

Foraminifera from Exmouth Gulf, Western Australia

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Manuscript received January 1997; accepted September 1997.

Abstract

Two hundred and thirty-six benthonic species and six planktonic species are identified among Foraminifera present in Holocene sediment of Exmouth Gulf, in a water depth of 5-30 m. The benthonic microfauna comprises 20 agglutinated species (including 9 Lituolida, 1 Trochamminida, and 10 Textulariida), 74 porcellaneous species (Miliolida), and 142 hyaline species (including 4 Spirillinida, 27 Lagenida, 37 Buliminida, and 75 Rotaliida). Abundant species, at least at one site, include *Ammotium australiensis*, *Textularia foliacea*, *Textularia lateralis*, and *Textularia oceanica* among the agglutinated types; *Parahauerinoides fragilissimus*, *Peneroplis pertusus*, *Planispirinella exigua*, *Pseudomassilina australis*, *Quinqueloculina arenata*, *Q. philippinensis*, *Q. sp 8*, *Sigmoihauerina involuta*, *Sorites marginalis*, *Triloculina tricarinata* among the porcellaneous species; and *Ammonia parkinsoniana*, *Amphistegina lessonii*, *A. sp cf A. papillosa*, *A. radiata*, *Asterorotalia gaimardi*, *Cibicides sp cf C. refulgens*, *Discorbinoides patelliformis*, *Elphidium sp cf E. advenum*, *E. crispum*, *E. sp 1*, *Heterostegina depressa*, *Operculina ammonoides*, *Pararotalia nipponica*, and *Rosalina cosymbosella* among the hyaline (Rotaliida) species.

Introduction

There are no comprehensive published records of foraminiferal faunas from inner neritic environments along the 2500 km Western Australian coast between Derby and Augusta (Fig 1), and this region remains one of the least documented for Foraminifera on any continent (see review by Murray 1991). The few records that exist detail only part of the fauna and illustrate only a few species. Betjeman (1969) presented a broad description of the distribution of Foraminifera on the western continental shelf, based on scattered samples (one in the western Exmouth Gulf) from latitudes 18 °S to 34 °S. Mention was made of 191 species and 38 of these were illustrated. From the data presented in Betjeman's (1969) paper and the material from his study housed in the Museum collection of the Department of Geology and Geophysics at the University of Western Australia, it is not possible to confirm the identifications of many of the species named but not illustrated in the article.

The most comprehensive reports of modern Foraminifera in Western Australia are studies by Mackenzie (1962) and Quilty (1977) on south coast estuarine and embayment faunas, and a major taxonomic study by Loeblich & Tappan (1994) who described and illustrated 946 species from sediment samples collected from the Sahul Shelf and Timor Trough (within a water depth range of 19 - 2716 m). The Sahul Shelf monograph of Loeblich & Tappan (1994) illustrates species by scanning electron micrographs which allow detailed comparison with Foraminifera found elsewhere along the shelf. The documentation of species along the coast, using a consistent nomenclature, will enhance the utility of the Foraminifera, particularly in biogeographic differentiation within this region.

The purpose of this paper is to provide a comprehensive record of the foraminiferal species present in Holocene sediment in Exmouth Gulf, a major embayment on the central north-west coast of Western Australia (Figs 1, 2). This taxonomic record is a prerequisite to studies that may elucidate aspects of sedimentology, ecology, and biogeography.

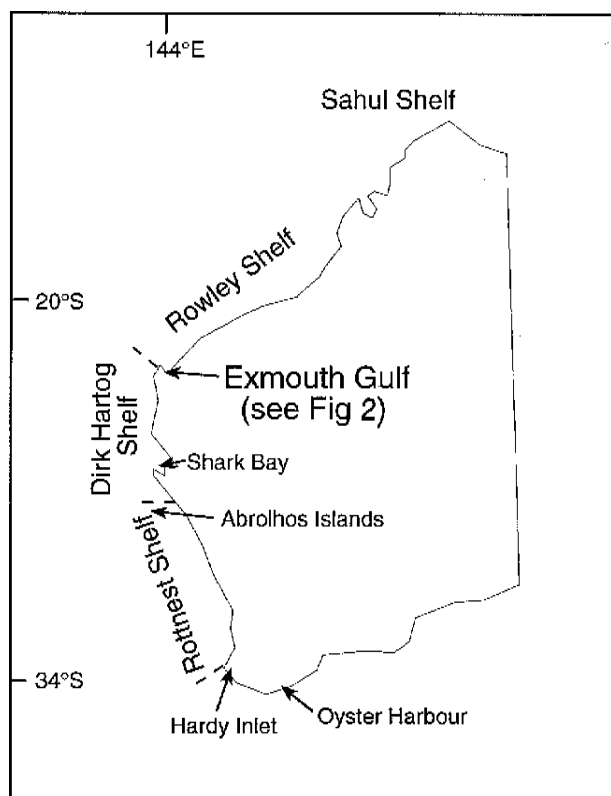


Figure 1. Map of Western Australia showing location of Exmouth Gulf and main sectors of the western continental shelf.

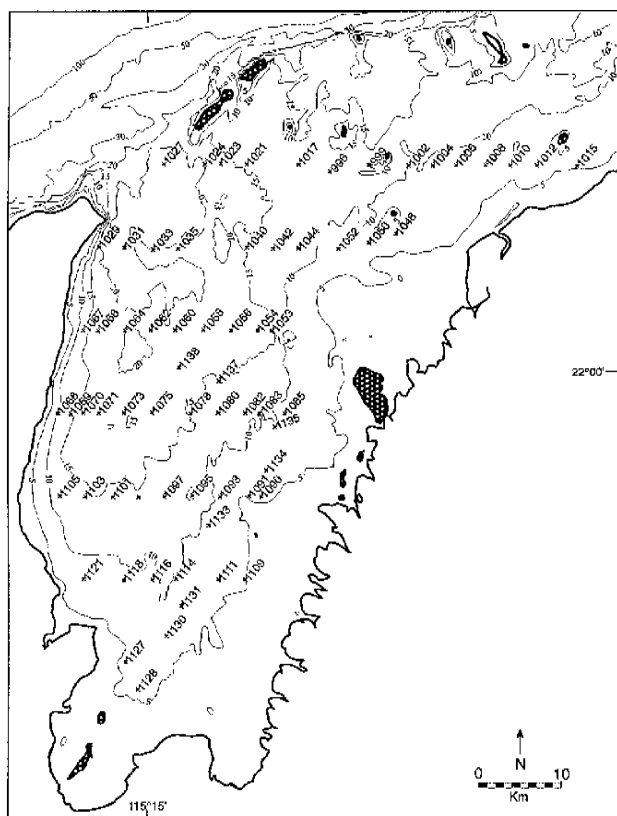


Figure 2. Map of Exmouth Gulf, showing grab-sample localities.

Material and Methods

The species identified in the present study were recovered from 68 sediment grab samples taken throughout Exmouth Gulf (Fig 2) during the AIMS RV Lady Basten cruise 669/672, in September - October 1994. The samples come from a water-depth range of 5-30 m. A portion of each sample was washed through 2 mm, 150 μm , and 63 μm sieves. At least 150 Foraminifera were systematically picked from the 150 μm - 2 mm sediment fraction, and comprehensive selective picks were made of rare species in all sediment fractions.

Physiographic setting

The environmental setting of Exmouth Gulf was described by Brown (1988) who recorded the sea-floor sediment as mainly red-brown and grey-brown muddy quartz sand. Exmouth Gulf occupies a hot, semi-arid region and, according to Brown (1988), winter salinities within the Gulf may range from 35 ‰ to 39 ‰, north to south, and winter water temperatures may vary from 21.5 ° to 18 °C in the same direction (based on a 1972 survey). During the September 1994 study by McCook *et al.* (1995), the highest salinity noted in the Gulf was 38.5 ‰. Strong currents are present, with spring-tide velocities about 0.5 m s⁻¹ in deep areas, 1 m s⁻¹ on shallow open flats, and several metres per second in tidal channels (Brown 1988). McCook *et al.* (1995) noted very turbid conditions with much suspended material in the water due to rough sea conditions and strong currents.

At the time of collection, the foraminiferal tests in the sand probably included specimens hundreds or thousands

of years old as well as recently dead skeletons and comparatively rare living individuals. The surficial sediment on the Gulf floor is doubtless reworked by currents, bioturbation, and, in some areas, by commercial trawling. Specimens eroded from Pleistocene rocks and incorporated in the modern sediment have been discarded in this study. These are differentiated from the modern types by cement-infilled, poorly preserved tests.

Record of Foraminifera

The species are arranged alphabetically within Orders recognized by Loeblich & Tappan (1994). Generic definitions follow Loeblich & Tappan (1987), except for: (1) the Lagenida where genera are interpreted following Jones (1994); (2) the Miliolida where *Quinqueloculina* is interpreted in a broader sense (after Haig 1988); and (3) recent revisions by Revets (1990, 1991, 1993, 1996) among the Buliminida and Rotaliida. For each species, the original generic attribution is given in square brackets if the current generic designation differs from the original. This allows easy reference to Ellis & Messina's (1940 *et seq*) Catalogue of Foraminifera which includes a copy of the original description of the species. Previous published records of the species from Western Australian waters, confirmed by examining original material or high quality published illustrations, are given in partial synonymies. Only those species not illustrated in Loeblich & Tappan's (1994) Sahul Shelf monograph are figured here (Figs 3-7). All materials from the study, including scanning electron micrographs of all the identified species, are housed in the micropalaeontological collection of the Department of Geology & Geophysics, The University of Western Australia.

Order Lituolida

Ammotium australiensis (Collins); [*Ammomarginulina*]; Figure 3:1.

Eggerelloides australis (Collins); [*Eggerella*]; Figure 3:2.

Gaudryina convexa (Karrer); [*Textilaria*]; Figure 3:3.

Gaudryina convexa (Karrer); Burdett *et al.*, 1963 (revision of species); Quilty 1977, Fig 14, Hardy Inlet.

Gaudryina sp; Figure 3:4.

Haplophragmoides pusillus Collins.

Haplophragmoides pusillus Collins; Loeblich & Tappan 1994, Pl 7, Figs 1-7, Sahul Shelf.

Nouria polymorphinoides Heron-Allen & Earland; Figure 3:5.

Nouria polymorphinoides Heron-Allen & Earland; Mackenzie 1962, Pl 1, Fig 3, Oyster Harbour.

?*Reophax* sp 1; Figure 3:6.

Reophax sp 2; Figure 3:7.

Veleroninoides jeffreysii (Williamson); [*Nonionina*]; Figure 3:11,12.

Order Trochamminida

Paratrochammina simplissima (Cushman & McCulloch); [*Trochammina*].

Paratrochammina simplissima (Cushman & McCulloch); Loeblich & Tappan 1994, Pl 24, Figs 1-12, Sahul Shelf.

