdomen, was clearly expressed. The latter forms on its slightly inflated adoral belt a fine delicate net of polygonal mesh." (from Dogiel and Reshetnyak, 1952; translation courtesy W.R. Riedel).

Subsequent investigators (Ling et al., 1971; Sachs, 1973) have not observed an abdomen on this species.

DIMENSIONS

"Maximum width of cephalis 32-40μ , of thorax 65-80μ ; maximum length of apical horn 50-75μ ." (from Ling et al., 1971).

"cephalic width: 26± 3μ ; thoracic width: 83± 5μ ; length of cephalis plus thorax: 73± μ. (Average for 16 specimens from 3 samples)." (from Sachs, 1973).

REMARKS

1. See Nigrini (1970) for explanation of generic assignment.

Plate 23, figures la,b

Pterocanium korotnevi (Dogiel)

RECENT DISTRIBUTION

1. Nigrini, 1970, fig. 27; belongs to a subarctic assemblage derived by recurrent group analysis of North Pacific sediments.

2. Ling et al., 1971; "The species is found only sparsely in the Bering Sea samples."

3. Sachs, 1973, Code 1N; "Maximum abundance in the surface study in NE part of region (7%); common accessory elsewhere. Maximum abundance in core V21-137 10-35% in interval from 30-90 cm. These anomalous concentrations forced exclusion of the species from data analyses."

4. Molina-Cruz, 1975, Code N26; not used in factor analysis of southeast Pacific assemblages, cf. Appendix 10 for percent N26 at each station; "rare in this study".

Pterocanium praetextum praetextum (Ehrenberg)

Lychnocanium praetextum Ehrenberg, 1872a, p. 316
Pterocanium praetextum (Ehrenberg), Haeckel, 1887, p. 1330, pl. 73, fig. 6
Pterocanium praetextum praetextum (Ehrenberg), Nigrini, 1967, p. 68, pl. 7, fig. 1

DESCRIPTION

"Cephalis subspherical, with closely-spaced pittings probably representing infilled pores. Apical horn usually cylindro-conical, occasionally angular, as long to twice as long as cephalis breadth. Thorax basically hemispherical, but with shape greatly modified by swellings between the 3 thoracic ribs, resulting in resemblance to a 3-cornered biretta in which the thoracic ribs are situated in depressions across the faces. Thoracic pores subcircular to subangular, separated by relatively thin bars. Feet 3-bladed, proximally fenestrated, curved with convexity outward near thorax, becoming almost straight distally, sub-parallel or slightly divergent, tapering to a point. Abdomen thin-walled, varying in state of development, having small subcircular to angular pores over most of its area, with a row of larger pores adjacent to the feet and in some individuals also along edge of thorax... This species differs from others of the genus in the biretta-shaped thorax and generally straight, almost parallel feet." (from Riedel, 1957).

"Specimens examined by the author are identical with those described by Riedel (1957). A feature not previously described, however, is that inside the cephalis both apical and vertical spines are free of the shell wall. Externally, the apical spine forms a strong cylindroconical horn; the vertical spine, a short, very much more delicate horn. On a few specimens additional by-spines occur on the cephalis and upper thorax." (from Nigrini, 1967).

DIMENSIONS

"Length of apical horn 30-50μ, of cephalis 14-20μ, of thorax 50-60μ, of abdomen 5-120μ, of feet 75-165μ. Breadth of cephalis 22-30μ, of thorax 70-90μ." (from Riedel, 1957).

REMARKS

1. For a more complete synonymy see Nigrini, 1967.
2. Benson's (1966) description and dimensions of this subspecies (p. 408) are consistent with the above except for a less well-developed abdomen.

Plate 23, figure 2

Pterocanium praetextum praetextum (Ehrenberg)

3. Molina-Cruz (1975) and Lozano (1974) combined this subspecies with P. praetextum eucolpum in their counts; Lozano notes that "most of the specimens in our area (i.e., Antarctic, Atlantic and Indian sectors) belong to the subspecies P. praetextum eucolpum but in the northernmost samples in the Atlantic, though it is not abundant, P. praetextum praetextum is the predominant subspecies and in some of them is the only subspecies present. In the slide prepared from core V27-199, there are 10 specimens, all of them P. praetextum praetextum. Some specimens in samples from the subtropical Atlantic (i.e., V18-166) have a thin three-bladed apical horn but the thorax is like the one of praetextum, no abdomen was observed (specimens are not well preserved), and the feet may be as short as 40μ."

RECENT DISTRIBUTION

1. Benson, 1966; "This species is very rare in the Gulf [of California]."

2. Nigrini, 1967, fig. 35; Indian Ocean occurrences - P. praetextum praetextum is abundant (3% to 14% of the described population) in low latitudes, but does not occur in samples from south of 35°S. It appears to be a reliable and potentially useful member of the low latitude assemblage.

3. Nigrini, 1970, fig. 24; belongs to a tropical assemblage derived by recurrent group analysis of North Pacific samples, but the species does range as far north as 40°N in the western Pacific.

4. Lozano, 1974, Fig. IV-5; counted together with P. praetextum eucolpum; "It is found in a few samples in the eastern Atlantic and in the Indian Ocean constituting always less than 0.7 of the total radiolarian fauna. It is found in relatively high percentages (0.2 to 0.6) in the Crozet basin indicating southward (occasional ?) penetration of sub-tropical waters. It is also present in core RC11-120 at the junction of the Kerguelen Plateau and the Mid Ocean Indian Ridge. The presence of the subspecies P. praetextum praetextum (see discussion under Taxonomic notes section) which is found only north of 33°S in the Indian Ocean (Nigrini, 1967) is in accord with the hypothesis proposed by Goll and Bjorklund (1974) that microplankton are seasonally introduced into the Atlantic Ocean during the summer months when the warm waters of the Agulhas current penetrate deeper into the Atlantic Ocean. The influence of the Agulhas current is suggested also by the distribution pattern of other species."

5. Molina-Cruz, 1975, Code N27; counted together with P. praetextum eucolpum and used in factor analysis of southeast Pacific assemblages; cf. Appendix 10 for percent N27 at each station.

Pterocanium praetextum (Ehrenberg) eucolpum Haeckel

Pterocanium eucolpum Haeckel, 1887, p. 1322, pl. 73, fig. 4
Pterocanium praetextum (Ehrenberg) eucolpum Haeckel, Nigrini, 1967, p. 70, pl. 7, fig. 2

DESCRIPTION

"Similar to Pterocanium praetextum praetextum, but differing from it in the following respects: (1) thorax more rounded, less like a biretta; (2) apical horn 3-bladed; (3) abdomen usually less well developed; and (4) shell generally thinner.

"P. praetextum eucolpum is found only in middle latitudes (30^o-45^oS) and seems to be the cool water form of P. praetextum praetextum which is found exclusively in warm water areas."(from Nigrini, 1967).

DIMENSIONS

"Length of apical horn 18-45μ; of cephalis 18-27μ; of thorax 36-63μ;of abdomen up to 54μ; of feet 72-136μ. Breadth of cephalis 18-27μ; of thorax 72-90μ." (from Nigrini, 1967).

Pterocanium praetextum (Ehrenberg) eucolpum Haeckel

RECENT DISTRIBUTION

1. Nigrini, 1967, fig. 36; "Indian Ocean occurrences - P. praetextum eucolpum is abundant (5% to 15% of the described population) south of 35°S, but does not occur in low latitude samples. It appears to be a reliable and potentially useful member of the middle latitude assemblage."

2. Nigrini, 1970, fig. 25; belongs to a transitional assemblage derived by recurrent group analysis of North Pacific samples, but does occur rarely in tropical sediments.

3. Lozano, 1974; see P. praetextum praetextum.

4. Molina-Cruz, 1975; see P. praetextum praetextum.

Pterocanium trilobum (Haeckel)

Dictyopodium trilobum Haeckel, 1860, p. 839
Pterocanium trilobum (Haeckel), Nigrini, 1967, p. 71, pl. 7, figs. 3a, b

DESCRIPTION

"Cephalis small, spherical with closely spaced pores, or pits (probably representing infilled pores), and bearing a stout conical apical horn approximately twice its length). Apical and vertical spines free within cephalis; both project to form external horns, the vertical horn being shorter and very much more delicate than the apical. Sometimes additional by-spines form on both cephalis and thorax.

"Thorax is an inflated tetrahedron with circular to subcircular pores, arranged in longitudinal rows. Thoracic ribs strong, becoming stout 3-bladed feet, latticed proximally and tapering to a point distally. Feet are divergent, convex outwards, as long to half again as long as thorax.

"Only traces of an abdomen are preserved. In most specimens a few lattice bars are present, and these seem to form a single row of large pores adjacent to the thorax, and sometimes one large pore bordering on the proximal end of the feet. The rest of the abdomen has smaller pores and apparently hangs free of the feet." (from Nigrini, 1967).

"The Antarctic representives of this species do not show the great range of variation described by Popofsky [1913]. Most Antarctic individuals are thicker than those previously described. By-spines were rarely detected on the thorax, though the vestiges of by-spines were commonly observed on the cephalis. The basal feet are invariably present and sometimes strongly developed. The mouth is often slightly constricted but never closed." (from Hays, 1965).

"There is great variability in the overall shell size. Some specimens were very similar to P. praetextum, while others were three times as large." (from Renz, 1976).

DIMENSIONS

"Length of apical horn 27-54μ; of cephalis 18-27μ; of thorax 63-100μ; of feet 90-173μ. Maximum breadth of cephalis 23-27μ; of thorax 90-136μ." (from Nigrini, 1967).

"Length of apical horn 23-68, of cephalis 17-30, of thorax 74-144, of feet 57-171." (from Hays, 1965).

Plate 23, figures 4a-c

Pterocanium trilobum (Haeckel)

REMARKS

1. For a more complete synonymy see Nigrini, 1967.

2. Benson's (1966) description and dimensions of this species (Pterocanium prosperinae Ehrenberg in Benson, p. 405) are consistent with the above, but it is likely that of the three specimens illustrated by him only the one shown in Plate 27, fig. 4 is P. trilobum.

RECENT DISTRIBUTION

1. Hays, 1965; "Pterocanium trilobum like Saturnulus planetes, with which it is usually associated in Antarctic sediments, is not found in the Recent surface sediments south of the Polar Front and was only rarely observed from surface sediments north of the Polar Front in this study. It was, however, reported to be cosmopolitan in the Challenger material from the Atlantic and the Pacific. It occurs at depth in some cores ranging back to zone ø."

2. Nigrini, 1967, fig. 37; "Indian Ocean occurrences - P. trilobum is fairly abundant (1% to 13% of the described population) in low latitudes, but south of 35^{o}S. it never forms more than 1 percent of the described population. It appears to be a reliable and potentially useful member of the low latitude assemblage."

3. Nigrini, 1970, fig. 26; belongs to a tropical assemblage derived by recurrent group analysis of North Pacific samples, but the species does range as far north as 40^{o}N right across the Pacific.

4. Molina-Cruz, 1975, Code N28; used in factor analysis of southeast Pacific assemblages; cf. Appendix 10 for percent N28 at each station.

Pterocanium grandiporus Nigrini

Pterocanium grandiporus Nigrini, 1968, p. 57, pl. 1, fig. 7

DESCRIPTION

"Similar in size and shape to P. trilobum but shell may be heavier and rougher, cephalic pores better defined, and apical horn usually longer. Thoracic pores larger than those of P. trilobum, 9-11 across the wides part of the segment.

"Abdomen often quite well developed and attached to the feet for at least most of its length. Pores large, subcircular, having no definite arrangement; those adjacent to the feet larger than the others. Termination always ragged." (from Nigrini, 1968).

DIMENSIONS

"Length of apical horn 45-81μ, of cephalis 14-27μ, of thorax 63-90μ, of feet 108-240μ. Maximum breadth of cephalis 23-27μ, of thorax 90-127μ." (from Nigrini, 1968).

Plate 23, figure 5

Pterocanium grandiporus Nigrini

RECENT DISTRIBUTION

1. Nigrini, 1968, text-fig. 8; "Few in 2 samples near the coast of Central America and in 2 equatorial samples near the coast of South America, rare or absent in all other samples examined.

2. Molina-Cruz, 1975, Code N6; used in factor analysis of southeast Pacific assemblages; cf. Appendix 10 for percent N6 at each station.

Pterocanium sp.

DESCRIPTION

Cephalis hemispherical with closely spaced pores or pits and bearing 2 stout 3-bladed or conical horns. Horns are equally well-developed, the same length as or slightly longer than cephalis; a third needle-like by-spine is frequently present also.

Thorax conical or with a slight shoulder bearing subcircular, hexagonally framed pores which increase in size distally and are usually arranged in longitudinal rows. Surface may be thorny.

Three well-developed, 3-bladed feet, latticed proximally and tapering distally. Feet are divergent, convex outwards as long to half again as long as thorax.

Abdomen, when present, consists of one or two rows of pores adjacent to thorax. (unpublished data, Nigrini).

DIMENSIONS

Based on 8 specimens; length of thorax and cephalis 83-107μ; maximum breadth of thorax 83-107μ. (unpublished data, Nigrini).

REMARKS

1. This species was called D. infabricatus Nigrini by Moore (1974). It differs from that species by having a distinct thoracic termination and is, as Moore noted, more robust.

2. Haeckel (1887, pl. 73, fig. 15) described a species, Pterocanium bicorne, which may be synonymous with our Pterocanium sp. However, the shape of the thorax in Haeckel's specimen is more biretta-shaped than any we have observed. On the other hand, we have not observed any other form with two equally developed apical horns. It would be necessary to examine topotypic material before adopting the name bicorne for the species here described.

Plate 23, figures 6a,b

Pterocanium sp.

RECENT DISTRIBUTION

1. Nigrini, unpublished data; cosmopolitan, but rare throughout the North Pacific (at least).

2. Molina-Cruz, 1975; cf. *D. infabricatus* herein. It is uncertain whether Molina-Cruz counted *D. infabricatus*, *Pterocanium* sp. or both species together.

Notes on the Genera Theocalyptra and Cycladophora

Riedel (1971) pointed out that the Family Theoperidae is a large, probably polyphyletic taxon of which there is, as yet, no satisfactory division into subfamilies. In the absence of such a revision it is necessary to approach taxonomic problems with caution and conservatism. What is fixed and relatively immovable is the concept of type species and that must be the starting point of any taxonomic considerations. With these thoughts in mind, consider the generic placement of the species variously described as Theocalyptra davisiana (Ehrenberg) and Cycladophora davisiana Ehrenberg. The type species of Theocalyptra is T. veneris Haeckel (1887, p. 1397); the type species of Cycladophora is C. tabulata Ehrenberg (1872b, pl. 4, fig. 18). Unfortunately, neither of these type species is entirely satisfactory.

T. veneris was described, but not illustrated by Haeckel. However, he does say that the species is similar to Eucephryphalus agnesae (pl. 59, fig. 3). But this species is not known. Haeckel probably means Corocalyptra agnesae which is the name of the species illustrated on plate 59, fig. 3. If one assumes then that the illustration on plate 59, fig. 3 is very like the type species of Theocalyptra, it may be argued that Theocalyptra veneris is similar to Theocalyptra bicornis and T. bicornis is similar to davisiana. Therefore, the appropriate generic assignment might be Theocalyptra. This line of reasoning was used by Riedel (1958).

Cycladophora tabulata Ehrenberg is poorly illustrated (1872b, pl. 4, fig. 1) and is somewhat similar to davisiana, but not at all like bicornis. In fact, Ehrenberg questioned the placement of davisiana in the genus Cycladophora. However, in the absence of a complete revision it could be argued that one should return to the original generic designation, i.e., Cycladophora davisiana. This line of reasoning was used by Petrushevskaya (1967).

Observations have suggested that bicornis and davisiana are sufficiently similar as to be placed in the same genus and hence the genus Theocalyptra is used herein. A detailed study of these forms is needed to finally resolve the taxonomy of these species.

N52

Theocalyptra bicornis (Popofsky)

Pterocorys bicornis Popofsky, 1908, p. 228, pl. 34, figs. 7, 8
Theocalyptra bicornis (Popofsky), Riedel, 1958, p. 240, pl. 4, fig. 4; Petrushevskaya, 1967, p. 124, fig. 7, I-VIII.

DESCRIPTION

"Shell conical campanulate, consisting usually of two or three segments. Cephalis subglobose, with numerous small pores, bearing two three-bladed spines of approximately the same length as the cephalis - one vertical, approximately apical, and the other lateral, oblique. Collar stricture slight. Major portion of the shell in most specimens now showing segmental division, and therefore termed the "thorax". Thorax conical proximally, campanulate distally, with subcircular to polygonal pores separated by rather narrow intervening bars. Thoracic pores increase in size distally, and are arranged in usually 9-11 transverse rows. Three short, downwardly directed acicular spines penetrate the wall of the thorax near the collar stricture. In some specimens, there is a marked change in thoracic contour at the position of the rather abrupt transition from subcircular proximal thoracic pores to more regular polygonal distal thoracic pores; it is apparently this change in contour, which in some specimens gives the impression of a segmental division, which Popofsky regarded as a lumbar stricture. In many specimens, one or two rows of pores are marked off from the distal end of the thorax by an internal septal ring; these may be considered to constitute an abdomen.

"... This species differs from T. davisiana principally in more delicate structure and larger thorax." (from Riedel, 1958).

"The specimens found under Antarctic and subantarctic waters are in agreement with the descriptions given by Riedel (1958) and Petrushevskaya (1967). Some specimens are closed below the fourth segment ... but generally the closing plate is missing...

"Other forms are found as constituents of the subtropical assemblage. Some of them are similar to those found by Petrushevskaya (1967) under subtropical and tropical waters of the Indian Ocean. They have essentially the same shape and differ from the southern forms in size... Generally they are closed at the bottom of the third segment but many specimens are found in which only three segments are preserved and the closing plate is missing... Where a fourth segment is present it is represented by one or two rows of pores... The abdominal pores increase distally in size but in some cases the last one or two rows of pores are smaller...

"A variety is found which is distinct enough and has not been previously described... It has a wider abdomen which is separated from the fourth segment by a brim that, where well developed, consists of three rows of small elongated pores. The fourth segment is closed at the bottom and consists of two

Plate 24, fig. 1

Theocalyptra bicornis (Popofsky)

to four rows of subelliptical to very irregular pores which are similar to the ones in the sieved flat plate which closes the segment at the bottom. As suggested by Petrushevskaya, the subtropical forms may belong to a different species." (from Lozano, 1974).

This latter form may be the same as Moore's (1974) N36 (see remarks herein).

DIMENSIONS

Length of cephalis 15-27μ, of thorax 80-97μ; maximum breadth 95-120μ". (from Riedel, 1958).

"width of cephalis: 22± 3μ; width of thorax: 84± 13μ; based on 17 specimens". (from Sachs, 1973).

REMARKS

1. For a more complete synonymy see Riedel (1958, synonymy and notes) and Petrushevskaya (1967). Petrushevskaya (1972, with Kozlova, and 1974) placed this species in the genus Clathrocyclas. The present author prefers to maintain the status quo until a thorough revision of this entire group can be made.*

2. Sachs (1973), Moore (1974) and Molina-Cruz (1975) all placed Halicalyptra? cornuta Bailey, 1856, in synonymy with P. bicornis Popofsky, 1908, without changing the specific name to that of the senior synonym, i.e., cornuta.

3. "Two forms of this highly variable species were distinguished. That form counted under the category N38... is most similar to previous descriptions and illustrations. The form listed under category N36 (Clathyrocyclas bicornis in Moore, 1973) is distinguished by the presence of a marked abdominal brim... The N36 category may be more properly placed under Coracalyptra cervus (Ehrenberg) ...; however, Haeckel's (1887, p. 1292) description of this latter species indicated a conical straight-sided thorax and polygonal pores. Neither of these features is typical of N36; therefore this form is considered a variety of Theocalyptra bicornis." (from Moore, 1974).

*Note that in placing Popofsky's bicornis species in the genus Clathrocyclas, Clathrocyalas bicornis Hays, 1965, becomes a junior homynym and the specific name must be replaced. Petrushevskaya (1975 and previous Russian language papers) has suggested the name Clathrocyclas antebicornis.

Theocalyptra bicornis (Popofsky)

RECENT DISTRIBUTION

1. Sachs, 1973, Code 12N; "Ubiquitous at frequencies to 8% of surface samples. Tends to be concentrated southern and eastern samples."

2. Lozano, 1974 fig. IV-23; "It is present in almost every sample. In nine cores located between 40°E and 61°E and 38°S and 42°S it attains values between 3.9 and 12.9 percent (RC8-44). In none of the other samples, T. bicornis reaches values over three percent. The cause of the abnormal abundance in this restricted area is unknown but it is partially coincident with the area in which C. davisiana is also more abundant. However, T. bicornis does not show the marked changes in the past that are characteristic for C. davisiana. T. bicornis constitutes less than one percent of the total Radiolaria south of the APF but seems to increase in relative abundance in a belt approximately coincident with the APF.

"In the Atlantic Ocean sector there is a decrease in abundance between 40°S and 45°S but there is a general increase to values over two percent in samples north of about 37°S and east of about 30°W. These changes in abundance in the Atlantic Ocean are clearly related with a change in morphology of the specimens (see Taxonomic Notes section). The subtropical forms decrease in abundance to the south as the typical Antarctic forms increase in abundance. In the Indian Ocean the same transition occurs but it seems to take place in a more gradual way. The distinct change in the Atlantic Ocean may be due to the influence of the Aguhlas current. Its distribution for the whole area does not show good correlation with temperature."

3. Molina-Cruz, 1975, Code N38; used in factor analysis of southeast Pacific assemblages; cf. Appendix 10 for percent N38 at each station.

4. Robertson, 1975; The two forms recognized by Moore (1974) were counted together. "This species loads most heavily in factor 3 (transitional). In comparison to the present, at 18,000 YBP the greatest abundances of this species are farther to south and east."

5. Morley, 1977, Fig. I-23; "This species loads highest in factor 3 (gyre margin). At present it is most frequently found in samples from under the subantarctic waters. Although there is a substantial reduction in abundance at 18,000 YBP, the area of maximum concentration is very similar to the present-day pattern."

N56

Theocalyptra davisiana (Ehrenberg)

Cycladophora ? davisiana Ehrenberg, 1861, p. 297
Theocalyptra davisiana (Ehrenberg), Riedel, 1958, p. 239, pl. 4, figs. 2, 3 text-fig. 10
Cycladophora davisiana Ehrenberg, Petrushevskaya, 1967, p. 122, pl. 69, I-VII.

DESCRIPTION

"Shell conical-campanulate, of moderately heavy structure, consisting of two, three or four segments. Cephalis subglobose, with small, sparse pores, and bearing two short, acicular spines - one vertical,approximately apical, and the other lateral, oblique. Collar stricture slight. Subsequent part of shell, comprising its main bulk, will be termed the thorax, though in some specimens it appears to be divided by an ill-defined internal transverse ridge into an upper and a lower portion. Thorax approximately conical, in many specimens flared at a wider angle distally than proximally. Thoracic pores subcircular proximally, becoming polygonal distally, arranged in usually 4-7 transverse rows which are indefinite in some specimens. In most specimens, three short, downwardly directed acicular spines penetrate the thoracic wall near its junction with the cephalis. In many specimens a further shell-segment is present marked off from the thorax by an internal septal ring. When present, this abdomen is short, truncate-conical, usually flared at a wider angle than the thorax, with usually 2-4 transverse rows of polygonal pores separated by more delicate bars than those of the thorax."(from Riedel, 1958).

DIMENSIONS

"Length of cephalis usually 17-25μ , of thorax 40-80 μ, of abdomen 15-35μ. Maximum breadth of shell 70-130μ." (from Riedel, 1958).

"Length of shell: 91± 16μ; maximum width of "thorax" (before basal stricture, if any): 66± 7μ; cephalic width: 23± 2μ; (15 specimens)" (from Sachs, 1973).

REMARKS

1. For a more complete synonymy see Riedel (1958); for further description see Petrushevskaya (1967).

2. Petrushevskaya (1975) tentatively placed davisiana in the genus Diplocyclas Haeckel and placed bicornis in the genus Clathrocyclas Haeckel. Until the entire group can be studied, further generic manipulation seems only to add to an already confusing situation.

Plate 24, figures 2a,b

Theocalyptra davisiana (Ehrenberg)

3. Petrushevskaya (1967) distinguished 2 varieties of this species besides the typical one, i.e., Cycladophora davisiana. C. davisiana var. semeloides, C. davisiana var. cornutoides, Lozano (1974) notes:

"Petrushevskaya described this species in detail and distinguished two varieties besides the typical one. All three are found in our samples. The variety semeloides ... is rarely found but it may be present anywhere. Well developed specimens of the typical variety...seem to be more common in samples in which the Antarctic fauna predominates but is found at all latitudes (present in V27-199). The variety cornutoides ... seems to be present at all latitudes in our area.

"In the mixed zone and under subtropical waters, forms with only three segments ... of the typical variant seem to be more common along with a variety in which the second segment may have five to six rows of well ordered pores increasing distally in size... This latter form seems to have a subtropical distribution."

