

**Benthic Foraminifera Assemblages from Shallow-Water
Ecosystems: Implications for Environmental Assessment and
Monitoring**

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Olugbenga T. Fajemila

To Taiwo, Modesire, Temil'Oluwa and Akinde

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Zusammenfassung

Benthische Foraminiferen haben sich als nützliche Indikatoren für heutige und vergangene aquatische Habitate erwiesen, da sie sensibel und schnell auf Umweltveränderungen in verschiedensten Ökosystemen reagieren. Die Kenntnis ihrer heutigen Ökologie lässt eine recht sichere Bewertung ihrer fossilen Verwandten mit Hinblick auf paläoökologische Rekonstruktionen und Taxonomie zu. Sie liefern hinreichende Informationen in der Beobachtung und Bewertung von Übergangs- und Küstensystemen, wie z.B. Ästuaren, Küstenlagunen, Deltas und Riffsystemen. Hierbei handelt es sich um produktive Lebensräume in Bezug auf Nährstoffeintrag, Sedimentation und Karbonatproduktion. Die Untersuchungsgebiete wurden so ausgewählt, dass sie ein weites Spektrum an Habitaten und mikropaläontologischen Analysen bereitstellen. Dazu gehören Moorea (südöstlicher Pazifik) und Flachwasserhabitate in Gabun und Nigeria im Golf von Guinea.

Moorea (Gesellschaftsinseln) befindet sich östlich des tropischen marinen Diversitätszentrums und liegt ungefähr im Zentrum des Diversitätsgradienten, wodurch es eine Übergangslotation zwischen der hochdiversen Fauna des Korallendreiecks und der niedrigdiversen Fauna des östlichen Pazifiks repräsentiert. Riffe im Allgemeinen weisen eine ausreichende Porosität und Durchlässigkeit auf um unter entsprechenden Bedingungen als Speichergesteine für Erdöl und Erdgas zu fungieren. Somit ist Moorea ein ideales Untersuchungsgebiet für Biogeographie-, Diversitäts- und Umweltstudien. Oberflächensedimente wurden innerhalb von Riff-Lagunen und Buchten genommen um habitat-spezifische Faunengemeinschaften zu untersuchen, welche als Indikatoren für paläoökologische Studien genutzt werden könnten.

Gabun fördert Erdöl und wird somit mit Umweltverschmutzungen durch offshore Exploration, untermeerische Pipelines und dem Entsorgen von Bohrrückständen konfrontiert. In der Summe bedrohen diese Verschmutzungen die noch weitestgehend ursprüngliche Diversität in Gabuns marinen Ökosystemen. Die tropisch warmen Gewässer der Flachwasserhabitate Gabuns enthalten eine reichhaltige Fauna mit vielen potentiell bedrohten Arten sowie besondere Ökosysteme wie Mangroven, die sich durch ihre spezielle Foraminiferen-Fauna auszeichnen. Für diese Studie wurden Sedimentproben aus dem Libreville Estuar, Point Gentil, sowie der Insel Iguela genommen. Darüber hinaus wurden bei Niedrigwasserstand Proben aus den Mangroven des Akanda Nationalparks nördlich von Libreville entnommen.

Die Olonge Lagune in Nigeria ist ein ideales Untersuchungsgebiet für den anthropogenen Einfluss auf Faunengemeinschaften. Die Lagune und ihre Flussarme sind von den industriellen und städtischen Gebieten von Lagos umgeben – der schnell wachsenden Stadt mit einer

geschätzten Population von 16 Millionen Einwohnern. Sedimentproben wurden aus der Lagune entnommen und analysiert um Basisdaten zu Art und Ausmaß von Diversitätsveränderungen im Zusammenhang mit Stressfaktoren zu erlangen, welche für künftige Kontrollstudien nützlich sein könnten.

Die Foraminiferengemeinschaften der Riffe und Lagunen der Insel Moorea wurden in dieser Arbeit untersucht. Bisherige Studien über die Foraminiferen Mooreas beschränkten sich auf ausgewählte Habitate, was zu einer eingeschränkten Anzahl an gefundenen Arten führte. Es handelt sich hierbei um die erste inselweite Untersuchung der Foraminiferen aus Flachwasser- und Riff-Habitaten von Moorea. Die benthischen Foraminiferen Mooreas zeigen großräumige Verbreitungsmuster Habitat-spezifischer Gemeinschaften. Dies zeigt sich besonders in den Häufigkeitsmustern bestimmter Arten, Gattungen und Funktionsgruppen. Generell steigt der Diversitätsgradient von der Bucht zur Rifffbarriere an, wobei die höchste Diversität in den Saumriffen zu finden ist, die ein Mosaik verschiedenster Mikrohabitate bilden. Verschiedene Funktionsgruppen (Symbionten-tragend, heterotroph und opportunistisch) wurden dokumentiert und für die Berechnung des Foram Index (FI) verwendet, um Habitate zu identifizieren, welche für die Karbonatproduktion eine besonders wichtige Rolle spielen. Der FI zeigt, dass die innersten Buchten sowie einige der äußeren Saumriffe unter natürlichen oder anthropogenen Einflüssen stehen. Diese Resultate können als Grundlage dienen um zunehmende natürliche oder anthropogene Einflüsse zu bewerten. Künftige Veränderungen können mit den Daten von 1992 verglichen werden und deren Einflüsse in künftigen Studien genauer untersucht werden. Zusätzlich können Foraminiferen Einflüsse wie globale Erwärmung, Anoxia und Versauerung ebenso darstellen wie lokale Faktoren wie Verschmutzung, industrielle Einflüsse oder Tourismus. In Moorea wurden insgesamt 364 Arten von Foraminiferen dokumentiert. Repräsentative rasterelektronenmikroskopische Aufnahmen wurden in 39 Tafeln dargestellt. Dies liefert eine Basis für die Artidentifikation der Foraminiferen von Französisch Polynesia.

Eine erstmalige Untersuchung der Foraminiferen aus Flachwasser-Habitaten in Gabun wurde vorgenommen. Die benthischen Foraminiferengemeinschaften zeigen diverse Gesellschaften, welche eine artenreiche und einzigartige Gemeinschaftsstruktur aufweisen. Die Artdiversität, welche in einer begrenzten Anzahl an Proben gefunden wurde deutet darauf hin, dass die tatsächliche Diversität der benthischen Flachwasserforaminiferen noch deutlich höher liegt. Symbionten-tragende Foraminiferen sind häufig und die Anzahl an verschiedenen Arten ist hoch. Dies deutet darauf hin, dass die Probenstationen noch nicht sehr durch die nahegelegenen Bohrungsaktivitäten beeinflusst sind. Die Foraminiferenfauna von Gabun unterscheidet sich im Vergleich deutlich von denen aus Namibia und Südafrika. Es wird

angenommen, dass eine biogeographische Barriere die nahe gelegenen Faunen trennt. Durch die Erstellung größerer mariner Schutzgebiete in Gabun können marine Reservate geschaffen werden und somit die noch relativ unberührten Gewässer Gabuns geschützt werden.

Zusätzlich wurden die Komposition sowie die vertikale Zonierung benthischer Foraminiferen in zwei intertidalen Mangroven-Habitaten aus dem Akanda National Park in Gabun untersucht. Insgesamt wurden dabei 21 Arten dokumentiert. Dabei konnten zwei Faunenzonen erstellt werden, welche sich durch eine vertikale Begrenzung auszeichnen. Die schlammigen Substrate im Umfeld der Mangrovenart *Avicennia germinans* sind durch eine niedrig-diverse, agglutinierte Faunengemeinschaft charakterisiert und wird durch *Ammotium salsum* und *Ammobaculites pseudospirale* dominiert, wobei sie repräsentativ für einen hohen mittleren Wasserstand bei Nipptide sind. Eine moderat diverse Fauna bestehend aus agglutinierten und kalkigen Foraminiferen wurde zwischen *Rhizomosa racemosa* gefunden und repräsentiert mittleren Tiefwasserstand bei Nipptide. Die Fauna wird durch *Miliammina* spp., *Arenoparella mexicana*, *Ammotium salsum* und *Astrononion stelligerum* dominiert. Die Gezeiten spielen beim Artenreichtum der einzelnen Gemeinschaften eine besondere Rolle. Deren Verbreitung zeigt ein hohes Potential für Meeresspiegel-Rekonstruktionen. Diese Studie repräsentiert die erste Untersuchung von Mangroven-assoziierten Foraminiferen Gabuns.

Die vorliegende Arbeit beinhaltet zudem eine Untersuchung der Foraminiferen, Thecamoeben und Diatomeen innerhalb der Ologe Lagune im südwestlichen Nigeria. Die benthischen Foraminiferen zeigen hier eine geringe Diversität mit nur 4 agglutinierten Foraminiferen-Arten. Nur 3 indikative Arten von Thecamoeben wurden zusammen mit 2 großen Diatomeen-Arten gefunden. Ihr Vorhandensein zeigt den Einfluss des Süßwassers, sowie das Ausmaß an Aktivitäten, welche die Gegend in den letzten Jahren beeinflusst haben. Die gefundenen Verbreitungsmuster zeigen individuelle Empfindlichkeiten und Toleranzen und betonen das Potential von Studien der Meiofauna in Umweltanalysen.

Abstract

Benthic foraminifera have proved to be useful as present and past indicators in aquatic habitats because they are sensitive and react rapidly to environmental changes in various ecosystems. The knowledge of their modern ecology presents a potent assessment of their fossil counterparts regarding paleoenvironmental reconstructions and taxonomy. They provide ample information in the assessment and monitoring of transitional and coastal ecosystems e.g. estuaries, coastal lagoons, deltas and reef environments. These are productive environments in terms of nutrient dumping, sedimentation and carbonate accretion. The study localities were chosen to cover a wide range of both environmental habitats and analytical micropaleontological procedures. These are Moorea (southeast Pacific Ocean island), and the nearshore habitats of Gulf of Guinea in both Gabon and Nigeria.

Moorea (Society Archipelago) is located east of the tropical marine diversity hotspot and occupies a strategic position on the diversity gradient being almost at the centre, and represents a transitional location between the high diversity assemblages of the coral triangle and the lower diversity biotas of the eastern Pacific. Moreover, reefs in general have sufficient porosity and permeability to permit the accumulation of crude oil or natural gas under suitable trap conditions. As such, Moorea is an ideal setting for biogeographic, biodiversity and environmental studies. Surface sediments were taken across the reef-lagoon and inner bay settings to study habitat-specific indicator assemblages useful for paleoecological studies.

Gabon, like other oil producing nations, is faced with the problems of oil spillage and pollution which arise from offshore exploration activities, undersea pipelines leakages and the discharge of drill cuttings, often contaminated with drilling fluid. These sum up to threaten the pristine diversity of Gabon's marine ecosystems. The tropical warm water of the nearshore habitats of Gabon are home to varieties of species of animals most of which are endangered species, and the mangroves which are noted for distinct foraminiferal assemblages. For this study, surface sediment samples were taken from the Libreville estuary, Point Gentil and the Iguela Lagoon. Further sampling was done at low tide within the mangroves of the Akanda National Park, north of Libreville. The Ologe Lagoon Nigeria is an ideal setting to investigate anthropogenic impacts on faunal assemblages. The lagoon and its river channels are surrounded by industrialized and urbanized areas of Lagos, the rapidly growing capital of Nigeria with an estimated population of 16 million inhabitants. Surface sediment samples were taken from the lagoon and were analysed to provide a baseline assessment of the nature and magnitude of biodiversity changes in response to stressors, and as yardstick for future monitoring.

The foraminiferal assemblages across reefal and lagoonal sites in Moorea Island were studied. Previous foraminifera studies around Moorea have focused on selected habitats which produced limited number of species. This is the first island-wide investigation of the foraminifera from shallow-water nearshore and reefal environments around Moorea. The benthic foraminifera around Moorea have large-scale spatial distribution patterns of habitat specific assemblages. This is evident in the abundance patterns of individual species, genera, and functional groups. Generally, diversity gradients increase from bay inlets to the reef barrier, but highest species richness is in fringing reefs, an area that represents a mosaic of habitats. The functional groups (symbiont-bearing, heterotrophic, opportunistic) were documented and utilized in Foram Index (FI) calculations to identify environments that are suitable and critical to support calcifying symbiosis and carbonate accretion. The FI indicates that the innermost bays and some outer bay fringing reef habitats are under direct natural and anthropogenic influences. These findings are sufficient for monitoring rising influences of natural events and anthropogenic activities. Future changes can be compared with this baseline data from 1992 and the development of those changes over time can be determined by further studies. In addition, as global warming, anoxia and acidification of the oceans increase, foraminifera can provide rapid indication of these worldwide changes as well as local ones such as pollution, impacts on reefs due to industrial development and tourist activities. In Moorea, a total of 364 foraminiferal species has been recorded. Images of representative species were taken by Scanning Electron Microscope (SEM) and arranged into 39 plates. Generally, this forms the basis of identification of benthic species from French Polynesia.

The first survey of foraminifera from very shallow coastal sites in Gabonese waters was carried out. The benthic foraminiferal communities display diverse assemblages of modern benthic foraminiferal representing a diversified and unique community structure. The diversity of foraminiferal species recovered from the limited number of samples suggests that the true diversity of shallow benthic foraminiferal species may be significantly higher. There are abundant symbiont-bearing taxa and a high species richness. This is an indication that the sampled sites are not yet strongly affected by drilling operations of the oil companies. The foraminiferal assemblages from shallow-water equatorial region of Gabon differ markedly from those from Namibia and South Africa when compared. It is assumed that there is a biogeographic barrier that separates biotas in close geographic proximity. The recent creation of a large-scale system of Marine National Parks in territorial waters off Gabon will create a vast marine reserve that provides future protection for its pristine waters and Gabonese livelihoods.

Moreover, the composition and vertical zonation of modern benthic foraminifera was studied at two intertidal mangrove environments in the Akanda National Park, Gabon. A total of twenty-one benthic species was recorded. Two faunal zones that are vertically constrained with regard to elevation were erected. The muddy substrate around *Avicennia germinans* mangroves is characterized by a low-diverse agglutinated foraminiferal assemblage, dominated by *Ammotium salsum* and *Ammobaculites pseudospirale*, and indicative for High Mean Water Neap Tide elevations. A moderately diverse assemblage of agglutinated and calcareous foraminifera was recovered from around *Rhizomosa racemose* stands and represents biotas at Mean Low Water Neap Tide elevation. The assemblage is dominated by species of *Miliammina* spp., *Arenoporella mexicana*, *Ammotium salsum* and *Astrononion stelligerum*. Tides play a critical role in the species richness of individual assemblages. Their distribution shows a great potential for sea level reconstructions. The study constitutes the first survey of mangrove foraminifera from Gabon.

Investigation of foraminifera, thecamoebians and diatoms within the Ologe Lagoon of southwestern Nigeria was performed. The benthic foraminifera show a low diversity with only four tolerant agglutinated species. Only three indicator species of thecamoebians were recorded along with two large benthic diatoms species. Their presence verifies the extent of freshwater invasion as well as the extent of activities that have impacted the habitat over time. The resulting patterns of distribution are interpreted to be a function of differential susceptibility and individual tolerance levels and highlight the potential of meiofauna studies as a tool for environmental monitoring.

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Chapter 1

Introduction

Foraminifera are marine organisms having a fundamental structural cell unit that contains specialized organelles in the cytoplasm (eukaryotic protists), which possess granuloreticulate pseudopodia and a test (shell). This test can be built of various materials. This gives rise to a classification that is based on wall texture and type. Foraminifera could be organic material (Allogromiina), agglutinated (Textulariacea, tests formed from foreign particles but glued together with a variety of cements), calcium carbonate microgranular (Fusulinacea), calcium carbonate porcelaneous (Miliolina), calcium carbonate hyaline (Rotaliina), opaline silica (Silicoloculinina). The test morphology varies greatly from single, unilocular forms to multilocular chambered forms, with chamber arrangements varying from simple uniserial to streptospiral or trochospiral. Apertural openings show a high diversity from single terminal to multiple sutural and cribrate openings. These features could be adaptive in response to the immediate environment of the foraminifera (Loeblich and Tappan 1964a).