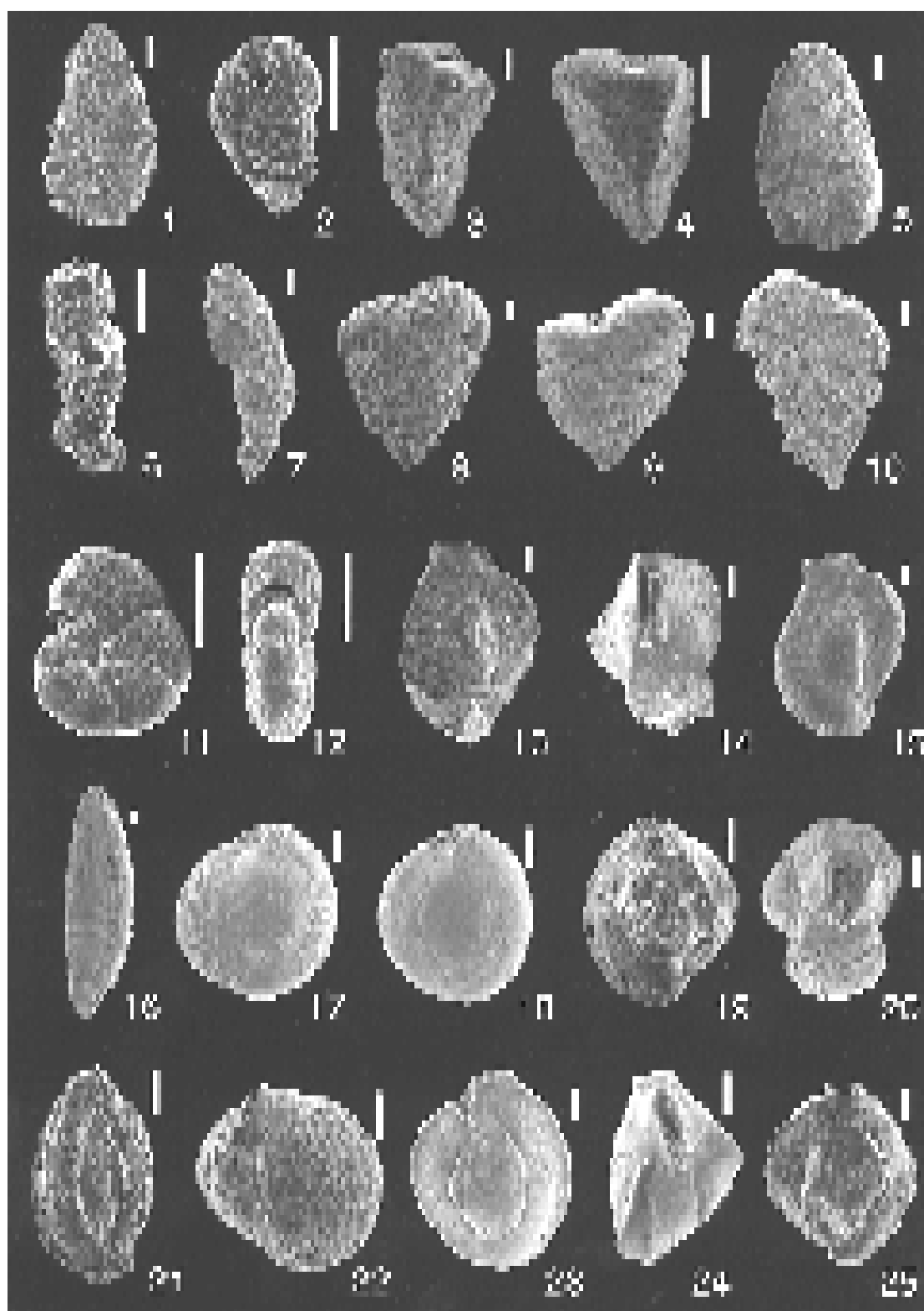


Figure 3. Agglutinated (1-12) and porcellaneous (13-25) Foraminifera (bar scales = 0.1 mm). 1, *Ammotium australiensis* (Collins) from sample 1134. 2, *Eggerelloides australis* (Collins) from sample 1116. 3, *Gaudryina convexa* (Karrer) from sample 1027. 4, *Gaudryina* sp from sample 1021. 5, *Nouria polymorphinoides* Heron-Allen & Earland from sample 999. 6, ?*Reophax* sp 1 from sample 1114. 7, *Reophax* sp 2 from sample 1134. 8, *Textularia kerimbaensis* Said from sample 1029. 9, *Textularia lateralis* Lalicker from sample 1134. 10, *Textularia occidentalis* Heron-Allen & Earland from sample 1134. 11, 12, *Veloroninoides jeffreysii* (Williamson) from sample 1029. 13, 14, *Affinetrina bassensis* (Parr) from sample 1095. 15, 20, *Affinetrina* sp from sample 1080. 16, *Borelis schlumbergeri* (Reichel) from sample 999. 17, 18, *Cribromiliolinella milletti* (Cushman) from sample 999. 19, *Hauerina* sp from sample 1024. 21, *Miliolinella* sp cf *M. baragwanathi* (Parr) from sample 1008. 22, *Miliolinella* sp from sample 1024. 23, 24, *Quinqueloculina barnardi* Rasheed from sample 1134. 25, *Quinqueloculina distorta* Cushman from sample 1008.

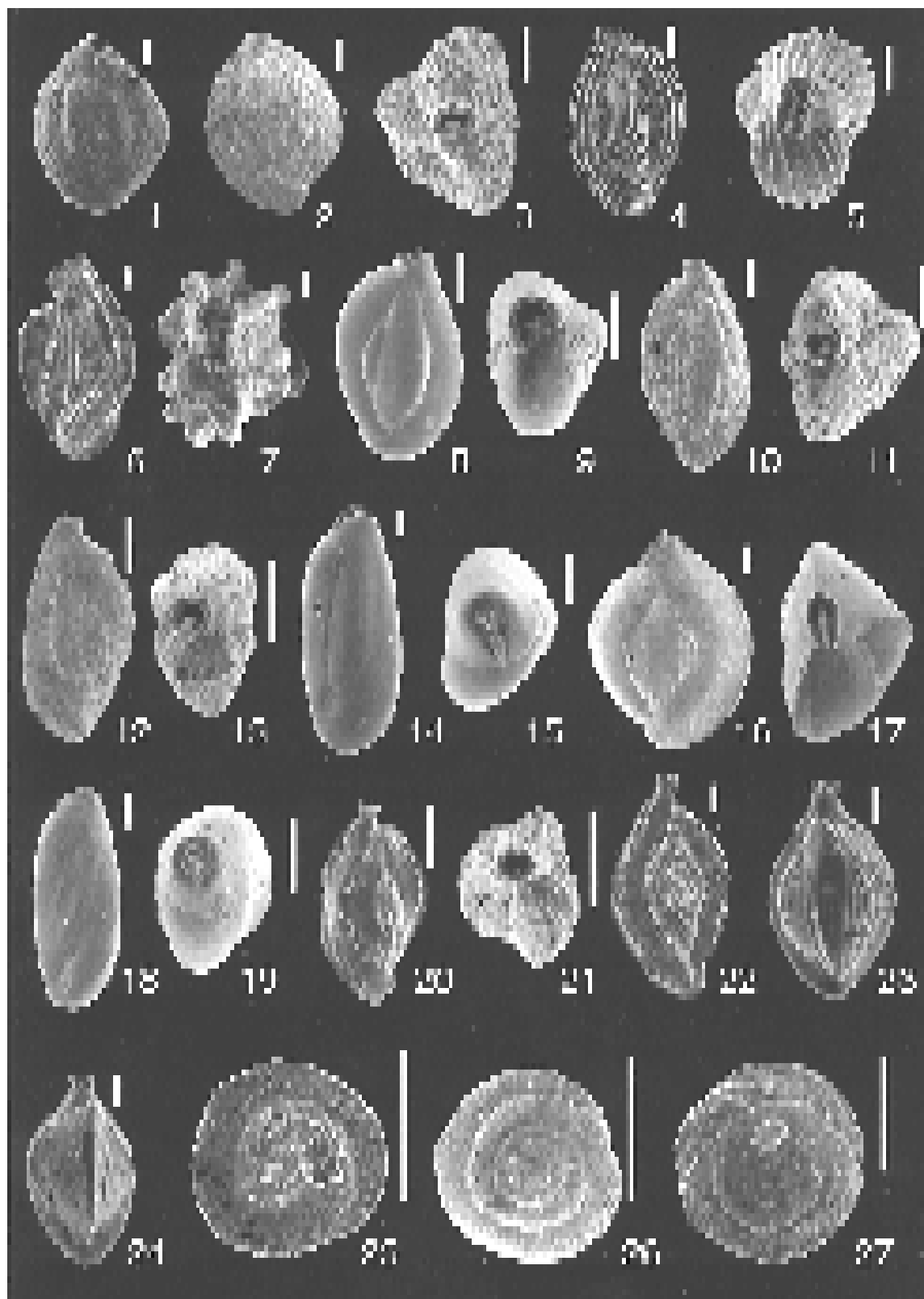


Figure 4. Porcellaneous (1-24) and hyaline-spirillinid (25-27) Foraminifera (bar scales = 0.1 mm). 1, *Quinqueloculina neostriatula* Thalmann from sample 1128. 2,3, *Quinqueloculina pittensis* Albani from sample 1134. 4, 5, *Quinqueloculina poeyana* d'Orbigny from sample 1024. 6, 7, *Quinqueloculina* sp1 from sample 1027. 8, 9, *Quinqueloculina* sp 3 from sample 1134. 10, 11, *Quinqueloculina* sp 4 from sample 1134. 12, 13, *Quinqueloculina* sp 5 from sample 999. 14, 15, *Quinqueloculina* sp 6 from sample 1134. 16, 17, *Quinqueloculina* sp 7 from sample 1134. 18, 19, *Quinqueloculina* sp 8 from sample 1134 (different specimens). 20, 21, *Sigmoilinella tortuosa* Zheng from sample 999. 22, *Spiroloculina angulata* Cushman from sample 1027. 23, *Triloculina barnardi* Rasheed from sample 1024. 24, *Triloculina papuaensis* Rasheed from sample 1128. 25-27, *Mychostomina* sp from sample 1008 (25 and 26, same specimen).

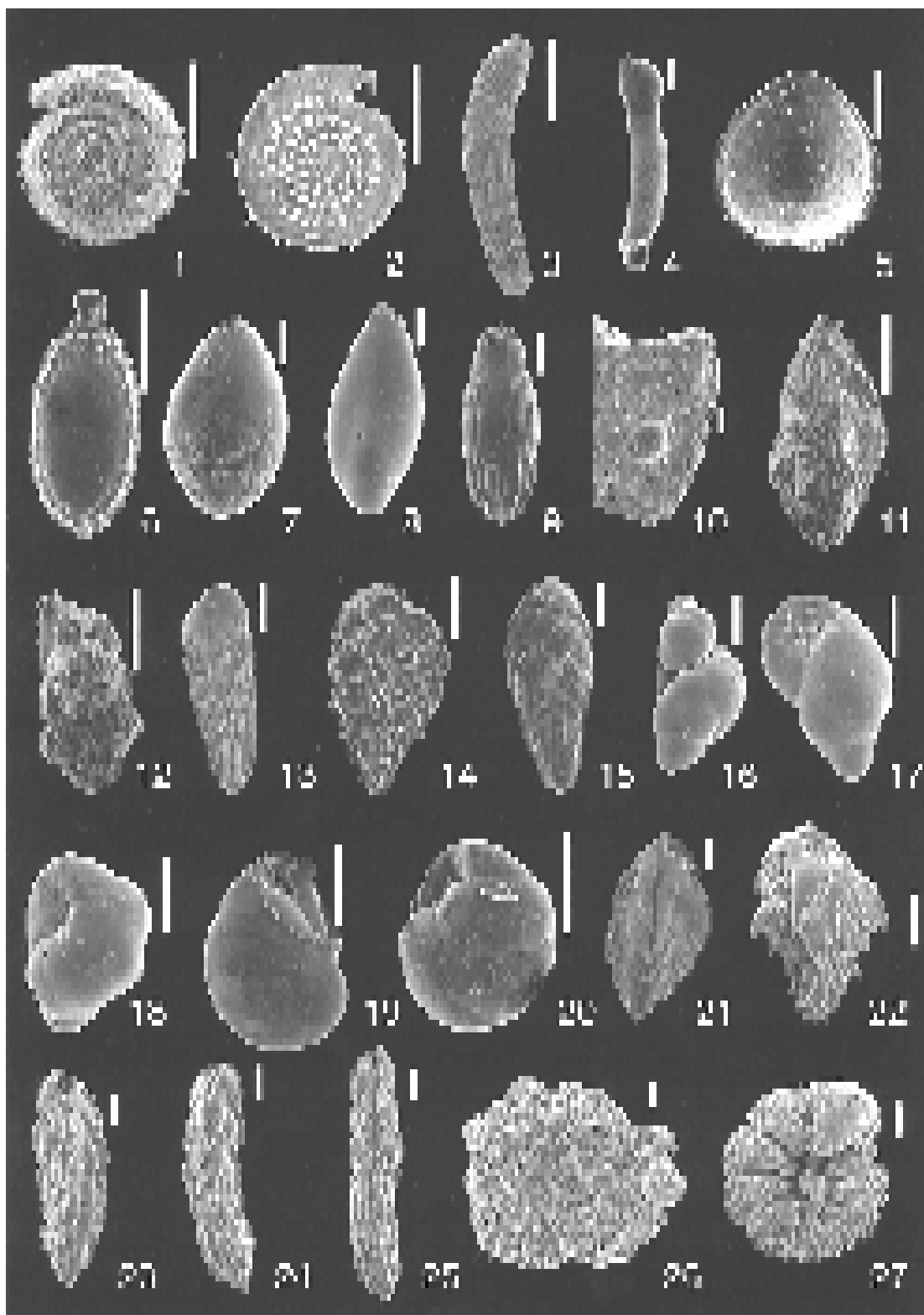


Figure 5. Hyaline Foraminifera: Spirillinida (1,2), Lagenida (3-10), Buliminida (11-25) and Rotaliida (26, 27) [bar scales = 0.1 mm]. 1, 2, *Conicospirillinoides* sp from sample 1091. 3, *Dentalina* sp 1 from sample 1024. 4, *Dentalina* sp 2 from sample 1010. 5, *Fissurina* sp 1 from sample 1134. 6, *Fissurina* sp 2 from sample 1029. 7, *Glandulina* sp from sample 1008. 8, *Guttulina* sp from sample 999. 9, *Pseudoglandulina* sp from sample 999. 10, *Webbinella* sp from sample 1029 (cemented to shell fragment). 11, *Angulogerina* sp 1 from sample 1067. 12, *Angulogerina* sp 2 from sample 999. 13, *Bolivina striatula* (Cushman) from sample 999. 14, *Bolivina* sp 1 from sample 999. 15, *Bolivina* sp 2 from sample 999. 16-18, *Elongobula milletti* (Cushman) from sample 1134 (different specimens). 19, *Evolvocassidulina* sp from sample 1021. 20, *Globocassidulina* sp from sample 1095. 21, *Reussella* sp 1 from sample 999. 22, *Reussella* sp 2 from sample 1134. 23-25, *Reussella* sp 3 from sample 1134 (different specimens). 26, *Acervulina mahabeti* (Said) from sample 1021. 27, *Ammonia* sp from sample 1023.