Ling et al. (1971) recognized the variety C. davisiana var. cornutoides and placed it in synonymy with Halicalyptra (?) cornuta Bailey...
Ling et al. note:

"The specimens found in the present Bering Sea study agree with the description given by PETRUSHEVSKAYA (1967), except that we frequently found specimens with longer lateral spines extended beyond the thoracic wall and even branched at the distal ends as illustrated in the figures. Because of the small size, BAILEY's species was not included within her new variety by PETRUSHEVSKAYA, we believe that it is best considered here as within the range of variation. KRUGLIKOVA ... illustrated a similar radiolarian species under the name of Cycladophora (?) cornuta, from core sediments of the North Pacific."

Sachs (1973), Moore (1974) and Molina-Cruz (1975) all placed Halicalyptra cornuta Bailey, 1856, in synonymy with Pterocorys bicornis (Popofsky), 1908 without changing the specific name to that of the senior synonymy, i.e., cornuta.

Petrushevskaya (1975) published the following synonymy with respect to her 1967 varieties, cornutoides and semeloides.

Diplocyclas sp. aff. D. bicorona Haeckel group

Diplocyclas bicorona Haeckel, 1887, p. 159, fig. 8; Petrushevskaya and Kozlova, 1972, p. 540, pl. 33, fig. 17, 18.
Cycladophora davisiana Ehrenberg cornutoides Petrushevskaya, 1967, pl..70, fig. 1-3.
Cycladophora davisiana Ehrenberg semeloides Petrushevskaya, 1967, pl. 70, fig. 4-7.

Theocalyptra davisiana (Ehrenberg)

RECENT DISTRIBUTION

1. Benson, 1966; "cosmopolitan in the Gulf [of California] but has a much greater frequency in the southern half of the Gulf."

2. Ling et al., 1971, Cycladophora davisiana var. cornutoides; "This variety is found commonly in most of the sediments studied. The senior author also noticed that this taxon was found in the central and eastern subarctic Pacific, and thus, it is widely distributed in the middle to higher latitudes of both hemispheres."

3. Sachs, 1973, Code 13N; "... only one form of this general morphology has been recognized. Ubiquitous, with distinct northern tendencies. Maximum frequency in surface sediments 15%."

4. Lozano, 1974, Fig. IV-22 (Cycladophora davisiana); "In chapter II it was shown that C. davisiana was more abundant at different times in the past than anywhere in recent sediments. Its presence in relative amounts over 5.5 percent was considered to be an indication of reworked or older than recent sediments. It is particularly abundant in cores along the western part of the Crozet and to the south in the Atlantic-Indian basins. Although this was tentatively explained by reworking, it seems that for some unknown reason the conditions in the Crozet basin and south of it in the Atlantic-Indian basin are favorable for this species. During certain times in the past these conditions were even more favorable and widespread, especially during the last glaciation. Gordon and Goldbert (1970) show a temperature profile (their profile 3) at about 55°E. It differs from the other profiles around Antarctica in the presence of a larger body of water with a temperature between 2° and 3°C which covers a zone about 5° of latitude wide in the surface and more than 10° of latitude wide at a depth of about 500 m. It is possible that this is a favorable type of environment for C. davisiana which is probably a deep living species as discussed in chapter II. The shallowest core we studied (V16-65) was taken at a depth of 1618 m and it has C. davisiana so, at least at the location of that core, it lives at depths shallower than 1618m.

"C. davisiana is found in almost all the samples studied. Its distribution does not show a preferentially latitudinal pattern but its lowest values of relative abundance (one percent or less) occur under subtropical waters."

5. Molina-Cruz, 1975, Code N35 (Cycladophora davisiana); "In this study, it was mostly abundant along the coast in areas of high nutrients content." Used in factor analysis of southeast Pacific assemblages; cf. Appendix 10 for percent N35 at each station.

<u>Theocalyptra</u> <u>davisiana</u> (Ehrenberg)

6. Robertson, 1975, (<u>Cycladophora</u> <u>davisiana</u>);"...in this study no distinction of these three varieties is made and all forms are counted together... This species loads in factor 4 (Davisiana). At the present this species is most abundant in the northwestern most part of the Pacific and Sea of Okhotsk. At 18,000 YBP its high abundances extend well into the northwest Pacific."

Eucyrtidium acuminatum (Ehrenberg)

Lithocampe acuminatum Ehrenberg, 1844a, p. 84
Eucyrtidium acuminatum (Ehrenberg), Nigrini, 1967, p. 81, pl. 8, figs. 3a,b

DESCRIPTION

"Cephalis simple, spherical, with numerous small subcircular pores. Short conical apical horn usually present. Primary lateral and dorsal spines continue as ribs in the thoracic wall for its entire length; rarely, these become external, forming wings. Collar stricture indistinct.

"Thorax small, conical, sometimes slightly inflated; thick-walled, with subcircular pores aligned approximately longitudinally. Lumbar stricture not indented externally.

"Abdomen and 4-5 post-abdominal segments, thick-walled, of approximately equal length, expanding distally to a maximum breadth at about the third post-abdominal segment; then, in complete specimens, narrowing to a quite constricted mouth. No peristome or terminal teeth but, rarely, with a short cylindrical terminal tube. Pores small, subcircular, aligned longitudinally, 4-6 per segment in a vertical series. Final segments may become irregular." (from Nigrini, 1967).

"Complete specimens were rarely observed. Most forms seen were sub-cylindrical, tapering to cephalis." (from Sachs, 1973).

DIMENSIONS

"Total length 119-182μ. Diameter of cephalis 9-13μ. Length of thorax 9-18μ. Maximum breadth 63-81μ." (from Nigrini, 1967).

"width of cephalis, 21 ± 2μ; maximum width of specimen, 71 ± 13μ; overall length, 110±8μ; based on measurements of 17 specimens" (from Sachs, 1973).

REMARKS

1. For a more complete synonymy see Nigrini, 1967 and Petrushevskaya, 1971.

Plate 24, figures 3a,b

Eucyrtidium acuminatum (Ehrenberg)

RECENT DISTRIBUTION

1. Nigrini, 1967, fig. 43; "Indian Ocean occurrences - E. acuminatum is very sparsely distributed in low latitudes, but is abundant (up to 13% of the described population) in middle latitudes. It appears to be a reliable and potentially useful member of the middle latitude assemblage."

2. Nigrini, 1970, fig. 28; belongs to a transitional assemblage derived by recurrent group analysis of North Pacific samples.

3. Sachs, 1973, Code 20N; "Patchy distribution, dominantly in Transitional waters. Maximum abundance about 4% in the surface study."

4. Lozano, 1974, Fig. IV-8; "It is always present in sediments under subtropical waters except for the westernmost Atlantic and in core V29-81 in the Indian Ocean. It reaches a maximum abundance of 1.5 percent in core V27-193 which is located at the subtropical convergence in the Atlantic Ocean. Minimum February sea surface temperature under which it is present is $8^{o}C$ in the Atlantic (RC11-67) and $6^{o}C$ in the Indian Ocean (V29-88)."

5. Molina-Cruz, 1975, Code N10; not used in factor analysis of south-east Pacific assemblages; cf. Appendix 10 for percent N10 at each station.

6. Robertson, 1975, "This species loads most heavily in factor 2 (subtropical). At present this species is largely absent north of $45^{o}N$. At 18,000 YBP it has a similar distribution but with slightly lower abundances."

Eucyrtidium hexagonatum Haeckel

Eucyrtidium hexagonatum Haeckel, 1887, p. 1489, pl. 80, fig. 11; Nigrini, 1967, p. 83, pl. 8, figs. 4a,b

DESCRIPTION

"Cephalis simple, spherical, with numerous subcircular pores and an erect, or sometimes oblique, needle-like apical horn supported by 3 membranous buttresses; length of horn 1 or 2 times diameter of cephalis. Apical spine free. Cephalis usually depressed into thorax; median bar and vertical spine form a V. Primary lateral and dorsal spines continue as ribs in the thoracic wall, giving the segment a 3-lobed appearance from some angles, and then continue on in the abdominal wall for almost its entire length. Rarely, 1 or more of these ribs becomes external, forming small latticed wings.

"Thorax small, inflated annular with rough surface and rather thick wall. Thoracic pores subcircular, usually irregularly arranged, but sometimes in longitudinal rows. Lumbar stricture distinct.

"Abdomen and up to 5 post-abdominal segments, thin-walled, smooth; they expand distally, reaching a maximum breadth at about the second or third post-abdominal segment, and then constrict slightly. Most specimens are broken off at this point, and thus appear to have a wide mouth, very slightly constricted; however, in relatively rare complete specimens, narrowing continues and a short cylindrical pored terminal tube is formed. Pores circular to subcircular, arranged in longitudinal rows, but may be irregular in the final 2 or 3 segments." (from Nigrini, 1967).

DIMENSIONS

"Total length (excluding apical horn) 146-209μ. Diameter of cephalis 9-18μ. Length of thorax 9-18μ. Breadth of thorax 27-36μ; maximum breadth 72-128μ." (fron Nigrini, 1967).

REMARKS

1. Petrushevskaya (1971) placed this species in synonymy with Eucyrtidium dictyopodium (Haeckel). However, the 3 shovel-shaped feet described and illustrated by Haeckel for that species have never been observed on E. hexagonatum and for that reason the synonymy is rejected herein.

2. Benson's (1966) description and dimensions of this species (Eusyringium siphonostoma Haeckel in Benson, p. 498) are generally consistent with the above although he does seem to have some longer specimens.

Plate 24, figures 4a,b

Eucyrtidium hexagonatum Haeckel

RECENT DISTRIBUTION

1. Benson, 1966 (Eusyringium siphonostoma); "This species is one of the most abundant nasselline species in the Gulf [of California] ... suggests its tolerance of waters with higher than average temperature and salinity."

2. Nigrini, 1967, fig. 44; "Indian Ocean occurrences - E. hexagonatum is rather sparsely distributed in low latitudes (1% to 4% of the described population), and is practically absent in middle latitudes. Though rather rare in Recent sediments, it appears to be a useful member of the low latitude assemblage."

3. Nigrini, 1970, fig. 29; belongs to a tropical assemblage derived by recurrent group analysis of North Pacific sediments, but the species does range as far north as 40°N in the western Pacific.

Lithocampe sp.

Lithocampe sp. Nigrini, 1967, p. 87, pl. 8, figs. 6a, b

DESCRIPTION

"Subcylindrical shell, rather rough and thick-walled, consisting of 5-8 segments. Cephalis simple, approximately hemispherical, with subcircular pores and a short needle-like apical horn. Collar structure indistinct. Median bar and vertical spine form a V; primary lateral and dorsal spines continue as ribs in the thoracic wall almost to the lumbar stricture.

"Thorax conical, usually longer than, but sometimes of the same length as, subsequent segments. Pores subcircular, arranged in transverse rows. Lumbar stricture not pronounced.

"Post-thoracic segments cylindrical, of approximately equal length (final segment often longer), each with 4-6 transverse rows of subcircular pores, 9-12 on a half-equator. In complete specimens the last segment narrows sharply to form a constricted mouth. However, the final 1 or 2 segments are often irregular; incomplete specimens in which the shell mouth is ragged and wide open are common." (from Nigrini, 1967).

DIMENSIONS

"Total length 128-218μ. Maximum breadth 54-72μ." (from Nigrini, 1967).

Plate 24, figures 5a,b

Lithocampe sp.

RECENT DISTRIBUTION

1. Nigrini, 1967, fig. 46; "Indian Ocean occurrences - L. sp. is sparsely distributed in low latitudes, but is abundant (2% to 16% of the described population) south of 30°S. It appears to be a reliable and potentially useful member of the middle latitude assemblage."

2. Nigrini, 1970, fig. 30; belongs to a transitional assemblage derived by recurrent group analysis of North Pacific samples; has been observed rarely in a few tropical samples.

3. Lozano, 1974, Fig. IV-3; "Maximum abundance of 0.5 percent. Present only in 3 samples west of 5°W with a maximum abundance of 0.3 percent. To the east it is rarely found under subantarctic waters and it is generally present under subtropical waters in proportions varying from 0.1 to 0.5 percent. Found only under waters with February surface temperatures about 15°C in the Atlantic and 12°C in the Indian Oceans."

4. Robertson, 1975; "This species loads most heavily in factor 2 (subtropical). At the present it is absent in the Sea of Okhotsk, Bering Sea, and extreme northern part of the northwest Pacific. With the exception of one sample it is absent north of 40°N at 18,000 YBP."

Anthocyrtidium ophirense (Ehrenberg)

Anthocyrtis ophirensis Ehrenberg, 1872a, p. 301; Haeckel, 1887, p. 1270
Anthocyrtidium ophirense (Ehrenberg), Nigrini, 1967, p. 56, pl. 6, fig. 3

DESCRIPTION

"Cephalis complex, elongate, ovate-cylindrical, with subcircular pores, bearing a three-bladed apical horn usually of about the same length as the cephalis. Thorax campanulate, inflated, with constricted mouth, having circular to subcircular pores hexagonally arranged, usually hexagonally framed, separated by rather delicate bars. Subterminal row of 8-11 sharp, 3-bladed teeth usually prominent, but in some individuals absent or scarcely discernible. Distally from the subterminal teeth, the thoracic wall curves inward abruptly, to terminate at a narrow delicate lamellar peristome. One or two thoracic pores between subterminal teeth and peristome. Peristome often bears inconspicuous, small triangular teeth directed either downward or inward, forming a terminal row." (from Riedel, 1957).

"Riedel (1957, p. 84) synonymized Anthocyrtidium cineraria Haeckel and Sethocyrtis oxycephalis Haeckel and described what he interpreted to be a single species. The present author does not believe that these species are identical, and consequently 2 separate species, A. ophirense (=A. cineraria) and A. zanguebaricum (=S. oxycephalis), are distinguished herein. Riedel's description was based, in part, on Indian Ocean material, and specimens found during the present study agree in most respects with his observations. However, A. ophirense has an apical horn which is always longer than the cephalis, and subterminal teeth are almost always well developed. A. zanguebaricum has a shorter apical horn, and subterminal teeth are poorly developed or absent." (from Nigrini, 1967).

DIMENSIONS

"Length of apical horn 45-90μ; of cephalis 27-36μ; of thorax 81-119μ; of subterminal teeth 9-27μ. Maximum breadth of cephalis about 27μ; of thorax 90-136μ." (from Nigrini, 1967).

REMARKS

1. For a more complete synonymy see Nigrini, 1967.

2. Benson's (1966) description and dimensions of this species (A. cineraria Haeckel in Benson, p. 472) are consistent with the above.

Plate 25, figure 1

Anthocyrtidium ophirense (Ehrenberg)

RECENT DISTRIBUTION

1. Benson, 1966 (Anthocyrtidium cineraria); "This species is much rarer in the Gulf [of California] than [A. zanguebaricum] ... appears to be an oceanic species."

2. Nigrini, 1967, fig. 30; "Indian Ocean occurrences - A. ophirense is abundant in low latitudes, but south of 35°S, it never forms more than 1 percent of the described population. It appears to be a reliable and potentially useful member of the low latitude assemblage."

3. Nigrini, 1970, fig. 32; belongs to a tropical assemblage derived by recurrent group analysis of North Pacific samples, but the species does range as far north as 40°N in the western and central Pacific.

4. Lozano, 1974, Fig. IV-1; "Present in a few samples from the Indian Ocean sector and only in core V27-191, the northernmost sample in the Atlantic Ocean. Maximum abundance of 0.5 percent in core V24-202. Found under waters with February sea surface temperature 18°C. Its southernmost appearance is in core RC11-101 (0.1%)."

5. Molina-Cruz, 1975, Code N2; used in factor analysis of southeast Pacific assemblages; cf. Appendix 10 for percent N2 at each station .

Anthocyrtidium zanguebaricum (Ehrenberg)

Anthocyrtis zanguebarica Ehrenberg, 1872a, pl. 301
Anthocyrtidium zanguebaricum (Ehrenberg), Nigrini, 1967, p. 58, pl. 6, fig. 4

DESCRIPTION

"Shell rather similar in form to Anthocyrtidium ophirense. Cephalis lobate as in A. ophirense , but apical horn is much shorter, usually about equal in length to the cephalis. Thorax less campanulate, more ovate, and always smaller, both in breadth and length. Subterminal teeth, when present, are poorly developed; terminal teeth may be entirely absent, rudimentary, or in the form of inconspicuous, small triangular teeth directed either downwards or inwards." (from Nigrini, 1967).

DIMENSIONS

"Length of apical horn 18-36μ; of cephalis 27-36μ; of thorax 63-90μ. Maximum breadth of cephalis 18-27μ; of thorax 63-81μ." (from Nigrini, 1967).

REMARKS

1. For a more complete synonymy see Nigrini, 1967.

2. Benson's (1966) description and dimensions of Anthocyrtidium oxycephalus (Haeckel) (p. 468) are similar to the above but he includes larger forms with an angular thoracic contour and lacking subterminal teeth which may not be conspecific.

Plate 25, figure 2

Anthocyrtidium zanguebaricum (Ehrenberg)

RECENT DISTRIBUTION

1. Nigrini, 1967, fig. 31; "Indian Ocean occurrences - A. zanguebaricum is sparsely distributed in both low and middle latitudes. Maximum abundances (up to 3% of the described population) occur in the western tropics."

2. Molina-Cruz, 1975, Code N3; used in factor analysis of southeast Pacific assemblages; cf. Appendix 10 for percent N3 at each station.

Androcyclas gamphonycha (Jorgensen)

Pterocorys gamphonyxos Jorgensen, 1899, p. 86
P. theoconus Jorgensen, P. ambycephalis Jorgensen, 1899, p. 86
Androcyclas gamphonycha (Jorgensen), 1905, p. 139, pl. XVIII, figs. 92-97; Hays, 1965, p. 178, pl. III, fig. 2

DESCRIPTION

"Test campanulate, consisting of three segments and a heavy three-bladed apical spine. Cephalis generally merges with thorax without any definite stricture, but some specimens, probably juvenile, have a weak collar stricture. Cephalis hemispherical to cylindrical; pores circular, arranged in longitudinal rows, four to five pores per row, equal in diameter to width of bars. Thorax campanulate; pores generally arranged in longitudinal rows, some with polygonal borders. Lumbar stricture distinct accompanied by an internal septal ring. Abdomen cylindrical to conical, inflated, of variable length; pores large and irregular in size, shape, and arrangement, distinctly larger than those of thorax, 5-10 times width of bars. By-spines short and slightly curved, reaching their maximum development on the broadest part of the abdomen. Mouth constricted about three-quarters the diameter of broadest part of abdomen.

"The internal skeleton has been described by Jorgensen [1905, p. 139] , and the specimens examined from the Antarctic agree with his description". (from Hays, 1965).

A. gamphonycha may be distinguished from Lamprocyrtis heteroporus (Hays) (Lamprocyclas heteroporus in Hays, 1965) by its conical rather than cylindrical abdomen and by its generally larger size.

DIMENSIONS

"Length of apical horn 30-60; of cephalis 18-30; of thorax 25-45; of abdomen 25-100; maximum breadth 90-130." (from Hays, 1965).

REMARKS

1. This species is very similar to species of Lamprocyclas, but it is retained in the genus Androcyclas until the evolution of each genus can be determined.

Plate 25, figure 3

Androcyclas gamphonycha (Jorgensen)

RECENT DISTRIBUTION

1. Hays, 1965, fig. 16; "Androcyclas gamphonycha has been observed only in sediment samples taken north of the Polar Front within the area studied. It has not been reported from the equatorial regions but was observed in North Atlantic cores SP-11-2, 62°17'N, 15°30'W, and A-157-5, 48°55'N, 36°51'W. Jorgensen originally described Androcyclas gamphonycha from off the coast of Norway and suggested that it was a temperate oceanic form.

"Androcyclas gamphonycha was not found in zone ø."

2. Lozano, 1974, Fig. IV-9; "This species is found to be more abundant between 40° and 45°S where percentages over 0.5 are more common. This is the latitude where generally the abundance of subtropical species decrease sharply to the south and Antarctic species practically disappear to the north. A. gamphonycha reaches a maximum of 1.2 percent in core RC15-96. This species is the only one of those considered in this study with a marked preference for subantarctic waters. It is found in sediments under February sea surface temperatures between 5° and 21° but it seems to prefer waters between 10° and 15°C. It is found in percentages greater than 0.5 only under waters between 8° and 17°C."

Notes on the Genera Lamprocyclas, Lamprocyrtis and Pterocorys

Genus Lamprocyclas Haeckel emend. Nigrini

Lamprocyclas Haeckel, 1881, p. 434; 1887, p. 1390; Nigrini, 1967, p. 74

Theocorythidae with double corona of solid terminal teeth around the mouth. Thoracic ribs present. The definition of this genus is emended to include forms having thoracic ribs. The distal projections of members of this genus are regarded as teeth rather than radial apophyses.

Type species: Lamprocyclas nuptialis Haeckel, 1887, p. 1390, pl. 74, fig. 15.

For further generic synonymy and description see Petrushevskaya and Kozlova, 1972, p. 544.

Species included herein:

Lamprocyclas maritalis maritalis Haeckel
Lamprocyclas maritalis Haeckel polypora Nigrini
Lamprocyclas maritalis Haeckel ventricosa Nigrini

Genus Lamprocyrtis Kling

Lamprocyrtis Kling, 1973, p. 638

"This genus is erected to accommodate the lineage from Lamprocyrtis heteroporos through L. haysi*and possibly L. (?) hannai, a possible ancestor of the lineage. It is difficult to characterize because of rather marked differences between the initial and latest members of the lineage. Included are two- (later) and three (earlier) segmented forms with a usually open, indistinctly three-lobed cephalis which tends to be cylindrical. The cephalis bears one stout, three-bladed apical horn and commonly one or more accessory spines. Pores of the post-cephalic segment(s) usually increase in size distally, earlier species displaying a distinctive discontinuity in pore size. The shells terminate in a single, irregular row of axially to inwardly directed teeth which sometimes occupy a weakly developed peristome. Teeth occasionally occur outside the terminal row, but do not constitute a distinct second row as in Lamprocyclas Haeckel, 1882.

Type species: Lamprocyclas heteroporos Hays, 1965, p. 179, pl. 3, fig. 1."

Species included herein:

Lamprocyrtis nigriniae (Caulet)
Lamprocyrtis (?) hannai (Campbell and Clark)

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*correct name is L. nigriniae

Genus Pterocorys Haeckel

Pterocorys Haeckel, 1881, p. 435
Theoconus Haeckel, 1887, p. 1399
Lithopilium Popofsky, 1913, p. 377

"Cephalis cylindrical or conical. Abdomen longer and broader than thorax (if fully developed). The margin of the abdomen without any teeth, or horns. No peristome. The mouth of the shell may be closed as a sack.

"Tertiary-Recent." (from Petrushevskaya and Kozlova, 1972).

Type species: Pterocorys campanula Haeckel, 1887, p. 1316, pl. 71, fig. 3.

Species included herein:

Pterocorys hertwigii (Haeckel)
Pterocorys minythorax (Nigrini)
Pterocorys zancleus (Muller)

Lamprocyclas maritalis maritalis Haeckel

Lamprocyclas maritalis Haeckel, 1887, p. 1390, pl. 74, figs. 13, 14
Lamprocyclas maritalis maritalis Haeckel, Nigrini, 1967, p. 74, pl. 7, fig. 5

DESCRIPTION

"Shell campanulate, usually thick-walled, and generally with a rather rough surface. Cephalis elongate, trilocular, the 2 secondary lobes beneath and somewhat lateral to the larger primary lobe. Pores numerous, subcircular; apical horn stout, 3-bladed, 2 or 3 times cephalic length. Primary lateral and dorsal spines continue as ribs in the thoracic wall for about half its length; rarely, these project from the thorax, forming small wings. Collar stricture not pronounced.

"Thorax cupola-shaped (conical above, inflated below) with hexagonally framed circular to subcircular pores, arranged in longitudinal rows and increasing slightly in size distally; 9-11 across the wides part of the segment.

"Lumbar stricture distinct and marked internally by a septal ring. Abdomen cylindrical, inflated. Pores hexagonally framed, circular to subcircular, arranged in longitudinal rows; larger than thoracic pores, 9-10 on a half-equator, 3-5 in a vertical series.

"Peristome well differentiated, poreless, sometimes with up to 12 triangular lamellar teeth arising from its lower edge, but often teeth are rudimentary or absent. Subterminal teeth, on the abdomen just above the peristome, are conical or thorn-like, divergent, and usually better developed than terminal teeth." (from Nigrini, 1967).

DIMENSIONS

"Total length (excluding apical horn) 119-173μ. Length of cephalis 27-36μ; of thorax 45-63μ; of abdomen (excluding peristome) 45-72μ. Maximum breadth of thorax 81-90μ; of abdomen 100-128μ." (from Nigrini, 1967).

"Total length, excluding apical horn: 136± 21μ; maximum width 87 ± 10μ; thorax length 43± 9μ; abdomen length 63± 19μ; based on measurements of 10 specimens." (from Sachs, 1973).

REMARKS

1. For a more complete synonymy see Nigrini, 1967.

Plate 25, figure 4

Lamprocyclas maritalis maritalis Haeckel

2. "Distinctions between L. maritalis maritalis and L. maritalis polypora might seem rather artificial, but they form a useful division insofar as there seems to be a correlation of the two forms with latitude. Both subspecies are found in low and middle latitudes, but in middle latitudes L. maritalis maritalis is fairly abundant and L. maritalis polypora is rare, and in low latitudes both subspecies are rather rare but L. maritalis polypora is relatively more abundant." (from Nigrini, 1967).

