

An annotated checklist of Foraminifera of Guam

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Abstract—This paper presents a checklist of 303 species of benthic and planktic Foraminifera from the marine waters off Guam, based on literature records and new collections. Notations on taxonomic synonymies and depositories of type and identified specimens are included in the list.

Introduction

The checklist given below is comprised of 303 species representing all of the major subclades of the clade Foraminifera (Pawlowski 2000). This species checklist was compiled from various resources in the published literature (Cushman 1917, 1932, 1933a, 1933b, 1934, 1942, Todd 1960, 1965, 1966, Matsumaru & Matsuo 1976, Lessard 1980) using the preliminary checklist of 150 species published by Clayshulte (1981a) as a foundation. In addition, several species identified from field collections by the authors were integrated into the list (Clayshulte 1981a, b, S. Richardson, unpublished observations). As much as possible, species identified in the published literature (Cushman 1917, 1932, 1933a, 1933b, 1934, 1942, Todd 1960, 1965, 1966) were checked against specimens housed in the Cushman Collection of Foraminifera, Department of Paleobiology, National Museum of Natural History, Smithsonian Institution, Washington, DC. USNM numbers are listed for those specimens housed in the Smithsonian primary and secondary type collections; however, many of specimens listed by Todd (1966) are stored on assemblage (faunal) microslides that are kept in separate slide cabinets adjacent to the type collections. These microslides are labeled with the locality numbers given in Table 4 of Todd (1966), rather than the USNM numbers assigned to individual slides in the type collections. Attempts to locate the specimens used by Lessard (1980) were unsuccessful. Accession numbers are also listed for those species for which DNA sequences have been deposited in the GenBank Database (Holzmann et al. 2001).

The 303 species of Foraminifera listed below were collected from various shallow-water habitats around Guam, including: beach sands (Todd 1966, Matsumaru & Matsuo 1976, Lessard 1980), sediments (Cushman 1917, 1932, 1933a, 1933b, 1934, 1942, Todd 1960, 1965, 1966), phytal substrata (Lessard 1980, S. Richardson, unpublished observations), and other solid substrata (Clayshulte 1981b). The foraminiferal species identified in the beach sands and sediment samples represent total (dead + live) foraminiferal populations, as no attempt was made in any of the published studies to distinguish between the tests of living foraminiferans and the empty tests of dead organisms. Field studies conducted by Clayshulte (1981b) and S. Richardson (unpublished observations); however, included observations of live individuals attached to settlement plates and other natural substrata, such as reef rock and seagrasses.

Many of the foraminiferal species identified from Guam, such as *Baculogypsina sphaerulata* (Parker & Jones, 1860) (Fig. 1), are distributed widely throughout the Indo-Pacific (Todd 1960, Langer & Hottinger 2000, Belasky 1996). Of the 303 species of Foraminifera identified from Guam, 129 are also known from Saipan (Todd 1957). In addition, several of the Recent species of large, endosymbiont-bearing foraminiferans living today in the shallow waters off Guam are also known from the fossil record (Cole 1939, 1963, Hanzawa 1957, Matsumaru 1976, Todd 1957, 1966).

Currently, the most widely used classification of Foraminifera is that published by Loeblich & Tappan (1987, 1992). In this scheme, Foraminifera is assigned the Linnaean rank of a Class within the Phylum Granuloreticulosa. More recently, molecular phylogenetic studies have challenged traditional ideas on the position of Foraminifera in the tree of life, as well as hypotheses of the evolutionary relationships within Foraminifera itself. While Foraminifera has been consistently shown to comprise a monophyletic clade of single-celled eukaryotes, the position of this clade within Eukaryota is still unresolved. In molecular studies based on 18S ribosomal DNA sequences, Foraminifera appears to be a deep-branching clade of basal mitochondrial eukaryotes, perhaps the earliest extant group with mitochondria (Pawlowski et al. 1996; Pawlowski et al. 1997; Pawlowski et al. 1999 a, b; Pawlowski 2000); however, in a recent molecular analysis based on actin gene sequences, Foraminifera emerges near the eukaryotic crown as the sister group to cercomonads and chlorachniophytes (photosynthetic amoebaflagellates) (Keeling 2001).

Molecular studies have also shed light on the taxonomic composition and relationships of the major subclades within Foraminifera, both confirming and invalidating earlier groupings. It is expected that future studies, both morphological and molecular, will result in further rearrangements. For these reasons, the checklist outlined below is organized in an untraditional manner.