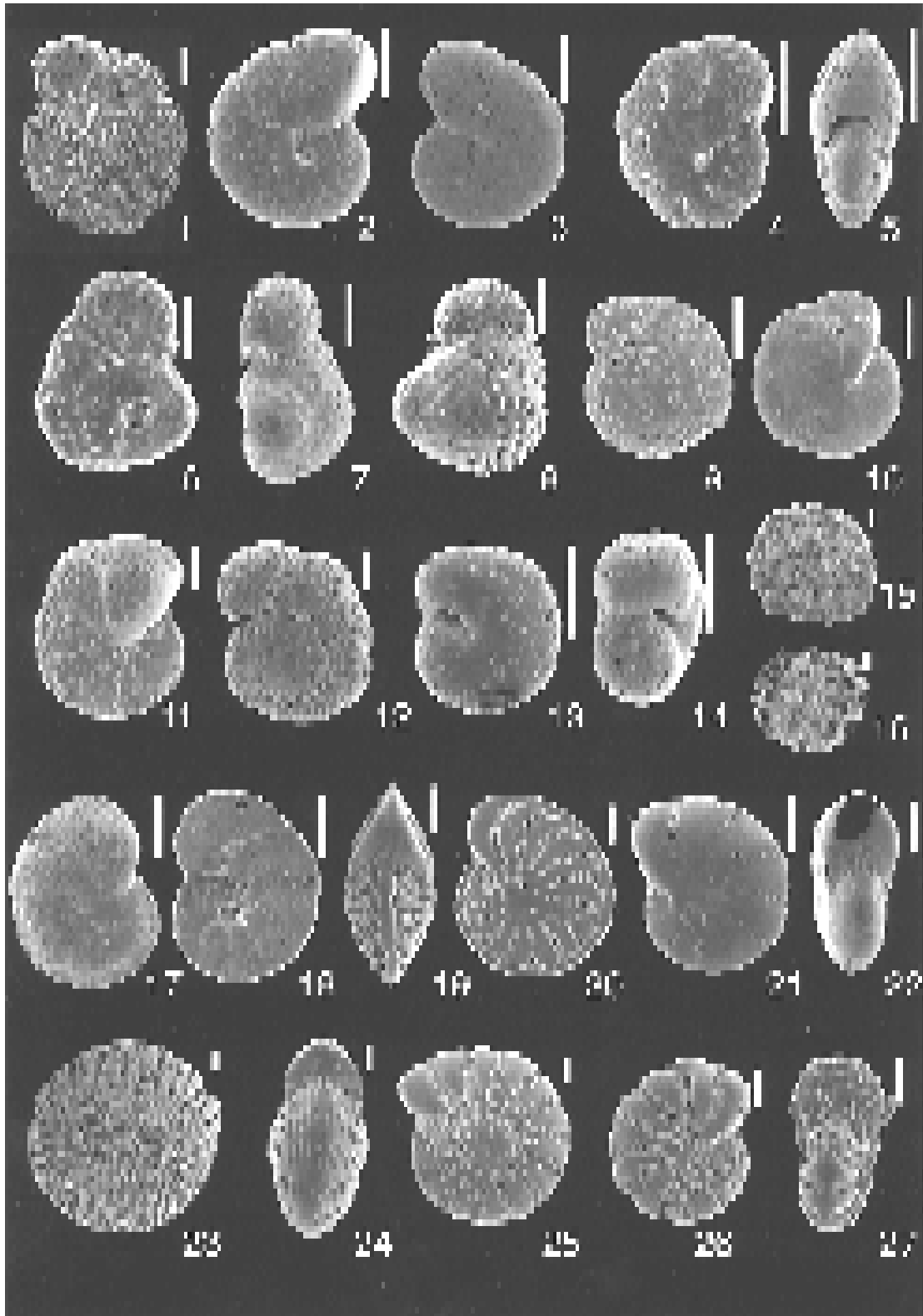


Figure 6. Hyaline Foraminifera: Rotaliida (bar scales = 0.1 mm). 1, *Ammonia* sp from sample 1023 (same specimen as Fig 4:27). 2, 3, *Anomalinulla glabrata* (Cushman) from sample 999. 4, 5, *Astrononion* sp from sample 1008. 6-8, ?*Cibicides* sp from sample 999. 9, 10, *Cibicoides basilanensis* (McCulloch) from sample 1134. 11, 12, *Cibicoides* sp from sample 1027. 13, 14, *Criobaggina socorroensis* McCulloch from sample 999. 15, 16, *Cymbaloporella tabellaeformis* (Brady) from sample 1029 (chambers, shown in 16 on ventral side of test, are broken). 17, 18, *Discorbinella rhodiensis* (Terquem) from sample 1134 (different specimens). 19, 20, *Elphidium* sp cf *advenum* (Cushman) from sample 1134. 21, 22, *Elphidium albanii* Hayward from sample 1134. 23, *Elphidium* sp cf *E. craticulatum* (Fichyel & Moll) from sample 1135. 24, 25, *Elphidium mortonbayensis* Albani & Yassini from sample 1134. 26, 27, *Elphidium oceanicum* Cushman from sample 1134 (different specimens).

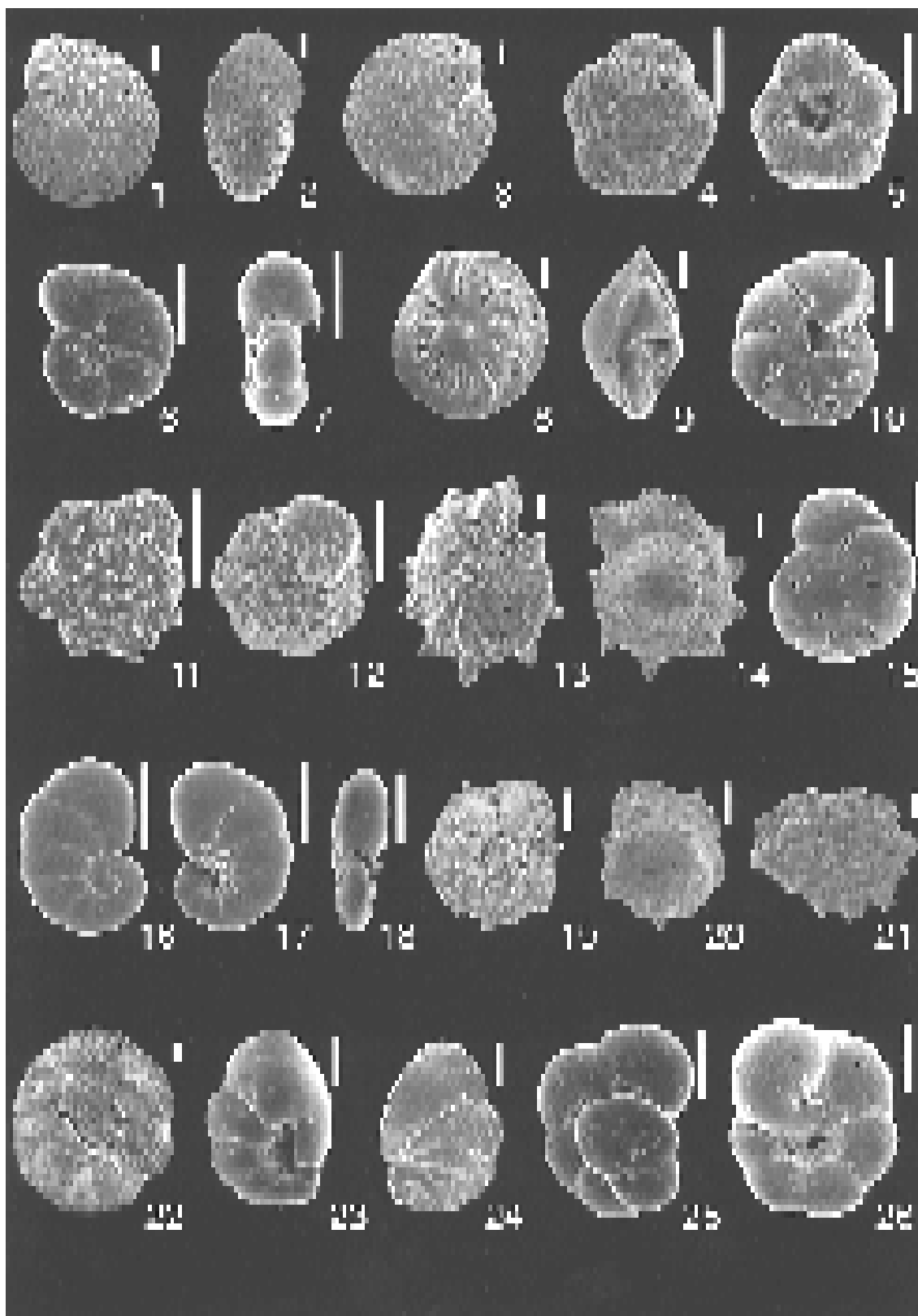


Figure 7. Hyaline Foraminifera: Rotaliida (bar scales = 0.1 mm). 1, 2, *Elphidium* sp cf *E. striatopunctatus* (Fichtel & Moll) from sample 1134 (different specimens). 3, *Elphidium* sp, from sample 1134. 4, 5, *Glabratella* sp from sample 999. 6, 7, *Haynesina* sp from sample 1067. 8, 9, *Lamelloscorbis melbyae* Hansen & Revets from sample 999. 10, 15, *Monspeliensina* sp 2 from sample 1135. 11, 12, *Murryinella murrayi* (Heron-Allen & Earland) from sample 999 (different specimens). 13, 14, *Neorotalia calcar* (d'Orbigny) from sample 999. 16-18, *Nonionoides* sp from sample 1095. 19, 20, *Pararotalia nipponica* (Asano) from sample 1134. 21, *Planogypsina acervalis* (Brady) from sample 999. 22, *Poroepionides lateralis* (Terquem) from sample 1116. 23, 24, *Saintclairoides* sp from sample 999. 25, 26, *Schwantzia* sp from sample 1067.

Order Textulariida

Clavulina multicamerata Chapman.

Clavulina serventyi Chapman & Parr; Mackenzie 1962, Pl 1, Fig 14, Oyster Harbour.

Clavulina multicamerata Chapman; Loeblich & Tappan 1994, Pl 47, Figs 11-15, Sahul Shelf.

Clavulina pacifica Cushman.

Clavulina pacifica Cushman; Mackenzie 1962, Pl 1, Fig 13, Oyster Harbour; Loeblich & Tappan 1994, Pl 47, Figs 16-24, Sahul Shelf.

Sahulia barkeri (Hofker); [*Textularia*].

Sahulia barkeri (Hofker); Loeblich & Tappan 1994, Pl 32, Figs 1-8, Sahul Shelf.

Textularia cushmani Said.

Textularia cushmani Said; Loeblich & Tappan 1994, Pl 35, Figs 1-4, Sahul Shelf.

Textularia foliacea Heron-Allen & Earland.

Textularia foliacea Heron-Allen & Earland; Loeblich & Tappan 1994, Pl 34, Figs 6-14, Sahul Shelf.

Betjeman (1969) recorded *T. foliacea* as a widespread species on the Western Australia shelf.

Textularia kerimbaensis Said; Figure 3:8.

Textularia lateralis Lalicker; Figure 3:9.

Textularia oceanica Cushman.

Textularia oceanica Cushman; Loeblich & Tappan 1994, Pl 40, Figs 15-17, Sahul Shelf.

Textularia occidentalis Heron-Allen & Earland; Figure 3:10.

This may be an extreme variant of *T. foliacea*, differing from typical *T. foliacea* by a much more flaring test.

Textularia sp.

Textularia secasensis; Loeblich & Tappan 1994, Pl 39, Figs 8-14 (not *T. secasensis* Lalicker & McCulloch), Sahul Shelf.

T. secasensis has a subacute peripheral margin in the adult stage that differs from the broadly rounded margin of the present species.

Order Miliolida

Affinetrina bassensis (Parr); [*Triloculina*]; Figure 3:13,14.

This species was recorded by Betjeman (1969) as *Triloculina bassensis*, abundant in the Abrolhos Islands and at stations north of the islands.

Affinetrina sp; Figure 3:15,20.

This species is related to some of the forms included originally in *Miliolina kerimbatica* Heron-Allen & Earland 1915 (e.g. Pl 43, Fig 19 of Heron-Allen & Earland, 1915).

Amphisorus hemprichii Ehrenberg.

Marginopora vertebralis Quoy & Gaimard; Mackenzie 1962, Pl 3, Fig 15, Oyster Harbour.

? *Marginopora vertebralis* Blainville; Quilty 1977, Fig 25 (juvenile specimen), Hardy Inlet.

Amphisorus hemprichii Ehrenberg; Loeblich & Tappan 1994, Pl 109, Figs 7-13; Pl 110, Figs 6,7, Sahul Shelf.

Marginopora vertebralis is distinguished from *Amphisorus hemprichii* by having multiple layers of chamberlets rather than two-layers in the adult stage. Betjeman's (1969) determination of *M. vertebralis* apparently refers to *A. hemprichii*, based on specimens which he mounted on slides in the UWA collection.

Articulina alticostata Cushman.

Articulina alticostata Cushman; Loeblich & Tappan 1994, Pl 104, Figs 5-10, Sahul Shelf.

This species was recorded by Betjeman (1969) as being more abundant on northern rather than southern sectors of the Western Australian shelf.

Articulina mucronata (d'Orbigny); [*Vertebralina*].

Articulina mucronata (d'Orbigny); Loeblich & Tappan 1994, Pl 104, Figs 1-4, Sahul Shelf.

Betjeman (1969) recorded this species as *Articulina pacifica* Cushman and found that it ranged north from Exmouth Gulf to the Rowley Shelf.

Articulina sp.

Articulina carinata Cushman; Loeblich & Tappan 1994, Pl 104, Figs 11-18, Sahul Shelf.

This species lacks the distinctly keeled periphery and numerous fine longitudinal costae that characterise *A. carinata* Cushman.

Borelis schlumbergeri (Reichel); [*Neovalveolina*]; Figure 3:16.

This may be the species recorded by Betjeman (1969) as *Alveolinella boscii* from Exmouth Gulf and the Rowley Shelf.