3. The specimens illustrated by Sachs (1973, pl. 2.6, figs. d,e) as L. maritalis maritalis are really Lamprocyrtis (?) hannai. His counts may have included both species.

RECENT DISTRIBUTION

1. Nigrini, 1967, fig. 39; "Indian Ocean occurrences - L. maritalis maritalis is very sparsely distributed in low latitudes, but is fairly abundant (3% to 9% of the described population) south of 35°S."

2. Nigrini, 1970, fig. 33; belongs to a tropical assemblage derived by recurrent group analysis of North Pacific sediments, but the species does range as far north as 40-45°N right across the Pacific.

3. Lozano, 1974, Fig. IV-2; "Maximum abundance of 3 percent of the total radiolarian fauna in core RC12-292. Never found under surface waters colder than 10°C and present in percentages greater than 1.0 only under waters with February temperatures greater than 16°C."

4. Molina-Cruz, 1975, Code N17; not used in factor analysis of southeast Pacific assemblages; cf. Appendix 10 for percent N17 at each station.

Lamprocyclas maritalis Haeckel polypora Nigrini

Lamprocyclas maritalis polypora Nigrini, 1967, p. 76, pl. 7, fig. 6

DESCRIPTION

"Similar to Lamprocyclas maritalis maritalis, but with a greater number abdominal pores (11-14 on a half-equator, 4-6 in a vertical series), and shell usually thinner-walled and more delicate. Abdomen tends to expand a little distally, thus becoming truncate conical rather than cylindrical." (from Nigrini, 1967). See also remarks for L. maritalis maritalis.

DIMENSIONS

"Total length (excluding apical horn) 128-164μ. Length of cephalis 27-36μ; of thorax 45-63μ; of abdomen (excluding peristome) 45-72μ. Maximum breadth of thorax 81-100μ; of abdomen 119-136μ." (from Nigrini, 1967).

Plate 25, figure 5

<u>Lamprocyclas</u> <u>maritalis</u> Haeckel <u>polypora</u> Nigrini

RECENT DISTRIBUTION

1. Nigrini, 1967, fig. 40; "Indian Ocean occurrences - *L. maritalis polypora* is rare in both low and middle latitudes, occurring in somewhat greater numbers (up to 4% of the described population) in the former."

2. Nigrini, 1970, fig. 34; belongs to a tropical assemblage derived by recurrent group analysis of North Pacific sediments.

3. Molina-Cruz, 1975, Code N16; counted together with *L. maritalis ventricosa* and used in factor analysis of southeast Pacific sediments; cf. Appendix 10 for percent N16 at each station.

Lamprocyclas maritalis Haeckel ventricosa Nigrini

Lamprocyclas maritalis ventricosa Nigrini, 1968, p. 57, pl. 1, fig. 9

DESCRIPTION

"Shell campanulate, rather thick-walled, rough. Cephalis trilocular with numerous small subcircular pores and a stout 3-bladed apical horn, 1 to 2 times the cephalic length. Primary lateral and dorsal spines continue as ribs in the thoracic wall and may become external, forming small wings. Collar stricture not pronounced.

"Thorax inflated conical with hexagonally framed, circular to subcircular pores, aligned longitudinally, 11-14 across the widest part of the segment. Lumbar stricture distinct.

"Abdomen inflated cylindrical, much larger than the thorax. Pores hexagonally framed, circular to subcircular, larger than thoracic pores, arranged in longitudinal rows, 3-9 (usually 5-9) in a vertical series, 11-14 on a half-equator.

"Peristome often small, but clearly differentiated, poreless, with numerous acute, sometimes forked teeth arising from its lower edge; sometimes teeth are rudimentary or absent. Subterminal teeth, on the abdomen just above the peristome, are divergent, small and thornlike...

"This subspecies is distinguished from Lamprocyclas maritalis maritalis Haeckel and Lamprocyclas maritalis Haeckel polypora Nigrini by its larger abdomen. At the lower limit of its abdominal dimensions, it grades into L. maritalis polypora, hence an arbitrary minimum abdominal breadth of 150μ has been selected for L. maritalis ventricosa. In Indian Ocean material, Nigrini (1971) found that the average abdominal breadth of L. maritalis polypora is 123μ (range 119-136μ)." (from Nigrini, 1968).

DIMENSIONS

"Length of apical horn 54-81μ, of cephalis 36-45μ, of thorax 54-63μ, of abdomen (excluding peristome and terminal teeth) 72-127μ.

"Maximum breadth of cephalis 36-45μ, of thorax 108-127μ, of abdomen 156-193μ." (from Nigrini, 1968).

REMARKS

1. Benson's (1966) description of L. maritalis (p. 475) probably includes specimens of L. maritalis polypora and L. maritalis ventricosa.

Plate 25, figure 6

Lamprocyclas maritalis Haeckel ventricosa Nigrini

RECENT DISTRIBUTION

1. Nigrini, 1968, text-fig. 10; "Few along the coast of Central America (south of 11°N) and South America, and extending westward in the regions of the North and South Equatorial Currents; rare or absent in all other samples examined...

"The distribution shown in text-figure 10 roughly corresponds to a plot of average abdominal size, based on 10 measured specimens of Lamprocyclas maritalis from each sample. In the area of few L. maritalis ventricosa the average abdominal breadth is >150μ, whereas it is <150μ in the area of rare or absent L. maritalis ventricosa."

2. Molina-Cruz, 1975, Code N16; counted together with L. maritalis polypora and used in factor analysis of southeast Pacific assemblages; cf. Appendix 10 for percent N16 at each station.

Lamprocyrtis nigriniae (Caulet)

Conarachnium ? sp. Nigrini, 1968, p. 56, pl. 1, fig. 5a (partim.)
?Conarachnium? sp. Nigrini, 1968, p. 56, pl. 1, fig. 5b (partim.)
Conarachnium nigriniae Caulet, 1971, p. 3, pl. 3, figs. 1-4, pl. 4, figs. 1-4
Lamprocyrtis haysi Kling, 1973, p. 639, pl. 5, figs. 15, 16; pl. 15, figs. 1-3

DESCRIPTION

"Two-segmented forms with hemispherical to cylindrical cephalis, commonly open, with irregularly arranged circular to elliptical pores and a three-bladed apical spine and usually one or more accessory spines. Collar stricture indistinct. Thorax inflated conical, thin-walled, smooth, with subcircular (rarely elliptical to irregular) pores generally aligned in longitudinal and transverse rows (rarely irregularly arranged) and gradually increasing in size distally. Thorax terminates, sometimes slightly constricted, with an irregular row of small teeth; a weak peristome is seldom developed." (from Kling, 1973).

See also Nigrini (1968) and Caulet (1971).

DIMENSIONS

"maximum width 80-90μ; length from top of cephalis 100-150μ; thoracic pores 2-20μ." (from Kling, 1973).

The thoracic breadth given by both Nigrini (1968) and Caulet (1971) is greater than that found by Kling for North Pacific specimens. For this reason Kling only tentatively included the specimen figured by Nigrini (1968) on plate 1, fig. 5b.

REMARKS

1. For generic definition see Kling (1973).

Plate 25, figure 7

Lamprocyrtis nigriniae (Caulet)

RECENT DISTRIBUTION

1. Nigrini, 1968, text-fig. 6 (Conarachnium ? sp); "Few along the coast of Central and South America, and to the west in the region of the North Equatorial Current; most abundant in the northernmost sample in the study area; rare or absent in all other samples examined."

2. Caulet, 1971 (Conarachnium nigriniae); western Mediterranean (37°30.6'N, 0°28.1'W).

3. Kling, 1973 (Lamprocyrtis haysi); DSDP Sites 173 (37°57.71'N, 125°27.12'W), 174 (44°53.38'N, 126°20.80'W) and 175 (44°50.2'N, 125° 14.5'W) in the Axoprunum angelinum and Artostrobium miralestense Zones of Kling.

4. Molina-Cruz, 1975, Code N5 (Lamprocyrtis haysi); used in factor analysis of southeast Pacific assemblages; cf. Appendix 10 for percent N5 at each station.

Lamprocyrtis (?) hannai (Campbell and Clark)

Calocyclas hannai Campbell and Clark, 1944, p. 48, pl. 6, figs. 21,22
Lamprocyrtis (?) hannai (Campbell and Clark), Kling, 1973, p. 638, pl. 5, figs. 12-14, pl. 12, figs. 10-14

DESCRIPTION

"Cephalis elongate, trilocular, the two secondary lobes lateral to the larger primary lobe, with subcircular pores and strong, eccentric, three-bladed apical horn, 1 - 4 times its length, sometimes with one or a few pores at the base. Cephalis usually open apically. In some specimens a delicate axial rod extends distally from the median bar into the thoracic cavity. Small secondary lateral bars may be seen in many specimens. Collar stricture indistinct. Thorax rather thick-walled, campanulate, with slightly rough surface and circular to subcircular pores increasing somewhat in size distally. Lumbar stricture not pronounced. Abdomen variable in form (truncate-conical, inflated or subcylindrical) with subcircular pores, variable in size, larger than those of the thorax and sometimes in distinct longitudinal rows. Thickness of the abdomen wall variable. Peristome undifferentiated with approximately 5-12 short conical teeth, sometimes bifurcate, at irregular intervals. Short conical teeth also developed subterminally on many specimens, sometimes scattered irregularly over the distal half of the abdomen." (from Nigrini, unpublished data).

DIMENSIONS (based on twenty specimens): Length of cephalis 20-45μ, of thorax 30-70μ, of abdomen 25-162 (generally 55-120μ). Maximum breadth of thorax 75-100μ, of abdomen 90-152μ (generally 90-132μ). Number of pores on the half equator of abdomen usually 9 (varies from 8 to 11). (from Nigrini, unpublished data).

REMARKS

1. This form has been described elsewhere as Lamprocyclas junonis (=Theoconus junonis Haeckel, 1887, p. 1401, pl. 69, fig. 7), i.e.,

a. Kruglikova, 1969, fig. 4-37
b. Moore, 1974, p. 22, pl. 12, figs. 8-10
c. Molina-Cruz, 1975, p. 131

However, Haeckel's illustration of Theoconus junonis shows a distinct peristome and smooth termination. Moore's and Kruglikova's illustrations show some terminal teeth or projections and no peristome. Sachs (1973) mistakenly called the same form Lamprocyclas maritalis maritalis. L. maritalis maritalis has a well-developed peristome, two rows of terminal teeth and smaller abdominal pores. Sachs' counts may include both species. The authors are indebted to Dr. Stanley Kling for some useful communication concerning this species.

Plate 25, figure 8

Lamprocyrtis (?) hannai (Campbell and Clark)

2. Renz's (1976) illustration (pl. 6, fig. 17) of T. junonis looks more like Pterocorys zancleus. Petrushevskaya and Kozlova's (1972) illustration (pl. 36, fig.8) of Lamprocyclas junonis is more like Haeckel's (1887) illustration.

3. The generic definitions for Lamprocyclas (in Nigrini, 1967) and for Pterocorys and Theoconus (in Petrushevskaya and Kozlova, 1972) do not provide for the specimen illustrated by Haeckel as Theoconus junonis. However, Petrushevskaya and Kozlova (1972, p. 544) in their definition of the genus Lamprocyclas permit the inclusion of forms without terminal teeth and the genus could, therefore, accomodate Haeckel's species.

RECENT DISTRIBUTION

1. Molina-Cruz, 1975, Code N15 (Lamprocyclas junonis); used in factor analysis of southeast Pacific assemblages; cf. Appendix 10 for percent N15 at each station.

Pterocorys hertwigii (Haeckel)

Eucyrtidium hertwigii Haeckel, 1887, p. 1491, pl. 80, fig. 12
Theoconus hertwigii (Haeckel), Nigrini, 1967, p. 73, pl. 7, figs. 4a,b

DESCRIPTION

"Shell conical to ovate, thin-walled, smooth except for longitudinal ridges at irregular intervals. Cephalis trilocular with numerous subcircular pores, heavier than rest of shell. Stout 3-bladed apical horn usually about the same length or a little longer than cephalis. Primary lateral and dorsal spines aligned with three ribs in the thoracic wall.

"Thorax campanulate with subcircular to circular pores arranged in longitudinal rows. Lumbar stricture distinct. Abdomen broader than thorax, but with similar pores. In complete specimens abdomen slightly constricted distally with a smooth termination, but most specimens are incomplete.

"Both thorax and abdomen ornamented by poreless ridges which run more or less longitudinally, irregularly spaced and not necessarily continuous for entire shell length. On the thorax some of the ridges frequently bear 1 or 2 small spines." (from Nigrini, 1967).

"Some specimens lacked ribs." (from Renz, 1976).

DIMENSIONS

"Total length (excluding apical horn) 119-191μ. Length of apical horn 9-45μ; of cephalis 23-32μ; of thorax 45-63μ; of abdomen up to 109μ. Maximum breadth of cephalis 27-32μ; of thorax 81-100μ; of abdomen 100-136μ." (from Nigrini, 1967).

REMARKS

1. Benson's (1966) description and dimensions of this species (Phormocyrtis fatuosa (Ehrenberg) in Benson, p. 485) are generally consistent with the above except for a greater thoracic length (64-80μ).

Plate 25, figure 9

Pterocorys hertwigii (Haeckel)

RECENT DISTRIBUTION

1. Benson, 1966 (Phormocyrtis fatuosa); "... very rare in the Gulf [of California]... indicates its preference for oceanic waters."

2. Nigrini, 1967 (Theoconus hertwigii), fig. 38; "Indian Ocean occurrences - T. hertwigii is very sparsely distributed in low latitudes, and does not occur in samples from south of 35°S.

3. Molina-Cruz, 1975, Code N39 (Theoconus hertwigii); not used in factor analysis of southeast Pacific assemblages; cf. Appendix 10 for percent N39 at each station.

Pterocorys minythorax (Nigrini)

Theoconus minythorax Nigrini, 1968, p. 57, pl. 1, fig. 8

DESCRIPTION

"Shell conical, rather thick-walled, smooth. Cephalis trilocular with relatively large subcircular pores and a short, 3-bladed apical horn, usually about ½ of the cephalic length. Primary lateral and dorsal spines continue as ribs in the thoracic wall for more than ½ of its length and may project to form small, thornlike wings. Collar stricture not pronounced.

"Thorax small, campanulate; pores subcircular, 8-10 on a half-equator, aligned longitudinally with very narrow intervening bars. Lumbar stricture distinct.

"Abdomen slightly flared, up to 3 times as long as thorax. Pores similar to those on thorax, 9-10 on a half-equator. Termination always ragged, mouth wide open...

"This species differs from other members of the genus Theoconus by its small thorax, relative to the size of its abdomen, and by its large pores. It was identified and described by Benson as Theoconus zancleus Muller, but T. zancleus is apparently not synonymous with the species here described. Also, it is thought that Benson's description encompasses 2 species; the specimen shown in plate 33, figure 5 appears to be the same as T. minythorax, but the one in plate 33, figure 4 is not." (from Nigrini, 1968).

DIMENSIONS

Length of cephalis 27-36μ, of thorax 36-45μ, of abdomen 63-127μ. Maximum breadth of cephalis 18-27μ, of thorax 63-72μ, of abdomen 90-118μ." (from Nigrini, 1968).

Plate 25, figure 10

Pterocorys minythorax (Nigrini)

RECENT DISTRIBUTION

1. Nigrini, 1968 (Theoconus minythorax), text-fig. 9; "Few to abundant in the regions of the North and South Equatorial and Peru Currents, but rare or absent in the region of the Equatorial Countercurrent."

2. Molina-Cruz, 1975, Code N7 (Theoconus minythorax); used in factor analysis of southeast Pacific assemblages; cf. Appendix 10 for percent N7 at each station.

Pterocorys zancleus (Muller)

Eucyrtidium zanclaeum Muller, 1858, p. 41, pl. 6, figs. 1-3
Theoconus zancleus (Muller), Benson, 1966, p. 482, pl. 33, fig. 4 (non fig. 5)

DESCRIPTION

"Structure of the cephalis including prominent dorso-lateral lobes, a straight dorsal face merging with a three-bladed apical horn, four collar pores, and the presence of three indistinct thoracic ribs extending as short spines above the base of the thorax the same as in the four preceding species. Cephalis closed at the top, with smooth surface and small, unequal to subequal, circular pores. Vertical spine indistinct but present; apical horn not robust. Thorax campanulate to truncate-conical, separated from the cephalis above by a change in contour and from the abdomen below by a distinct constriction* occupied by an internal septal ring. Surface of thorax smooth. Thoracic pores ranging from circular and subequal to subpolygonal and increasing slightly in size distally with regular hexagonal arrangement in longitudinal rows. Abdomen smooth, ranging from subcylindrical with its distal portion tapering inward and with equal (6-12μ), circular pores arranged hexagonally in longitudinal rows to truncate-conical with distal portion broader and not constricted and with polygonal to subpolygonal pores having the same arrangement but gradually increasing in size distally (from about 6-8μ, to 20-26μ)." (from Benson, 1966).

*The present authors have not noted a distinct lumbar constriction.

DIMENSIONS

"Length of cephalis 21-39μ, of thorax 36-49μ, of abdomen 37-143μ; breadth of cephalis 21-32μ, of thorax 64-80μ, of abdomen 75-119μ; length of apical horn 9-36μ, of vertical spine 0-5μ, of dorsal and primary lateral spines 0-12μ." (from Benson, 1966).

"overall length excluding horn, 134 ± 16μ; thorax length, 50 ± 6μ, thorax width, 78 ± 4μ, abdomen width, 91 ± 9μ; abdomen length, 59 ± 11μ" (from Sachs, 1973).

REMARKS

1. For a more complete synonymy see Benson (1966). Note, however, that the specimen figured by Benson on Pl. 33, fig. 5 is probably P. minythorax (Nigrini). Benson apparently combined these 2 species in his description, dimensions and distribution.

Plate 25, figures 11a,b

Pterocorys zancleus (Muller)

RECENT DISTRIBUTION

1. Benson, 1966 (*Theoconus zancleus*); "a common member of the Gulf [of California] assemblage, but its average frequency is greater in the southern half of the Gulf than in the northern half."

2. Sachs, 1973, text-fig. 2G, Code 21N (*Theoconus zancleus*); "Essentially confined to the Southern region (beneath Transitional waters), where it may reach abundances of 14%."

Sachs (personal communication) counted only *P. zancleus*. *P. minythorax* was not observed by him in North Pacific sediments.

3. Molina-Cruz, 1975, Code N40 (*Theoconus zancleus*); used in factor analysis of southeast Pacific assemblages; cf. Appendix 10 for percent N40 at each station.

4. Robertson, 1975, text-fig. 2G (*Theoconus zancleus*); "This species loads quite heavily in factor 3 (transitional). At present its highest abundances occur in a band between 35^{o} and 45^{o}N. At 18,000 YBP the zone of highest abundance is shifted to the south."

Stichopilium bicorne Haeckel

Stichopilium bicorne Haeckel, 1887, p. 1437, pl. 77, fig. 9; Benson, 1966, p. 422, pl. 29, figs. 1, 2

DESCRIPTION

"Cephalis smooth, cap-shaped, separated from thorax by a change in contour but in most specimens the apical-lateral arches and the ventral arch are represented by ribs which occupy slight furrows separating the cephalis from small, dorsal and ventral lobate swellings of the proximal portion of the thorax; pores of cephalis small, equal, subcircular to polygonal, regularly arranged. Two prominent, straight, nearly equal, three-bladed cephalic horns lying in the sagittal plane correspond to the dorsally ascending apical horn and ventrally ascending vertical horn. The former extends from the apical bar which in its upper portion above the junction with the apical-lateral arches is a dorsal rib in the wall of the cephalis and in its lower portion is free within the cephalic cavity. The latter extends from and in collinear with the vertical bar which joins with the ventral arch. The dorsal and primary lateral bars extend as ribs in the thoracic wall and are prolonged into heavy, equal, three-bladed wing-like spines which are generally straight and diverge downward but are nearly horizontal in a few specimens; spines latticed proximally in a few tests. Thorax pyramidal with slightly concave sides between the thoracic ribs in its proximal portion; its distal portion circular in section, campanulate or inflated cylindrical; the wall of the thorax is extended outward where each of the three basal spines originate, thus giving the appearance of three latticed wings originating from the middle portion of the thorax. Number of abdominal segments variable from none to at least two; these joints separated from one another and the thorax by distinct constrictions which are generally occupied by continuous internal septal rings. Abdominal joints cylindrical, inflated, truncate conical or campanulate. Surface of thorax and abdominal joints smooth. Pores of these joints similar, of equal size, small, hexagonal to subcircular, hexagonally arranged in transverse rows." (from Benson, 1966).

"abdomen may or may not be fully developed" (Renz, 1976).

DIMENSIONS

"length of test 98-193μ; maximum breadth (thoracic or abdominal joints) 80-138μ; length of cephalis 21-25μ, of thorax 62-102μ, of first abdominal joint 25-49μ; breadth of cephalis 20-31μ, of thorax (distal portion) 83-111μ; length of apical horn 14-49μ, of vertical horn 15-37μ, of basal spines 12-53μ." (from Benson, 1966).

Plate 26, figures 1a,b

<u>Stichopilium</u> <u>bicorne</u> Haeckel

RECENT DISTRIBUTION

1. Benson, 1966; "... cosmopolitan but very rare in the Gulf [of California]."

2. Molina-Cruz, 1975, Code N34; not used in factor analysis of southeast Pacific assemblages; cf. Appendix 10 for percent N34 at each station.

Theocorythium trachelium trachelium (Ehrenberg)

Eucyrtidium trachelius Ehrenberg, 1872a, p. 312
Theocorythium trachelium trachelium (Ehrenberg), Nigrini, 1967, p. 79, pl.8, fig. 2, pl.9, fig. 2

DESCRIPTION

"Shell rather rough and thick-walled. Cephalis in 2 parts: (1) spherical portion, with circular to subcircular pores, bearing a 3-bladed apical horn, 1 or 2 times its length; and (2) "neck," separated from the first part by an internal ringlike ledge, pores similar but larger and in 2 transverse rows, shell a little heavier. This "neck" is apparently homologous with the paired lobes of a trilocular cephalis in which the lobes are directly beneath the larger unpaired lobe. Collar structure at the base of the "neck." Apical spine incorporated in the cephalic wall (both spherical and "neck" parts). A short vertical spine meets the shell wall about midway up the "neck." Primary lateral and dorsal spines continue as ribs in the thoracic wall for about half its length; sometimes these project, or are external, forming small wings.

"Thorax large, distinctly cupola-shaped (conical above, expanded below) with hexagonally framed, circular to subcircular pores, closely spaced, quincuncially arranged and aligned longitudinally, 12-15 on a half-equator, 8-10 in a vertical series. Pronounced lumbar stricture.

"Abdomen usually elongated, cylindrical or with a slight medial constriction. Pores similar in size, shape, and arrangement to those of the thorax, 12-15 on a half-equator, 8-14 in a vertical series.

"Slight terminal constriction usually with 4-6 triangular lamellar teeth. Some specimens have similar subterminal teeth near the mouth or scattered irregularly over the distal half of the abdomen. In most specimens a peristome is either absent or only poorly developed, but a few have a well-differentiated poreless peristome." (from Nigrini, 1967).

DIMENSIONS

"Total length (excluding apical horn and terminal teeth) 146-209μ. Length of cephalis 27-36μ; of thorax 45-72μ; of abdomen (excluding terminal teeth) 54-109μ. Maximum breadth of cephalis 27-36μ; of thorax 81-100μ; of abdomen 72-100μ." (from Nigrini, 1967).

REMARKS

1. For a more complete synonymy see Nigrini, 1967.

2. Benson's (1966) description and dimensions of this subspecies (Calocyclas amicae Haeckel in Benson, p. 487) are consistent with the above.

Plate 26, figure 2

Theocorythium trachelium trachelium (Ehrenberg)

RECENT DISTRIBUTION

1. Benson, 1966 (Calocyclas amicae), "... very rare in the Gulf [of California] ... predominantly an oceanic species."

2. Nigrini, 1967, fig. 42; "Indian Ocean occurrences - T. trachelium trachelium is fairly abundant in low latitudes, but does not occur in samples from south of 35^{0}S. It appears to be a reliable and potentially useful member of the low latitude assemblage."

3. Nigrini, 1968, text-fig. 16; "Rare or absent in the regions of the Peru Current and the North Equatorial Current (except for few in the 2 northernmost samples examined), few throughout most of the regions of the South Equatorial Current and the Equatorial Countercurrent."

4. Nigrini, 1970, fig. 35; belongs to a tropical assemblage derived by recurrent group analysis of North Pacific samples, but the subspecies does range as far north as 40-45^{0}N right across the Pacific.

5. Nigrini, 1971; used in Quaternary stratigraphic study of tropical Pacific sediments; present in varying amounts in the lowermost Quaternary, but essentially absent from the uppermost 'Pliocene'.

6. Lozano, 1974, fig. IV-4; counted together with T. trachelium dianae.

"The specimens observed correspond mostly to the subspecies T. trachelium (Ehrenberg) dianae (Haeckel) and only occasionally a few specimens of T. trachelium trachelium were observed in the northernmost samples."

"It is found in larger relative abundances in the Atlantic Ocean east of the Argentine Basin with values between 2 and 3 percent reaching a maximum of 3.5 in core V18-166. The percent values decrease in the western Indian Ocean and increase again east of the Crozet Basin."

"It is present under subantarctic waters with values under one percent."