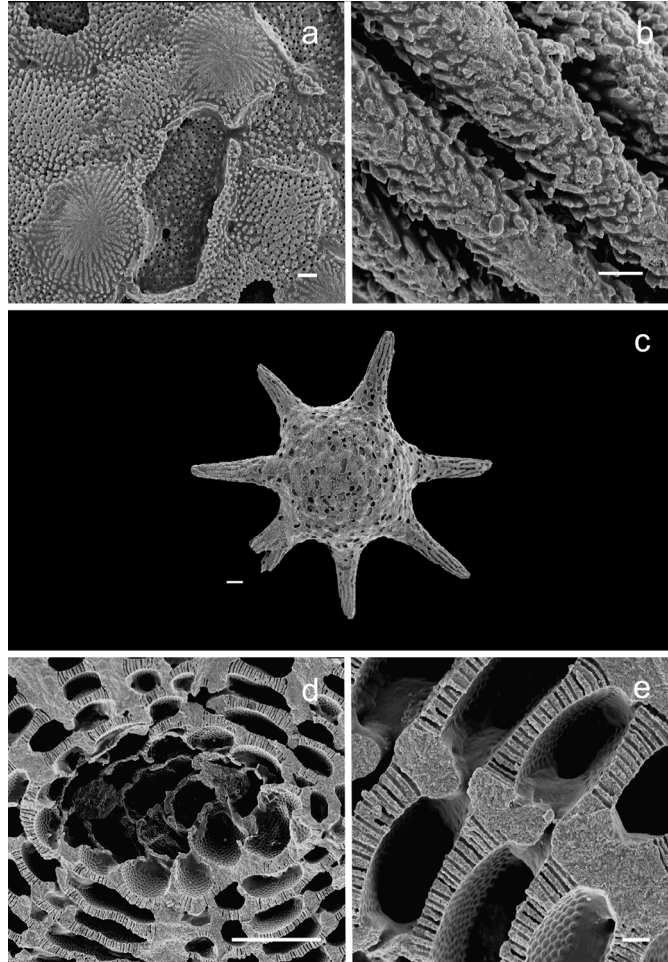


Figure 1. *Baculogypsina sphaerulata* (Parker & Jones, 1860), a benthic foraminiferal species that hosts intracellular diatom endosymbionts. All SEM images are of specimens found in beach sand collected near the entrance to Lost Pond, Guam. a close-up view of test surface, radial-patterned projections represent surface expression of imperforate conical pillars; scale bar = 10 μm . b close-up view of ornamentation on spine surface; scale bar = 10 μm . c view of whole test showing spines radiating from central body of chambers; scale bar = 100 μm . d view of early coiled chambers in sectioned test; scale bar = 100 μm . e close-up view of peripheral chambers in sectioned test showing perforated chamber walls and imperforate conical pillar; scale bar = 10 μm .

Foraminifera and its inclusive subclades (as listed in Appendix 1 below), are not assigned to traditional Linnaean ranks, but are given names based on the most recent molecular phylogeny of Foraminifera (Pawlowski 2000), as is consistent with the principles of phylogenetic taxonomy (de Queiroz & Gauthier 1990,

1992, 1994). The Linnaean system of binomial nomenclature is retained, however, for ease of information retrieval, and species are ordered alphabetically by genus and species within each subclade.

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Appendix 1. Checklist of foraminiferal species

Catalogue numbers with an USNM-prefix are given for type specimens (holo=holotype, para(s)=paratypes(s)) of those species deposited in the Cushman Collection of Foraminifera, Department of Paleobiology, National Museum of Natural History of the Smithsonian Institution in Washington, DC. Accession numbers are listed for those species for which sequences have been deposited in the GenBank Database. USNM a.s.: USNM assemblage slide(s).

Refs: references: numbered references follow at the end of the Appendix

Notes: numbered notes follow at the end of the Appendix

Taxon	Catalogue #	Refs.	Notes
CLADE ASTRORHIZIDA+ALLOGROMIIDA			
<i>Bdelloidina aggregata</i> Carter, 1877	USNM a.s.	9,12	
<i>Haddonina torresiensis</i> Chapman, 1898	USNM a.s.	9,12	
<i>Halyphysema bayeri</i> Loeblich, 1958		14	
<i>Halyphysema</i> cf. <i>H. harryi</i> Loeblich, 1958		14	
<i>Hemidiscella</i> cf. <i>H. palabunda</i> Bock, 1971		14	
<i>Iridia diaphana</i> Heron-Allen & Earland, 1915		14	
<i>Saccamina</i> sp. Todd, 1966	USNM a.s.	9	
<i>Sagenina frondescens</i> (Brady, 1879)	USNM 642328a	9,12	
<i>Spiculidendron coralicolum</i> Richardson & Rützler, 1996		14	
CLADE MILIOLIDA			
<i>Ammomassilina alveoliniformis</i> (Millett, 1898)	USNM a.s.	9	
<i>Amphisorus</i> cf. <i>A. kudakajimensis</i> (Gudmundsson, 1994)	GenBank AJ404316 AJ278050	15	16
<i>Articulina pacifica</i> Cushman, 1944	USNM a.s.	9,12	
<i>Articulina</i> sp. Todd, 1966	USNM 642321, USNM a.s.	9	
<i>Biloculina globula</i> (Bornemann, 1855)	USNM 642315, USNM a.s.	9	
<i>Borelis pulchrus</i> (d'Orbigny, 1839)	USNM a.s.	9,12	
<i>Cornuspira planorbis</i> Schultze, 1854	USNM CC14825	2,9,11 12	17
<i>Cornuspiramia antillarum</i> Cushman, 1922	USNM 642328b	9,14	18
<i>Coscinospira</i> cf. <i>C. pertusus</i> (Forsskål, 1775)		11	19
<i>Dendritina ellipticus</i> (d'Orbigny, 1904)	USNM a.s.	9,12	20
<i>Flintina bradyana</i> Cushman, 1921	USNM 642308	9,12	
<i>Fischerina pellucida</i> Millett, 1898	USNM slide missing	2	
<i>Hauerina diversa</i> Cushman, 1946	USNM a.s.	9,12	
<i>Hauerina involuta</i> Cushman, 1946	USNM a.s.	9,12	
<i>Hauerina milletti</i> Cushman, 1954	USNM a.s.	9,12	
<i>Hauerina ornatissima</i> (Karrer, 1868)	USNM slide missing	2	
<i>Hauerina pacifica</i> Cushman, 1917	USNM CC14971, USNM CC46252	2,9,12	
<i>Massilina durrandi</i> (Millett, 1898)	USNM a.s.	9,12	
<i>Massilina reticulata</i> Heron-Allen & Earland, 1915	USNM a.s.	9	
<i>Massilina secans</i> (d'Orbigny, 1826)	USNM a.s.	9	
<i>Massilina planata</i> Cushman, 1932	USNM CC14629 (holo); USNM CC15031 (paras)	2	

Appendix 1. Checklist of foraminiferal species / (*continued*)