Cornuspira planorbis Schultze.

Cornuspira planorbis Schultze; Loeblich & Tappan 1994, Pl 56, Figs 1-7, Sahul Shelf.

Coscinospira acicularis (Batsch); [*Nautilus (Lituus)*].

Coscinospira acicularis (Batsch); Loeblich & Tappan 1994, pl. 107, Figs 5-10, Sahul Shelf.

Cribromiliolinella milletti (Cushman); [*Hauerina*]; Figure 3:17,18.

Miliola sp A of Betjeman 1969, Pl 18, Fig 23, Rowley Shelf.

Dendritina ambigua (Fichtel & Moll); [*Nautilus*].

Dendritina ambigua (Fichtel & Moll); Loeblich & Tappan 1994, Pl 108, Figs 1-4, Sahul Shelf.

Edentostomina cultrata (Brady); [*Miliolina*].

Edentostomina cultrata (Brady); Loeblich & Tappan 1994, Pl 63, Figs 8-12, Sahul Shelf.

Euthymonacha polita (Chapman); [*Peneroplis (Monalysidium)*].

Euthymonacha polita (Chapman); Loeblich & Tappan 1994, Pl 109, Figs 1-6, Sahul Shelf.

Hauerina sp; Figure 3:19.

The Exmouth Gulf specimens may be juvenile forms of *H. pacifica* Cushman.

Inaequalina disparilis (Terquem); [*Spiroloculina*].

Inaequalina disparilis (Terquem); Loeblich & Tappan 1994, Pl 64, Figs 11-18, Sahul Shelf.

Mikrobelodontos bradyi (Barker); [*Spiroloculina*].

Spiroloculina sp A of Betjeman 1969, Pl 19, Fig 16, Rowley and Dirk Hartog Shelf areas.

Mikrobelodontos bradyi (Barker); Loeblich & Tappan 1994, Pl 66, figs 1-8, Sahul Shelf.

Miliolinella* sp cf *M. baragwanathi (Parr); [*Quinqueloculina*]; Figure 3:21.

Quinqueloculina lamarckiana d'Orbigny; Quilty 1977, Fig 18, Hardy Inlet.

The Western Australian specimens lack the distinct obliquely curved costae of the type specimens of *M. baragwanathi*.

Miliolinella philippinensis (McCulloch); [*Pateoris*].

Miliolinella philippinensis (McCulloch); Loeblich & Tappan 1994, Pl 76, Figs 6-11, Sahul Shelf.

Miliolinella pseudooblonga Zheng.

Miliolinella circularis (Bornemann); Mackenzie 1962, Pl 2, Fig 13, Oyster Harbour.

Triloculinella pseudooblonga (Zheng); Loeblich & Tappan 1994, Pl 88, Figs 7-18, Pl 97, Figs 10-12, Pl 98, Figs 1-3, 7-9, Sahul Shelf.

Miliolinella quinquangula Loeblich & Tappan.

Quinqueloculina sp A of Betjeman 1969, Pl 19, Fig 4, Rowley, Dirk Hartog, and Rottneest Shelf areas.

Miliolinella quinquangula Loeblich & Tappan 1994, Pl 82, Figs 14-16, Sahul Shelf.

Miliolinella suborbicularis (d'Orbigny); [*Triloculina*].

Miliolinella sp B of Betjeman 1969, Pl 18, Fig 24, Rottneest Shelf.

Miliolinella suborbicularis (d'Orbigny); Loeblich & Tappan 1994, Pl 89, Figs 1-9, Sahul Shelf.

***Miliolinella* sp**; Figure 3:22.

Nodophthalmidium gracile Collins.

Nodophthalmidium gracile Collins; Loeblich & Tappan 1994, Pl 57, Figs 18,19, Sahul Shelf.

Nubeculina advena Cushman.

Reophax scorpiurus Montfort; Mackenzie 1962, Pl 1, Fig 2, Oyster Harbour.

Nubeculina advena Cushman; Loeblich & Tappan 1994, Pl 59, Figs 1-12, Sahul Shelf.

Parahauerinoides fragilissimus (Brady); [*Spiroloculina*].

Parahauerinoides fragilissimus (Brady); Loeblich & Tappan 1994, Pl 87, Figs 1-6, Sahul Shelf.

As *Hauerina fragilissima*, this species was noted by Betjeman (1969) as having a preference for the tropical-subtropical sectors of the Western Australian shelf.

Peneroplis pertusus (Forskål); [*Nautilus*].

Peneroplis pertusus (Forskål); Mackenzie 1962, Pl 3, Fig 1, Oyster Harbour; Loeblich & Tappan 1994, Pl 110, Figs 1-5, Sahul Shelf.

Peneroplis planatus (Fichtel & Moll); McKenzie 1962, Pl 2, Fig 27, Oyster Harbour.

Betjeman (1969) recorded both *P. pertusus* and *P. planatus* (species considered by the present author to be synonymous) as more abundant on the northern rather than the southern sectors of the Western Australian shelf.

Planispirinella exigua (Brady); [*Hauerina*].

Planispirinella exigua (Brady); Loeblich & Tappan 1994, Pl 57, Figs 7,8, Sahul Shelf.

Betjeman (1969) recorded this species from the Dirk Hartog Shelf and Rowley Shelf.

Pseudomassilina australis (Cushman); [*Massilina*].

Massilina secans var. *tenuistriata* Earland; Mackenzie 1962, Pl 2, Fig 25, Oyster Harbour.

Pseudomassilina australis (Cushman); Loeblich & Tappan 1994, Pl 91, Figs 1-3, Sahul Shelf.

Not *Pseudomassilina australis* (Cushman); Mackenzie, 1962.

Pseudomassilina robusta Lacroix.

Pseudomassilina robusta Lacroix; Loeblich & Tappan 1994, Pl 90, Figs 1-4, Sahul Shelf.

This species is similar to *Pseudomassilina* sp B of Hottinger *et al.* (1993, Pl 45, Figs 1-10).

Pseudopyrgo milletti (Cushman); [*Biloculina*].

Pseudopyrgo milletti (Cushman); Loeblich & Tappan 1994, Pl 89, Figs 10,11, Sahul Shelf.

Pyrgo denticulata (Brady); [*Biloculina*].

Pyrgo denticulata (Brady); Loeblich & Tappan 1994, Pl 92, Figs 1,2, Sahul Shelf.

Pyrgo striolata (Brady); [*Biloculina*].

Pyrgo striolata (Brady); Loeblich & Tappan 1994, Pl 92, Figs 9-15, Sahul Shelf.

Pyrgoella tenuiaperta (Huang); [*Biloculinella*].

Pyrgoella tenuiaperta (Huang); Loeblich & Tappan 1994, Pl 94, Figs 10-14, Pl 99, Figs 10-17, Sahul Shelf.

This species is the same as *Pyrgoella* sp A of Haig (1988, Pl 4, Figs 7,8) and Hottinger *et al.* (1993, Pl 53, Figs 7,8).

Quinqueloculina adiazeta Loeblich & Tappan.

Quinqueloculina adiazeta Loeblich & Tappan 1994, Pl 85, Figs 1-18, Sahul Shelf.

Contrary to Loeblich & Tappan's (1994, p. 48) proposition, this species is not the same as *Q. cf Q. berthelotiana* of Haig (1988, p. 233, Pl 4, Figs 23-26), but resembles *Q. cf Q. rugosa* of Haig (1988, p. 234, Pl 8, Figs 1-5).

Quinqueloculina agglutinans d'Orbigny.

Quinqueloculina agglutinans d'Orbigny; Betjeman 1969, Rowley Shelf and Dirk Hartog Shelf.

Agglutinella agglutinans (d'Orbigny); Loeblich & Tappan 1994, Pl 70, Figs 1-9, Sahul Shelf.

Quinqueloculina arenata Said.

Siphonaperta ammophila (Parr); Mackenzie 1962, Oyster Harbour.

Agglutinella arenata (Said); Loeblich & Tappan 1994, Pl 69, Figs 9-11; Pl 70, Figs 10-15; Pl 74, Figs 10-13, Sahul Shelf.

Quinqueloculina barnardi Rasheed; Figure 3:23,24.

Quinqueloculina crassicarinata Collins.

Quinqueloculina crassicarinata Collins; Loeblich & Tappan 1994, Pl 77, Figs 4-12, Sahul Shelf.

Quinqueloculina distorta Cushman; Figure 3:25.

Quinqueloculina eburnea (d'Orbigny); [*Triloculina*].

Miliolinella oblonga (Montagu); Mackenzie 1962, Oyster Harbour.

Pseudolachlanella slitella Langer; Loeblich & Tappan 1994, Pl 73, Figs 16-18; Pl 101, Figs 1-3, Sahul Shelf.

Quinqueloculina neostriatula Thalmann; Figure 4:1.

Quinqueloculina sp C of Betjeman 1969, Pl 19, Fig 5, Rowley Shelf.

Quinqueloculina parkeri (Brady); [*Miliolina*].

Lachlanella parkeri (Brady); Loeblich & Tappan 1994, Pl 74, Figs 1-6, Sahul Shelf.

Betjeman (1969) recorded this species from the Abrolhos Islands and areas north on the Western Australia shelf.

Quinqueloculina philippinensis Cushman.

Quinqueloculina philippinensis Cushman; Loeblich & Tappan 1994, Pl 81, Figs 1-10, Sahul Shelf.

A broad range of ornament and apertural neck development is included here (similar to the range shown by the Papuan specimens illustrated by Haig 1988). Betjeman (1969) recorded the species from the Dirk Hartog Shelf and Rowley Shelf.

Quinqueloculina pittensis Albani; Figure 4:2,3.

Quinqueloculina subarenaria Cushman; Mackenzie 1962, Pl 2, Fig 22, Oyster Harbour.

Quinqueloculina poeyana d'Orbigny; Figure 4:4,5.

Quinqueloculina poeyana d'Orbigny; Mackenzie 1962, Oyster Bay.

The Papuan specimens identified as *Q. poeyana* by Haig (1988, Pl 7, Figs 15-17) do not belong to this species (see Loeblich & Tappan 1994, p. 51).

Quinqueloculina quinquecarinata Collins.

Quinqueloculina quinquecarinata Collins; Loeblich & Tappan 1994, Pl 79, Figs 13-18, Sahul Shelf.

Quinqueloculina sulcata d'Orbigny.

Quinqueloculina sulcata d'Orbigny; Loeblich & Tappan 1994, Pl 82, Figs 1-6, Sahul Shelf.

Not *Quinqueloculina sulcata* d'Orbigny; Mackenzie 1962.

Quinqueloculina tropicalis Cushman.

Quinqueloculina tropicalis Cushman; Loeblich & Tappan 1994, Pl 78, Figs 13-15, Sahul Shelf.

Quinqueloculina vandiemeniensis Loeblich & Tappan.

Quinqueloculina vandiemeniensis Loeblich & Tappan; Loeblich & Tappan 1994, Pl 83, Figs 1-3, Sahul Shelf.

***Quinqueloculina* sp 1**; Figure 4:6,7.

? *Quinqueloculina granulocostata* Germeraad; Mackenzie 1962, Pl 2, Fig 18, Oyster Harbour.

The costate ornament resembles that in *Q. granulocostata*, but the elongate apertural tooth differs from the bifid tooth in *Q. granulocostata*.

***Quinqueloculina* sp 2.**

Quinqueloculina costata d'Orbigny; Mackenzie 1962, Pl 2, Fig 17, Oyster Harbour.

Quinqueloculina undulata d'Orbigny; Loeblich & Tappan 1994, Pl 81, Figs 11-13, Sahul Shelf.

In Papuan Lagoon assemblages, this species was misidentified as *Q. poeyana* by Haig (1988, p. 234, Pl 7, Figs 15-17).

***Quinqueloculina* sp 3**; Figure 4:8,9.

This species may be the species identified by Loeblich & Tappan (1994, p. 49, Pl 80, Figs 13-15) as *Q. incisa* Vella. It may be related to *Quinqueloculina patagonica* d'Orbigny.

***Quinqueloculina* sp 4**; Figure 4:10,11.

This species is close to the type recorded from the Papuan Lagoon as *Quinqueloculina* sp A by Haig (1988, Pl 9, Figs 1-3).

***Quinqueloculina* sp 5**; Figure 4:12,13.

This species was recorded from the Papuan Lagoon as *Quinqueloculina* sp C by Haig (1988, Pl 9, Figs 7-10).

***Quinqueloculina* sp 6**; Figure 4:14,15.

This species was recorded from the Papuan Lagoon as *Quinqueloculina* cf *Q. oblonga* (Montagu) by Haig (1988, Pl 6, Figs 26-29).

***Quinqueloculina* sp 7**; Figure 4:16,17.

This species may be related to *Quinqueloculina multimarginata* Said.

***Quinqueloculina* sp 8**; Figure 4:18,19.

Quinqueloculina bosciana d'Orbigny; Mackenzie 1962, Pl 2, Fig 16, Oyster Harbour.

In chamber arrangement and apertural detail, this species resembles *Pitella haigi* Langer; but lacks distinct pseudopores.

Rupertianella rupertiana (Brady); [*Miliolina*].

Rupertianella rupertiana (Brady); Loeblich & Tappan 1994, Pl 106, Figs 1-14, Sahul Shelf.

Schlumbergerina alveoliniformis (Brady); [*Miliolina*].

Schlumbergerina alveoliniformis (Brady); Loeblich & Tappan 1994, Pl 72, Figs 9-11, Sahul Shelf.