More importantly, foraminifera are characterized by their abundance, extensive variability and rapid evolution in all marine habitats and they form a vital part of the marine food chain. They constitute about 90% of the deep-sea biomass (Armstrong and Brasier 2005). Loeblich and Tappan (1987) listed and described 2455 foraminiferal genera, 878 of which are recent ones (Sen Gupta 1999). Their great abundance has made them very useful for biostratigraphy, chronology and correlation of stratigraphic surfaces, and paleoecological interpretation (Loeblich and Tappan 1987). The first appearance of benthic foraminifera was in the Precambrian (Langer 1999; Sen Gupta 1999) while the earliest most-probable and functional foraminifera are Precambrian in age (Langer 1999).

The larger foraminifera, which are very important because they house endosymbionts, are exclusively benthic and are either epiphytes or move on or in the sediments. They house unicellular algae in their protoplasm where they photosynthesize (Hallock 1988; Langer et al. 1997; Hallock et al. 2003). An environment with clear water, which can be found best in oligotrophic settings of neritic shallow regions, is necessary for photosynthesis. This kind of environment is similar to that of corals and it forms part of the bases on which the Foraminifera Index was developed (Hallock et al. 2003). The larger foraminifera may build thin transparent test walls or light-collecting mechanisms like nodes and pillars in order to optimize the light intensity or retard high irradiation by building thicker tests or porcelaneous structures, making the walls impenetrable (Hottinger 1997; Hohenegger et al. 1999). They are very good reef

builders and stabilizers because of their calcium carbonate (CaCO_3) production and are therefore relevant dwellers in the corals habitat and coastal ecosystems (Langer et al. 1997; Hallock 1999; Langer 2008b). Generally benthic foraminifera have substrate modifying capabilities that portray them as environmental engineers resulting in fortification of reefal structures.

The focus of this study is on the use of benthic foraminifera as ecosystem indicators. Therefore, the study localities were carefully chosen in southeast Pacific Ocean island of Moorea and the nearshore habitats behind the shores of the Atlantic Ocean in Gabon and Nigeria. These are timeline studies to document the conditions of the various habitats with regard to anthropogenic or natural interferences.

1.1 Study Localities

1.1.1 Moorea, (Society Islands) French Polynesia

Generally, the Society Islands of the French Polynesia (Fig. 1) are peaks of enormous shield volcanoes that rise from the floor of the ocean which could be as deep as 4000m, and these peaks of volcanoes could reach up to 2200m in Tahiti (Dostal et al. 1982; Duncan and McDougall 1976). The volcanoes become less prominent at the end of the island chain, subsiding into atolls and then seamounts (Rougerie et al. 1997). The island of Moorea is a high-volcanic island (total area of 134 km²) located in the South Pacific (17°30'S, 149°50"W) just 11 km west of Tahiti, and both are part of the Society Islands, French Polynesia. Moorea is a more heavily dismembered and eroded cone of volcano but still partly preserves the constructional form of a shield volcano (e.g. Moorea and Bora Bora: Fig. 2). Coastal cliffs are prominent on the north coast but are rarely significant on the south coast. The central caldera region opens to the north and is surrounded by a wall of heavily grooved peaks, the highest of which is 1207m (Duncan and McDougall 1976). Moorea, just like the rest of the Society Islands, is made up of basaltic lavas of alkaline affinities (Dostal et al. 1982). These are significantly young lavas, with ages ranging from Pliocene to present, with increasing distance from the hotspot (Rougerie et al. 1997). From the island of Mehetia which is recently active to the island of Maupiti, the average age of the islands increases progressively from southeast to northwest, which is about 3.9 to 4.3 M.y. old (Duncan and McDougall 1976; Dostal et al. 1982; Rougerie et al. 1997).

Moreover, French Polynesia is washed by the oligotrophic Southeast Pacific Ocean gyre centered in the Easter Island zone and longitudinally limited by the equatorial zone northwards and the Tropic of Capricorn (Fig. 3). Currents flow westward and counter currents flow eastward. Movement of surface water masses inside the gyre is anti-clockwise and directly sustained by the trade wind stress (Levitus 1982). The temperature and salinity of the waters

around the French Polynesia is maintained by the Equatorial Counter Current (ECC) which runs along the South Pacific Convergence Zone (SPCZ) and brings warm, low-salinity waters originating from the Solomon Sea axis toward French Polynesia. This may decrease surface salinity to 35.5 PSU during the peak of the summer rainy season; but generally, along the Tropic of Capricorn, seawater temperature is around 21°C in winter, largely above the 18°C lower lethal limit for tropical reef-building corals (Delcroix and Henin 1991; Rougerie et al. 1997).

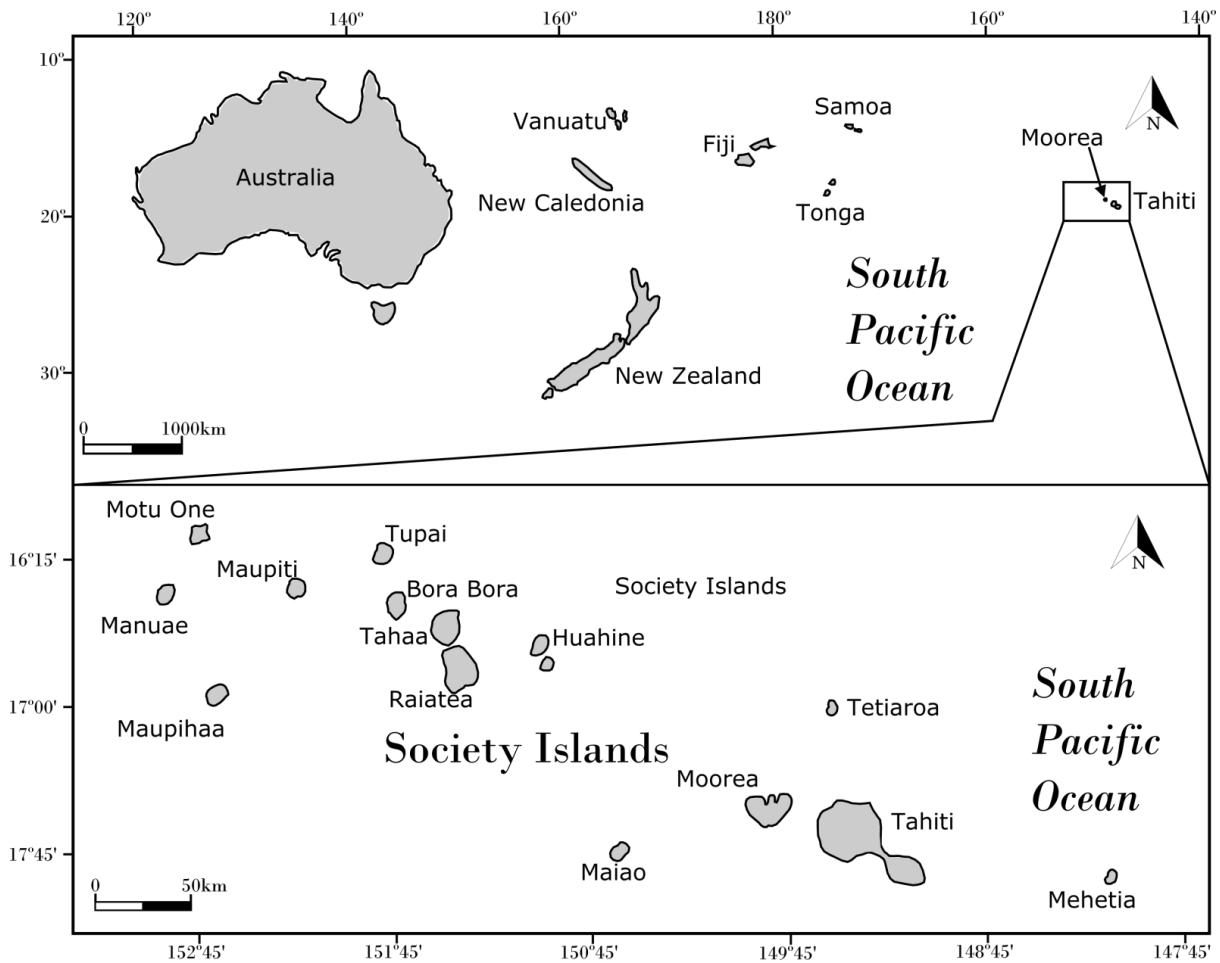


Fig. 1: The Society Islands of the French Polynesia showing the position of Moorea.

The Society Islands are located east of the tropical marine diversity hotspot with significance as recipients and redistributors of biotas via equatorial currents. They represent a transitional location between the high diversity assemblages of the coral triangle and the lower diversity biotas of the eastern Pacific. The beautiful coral rings (Fig. 4) and variety of habitats has made these islands ideal settings for coral health and reef management studies (Salvat 1987; Endean and Cameron 1990; Jokiel and Coles 1990; Cameron et al. 1991; Done et al. 1991; Harmelin-Vivien 1994; Hoegh-Guldberg and Salvat 1995; Chazottes et al 1995; Gleason 1996; Adjeroud 1997; Hodgson 1999; Bessat and Buigues 2001; Adjeroud et al. 2002, 2005, 2007a,b;

Penin et al. 2007; Baker et al. 2008; Salvat et al. 2008; Juhasz et al. 2010; Lipps 2011). These islands are characterized by oceanic climate between a relatively dry and cold season (May/October) and wet and warm season (November/April; Bessat and Buigues 2001). These islands with barrier and atoll reef-lagoon system are a home to a wide variety of shallow marine habitats. The shoreline habitats at Moorea range from the mangrove to the lagoon and to the reef environments. They are distributed along the shallow lagoon, which is slightly less than 45 km in circumference around the island.



Fig. 2: Moorea (A, C, E) and BoraBora (B, D, F) Islands showing high volcanics and beautiful coral beaches (<http://www.tahiti-tourisme.com>)

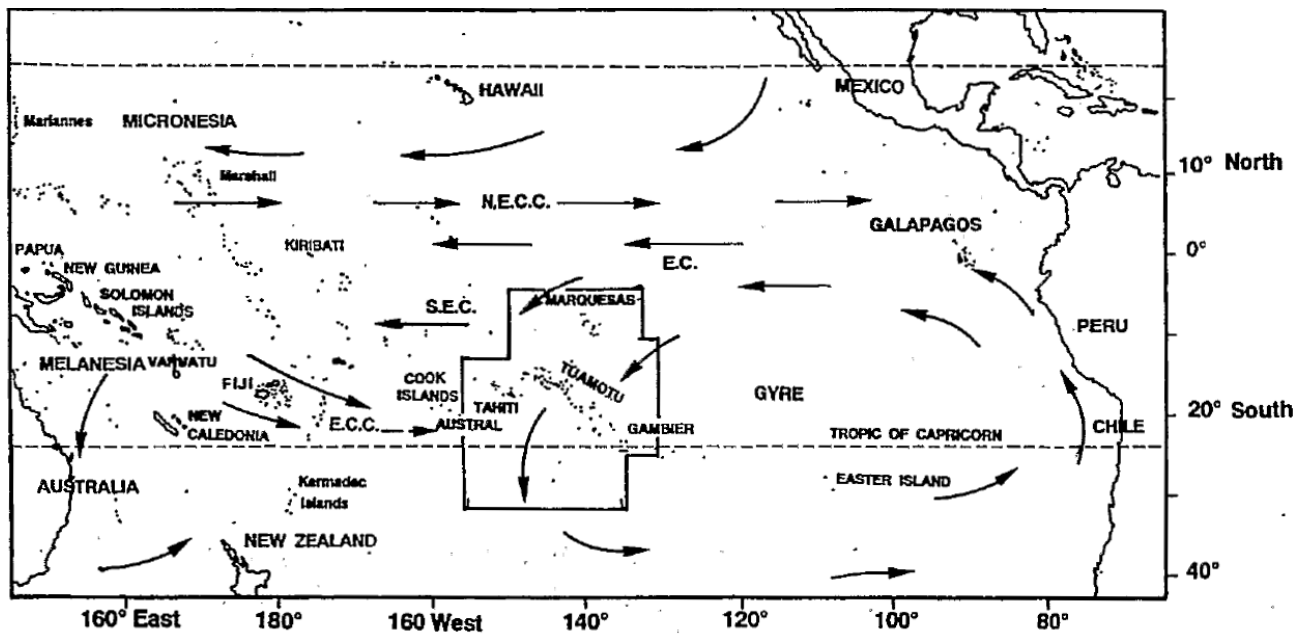


Fig. 3: Map of the Intertropical Pacific. French Polynesia is bathed by the oligotrophic oceanic gyre centered in the Easter Island zone. Currents flow westward and counter currents flow eastward. Abbreviations: E.C., Equatorial Current; S.E.C., South Equatorial Current; N.E.C.C., North Equatorial Counter Current; E.C.C., Equatorial Counter Current (After Rougerie et al 1997)

The mangrove habitats are predominantly muds and roots in *Rhizophora stylosa*, shore sands and muds under overhanging *Hibiscus tiliaceus*, *Paspalum vaginatum* salt grass marshes, and mud and rocks without significant vegetation associated with them, with some sand and rare beach rock. Towards the outer bay and the coastal fringing reefs the sediments vary in general with increases from muddy and silty sediments to sandy and coarse-grained carbonaceous sand and rubble along the coast. The reef barrier sediments comprise coral rubble, and coarse detrital sand that accumulates in furrows and valley bottoms (Langer and Lipps 2006; Fajemila et al. 2015).

In Moorea and in the French Polynesia generally, there is limited information about foraminifera (e.g. Vénec-Peyré 1984, 1987, 1988; Langer and Lipps 2006). They are important member of tropical biotas and are prominent producers of calcium carbonate which contribute significantly to the carbonate budget of coral reefs (Hallock 1981; Langer et al. 1997; Hallock 2000). Foraminifera are excellent indicators for studies of reef health and they preserve environmental information that is useful in interpreting changing ecological conditions and paleoecological studies. This study provides a baseline for environmental changes since 1992. New information on foraminifera community structure and reef vitality with the aid of the FORAM Index, a single metric index indicative of reef health and conditions for carbonate accretion were provided (Hallock et al. 2003; Stephenson et al. 2015; Fajemila et al. 2015).



Fig. 4: Satellite images of some Society Islands surrounded by barrier reefs; A. Tupai, B. Bora Bora, C. Tahaa and Raiatea, D. Moorea (Google earth)

Moreover, Moorea is an ideal setting for biogeographic studies connecting the high-diversity western Pacific with the low-diversity eastern Pacific Ocean. It occupies a strategic position on the diversity gradient being almost at the centre. The west Pacific Coral Reef Triangle between the Great Barrier Reef, the Philippines and Papua New Guinea represents the hotspot of marine tropical diversity in modern oceans (Fig. 5; Done et al. 1995; Roberts et al. 2002; Makled and Langer 2011). This region probably has the highest diversity of reef-building organism which includes unicellular foraminifera, especially the larger symbiont-bearing group (Langer and Hottinger 2000; Langer and Lipps 2003). This diversity diminishes from the Coral Triangle in stepwise drop down along the gradients towards the open Pacific Ocean, down the eastern coast of Australia, north along the Kuroshio Current towards Japan and through the Torres Strait into the open Indian Ocean (Fig. 6; Haig 1979, 1988a, b, 1993; Langer and Lipps 2003; Renema 2006, 2008; Makled and Langer 2011). Langer and Hottinger (2000) referred to this decrease of species richness from the hotspot of diversity to the open eastern and North Pacific Ocean as a transect along the biodiversity gradient. The benthic foraminiferal

assemblages from the different habitats within Moorea were documented to complete the record along the W-E Pacific biodiversity gradient and to assess their biogeographic relation to adjacent faunal provinces of the eastern Pacific and the Indian Ocean (Roberts et al. 2002; Veron 1995; Fajemila et al. 2015).