Taxon	Catalogue #	Refs.	Notes
<i>Miliolinella australis</i> (Parr, 1932)	USNM a.s.	9,11 12	
<i>Miliolinella circularis</i> Bornemann, 1855		11	
<i>Miliolinella labiosa</i> (d'Orbigny, 1839)	USNM a.s.	9,12	
<i>Miliolinella oceanica</i> (Cushman, 1932)	USNM a.s.	9,12	
<i>Miliolinella flintiana</i> (Cushman, 1932)	USNM a.s.	9,12	21
<i>Nubeculina advena</i> Cushman, 1924	USNM 642303	9	22
<i>Nubeculina divaricata</i> (Brady, 1879)	USNM a.s.	9	
<i>Orbitolites vertebralis</i> (Quoy & Gaimard in de Blainville, 1834)	USNM a.s., GenBank AJ278059-62	9,10 11,12 15	23
<i>Parrina bradyi</i> (Millett, 1898)	USNM CC15077	2,9,12	
<i>Parasorites</i> cf. <i>P. carpenteri</i> (Smout, 1963)	USNM CC19973, GenBank AJ404305	3,9,12 15	24
<i>Planispirinella exigua</i> (Brady, 1879)	USNM a.s.	9,11 12	
<i>Pseudomassilina reticulata</i> Heron-Allen & Earland, 1915	USNM a.s.	9	25
<i>Puteolina malayensis</i> Hofker, 1951	USNM a.s., GenBank AJ404300	9,14*	26
<i>Pyrgo denticulata</i> (Brady, 1884)	USNM CC15095	2,9,11 12	
<i>Pyrgo striolata</i> (Brady, 1884)	USNM a.s.	9	
<i>Quinqueloculina agglutinans</i> d'Orbigny, 1839	USNM a.s.	9,12	
<i>Quinqueloculina agglutinans</i> (Wiesner in Heron-Allen & Earland, 1915)	USNM CC14722, USNM 642310	2	27
<i>Quinqueloculina apicula</i> Cushman, 1921	USNM a.s.	9,12	
<i>Quinqueloculina arenata</i> Said, 1949	USNM a.s.	9,12	28
<i>Quinqueloculina berthelotiana</i> d'Orbigny, 1839	USNM a.s.	9,12	
<i>Quinqueloculina bidentata</i> d'Orbigny, 1839	USNM a.s.	9,12	
<i>Quinqueloculina bosciiana</i> d'Orbigny, 1839	USNM 642311	9,11 12	
<i>Quinqueloculina ferussacii</i> d'Orbigny, 1826	USNM a.s.	9,12	
<i>Quinqueloculina lamarckiana</i> d'Orbigny, 1839	USNM a.s.	9,12	
<i>Quinqueloculina parkeri</i> (Brady, 1881)	USNM 13070, USNM 13071, USNM CC14735	1,2,9 11,12	
<i>Quinqueloculina plana</i> d'Orbigny, 1839		11	
<i>Quinqueloculina poeyana</i> d'Orbigny, 1839	USNM 642307	9,12	
<i>Quinqueloculina polygona</i> d'Orbigny, 1839	USNM a.s.	9,12	
<i>Quinqueloculina samoensis</i> Cushman, 1924	USNM CC14994	2	
<i>Quinqueloculina</i> cf. <i>Q. seminulum</i> (Linné, 1758)	USNM a.s.	9,12	
<i>Quinqueloculina subarenaria</i> Cushman, 1917	USNM a.s.	9,12	
<i>Quinqueloculina subcuneata</i> Cushman, 1921	USNM 642301	9,12	
<i>Quinqueloculina tubus</i> Todd, 1957	USNM a.s.	9,12	
<i>Schlumbergerina alveoliniformis</i> (Brady, 1879)	USNM a.s.	9	
<i>Siphonaperta distorta</i> Cushman, 1954	USNM a.s.	9,12	29
<i>Sorites</i> cf. <i>S. orbiculus</i> (Forsskål, 1775)	GenBank AJ278053-55	10,14 15	30

Appendix 1. Checklist of foraminiferal species / (continued)

Taxon	Catalogue #	Refs.	Notes
<i>Spirolina acicularis</i> (Batsch, 1791)	USNM a.s.	9,11 12	
<i>Spirolina arietina</i> (Batsch, 1791)	USNM a.s.	9,12	
<i>Spirolina okinawaensis</i> Ujiéé & Hatta, 1994		14	
<i>Spiroloculina angulata</i> Cushman, 1917	USNM CC14937,	2,9,11	31
	USNM a.s.	12	
<i>Spiroloculina caduca</i> Cushman, 1922	USNM a.s.	9,12	
<i>Spiroloculina clara</i> Cushman, 1932	USNM slide missing	2,9	
<i>Spiroloculina communis</i> Cushman & Todd, 1944	USNM a.s.	9,12	
<i>Spiroloculina depressa</i> d'Orbigny, 1826	USNM I388044	1	
<i>Spiroloculina eximia</i> Cushman, 1922	USNM a.s.	9,12	
<i>Spiroloculina folia</i> Todd, 1957	USNM a.s.	9	
<i>Spiroloculina foveolata</i> Egger, 1893	USNM a.s.	9,12	
<i>Spiroloculina grata</i> Terquem, 1878	USNM I388945	1	
<i>Spiroloculina grateloupi</i> d'Orbigny, 1826	USNM slide missing	2	
<i>Spiroloculina hadai</i> Thalmann, 1933	USNM a.s.	9,12	
<i>Spiroloculina marshallana</i> Todd in Cushman, Todd & Post, 1954	USNM a.s.	9	
<i>Spiroloculina rugosa</i> Cushman & Todd, 1944	USNM a.s.	9,12	
<i>Spirophthalmidium acutimargo</i> (Brady, 1884)	USNM I388032	1	32
<i>Triloculina affinis</i> d'Orbigny, 1826	USNM CC14876	2	
<i>Triloculina</i> cf. <i>T. bassensis</i> Parr, 1945	USNM a.s.	9	
<i>Triloculina</i> cf. <i>T. bicarinata</i> d'Orbigny, 1839	USNM a.s.	9,12	
<i>Triloculina bikiniensis</i> Todd in Cushman, Todd & Post, 1954		11	
<i>Triloculina earlandi</i> Cushman, 1954	USNM a.s.	9,12	
<i>Triloculina fichteliana</i> d'Orbigny, 1839	USNM CC14618	2	
<i>Triloculina incisura</i> Todd, 1957	USNM a.s.	9,12	
<i>Triloculina involuta</i> Todd, 1954	USNM a.s.	9	
<i>Triloculina irregularis</i> (d'Orbigny, 1839)	USNM a.s.	9,12	
<i>Triloculina kerimbatica</i> (Heron-Allen & Earland, 1915)	USNM a.s.	9,11 12	
<i>Triloculina marshallana</i> Todd in Cushman, Todd & Post, 1954	USNM a.s.	9,12	
<i>Triloculina oblonga</i> (Montagu, 1803)	USNM CC14924	2,9,11 12	
<i>Triloculina oceanica</i> Cushman, 1932		11	
<i>Triloculina spinata</i> Cushman, 1932	USNM a.s.	9	
<i>Triloculina striolata</i> Cushman, 1918		11	
<i>Triloculina subgranulata</i> Cushman, 1918	USNM 642304	9,12	
<i>Triloculina subplanciana</i> Cushman, 1954	USNM a.s.	9,12	
<i>Triloculina terquemiana</i> (Brady, 1884)	USNM a.s.	9,12	
<i>Triloculina transversistriata</i> (Brady, 1881)	USNM a.s.	9,12	
<i>Triloculina tricarinata</i> d'Orbigny, 1826	USNM a.s.	9,12	
<i>Triloculina trigonula</i> (Lamarck, 1804)	USNM a.s.	9,12	
<i>Varidentella neostriatula</i> (Thalmann, 1950)	USNM a.s.	9,12	33
<i>Vertebralina striata</i> d'Orbigny, 1826	USNM CC14964	2,9,12	
CLADE SPIRILLINIDA			
<i>Conicospirillina semiinvoluta</i> Cushman, 1933	USNM a.s.	9	