"Never found in relative abundances of two percent under waters with February sea surface temperatures below 12^{0}C. Minimum temperature under which it is found is 5^{0}C (V16-591.)"

7. Molina-Cruz, 1975, Code N42; counted together with T. trachelium dianae and used in factor analysis of southeast Pacific assemblages; cf. Appendix 10 for percent N42 at each station.

Theocorythium trachelium trachelium (Ehrenberg)

8. Morley, 1977, Fig. I-22; "The two subspecies described by Nigrini (1967) are grouped into one taxonomic group in this study. Specimens of both T. trachelium trachelium and T. trachelium dianae are observed with the former more abundant in tropical and subtropical waters and the latter more abundant in subantarctic waters... These species load highest in factor 3 (gyre margin). At present this group is absent from samples south of about 45°S. The abundance of these species is lower than present in most 18,000 YBP samples."

N96

Theocorythium trachelium (Ehrenberg) dianae (Haeckel)

Theocorys dianae Haeckel, 1887, p. 1416, pl. 69, fig. 11
Theocorythium trachelium (Ehrenberg) dianae (Haeckel), Nigrini, 1967, p. 77, pl. 8, figs. 1a,b, pl. 9, figs. 1a,b.

DESCRIPTION

"Shell quite smooth and rather thin-walled. Cephalis trilocular, the paired lobes beneath and slightly lateral to the larger unpaired lobe. Apical horn 3-bladed, 1 or 2 times cephalic length. Primary lateral and dorsal spines continue as ribs in the thoracic wall for about half its length, but in none of the specimens examined did these ribs become external. Secondary laterals present.

"Thorax inflated conical with circular to subcircular pores, hexagonally framed, arranged in longitudinal rows, 10-13 on a half-equator, 6-9 in a vertical series. Pronounced lumbar stricture.

"Abdomen elongated, basically cylindrical, but expanding a little distally; sometimes slightly inflated. Pores similar in size, shape, and arrangement to those of the thorax, 12-15 on a half-equator, 8-17 in a vertical series.

"Slight, but sharp, terminal constriction with a poreless peristome and up to 8 triangular terminal teeth. Usually, conical subterminal teeth are present, near the mouth and scattered irregularly over the distal half of the abdomen. Sometimes terminal teeth absent, but a poreless, often poorly developed, peristome is always present ...

"T. trachelium dianae differs from T. trachelium trachelium in the following respects: (1) cephalis forms a less distinct "neck," thus making the collar stricture less pronounced; (2) thorax is "inflated conical" rather than "cupola-shaped" and is rather smaller; and (3) abdomen expands distally and may be slightly inflated, and is thus broader than the thorax, whereas in T. trachelium trachelium the abdomen is approximately cylindrical and about the same breadth as the thorax." (from Nigrini, 1967).

DIMENSIONS

"Total length (excluding apical horn and terminal teeth) 128-227μ (usually 155-227μ). Length of cephalis 27-36μ; of thorax 45-54μ; of abdomen (excluding terminal teeth) 45-146μ(usually 81-100μ). Maximum breadth of cephalis 18-36μ; of thorax 63-81μ; of abdomen 72-109μ." (from Nigrini, 1967).

Plate 26, figures 3a,b

Theocorythium trachelium (Ehrenberg) dianae (Haeckel)

REMARKS

1. For a more complete synonymy and taxonomic notes see Nigrini, 1967.

RECENT DISTRIBUTION

1. Hays, 1965 (Calocyclas amicae Haeckel, p. 178), fig. 11; "does not occur south of the Polar Front and in fact is not an important element of the fauna north of the Front except in several cores from the Indian Ocean that are about 10° north of the Front. In these cores C. amicae is often associated with Pterocanium praetextum (Ehrenberg). Anthocyrtidium cineraria Haeckel, and other species that are important elements of the tropical radiolarian assemblage.

"Calocyclas amicae occurs in V-16-66 and V-17-88 in zone ø."

2. Nigrini, 1967, fig. 41; "Indian Ocean occurrences - T. trachelium dianae is absent in low latitudes, but south of 30°S. it is abundant in all samples, except one near the African coast (SERPENT(?)9) which contains a warm water fauna. It appears to be a reliable and potentially useful member of the middle latitude assemblage."

3. Lozano, 1974, see T. trachelium trachelium.

4. Molina-Cruz, 1975, Code N42, see T. trachelium trachelium.

5. Morley, 1977; see T. trachelium trachelium.

Botryostrobus aquilonaris (Bailey)

Eucyrtidium aquilonaris Bailey, 1856, p. 4, pl. 1, fig. 9
Eucyrtidium tumidulum Bailey, 1856, p. 5, pl. 1, fig. 11
Botryostrobus aquilonaris (Bailey), Nigrini, 1977, p. 246, pl. 1, fig. 1.

DESCRIPTION

"Shell typically heavy, thick walled, but early forms are not so robust. Constrictions (other than collar and lumbar strictures) unevenly spaced and all strictures usually obscure externally. Shell is spindle-shaped with 4 or 5 post-cephalic segments, the fourth being the widest. Cephalis hemispherical with small irregular pores; vertical tube robust, cylindrical, directed obliquely upwards at approximately 45^{o}. Apical horn very small, needle-like. Thorax inflated with 2 or 3 transverse rows of large subcircular pores. Subsequent segments with 3 to 6 (usually 4) transverse rows of very closely spaced circular pores. The thickness of the shell makes each pore appear to have a ring around it. Shell narrows distally, terminating in a smooth peristome of variable width; peristome may have a single row of pores. Termination smooth or with an undulating margin." (from Nigrini, in press).

DIMENSIONS

"Total length 110-155μ; maximum breadth 60-90μ." (from Nigrini, 1977).

REMARKS

1. For a more complete synonymy see Nigrini, 1977.

2. Benson's (1966) description and dimensions of this species (Siphocampium erucosum (Haeckel) in Benson, p. 527) are consistent with the above.

Plate 27, figure 1

Botryostrobus aquilonaris (Bailey)

RECENT DISTRIBUTION

1. Benson, 1966 (Siphocampium erucosum); "...nearly cosmopolitan in the Gulf |of California| ... Its sparse distribution in the northern Gulf and its slightly greater frequency and more general distribution in the southern Gulf indicate that is primarily an oceanic species."

2. Sachs, 1973, Code 17N (Siphocampe aquilonaris); "Widespread, with maximum occurrence about 6%."

3. Molina-Cruz, 1975, Code N33 (Siphocampe aquilonaris); used in factor analysis of southeast Pacific assemblages; cf. Appendix 10 for percent N33 at each station.

4. Robertson, 1975, (Siphocampe aquilonaris); "This species loads most heavily in factor 3 (transitional). At present it occurs most abundantly in the area north of about 40^{o}N with the exception of the Sea of Okhotsk where it is absent. At 18,000 YBP the abundance of this species is significantly reduced, especially to the north."

Botryostrobus auritus/australis (Ehrenberg) group

Lithocampe aurita Ehrenberg, 1844a, p. 84
Lithocampe australe Ehrenberg, 1844b, p. 187
Lithostrobus seriatus Haeckel, 1887, p. 1474, pl. 79, fig. 15; Petrushevskaya, 1967, p. 145, pl. 82, figs. I-IV; 1971 , pl. 24, figs. 6-8.
Botryostrobus auritus/australis (Ehrenberg) group, Nigrini, 1977, p. 246, pl. 1, figs. 2-5.

DESCRIPTION

"Shell approximately cylindrical, may be either thick or thin walled, rough or smooth surfaced. Cephalis hemispherical with a few subcircular pores, small, thorn-like apical horn and a well-developed cylindrical vertical tube directed obliquely upward at about 45°. Tube may have a slight distal flare. Vertical spine often visible as are well-developed axial rods which often extend well beyond the abdomen. Collar stricture indistinct.

"Thorax inflated with 3 to 4 transverse rows of subcircular pores. Lumbar stricture distinct and marked, as are subsequent strictures, by a poreless band. Shell has a well-developed network of surface sculpture which can be seen most easily on the poreless bands of heavy shelled forms; it is more difficult to see the surface sculpture on hyaline forms.

"Three or more post-thoracic segments of more or less uniform size with 4 to 5 transverse rows of subcircular pores per segment. Termination ragged." (from Nigrini, 1977).

DIMENSIONS

"Total length 123-195μ; maximum breadth 53-70μ." (from Nigrini, 1977).

REMARKS

1. "The individuals included in this species group are quite variable. Attempts by the present author and by others (e.g., Caulet, 1971, 1974; Petrushevskaya and Kozlova, 1972; Petrushevskaya, 1975) to divide them into a number of species are not thought to be entirely satisfactory. Petrushevskaya (1975) distinguished between individuals which were widest at the fourth segment (B. australis) and those which attained maximum shell breadth at the fifth or six segment (B. auritus). Unfortunately, many individuals are so nearly cylindrical that it is often impossible to make this distinction with certainty. It is, however, true that in younger sediments (Pliocene to Recent) there tend to be more decidedly conical specimens and this may indeed be a useful intraspecific variation, but seems too vague for specific distinction. The present author has attempted to subdivide the group on the basis of number of pore rows per segment, but there are too

Plate 27, figures 2a-d

Botryostrobus auritus/australis (Ehrenberg) group

many transitional forms for this to be a reliable division. Caulet (1971) tried a similar subdivision, but he also had some misgivings about the validity of such a division. There is, however, a tendency for there to be more individuals with a smaller number of pore rows per segment in younger sediments.

"A few individuals which are markedly wider and shorter have been observed, but are too rare in the present material for an adequate description. A good example of such a form is shown in Petrushevskaya and Kozlova, 1972, pl. 24, fig. 19 and has been called by them Botryostrobus lithobotrys Haeckel. A number of additional names and references which may refer to this same form are listed below:

Eucyrtidium euporum Ehrenberg, 1872a, p. 291; 1872b, pl. 4, fig. 20.
Lithocampe eupora (Ehrenberg), Haeckel, 1887, p. 1502; Petrushevskaya, 1967, p. 141, pl. 80, figs. I-V.
Lithostrobus lithobotrys Haeckel, 1887, p. 1475, pl. 79, fig. 17.
Lithostrobus botryocyrtis Haeckel, 1887, p. 1475, pl. 79, figs. 18, 19; Petrushevskaya, 1967, p. 143, pl. 73, figs. IV-VI; pl. 80, figs. VI; pl. 81, figs. I-IV.

"There is one other closely related form which is also generally shorter and broader with very regular transverse pore rows and a thinner shell wall. Again this species is not adequately represented in the present material, but has been well illustrated and described by Caulet (1971, 1974) and has the following synonomy:

Eucyrtidium seriatus Jorgensen, in Gran, 1902, p. 150.
Stichocorys seriatus (Jorgensen), Jorgensen, 1905, p. 140, pl. 18, figs. 102-104.
Siphocampe seriatum (Jorgensen), Caulet, 1971, p. 4, pl. 1, figs. 1-5; pl. 2, figs. 1, 2.
Botryostrobus seriatus (Jorgensen), Caulet, 1974, p. 236, pl. X, figs. 1, 2.

Finally, another form which is more sinuous in outline has been observed rarely and may constitute a separate species." (from Nigrini, 1977).

2. For a more complete synonymy see Nigrini, 1977.

RECENT DISTRIBUTION

1. Sachs, 1973, Code 19N (Lithostrobus (?) seriatus Haeckel); "Scattered, but tends toward SE sector. Maximum abundance less than 5%, and loads slightly onto bottom-influenced factor, which is most developed in the SE."

2. Molina-Cruz, 1975, Code N18 (Lithostrobus (?) botryostrobus, Lithostrobus (?) lithobotrys and Lithostrobus (?) seriatus); used in factor analysis of southeast Pacific assemblages; cf. Appendix 10 for percent N18 at each station."...mostly abundant in waters of equatorial upwelling (divergence)."

Phormostichoartus corbula (Harting)

Lithocampe corbula Harting, 1863, p. 12, pl. 1, fig. 21
Siphocampe corbula (Harting), Nigrini, 1967, p. 85, pl. 8, fig. 5; pl. 9, fig. 3
Phormostichoartus corbula (Harting), Nigrini, 1977, p. 252, pl. 1, fig. 10

DESCRIPTION

"Shell thin-walled, smooth, subcylindrical, consisting of 4 segments of which the fourth is the broadest. Cephalis approximately spherical with a well-developed, poreless [vertical] tubule which curves downwards so as to lie close to the thorax; numerous subcircular pores; no apical horn. Collar stricture indistinct.

"Thorax short, truncate conical, with circular to subcircular pores arranged approximately in transverse rows. Lumbar and post-lumbar strictures distinct.

"Abdomen annular, somewhat longer than thorax. Pores small, subcircular to squarish, arranged in 5-8 regular closely spaced transverse rows.

"Fourth segment 2-4 times as long as abdomen; pores similar in size and shape to those on abdomen, in 9-17 transverse rows. Segment tapers slightly distally and ends in a generally poreless peristome. Termination smooth." (from Nigrini, 1967).

DIMENSIONS

"Total length 130-165μ; maximum breadth 65-75μ. Measurements given by Nigrini (1967) have a greater range for both length and breadth." (from Nigrini, 1977).

REMARKS

1. For a more complete synonymy see Nigrini, 1977.

2. Benson's (1966) description and dimensions of this species (Siphocampium cf. polyzona Haeckel in Benson, p. 513) are consistent with the above.

Plate 27, figure 3

Phormostichoartus corbula (Harting)

RECENT DISTRIBUTION

1. Benson, 1966 (Siphocampium cf. polyzona); "...rare but nearly cosmopolitan in the Gulf [of California]".

2. Nigrini, 1967, fig. 45 (Siphocampe corbula); "Indian Ocean occurrences - S. corbula is sparsely distributed in both low and middle latitudes, occurring in somewhat greater numbers (up to 3% of the described population) in the former."

3. Nigrini, 1970, fig. 36 (Siphocampe corbula); belongs to a tropical assemblage derived by recurrent group analysis of North Pacific samples, but the species does range as far north as 40°N in the western Pacific.

4. Molina-Cruz, 1975, Code N32 (Siphocampe corbula); used in factor analysis of southeast Pacific assemblages; cf. Appendix 10 for percent N32 at each station.

Botryocyrtis scutum (Harting)

Haliomma scutum Harting, 1863, p. 11, pl. 1, fig. 18
Botryocyrtis scutum (Harting), Nigrini, 1967, p. 52, pl. 6, figs. 1a-1c

DESCRIPTION

"Cephalis tri- or quadrilobate: (1) heavy central lobe (A) directly over collar pores; (2) large lobe (B) on the dorsal side of A; (3) usually indistinct lobe (D) on the ventral side of A; and (4) in many specimens there appears to be a small, inconspicuous lobe (C) beneath and slightly lateral to B. Petrushevskaya (1964) figured this fourth lobe beneath and slightly lateral to lobe D, and in some specimens this appears to be so, but usually lobe C cannot be distinguished either dorsally or ventrally. Possibly the spongy sheath surrounding the entire shell gives the illusion of a fourth lobe. There are 2 large pores at the base of lobe B, leading to the thoracic cavity. Details of the structure of lobes C and D could not be determined. All lobes with numerous small subcircular to subangular pores.

"Thorax short, lenticular in cross section, somewhat inflated, with relatively large subangular pores. Lumbar stricture not pronounced externally, but marked internally by a septal ring.

"In some specimens there is an abdomen, similar to the thorax, and then a fourth segment of varying length and having smaller pores. In other specimens, the "abdominal segment" is missing, and the small-pored segment adjoins the thorax. Mouth usually wide open or only slightly constricted, with a ragged termination.

"Entire shell surrounded by a sheath of spongy material. Particularly spongy specimens have a tubelike protuberance near the lumbar stricture (Petrushevskaya (1964) figured it near the collar stricture), but this feature is not constant, and, therefore, the species is not treated as a tubed Botryoid." (from Nigrini, 1967).

DIMENSIONS

"Total length 81-128μ. Maximum breadth 54-81μ." (from Nigrini, 1967).

REMARKS

1. For a more complete synonymy and taxonomic discussion see Nigrini, 1967.

2. Benson's (1966) description, dimensions and detailed diagram of this species (Botryopyle sp. in Benson, p. 345) are consistent with the above. Benson's Botrycyrtis cf. caput-serpentis is not the same as B. scutum herein.

Plate 28, figures 1a,b

Botryocyrtis scutum (Harting)

RECENT DISTRIBUTION

1. Benson, 1966 (Botryopyle sp); "This species is very rare in the Gulf [of California] but is the most abundant of the four cannobotryd species present. It is generally confined to the southern part of the Gulf... It is, therefore, a species with greater affinity for oceanic than for Gulf waters."

2. Nigrini, 1967, fig. 28; "Indian Ocean occurrences - B. scutum is fairly abundant in low latitudes. South of 20°S abundances decrease sharply to 1 percent to 2 percent of the described population, and south of 35°S the species is practically absent. It appears to be a reliable and potentially useful member of the low latitude assemblage."

3. Nigrini, 1970, fig. 30; belongs to a tropical assemblage derived by recurrent group analysis of North Pacific samples, but the species does range as far north as 40°N in the western and central Pacific.

4. Molina-Cruz, 1975, Code N19; used in factor analysis of southeast Pacific assemblages; cf. Appendix 10 for percent N19 at each station.

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PLATES

PLATE 1

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1 *Collosphaera tuberosa* Haeckel. AMPH 9P (7°31′S, 121° 56′W), 8–10 cm, T19/4, USNM No. 650930. Nigrini, 1971, pl. 34.1, fig. 1. ×233.

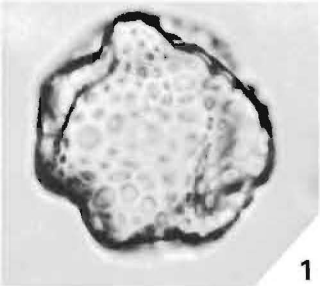
2 *Disolenia quadrata* (Ehrenberg). MSN 39G (12°22′S, 101° 25′E), B-H42/1; Sedgwick Museum (Cambridge) No. 847.1. Nigrini, 1967, pl. 1, fig. 5. ×233.

3 *Disolenia zanquebarica* (Ehrenberg). Discovery 5194 (2° 34′S, 44°53′E), A-K28/0; Sedgwick Museum (Cambridge) No. 860.2. Nigrini, 1967, pl. 1, fig. 6. ×233.

4 *Otosphaera auriculata* Haeckel. MSN 34G (11°38′S, 109° 33′E), B-U36/4, Sedgwick Museum (Cambridge) No. 844.5. Nigrini, 1967, pl. 1, fig. 7. ×233.

5 *Otosphaera polymorpha* Haeckel. LSDA 124G (32°44′S, 62°24′E), A-R32/0, Sedgwick Museum (Cambridge) No. 856.6. Nigrini, 1967, pl. 1, fig. 8. ×233.

6a, b *Siphonosphaera polysiphonia* Haeckel. MSN39G (12°22′S, 101°25′E), A-B30/3, Sedgwick Museum (Cambridge) No. 846.1. Nigrini, 1967, pl. 1, figs. 4a, b. ×233. a. Focused on surface. b. Focused on perimeter.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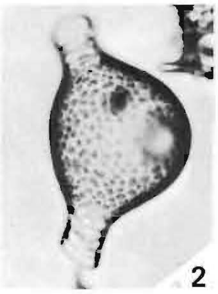
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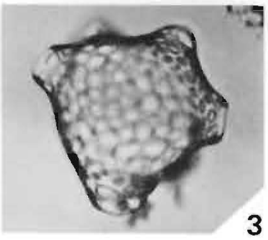
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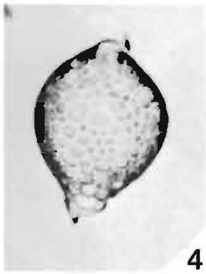
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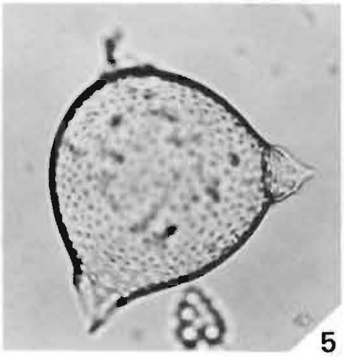
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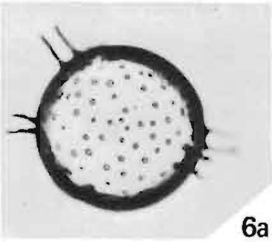
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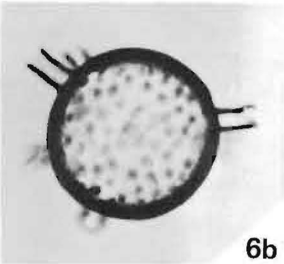

6b

PLATE 2

→

1 *Polysolenia arktios* Nigrini. CK 11 (49°39′N, 177°39′W), A-W33/2, USNM No. 651202 (holotype). Nigrini, 1970, pl. 1, fig. 4. ×233.

2 *Polysolenia flammabunda* (Haeckel). Discovery 5194 (2°34′S, 44°53′E), C-V39/4; Sedgwick Museum (Cambridge) No. 862.3. Nigrini, 1967, pl. 1, fig. 2. ×233.

3a, b *Polysolenia lappacca* (Haeckel). Discovery 5194 (2°34′S, 44°53′E), C-U33/0; Sedgwick Museum (Cambridge) No. 862.2. Nigrini, 1967, pl. 1, figs. 3a, b. ×233. a. Focused on perimeter. b. Focused on surface.

4a, b *Polysolenia murrayana* (Haeckel). RIS 36G (9°07′S, 81° 32′W), A-G27/2, USNM No. 650022. Nigrini, 1968, pl. 1, figs. 1a, b. ×233. a. Focused on surface. b. Focused on perimeter.

5 *Polysolenia spinosa* (Haeckel). MSN 34G (11°38′S, 109′ 33′E), A-W26/4; Sedgwick Museum (Cambridge) No. 843.5. Nigrini, 1967, pl. 1, fig. 1. ×233.

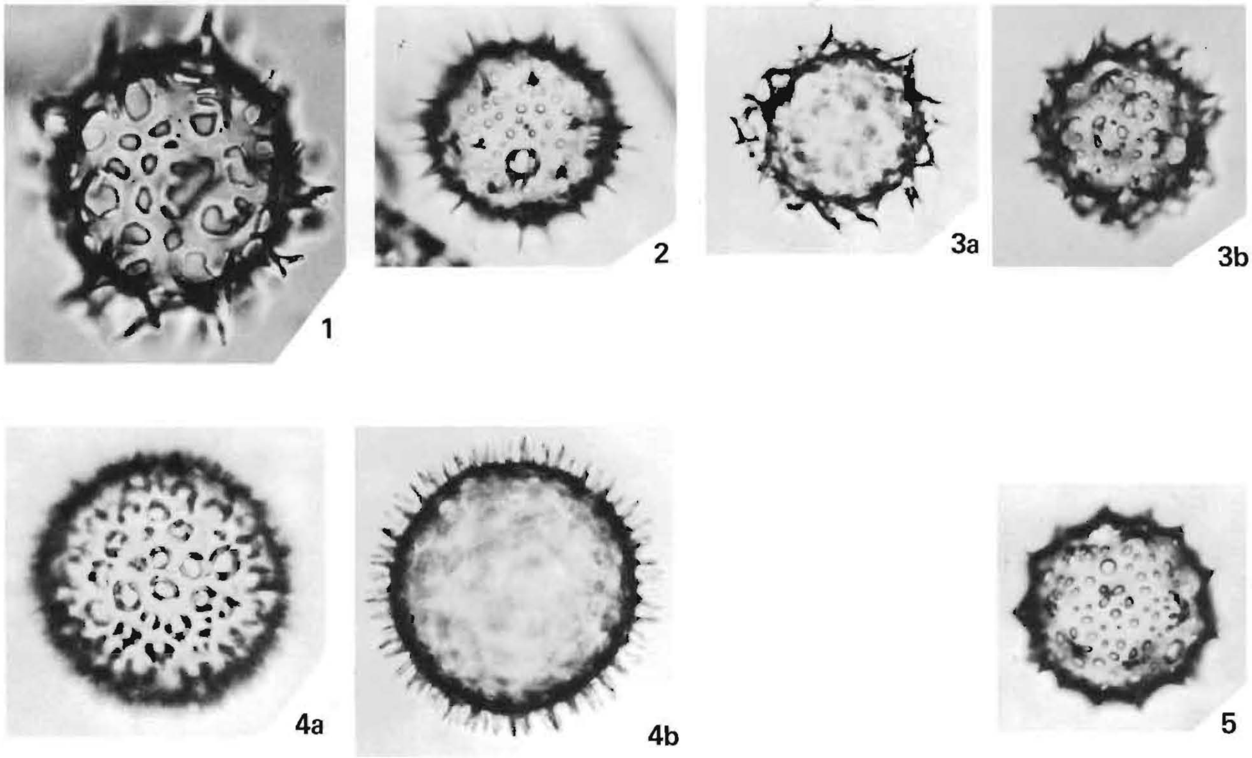

1
2
3a
3b
4a
4b
5

PLATE 3

→

1a, b *Actinomma antarcticum* (Haeckel). LSDA 128G (44°38′S, 70°58′E), D-Q36/0; Sedgwick Museum (Cambridge) No. 859.2. Nigrini, 1967, pl. 2, figs. ×150. a. Focused on surface, no medullary shell or meshwork. b. Focused to show presence of medullary shell and meshwork.