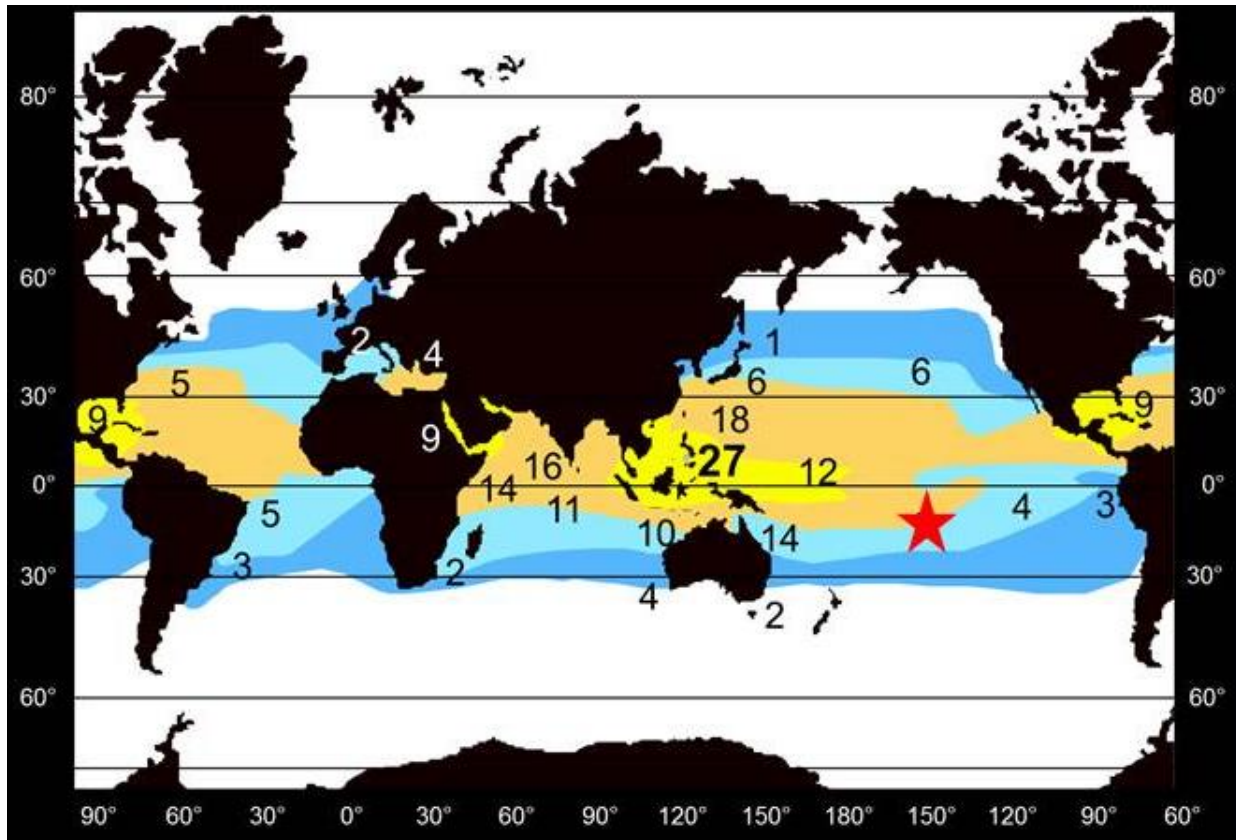


Fig. 5: Several studies at different locations represented by number of symbiont-bearing foraminifera taxa recorded. The position of Moorea is indicated by a red star (modified after Langer 1997).

1.1.2 Nearshore habitats of Gabon

Gabon is located on the western flank of Africa bordering the Atlantic Ocean in the Gulf of Guinea (Fig. 6). The tropical warm water of the nearshore habitats of Gabon are home to diverse communities of marine organisms and plants. These are part of the Guinea Current Large Marine Ecosystem (GLMC,) situated along the Atlantic coast of western central Africa (McGlade et al. 2002; Friedlander et al. 2014). They house varieties of species of animals including manatees, manta rays, hammerhead-, tiger- and whale sharks and leatherback turtles. Most of these are endangered species. Gabon, like other oil producing nations, is faced with the problems of oil spillage and pollution which arise from offshore exploration activities, undersea pipelines leakages and the discharge of drill cuttings, often contaminated with drilling fluid. These sum up to threaten the pristine diversity of Gabon's marine ecosystems. Its effect on the ecology of the macro- and micro benthic communities could be predictable. Therefore there has

to be a balance between environmental and economic interests in a country where the oil precedes accounts for more than 50% of the gross domestic product and 80% of exports is a big challenge (Voituriez and Herbland 1982; Loeuff and Cosel 1998; McGlade et al. 2002). In view of these the government carved out pristine coastal parks and waters which accounted for more than 20% of the country's coastal waters. Some of these parks house the mangroves (*Avicennia germinans*, *Conocarpus erectus*, *Laguncularia racemosa*, *Rhizophora harrisonii*, *Rhizophora mangle*, *Rhizophora racemosa*) which are noted for distinct foraminiferal assemblages (e.g. Langer and Lipps 2006; Langer et al. 2016b; Fig. 7)

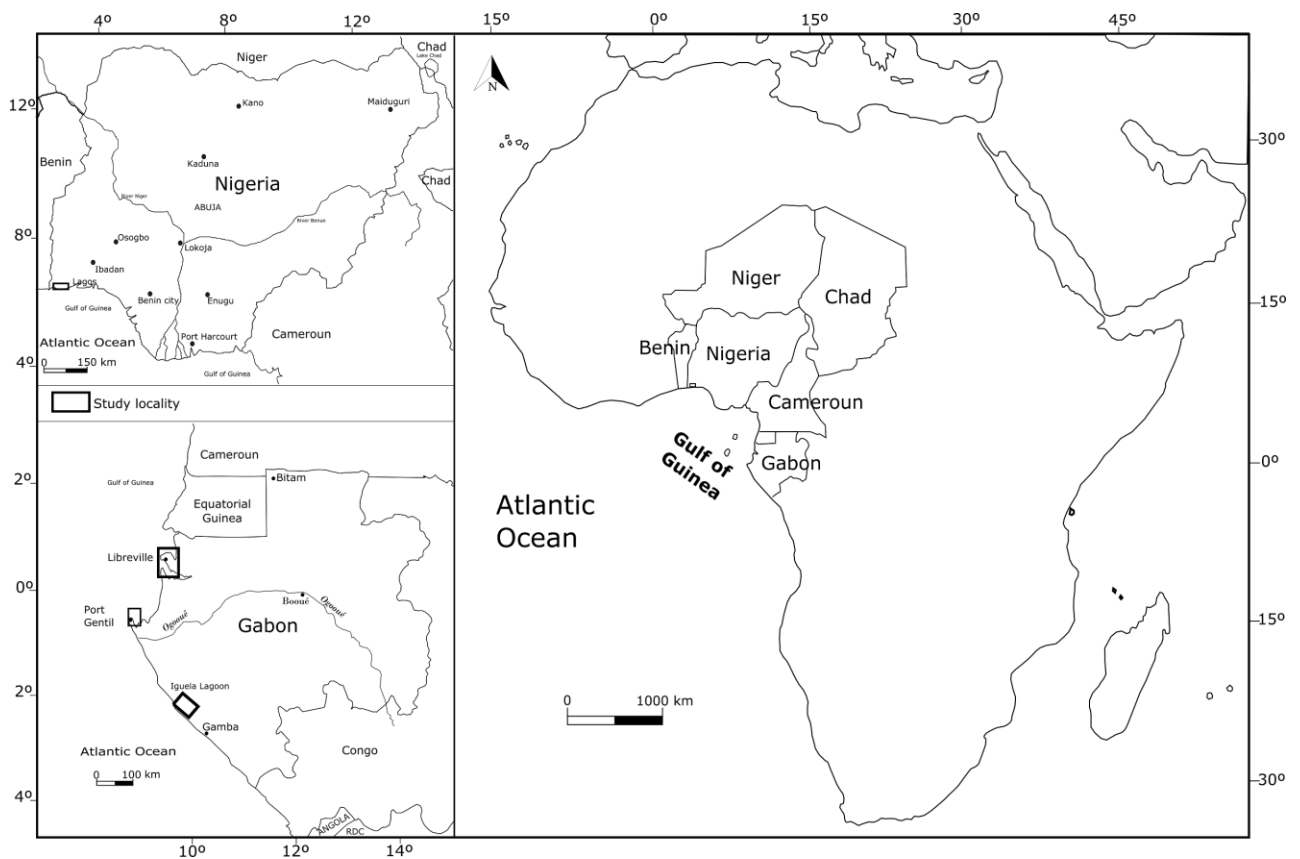


Fig. 6: Africa map showing Gabon, Nigeria and study localities.

The coastal areas are also fed with large quantities of dissolved and particulate organic matter from the Congo and Ogooué River which encourages vibrant food chain and rich fishery resources that are crucial to coastal populations (Fig.8; Voituriez and Herbland 1982; Loeuff and Cosel 1998; McGlade et al. 2002). However, little is known about the marine biodiversity of Gabon's shallow-water. Reports have shown that a strong biogeographic barrier (Benguela Barrier; Fig. 9) exists between the Gulf of Guinea and the coasts of Southwestern Africa which prevents species from the southwestern region of the African continent and the Indian Ocean from colonizing the Gulf of Guinea. This invariably creates a hotspot of distinctive and isolated

marine biodiversity in the Gulf of Guinea with a high percentage of native species. (Martin 1981; Roberts et al. 2002; Toefy et al. 2005; Langer and Schmidt-Sinns 2006a,b; Schmidt-Sinns 2008; Luiz et al. 2012; Langer et al. 2013a; Friedlander et al. 2014). Low diversity foraminifera communities have been recorded from a location off Port Gentil which was used to discharge drilling waste from oil platforms (Durrieu et al. 2006; Duchemin et al. 2008). This was a posthumous evaluation of aged drilled cuttings with reference to toxicity and most importantly alteration in benthic microfaunal community. These studies confirm the usefulness of benthic foraminifera as a potent tool for assessing the impact of offshore drilling activities on the environment.



Fig. 7: Protected areas along the coast of Gabon. The mangrove regions are in green colour (after Vande Weghe 2005)



Fig. 8: Aerial images of the coastal areas of Gabon (nationalgeographic.com)

For this study, surface sediment samples were taken from the Libreville estuary, Point Gentil and the Iguela Lagoon. Further sampling was done at low tide within the mangroves of the Akanda National Park, north of Libreville.

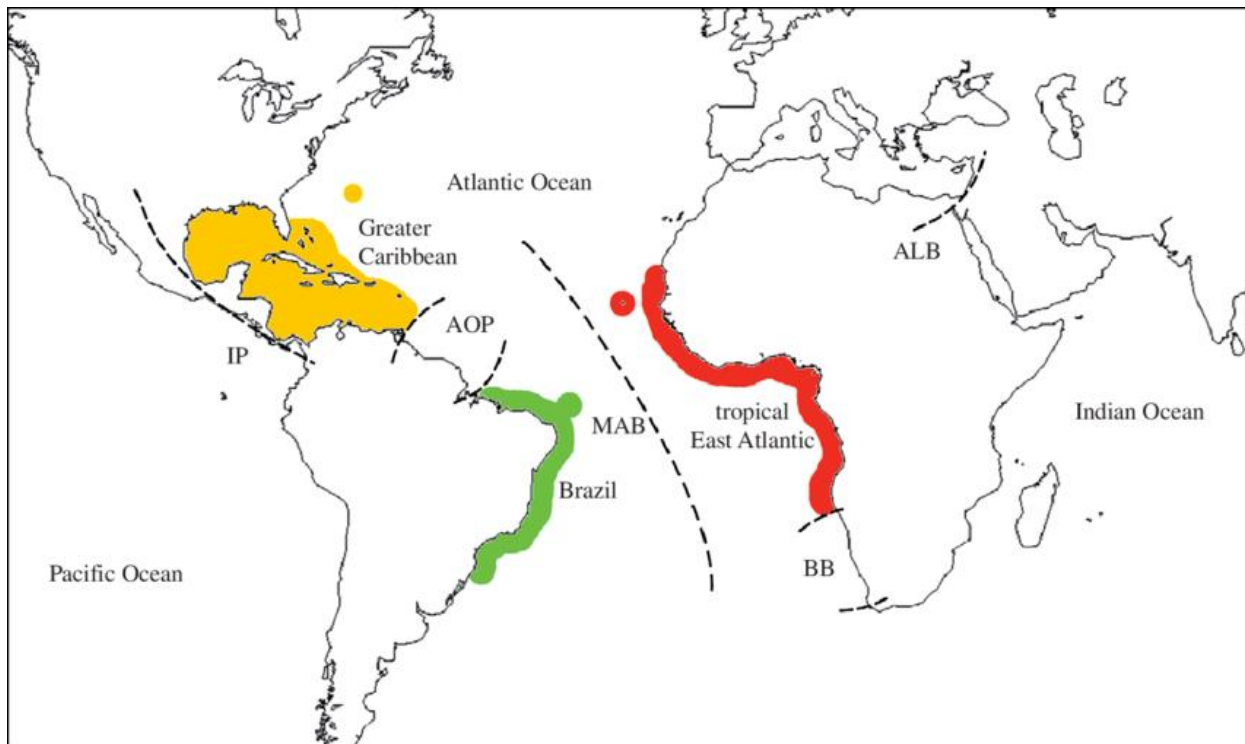


Fig. 9: Biogeographic provinces and barriers in the Atlantic Ocean. Land barriers: IP, Isthmus of Panama; ALB Arabian Land Bridge. Soft barriers: AOP, Amazon–Orinoco Plume; MAB, Mid-Atlantic Barrier; BB, Benguela Barrier (After Luiz et al. 2012)

1.1.3 Ologe Lagoon, Nigeria

The study locality is situated in the immediate neighborhood of Lagos, southwestern Nigeria (Figs. 6, 10). It is within the coastal environment sprawling into the Gulf of Guinea in the Atlantic Ocean. The Ologe Lagoon is a hyposaline, brackish water system connected to the Atlantic Ocean by strings of channels leading to the Lagos harbor (Fajemila and Langer 2016). It is located between latitudes 6° 26'N to 6° 30'N and longitudes 3° 01'E to 3° 07'E. Ologe Lagoon has a total surface area of 9.4km², and is the smallest of nine lagoons that parallel to the Atlantic coast (Webb and Hill 1958; Sandison 1966; Sandison and Hill 1966; Adegoke 1975). The lagoon is surrounded by rooted mangrove trees (*Rhizophora racemosa* Meyer) having dense undergrowth of shrubs and grasses and coconut palm trees (*Cocos nucifera*; Fig. 11). At the rear, mangroves form overhangs towards the Lake.

The lagoon is a catchment area of the Owo, Imede, Opunu and Ilo rivers and characterized by shallow depths, mud flats and sand bars. The waters of Ologe Lagoon drain through Elete Creek, through which it connects to other rivers and lagoons before it reaches Lagos harbor and finally the Atlantic Ocean (Fajemila and Langer 2016).

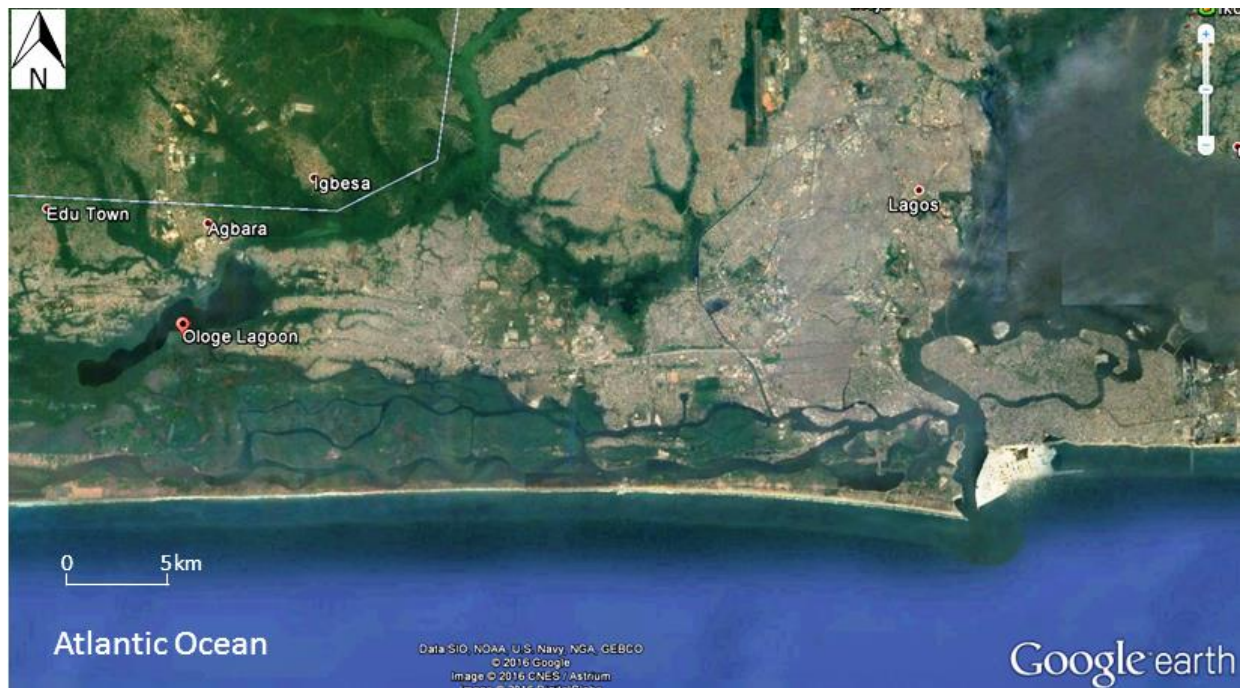


Fig. 10: Satellite image of Ologe Lagoon and the surrounding built-up areas of Lagos, Nigeria (Google earth).