Appendix 1. Checklist of foraminiferal species / (continued)

Taxon	Catalogue #	Refs.	Notes
<i>Conicospirillina trochoidea</i> Cushman, 1933	USNM CC19284 (holo)	4	
<i>Conicospirillina</i> sp.	USNM a.s.	8	
<i>Patellina advena</i> Cushman, 1922	USNM CC17552	8	
<i>Patellina altiformis</i> Cushman, 1933	USNM CC17548, USNM a.s.	8,9	34
<i>Patellinella inconspicua</i> (Brady, 1884)	USNM 517045	8	
<i>Spirillina decorata</i> Brady, 1884	USNM a.s.	9	
<i>Spirillina denticulogranulata</i> Chapman, 1907	USNM a.s.	9,12	
<i>Spirillina revertens</i> Rhumbler, 1906	USNM 517050	8,9,12	35
<i>Spirillina spinigera</i> Chapman, 1899	USNM 517049	8	
<i>Spirillina vivipara</i> Ehrenberg, 1843	USNM a.s.	8,9,12	
CLADE NODOSARIIDA			
<i>Amphicoryna scalaris</i> (Batsch, 1791)	USNM a.s.	9	36
<i>Astacolus bradyi</i> (Cushman, 1917)	USNM 642320, USNM a.s.	9	
<i>Astacolus</i> aff. <i>A. californicus</i> Galloway & Wissler, 1927	USNM a.s.	9	
<i>Astacolus planulatus</i> Galloway & Wissler, 1927	USNM 642317, USNM a.s.	9	
<i>Darbyella</i> sp.	USNM a.s.	9	
<i>Dentalina mucronata</i> Neugeboren, 1856	USNM a.s.	9	
<i>Fissurina marginata</i> (Montagu, 1803)		11	
<i>Fronicularia repanda</i> Cushman, 1913	USNM 642329, USNM a.s.	9	37
<i>Lagena desmophora</i> Rymer-Jones, 1872	USNM 15725	3	
<i>Lagena marginato-perforata</i> Seguenza, 1880	USNM 19837	3	
<i>Lagena spiralis</i> Brady, 1884	USNM 15727	3	
<i>Lenticulina orbicularis</i> (d'Orbigny, 1902)	USNM 642316, USNM a.s.	9	38
<i>Lenticulina vortex</i> (Fichtel & Moll, 1798)	USNM a.s.	9	
<i>Nodosaria calomorpha</i> Reuss, 1866	USNM 642323, USNM a.s.	9	
CLADE GLOBIGERINIDA+ROTAIIDA+TEXTULARIIDA, SUBCLADE GLOBIGERINIDA			
<i>Candeina nitida</i> d'Orbigny, 1839	USNM 642286, USNM a.s.	9	
<i>Globigerinella aequilateralis</i> (Brady, 1884)	USNM a.s.	8	
<i>Globigerinella adamsi</i> (Banner & Blow, 1959)	USNM slide missing	8	
<i>Globigerinita glutinata</i> (Egger, 1893)	USNM 517040, USNM a.s.	8,9	
<i>Globigerinoides conglobatus</i> (Brady, 1879)		11	
<i>Globigerinoides sacculifer</i> (Brady, 1884)	USNM 517041, USNM a.s.	8,9,11	39
<i>Globorotalia hirsuta</i> (d'Orbigny, 1839)	USNM a.s.	9	
<i>Globorotalia menardii</i> (Parker, Jones & Brady, 1865)	USNM a.s.	9	
<i>Globorotalia tumida</i> (Brady, 1877)	USNM a.s.	9	
<i>Globorotalia ungulata</i> Bermudez, 1960	USNM slide missing	8	40
<i>Neogloboquadrina dutertrei</i> (d'Orbigny, 1839)	USNM a.s.	9	41
<i>Orbulina universa</i> d'Orbigny, 1839	USNM a.s.	9	