Sigmamiliolinella australis (Parr); [*Quinqueloculina*].

Sigmamiliolinella australis (Parr); Loeblich & Tappan 1994, Pl 100, Figs 1-3, Sahul Shelf.

Betjeman (1969) recorded "*Miliolinella australis*" as rare but widespread on the Western Australian shelf.

Sigmoihauerina involuta (Cushman); [*Hauerina*].

Sigmoihauerina involuta (Cushman); Loeblich & Tappan 1994, Pl 100, Figs 8-12, Sahul Shelf.

Sigmoilinella tortuosa Zheng; Figure 4:20,21.

Cycloforina collinsi Langer and *Adelosina pascuaensis* Koutsoukos & Falchetta are probably junior subjective synonyms of *S. tortuosa*.

Sorites marginalis (Lamarck); [*Orbulites*].

Sorites marginalis (Lamarck); Loeblich & Tappan 1994, Pl 112, Figs 1-5, Sahul Shelf.

Spiroloculina angulata Cushman; Figure 4:22.

Spiroloculina angulata Cushman; Mackenzie 1962, Oyster Harbour.

Quilty (1977) noted this species from Hardy Inlet.

Spiroloculina hadai Thalmann.

Spiroloculina hadai Thalmann; Loeblich & Tappan 1994, Pl 66, Figs 11-15, Sahul Shelf.

Spiroloculina scrobiculata Cushman.

Spiroloculina milletti Wiesner; Mackenzie 1962, pl.2, Fig 4, Oyster Harbour.

Spiroloculina scrobiculata Cushman; Loeblich & Tappan 1994, Pl 67, Figs 12-16, Sahul Shelf.

Spiroloculina subimpressa Parr.

Spiroloculina subimpressa Parr; Loeblich & Tappan 1994, Pl 68, Figs 9-15, Sahul Shelf.

Triloculina barnardi Rasheed; Figure 4:23.

Triloculina littoralis Collins.

Triloculina littoralis Collins; Loeblich & Tappan 1994, Pl 95, Figs 11-13, Sahul Shelf.

Triloculina papuaensis Rasheed; Figure 4:24.

Triloculina tricarinata d'Orbigny; Mackenzie 1962, Oyster Harbour.

T. papuaensis differs from *T. tricarinata* by the presence of a apertural neck.

Triloculina tricarinata d'Orbigny.

Triloculina tricarinata d'Orbigny; Loeblich & Tappan 1994, Pl 96, Figs 1-7, Sahul Shelf.

Betjeman (1969) recorded this species as widespread on the Western Australian shelf.

Triloculina vespertilio Zheng.

Triloculina striatotrigonula Parker & Jones; Quilty 1977, Fig 17, Hardy Inlet.

Triloculina vespertilio Zheng; Loeblich & Tappan 1994, Pl 97, Figs 1-6, Sahul Shelf.

Vertebralina striata d'Orbigny.

Vertebralina striata d'Orbigny; Mackenzie 1962, Pl 1, Fig 20, Oyster Harbour; Loeblich & Tappan 1994, Pl 60, Figs 1-7, Sahul Shelf.

Betjeman (1969) noted this species as common in Cockburn Sound (Rottnest Shelf region).

Wiesnerella auriculata (Egger); [*Planispirina*].

Wiesnerella auriculata (Egger); Loeblich & Tappan 1994, Pl 62, Figs 1-3, Sahul Shelf.

Order Spirillinida

Conicospirillinoides semidecoratus (Heron-Allen & Earland); [*Spirillina*].

Conicospirillinoides semidecoratus (Heron-Allen & Earland); Loeblich & Tappan 1994, Pl 50, Figs 1-9, Sahul Shelf.

***Conicospirillinoides* sp;** Figure 5:1,2.

***Mychostomina* sp;** Figure 4:25-27.

Spirillina vivipara Ehrenberg.

Spirillina vivipara Ehrenberg; Loeblich & Tappan 1994, Pl 54, Figs 5-10, Sahul Shelf.

The Exmouth specimens fit within the range of variability shown by Brady's (1884, Pl 85, Figs 1-4) figures.

Order Lagenida

***Dentalina* sp 1;** Figure 5:3.

***Dentalina* sp 2;** Figure 5:4.

Fissurina contusa Parr.

Fissurina contusa Parr; Loeblich & Tappan 1994, Pl 136, Figs 11-16, Sahul Shelf.

Betjeman (1969) noted that this species is more abundant on southern rather than northern sectors of the Western Australian shelf.

Fissurina crassiporosa McCulloch.

Fissurina crassiporosa McCulloch; Loeblich & Tappan 1994, Pl 155, Figs 15,16, Sahul Shelf.

The Western Australian specimens appear closer to the holotype (McCulloch 1977, p. 98, Pl 56, Fig 16) than the paratypes which appear to have a granular rather than smooth surface and lack a distinct basal spine.

Fissurina globosocaudata Albani & Yassini.

Fissurina robusta Zheng; Loeblich & Tappan 1994, Pl 158, Figs 5-8, Sahul Shelf.

F. robusta lacks the basal protrudences of *F. globosocaudata*, and has opaque U-shaped areas on either side of test which are absent in *F. globosocaudata*.

Fissurina* sp cf *F. granulocostulata Zheng.

Cerebrina granulocostata (Zheng); Loeblich & Tappan 1994, Pl 135, Figs 1-7, Sahul Shelf.

The apertural neck in the Western Australian specimens is more extended than in *F. granulocostulata*.

Fissurina lacunata (Burrows & Holland); [*Lagena*].

Cerebrina lacunata (Burrows & Holland); Loeblich & Tappan 1994, Pl 135, Figs 8-15, Sahul Shelf.

Betjeman (1969) noted that this species is more abundant on southern rather northern sectors of the Western Australian shelf.

Fissurina subquadrata Parr.

Fissurina quadrata (Williamson); Loeblich & Tappan 1994, Pl 155, Figs 1-10, Sahul Shelf.

F. quadrata has a short neck and lacks the marginal groove of *F. subquadrata*.

Fissurina sanpedroensis (McCulloch); [*Lagenosolenia*].

Lagenosolenia sanpedroensis McCulloch; Loeblich & Tappan 1994, Pl 161, Figs 3,4, Sahul Shelf.

Fissurina trinalimarginata (Loeblich & Tappan); [*Duplella*]

Duplella trinalimarginata Loeblich & Tappan 1994, Pl 154, Figs 4-8, Sahul Shelf.

A distinct double slit aperture is not present in the Exmouth specimens and was not shown on Loeblich & Tappan's (1994) figures of the type specimens.

Fissurina wrightiana (Brady); [*Lagena*].

Fissurina wrightiana (Brady); Loeblich & Tappan 1994, Pl 158, Figs 1,2, Sahul Shelf.

***Fissurina* sp 1**; Figure 5:5.

***Fissurina* sp 2**; Figure 5:6.

Glandulina* sp cf *G. symmetrica McCulloch.

Glandulina symmetrica McCulloch; Loeblich & Tappan 1994, Pl 168, Figs 6-8, Sahul Shelf.

The species differs from the bathyal *G. symmetrica* by lacking the series of short diverging spines at the base of the test.

***Glandulina* sp**; Figure 5:7.

Guttulina bartschi Cushman & Ozawa.

Guttulina bartschi Cushman & Ozawa; Loeblich & Tappan 1994, Pl 145, Figs 5-15, Sahul Shelf.

Guttulina regina (Brady, Parker & Jones); [*Polymorphina*].

Guttulina regina (Brady, Parker & Jones); Loeblich & Tappan 1994, Pl 146, Figs 1-3. ***Guttulina* sp**; Figure 5:8.

Lagena dorbignyi R.W. Jones.

Lagena dorbignyi R.W. Jones; Loeblich & Tappan 1994, Pl 138, Figs 6-9, Sahul Shelf.

Lagena oceanica Albani.

Pygmaeoseistron oceanicum (Albani); Loeblich & Tappan 1994, p. 80, Pl 144, Figs 4-7, Sahul Shelf.

Lenticulina domantayi (McCulloch); [*Robulus*].

Lenticulina domantayi (McCulloch); Loeblich & Tappan 1994, Pl 121, Figs 1-8, Sahul Shelf.

Nodosaria catesbyi d'Orbigny.

Pyramidulina catesbyi (d'Orbigny); Loeblich & Tappan 1994, Pl 116, Figs 10-12, Sahul Shelf.

Oolina melosquamosa McCulloch.

Favulina melosquamosa (McCulloch); Loeblich & Tappan 1994, Pl 151, Figs 13-17, Sahul Shelf.

Procerolagena gracillima (Seguenza); [*Amphorina*].

Hyalinonetrion distomapolitum (Parker & Jones); Loeblich & Tappan 1994, Pl 137, Figs 10-12.

***Pseudoglandulina* sp**; Figure 5:9.

Sigmoidella elegantissima (Parker & Jones); [*Polymorphina*].

Sigmoidella elegantissima (Parker & Jones); Mackenzie 1962, Pl 3, Fig 4, Oyster Harbour; Loeblich & Tappan 1994, Pl 148, Figs 4-12, Sahul Shelf.

***Webbinella* sp**; Figure 5:10.

Order Buliminida

Abditodendrix rhomboidalis (Millett); [*Textularia*].

Tortoplectella rhomboidalis (Millett); Loeblich & Tappan 1994, Pl 216, Figs 1-6, Sahul Shelf.

***Angulogerina* sp 1**; Figure 5:11.

***Angulogerina* sp 2**; Figure 5:12

Bolivina striatula Cushman; Figure 5:13.

Bolivina vadescens Cushman.

Bolivina vadescens Cushman; Loeblich & Tappan 1994, Pl 214, Figs 1-4,7-12, Sahul Shelf.

Bolivina variabilis (Williamson); [*Textularia*].

Bolivina variabilis (Williamson); Loeblich & Tappan 1994, Pl 216, Figs 7-15, Sahul Shelf.

***Bolivina* sp 1**; Figure 5:14.

***Bolivina* sp 2**; Figure 5:15.

Bulimina marginata d'Orbigny.

Bulimina marginata d'Orbigny; Loeblich & Tappan 1994, Pl 242, Figs 1-4, Sahul Shelf.

Buliminoides williamsonianus (Brady); [*Bulimina*].

Buliminoides williamsonianus (Brady); Loeblich & Tappan 1994, Pl 297, Figs 1-9, Sahul Shelf.

Quilty (1977) noted this species in Hardy Inlet. The suprageneric classification of the species is uncertain (Revets 1990).

Chrysalidinella dimorpha (Brady); [*Chrysalidina*].

Chrysalidinella dimorpha (Brady); Loeblich & Tappan 1994, Pl 252, Figs 7-13, Sahul Shelf.

Elongobula* sp cf *E. cochlea (Wiesner).

Floresina durrandi Revets; Loeblich & Tappan, Pl 245, Figs 1-6, Sahul Shelf.

Elongobula milletti (Cushman); [*Buliminella*]; Figure 5:16-18.

***Evolvocassidulina* sp**; Figure 5:19.

Fursenkoina pauciloculata (Brady); [*Virgulina*].

Fursenkoina pauciloculata (Brady); Loeblich & Tappan 1994, Pl 256, Figs 1-5, Sahul Shelf.

The Exmouth specimens differ from typical *F. pauciloculata* in having a few more chambers in the adult test.

***Globocassidulina* sp**; Figure 5:20.

Hopkinsinella glabra (Millett); [*Uvigerina*].

Hopkinsinella glabra (Millett); Loeblich & Tappan, Pl 232, Figs 1-11, Sahul Shelf.

Loxostomina costatapertusa Loeblich & Tappan.

Loxostomina costatapertusa Loeblich & Tappan 1994, Pl 234, Figs 1-12, Sahul Shelf.

Loxostomina costulata (Cushman); [*Bolivina*].

Loxostomina costulata (Cushman); Loeblich & Tappan 1994, Pl 232, Figs 12-16, Sahul Shelf.

This identification follows the interpretation of Hottinger *et al.* (1993) who showed a range of ornament from a few costae (as in Cushman's type) to numerous costae over the entire test.

Loxostomina limbata (Brady); [*Bolivina*].

Loxostomina limbata (Brady); Loeblich & Tappan 1994, Pl 233, Figs 1-8, Sahul Shelf.

Specimens with few faint costae over the initial part of test are transitional to *L. costulata*.

Millettia limbata (Brady); [*Sagrina*].

Millettia limbata (Brady); Loeblich & Tappan, Pl 255, Figs 7-8, Sahul Shelf.

Neocassidulina abbreviata (Heron-Allen & Earland); [*Bolivina*].

Neocassidulina abbreviata (Heron-Allen & Earland); Loeblich & Tappan 1994, p.131, Pl 258, Figs 1-7, Sahul Shelf.

This species is synonymous with *Bolivina makiyamae* Ishizaki. Haig (1993) suggested that transitional morphotypes may exist between *N. abbreviata* and *Neocassidulina capitata* (Cushman). Although *N. capitata* has not been found in Exmouth Gulf, morphotypes of *N. abbreviata* trending toward the more inflated, more loosely embracing chamber arrangement of *N. capitata* are present.

Neouvigerina ampullacea (Brady); [*Uvigerina*].

Neouvigerina ampullacea (Brady); Loeblich & Tappan 1994, Pl 246, Figs 9-19, Sahul Shelf.

Radiatobolivina okinawaensis Hatta.

Radiatobolivina okinawaensis Hatta in Hatta & Ujiie 1992, p. 205-206, Pl 51, Figs 1a-2c, 3-5.