Fig. 11: Ologe Lagoon showing coconut trees and mangrove overhangs (<http://mapcarta.com>)

The lagoon and its river channels are surrounded by industrialized and urbanized areas of Lagos, the rapidly growing capital of Nigeria with an estimated population of 16 million inhabitants. The industries produce goods ranging from food processing to pharmaceuticals. The effluents from these factories eventually find their way into the lagoon. Several studies have shown the increase of anthropogenic impact on the natural habitat of the Ologe Lagoon from both industrial and residential estates (Clarke et al. 2008; Kumolu-Johnson and Ndimele 2012; Samuel et al. 2015). Pollution studies within the nearshore coastal environments in Nigeria have long been a subject of environmental concern. However, limited effort has been made in to utilize meiofauna components as bioindicators of environmental change. Surface sediment samples were taken from the lagoon and were analysed to provide a baseline assessment of the nature and magnitude of biodiversity changes in response to stressors, and as yardstick for future monitoring.

1.2 Previous Foraminifera Studies

1.2.1 Society Islands, French Polynesia

The first study of foraminifera in the French Polynesian Islands was attributed to the H.M.S. *Challenger* Expedition (1873-1876). It produced 10 new species from around the Society archipelago (Brady 1884). This was followed by the Albatross expedition of 1899-1900 which provided new materials from the Tuamotu, the Marquesas and the Society Islands (Cushman 1932, 1933, 1942; Todd 1965). Limited study was seen in the Society Islands until in the 80s (Le Calvez and Salvat 1980; Salvat and Vénec-Peyré 1981; Vénec-Peyré and Salvat 1981; Vénec-Peyré 1981, 1984, 1985, 1987, 1988). Le Calvez and Salvat (1980) and Vénec-Peyré and Salvat (1981) gave concise reports on the foraminiferal assemblages from the reef-lagoon system of the island of Moorea and the Scilly Atoll (French Polynesia). By 1985, Vénec-Peyré listed a total of 182 species that belonged to 39 families (Vénec-Peyré 1984, 1985a). To date, this published list of species represented the largest source of information to assess the diversity of foraminiferal communities from Polynesia. Vénec-Peyré (1987, 1988, 1985b) also noted that lagoonal biocoenoses are less diverse compared to assemblages from the outer slope and showed that substrate types control the composition of assemblages. Later, she examined living foraminifera on both sides of the barrier reef across a section along the northwestern part of Moorea. A total of 87 species were recorded, with 62 in the back-reef area (fringing reef, channel and barrier reef) and 72 on the outer slope; 47 were common to both zones. Furthermore, Langer and Lipps (2006) documented the foraminifera assemblages associated with the introduced mangroves of Moorea. A total of 96 species were recorded from this unique habitat.

The assemblages also differ and distinct from other nearshore habitats assemblages. This was further consolidated by the results of Fajemila et al., (2015). They carried out the first island-wide study of foraminifera around Moorea. New information on the structure, patterns of distribution and diversity of benthic foraminiferal assemblages with respect to their role as environmental indicators were documented. The position of Moorea on the diversity gradients from the highly diverse western epicenter and hotspot of the Coral Triangle to the eastern low diversity flanks was also further substantiated. The species list recorded now more than doubles the number earlier documented by Vénec-Peyré (1984, 1985a).

1.2.2 Gulf of Guinea and Southern Africa

The Gulf of Guinea and its associated countries are located on the eastern frontiers of the Atlantic Ocean (Fig. 12). It is the northernmost part of the tropical Atlantic Ocean, between Ghana and Gabon. The shallow warm-water coastal-lagoon habitats of this region contain faunal assemblages that simply differ from those of the cold-water environment in the southern Atlantic coast. There have been few known publications on foraminifera from this region (Fayose 1970; Asseez et al. 1974; Adegoke 1975; Adegoke et al., 1976; Bianchi 1992; Dublin-Green 1994; Durrieu et al. 2006; Duchemin et al. 2008; Sibuet and Vangriesheim 2009; Olayiwola and Odebode 2013; Friedlander et al. 2014; Langer et al. 2016a, b; Fajemila and Langer 2016). Most of these studies are basically environmental impact assessment using foraminifera as a tool or faintly looking at distribution on a temporal scale. The earliest detailed reports on foraminifera in the Gulf of Guinea are those from the Nigerian sector (e.g. Asseez et al. 1974; Adegoke 1975; Adegoke et al. 1976). Adegoke (1975) studied the foraminifera fauna from the polyhaline lagoons of West Africa, stretching from Ivory Coast to the western edge of the Niger Delta. He recorded diverse foraminifera assemblages which change from one lagoon to another. He also mentioned larger miliolids in the high salinity lagoons of Ghana. The role of benthic foraminifera as pollution indicators in the Bonny estuary of the Niger Delta was studied by Dublin-Green (1994). He documented 32 benthic foraminifera species belonging to 18 genera. Fajemila and Langer (2016) investigated and documented the benthic foraminifera, thecamoebian and diatom species from the Ologe Lagoon, southwestern Nigeria. This was to ascertain its current status, composition, spatial distribution, and response of microfaunal assemblages to environmental stressors within the lagoon with regards to its proximity to both residential and industrial pollutants. The benthic foraminiferal assemblage is composed of four highly specialized agglutinated species of *Ammotium salsum*, *Miliammina fusca*, *Ammobaculites dilatatus* and *Ammobaculites aff. A. exiguus*. The high abundance of *Ammotium salsum* is

considered an indication of environmental stress. The faunal assemblages recovered are characterized by low species richness and alpha diversity indices and are typical of shallow, marginal-marine hyposaline environments.



Fig. 12: Gulf of Guinea and its coastal countries (modified after Google earth)

The first survey of shallow-water foraminifera from nearshore coastal waters of Gabon, an area from which modern benthic foraminifera are virtually unknown was carried out by Langer et al., (2016a). They recorded 39 species which is a higher number when compared with the lower diversity recorded at drilling waste disposal sites studied by Durrieu et al., (2003). The composition of foraminiferal biotas found off Gabon shows them to be distinct from faunas recorded from off Namibia and South Africa (Schmidt-Sinns 2008), indicating the presence of a marine biogeographic barrier. Furthermore, studies on the shallow sub- and intertidal microbiota are virtually lacking within the coastal settings of Gabon. Bianchi (1992), Sibuet and Vangriesheim (2009), Friedlander et al. (2014) have all looked at biotic communities from the continental margins near hydrocarbon exploration sites or fishery resources along the shelf and slope. In view of this, Langer et al. (2016b) carried out a survey of the intertidal benthic foraminifera from the mangroves areas of Gabon. They recorded two distinct foraminifera assemblages which are related to sea level fluctuations and are typical of intertidal zonation patterns in mangroves and estuaries.

In Southern Africa, there have been many foraminiferal studies around the coasts of western Indian Ocean and the eastern coasts of Atlantic Ocean (Fig. 13). Workers have evolved

through ages with different approaches to study the foraminifera assemblages of these regions (Wright 1876, 1877; Möbius 1880; Brady 1884; Egger 1893; Heron-Allen and Earland 1914, 1915; Braga 1961; Moura 1965; Le Calvez 1965; Monier 1973; Battistini et al. 1976; Phleger 1976a, b; Hottinger 1977; Pereira 1979; Chasens 1981; Montaggioni 1981; Banner and Pereira 1981; Neagu 1982; Levy et al. 1982; McMillan 1974, 1986; Cooper and Mcmillan 1987; Wright et al. 1990; Dale and Mcmillan 1998, 1999; Langer and Hottinger 2000; Perry 2003; Langer and Schmidt-Sinns 2008; Pignatti et al. 2012). These studies stretch from the coasts of Somalia down south to the adjoining countries of South Africa and Tanzania, and also along the Atlantic coasts of South Africa, Namibia and Angola. Shallow-water foraminifera were first identified and described by Möbius (1880) on the western Indian Ocean islands of Mauritius and Seychelles. This was followed by a very detailed and comprehensive study by Heron-Allen and Earland (1914, 1915) on the foraminifera of the Kerimba Archipelago (today Quirimbas Islands). They documented 477 species from depths of up to 155m. Two foraminiferal genera, *Iridia* and *Nouria*, and a few new species were described. Furthermore, Braga (1961) documented diverse foraminifera assemblage from materials off the coast of southern Mozambique, up to 700m. Shallow-water foraminifera were also studied from an island around the bay of Maputo (Moura 1965). Recently, Langer et al. (2013a) documented 158 foraminifera species from the Bazaruto Island (Mozambique). Biogeographical data and foraminiferal habitat preferences that might be useful in paleoecological studies were also documented. From southernmost Somalia to Kenya, foraminifera assemblages have been studied across the fringing reefs to the lagoon settings (Pereira 1979; Chasens 1981; Levy et al. 1982). A more comprehensive study was carried out in shallow marine habitats and tidal channels across the Somali-Kenyan coastal border by Pignatti et al. (2012). A total of 256 foraminiferal species were described and documented. Thissen and Langer (2016) recorded a total of 157 species of benthic foraminifera from samples taken around the three main islands of the Zanzibar Archipelago. The foraminiferal assemblages recorded represent 88 genera. Among them are 8 genera of larger symbiont-bearing foraminifera (LBF) which are *Borelis schlumbergeri*, *Peneroplis* spp., *Amphisorus hemprichii*, *Sorites orbiculus*, *Amphistegina* spp., *Neorotalia calcar*, *Assilina* spp., and *Heterostegina depressa*. They constitute about 52.03 % of all individuals counted.

Similarly on the Atlantic coasts of Namibia, Angola or South Africa, foraminifera assemblages identical to those of the east African coasts have been documented by few authors (Martin 1981; Licari et al. 2003; Toefy et al. 2005; Licari and Mackensen 2005; Langer and Schmidt-Sinns 2006a; Schmidt-Sinns 2008). However, regions of southwest Africa have not

been thoroughly studied over the years. Schmidt-Sinns (2008) worked on sediment samples taken from Cape Town (34.4 ° S) to South Angola (14.2° S) in water depths ranging from 0 to 200m. A total of 59 genera and 129 benthic species were identified in this study and were documented with scanning electron microscope (SEM). Further results on the ontogenic growth steps of *Criboelphidium mirum* and *Pararotalia* sp. 1. were also documented (Langer and Schmidt-Sinns 2006a). The existence of a biogeographic barrier restricting interactions between cold water habitats of southern Africa and the warm water habitats of the Gulf of Guinea was further substantiated. This is the most detailed report from the southwestern Atlantic coast of Africa.

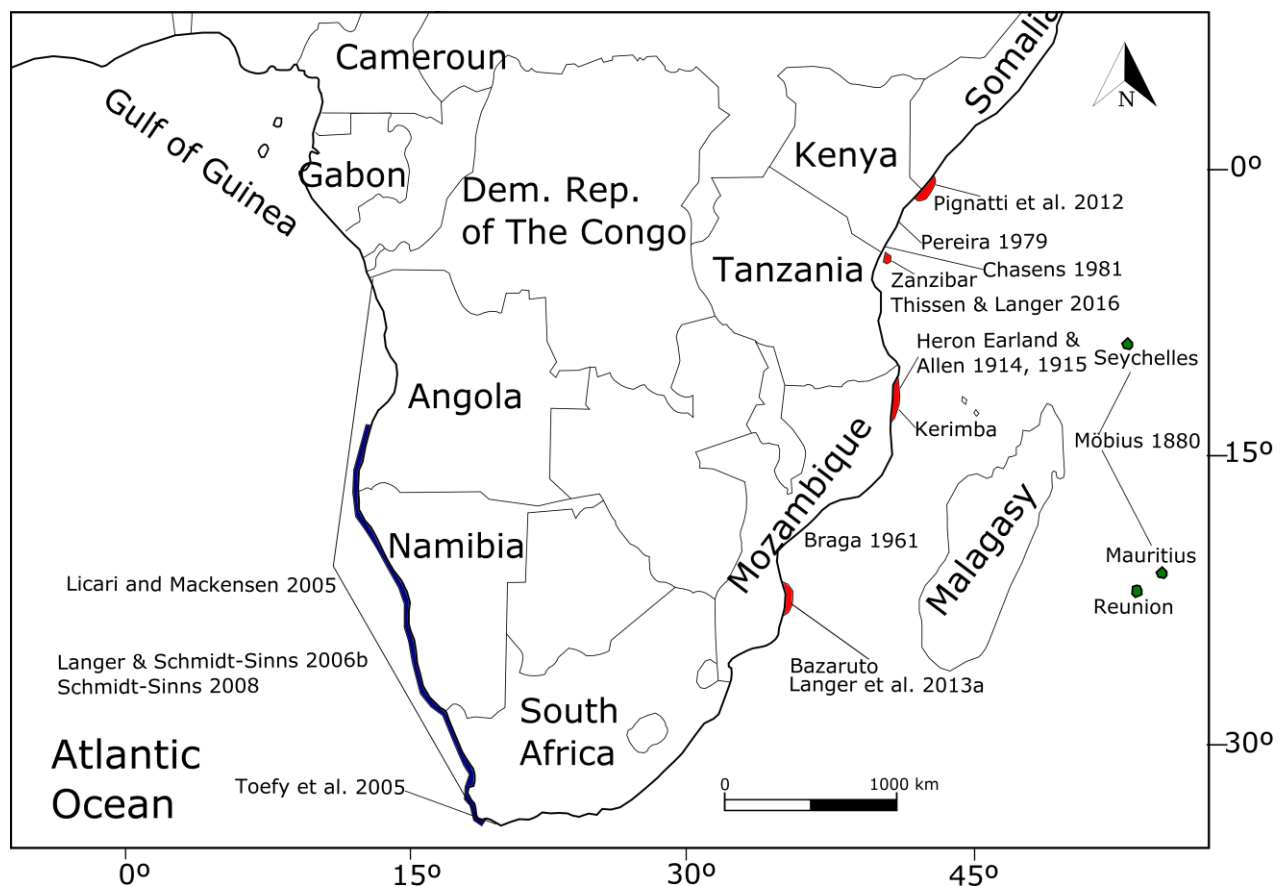


Fig. 13: Southern Africa showing some of the foraminifera studies and corresponding coastal localities.

1.3 Benthic Foraminifera in Environmental Assessment and Monitoring

Climate change and other environmental disturbances are on the increase and these have agitated many interest groups and researchers worldwide. The need to use microfossils, especially foraminifera, as agents of environmental monitoring, has equally advanced over the decades. Foraminifera facilitate biological characterization of a variety of environments ranging from freshwater to brackish to marine and they respond very fast to environmental stress, either natural or anthropogenic. Because of their small size, they occur in large numbers in small-diameter core samples, and since they have a hard shell, they yield fossil assemblages that can

be used as proxies to reconstruct past environmental conditions (Scott et al. 2001). Moreover, the large number of living species (>5000) gave it a relative advantage over other forms of microfossils (Armstrong and Brasier 2005). The factors controlling the abundance of foraminifera include dissolved oxygen, nutrition, pH, salinity, substrate type and temperature as highlighted by many authors (Murray 1968; Alve and Nagy 1986; Boltovskoy et al. 1991; de Rijk 1995; Barbosa and Suguio 1999; Debenay et al. 2002; Horton et al. 2003). However, Langer et al. (2016b) pointed out the role of elevation with regards to tidal regime within the mangroves of Gabon. Moreover, the influence of temperature, sparse vegetation cover and low organic content in tropical locations are equally important considerations (Murray 1968; Dublin-Green 1992; de Rijk 1995).