Appendix 1. Checklist of foraminiferal species / (continued)

Taxon	Catalogue #	Refs.	Notes
<i>Pulleniatina obliquiloculata</i> (Parker & Jones, 1865)	USNM 642285, USNM a.s.	9	
<i>Sphaeroidinella dehiscens</i> (Parker & Jones, 1865)	USNM a.s.	9	
CLADE GLOBIGERINIDA+ROTAIIDA+TEXTULARIIDA, SUBCLADE ROTAIIDA			
<i>Acervulina inhaerans</i> Schultze, 1856	USNM 517032	8,9-13	
<i>Acervulina</i> sp.	USNM a.s.	9	
<i>Alliatina translucens</i> (Cushman, 1933)	USNM a.s.	9	
<i>Ammonia beccarii</i> (Linné, 1758)	USNM a.s.	9,11 12	42
<i>Ammonia beccarii</i> (Linné, 1758) var. Todd, 1957	USNM 642306	9,11	43
<i>Ammonia tepida</i> (Cushman, 1926)	USNM a.s.	8,9,11 12	44
<i>Amphistegina lessonii</i> d'Orbigny, 1826	USNM a.s.	9,11 12	
<i>Amphistegina lobifera</i> Larsen, 1976	USNM a.s.	9,12	45
<i>Amphistegina madagascarensis</i> d'Orbigny, 1826	USNM a.s.	9	
<i>Amphistegina papillosa</i> Said, 1949	USNM a.s.	9	46
<i>Angulogerina albatrossi</i> Cushman, 1932	USNM a.s.	9	
<i>Anomalina coronata</i> Parker & Jones, 1857	USNM a.s.	9	
<i>Anomalina glabrata</i> Cushman, 1924	USNM a.s.	9,12	
<i>Anomalina maculosa</i> Todd, 1957	USNM 517033	8,9,12	
<i>Baculogypsina sphaerulata</i> (Parker & Jones, 1860)	USNM a.s.	7,9-12	
<i>Baggina indica</i> (Cushman, 1921)		11	
<i>Baggina totomiensis</i> Makiyami, 1931	USNM 642332, USNM a.s.	9	
<i>Biarritzina proteiformis</i> (Goes, 1882)	USNM a.s.	9,12 13	47
<i>Bolivina compacta</i> Sidebottom, 1905	USNM CC17412	6,9,12	
<i>Bolivina hantkeniana</i> Brady, 1881	USNM 642330, USNM a.s.	9,12	
<i>Bolivina pseudopygmaea</i> Cushman, 1933	USNM a.s.	9,12	
<i>Bolivina rhomboidalis</i> (Millett, 1899)	USNM a.s.	9,11 12	
<i>Bolivina spinescens</i> Cushman, 1911	USNM a.s.	9	
<i>Bolivina robusta</i> Brady, 1881	USNM a.s.	9,12	
<i>Bolivina tortuosa</i> Brady, 1881	USNM a.s.	9,11 12	
<i>Bolivina vadescens</i> Cushman, 1933	USNM 17437	4	
<i>Bolivinella folia</i> (Parker & Jones, 1865)	USNM a.s.	9	
<i>Brizalina striatula</i> Cushman, 1922	USNM a.s.	9,11 12	48
<i>Bronnimannia haliotis</i> (Heron-Allen & Earland, 1924)	USNM 642314, USNM a.s.	9	
<i>Bulimina costata</i> d'Orbigny, 1852	USNM a.s.	9	
<i>Buliminella milletti</i> Cushman, 1933	USNM CC17324	4,6,9 11,12	
<i>Buliminoides williamsoniana</i> (Brady, 1884)	USNM a.s.	9,12	
<i>Calcarina hispida</i> Brady, 1884	USNM 64944	8	

Appendix 1. Checklist of foraminiferal species / (*continued*)

Taxon	Catalogue #	Refs.	Notes
<i>Calcarina spengleri</i> (Gmelin, 1791)	USNM a.s.	9,10- 12	
<i>Cancriis auriculus</i> (Fichtel & Moll, 1798)	USNM 517034	8	
<i>Cancriis sagra</i> (d'Orbigny, 1839)	USNM 642309, USNM a.s.	9,12	
<i>Carpenteria monticularis</i> (Carter, 1877)		12,13	
<i>Carpenteria utricularis</i> (Carter, 1876)		12,13	
<i>Cassidulina delicata</i> Cushman, 1927	USNM 642326, USNM a.s.	9	
<i>Cassidulina minuta</i> Cushman, 1933	USNM 642327, USNM a.s.	9,11	
<i>Chrysalidinella earlandi</i> Cushman, 1945	USNM a.s.	9	
<i>Cibicides cicatricosus</i> (Schwager, 1866)	USNM a.s.	9,12	
<i>Cibicides floridanus</i> (Cushman, 1918)	USNM 517037	8	
<i>Cibicides lobatulus</i> (Walker & Jacob, 1798)	USNM 517038	8,9,11 12	
<i>Cibicides mayori</i> (Cushman, 1924)	USNM 64948	8,9,12	
<i>Cibicides pseudoungerianus</i> (Cushman, 1922)	USNM a.s.	9	
<i>Cibicidella variabilis</i> (d'Orbigny, 1826)	USNM 517035	8,9,12	
<i>Cycloclypeus carpenteri</i> Brady, 1881	USNM 642328, USNM a.s.	9	
<i>Cymbaloporella tabellaeformis</i> (Brady, 1884)	USNM 64946	8,9,12	
<i>Cymbaloporetta bradyi</i> (Cushman, 1915)	USNM 47270, USNM CC47272	8,9,11 12	
<i>Cymbaloporetta squamosa</i> (d'Orbigny, 1839)	USNM a.s.	9,11 12	
<i>Discorbis orbicularis</i> (d'Orbigny in Fornasini, 1906)		11	
<i>Discorbis nipponica</i> Husezima & Maruhasi, 1944		11	
<i>Elphidium advenum</i> (Cushman, 1922)	USNM a.s.	9,12	
<i>Elphidium craticulatum</i> (Fichtel & Moll, 1798)		11	
<i>Elphidium crispum</i> (Linné, 1758)	USNM 19892	3,9,12	
<i>Elphidium hyalocostatum</i> Todd, 1957	USNM a.s.	9,12	
<i>Elphidium jenseni</i> (Cushman, 1924)	USNM CC19896	3,9,12	
<i>Elphidium sagrum</i> (d'Orbigny, 1839)		11	
<i>Elphidium simplex</i> Cushman, 1933	USNM a.s.	9,12	
<i>Elphidium striatopunctatum</i> (Fichtel & Moll, 1798)	USNM a.s.	9,12	
<i>Epistominella pulchra</i> (Cushman, 1933)	USNM 517039	8	
<i>Epistominella tubulifera</i> (Heron-Allen & Earland, 1915)	USNM 64945, USNM a.s.	8,9,12	
<i>Epistomaroides polystomelloides</i> (Parker & Jones, 1865)	USNM a.s.	9,12	
<i>Epistomaroides rimosa</i> (Parker & Jones in Carpenter, 1862)		11	
<i>Epistominella</i> cf. <i>E. obtusa</i> (Burrows & Holland in Jones, 1896)	USNM a.s.	9	
<i>Epistominella rugosa</i> (Phleger & Parker, 1951)	USNM a.s.	9	
<i>Eponides orientalis</i> Asano, 1937		11	
<i>Eponides repandus</i> (Fichtel & Moll, 1798)	USNM CC47320, USNM 642312, USNM a.s.	8,9,12	
<i>Fontbotia wuellerstorfi</i> (Schwager, 1866)	USNM 517047	8	49