Krebsina subtenuis (Cushman); Loeblich & Tappan 1994, Pl 146, Figs 12-16; Sahul Shelf.

***Radiatobolivina* sp.**

Krebsina pilasensis (McCulloch); Loeblich & Tappan 1994, Pl 146, Figs 10,11.

The relationship of *Krebsina* McCulloch to *Radiatobolivina* Hatta is uncertain, as is the suprageneric classification of these taxa.

***Reussella* sp 1**; Figure 5:21.

***Reussella* sp 2**; Figure 5:22

***Reussella* sp 3**; Figure 5:23-25.

Rugobolivinella elegans (Parr); [*Bolivinella*].

Rugobolivinella elegans (Parr); Loeblich & Tappan 1994, Pl 220, Figs 1-6, Sahul Shelf.

Betjeman (1969) noted the species (as *Bolivinella elegans*) from Exmouth Gulf and the Rowley Shelf.

Sagrinnella jugosa (Brady); [*Textularia*].

Sagrinnella jugosa (Brady); Loeblich & Tappan 1994, Pl 237, Figs 12-17, Sahul Shelf.

The generic attribution follows Revets (1996).

***Sagrinnella* sp.**

Sagrinnella zanzibarica (Cushman); Loeblich & Tappan 1994, Pl 238, Figs 12-17, Sahul Shelf.

The species differs from *Bolivina zanzibarica* Cushman in apertural details (having a high-arched aperture without projecting toothplate in contrast to an elliptical aperture with distinct raised lip) and in having more inflated, less angulate adult chambers.

Sagrinnella scutata Saidova.

Sagrinnella scutata Saidova; Loeblich & Tappan 1994, Pl 236, Figs 9, 10, Sahul Shelf.

The generic attribution is uncertain. Haig (1993) included similar morphotypes in "*Sagrinnella*" gr. *convallarium* (Millett); however, the apparent broad range of variability recorded in the Papuan assemblage is not present among the Exmouth Gulf specimens.

Sagrinnopsis fimbriata (Millett); [*Bigenerina*].

Sagrinnopsis fimbriata (Millett); Loeblich & Tappan 1994, Pl 239, Figs 1-10, Sahul Shelf.

Sigmavirgulina tortuosa (Brady); [*Bolivina*].

Sigmavirgulina tortuosa (Brady); Loeblich & Tappan 1994, Pl 261, Figs 1-10, Sahul Shelf.

Betjeman (1969) noted this species is more abundant on southern sectors of the Western Australian shelf.

Siphogenerina raphana (Parker & Jones); [*Uvigerina*].

Siphogenerina raphana (Parker & Jones); Mackenzie 1962, Oyster Harbour; Loeblich & Tappan 1994, Pl 240, Figs 1-3, ?4-5, 6-11, Sahul Shelf.

Quilty (1977) noted the species (as *Rectobolivina raphanus*) in Hardy Inlet.

Siphouvigerina porrecta (Brady); [*Uvigerina*].

Siphouvigerina porrecta (Brady); Loeblich & Tappan, Pl 247, Figs 6-11, Sahul Shelf.

Valvobifarina mackinnoni (Millett); [*Bifarina*].

Valvobifarina mackinnoni (Millett); Loeblich & Tappan 1994, Pl 254, Figs 9-12, Sahul Shelf.

Order Rotaliida

Acervulina mahabeti (Said); [*Planorbulina*]; Figure 5:26.

Planorbulina acervalis Brady; Mackenzie 1962, Pl 3, Fig 16, Oyster Harbour.

The identification of this species follows Hottinger *et al.* (1993, p. 122,123, Pl 165, Figs 1-7, Pl 166, Figs 1-8). The specimen figured by Loeblich & Tappan (1994, Pl 323, Figs 11-13) may be a juvenile of the species.

Ammonia parkinsoniana (d'Orbigny); [*Rosalina*].

Ammonia parkinsoniana (d'Orbigny); Loeblich & Tappan 1994, Pl 368, Figs 7-16; Sahul Shelf.

? *Streblus beccarii* (Linné); Mackenzie 1962, Pl 3, Fig 18, Oyster Harbour.

Ammonia supera Belford.

Ammonia supera Belford; Loeblich & Tappan 1994, Pl 370, Figs 7-9, Sahul Shelf.

***Ammonia* sp**; Figures 5:27, 6:1.

This seems to be the same form illustrated by Loeblich & Tappan (1994, Pl 387, Figs 4-6) as *Notorotalia inornata* Vella. Unlike Vella's types, the Exmouth specimens have an open umbilicus and some (e.g. Fig 5:27) have a prominent umbonal plug. A peripheral keel, prominent in *N. inornata*, is absent in the Western Australian species.

Amphistegina lessonii d'Orbigny.

Amphistegina lessonii d'Orbigny; Loeblich & Tappan 1994, Pl 340, Figs 1-9, Sahul Shelf.

Betjeman (1969) noted this species as widespread on the Western Australian shelf, and Quilty (1977) recorded it from Hardy Inlet.

***Amphistegina* sp cf *A. papillosa* Said.**

Amphistegina papillosa Said; Loeblich & Tappan 1994, Pl 339, Figs 4-7; Pl 341, Figs 1-7, Sahul Shelf.

The Western Australian specimens are generally smaller and do not have the intensity of ornament shown by the type specimen. Betjeman (1969) recorded "*Amphistegina radiata* var. *papillosa*" from Shark Bay and areas north on the Western Australian shelf.

***Amphistegina radiata* (Fichtel & Moll); [*Nautilus*].**

Amphistegina radiata (Fichtel & Moll); Loeblich & Tappan 1994, Pl 339, Figs 8-11, Pl 341, Figs 8-10.

***Angulodiscorbis corrugatus* (Millett); [*Discorbina*].**

Angulodiscorbis corrugatiformis (McCulloch); Loeblich & Tappan 1994, Pl 290, Figs 8-10, Sahul Shelf.

***Anomalinulla glabrata* (Cushman); [*Anomalina*]; Figure 6:2,3.**

Anomalinoides globulosa (Chapman & Parr); Loeblich & Tappan 1994, Pl 355, Figs 4-5, 10-13 (not Figs 7,8; not Pl 354, Figs 11-12).

***Asanonella tubulifera* (Heron-Allen & Earland); [*Truncatulina*].**

Asanonella tubulifera (Heron-Allen & Earland); Loeblich & Tappan 1994, Pl 337, Figs 1-10, Sahul Shelf.

***Ashbrookia ornata* McCulloch.**

Ashbrookia tuberculata Ujiie; Loeblich & Tappan 1994, Pl 262, Figs 1-3, Sahul Shelf.

The Western Australian specimens lack the distinct radial grooves around the aperture that characterise *A. tuberculata*; and have the matte granular surface of the spiral side of *A. ornata*.

***Asterorotalia gaimardi* (d'Orbigny); [*Turbinulina*].**

Asterorotalia gaimardi (d'Orbigny); Loeblich & Tappan 1994, Pl 372, Figs 1-7, Sahul Shelf.

***Astrononion* sp; Figure 6:4,5.**

***Baggina bubnanensis* McCulloch.**

Baggina bubnanensis McCulloch; Loeblich & Tappan, Pl 264, Figs 5-10, Sahul Shelf.

***Cancris auriculus* (Fichtel & Moll); [*Nautilus*].**

Cancris auriculus (Fichtel & Moll); Loeblich & Tappan 1994, Pl 265, Figs 7-10, Sahul Shelf.

The specimens figured by Loeblich & Tappan (1994, Pl 266, Figs 1-13) as *C. carinatus* (Millett) may belong to this species; they lack the triangular cross-section in the last chamber that is characteristic of Millett's species.

***Caribbeanella* sp cf *C. ogiensis* (Matsunaga); [*Oinomikadoina*].**

Caribbeanella ogiensis (Matsunaga); Loeblich & Tappan 1994, Pl 325, Figs 1-10, Sahul Shelf.

In contrast to the types of *C. ogiensis*, the Western Australian specimens maintain an angulate margin in the adult stage and have a more lobulate periphery in the last few chambers. *Caribbeanella elatensis* Perelis & Reiss has a thicker test.

***Caribbeanella philippinensis* McCulloch.**

Caribbeanella philippinensis McCulloch; Loeblich & Tappan 1994, Pl 324, Figs 1-9, Sahul Shelf.

***Cibicides* sp cf *C. refulgens* Montfort.**

Cibicides refulgens Montfort; Mackenzie 1962, Pl 3, Fig 33, Oyster Harbour; Quilty 1977, Figs 42,43, Hardy Inlet; Loeblich & Tappan 1994, Pl 318, Figs 7-9, Sahul Shelf.

The Western Australian specimens have 9-10 chambers in the final whorl in contrast to 6 chambers in *C. refulgens*. The sutures on the umbilical side tend to be limbate, and the umbilical shoulder of the final chamber tends to be elevated above the shoulders of previous chambers. Betjeman (1969) noted that "*Cibicides refulgens*" is common and widespread on the Western Australian shelf.

?*Cibicides* sp; Figure 6:6-8.

A relationship between this species and *Pulvinulina corticata* Heron-Allen & Earland is suspected.

***Cibicoides basilanensis* McCulloch; Figure 6:9,10.**

An opaline sheen on the spiral side is a feature of the Exmouth specimens and McCulloch's (1977, p. 445, Pl 187, Figs 1,2) types housed at the Smithsonian Institution, Washington.

***Cibicoides* sp; Figure 6:11,12.**

***Colonimilesia obscura* McCulloch.**

Colonimilesia obscura McCulloch; Loeblich & Tappan 1994, Pl 282, Figs 1-6, 13-14, Sahul Shelf.

***Criobaggina socorroensis* McCulloch; Figure 6:13,14.**

***Cymbaloporella tabellaeformis* (Brady); [*Cymbalopora*]; Figure 6:15,16.**

***Cymbaloporella bradyi* (Cushman); [*Cymbalopora*].**

Cymbaloporella bradyi (Cushman); Mackenzie 1962, Oyster Harbour; Loeblich & Tappan 1994, Pl 328, Figs 1-3, Sahul Shelf.

Betjeman (1969) recorded this species as more abundant in northern sectors of the Western Australian shelf.

***Discorbinella bodjongensis* (Le Roy); [*Discorbis*].**

Discorbinella bodjongensis (Le Roy); Loeblich & Tappan 1994, Pl 310, Figs 1-13, Sahul Shelf.

***Discorbinella rhodiensis* (Terquem); [*Truncatulina*]; Figure 6:17,18.**

The identification follows Hottinger *et al.* (1993, p. 115, Pl 150, Figs 5-9).

***Discorbinoides patelliformis* (Brady); [*Discorbina*].**

Discorbinoides minogisiformis Ujiie; Loeblich & Tappan 1994, Pl 291, Figs 1-10, Sahul Shelf.

The Western Australian specimens lack strong ornament on the spiral side. The specimens from Hardy Inlet that Quilty (1977, Figs 38,39) attributed to this species, do not belong here.

***Elphidium* sp cf *E. advenum* (Cushman); [*Polystomella*]; Figure 6:19,20.**

The Exmouth specimens differ from the specimens illustrated as *E. advenum* by Loeblich & Tappan (1994, Pl 379, Figs 1-4) in having a larger number of chambers

in the final whorl, and more prominent retral processes across the sutures. The Exmouth specimens differ from Oyster Harbour types included in *E. advenum* by Mackenzie (1962) in having slightly fewer chambers in the final whorl and a sharper periphery, and from a specimen figured by Quilty (1977, Fig 54) in having fewer chambers in the adult whorl.

Elphidium albanii Hayward; Figure 6:21,22.

Elphidium albanii Hayward 1997, p. 70,71, Pl 6, Figs 1-5.

Elphidium carteri Hayward.

Elphidium carteri Hayward 1997, p. 71,72, Pl 1, fig.15, Pl 6, Figs 8-12.

Elphidium jenseni (Cushman); Loeblich & Tappan 1994, Pl 381, Figs 4,5, ?1-3, Sahul Shelf.

E. jenseni has more chambers in the adult whorl (around 17) than has *E. carteri* (12-14).

Elphidium* sp cf *E. craticulatum (Fichtel & Moll); [Nautilus]; Figure 6:23.

This species belongs to the group of *Elphidium craticulatum* (Fichtel & Moll), but differs from typical specimens by having interconnected vermiform ridges crossing the broad central umbo.

Elphidium crispum (Linné); [Nautilus].

Elphidium crispum (Linné); Mackenzie 1962, Pl 3, Fig 21, Oyster Harbour; Quilty 1977, Fig 55, Hardy Inlet; Loeblich & Tappan 1994, Pl 378, Figs 4-6, Sahul Shelf.

Betjeman (1969) recorded this species as widespread on the Western Australian shelf.

Elphidium mortonbayensis Albani & Yassini; Figure 6:24,25.

Elphidium mortonbayensis Albani & Yassini 1993, p. 30, Figs 74, 78.

The Exmouth specimens have a more broadly rounded periphery than in the type specimens.

Elphidium neosimplex McCulloch.

Elphidium neosimplex McCulloch; Loeblich & Tappan 1994, Pl 381, Figs 6-11, Sahul Shelf.

Elphidium oceanicum Cushman; Figure 6:26,27.

This is probably the same form as Albani & Yassini (1993, p. 21, Figs 27,28) recorded as *Cribrononion schmitti* (Cushman & Wickenden). The species has a greater number of chambers in the final whorl, and a greater number of more distinct retral processes crossing the sutures than has *C. schmitti*.

Elphidium simplex Cushman.