Indicator species and or habitat specific assemblages have been put into use, recognizing their habitat preferences and the peculiarities of the local environment. Langer and Lipps (2003) recognized faunal groups, which are characterized by a number of indicator species, and range from the Bay inlets into the lagoon, fringing reef and fore- and back reef sites of Madang, Papua New Guinea (Fig. 14). This is very similar in composition to other reef-lagoons systems, within the Pacific Ocean and other parts of the world (Venec-Peyré 1991; Cockey et al. 1996; Uthicke and Nobes 2008; Schueth and Frank 2008; Carilli and Walsh 2012; Fujita and Omori 2015; Fajemila et al. 2015). The mangrove habitat is equally of great importance and the foraminifera assemblage within it has been studied along different latitudes. The assemblage mimics similar species and assemblage, although some are not present in all the latitudes. The tropical and subtropical mangroves are characterized by the presence of *Miliammina*, *Ammotium*, *Ammonia* and *Elphidium* species (Debenay et al. 2002; Horton et al. 2003; Langer and Lipps 2006; Langer et al. 2016b; Fajemila and Langer 2016). But this is not a thumb rule as there are modifications as you change localities.

Foraminifera have a documented invaluable record as proxies for environmental change in temperate, tropical and subtropical ecosystems (Saunders 1958; Bartlett 1966; Madeira-Falcetta 1974; Hallock 1981; Culver 1990; Scott and Leckie 1990; Asioli et al. 1996; Debenay et al. 1998; Scott et al. 2001; Duleba and Debenay 2003; Hallock et al. 2003; Reinhardt et al. 2005; Eichler et al. 2006; Hohenegger 2006; Langer and Lipps 2006; Pereira et al. 2006; Goldbeck and Langer 2006; Katarina 2007; Qin et al. 2013; Debenay et al. 2015; Eichler et al. 2015; Martin and Nesbitt 2015; Fajemila et al. 2015; Langer et al. 2016b). Their use as bio-indicators in correlation with hydrographic parameters provides important information for monitoring their immediate habitat with regards to ecological limits.

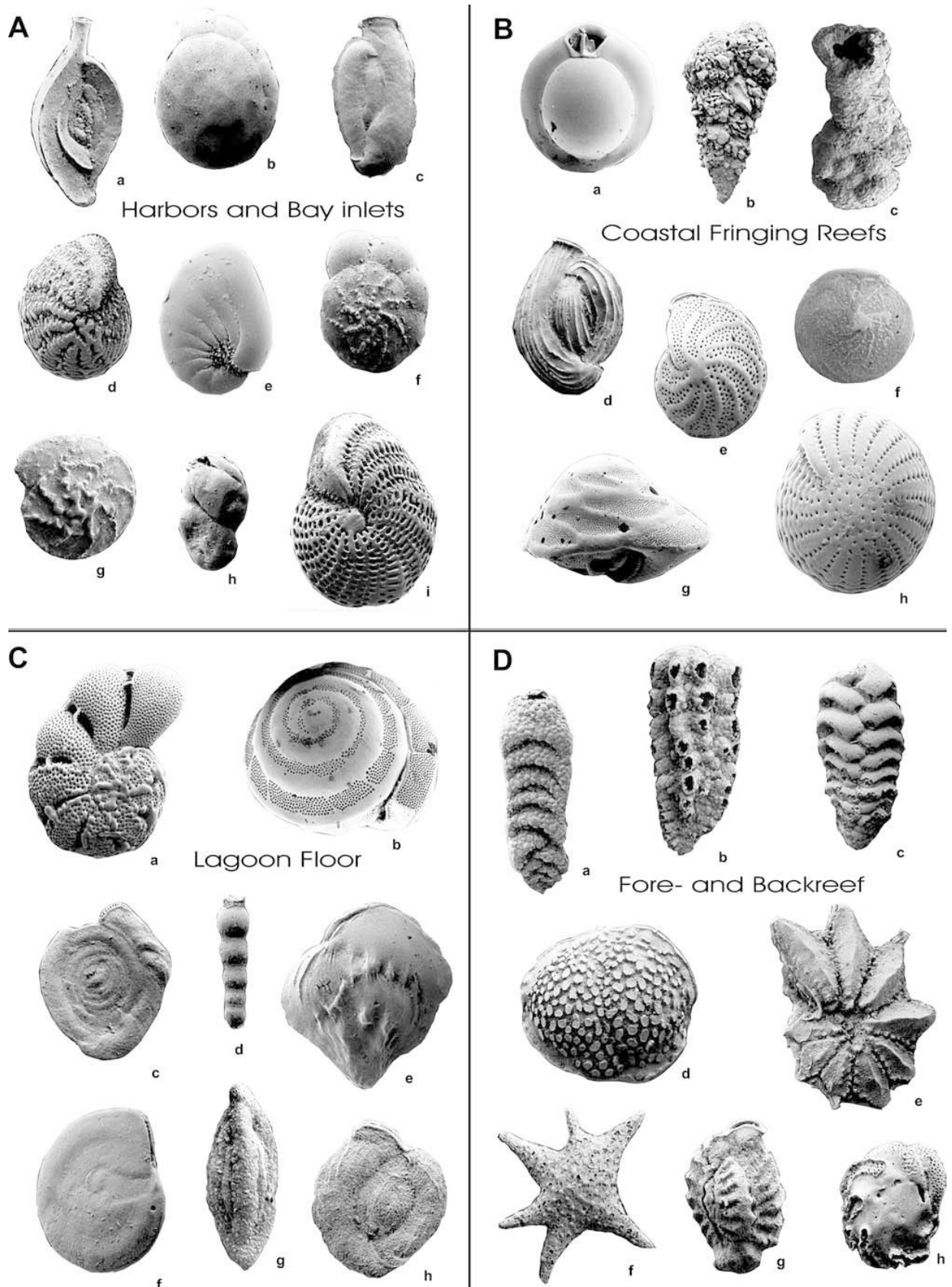


Fig. 14: Habitat specific assemblages characterizing the four major habitats in the lagoon at Madang (after Langer and Lipps 2003).

Foraminifera respond quickly to anthropogenically induced environmental changes in aquatic settings and several workers, during the past decades have attempted to relate

foraminiferal distribution patterns to many kinds of pollution (Bandy et al. 1964a, b, 1965a, b; Seiglie 1968, 1975; Schafer 1973; Bates and Spencer 1979; Alve 1991). Some studies also consider thermal and various kinds of chemical pollution (Schafer 1970, 1973; Buckley et al. 1974; Seiglie 1975), while others looked at benthic foraminifera showing morphological abnormalities in response to increased heavy metal concentrations (e.g. Boltovskoy et al. 1991; Alve 1991, 1995; Sharifi et al. 1991; Yanko et al. 1998; Le Cadre and Debenay 2006; Frontalini and Coccioni, 2008; Frontalini et al. 2009).

Heavy metal pollution has been shown as an anthropogenic cause for abnormal tests behavior and growth (e.g. Alve 1991, 1995; Frontalini and Coccioni 2008; Frontalini et al. 2009). This deformation may occur during the earlier stages or during matured life of the organism. Chambers are distorted in shape, size and arrangement with radical number of apertures. These are termed aberrant. Alve (1991) worked on two short sediment cores from heavy metal polluted Soerfjord at 15 and 53m water depth were analysed. Soerfjord has been a dump of industrial waste for many decades. Test abnormalities were observed as well as normal test which were present in all parts of the cores. These were attributed to natural environmental stress caused by anthropogenic pollution. Faunal shift from the moderately polluted environment of *Verneuilina media* assemblage to an extremely polluted environment characterized by *Eggerelloides scabrus* assemblage was observed. Frontalini and Coccioni (2008) looked at living benthic foraminifera assemblages from the Adriatic Sea Coast of Italy. Faunal changes and numbers of test abnormalities were tagged to heavy metal concentrations. *Ammonia parkinsoniana* as the dominant species of the benthic fauna prefers clean to low polluted environments and decreases in abundance with rising heavy metal concentration. Other species such as *Ammonia tepida* are more tolerant with relative rise in heavy metal pollution. This was the similar situation in the heavily contaminated Santa Gilla lagoon, Cagliari, Italy (Frontalini et al. 2009; fig. 14). Many experiments have been done to verify the extent of heavy metal pollution effect on foraminifera (e.g. Sharifi et al. 1991; Le Cadre and Debenay 2006). Sharifi et al. (1991) have shown that some foraminifera species from Southampton waters were able to tolerate pollution while others developed abnormal test deformities. The deformed specimens contain higher levels of elements such as Cu and Zn than non-deformed specimens. For instance, it was deduced that *Ammonia beccarii* produces abnormal tests at 10–20µg/l of copper in seawater (Sharifi et al. 1991; Le Cadre and Debenay 2006) and dies at concentrations exceeding 200µg/l (Le Cadre and Debenay 2006).

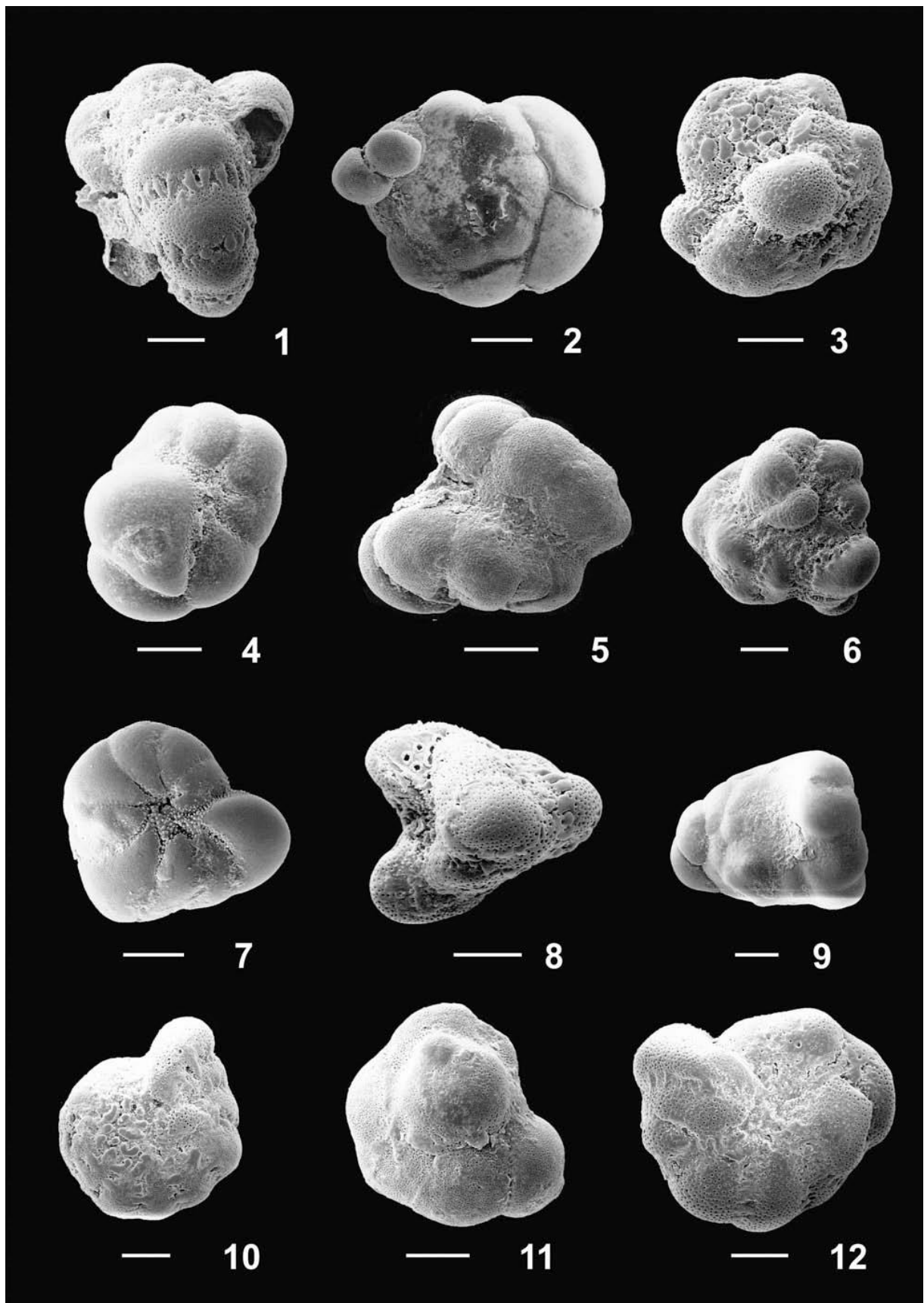


Fig. 15: Disfiguration of foraminifera by heavy metals pollution from the Santa Gilla Lagoon, Cagliari, Italy (after Frontalini et al. 2009)

The distribution and composition of foraminifera assemblages are useful signatures for past sea level changes (e.g. Scott and Medioli 1978, 1986; Scott and Leckie 1990; Horton et al. 2003, 2005; Edwards et al. 2004; Woodroffe et al. 2005; Shaw et al. 2016; Langer et al. 2016b). These studies have shown that foraminifera are related to altitude; and the approach requires the use of sea-level indicators species which are contained in both contemporary and fossil sedimentary deposits (Woodroffe et al. 2005). These sea-level indicators which were developed from observed changes in microfossil assemblages with elevation have been used for decades to provide reconstructions of Holocene Relative sea-level change for many regions of the world (Shennan et al. 2002; Peltier 2002; Shennan and Horton 2002; Horton et al. 2003, 2005; Woodroffe et al. 2005).

When compared to the temperate environments, a few studies worthy of mention have been carried out in the tropical coastal environments with regards to relative sea level and foraminifera assemblage [Michie (northern Australia, 1987), Scott et al. (Brazil, 1990), Barbosa and Suguio (Brazil, 1999), Hayward et al. (New Zealand, 1999b, 2004b), Debenay et al. (west coast of Africa, New Caledonia and northern Australia, 2000), Haslett (northern Australia, 2001), Debenay et al. (French Guiana, 2002), Javaux and Javaux and Scott (Bermuda 1999, 2003), Horton et al. (Great Barrier Reef coastline, Australia, 2003), and Horton et al. (Indonesia, 2005), Langer et al. (Gabon, 2016a, 2016b)]. Unfortunately, Woodroffe et al. (2005) pointed out that most these studies are concerned with individual sites and do not investigate the potential for diversity in foraminiferal faunas over local or regional scales.

Environmental monitoring and assessment of the endangered coral species in reefal regions of the world have led to the development of the FORAM Index (FI) (Hallock et al. 2003). This is a single metric index to determine the impact of environmental stressors on coral reef environments and to assess whether the quality of water is sufficient to support mixotrophy (algal symbiosis). This measure is based on foraminiferal shells present in the sediment and is independent of coral populations. The larger benthic foraminifera are very good reef stabilizers because of their calcium carbonate production and are therefore considered highly relevant because they share similar habitats with the corals (Langer et al. 1997; Hallock 1999; Langer 2008b). By virtue of foraminiferal abundance, the index allows a rapid and cost-effective assessment of environmental conditions. Calculation of FI depends on the relative abundances of symbiont-bearing, opportunistic and heterotrophic taxa (Table 1) and is particularly meaningful in populations that “integrate anthropogenic and natural stressors on the organisms over time.

The opportunistic taxa are ever expanding, depending on local environmental conditions (Hallock et al. 2003); this is evident in Low Isles reef (Northern Great Barrier Reef, Australia), Kiritimati (Christmas) and Moorea Islands in the Pacific Ocean (Schueth and Frank 2008; Carilli and Walsh 2012; Fajemila et al. 2015). Island Reef-building corals and larger foraminifers are both dependent on algal symbionts to enhance growth and calcification (Lee and Anderson 1991; Langer et al. 1997; Hallock et al. 2003). Therefore, the survival of Coral reefs and foraminifers with algal symbionts is threatened by increase in the nutrient supplies. This will eventually lead to their empty tests becoming rare in the sediments, and left overs become more abraded and corroded (Cotter and Hallock 1988). Therefore, with continuous nutrient supply, coral and calcareous algae rubbles, molluscan debris, and smaller opportunistic foraminifers become more common as sediment constituents (Hirshfield et al. 1968; Hallock, 1988; Cockey et al. 1996; Carilli and Walsh 2012; Fajemila et al. 2015).