Appendix 1. Checklist of foraminiferal species / (*continued*)

Taxon	Catalogue #	Refs.	Notes
<i>Gavelinopsis praegeri</i> (Heron-Allen & Earland, 1913)	USNM a.s.	9	
<i>Glabratella orientalis</i> (Cushman, 1925)		11	50
<i>Glabratella patelliformis</i> (Brady, 1884)	USNM a.s.	9,11	51
		12	
<i>Glabratella tabernacularis</i> (Brady, 1881)	USNM a.s.	9,12	52
<i>Glandulina laevigata</i> d'Orbigny, 1826	USNM CC15731	3	
<i>Globocassidulina subglobosa</i> (Brady, 1881)	USNM a.s.	9	
<i>Gypsina vesicularis</i> (Parker & Jones, 1860)	USNM a.s.	9,11-	
		13	
<i>Hanzawaia concentrica</i> (Cushman, 1918)	USNM 517043	8	
<i>Heronallenia lingulata</i> (Burrows & Holland in Jones, 1896)	USNM 641043	8	
<i>Heterostegina depressa</i> d'Orbigny, 1826	USNM CC15684	3,11	
<i>Heterostegina suborbicularis</i> d'Orbigny, 1904	USNM a.s.	9,12	
<i>Hoeglundina elegans</i> (d'Orbigny, 1826)	USNM a.s.	9	
<i>Homotrema rubra</i> (Lamarck, 1816)	USNM a.s.	9,12	
		13	
<i>Loxostomum costulatum</i> (Cushman, 1922)	USNM CC38414	6,9	54
<i>Loxostomum limbatum</i> (Brady, 1884)	USNM a.s.	9	53
<i>Loxostomum mayori</i> (Cushman, 1922)	USNM 17380	6,9	55
<i>Loxostomum porrectum</i> (Brady, 1881)	USNM a.s.	9	56
<i>Miniacina miniaceae</i> (Pallas, 1766)		12,13	
<i>Neoconorbina crustrata</i> (Cushman, 1933)	USNM 642324, USNM a.s.	9	
<i>Neoconorbina fulva</i> (Todd, 1957)	USNM a.s.	9,12	
<i>Neoconorbina terquemi</i> (Rzehak, 1888)	USNM a.s.	8,9,12	
<i>Neoconorbina tuberculata</i> (Chapman, 1899)	USNM CC47234	8,9	
<i>Nodogenerina milletti</i> Cushman, 1933	USNM CC19017 (holo), USNM CC19018 (paras)	4,6	
<i>Nonion boueanum</i> (d'Orbigny, 1846)	USNM a.s.	9,12	
<i>Nonion japonicum</i> Asano, 1938	USNM a.s.	9,12	
<i>Nonion pacificum</i> (Cushman, 1927)	USNM a.s.	9	
<i>Nonionella translucens</i> Cushman, 1933	USNM CC19870	3	
<i>Operculina granulosa</i> Leymerie, 1846	USNM CC15685	3	
<i>Oridorsalis umbonatus</i> (Reuss, 1851)	USNM specimen missing	8	
<i>Paumotua terebra</i> (Cushman, 1933)	USNM a.s.	9	
<i>Pararotalia calcar</i> (d'Orbigny, 1826)		11	57
<i>Pegidia dubia</i> (d'Orbigny in Fornasini, 1908)	USNM 642319, USNM a.s.	9,12	
<i>Planispirinella exigua</i> (Brady, 1879)	USNM a.s.	9	
<i>Planodiscorbis rarescens</i> (Brady, 1885)	USNM a.s.	9	
<i>Planorbulina acervalis</i> Brady, 1885	USNM 641049	8,9,11	
		12	
<i>Planorbulinella larvata</i> (Parker & Jones, 1865)	USNM 517046	8,9,12	
<i>Planorbulinoides retinaculatus</i> (Parker & Jones, 1862)	USNM a.s.	9,12	
<i>Planogypsina squamiformis</i> (Chapman, 1901)	USNM a.s.	9,12	
		13	
<i>Rectobolivina striatula</i> (Cushman, 1937)	USNM a.s.	9	58