Elphidium simplex Cushman; Loeblich & Tappan 1994, Pl 385, Figs 1-12, Sahul Shelf.

Betjeman (1969) noted that *E. simplex* occurs from Shark Bay north on the Western Australian shelf. Quilty (1977) recorded the species much further south in Hardy Inlet.

Elphidium* sp cf *E. striatopunctatus (Fichtel & Moll); [Nautilus]; Figure 7:1,2.

***Elphidium* sp 1**; Figure 7:3.

Eupatellinella fastidiosa (McCulloch); [Patellinella].

Eupatellinella fastidiosa (McCulloch); Loeblich &

Tappan 1994, Pl 262, Figs 4-11, Pl 263, Figs 1-6, Sahul Shelf.

Some doubt exists as to the specific identity of the Western Australian specimens. The Exmouth specimens have a keeled margin with the keels of earlier chambers forming low ridges at the chamber contacts on the conical spiral surface. McCulloch (1977, p. 283) described the spiral surface of *E. fastidiosa* as smooth.

Gavelinopsis praegeri (Heron-Allen & Earland); [Discorbina].

Gavelinopsis praegeri (Heron-Allen & Earland); Loeblich & Tappan 1994, Pl 281, Figs 1-10, Sahul Shelf.

***Glabratella* sp**; Figure 7:4,5.

?***Haynesina* sp**; Figure 7:6,7.

Heterolepa subhaidingeri (Parr); [Cibicides].

Heterolepa subhaidingeri (Parr); Loeblich & Tappan 1994, Pl 359, Figs 1-13, Sahul Shelf.

Heterostegina depressa d'Orbigny.

Heterostegina depressa d'Orbigny; Loeblich & Tappan 1994, Pl 389, Figs 1-6, Pl 390, Figs 1-3, Sahul Shelf.

Homotrema rubrum (Lamarck); [Millepora].

Homotrema rubrum (Lamarck) [Millepora]; Loeblich & Tappan 1994, Pl 335, Figs 1-4, Sahul Shelf.

Lamellogorbis melbyae Hansen & Revets; Figure 7:8,9.

Lamellogorbis melbyae Hansen & Revets 1992, Pl 4, Figs 4-6, 9.

Discorbis dimidiatus (Jones & Parker) var. *acervulinoides* Parr; Mackenzie 1962, Pl 3, Fig 9, Oyster Harbour.

Discorbis dimidiatus (Jones & Parker); Quilty 1977, Figs 31,32, Hardy Inlet.

?***Melonis* sp.**

Anomalinoides globulosus (Chapman & Parr); Loeblich & Tappan 1994, Pl 354, Figs 11-13, Pl 354, Figs 11-13, Pl 355, Figs 7-9 (not Figs 4,5,10-13).

Millettiana millettii (Heron-Allen & Earland); [Cymbalopora].

Millettiana millettii (Heron-Allen & Earland); Loeblich & Tappan 1994, Pl 329, Figs 1-12, Sahul Shelf.

Miniacina miniacea (Pallas); [Millepora].

Miniacina miniacea (Pallas); Loeblich & Tappan 1994, Pl 335, Figs 5-6, Sahul Shelf.

***Monspelisina* sp 1.**

Ammonia convexa (Collins); Loeblich & Tappan 1994, Pl 369, Figs 1-10, Sahul Shelf.

A. convexa has a prominent umbonal plug and lacks the sutural clefts of *Monspelisina*.

***Monspelisina* sp 2**; Figure 7:10,15.

Murrayinella murrayi (Heron-Allen & Earland); [Rotalia]; Figure 7:11-12.

Most of the specimens figured by Loeblich & Tappan (1994, Pl 293, Figs 1-10) seem atypical of this species.

Neoconorbina terquemi (Rzehak); [Discorbina].

Neoconorbina terquemi (Rzehak); Loeblich & Tappan 1994, Pl 284, Figs 1-12, Sahul Shelf.

Betjeman (1969) recorded the species as more abundant on northern sectors of the Western Australian shelf. Quilty (1977) noted it from Hardy Inlet.

Neorotalia calcar (d'Orbigny); [*Calcarina*]; Figure 7:13,14.

Betjeman (1969) recorded "*Calcarina calcar*" from the Abrolhos Islands and areas north on the Western Australian shelf.

Nonion sp cf N. subturgidum (Cushman); [*Nonionina*].

Nonion subturgidum (Cushman); Loeblich & Tappan 1994, Pl 343, Figs 1-9, Sahul Shelf.

The Western Australian species has a greater number of chambers (11-12) in the adult whorl than has *N. subturgidum* (8-9).

Nonionoides sp; Figure 7:16-18.

Nummulites venosus (Fichtel & Moll); [*Nautilus*].

Nummulites venosus (Fichtel & Moll) [*Nautilus*]; Loeblich & Tappan 1994, Pl 388, Figs 5-9, Sahul Shelf.

Betjeman (1965) recorded "*Operculinella venosa*" as more abundant on northern rather than southern sectors of the Western Australian shelf.

Operculina ammonoides (Gronovius); [*Nautilus*].

Assilina ammonoides (Gronovius); Loeblich & Tappan 1994, Pl 387, Figs 7-9, Pl 388, Figs 1-4, Sahul Shelf.

Operculina heterosteginoides Hofker.

Operculina heterosteginoides Hofker; Loeblich & Tappan 1994, Pl 390, Fig 4, Sahul Shelf.

Orbitina carinata Sellier de Civrieux.

Orbitina carinata Sellier de Civrieux; Loeblich & Tappan 1994, Pl 275, Figs 7-12, Sahul Shelf.

Pararotalia nipponica (Asano); [*Rotalia*]; Figure 7:19,20.

Calcarina calcar d'Orbigny; Quilty 1977, Figs 52,53, Hardy Inlet.

The species identification follows Ujiie (1966) who placed spinose *Rotalia ozawai* Asano into synonymy with *P. nipponica*.

Planogypsina acervalis (Brady); [*Planorbulina*]; Figure 7:21.

Planorbulinella larvata (Parker & Jones); [*Planorbulina*].

Planorbulinella larvata (Parker & Jones); Mackenzie 1962, Pl 3, Fig 17, Oyster Harbour; Loeblich & Tappan 1994, Pl 327, Figs 1-7, Sahul Shelf.

Poroeponides lateralis (Terquem); [*Rosalina*]; Figure 7:22.

The Sahul Shelf specimens figured by Loeblich & Tappan (1994, Pl 269, Figs 1-9) as *Eponides cribroreandus* (Asano & Uchio) belong to *P. lateralis* as recognized by Hottinger *et al.* (1991). The figured Exmouth specimen represents an end member of the *P. lateralis* plexus.

Rosalina cosymbosella Loeblich & Tappan 1994.

Rosalina cosymbosella Loeblich & Tappan 1994, p. 140, Pl 287, Figs 1-3, Sahul Shelf.

Rosalina globularis d'Orbigny.

Rosalina globularis d'Orbigny; Loeblich & Tappan 1994, Pl 286, Figs 7-15, Sahul Shelf.

Rotorbis auberi (d'Orbigny); [*Rosalina*].

Discorbis mira Cushman; Mackenzie 1962, Pl 3, Fig 10, Oyster Harbour.

Rotorbis auberi (d'Orbigny); Loeblich & Tappan 1994, Pl 278, Figs 1-8, 9-11, Sahul Shelf.

Betjeman (1969) recorded "*Discorbis mira*" as a widespread although rare species on the Western Australian shelf.

?**Saintclairoides sp**; Figure 7:23,24.

The generic designation is tentative. Loeblich & Tappan (1987) provisionally placed *Saintclairoides* McCulloch among the ceratobulmines (Order Robertinida), and suggested that the systematic position of the genus depended on additional information regarding the aperture and internal features of the test. The Exmouth specimen appears to lack an internal partition.

Schwantzia sp; Figure 7:25,26.

Siphonina tubulosa Cushman.

Siphonina tubulosa Cushman; Loeblich & Tappan 1994, Pl 299, Figs 1-10, Sahul Shelf.

Siphoninoides laevigatus (Howchin); [*Truncatulina*].

Siphoninoides laevigatus (Howchin); Loeblich & Tappan 1994, Pl 300, Figs 1-4, Sahul Shelf.

Sphaerogypsina globula (Reuss); [*Cerriopora*].

Gypsina globulus (Reuss); Quilty 1977, Fig 60, Hardy Inlet.

Sphaerogypsina globula (Reuss); Loeblich & Tappan 1994, Pl 334, Figs 4-6, Sahul Shelf.

Stomatorbina concentrica (Parker & Jones); [*Pulvinulina*].

Stomatorbina concentrica (Parker & Jones); Loeblich & Tappan 1994, Pl 273, Figs 1-7, Sahul Shelf.

Quilty (1977) noted this species, as *Mississippina concentrica*, from Hardy Inlet.

Order Globigerinida

Globigerinoides ruber (d'Orbigny); [*Globigerina*].

Globigerinoides ruber (d'Orbigny); Loeblich & Tappan 1994, Pl 203, Figs 1-9, Pl 206, Figs 10-12, Sahul Shelf.

Globigerinoides trilobus (Reuss); [*Globigerina*].

Globigerinoides trilobus (Reuss); Loeblich & Tappan 1994, Pl 206, Figs 1-6, Sahul Shelf.

Globorotalia menardii (Parker, Jones & Brady); [*Rotalia*].

Globorotalia menardii (Parker, Jones & Brady); Loeblich & Tappan 1994, Pl 183, Figs 1-6.

Globoturborotalita rubescens (Hofker); [*Globigerina*].

Globoturborotalita rubescens (Hofker); Loeblich & Tappan 1994, Pl 208, Figs 1-12, Sahul Shelf.

Neogloboquadrina humerosa (Takayanagi & Saito); [*Globorotalia*].

Neogloboquadrina humerosa (Takayanagi & Saito); Loeblich & Tappan 1994, Pl 199, Figs 1-6, Sahul Shelf.

Tinophodella ambitacrena Loeblich & Tappan.

Tinophodella ambitacrena Loeblich & Tappan; Loeblich & Tappan 1994, Pl 192, Figs 1-9, Pl 200, Figs 1-6, Sahul Shelf.

Table 1.

Distributions of major foraminiferal groups and those species present in at least one sample at frequencies <5%. Abundances are given as percentages in systematic foraminiferal counts from the 150 µm - 2 mm sediment fraction.