Table 1: Functional groups of foraminifers used in coral reef assessments (After Hallock et al. 2003)

<i>Functional Group</i>	<i>Order</i>	<i>Family</i>	<i>Genus</i>	<i>Distribution</i>
Symbiont-Bearing	Rotaliida	Amphisteginidae	<i>Amphistegina</i>	Circumtropical
		Calcarinidae	5 genera	Indo-Pacific
		Nummulitidae	<i>Heterostegina</i> 3 other genera	Circumtropical Indo-Pacific
	Miliolida	Alveolinidae	<i>Alveolinella</i>	Indo-Pacific
			<i>Borelis</i>	Circumtropical
		Peneroplidae	Several genera	Circumtropical
		Soritidae	<i>Sorites</i>	Circumtropical
			<i>Amphisorus</i>	Circumtropical
			3 genera	Caribbean
		<i>Marginopora</i>	Indo-Pacific	
Opportunistic*	Trochamminida	Trochamminidae	Several genera	Cosmopolitan
	Textulariida	Lituolidae	Several genera	Cosmopolitan
	Buliminida	Bolivinidae	Several genera	Cosmopolitan
		Buliminidae	Several genera	Cosmopolitan
	Rotaliida	Rotaliidae	<i>Ammonia</i>	Cosmopolitan
		Elphidiidae	<i>Elphidium</i>	Cosmopolitan
	Other Small Taxa	Miliolida	Most except larger taxa noted above	
Rotaliida		Most except those noted above		Cosmopolitan
Textulariida		Most		Cosmopolitan
Other		Most		Cosmopolitan

*Full range of opportunistic genera under local conditions is not well known.

The FORAM Index is calculated using the steps highlighted by Hallock et al. 2003:

1. From each subsample examined, sort all foraminiferal specimens by genus, count, and record in a spreadsheet, with genera arranged by functional group.

2. Calculate the proportion (P) of specimens for each functional group by summing the specimens of each genus of that group (N) and dividing by the total number of specimens counted (T).

a) $P_s = N_s/T$, where subscript “s” represents symbiont-bearing foraminifers

b) $P_o = N_o/T$, where subscript “o” represents opportunistic foraminifers

c) $P_h = N_h/T$, where subscript “h” represents other small, heterotrophic foraminifers

3. Weight proportions to calculate the FORAM Index (FI):

$$FI = (10 \times P_s) + (P_o) + (2 \times P_h)$$

4. Interpretation:

FI > 4 indicates environment conducive to reef growth

FI varying between 3 and 5 indicates environmental change (Coefficient of Variation > 0.1)

2 < FI < 4 indicates environment marginal for reef growth and unsuitable for recovery

FI < 2 indicates stressed conditions unsuitable for reef growth

1.4 Aims of this study and thesis outline

The enormous information embedded in foraminifera has made it a useful tool in the study of modern environments. Because of their great number of species and assemblages, it is easier to decipher the response of each foraminifera group to environmental stressors. Their use as an assessment tool was tested both in the Pacific and Atlantic environments. Each environment is characterized by definite habitat requirements and any change in these requirements would invariably lead to changes in the assemblage group that make up that habitat. It is therefore imperative to study the assemblages with regards to these environments.

This study commenced with the ecological significance of benthic foraminifera with regards to spatial distribution and diversity around the reefal Moorea Island, French Polynesia. This presents the first Island-wide study of foraminifera around Moorea, and was meant to build upon the works of Vénec-Peyré (1991, 1985a, 1985b) and Langer and Lipps (2006). In light of this, new information on foraminiferal community structure and distribution within the different habitats of Moorea was documented. This enabled us to assess reef health and vitality using the FORAM Index (FI), a single metric index indicative of reef health and conditions for carbonate accretion (Langer 1997; Hallock et al. 2003; Fajemila et al. 2015). This is presented in Chapter 2 and was published in *PLoS ONE*, December 2015. Chapter 3 contains the first scientific survey of modern coastal shallow benthic foraminifera from non-impacted sites of Gabon. This was to determine the structure and diversity of communities of benthic foraminifera from six non-impacted sites in the Gabon Estuary (Port Michel Marine), the Pongara National Park (Point Denise) and from Petit Loango in terms of the species richness and composition. The results were compared with those of Namibia and South Africa and found to be different and distinct;

this could be due to the presence of a marine biogeographic barrier which would have prevented fauna migration (Langer et al. 2016a). This was published in *Micropaleontology*, June, 2016.

In Chapter 4, studies on the subtidal and intertidal microbiota from the estuary of Akanda National Park, Gabon were presented. This is the first scientific survey of modern intertidal mangrove foraminifera from Gabon. The compositional structure of benthic foraminifera at different intertidal elevations is similar to zonations and patterns in mangroves and estuaries, and their potential for sea-level reconstructions were highlighted. The fauna assemblages were also compared to other non-mangrove shallow water habitats along the western coasts of Africa (Langer et al. 2016b). This was published in *Neues Jahrbuch für Geologie und Paläontologie, Abhandlungen* September, 2016. The utilization of foraminifera, thecamoebians and diatoms as ecosystem indicators was put to test within Ologe Lagoon in southwestern Nigeria. This was a baseline study to document the current status of the lagoon with regards to the abundance and distribution of these species. Their use as bio-indicators in correlation with hydrodynamic readings gives information for monitoring, management and exploration of lagoon and water resources with regards to ecological limits especially in a highly populated environment of Ologe Lagoon (Fajemila and Langer 2016). This is presented in Chapter 5 and was accepted for publication in *Revue de Micropaléontologie*, September, 2016.

The first Atlas of shallow-water benthic foraminifera from Moorea, Society Archipelago is presented in Chapter 6. More than 16000 individuals were picked and identified to species level where possible. Images of representative species were taken by Scanning Electron Microscope (SEM) and are arranged into 39 plates of 364 species of benthic foraminifera. They form the basis of identification of benthic species from the French Polynesia in general (Fajemila and Langer, in prep.).

Chapter 2

Spatial Patterns in the Distribution, Diversity and Abundance of Benthic Foraminifera around Moorea (Society Archipelago, French Polynesia)

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Abstract

Coral reefs are now subject to global threats and influences from numerous anthropogenic sources. Foraminifera, a group of unicellular shelled organisms, are excellent indicators of water quality and reef health. Thus, we studied a set of samples taken in 1992 to provide a foraminiferal baseline for future studies of environmental change. Our study provides the first island-wide analysis of shallow benthic foraminifera from around Moorea (Society Archipelago). We analyzed the composition, species richness, patterns of distribution and abundance of unstained foraminiferal assemblages from bays, fringing reefs, nearshore and back- and fore-reef environments. A total of 380 taxa of foraminifera were recorded, a number that almost doubles previous species counts. Spatial patterns of foraminiferal assemblages are characterized by numerical abundances of individual taxa, cluster groups and gradients of species richness, as documented by cluster, Fisher α , ternary plot and Principal Component Analyses (PCA). The inner bay inlets are dominated by stress-tolerant, mostly thin-shelled taxa of *Bolivina*, *Bolivinella*, *Nonionoides*, *Elongobula*, and *Ammonia* preferring low-oxygen and/or nutrient-rich habitats influenced by coastal factors such as fresh-water runoff and overhanging mangroves. The larger symbiont-bearing foraminifera (*Borelis*, *Amphistegina*, *Heterostegina*, *Peneroplis*) generally live in the oligotrophic, well-lit back- and fore-reef environments. Amphisteginids and peneroplids were among the few taxa found in the bay environments, probably due to their preferences for phytal substrates and tolerance to moderate levels of eutrophication. The fringing reef environments along the outer bay are characterized by *Borelis schlumbergeri*, *Heterostegina depressa*, *Textularia* spp. and various miliolids which represent a hotspot of diversity within the complex reef-lagoon system of Moorea. The high foraminiferal Fisher α and species richness diversity in outer bay fringing reefs is consistent with the disturbance-mosaic (microhabitat heterogeneity) hypothesis.

Calculations of the FORAM Index (FI), a single metric index to assess reef vitality, indicate that all fore- and most back-reef environments support active carbonate accretion and provide habitat suitability for carbonate producers dependent on algal symbiosis. Lowest suitability values were

recorded within the innermost bays, an area where natural and increasing anthropogenic influences continue to impact the reefs. The presence of habitat specific assemblages and numerical abundance values of individual taxa show that benthic foraminifera are excellent recorders of environmental perturbations and good indicators useful in modern and ancient ecological and environmental studies.

2.1 Introduction

The Society Islands are located east of the tropical marine diversity hotspot with significance as recipients and redistributors of biotas via equatorial currents. They represent a transitional location between the high diversity assemblages of the coral triangle and the lower diversity biotas of the eastern Pacific. The beautiful coral rings and variety of habitats has made these islands ideal settings for coral health and reef management studies. While the coral community structure has been extensively studied (Chazottes et al 1995, Gleason 1996, Bessat and Buigues 2001, Juhasz et al. 2010), the foraminifera have received localized attention and are limited to case studies of specific environments (Véneç-Peyré 1984, 1987, 1988; Langer and Lipps 2006) yet they are important members of tropical biotas, as monitoring aids for ecologic change, including global warming (Hallock 2000), and in understanding the history and development of islands. Foraminifera are prominent producers of calcium carbonate and contribute significantly to the calcium carbonate budget of coral reefs (Hallock 1981, Langer *et al.* 1997). Given the present shortage of quantitative data on the spatial distribution of reef organisms, we studied an island-wide collection made in 1992 to analyze the structure and distribution of foraminiferal communities, to assess their diversity and to identify the dominant components in relation to their habitat. Moreover, coral reefs of Polynesia have experienced large-scale disturbances such as temperature increases, bleaching events (Hallock 2000), hurricanes and cyclones (Salvat et al. 2008), human disturbance through sedimentation, pollution and damage on reefs (Salvat 1987; Lipps 2011), and outbreaks of *Acanthaster planci* which were followed by high rates of mortality (Juhasz et al. 2010; Endean and Cameron 1990; Jokiel and Coles 1990; Cameron et al. 1991; Done et al. 1991; Gleason 1996; Harmelin-Vivien 1994; Hoegh-Guldberg and Salvat 1995; Adjeroud 1997; Hodgson 1999; Adjeroud et al. 2002; Adjeroud et al. 2005; Adjeroud et al. 2007a, 2007b; Penin et al. 2007; Baker et al. 2008). Because of their abundance, ubiquity and rapid turnover rates, foraminifera are excellent indicators for studies of reef health and they preserve environmental information that is useful in interpreting changing ecological conditions and paleoecological studies. Our study, because of the distribution of collecting sites and number of species documented, provides a baseline for

environmental changes since 1992. In light of this we provide new information on foraminiferal community structure and assess reef vitality using the FORAM Index (FI), a single metric index indicative of reef health and conditions for carbonate accretion (Hallock *et al.* 2003, Stephenson *et al.* 2015).

The study of foraminifera in the French Polynesian Islands dates back to the H.M.S. *Challenger* Expedition (1873-1876) when 10 new species were described and documented from around the Society archipelago (Brady 1884). Later the Albatross expedition of 1899-1900 provided new material from the Tuamotu, the Marquesas and the Society Islands (Cushman 1932, 1933, 1942; Todd 1965). However, these efforts were followed by longer years of inattention in the Polynesian corridor until in the 1970s and 80s. Le Calvez and Salvat (1980) and Vénec-Peyré and Salvat (1981) gave concise reports on the foraminiferal assemblages from the reef-lagoon system of the island of Moorea and the Scilly Atoll (French Polynesia). Salvat and Vénec-Peyré (1981) recognized 25 living foraminifera and concluded that the majority of the species are cosmopolitan and the population is affected by dwarfism. By 1985, Vénec-Peyré listed a total of 182 species that belonged to 39 families (Vénec-Peyré 1984, 1985a). To date, this published list of species represented the largest source of information to assess the diversity of foraminiferal communities from Polynesia. In light of recent large-scale surveys on foraminifera from other areas of the Indo-Pacific where up to 1000 species were recorded (Debenay *et al.* 2012; Loeblich and Tappan 1994; Langer and Lipps 2003; Parker 2009), the number currently known appears to be comparatively low. Vénec-Peyré (1987, 1988, 1985b) also noted that lagoonal biocoenoses are less diverse compared to assemblages from the outer slope and showed that substrate types control the composition of assemblages. Later, she examined living foraminifera on both sides of the barrier reef across a section along the northwestern part of Moorea. A total of 87 species were recorded, with 62 in the back-reef area (fringing reef, channel and barrier reef) and 72 on the outer slope; 47 were common to both zones. Mangrove foraminifera were the focus of research by Langer and Lipps (2006) with a total of 96 species recorded from introduced mangrove habitats, showing that the assemblages are distinct from other nearshore habitats.

The present paper reports the results of the first island-wide study of foraminifera around Moorea. This study presents new information on the structure, patterns of distribution and diversity of benthic foraminiferal assemblages with respect to their role as environmental indicators. It also contributes to the worldwide biogeographic studies of larger benthic foraminifera, which would form an integral part of the diversity gradients from the epicenter and

hotspot of the Coral Triangle (Roberts et al. 2002, Veron 1995) towards the flanks of the eastern Pacific and into the Indian Ocean.

2.2 Materials and Methods

Study area and sampling sites

This study was conducted around the high island of Moorea, French Polynesia (17°30S, 149°50W), just 25 km NW of Tahiti and is part of the Society Archipelago in the South Pacific. The island, of volcanic origin, is 1.2 million years old and is surrounded by an encircling barrier reef only a few thousand years old, at least at their present sea level elevation. Water exchange from within the barrier and the open ocean is controlled by several larger and smaller passes in the barrier reef. The barrier reef encloses a shallow back-reef and lagoonal area that ranges between 500 and 1000m in width. On the northern side are two deep bays (Opunohu and Cook's Bays) that give the island a "heart-shaped" appearance. The island has a total area of 134 km², a circumference of 61 km, a height of 1207 m, and has 49 km² of reefs, lagoons and nearshore habitats (Fig 1). Forty-five sample stations were selected around the island within the bays, lagoons, and back- and fore-reef environments for good representation of environmental habitats. These comprise the shallow water habitats of Opunohu Bay and Tareu Pass, Cook's Bay and Teavaru Pass, Irihoriu Pass, Teonehua and Matauvau and near Motu Ahi and Point Faaupo (Fig 1). Samples were collected in 1992 from the sediment surface by filling plastic bags (20x40 cm) with substrata from the top 2cm while Scuba diving and snorkeling. The sampling sites cover a depths range from 0-40m. All samples were washed over 63µm mesh sieves and dried at 50⁰C in an oven overnight. Foraminifera were picked from each sample and individuals of each species were counted. Live foraminifera were grouped with dead tests in our study because our aim was to provide general environmental and biogeographic data useful in paleoecology. Our samples are thus time-averaged and as such provide an effective means of defining reefal habitats (Langer and Lipps 2003).

More than 16,000 individuals were picked, identified to species level and counted wherever possible. Based on their ecological roles in warm-water environments, all genera were categorized into three functional groups (symbiont-bearing, heterotrophic and stress-tolerant opportunistic taxa; (Hallock et al. 2003) and percent abundances of each group were calculated. Images of representative species were taken by Scanning Electron Microscope (SEM) and arranged into the plate using the Adobe Photoshop CS6. All samples and illustrated specimens will be deposited in the micropaleontological collections of the Museum of Paleontology, University of California, Berkeley (no. MF9218 to MF9299 and specimen nos. 16310 to 16399).

This work was done under permit No. 568/BCO from Haut-Commissariat de La Republique en Polynesie Francaise.