2a, b *Actinomma antarcticum* (Haeckel). Medullary shell of broken specimen, photographed in wet preparation. Nigrini, 1967, pl. 2, figs. 1c, d. ×108.

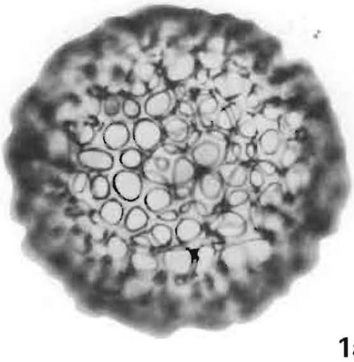
3 *Actinomma antarcticum* (Haeckel). Antarctic sediments; portion of cortical shell broken away to reveal inner meshwork. Hays, 1965, pl. 1, fig. 1, (*Spongoplegma antarcticum*). ×225.

4 *Actinomma arcadophorum* Haeckel. MSN39G (12°22′S, 101°25′E), B-Y40/4/ Sedgwick Museum (Cambridge) No. 847.7. Nigrini, 1967, pl. 2, fig. 3. ×233.

5 *Actinomma medianum* Nigrini. LSDA 124G (32°44′S, 62° 24′E), A-P25/0, Sedgwick Museum (Cambridge) No. 856.5 (holotype). Nigrini, 1967, pl. 2, fig. 2a. ×233.

6 *Actimomma medianum* Nigrini. Medullary shell and meshwork of broken specimen. Nigrini, 1967, pl. 1, fig. 2b. ×108.

7 *Actinomma leptodermum* (Jorgensen). VS-R-27b (22° 38.4′N, 108°51.5′W), 1–3 cm, J18/3. Benson, 1966, pl. 5, fig. 6, (*Actinomma* sp.). ×233.



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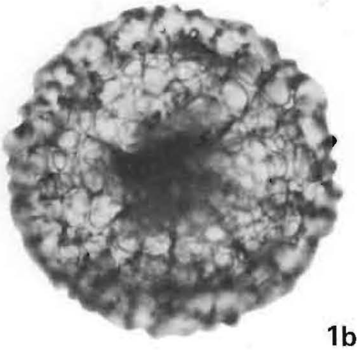
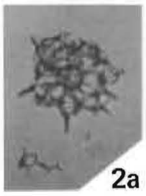


1b



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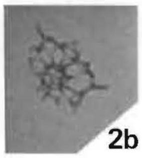

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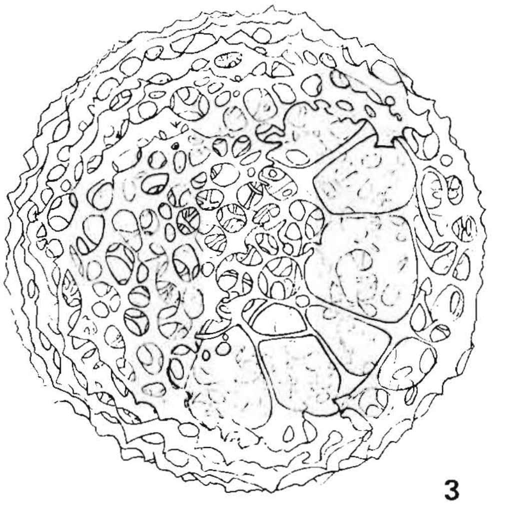

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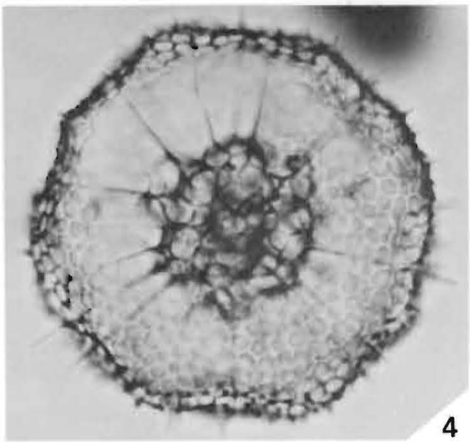

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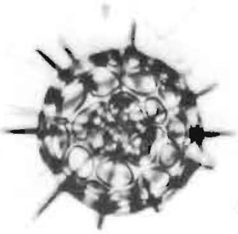

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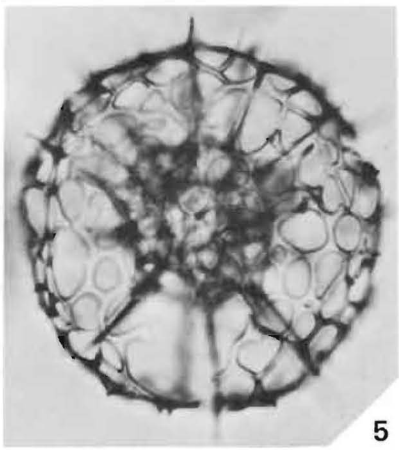

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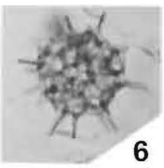


6

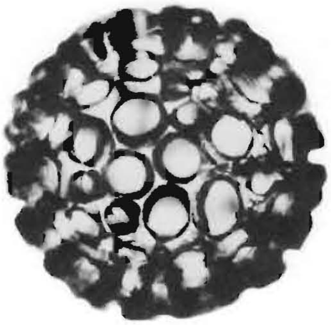
PLATE 4 →

1 *Cenosphaera coronata* Haeckel. RIS 127G (28°47′N, 123° 36′W). Moore, 1974, pl. 5, fig. 1. ×233.

2a, b *Cenosphaera cristata* Haeckel?. BANZARE Station 94 (64°28′S, 114°59′E). Riedel, 1958, pl. 1, figs. 1, 2. ×233.

3a–d *Cenosphaera* spp. a. V21-71TW (27°54′N, 162°31′E). b. RC12-417TW (38°06′N, 170°00′E). c. RC14-104TW (40° 19.3′N, 154°39.9′E). d. RC10-182TW (45°37′N, 177°52′E). Robertson, 1975, pl. 2, figs. 5–8. ×233.

4 *Anomalacantha dentata* (Mast). JYNII 10G (40°30′N, 169°48′E), A-W47/0, USNM No. 651207. Nigrini, 1970, pl. 1, fig. 9. ×210.



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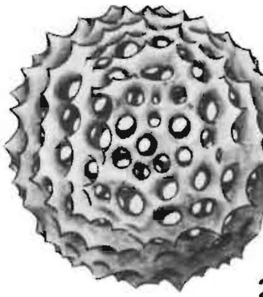

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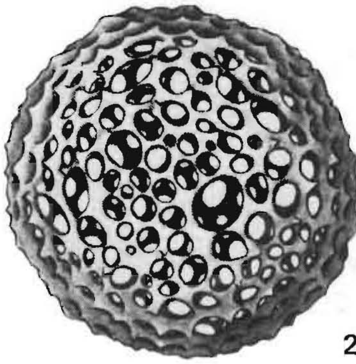

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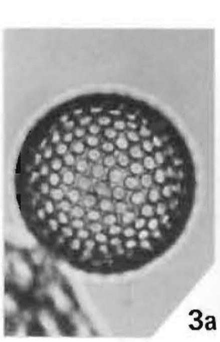

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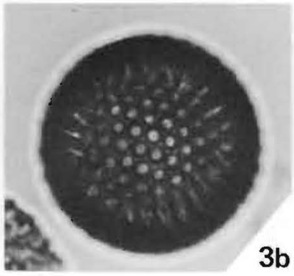

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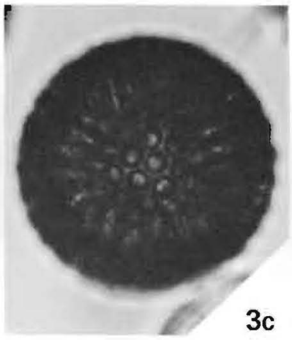

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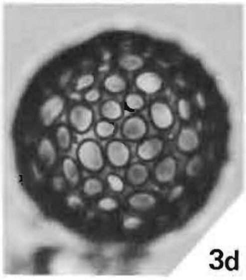

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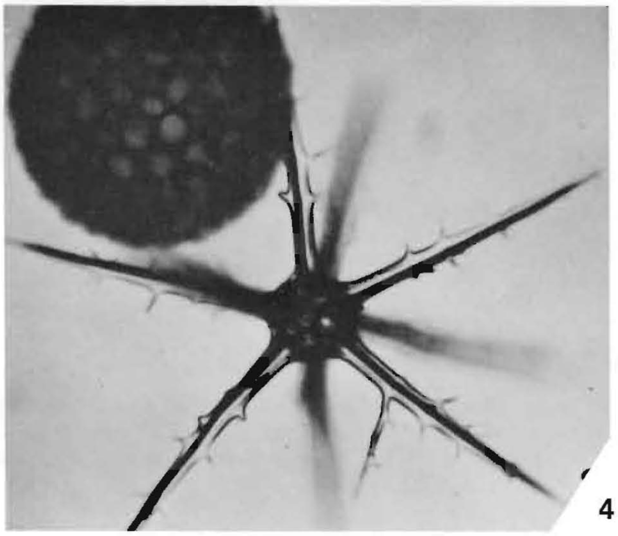


4

PLATE 5

→

1a, b *Hexacontium enthacanthum* Jorgensen. a. VS-R-81a (25° 19.0′N, 110°06.5′W), 1–3 cm, Q43/0. b. VS-R-81a (25° 19.0′N, 110°06.5′W), 1–3 cm, E18/0. Benson, 1966, pl. 4, figs. 1, 2. ×233.

2a, b *Hexacontium laevigatum* Haeckel. a. VS-R-60b (24°20.5′ N, 108°58.0′W), 3–5 cm, S14/3. b. VS-R-71b (24°42.5′N, 109°48.7′W), 1–3 cm, W31/2. Benson, 1966, pl. 4, figs. 4, 5. ×233.

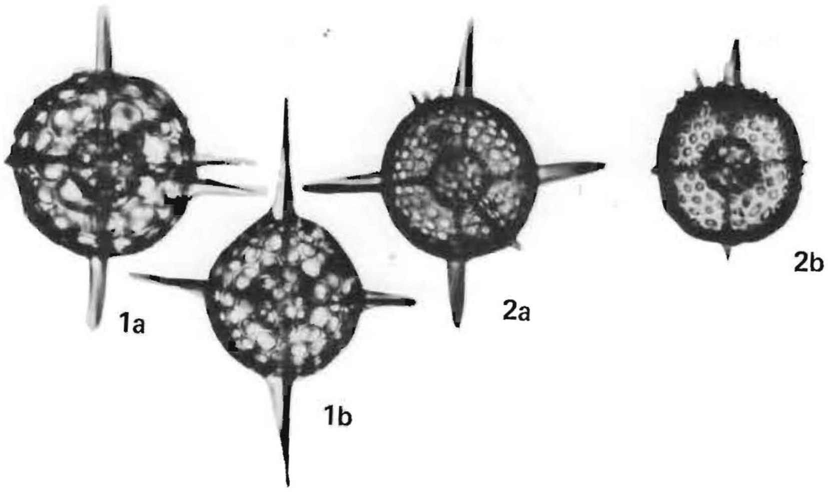


PLATE 6

→

1a–d *Ommatartus tetrathalamus tetrathalamus* (Haeckel). a. MSN 39G (12°22′S, 101°25′E), B-W27/3, Sedgwick Museum (Cambridge) No. 847.6, without polar caps. b. LSDA 124G (32°44′S, 62°24′E), A-K34/4, Sedgwick Museum (Cambridge) No. 856.4, with single polar cap bearing prominent spines. c. MSN 39G (12°22′S, 101°25′E), B-Z39/2, Sedgwick Museum (Cambridge) No. 847.8, with single polar caps. d. VEMA 19-168 (12°44′S, 82°01′E), A-C43/3, Sedgwick Museum (Cambridge) No. 864.1, with single polar caps and lateral meshwork. Nigrini, 1967, pl. 2, figs. 4a–d. ×233.

2a, b *Ommatartus tetrathalamus coronatus* (Haeckel). a. JYN II 19G (37°46′N, 149°49′E), AOY 25/2, USNM No. 651211. b. ZETES III, 3G (33°19′N, 158°02′E), A-N20/0, USNM No. 651212. Nigrini, 1970, pl. 1, figs. 13, 14. ×233.

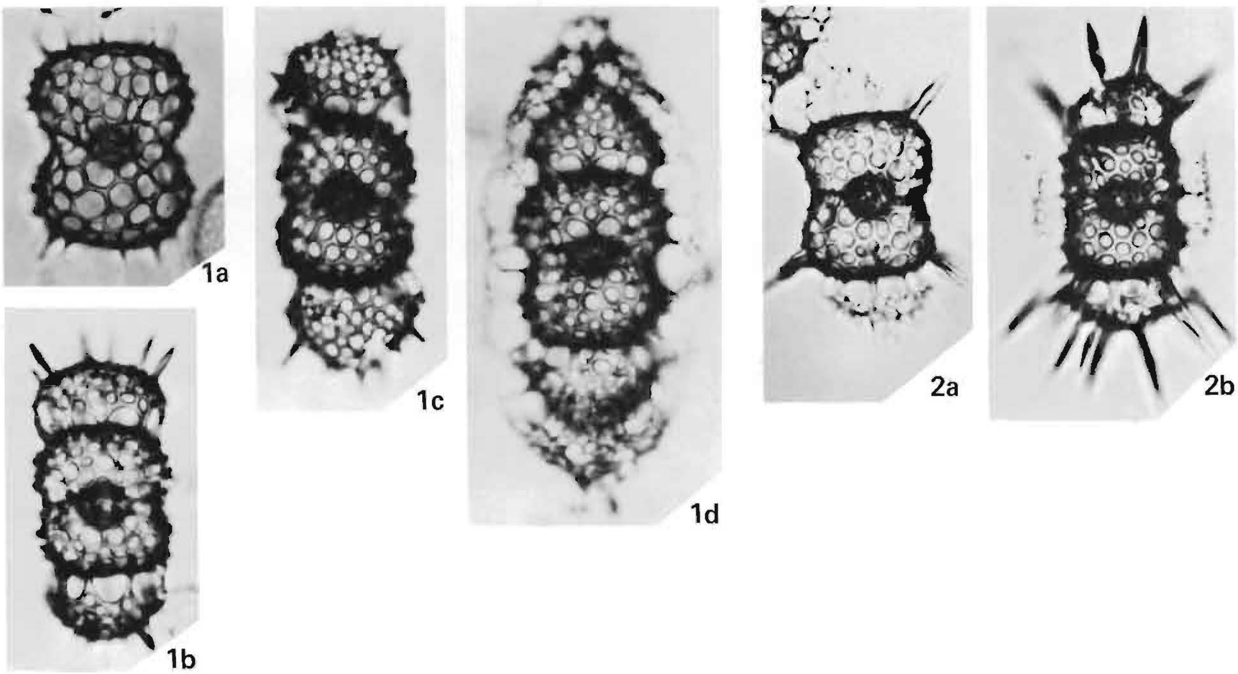

1a
1b
1c
1d
2a
2b

PLATE 7

→

1a, b *Stylatractus* spp. 6604-10P (43°16′N, 126°24′W). Moore, 1974, pl. 9, figs. 5, 6. ×233.

2 *Axoprunum stauraxonium* Haeckel. Antarctic sediments. Hays, 1965, pl. 1, fig. 3. ×225.

3 *Axoprunum stauraxonium* Haeckel. V24-52P (1°49′N, 127° 00′W). Moore, 1974, pl. 9, fig. 4. ×233.

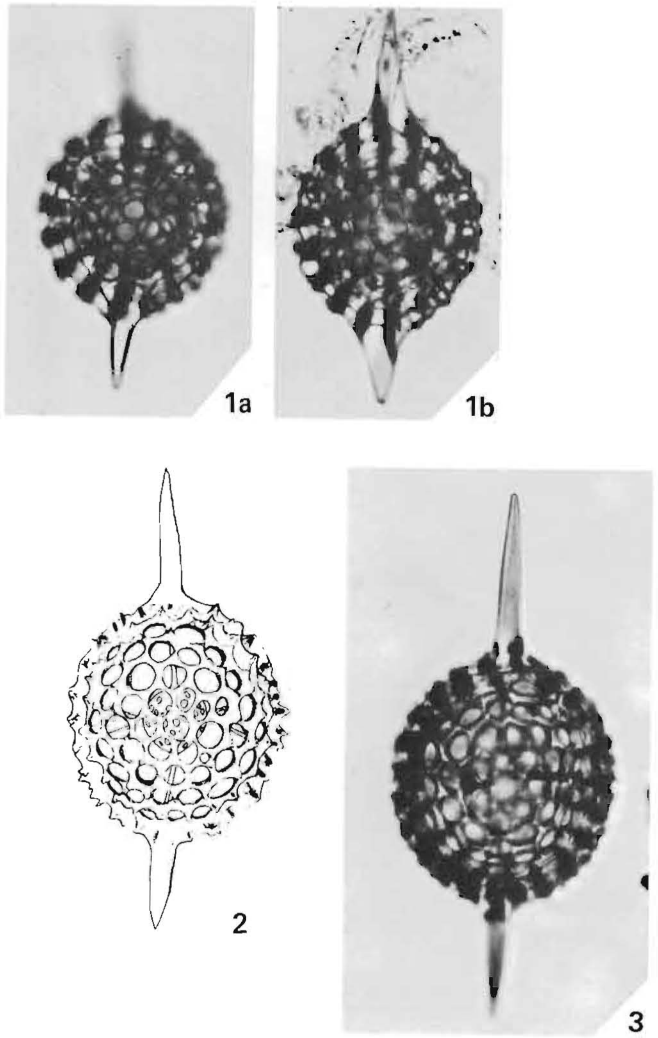

1a
1b
2
3

PLATE 8

→

1 *Ommatogramma dumitricai* Petrushevskaya. DSDP Leg 29, 278-28-3 (56°33.42′S, 160°04.29′E). Petrushevskaya, 1974, pl. 7, fig. 3. ×170.

2 *Spongurus* cf. *elliptica* (Ehrenberg). VS-R-27b (22°38.4′N, 108°51.5′W), 1–3 cm, T52/2. Benson, 1966, pl. 8, fig. 4. ×233.

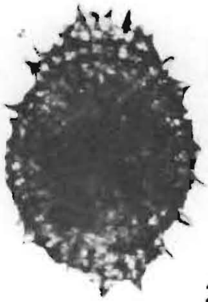
3a, b *Spongurus pylomaticus* Reidel. BANZARE Station 94 (64°28′S, 114°59′E). a. Holotype. b. Paratype. Riedel, 1958, pl. 1, figs. 10, 11. ×233.

4 *Spongurus* (?) sp. Deep water Antarctic sediments (station 16). Petrushevskaya, 1967, fig. 26-I. ×195.

5a–c *Spongocore puella* Haeckel. VS-R-71a (24°42.5′N, 109° 48.7′W), 1–3 cm. a. V 23/4, mantle lacking. b. Q12/0, mantle rudimentary. c. N26/4, mantle complete. Benson, 1966, pl. 8, figs. 1–3. ×233.

6a, b *Styptosphaera* (?) *spumacea* Haeckel. 5a. CAS 2 (45°02′N, 127°13′W), A-M 25/0, USNM No. 651205; 5b. CK3 39°56′N, 158°38′W), A-Y 12/2, USNM No. 651206. Nigrini, 1970, pl. 1, figs. 7, 8. ×233.


1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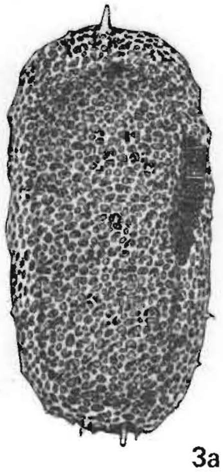
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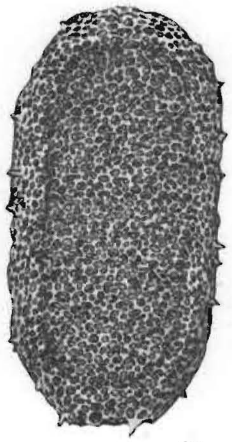
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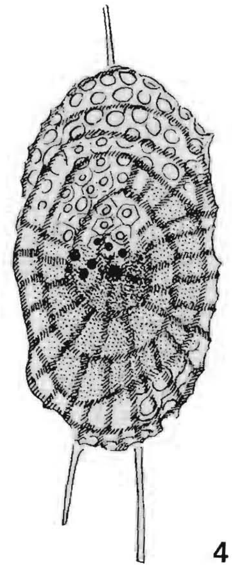
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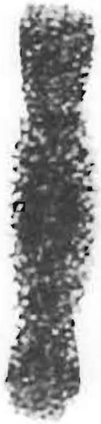
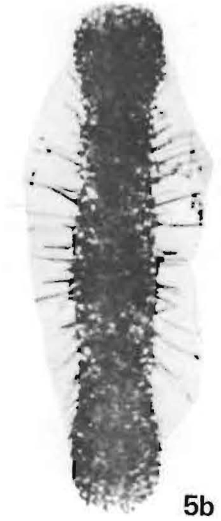

5a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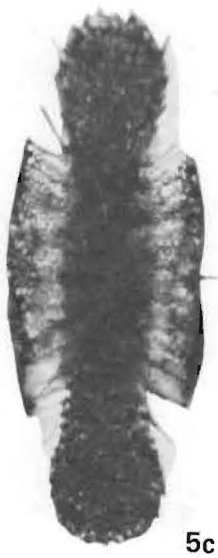
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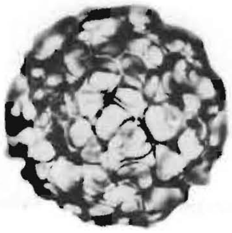
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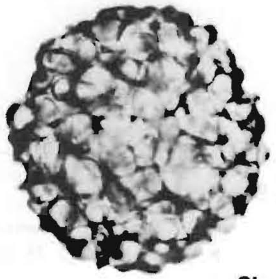
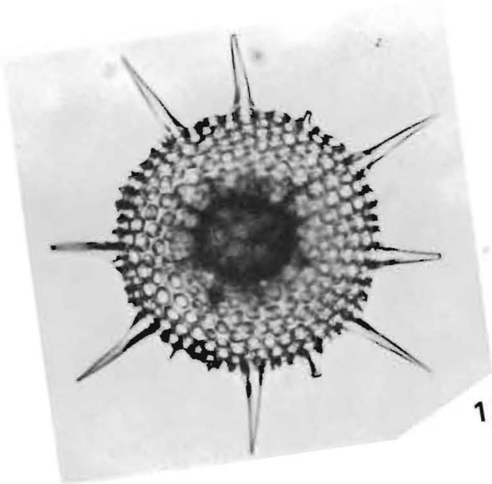

6b

PLATE 9

→

1 *Heliodiscus asteriscus* Haeckel. Discovery 5194 (2°34′S, 44°53′E), A-H 24/4, Sedgwick Museum (Cambridge) No. 860.1. Nigrini, 1967, pl. 3, fig. 1a. ×150.

2 *Heliodiscus asteriscus* Haeckel. Antarctic sediments. Hays, 1965, pl. II, fig. 7. ×255.



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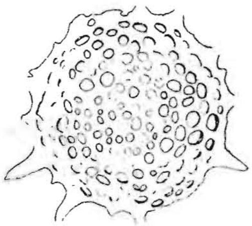


2

PLATE 10 →

1a–e *Amphirhopalum ypsilon* Haeckel. a. Discovery 5194 (2°34′S, 44°53′E), C-X 34/0, Sedgwick Museum (Cambridge) No. 862.4, with patagium. b. MSN 34G (11°38′S, 109°33′E), B-Q 43/0, Sedgwick Museum (Cambridge) No. 844.3, without patagium; Nigrini, 1967, pl. 3, figs. 3a, b; ×233. c. AMPH 9P (7°31′S, 121°56′W), 8–10 cm, L54/2, USNM No. 650938, showing 5 chambers on the forked arm before bifurcation. d. SDSE 62 (3°00′S, 136°26′W), 1028–30 cm, M22/1, USNM No. 650939, showing 2 chambers on the forked arm before bifurcation. e. SDSE (3°00′S, 136°26′W), 788–90 cm, A-H 53/3, USNM No. 650940, showing 1 chamber on the forked arm before bifurcation. Nigrini, 1971, pl. 34.1, figs. 7a–c. ×233.