Appendix 1. Checklist of foraminiferal species / (continued)

Taxon	Catalogue #	Refs.	Notes
<i>Reusella pulchra</i> Cushman, 1945	USNM 642331, USNM a.s.	9	
<i>Reusella simplex</i> (Cushman, 1929)	USNM a.s.	9,11 12	
<i>Reussella spinulosa</i> (Reuss, 1850)	USNM CC17467	6	
<i>Rosalina</i> cf. <i>R. floridana</i> (Cushman, 1922)	USNM CC47250	8,9,12	
<i>Rosalina micens</i> (Cushman, 1933)	USNM CC47271	8,9	
<i>Rosalina opima</i> (Cushman, 1933)		11	59
<i>Rosalina rugosa</i> d'Orbigny, 1839	USNM a.s.	9,12	
<i>Rosalina subbertholoti</i> (Cushman, 1924)	USNM 517031	8	
<i>Siphogenerina raphana</i> (Parker & Jones, 1865)	USNM CC17482	6,9,11 12	
<i>Siphonina tubulosa</i> Cushman, 1924	USNM a.s.	9	
<i>Siphoninoides echinatus</i> (Brady, 1897)	USNM 517048	8,9,12	
<i>Sphaeridia papillata</i> Heron-Allen & Earland, 1923	USNM a.s.	9,12	
<i>Sphaerogypsina globulus</i> (Reuss, 1848)	USNM 517042	8,9,12 13	60
<i>Sphaeroidina bulloides</i> d'Orbigny, 1826	USNM a.s.	9	
<i>Sporadotrema</i> aff. <i>S. cylindrica</i> (Carter, 1880)		12,13	
<i>Sporadotrema rubra</i> (d'Orbigny in Fornasini, 1908)		12,13	
<i>Stomatorbina concentrica</i> (Parker & Jones in Brady, 1884)	USNM 642325, USNM a.s.	9	
<i>Svratkina australiensis</i> (Chapman, Parr & Collins, 1956)	USNM a.s.	7,9	
<i>Tretomphalus clarus</i> Cushman, 1934	USNM CC21562 (holo)	5	
<i>Tretomphalus concinnus</i> (Brady, 1884)	USNM 21566, USNM a.s.	8,9,11 12	61
<i>Tretomphalus grandis</i> Cushman, 1934		11	
<i>Tretomphalus milletti</i> (Heron-Allen & Earland, 1915)	USNM 51730	8	
<i>Tretomphalus planus</i> Cushman, 1924	USNM 641047	8,9,12	
<i>Trifarina bradyi</i> Cushman, 1923	USNM a.s.	9	
<i>Trochulina mira</i> (Cushman, 1922)	USNM 642313, USNM a.s.	9,11 12	62
<i>Uvigerina ampullacea</i> Brady, 1881	USNM a.s.	9	
<i>Uvigerina porrecta</i> Brady, 1879	USNM a.s.	9	
<i>Uvigerina vadescens</i> Cushman, 1933	USNM CC17515 (holo)	4,9	63
CLADE GLOBIGERINIDA+ROTAIIDA+TEXTULARIIDA			
SUBCLADE TEXTULARIIDA			
<i>Carterina spiculotesta</i> (Carter, 1879)	USNM a.s.	9	
<i>Clavulina difformis</i> Brady, 1884	USNM 14708, USNM 14709, USNM a.s.	2,9,12	
<i>Clavulina multicamerata</i> Chapman, 1907		11	
<i>Gaudryina angulata</i> Cushman, 1924	USNM a.s.	9,12	64
<i>Gaudryina rugulosa</i> Cushman, 1932	USNM 14701, USNM a.s.	2,9,11 12	
<i>Gaudryina siphonifera</i> (Brady, 1884)	USNM a.s.	9,12	
<i>Gaudryina transversaria</i> (Brady, 1884)	USNM a.s.	9	

Appendix 1. Checklist of foraminiferal species / (continued)

Taxon	Catalogue #	Refs.	Notes
<i>Gaudryina trullissata</i> Todd in Cushman, Todd & Post, 1954	USNM a.s.	9,12	
<i>Liebusella bradyi</i> (Cushman, 1911)	USNM a.s.	9	65
<i>Rotaliammina mayori</i> Cushman, 1924	USNM a.s.	9	
<i>Textularia agglutinans</i> d'Orbigny, 1839	USNM a.s.	9,12	
<i>Textularia alveata</i> Todd, 1957	USNM a.s.	9,12	
<i>Textularia candeiana</i> d'Orbigny, 1839		11	
<i>Textularia conica</i> d'Orbigny, 1839	USNM a.s.	9,11	
		12	
<i>Textularia corrugata</i> Heron-Allen and Earland, 1915	USNM CC14666	2	
<i>Textularia dupla</i> Todd in Cushman, Todd & Post, 1954	USNM a.s.	9,12	
<i>Textularia foliacea</i> Heron-Allen and Earland, 1915	USNM 14658	2,9,12	
<i>Textularia kerimbaensis</i> Said, 1949	USNM a.s.	9,12	
<i>Textularia oceanica</i> Cushman, 1932	USNM a.s.	9	66
<i>Textularia semialata</i> Cushman, 1913	USNM a.s.	9,12	
<i>Valvulina davidiana</i> Chapman, 1900	USNM a.s.	9,12	

References: 1. Cushman 1917; 2. Cushman 1932; 3. Cushman 1933a; 4. Cushman 1933b; 5. Cushman 1934; 6. Cushman 1942; 7. Todd 1960; 8. Todd 1965; 9. Todd 1966; 10. Matsumaru & Matsuo 1976; 11. Lessard 1980; 12. Clayschulte 1981a; 13. Clayschulte 1981b; 14. S. Richardson, unpublished observations; 15. Holzmann et al. 2001