SAMPLES	Planktonic Foraminifera	Benthonic Groups	Agglutinated	Porcellaneous	Hyaline (Lagenida)	Hyaline (Bulminida)	Hyaline (Rotaliida)	Agglutinated species	Ammonitium australiensis	Textularia foliacea	Textularia oceanica	Textularia lateralis	Porcellaneous species	Parahauerinoides fragillissimus	Peneroplis pertusus	Planispirinella exigua	Pseudomassilina australis	Quinqueloculina arenata	Quinqueloculina philippinensis	Quinqueloculina sp 8	Sigmoilohauerina involuta	Sortes marginalis	Trilobulina tricarinata	Hyaline species - Rotaliida	Ammonia parkinsoniana	Amphistegina lessonii	Amphistegina sp cf A. papillosa	Amphistegina radiata	Asterotalia gainardi	Cibicides sp cf C. refulgens	Discorbinoidea patelliformis	Elphidium crispum	Elphidium sp cf E. advenum	Elphidium sp 1	Heterostegina depressa	Operculina ammonoides	Pararotalia nipponica	Rosalina corymbosella												
996	2	7	53	1	3	36	0	0	0	0	0	4	1	0	1	2	3	1	2	1	0	5	4	0	0	0	7	2	0	1	0	0	2	1	0	0	2	1	0											
999	0	4	55	1	4	36	0	0	2	1	0	2	8	2	1	0	0	0	2	6	1	1	0	1	1	0	0	0	0	0	0	0	0	0	1	3	0	0	0	0										
1002	0	3	53	1	0	42	0	0	0	1	0	1	10	1	1	3	1	0	1	0	1	0	0	7	4	0	0	0	10	1	1	2	1	0	10	0	0	0	0	0										
1004	0	6	55	0	1	38	1	0	1	2	0	0	2	10	5	1	1	0	1	10	3	3	0	4	3	0	0	0	9	1	2	0	0	0	0	5	1	0	0	0										
1006	0	5	50	1	0	45	0	1	2	1	0	0	13	2	1	0	2	0	0	1	2	1	1	4	1	0	0	0	6	3	2	2	1	1	11	0	0	0	0	0	0									
1008	0	5	60	0	1	33	1	0	1	1	0	0	12	1	1	2	1	2	3	2	5	0	1	1	0	0	0	7	1	1	0	1	1	8	2	0	0	0	0	0	0									
1010	1	10	56	2	4	27	0	0	3	5	0	0	3	2	0	1	5	7	2	0	2	0	0	3	2	0	1	0	1	1	2	1	0	2	0	1	0	0	0	0	0									
1012	0	1	66	1	1	32	0	0	1	0	0	0	10	5	1	1	2	0	0	7	1	0	0	0	1	0	0	0	3	2	2	1	1	9	1	0	0	0	0	0	0	0								
1015	1	11	49	0	1	39	1	0	3	0	0	0	3	3	0	2	3	4	4	0	6	0	4	0	1	0	0	6	2	2	1	2	1	7	0	0	0	0	0	0	0	0								
1017	1	5	42	2	2	49	0	1	3	0	0	0	7	4	1	3	1	0	1	1	1	1	0	6	6	0	1	1	6	4	1	0	8	1	5	1	0	0	0	0	0	0								
1021	2	8	41	1	4	47	0	1	2	2	0	0	5	4	1	1	0	1	2	2	2	0	0	3	3	0	1	2	0	1	0	2	0	2	3	0	0	0	0	0	0	0	0							
1023	1	4	33	0	7	57	0	0	2	0	0	0	7	2	1	0	3	1	1	0	0	0	0	3	0	0	0	8	3	4	1	3	1	3	4	0	0	0	0	0	0	0	0							
1024	2	4	36	1	5	53	0	0	1	1	0	0	4	1	0	1	1	2	1	1	1	1	1	5	3	0	0	7	1	5	1	4	1	2	3	0	0	0	0	0	0	0	0							
1027	0	4	12	1	2	81	0	0	1	2	0	0	2	0	0	0	0	0	0	0	1	0	0	21	6	21	0	3	0	6	3	1	0	0	0	0	0	0	0	0	0	0	0	0						
1029	0	13	43	0	0	44	0	3	1	3	0	0	11	2	2	4	6	0	0	0	2	0	0	3	3	0	1	4	0	11	3	4	1	2	3	0	0	0	0	0	0	0	0							
1031	0	17	38	1	2	43	0	0	7	4	0	0	6	1	2	3	4	1	0	1	1	1	0	6	10	0	2	3	0	6	3	3	1	1	1	0	0	0	0	0	0	0	0	0						
1033	0	9	33	4	1	53	0	1	1	6	0	0	5	0	1	3	6	0	0	0	1	0	0	6	6	0	0	0	16	2	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0					
1035	0	5	48	0	1	46	0	0	1	3	0	0	12	2	4	1	3	0	1	0	1	0	0	3	4	0	0	4	0	15	3	3	1	1	0	1	0	0	0	0	0	0	0	0	0					
1040	0	8	38	1	2	52	0	1	3	3	0	0	7	0	1	0	3	1	0	2	3	0	0	8	5	0	1	1	1	2	0	6	1	5	1	0	0	0	0	0	0	0	0	0	0					
1042	0	19	48	0	7	34	0	1	6	4	0	0	4	2	1	1	0	1	1	4	2	3	0	1	1	0	4	1	1	0	1	1	1	4	1	0	0	0	0	0	0	0	0	0	0	0				
1044	0	11	55	0	4	28	0	2	2	6	0	0	8	5	4	0	0	2	3	1	3	0	0	1	1	0	1	0	3	0	2	0	2	0	1	2	0	0	0	0	0	0	0	0	0	0				
1048	0	8	41	1	5	45	0	1	1	5	0	0	1	1	1	0	0	1	1	3	4	0	4	0	0	0	0	12	0	1	0	2	0	0	4	0	0	0	0	0	0	0	0	0	0	0				
1050	1	30	44	1	0	26	0	2	10	6	0	0	7	1	1	3	6	0	1	1	1	1	0	6	3	0	0	1	0	0	3	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0			
1052	1	6	66	0	0	27	0	0	3	1	0	0	18	3	2	5	0	0	5	1	0	0	2	0	0	0	1	0	5	0	0	3	2	0	5	1	0	0	0	0	0	0	0	0	0	0				
1053	0	12	47	0	3	38	0	3	4	3	0	0	5	8	2	0	0	1	1	4	3	0	3	2	0	0	3	1	3	0	3	1	1	0	6	0	0	0	0	0	0	0	0	0	0	0				
1054	0	11	41	0	4	51	0	1	6	3	0	0	4	5	4	0	0	1	1	1	0	0	2	0	1	0	2	1	7	1	1	1	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0			
1056	0	14	45	1	3	37	2	2	6	1	0	0	2	3	1	1	0	0	2	3	2	0	1	1	0	0	0	5	0	2	0	2	0	3	1	0	0	0	0	0	0	0	0	0	0	0	0			
1058	0	24	38	1	2	35	0	2	8	4	0	0	4	4	0	4	0	0	1	2	0	0	1	0	0	4	1	1	0	1	0	0	6	1	1	0	0	0	0	0	0	0	0	0	0	0	0			
1060	0	18	42	3	3	34	0	3	10	4	0	0	4	2	0	3	8	0	0	1	2	0	0	1	2	0	2	1	1	0	0	2	1	2	0	1	0	0	0	0	0	0	0	0	0	0	0			
1062	1	8	54	0	2	36	0	3	1	2	0	0	12	2	2	2	0	1	5	0	0	0	0	0	3	0	0	0	5	0	1	3	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0		
1064	0	23	48	0	1	29	0	2	9	7	0	0	8	2	2	5	7	0	2	0	1	0	0	2	2	0	2	1	0	5	5	0	1	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0		
1066	0	22	50	0	2	26	0	1	12	5	0	0	9	5	3	3	5	1	2	0	1	0	1	2	3	0	2	1	0	1	0	1	3	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0		
1067	1	12	50	0	5	32	1	1	6	3	0	0	10	3	4	2	4	0	4	1	0	0	1	3	2	0	0	0	5	1	2	6	1	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
1068	0	13	49	0	2	37	0	0	6	3	0	0	16	2	0	0	3	1	0	0	3	0	0	6	3	0	0	0	2	1	0	2	3	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	
1069	0	12	60	1	1	27	0	0	6	2	0	0	10	5	2	2	6	2	1	0	3	0	0	0	4	0	2	0	0	0	2	4	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
1070	1	26	42	1	2	29	0	9	9	3	0	0	6	2	3	1	3	0	0	0	3	0	0	1	1	1	0	1	0	2	0	0	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	
1071	0	5	72	1	0	23	0	1	1	3	0	0	20	1	0	0	3	0	7	0	1	0	0	0	0	0	0	0	7	1	2	1	0	0	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	
1073	0	2	68	0	0	29	0	0	0	1	0	0	22	0	1	0	2	0	1	0	0	0	0	8	1	0	0	0	2	2	0	3	1	0	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	
1075	0	17	46	2	2	32	0	3	7	2	0	0	2	2	3	2	2	1	0	2	6	0	2	1	1	0	7	0	2	0	1	2	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1078	1	21	50	0	1	28	0	2	10	3	0	0	6	8	3	1	2	0	0	3	4	0	2	0	1	0	3	0	1	0	2	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1080	1	5	51	1	4	39	0	2	2	1	0	0	4	12	2	0	2	0	2	3	0	0	2																											

Discussion

The identified microfauna is composed of 242 species, including 236 benthonic taxa (comprising 20 agglutinated, 74 porcellaneous, and 142 hyaline types). Six planktonic species are also present. In terms of abundance (Table 1), the porcellaneous species dominate and, with the hyaline Rotaliida, they form the bulk of the foraminiferal assemblages. Most of the species are very rare and sporadic within gulf sediments. Four agglutinated species, ten porcellaneous species, and 14 hyaline rotaliid species are present at frequencies >5% of the total foraminiferal count in the 150 µm - 2 mm sediment fraction (Table 1).

Because of lack of similar taxonomic databases for other areas along the western coast of Western Australia, only limited biogeographic comparisons can be drawn at present. In comparison with the shallow-marine microfauna from the Sahul Shelf recorded by Loeblich & Tappan (1994), unusual occurrences in Exmouth Gulf which may have biogeographic significance include; (1) the presence of *Borelis schlumbergeri* not recorded from the Sahul Shelf, and the absence of related *Alveolinella quoyi* (d'Orbigny) which was recorded from the Sahul Shelf; (2) the absence of *Calcarina* which is represented by several species on the Sahul Shelf; (3) the absence of *Baculogypsinoidea* present on the Sahul Shelf; and (4) the presence of *Neorotalia calcar* not recorded from the Sahul Shelf, and the absence of *Pararotalia domantayi* McCulloch (often misidentified as *Calcarina calcar* d'Orbigny) which is present on the Sahul Shelf.

A major foraminiferal habitat that is rare in Exmouth Gulf is the seagrass meadow. McCook *et al.* (1995) recorded low abundances of seagrasses in the Gulf, and attributed this to the lack of suitable substrates. The lack of seagrass beds is reflected in the foraminiferal assemblages by the very low abundance of the porcellaneous "larger" Foraminifera, *Amphisorus hemprichii*, which is an abundant epiphytic species elsewhere on the Western Australian coast. The paucity of *Amphisorus* and absence of related *Marginopora* in the Holocene sediment, suggest that seagrass stands may have been rare in the Gulf throughout the Holocene.

Acknowledgements: Samples for this study were made available by the Australian Institute of Marine Science, and were collected by the ship-board scientists on AIMS cruises 669 and 672 during September-October 1994. Sedimentological and bathymetric data were provided by A Orpin and K Woolfe of the Department of Earth Sciences, James Cook University of North Queensland. S Revets provided taxonomic advice on some of the species.

References

Albani A D & Yassini I 1993 Taxonomy and distribution of the Family Elphidiidae (Foraminiferida) from shallow Australian waters. In: Centre for Marine Science, Technical Contribution 5 (ed P Dixon). University of New South Wales, Kensington, 1-49.

Betjeman K J 1969 Recent Foraminifera from the western continental shelf of Western Australia. Contributions from the Cushman Foundation for Foraminiferal Research 20:119-138.

Brady H B 1884 Report on the Foraminifera dredged by HMS Challenger during the years 1873-1876. Reports of the Scientific Results of the Voyage of HMS Challenger 9 (Zoology): 1-814.

Brown R G 1988 Holocene sediments and environments, Exmouth Gulf, Western Australia. In: The North West Shelf, Australia: Proceedings of Petroleum Exploration Society Australia Symposium, Perth, 1988 (eds P G & R R Purcell). Petroleum Exploration Society of Australia, Perth, 85-93.

Burdett, I.D.J., Hedley, R.H., Hornibrook, N. de B., Hurdle, C.M., 1963. *Gaudryina convexa* (Karrer) 1865 - Upper Eocene to Recent; an example of variation and synonymy among Foraminifera. New Zealand Journal of Science 6:513-530.

Ellis B F & Messina A 1940 *et seq* Catalogue of Foraminifera. American Museum of Natural History, New York.

Haig D W 1988 Miliolid Foraminifera from inner neritic sand and mud facies of the Papuan Lagoon, New Guinea. Journal of Foraminiferal Research 18:203-236.

Haig D W 1993 Buliminid Foraminifera from inner neritic sand and mud facies of the Papuan Lagoon, New Guinea. Journal of Foraminiferal Research 23:162-179.

Hatta A & Ujiie H 1992 Benthic Foraminifera from Coral Seas between Ishigaki and Iriomote Islands, Southern Ryukyu Island Arc, Northwestern Pacific. Part 2. Systematic descriptions of Rotalina. Bulletin of the College of Science, University of the Ryukyus 53:163-287.

Hayward B W Hollis C J & Grenfell H R 1997. Recent Elphidiidae (Foraminiferida) of the South-West Pacific and fossil Elphidiidae of New Zealand. New Zealand Institute of Geological & Nuclear Sciences Monograph 16:1-170.

Heron-Allen E & Earland A 1915 The Foraminifera of the Kerimba Archipelago (Portuguese East Africa). Part II. Transactions of the Zoological Society of London 20:543-794.

Hottinger L Halicz E & Reiss Z 1991 Architecture of *Eponides* and *Poroeponides* reexamined. Micropaleontology 37:60-75.

Hottinger L Halicz E & Reiss Z 1993 Recent Foraminiferida from the Gulf of Aqaba, Red Sea. Slovenska Akademija Znanosti in Umetnosti, Ljubljana.

Jones R W 1994 The Challenger Foraminifera. Oxford University Press, Oxford, New York & Tokyo.

Loeblich A R Jr & Tappan H 1987 Foraminiferal Genera and their Classification. Van Nostrand Reinhold Company, New York.

Loeblich A R Jr & Tappan H 1994 Foraminifera of the Sahul Shelf and Timor Sea. Cushman Foundation for Foraminiferal Research, Special Publication 31:1-661.

McCook L J, Klumpp D W & McKinnon A D 1995 Seagrass communities in Exmouth Gulf, Western Australia: A preliminary survey. Journal of the Royal Society of Western Australia 78:81-87.

McCulloch I 1977 Qualitative Observations on Recent Foraminiferal Tests with Emphasis on the Eastern Pacific. University of Southern California, Los Angeles.

McKenzie K G 1962 A record of Foraminifera from Oyster Harbour, near Albany, Western Australia. Journal of the Royal Society of Western Australia 45:117-132.

Murray J W 1991 Ecology and Palaeoecology of Benthic Foraminifera. Longman Scientific & Technical, Harlow.

Quilty P G 1977 Foraminifera of Hardy Inlet, southwestern Australia. Journal of the Royal Society of Western Australia 59:79-90.

Revets S A 1990 The revision of *Buliminoides* Cushman, 1911. Journal of Foraminiferal Research 20:50-55.

Revets S A 1991 The generic revision of the reusellids (Foraminiferida). Journal of Micropaleontology 10:1-15.

Revets S A 1993 The revision of the genus *Elongobula* Finlay, 1939. Journal of Foraminiferal Research 23:254-266.

Revets S A 1996 The generic revision of five families of rotaliine Foraminifera. Part I, The Bolivinitidae; Part II, The Anomaliniidae, Alabaminidae, Cancrisidae & Gavelinellidae. Special Publication, Cushman Foundation for Foraminiferal Research 34:1-113.

Ujiie H Shell structure of Japanese smaller Foraminifera Part 2. *Pararotalia nipponica* (Asano, 1936). Transactions of the Palaeontological Society of Japan, New Service 61:191-200.