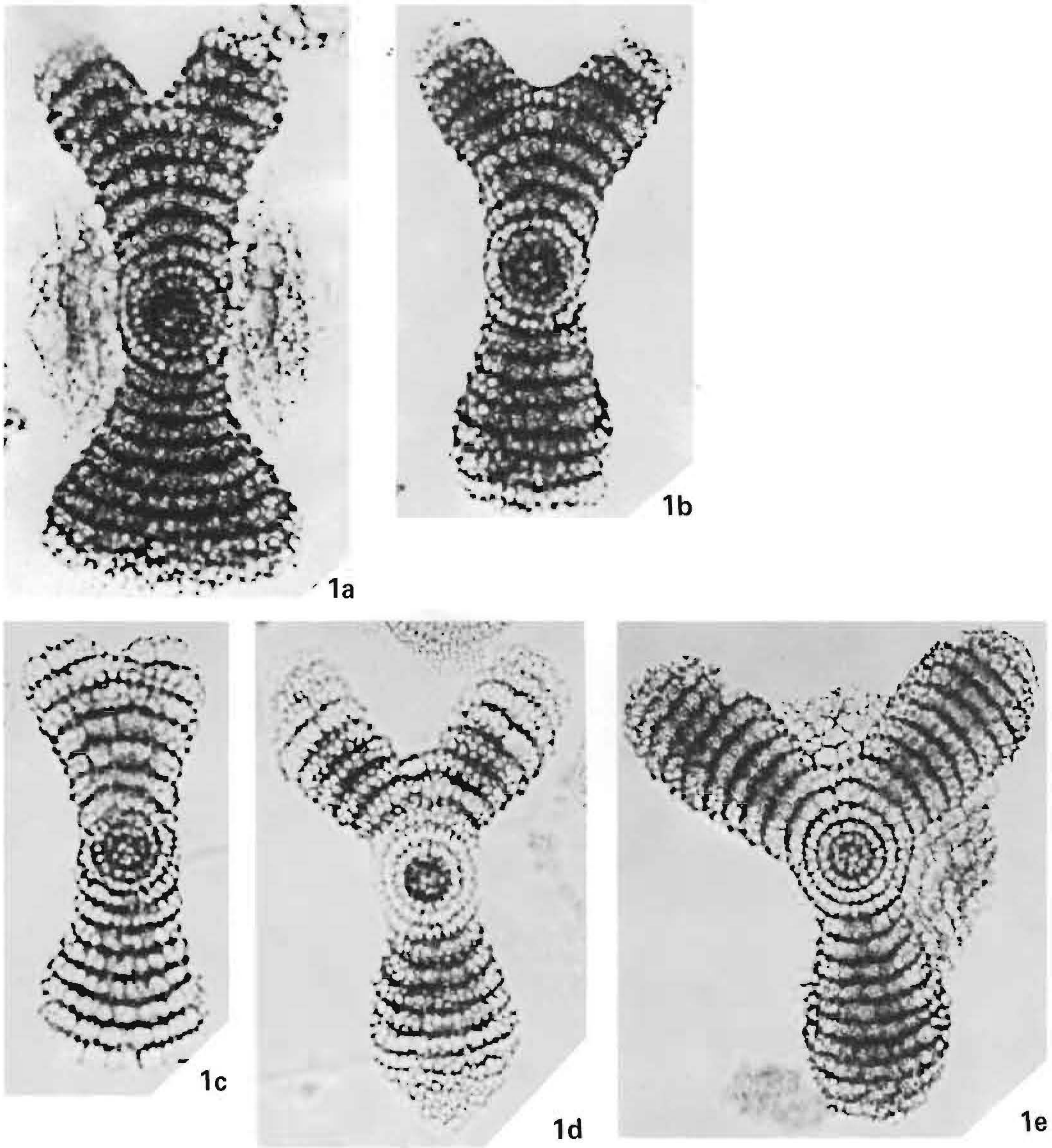

1a
1b
1c
1d
1e

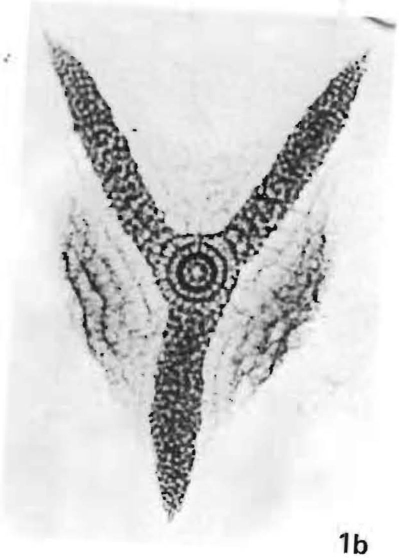
PLATE 11

→

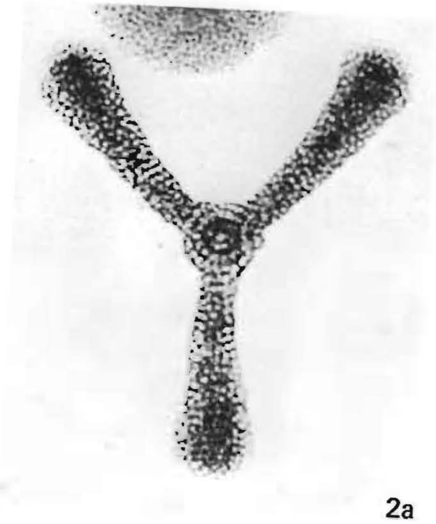
1a, b *Euchitonia elegans* (Ehrenberg). a. Discovery 5194 (2° 34′S, 44°53′E), D-K38/0, Sedgwick Museum (Cambridge) No. 863.5, without patagium. b. Discovery 5194 (2°34′S, 44°53′E), D-J 33/0, Sedgwick Museum (Cambridge) No. 863.2, with patagium. Nigrini, 1967, pl. 4, figs. 2a, b. ×150.

2a, b *Euchitonia furcata* Ehrenberg. a. MSN34G (11°38′S, 109° 33′E), B-V35/1, Sedgwick Museum (Cambridge) No. 844.7, without patagium. b. MSN39G (12°22′S, 101°25′E), B-N41/2, Sedgwick Museum No. 847.2, with patagium. Nigrini, 1967, pl. 4, figs. 1a, b. ×150.

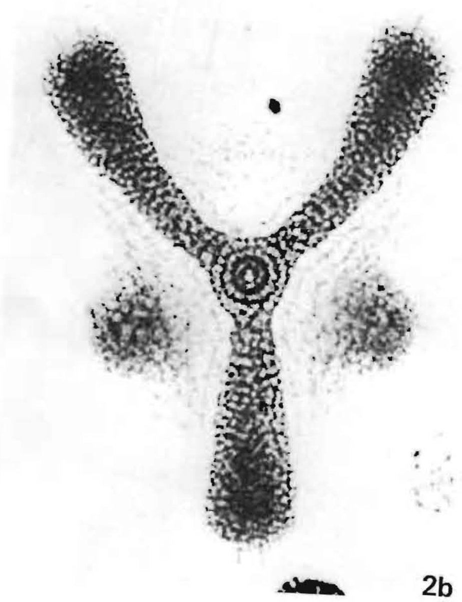
1a



1b



2a



2b

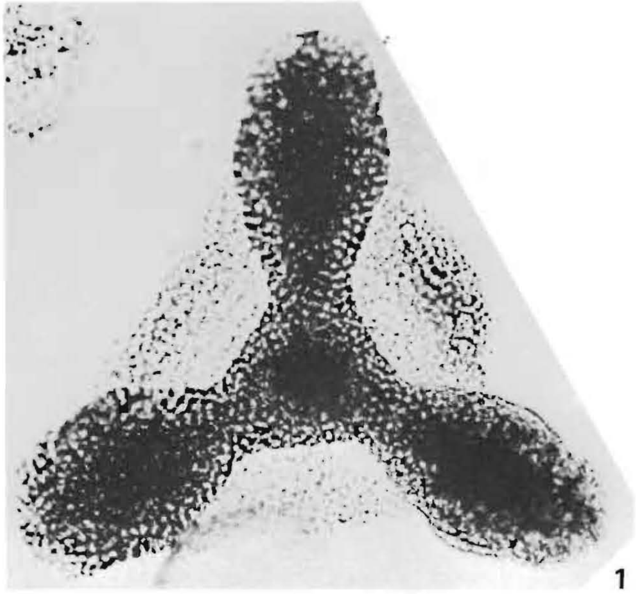
PLATE 12

→

1 *Dictyocoryne profunda* Ehrenberg. RC11-209P (3°39′N, 140°04′W). Moore, 1974, pl. 7, fig. 5. ×233.

2a, b *Dictyocoryne truncatum* (Ehrenberg). a. RC11-209P (3° 39′N, 140°04′W); Moore, 1973, pl. 7, fig. 4; ×233. b. RC11-209P (3°39′N, 140°04′W); Moore, 1974, pl. 6, fig. 8 (*Euchitonia triangulum*). ×233.

3 *Hymeniastrum euclidis* Haeckel. VS-R-46b (23°39.0′N, 108°37.8′), 1–3 cm, U54/0; Benson, 1966, pl. 12, fig. 2. ×233.



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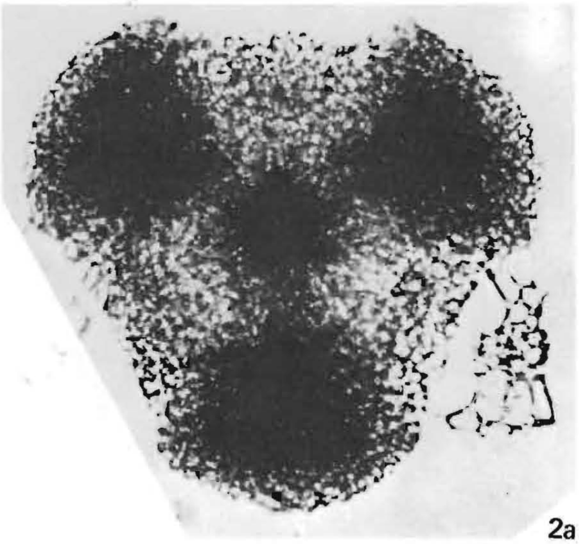
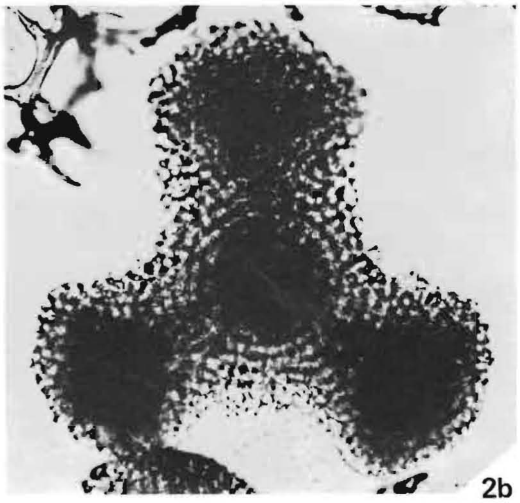


2a



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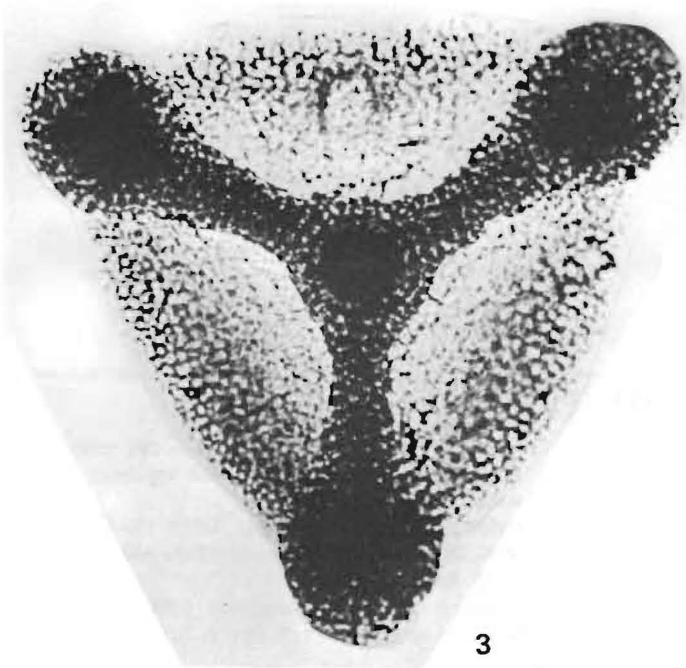


3

PLATE 13

→

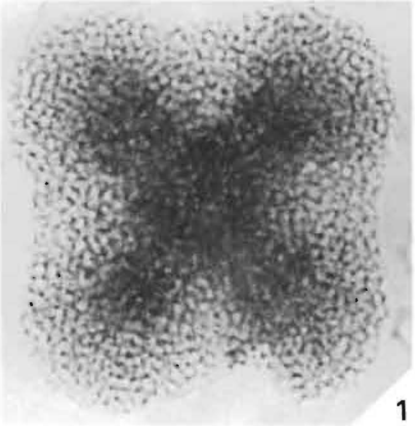
1 *Spongaster tetras tetras* Ehrenberg. MSN34G (11°38′S, 109°33′E), A-T43/4, Sedgwick Museum (Cambridge No. 843.4. Nigrini, 1967, pl. 5, fig. 1a. ×233.

2 *Spongaster tetras* Ehrenberg *irregularis* Nigrini. LSDA 124G (32°44′S, 62°24′E), A-K31/0, Sedgwick Museum (Cambridge) No. 856.2 (holotype). Nigrini, 1967, pl. 5, fig. 2. ×233.

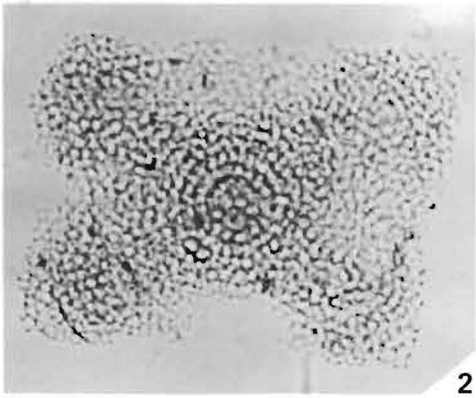
3 *Styloditya aculeata* Jorgensen. Antarctic sediments (stn. 33) south of 60°S; well-preserved specimen. Petrushevskaya, 1967, fig. 17, I. ×380.

4 *Stylodictya aculeata* Jorgensen. DSDP 139-1-2 (23°31.14′N, 18°42.26′W), 5–7 cm. Petrushevskaya and Kozlova, 1972, pl. 18, fig. 6. ×200.

5a, b *Stylodictya validispina* Jorgensen. 6604-10P (43°16′N, 126° 24′W). Moore, 1974, pl. 9, figs. 1, 2. ×233.



1



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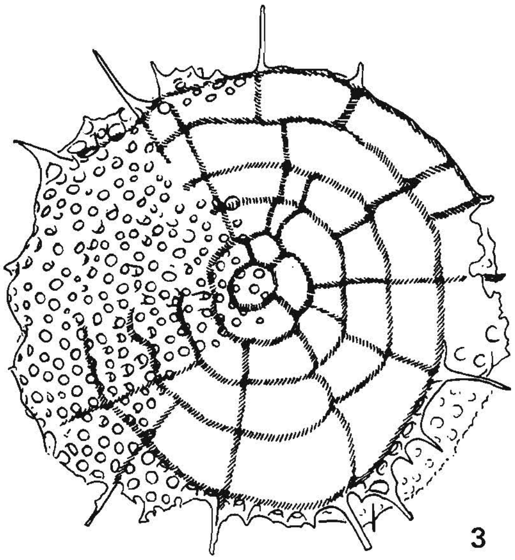

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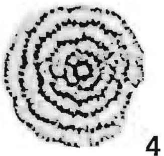

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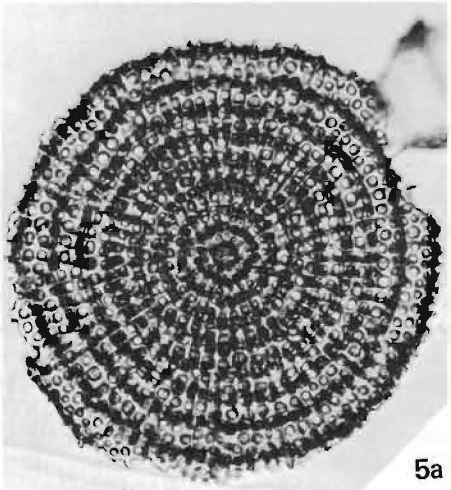
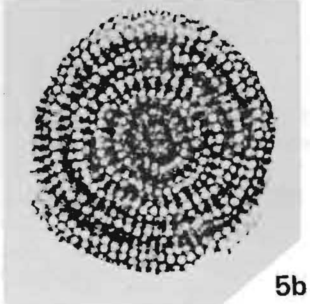


5a



5b

PLATE 14

→

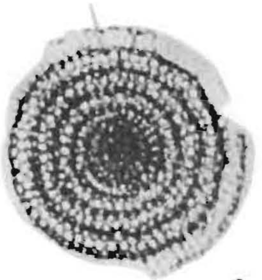
1 *Porodiscus* sp. A. VS-R-27b (22°38.4′N, 108°51.5′W), 1–3 cm, C46/4. Benson, 1966, pl. 10, fig. 3 (*Ommatodiscus* sp.). ×233.

2a, b *Porodiscus* sp. A. Y70-2-34P (54°0.6′N, 154°47.2′W). Moore, 1974, pl. 8, figs. 4, 5 (*Ommatodiscus* sp. A). ×233.

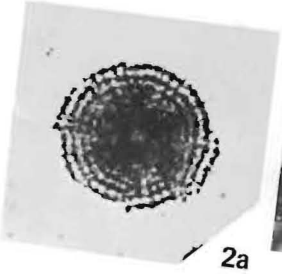
3 *Porodiscus* (?) sp. B. VS-R-71a (24°42.5′N, 109°48.7′W), 1–3 cm, X24/1. Benson, 1966, pl. 10, fig. 4 (*Ommatodiscus* sp.). ×233.

4 *Porodiscus* (?) sp. B. 6604-10P (43°16′N, 126°24′W). Moore, 1974, pl. 9, fig. 3 (*Ommatodiscus* sp. B). ×233.

5 *Stylochlamydium asteriscus* Haeckel. RC 9-79P (19°32.9′S, 80°19.8′W). Moore, 1974, pl. 6, fig. 3. ×233.



1



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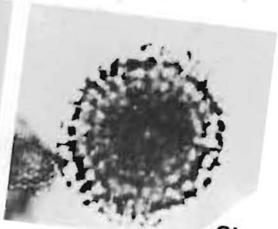

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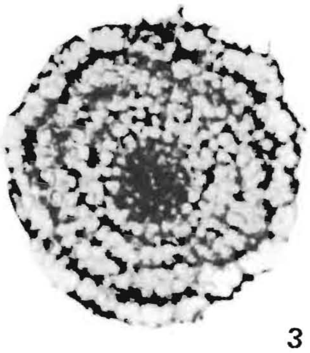

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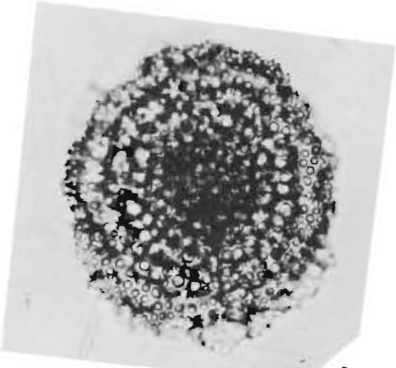

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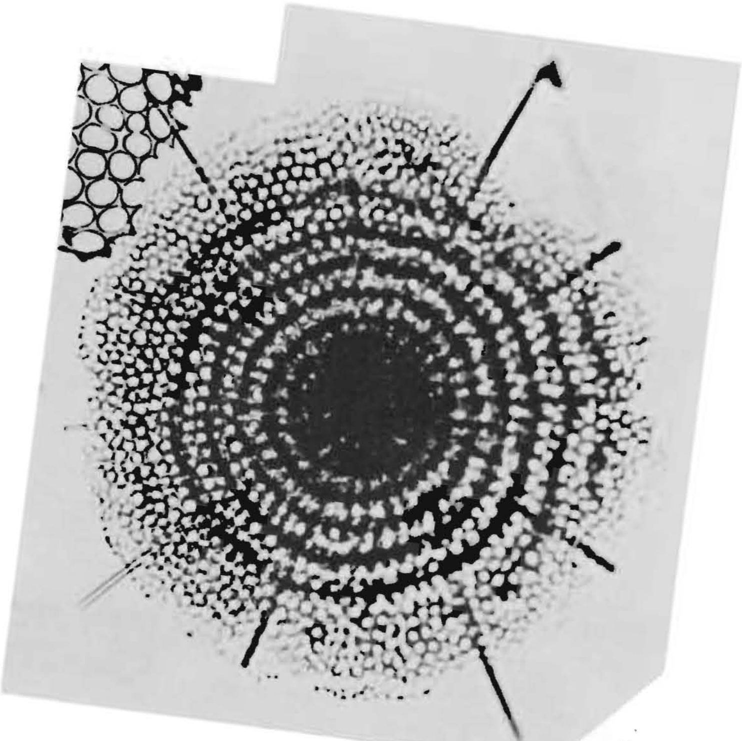


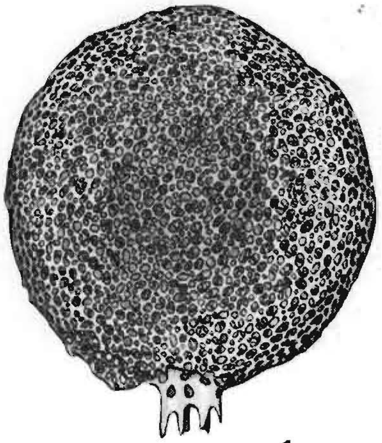
5

PLATE 15 →

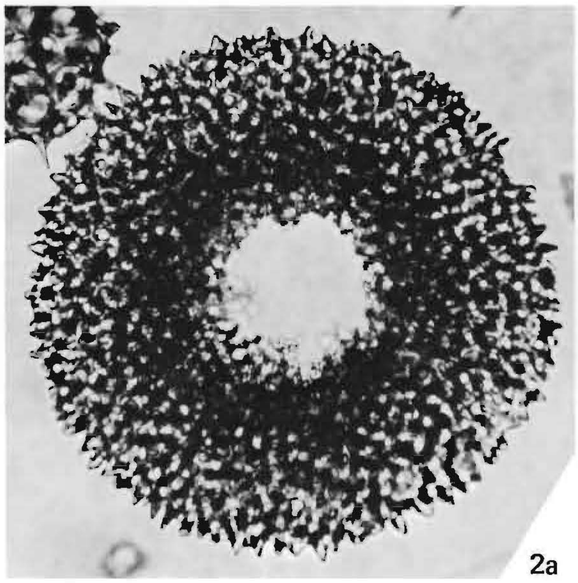
1 *Spongopyle osculosa* Dreyer. BANZARE Station 94 (64°28′S, 114°59′E). Riedel, 1958, pl. 1, fig. 12. ×233.

2a–d *Spongotrochus glacialis* Popofsky group. a. V 29-88 (47°51′S, 26°47′E). b. V29-87 (49°10′S, 27°23′E). c. V16-65 (45°00′S, 45°46′E). d. V29-84 (43°51′S, 27°36′E), corroded specimen. ×100.

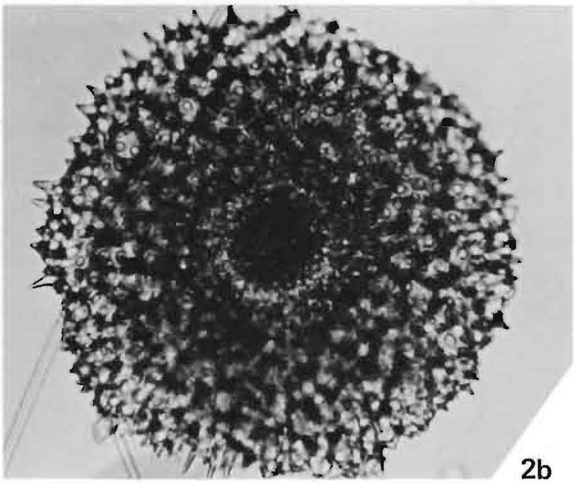
3a, b *Spongotrochus* (?) *venustum* (Bailey). Y71-10-116PG (28° 27′N, 116°56′W). ×233.



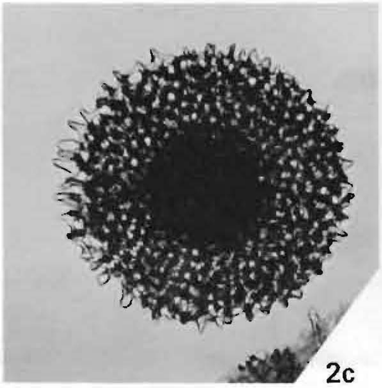
1



2a



2b



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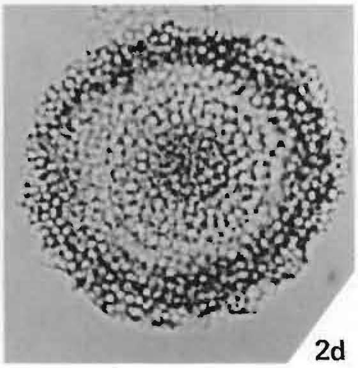
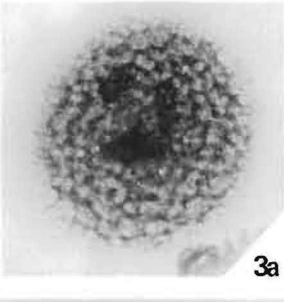
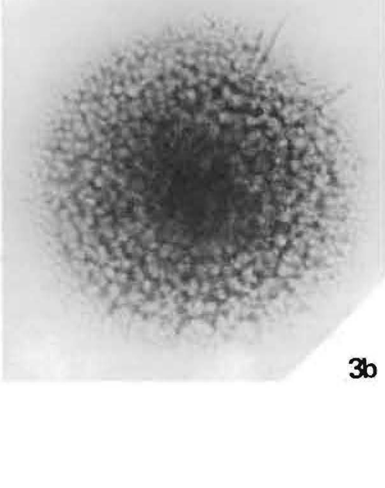


2d



3a



3b

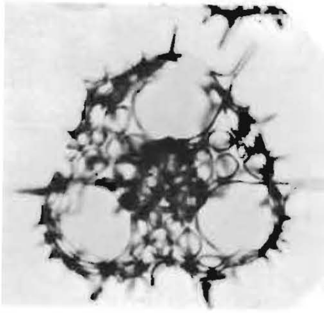
PLATE 16 →

1a–c *Hexapyle* spp. a. VS-R-27b (28°38.4′N, 108°51.5′W), 1–3 cm, Y17/0. b. VS-R-81a (25°19.0′N, 110°06.5′W), 1–3 cm, X51/2. c. VS-R-92a (25°51.0′N, 110°40.6′W), 1–3 cm, H17/1. Benson, 1966, pl. 18, figs. 14–16 (*Hexapyle dodecantha*). ×233.