Notes: 16. Synonym: *Marginopora* cf. *M. kudakajimensis* (Gudmundsson, 1994) (Ref. 15) 17. Synonym: *Cornuspira involvens* Reuss, 1850 (Ref. 2) 18. Synonym: *Placopsilina?* sp. (Ref. 9) 19. Synonym: *Peneroplis pertusus* (Forsskål, 1775) (Ref. 11) 20. Synonym: *Peneroplis ellipticus* (d'Orbigny, 1904) (Refs. 9, 12) 21. Synonym: *Miliolinella oceanica* var. *flintiana* (Cushman, 1932) (Refs. 9, 12) 22. Synonym: *Nubeculina divaricata advena* Cushman, 1924 (Ref. 9) 23. Synonym: *Marginopora vertebralis* (Quoy and Gaimard in de Blainville, 1834) (Refs. 9-12, 15) 24. Synonyms: *Sorites marginalis* (Lamarck, 1801) (Refs. 3, 9, 12); *Parasorites* sp. (Ref. 15) 25. Synonym: *Massilina secans reticulata* Heron-Allen & Earland, 1915 (Ref. 9) 26. Synonyms: *Peneroplis proteus* d'Orbigny, 1839 (Ref. 9); *Laevipeneroplis* sp. (Ref. 15) 27. Synonym: *Quinqueloculina anguina* Terquem var. *agglutinans* (Wiesner in Heron-Allen & Earland, 1915) (Ref. 2) 28. Synonym: *Quinqueloculina anguina* var. *arenata* Said, 1949 (Refs. 9, 12) 29. Synonym: *Quinqueloculina distorta* Cushman, 1954 (Refs. 9, 12) 30. Synonym: *Sorites marginalis* (Lamarck, 1801) (Ref. 10). J. J. Lee (personal communication, December 2001) believes this is a new species. It may also be conspecific with a new unnamed species from Pohnpei, Micronesia identified by the senior author as New clade I n. sp. in Richardson (2001). 31. Synonym: *Spiroloculina grata* var. *angulata* Cushman, 1917 (Ref. 2) 32. Synonym: *Spiroloculina acutimarginata* Brady, 1884 (Ref. 1) 33. Synonym: *Quinqueloculina neostriatula* Thalmann, 1950 (Refs. 9, 12) 34. Synonym: *Patellina advena altiformis* Cushman, 1933 (Refs. 8, 9) 35. Synonym: *Spirillina vivipara revertens* Rhumbler, 1906 (Refs. 8, 9, 12) 36. Synonym: *Lagenonodosaria scalaris* (Batsch, 1791) (Ref. 9) 37. Synonym: *Fronicularia robusta* var. *repanda* Cushman, 1913 (Ref. 9) 38. Synonym: *Robulus orbicularis* (d'Orbigny, 1902) (Ref. 9) 39. Synonym: *Globigerinoides triloba* (Reuss, 1850) (Ref. 11) 40. Synonym: *Globorotalia menardii unguolata* Bermudez, 1960 (Ref. 8) 41. Synonym: *Globigerina eggeri* Rhumbler, 1911 (Ref. 9) 42. Synonym: *Streblus beccarii* (Linné, 1758) (Refs. 9, 12) 43. Synonym: *Streblus beccarii* (Linné, 1758) var. Todd, 1957 (Refs. 9, 12) 44. Synonym: *Streblus beccarii* var. *tepida* (Cushman, 1926) (Refs. 9, 12) 45. Synonym: *Amphistegina radiata* var. *papillosa* Said, 1949 (Ref. 9) 46. Synonym: *Amphistegina radiata* (Fichtel & Moll, 1798) 47. Synonym: *Carpenteria proteiformis* Goes,

1882 (Refs. 9, 12, 13) 48. Synonym: *Bolivina striatula* Cushman, 1922 (Refs. 9, 12, 13) 49. Synonym: *Planulina wuellerstorfi* (Schwager, 1866) (Ref. 8) 50. Synonym: *Discorbis orientalis* Cushman, 1925 (Ref. 11) 51. Synonym: *Neoconorbina patelliformis* (Brady, 1881) (Refs. 9, 12); *Pileolina (?) patelliformis* (Brady, 1884) (Ref. 11) 52. Synonym: *Neoconorbina tabernacularis* (Brady, 1881) (Refs. 9, 12) 53. Synonym: *Bolivina (Loxostomum) limbata* Brady, 1884 (Ref. 9) 54. Synonym: *Bolivina (Loxostomum) limbata* var. *costulata* (Cushman, 1922) (Refs. 6, 9) 55. Synonym: *Bolivina (Loxostomum) mayori* Cushman, 1922 (Refs. 6, 9) 56. Synonym: *Bolivina (Loxostomum) porrecta* Brady, 1881 (Ref. 9) 57. Synonym: *Tinoporus calcar* (d'Orbigny, 1826) (Ref. 11) 58. Synonym: *Rectobolivina bifrons* var. *striatula* (Cushman, 1937) (Ref. 9) 59. Synonym: *Discorbis opima* Cushman, 1933 (Ref. 11) 60. Synonym: *Gypsina globula* (Reuss, 1848) (Ref. 8, 9, 13) 61. Synonym: *Rosalina concinna* Brady, 1884 (Refs. 9, 12); *Tretomphalus bulloides* (d'Orbigny, 1839) (Ref. 11) 62. Synonyms: *Rotorbinella? mira* (Cushman, 1922) (Refs. 9, 12); *Discorbis mirus* (Cushman, 1922) (Ref. 11) 63. Synonym: *Uvigerina proboscidea* Schwager var. *vadescens* Cushman, 1933 (Refs. 4, 9) 64. Synonym: *Gaudryina triangularis* var. *angulata* Cushman, 1924 (Refs. 9, 12) 65. Synonym: *Clavulina bradyi* Cushman, 1911 (Ref. 9) 66. Synonym: *Textularia foliacea* var. *oceanica* Cushman, 1932 (Ref. 9)