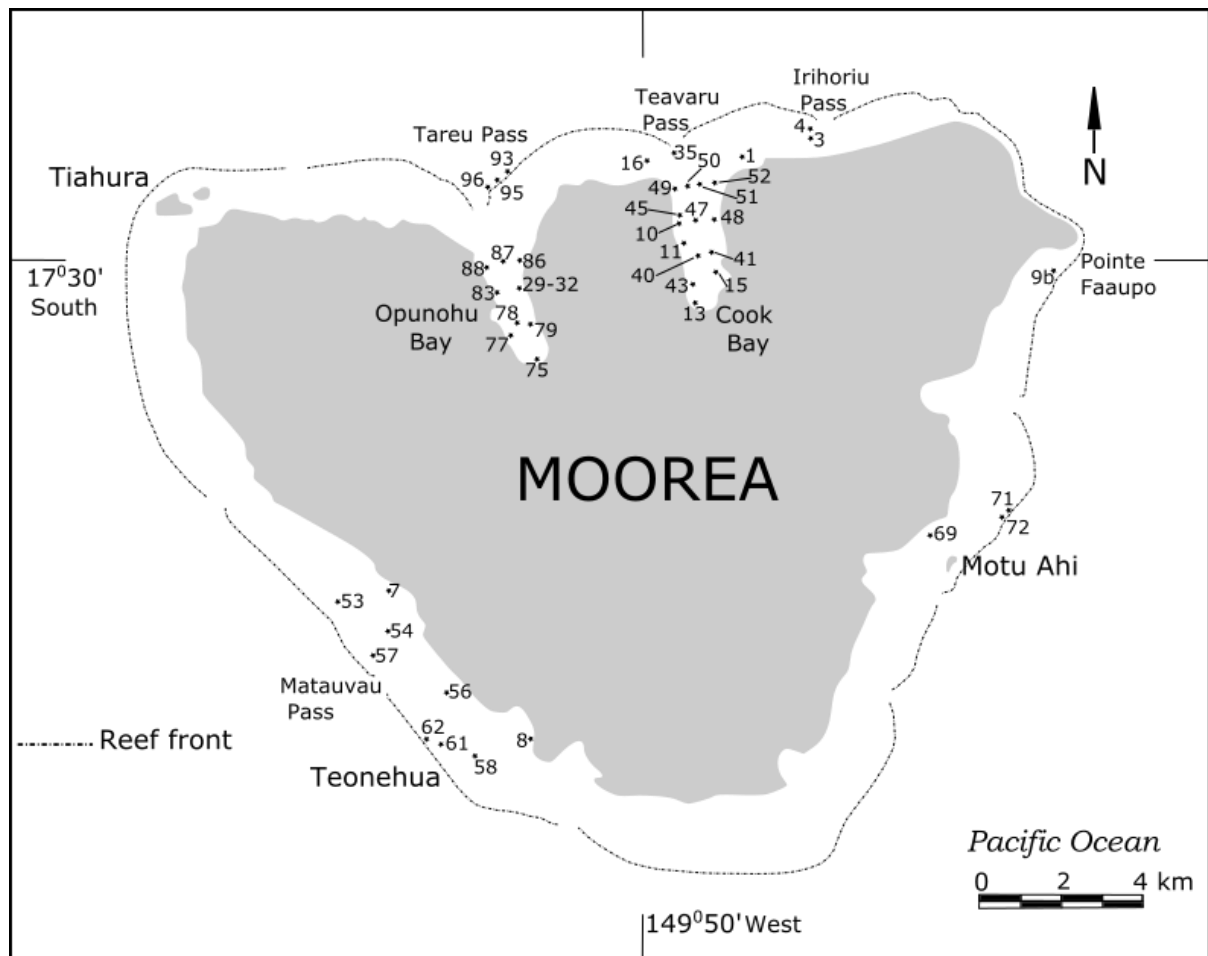


Fig. 1: Location of the 45 sample stations around Moorea, French Polynesia (for details see Table 1)

The reefal, bay and lagoonal habitats exhibit specific environmental features: these include the nature and composition of sediments, fresh water runoff and the coverage by mangroves, algae and corals. The shoreline habitats are distributed along the shallow lagoon. Within the innermost bays and at several shore sites mangroves (*Rhizophora stylosa*) trees introduced in 1937 line the coastal areas. These habitats are mostly muds and roots in mangrove forests, in shore sands and organic-rich mud/silt under overhanging native *Hibiscus tiliaceus*, in *Paspalum vaginatum* salt grass marshes, and in some sand and beach rock.

Fringing reefs are located along the shores of the outer bays and are also present as patches along the surrounding coast. Their depth usually does not exceed 3 meters. The coral assemblage is characterized by *Synarea*, *Psammocora*, *Montipora* and *Acropora*. Algal vegetation within the bay is dominated by *Halimeda*, *Padina*, *Microdictyon*, *Caulerpa*, *Turbinaria* and *Porolithon*. The composition of sediments towards the outer bay and the coastal

fringing reefs varies in general from site to site by increases from muddy and silty sediments to sandy and coarse-grained carbonaceous sand and rubble along the coast.

The reef barrier is up to 400 meters wide, formed by a shallow reef flat (2m) and bordered by a reef crest. The outer reef slope comprises furrowed platforms, buttresses and valleys and downward sloping platforms to very deep waters. *Acropora*, *Montipora*, and *Pocillopora* corals are among the dominant genera in the fore-reef areas. Sediments comprise coral rubble, and coarse detrital sand that accumulates in furrows and valley bottoms. The bottom then drops steeply to the ocean floor (2000m).

Tides at Moorea are semi-diurnal with a maximum range of <0.4 m. Current velocities are generally low (0.5 km/h) but may reach up to 3.5 km/h in the channels intersecting the passes (Vénec-Peyré 1991; Lenhardt 1991). Lagoon water temperature is around 27°C with variations of up to 5°C. Waters that cross the reef barrier into the lagoon flows back through the passes and channels into the open ocean. The average residence time for waters in this system has been estimated to be around 6 hours (Delesalle and Sournia 1992). Being located in the middle of an ocean and far from continental runoff, the waters surrounding Moorea are oligotrophic, except within the innermost bays where occasional runoff from the island and sewage disposal eutrophicates Moorea's pristine waters. Rarely, storms push seawater into the lagoon sufficient to flood the mangrove, marshes, and other near shore habitats and human infrastructure. These conditions do not last for more than a few days but may serve to distribute organisms to new locations within the lagoon.

To determine the structure in the foraminiferal data set we performed Q-mode clustering techniques with the paired group algorithm using the Bray-Curtis dissimilarity. Cluster analysis is a large-scale analytical procedure to detect structural entities within complex data sets. This entails data mining and patterns discovery. For the cluster analysis, the data was imported into PAST software and analyzed (Hammer et al. 2001). This technique grouped together samples with similar faunal assemblages and revealed a typology of environmental signatures embedded in a hierarchical dendrogram of foraminiferal assemblages. The full set of samples was subjected to Q-mode cluster analyses and the resulting dendrogram referenced to collection points.

For structural refinement a principal component analysis (PCA) was conducted to identify similarities and differences among foraminiferal assemblages. This is helpful in a multivariate analysis to structure and visualize larger data sets by reducing a large number of variables to a few linear combinations (principal components). The eigenvectors are mutually perpendicular axes defining the coordinate system of the space and the eigenvalues give a

measure of the ‘importance’ of each new axis to the data (Parker and Arnold 1999). For PCA the most abundant genera were selected for this analysis (see Table 2). They include: *Ammonia*, *Amphistegina*, *Bolivina*, *Elphidium*, *Hauerina*, *Homotrema*, *Miliolinella*, *Peneroplis*, *Quinqueloculina*, *Schlumbergerina*, *Sorites*, *Textularia* and *Triloculina*. The data sets were entered into PAST software and analyzed. To measure diversity, species richness was determined for each sample and illustrated by the Fisher α diversity index (Table 1; Fisher *et al.* 1943, Murray 1973). For this, the total number of individuals was plotted against the total number of species using the PAST software. This allows a comparison of foraminiferal assemblage diversity (species richness) with regards to the sampled habitats. Ternary diagrams were employed to accentuate assemblage differences among reefal habitats, by plotting percent abundances of wall structural types present in each sample (Murray 1973, 1991)

For supraspecific identification we follow Loeblich and Tappan 1987 and modifications proposed by Hottinger *et al.* 1993. For species identifications, we have applied the concepts of the nearest complete faunal studies from the Sahul Shelf (Loeblich and Tappan 1994), off Malaysia west of New Guinea (Millett 1904), the Great Barrier Reef (Baccaert 1987), Madang Lagoon and Chuuk Atoll (Langer and Lipps 2003; Makled and Langer 2011), New Caledonia (Debenay 2012; Hayward *et al.* 1999) and Ningaloo Reef (Parker 2009).

To assess the general state of reefal conditions, the FORAM-Index (FI) was calculated at each sample station (Baker *et al.* 2008; Hallock *et al.* 2003; Hallock 2012). The FI is a single metric index to determine the impact of environmental stressors on coral reef environments and to assess whether the quality of water is sufficient to support mixotrophy (algal symbiosis). This measure is based on foraminiferal shells present in the sediment and is independent of coral populations. By virtue of foraminiferal abundance, the index allows a rapid and cost-effective assessment of environmental conditions. Calculations of FI depends on the relative abundances of symbiont-bearing, opportunistic and heterotrophictaxa and is particularly meaningful in populations that “integrate anthropogenic and natural stressors on the organisms over time” (Engle 2000). The FORAM Index is calculated using the following equation: $FI = (10 \times P_s) + P_o + (2 \times P_h)$.

Where FI = FORAM Index, P_s = Number of Larger Symbiont-bearing species/T, P_o = Proportion of the opportunistic taxa/T, P_h = Proportion of Symbiont-bearing species/T, P_o = Proportion of the opportunistic taxa/T, P_h = Proportion of smaller heterotrophic taxa/T, and T = the total number of foraminifera counted (for details see Hallock *et al.* 2003).

Table 1. Sample sites showing location, depth, calculated Fisher α indices, FORAM-Index (FI) values, and total number of genera and species recorded in individual environments.

Sample No	Location		Depth (m)	Fischer α index	Foram Index	No of Genera	No of Species	No of Specimen
	Latitude	Longitude						
Lagoon								
M1	17° 28' 53.96" S	149° 48' 55.67" W	8 – 10	14.97	3.4	18	53	503
M3	17° 28' 36.49" S	149° 47' 59.91" W	1.5	16.03	2.9	16	51	377
M4	17° 28' 31.02" S	149° 48' 00.02" W	1	3.385	3.2	12	14	280
M51	17° 29' 01.85" S	149° 49' 16.53" W	20	2.512	1.7	13	13	449
Back-reef								
M16	17° 28' 57.96" S	149° 49' 54.73" W	3	14.04	3.6	14	47	396
M35	17° 28' 58.07" S	149° 49' 26.67" W	2.5	30.85	2.5	47	75	325
M53	17° 33' 24.12" S	149° 53' 11.43" W	1-1.4	16.74	3.0	34	50	321
M54	17° 33' 47.14" S	149° 52' 41.24" W	1.4	16.73	3.0	35	51	338
M58	17° 35' 15.52" S	149° 51' 42.40" W	1.4	8.227	3.8	24	31	369
Fore-reef								
M9b	17° 30' 10.14" S	149° 45' 40.19" W	20	1.59	6.4	7	8	242
M61	17° 35' 10.39" S	149° 52' 01.11" W	20-25	4.2	7.7	13	19	383
M62	17° 35' 04.42" S	149° 52' 11.39" W	20-25	12.84	4.9	29	43	353
M71	17° 32' 25.53" S	149° 45' 50.31" W	20	5.133	6.6	17	22	368
M72	17° 32' 33.89" S	149° 45' 59.66" W	20	10.26	6.9	30	38	410
M93	17° 28' 49.43" S	149° 51' 08.23" W	12	10.87	5.7	30	40	422
M95	17° 29' 03.78" S	149° 51' 26.33" W	22	8.99	6.5	26	36	492
M96	17° 29' 05.72" S	149° 51' 28.35" W	20	16.44	5.4	32	52	310
Mangrove								
M7	17° 33' 21.26" S	149° 52' 39.47" W	0-0.5	6.914	2.1	9	30	526
M8	17° 33' 02.70" S	149° 51' 08.71" W	0-0.5	3.856	1.8	11	17	318
Inner Bay								
M13	17° 30' 21.29" S	149° 49' 19.95" W	1.5	15.39	1.6	35	48	329
M15	17° 30' 04.87" S	149° 49' 04.03" W	3	13.32	1.7	34	48	520
M40	17° 29' 59.57" S	149° 49' 15.90" W	10	5.298	1.3	16	40	503
M41	17° 29' 57.90" S	149° 49' 08.45" W	10 – 15	6.476	1.3	17	25	304
M43	17° 30' 15.68" S	149° 49' 23.40" W	6	6.682	1.4	18	25	275
M47	17° 29' 26.54" S	149° 49' 17.87" W	15 – 20	14.07	1.7	34	46	370
M50	17° 29' 10.35" S	149° 49' 26.16" W	20 – 25	17.5	1.8	34	51	320
M56	17° 34' 19.16" S	149° 52' 01.39" W	3.6	14.79	2.0	27	47	350
M75	17° 30' 01.20" S	149° 51' 04.32" W	1.4	5.412	1.5	22	22	315
M77	17° 30' 42.00" S	149° 51' 20.43" W	20	19.53	1.9	38	57	341
M78	17° 30' 33.77" S	149° 51' 17.32" W	24.5	15.62	1.6	24	47	300
M79	17° 30' 34.84" S	149° 51' 07.45" W	20	10.78	1.7	25	37	321
M83	17° 30' 22.85" S	149° 51' 27.00" W	14	21.71	2.6	41	59	311
Fringing-reef								
M10	17° 29' 43.24" S	149° 49' 28.84" W	0.5	17.55	1.9	36	52	327
M11	17° 29' 55.20" S	149° 49' 24.34" W	2 - 2.5	3.235	2.4	35	53	353
M31	17° 30' 15.69" S	149° 51' 12.83" W	1.4	31.19	2.9	41	77	358
M32	17° 30' 15.69" S	149° 51' 12.83" W	1.4	17.51	2.6	41	56	443
M45	17° 29' 29.40" S	149° 49' 31.02" W	0.5-2.5	22.48	2.4	51	62	273
M48	17° 29' 27.46" S	149° 49' 08.07" W	0.5-2.5	30.52	2.1	46	71	292
M49	17° 29' 11.57" S	149° 49' 39.62" W	8 – 10	25.9	2.4	49	69	364
M52	17° 29' 09.77" S	149° 49' 06.10" W	10-15	23.94	2.7	37	57	238
M57	17° 34' 01.56" S	149° 52' 49.55" W	1.3	15.5	2.3	32	46	295
M69	17° 32' 47.19" S	149° 46' 42.45" W	2.5	19.52	2.5	31	54	302
M86	17° 29' 51.61" S	149° 51' 16.16" W	0.5-2.5	26.79	3.5	46	72	373
M87	17° 29' 52.23" S	149° 51' 28.67" W	38	27.5	2.3	48	70	340
M88	17° 29' 55.90" S	149° 51' 43.21" W	0.5-2.5	23.1	4.2	50	70	466

Table 2: Generic categorization of functional groups of foraminifera based on ecological preferences in warm water environments (Hallock et al. 2003; Yanko et al. 1999; Bernhard and Gupta 1999).