2a, b *Octopyle stenozona* Haeckel. a. VS-R-27b (22°38.4′N, 108° 51.5′W), 1–3 cm, E33/4, frontal view. b. VS-R-71a (24° 42.5′N, 109°48.7′W), 1–3 cm, G19/4, frontal view. Benson, 1966, pl. 16, figs. 3, 4. ×233.

3a, b *Tetrapyle octacantha* Muller. a. VS-R-71A (24°42.5′N, 109°48.7′W), 1–3 cm, X20/0, frontal view. b. VS-R-71A (24°42.5′N, 109°48.7′W), 1–3 cm, D4/2, frontal view, eight diagonal spines. Benson, 1966, pl. 15, figs. 3, 8. ×233. See Benson, 1966, for additional illustrations.

4 ? *Prunopyle antarctica* Dreyer. 6604-10P (43°16′N, 126° 24′W). Moore, 1974, pl. 2, fig. 4 (*Cromyechinus antarctica*). ×233.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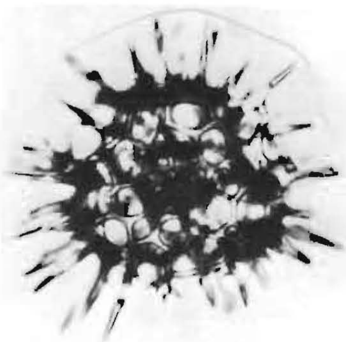
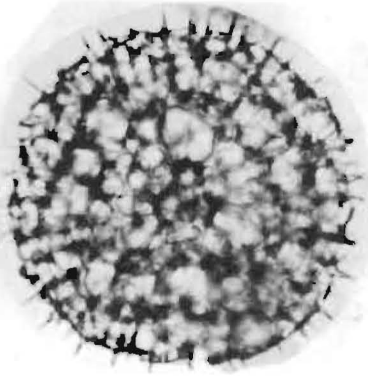

1b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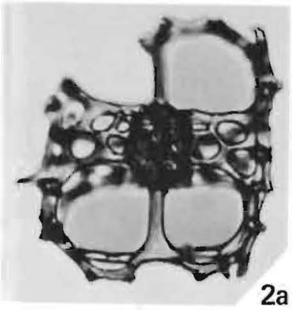
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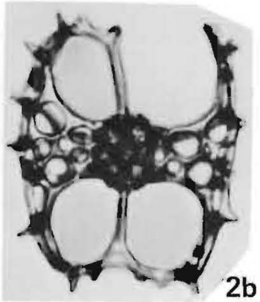
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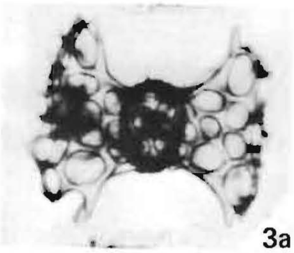
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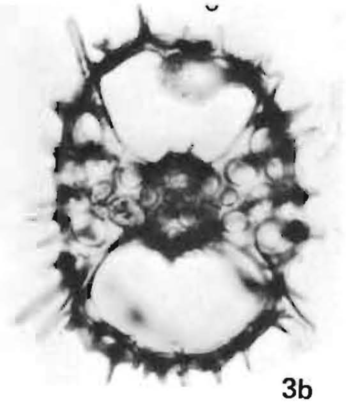

3b

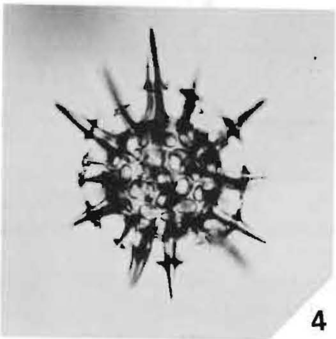

4

PLATE 17

→

1a, b *Larcopyle butschlii* Dreyer. A. V18-314P (1°14′S, 122°55′W). b. RIS 127G (28°47′N, 123°36′W). Moore, 1974, pl. 6, figs. 1, 2. ×233.

2 *Larcospira quadrangula* Haeckel. CAS2 (45°02′N, 127° 13′W), A-Y44/0, USNM No. 651221. Nigrini, 1970, pl. 2, fig. 9. ×233.

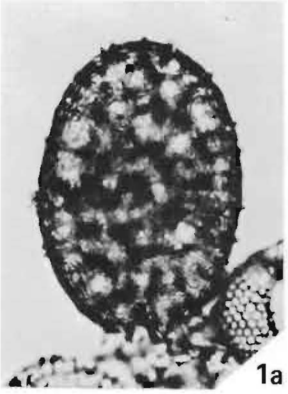
3 *Lithelius minor* Jorgensen. VS-R-71a (24°42.5′N, 109°48.7′ W), 1–3 cm, L42/3. Benson, 1966, pl. 17, fig. 10. ×233.

4a, b *Lithelius minor* Jorgensen. 6604-10P (43°16′N, 126°24′W). Moore, 1974, pl. 5, figs. 3, 4. ×233.

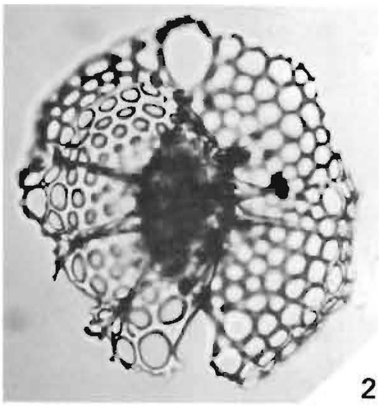
5 *Lithelius nautiloides* Popofsky. BANZARE Station 94, (64°28′S, 114°59′E). Riedel, 1958, pl. 2, fig. 3. ×233.

6a–c *Pylospira octopyle* Haeckel (?). 6604-10P (43°16′N, 126° 24′W). Moore, 1974, pl. 5, figs. 8–10. ×233.

7 *Spirema melonia* Haeckel (?). 6604-10P (43°16′N, 126° 24′W). Moore, 1974, pl. 5, fig. 11. ×233.


1a


1b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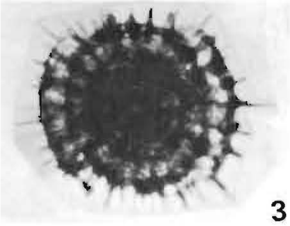
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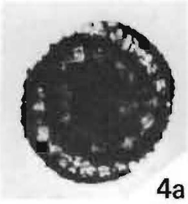
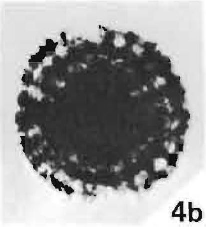
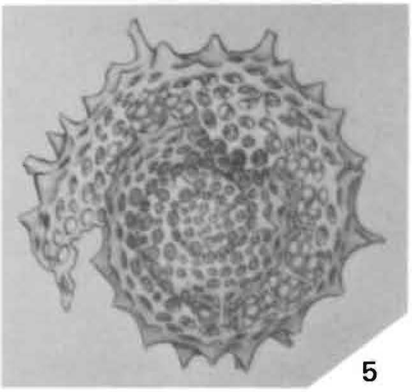

4a


4b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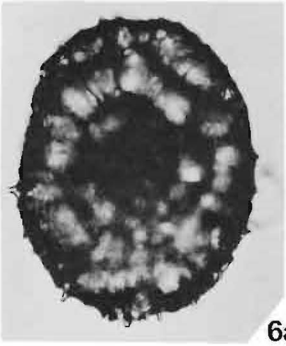
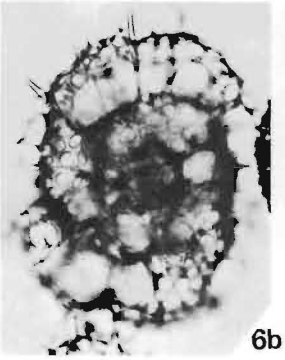
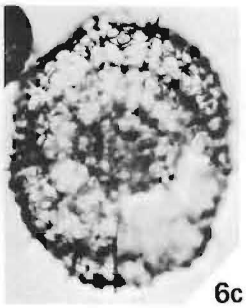

6a


6b


6c

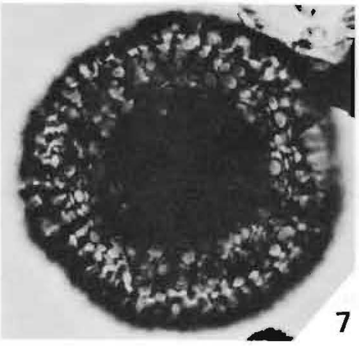
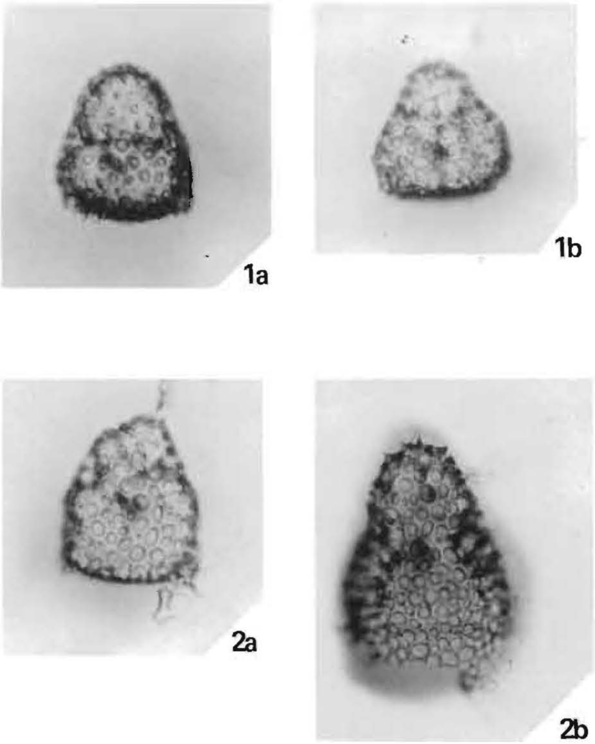

7

PLATE 18 →

1a, b *Antarctissa denticulata* (Ehrenberg). V16-129 (59°22′S, 142°53′W), 10–2 cm. ×233.

2a, b *Antarctissa strelkovi* Petrushevskaya. V16-129 (59°22′S, 142°53′W), 0–2 cm. ×233.



1a 1b 2a 2b

PLATE 19

→

1a–d *Ceratospyris borealis* (Bailey). a. CK 11 (44°39′N, 177° 39′W), A-J51/3, USNM No. 651224. b. CK 8 (53°01′N, 176°15′W), A-A16/3. USNM No. 651225. c. CK 8 (53° 01′N, 176°15′W), A-U43/2, USNM No. 651226. d. CK 11 (44°39′N, 177°39′W), A-P22/1, USNM No. 651227. Nigrini, 1970, pl. 3, figs. 3–6, (*Tristylospyris* sp.). ×233.

2a–d *Giraffospyris angulata* (Haeckel). Goll, 1969, pl. 59, figs. 4, 6, 7, 9. a. Front view. b. Back view. c. Left side. d. Basal view. ×233.

3a, b *Giraffospyris angulata* (Haeckel). DWBG 13 (1°01′N, 132°14′W), 2–4 cm. ×233.

4a–b *Liriospyris reticulata* (Ehrenberg). a. DISCOVERY 5194 (2°34′S, 44°53′E), D-H32/0, Sedgwick Museum (Cambridge) No. 863.1. b. MSN 34G (11°38′S, 109°33′E), B-B32/0, Sedgwick Museum (Cambridge) No. 844.1. Nigrini, 1967, pl. 5, fig. 3 (*Amphispyris reticulata*), pl. 5, fig. 4 (*Amphispyris costata*). ×233.

5 *Lophospyris pentagona pentagona* (Ehrenberg) *emend.* Goll. DISCOVERY 5194 (2°34′S, 44°53′E), C-D23/3; Sedgwick Museum (Cambridge) No. 862.1. Nigrini, 1967, pl. 5, fig. 6 (*Ceratospyris* sp.). ×233.

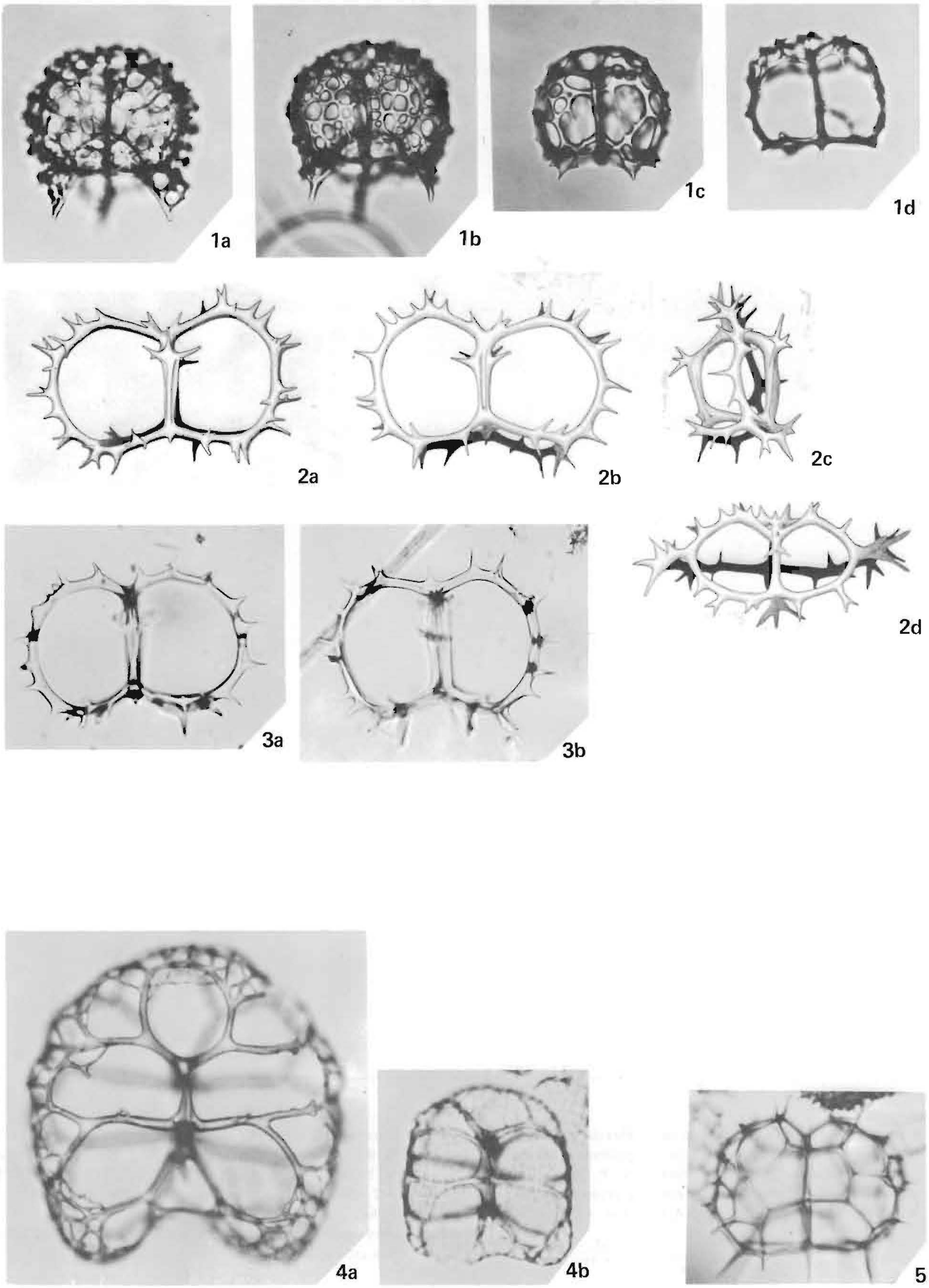

1a
1b
1c
1d
2a
2b
2c
2d
3a
3b
4a
4b
5

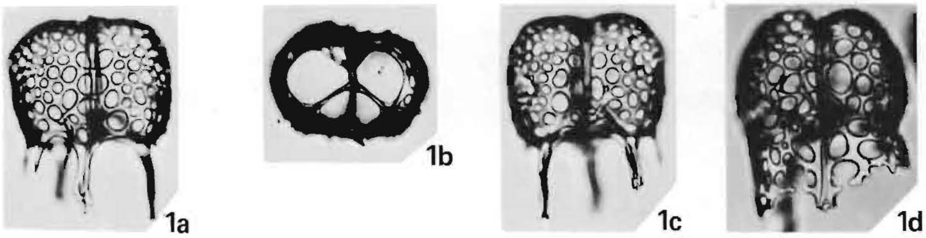
PLATE 20

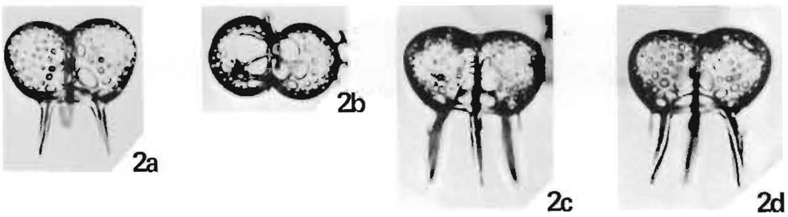
→

1a–d *Phormospyris stabilis* (Goll) *antarctica* (Haecker). V22-106 TW (46°08′S, 10°54′W), 0–2 cm. a–c. Specimen with delicate skeletal development: a. front view, b. basal view, c. back view. d. Specimen with massive skeletal development, front view. Goll, 1977, pl. 4, figs. 1–4. ×233.

2a–d *Phormospyris stabilis* (Goll) *scaphipes* (Haeckel). a, b. V19-259 TW (19°52′S, 11°02′E), 0–2 cm: a. front view, b. basal view. c, d. RC11-162 TW (33°12′N, 139°02′E), 0–2 cm: c. front view, d. back view. Goll, 1977, pl. 8, figs. 1, 2, 14, 15. ×233.

3a, b *Tholospyris procera* Goll. DWBG 13 (1°01′N, 132°14′W), 2–4 cm. ×233.


1a 1b 1c 1d


2a 2b 2c 2d

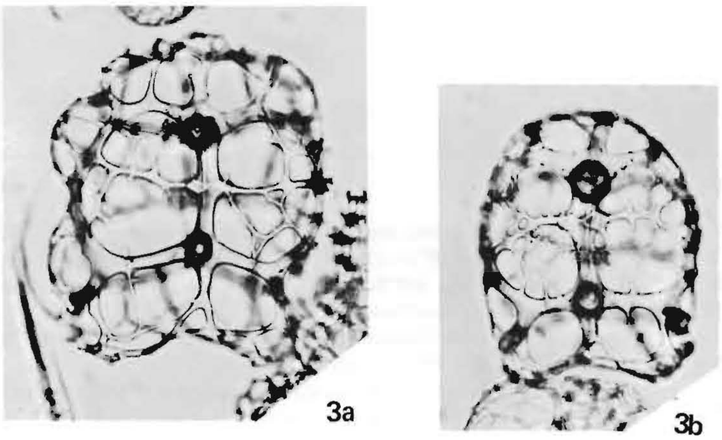

3a 3b

PLATE 21 →

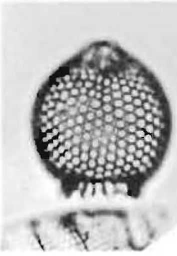
1a–c *Carpocanistrum* spp. a. MSN 155G (15°09′N, 137°06′W), A-X51/2, USNM No. 651236. b. MUK B31G (52°32′N, 141°44′W), A-R31/3, USNM No. 651237. c. JYN II 19G (37°46′N, 149°49′E), B-C36/3, USNM 651238. Nigrini, 1970, pl. 4, figs. 4–6 (*Carpocanarium* spp.). ×233.

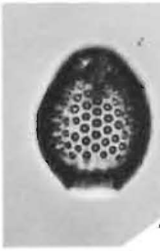
2 *Carpocanistrum* sp. A. RIS 11G (9°45′N, 117°37′W), 0–4 cm, B-R46/3, USNM No. 650028. Nigrini, 1968, pl. 1, fig. 4, (*Carpocanium* sp. A). ×233.

3 *Carpocanarium papillosum* (Ehrenberg) group. MSN 34G (11°38′S, 109°33′E), B-V44/2, Sedgwick Museum (Cambridge) No. 844.8. Nigrini, 1967, pl. 6, fig. 6 (*Dictyocryphalus papillosus*). ×233.

4a, b *Peripyramis circumtexta* Haeckel. BANZARE Station 94 (64°28′S, 114°59′E). Riedel, 1958, pl. 2, figs. 8, 9. ×233.

5 *Plectopyramis dodecomma* Haeckel. OSU 6604-10P (43° 16′N, 126°24′W). Moore, 1974, pl. 13, fig. 8. ×233.


1a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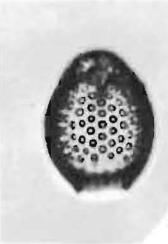
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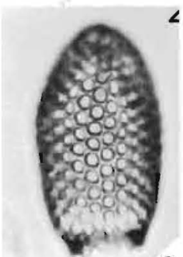
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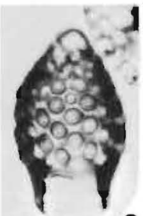
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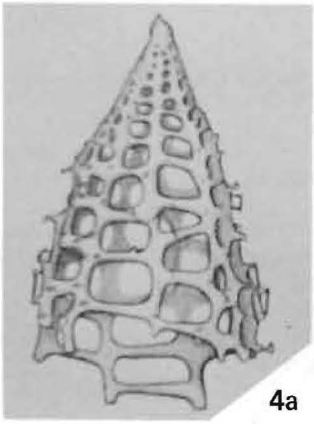
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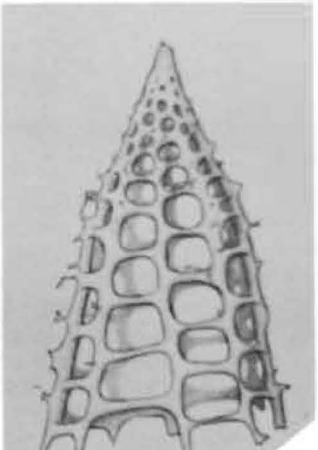
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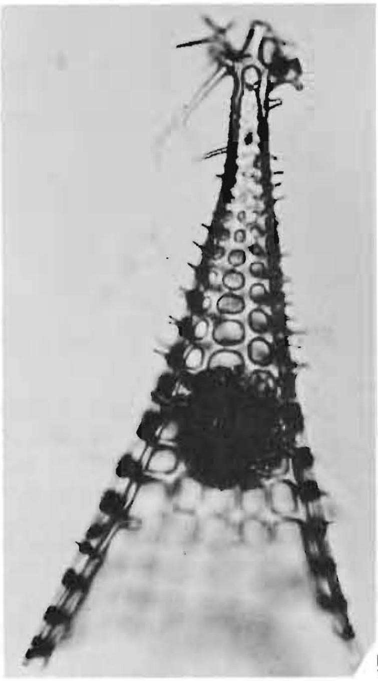
5

PLATE 22

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1a, b *Dictyophimus crisiae* Ehrenberg. a. MSN39G (12°22′S, 101°25′E), B-T45/1, Sedgwick Museum (Cambridge) No. 847.5. b. MSN39G (12°22′S, 101°25′E), B-Q44/3, Sedgwick Museum (Cambridge) No. 847.3. Nigrini, 1967, pl. 6, figs. 7a, b. ×233.

2 *Dictyophimus hirundo* (Haeckel) group. BANZARE Station 94 (64°28′S, 114°59′E). Riedel, 1958, pl. 3, fig. 11, pl. 4, fig. 1 (*Pterocorys hirundo*). ×233.

3a, b *Dictyophimus hirundo* (Haeckel) group. a. DSDP 139-1-1, (23°31.14′N, 18°42.26′W), 80–2 cm. b. DSDP 139-1-2 (23°31.14′N, 18°42.26′W), 5–7 cm. Petrushevskaya and Kozlova, 1972, pl. 27, figs. 16, 17 (*Dictyophimus* sp. aff. *D. hirundo*). ×200.

4 *Dictyophimus hirundo* (Haeckel) group. OSU 6604-10P (43°16′N, 126°24′W). Moore, 1974, pl. 14, fig. 8 (*Pterocorys* cf. *hirundo*). ×233.

5 *Dictyophimus infabricatus* Nigrini. RIS 36G (9°07′S, 81°32′W) 4–7 cm, B-E 41/0, USNM No. 650031 (holotype). Nigrini, 1968, pl. 1, fig. 6. ×233.

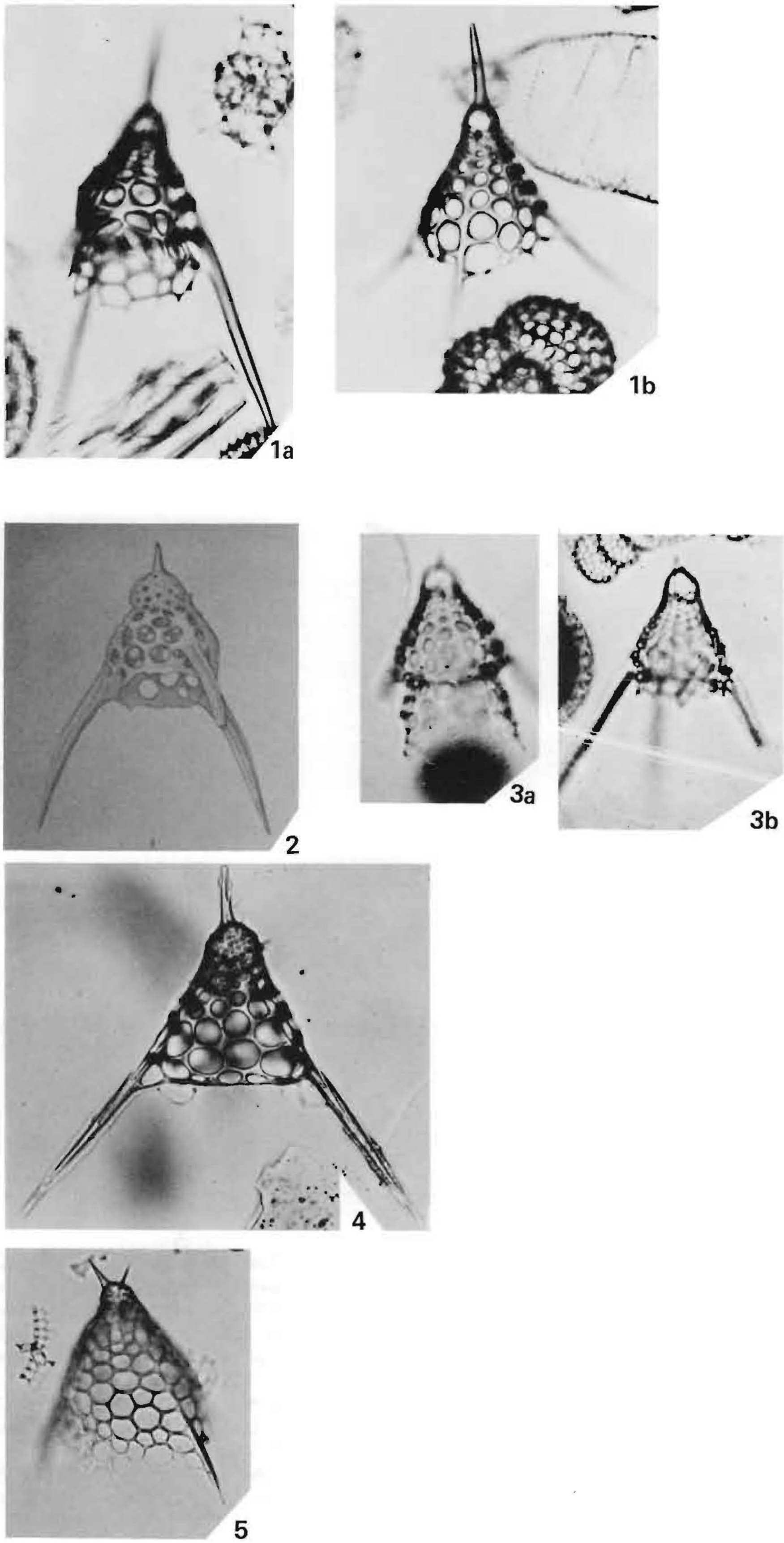

1a
1b
2
3a
3b
4
5

PLATE 23 →

1a, b *Pterocanium korotnevi* (Dogiel). a. CK8 (53°01′N, 176° 15′W), A-U32/1, USNM No. 651231. b. MUK B21G (52°32′N, 141°44′W), A-028/2, USNM No. 651232. Nigrini, 1970, pl. 3, figs. 10, 11. ×233.

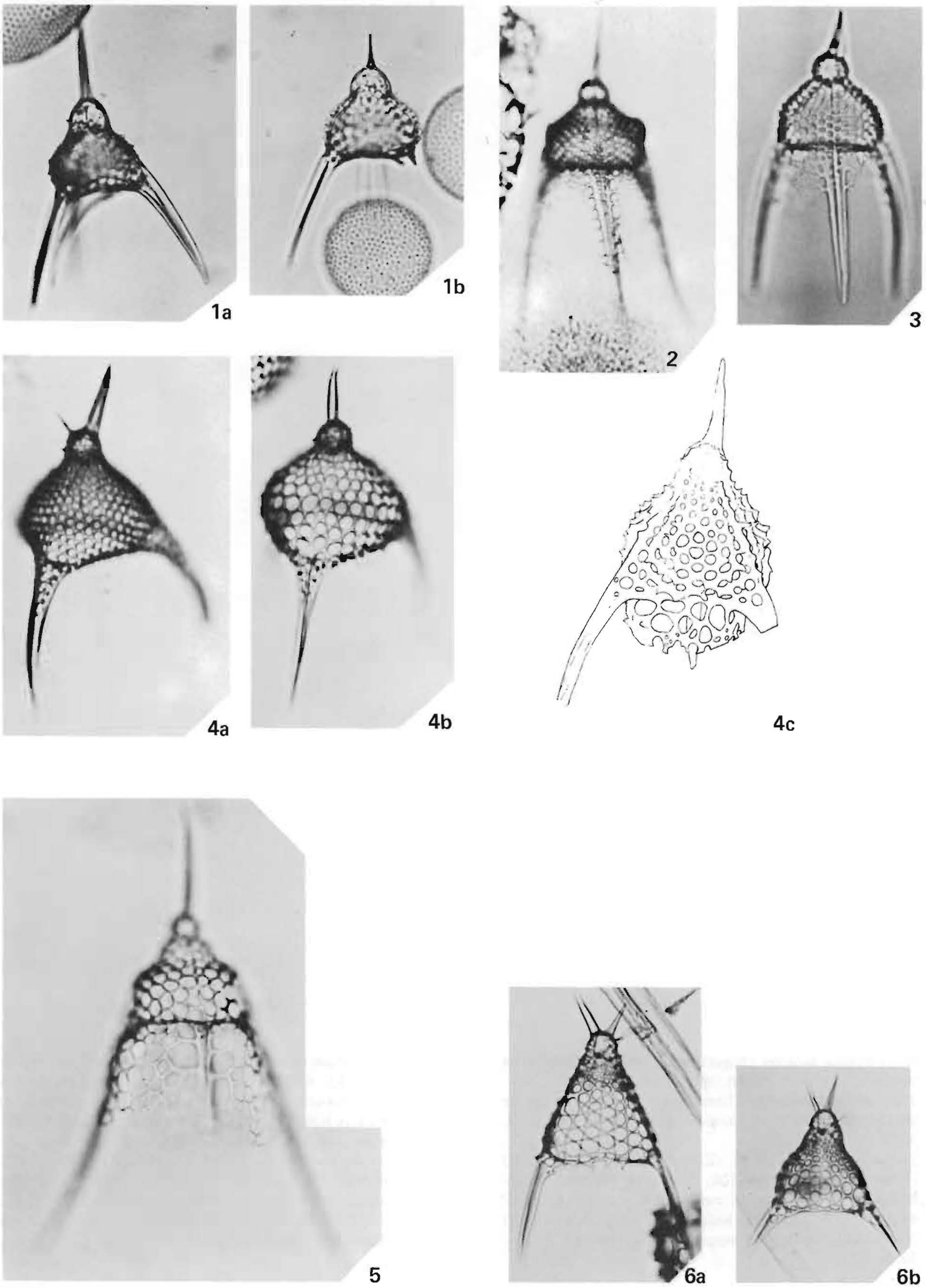
2 *Pterocanium praetextum praetextum* (Ehrenberg). MSN 39G (12°22′S, 101°25′E), B-Q46/0, Sedgwick Museum (Cambridge) No. 847.4. Nigrini, 1967, pl. 7, fig. 1. ×233.

3 *Pterocanium praetextum* (Ehrenberg) *eucolpum* Haeckel. MSN 61G (37°44′S, 71°42′E) D-L41/1, Sedgwick Museum (Cambridge) No. 855.1. Nigrini, 1967, pl. 7, fig. 2. ×233.

4a–c *Pterocanium trilobum* (Haeckel). a. LSDA 124G (32°44′S, 62°24′E), B-S22/2, Sedgwick Museum (Cambridge) No. 857.1. b. MSN34G (11°38′S, 109°33′E), C-V42/2, Sedgwick Museum (Cambridge) No. 845.1. c. Antarctic sediments. a, b from Nigrini, 1967, pl. 7, figs. 3a, b; ×233. c from Hays, 1965, pl. 3, fig. 10; ×225.

5 *Pterocanium brandiporus* Nigrini. R1S 11G (9°45′N, 117° 37′W), 0–4 cm, A-J34/4, USNM No. 650032 (holotype). Nigrini, 1968, pl. 1, fig. 7. ×233.

6a, b *Pterocanium* sp. OSU 6604-10P (43°16′N, 126°24′W). Moore, 1974, pl. 13, figs. 6, 7 (*Dictyophimus infabricatus*). ×233.


1a
1b
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4a
4b
4c
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6a
6b

PLATE 24 →

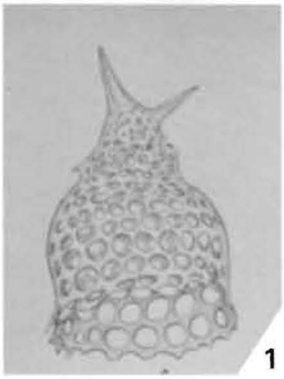
1 *Theocalyptra bicornis* (Popofsky). BANZARE Station 94 (64°28′S, 114°59′E). Riedel, 1958, pl. 4, fig. 4. ×233.

2a, b *Theocalyptra davisiana* (Ehrenberg). BANZARE Station 94 (64°28′S, 114°59′E). Riedel, 1958, pl. 4, figs. 2, 3. ×233.

3a, b *Eucyrtidium acuminatum* (Ehrenberg). a. LSDA 124G (32°44′S, 62°24′E), A-K32/2, Sedgwick Museum (Cambridge) No. 856.3, mouth constricted. b. MSN 61G (37° 44′S, 71°42′E), A-S29/3, Sedgwick Museum (Cambridge) No. 852.1, mouth wide open. Nigrini, 1967, pl. 8, figs. 3a, b. ×233.

4a, b *Eucyrtidium hexagonatum* Haeckel. a. MSN 39G (12°22′S, 101°25′E), A-J32/2, Sedgwick Museum (Cambridge) No. 846.3, mouth constricted. b. MSN 34G (11°38′S, 109° 33′E), A-N30/3, Sedgwick Museum (Cambridge) No. 843.2; mouth wide open. Nigrini, 1967, pl. 8, figs. 4a, b. ×233.

5a, b *Lithocampe* sp. a. LSDA (32°44′S, 62°24′E), A-F26/0, Sedgwick Museum (Cambridge) No. 856.1, mouth constricted. b. MSN 61G (37°44′S, 71°42′E), B-F37/1, Sedgwick Museum (Cambridge) No. 853.1, mouth wide open. Nigrini, 1967, pl. 8, figs. 6a, b. ×233.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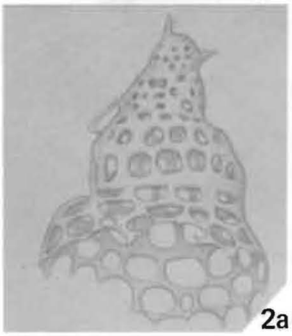
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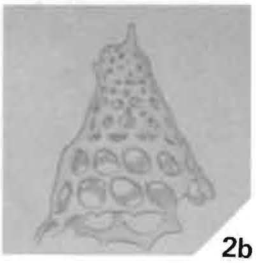
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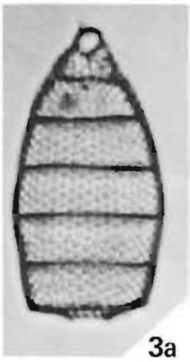
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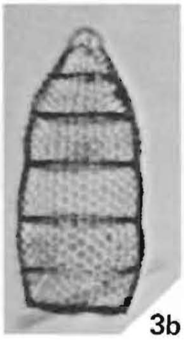
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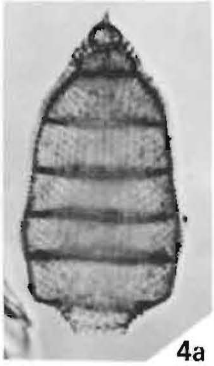
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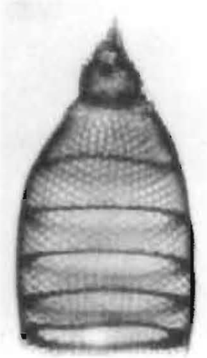
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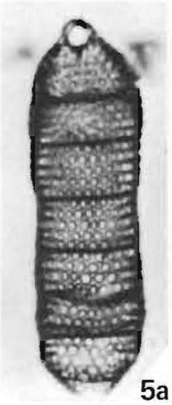
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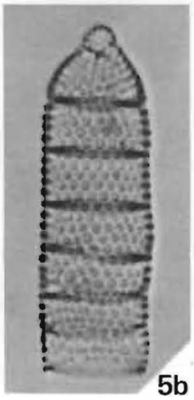

5b

PLATE 25 →

1 *Anthocyrtidium ophirense* (Ehrenberg). VEMA 19-168 (12°44′S, 82°01′E), B-R39/3, Sedgwick Museum (Cambridge) No. 865. 1. Nigrini, 1967, pl. 6, fig. 3. ×233.

2 *Anthocyrtidium zanguebaricum* (Ehrenberg). MSN 34G (11°38′S, 109°33′E), B-S44/2; Sedgwick Museum (Cambridge) No. 844.4. Nigrini, 1967, pl. 6, fig. 4. ×233.

3 *Androcyclas gamphonycha* (Jorgensen). Antarctic sediments. Hays, 1965, pl. 3, fig. 2. ×225.

4 *Lamprocyclas maritalis maritalis* Haeckel. MSN 40Ga (1030′S, 99°00′E), B-G24/3, Sedgwick Museum (Cambridge) No. 850.2. Nigrini, 1967, pl. 7, fig. 5. ×233.

5 *Lamprocyclas maritalis* Haeckel *polypora* Nigrini. MSN 39G (12°22′S, 101°25′E), A-J41/1, Sedgwick Museum (Cambridge) No. 846.4 (holotype). Nigrini, 1967, pl. 7, fig. 5. ×233.

6 *Lamprocyclas maritalis* Haeckel *ventricosa* Nigrini. RIS 36G (9°07′S, 81°32′W), 4–7 cm, A-E45/1, USNM No. 650034 (holotype). Nigrini, 1968, pl. 1, fig. 9. ×233.

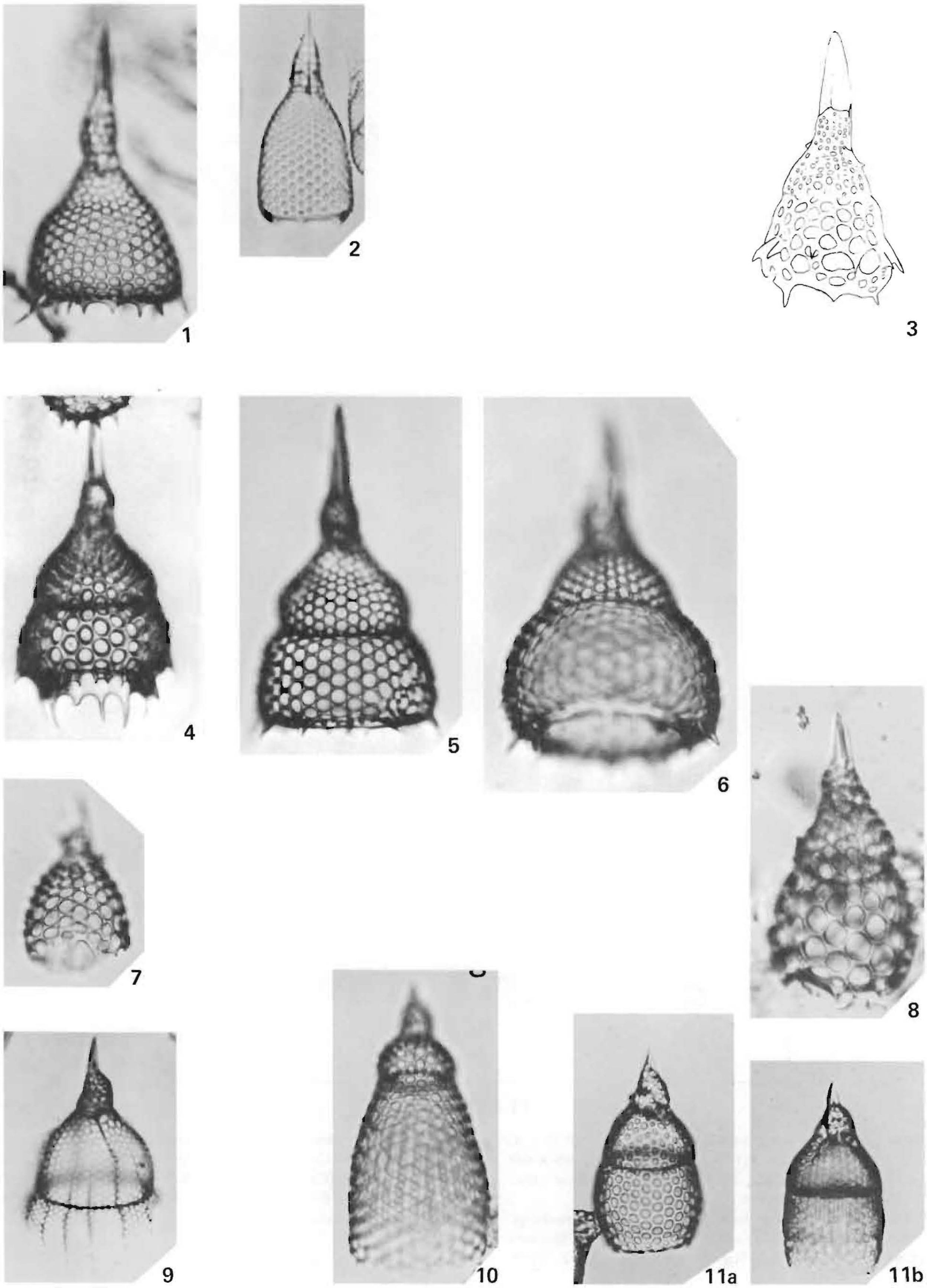
7 *Lamprocyrtis nigriniae* (Caulet). RIS 36G (9°07′S, 81°32′W), 4–7 cm, A-047/4, USNM No. 650029. Nigrini, 1968, pl. 1, fig. 5a. ×233.

8 *Lamprocyrtis* (?) hannai (Campbell and Clark). DSDP 173-1-2 (39°58′N, 125°27′W), 102–4 cm, SL1.1, D65/4. Kling, 1973, pl. 5, fig. 12. ×233.

9 *Pterocorys hertwigii* (Haeckel). Discovery 5194 (2°34′S, 44°53′E), A-N25/0, Sedgwick Museum (Cambridge) No. 860.3. Nigrini, 1967, pl. 7, fig. 4a. ×233.

10 *Pterocorys minythorax* (Nigrini). RIS 36G (9°07′S, 81° 32′W), 4–7 cm, A-T37/3, USNM No. 650033 (holotype). Nigrini, 1968, pl. 1, fig. 8. ×233.

11a, b *Pterocorys zancleus* (Mueller). OSU 6604-10P (43°16′N, 126°24′W). Moore, 1974, pl. 16, figs. 3, 4 (*Pterocorys zancleus*). ×233.



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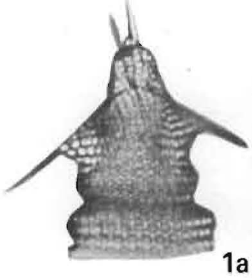
11a
11b

PLATE 26 →

1a, b *Stichopilium bicorne* Haeckel. a. VS-R-60b (24°20.5′N, 108°58.0′W), 3–5 cm, E17/4, dorsal view. b. VS-R-64b (24°45.4′N, 108°23.3′W), 1–3 cm G13/0, left lateral view. Benson, 1966, pl. 29, figs. 1, 2. ×233.

2 *Theocorythium trachelium trachelium* (Ehrenberg). MSN40Ga (10°30′S, 99°00′E), C-T26/4, Sedgwick Museum (Cambridge) No. 851.2. Nigrini, 1967, pl. 8, fig. 2. ×233.

3a, b *Theocorythium trachelium* (Ehrenberg) *diannae* (Haeckel). a. LSDA124G (32°44′S, 62°24′E), A-S32/0, Sedgwick Museum (Cambridge) No. 856.7. b. MSN61G (37°44′S, 71°42′E), B-W21/2, Sedgwick Museum (Cambridge) No. 853.2. Nigrini, 1967, pl. 8, figs. 1a, b. ×233.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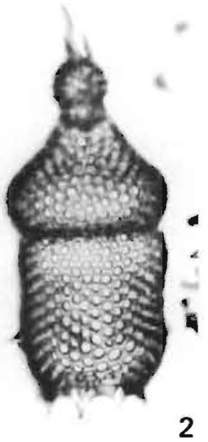
1b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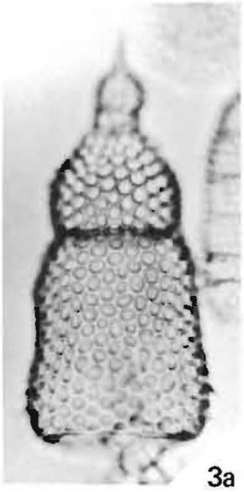
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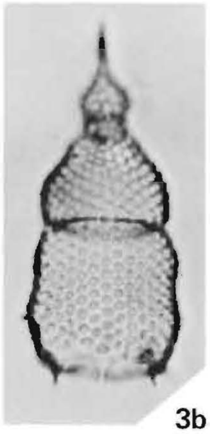
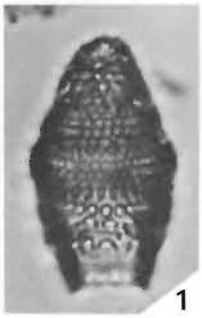

3b

PLATE 27 →

1 *Botryostrobus aquilonaris* (Bailey). DSDP 77B-2-2 (00° 28.9′N), 133°13.7′W), A-V34/1. Nigrini, 1977, pl. 1, fig. 1. ×233.

2a–d *Botryostrobus auritus/australis* (Ehrenberg) group. a. DSDP 77B-2-2 (00°28.9′N, 133°13.7′W), A-V44/1, conical shell outline. b. DSDP 77B-8-5 (00°28.9′N, 133°13.70′W), A-N35/3, wide poreless intersegmental bands. c. DSDP 77B-15-2 (00°28.9′N, 133°13.7′W), A-020/4. Nigrini, 1977, pl. 1, figs. 2–5. ×233.

3 *Phormostichoartus corbula* (Harting). MSN 40 Ga (10° 30′S, 99°00′E), B-E23/0, Sedgwick Museum (Cambridge) No. 850.1. Nigrini, 1967, pl. 8, fig. 5 (*Siphocampe corbula*). ×233.



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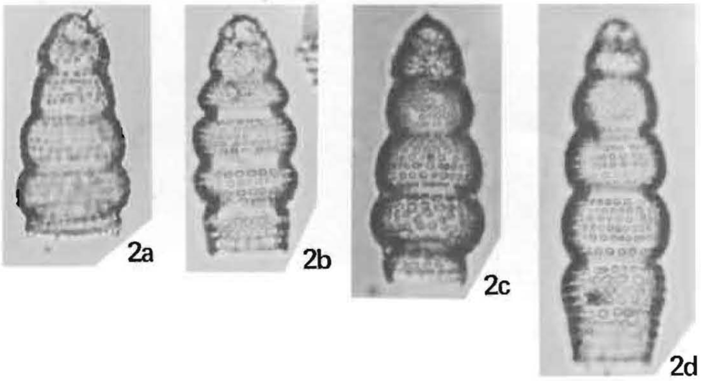
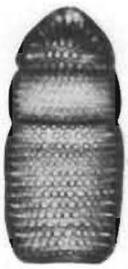


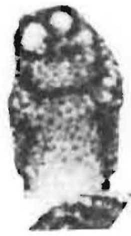
2a 2b 2c 2d



3

PLATE 28 →

1a, b *Botryocyrtis scutum* (Harting). a. discovery 5194 (2°34′S, 44°53′E), B-K29/1, Sedgwick Museum (Cambridge) No. 861.1, with one post-thoracic segment. b. MSN40Ga (10° 30′S, 99°00′E), C-R29/3, Sedgwick Museum (Cambridge) No. 851.1, with two post-thoracic segments. Nigrini, 1967, pl. 6, figs. 1a, b. ×233.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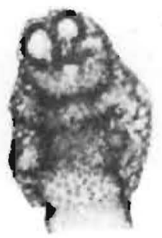
1b

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