Symbiont-bearing	Opportunistic Genera	Heterotrophic Genera
<i>Amphistegina</i> , <i>Amphisorus</i> , <i>Assilina</i> (<i>Operculina</i>), <i>Borelis</i> , <i>Coscinospira</i> , <i>Heterostegina</i> , <i>Monalysidium</i> <i>Parasorites</i> , <i>Peneroplis</i> , <i>Sorites</i> .	<i>Ammonia</i> , <i>Bolivina</i> , <i>Bolivinella</i> , <i>Bulimina</i> , <i>Buliminella</i> , <i>Elongobula</i> , <i>Elphidium</i> , <i>Fursenkoina</i> , <i>Hopkinsina</i> , <i>Loxostomina</i> , <i>Nonionoides</i> <i>Reusella</i> , <i>Sigmavirgulina</i> , <i>Trifarina</i>	<i>Abditodentrix</i> , <i>Acervulina</i> , <i>Acupeina</i> , <i>Adelosina</i> , <i>Agglutinella</i> , <i>Ammobaculites</i> , <i>Ammoscalaria</i> , <i>Anomalina</i> , <i>Articulina</i> , <i>Baggina</i> , <i>Bronnimannia</i> , <i>Cancris</i> , <i>Caronia</i> , <i>Cerebrina</i> , <i>Cibicides</i> , <i>Cibrobaggina</i> , <i>Clavulina</i> , <i>Conicospirilinoides</i> , <i>Cornuspira</i> , <i>Cyclammina</i> , <i>Cycloforina</i> , <i>Cymbaloporetta</i> , <i>Discorbinella</i> , <i>Dyocibicides</i> , <i>Endostomina</i> , <i>Eponides</i> , <i>Euthymonacha</i> , <i>Falsagglutinella</i> , <i>Fijiella</i> , <i>Fisherinella</i> , <i>Fissurina</i> , <i>Haddonina</i> , <i>Haynesina</i> , <i>Hauerina</i> , <i>Homotrema</i> , <i>Inaequalina</i> , <i>Lagena</i> , <i>Lobatula</i> , <i>Massilina</i> , <i>Mesosigmoilina</i> , <i>Miliola</i> , <i>Miliolinella</i> , <i>Milletiana</i> , <i>Mimosina</i> , <i>Murrayinella</i> , <i>Neoconorbina</i> , <i>Nubeculina</i> , <i>Nodophtalidium</i> , <i>Oolina</i> , <i>Palliotella</i> , <i>Paratrochammina</i> , <i>Pitela</i> , <i>Planispirillina</i> , <i>Planispirinella</i> , <i>Planogypsina</i> , <i>Porosonion</i> , <i>Procerolagena</i> , <i>Pseudogaudryina</i> , <i>Pseudohauerina</i> , <i>Pseudohauerinella</i> , <i>Pseudomassilina</i> , <i>Pseudononion</i> , <i>Pseudoschlumbergerina</i> , <i>Pseudotriloculina</i> , <i>Pyrgo</i> , <i>Quinqueloculina</i> , <i>Reophax</i> , <i>Rhabdammina</i> , <i>Rosalina</i> , <i>Rotorbis</i> , <i>Sagrinella</i> , <i>Sagrinopsis</i> , <i>Sahulina</i> , <i>Schlumbergerina</i> , <i>Septotextularia</i> , <i>Sigmoihauerina</i> , <i>Sigmoilinita</i> , <i>Sigmoilopsis</i> , <i>Siphonaperta</i> , <i>Siphogenerina</i> , <i>Siphonina</i> , <i>Siphotrochammina</i> , <i>Sphaerogypsina</i> , <i>Spirillina</i> , <i>Spiroloculina</i> , <i>Spirophthalmidium</i> , <i>Spirosigmoilina</i> , <i>Stictogongylus</i> , <i>Textularia</i> , <i>Tremptophalus</i> , <i>Triloculina</i> , <i>Trimorsina</i> , <i>Trochammina</i> , <i>Valvulinaria</i> , <i>Verneuilina</i> , <i>Vertebralina</i> , <i>Wiesrenella</i> .

2.3 Results

2.3.1 Structure of foraminiferal assemblages

A total of more than 16,000 benthic foraminifera belonging to 380 species including agglutinated, perforate-hyaline and imperforate-porcellaneous types were recovered from the 45 samples from around Moorea island. The number of species increases to 422 when additional species listed in Vénec-Peyré (1985a) and Langer and Lipps (2006) are included (see Appendix I). The foraminiferal assemblages represent 127 genera. Agglutinated foraminifera account for 16 genera, while porcelaneous and hyaline perforate have 45 and 66 respectively. Ten symbiont-bearing foraminiferal genera include *Amphistegina*, *Amphisorus*, *Assilina* (*Operculina*), *Borelis*, *Coscinospira*, *Heterostegina*, *Monalysidium*, *Parasorites*, *Peneroplis* and *Sorites* (Table 2 and Fig 2). All species were categorized into symbiont-bearing, heterotrophic and opportunistic taxa (Table 2). Symbiont-bearing species represent 18% of all individuals counted, heterotrophic taxa make up 66% and opportunistic species account for 16% of all specimens.

Symbiont-bearing individuals are particularly abundant at some reefal sites (M9b, M61-62, M71-72, M93, M95-96) where they represent up to 72% of the total foraminifera. The number of individuals in this group gradually increases from back-reef settings to fore-reef habitats. They constitute between 0-20% of the samples in Cook's Bay, 0-28% in Opunohu Bay,

7-69% at Motu Ahi and 1-72% at Teonehua. *Amphistegina lessonii* is the most abundant species in this group. It is recorded with particularly high numbers within the reefal settings.

Opportunistic taxa (*Ammonia*, *Bolivina*, *Bolivinella*, *Elphidium*, *Elongobula*, *Hopkinsina*, *Loxostomina* and *Nonionoides*) are quite abundant in the bay inlets of Opunohu and Cook's Bay. Other typical opportunistic species include *Bulimina*, *Buliminella*, *Fursenkoina*, *Reusella*, *Sigmavirgulina* and *Trifarina* occur rarely. Percent abundances of all opportunistic taxa range between 1-67% in Cook's and Opunohu Bays, 7-69% at Motu Ahi and 0-32% at Teonehua. In general, they are more abundant in the lagoon and bays (Fig. 3a). Their frequency decreases towards the back and fore-reef sites where symbiont-bearing taxa often dominate the assemblages.

Heterotrophic species of foraminifera occur in all samples and form the bulk of the overall number of species recorded. They range between 25 and 90% of foraminifera in all the samples. Highest abundances were recorded at various lagoon, bay and fringing reef sites (M3, M4, M7, M13, M16, M35, M51, M79, M83, M86) where they represent between 47 and 90 percent of all individuals counted (Fig 3b).

Fig 2. Scanning electron micrographs of selected species of indicator foraminifera characterizing the major cluster habitats around Moorea Island. Species that bear symbionts: 1. *Coscinospira hemprichii* Ehrenberg; 2. *Peneroplis pertusus* Forskål; 3. *Borelis schlumbergeri* Reichel; 4, 5. *Amphisorus hemprichii* Ehrenberg (Scale bar is 200µm); 6, 7. *Sorites orbiculus* Ehrenberg; 8, 9. *Parasorites orbitolitoides* Hofker; 10. *Monalysidium confusa* McCulloch; 11. *Assilina (Operculina) ammonoides* Schröter; 12. *Amphistegina lessonii* d'Orbigny; 13. *Heterostegina depressa*, d'Orbigny; Species associated with the symbiont-bearing taxa: 14. *Schlumbergerina alveoliniformis* Brady; 15. *Anomalinella rostrata* Brady; 16. *Eponides repandus* Fitchel and Moll; Opportunistic species: 17. *Ammonia tepida* Cushman; 18. *Bolivina striatula* Cushman 19. *Bolivinella elegans* Parr; 20. *Bulimina* sp. 1 (Scale bar is 50µm); 21. *Buliminella elegantissima* d'Orbigny; 22. *Elongobula spicata* Cushman and Parker; 23. *Elphidium oceanicum* Cushman; 24. *Fursenkoina schreibersiana* Czjzek; 25. *Hopkinsina pacifica*, Cushman; 26. *Loxostomina limbata*, Brady; 27. *Nonionoides grateloupi* d'Orbigny; 28. *Reusella pacifica* Cushman and McCulloch; 29. *Sigmavirgulina tortuosa* Brady; 30. *Trifarina bradyi* Cushman; Heterotrophic species: 31. *Sagrinella convallaria*, Millett; 32. *Wiesnerella auriculata* Egger; 33. *Quinqueloculina cf. Q. semireticulosa* Cushman; 34. *Quinqueloculina funafutiensis*, Chapman; 35. *Quinqueloculina exsculpta* Heron-Allen and Earland; 36. *Quinqueloculina eburnea* d'Orbigny; 37. *Quinqueloculina cuvieriana* d'Orbigny. Scale bar is 100µm for all magnifications.

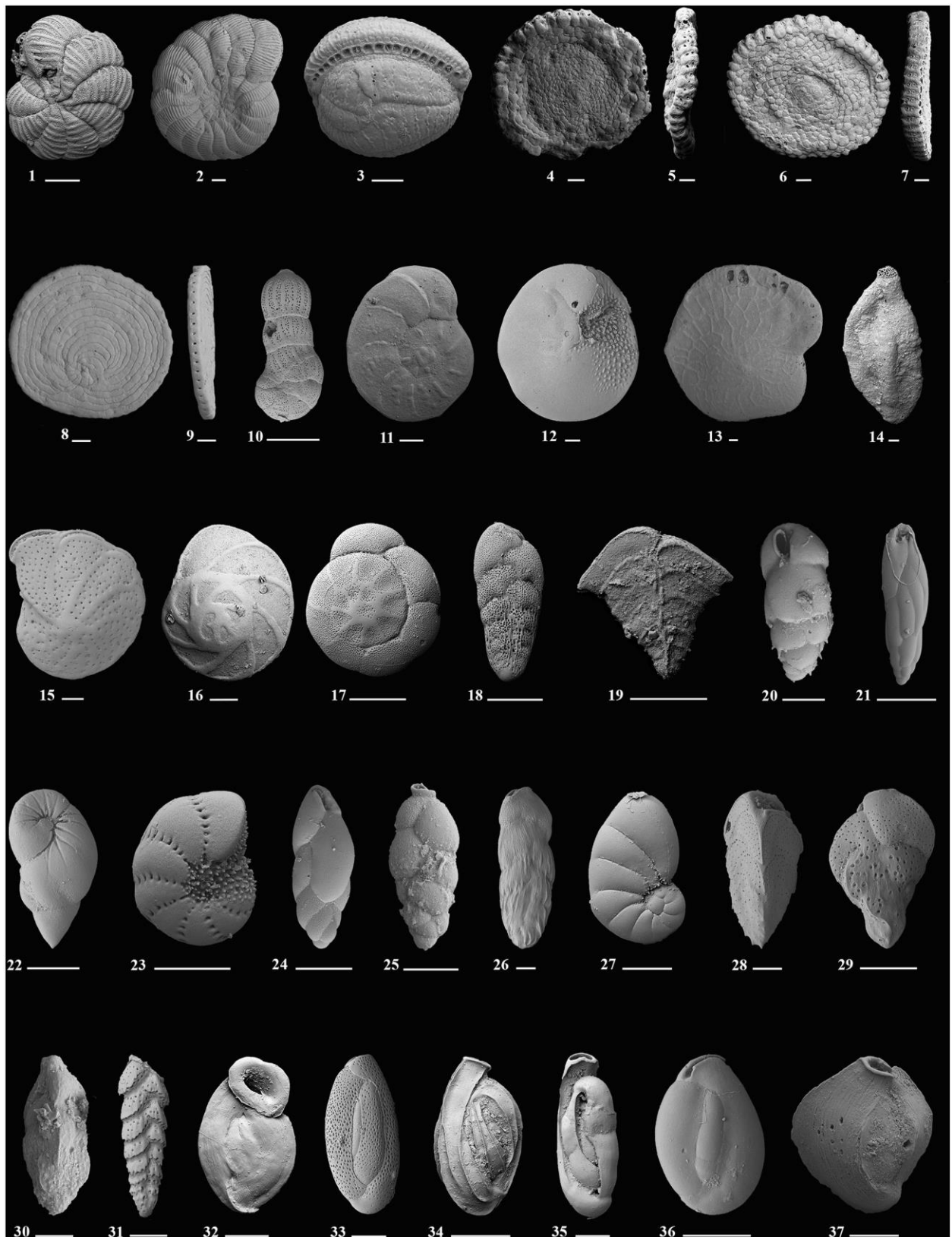


Fig. 2

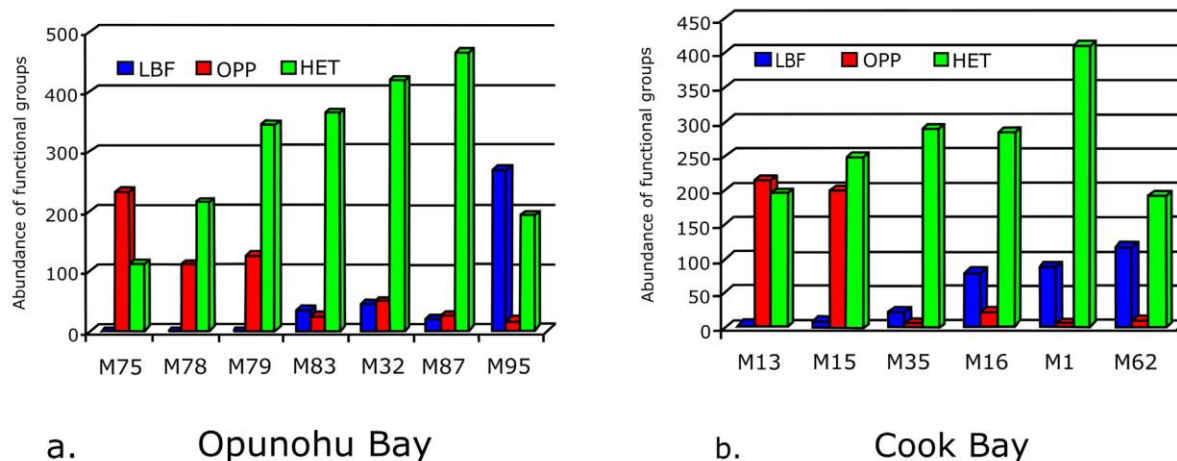


Fig 3. Abundance records of larger symbiont-bearing (LBF), Opportunistic (OPP) and Heterotrophic (HET) foraminifera within a) Opunohu and b) Cook's Bay.

2.3.2 Fisher α diversity indices

Assemblage indices revealed more genera in the fringing-reef than in the fore-reef, bay and lagoonal environments (Table 1). In general, the Fisher α diversity indices increase from the bays towards the lagoonal sites, towards fringing reefs, and the back- and fore-reef sites. This trend is particularly evident in Opunohu and Cook's Bay, where species richness and Fisher α diversity rises along transects from bay inlets towards fore-reefs (Fig 4). Individual assemblages, however, display a substantial species richness range. Within the bay inlets, especially in the Opunohu Bay, the Fisher α index range from 5 (innermost bay sample sites) to 27 at the outer most oceanward sample station. A similar trend was recorded at Cook's Bay, where Fisher α diversity increases from 6 to 30 towards the open ocean.

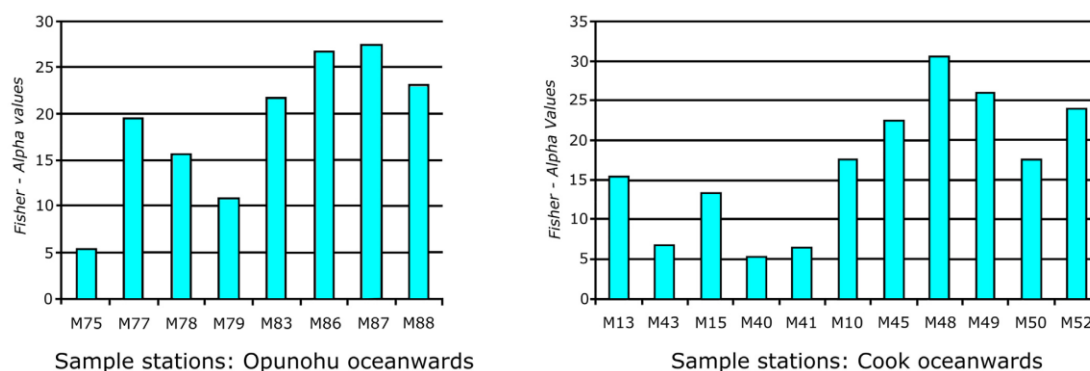


Fig 4. Increase in Fisher α diversity indices from the bays to the back-reef habitats.

2.3.3 Cluster Analysis

Cluster analysis comparing the composition and abundance data of foraminifera in all sample stations revealed the presence of six clusters separated in two major groups (cluster A-F, Fig 5). Sample sites belonging to individual clusters were marked with symbols and are plotted in Fig 6. The figure shows that individual clusters characterize specific habitats and

environmental conditions. These include bays, fringing reefs, lagoon, coastal mangrove areas, and back- and fore-reefs.

Cluster A (Lagoon)

Cluster A (Lagoon) comprises samples from the northwestern part of the island along the Irihoriu Pass and environments of the lagoon floor with coral rubble, fine calcareous sand and limited algal cover. It is characterized by smaller miliolids, some larger symbiont-bearing foraminifera and *Homotrema rubra*, a permanently attached taxon. This cluster includes at least 100 species of foraminifera among which *Homotrema rubra*, *Amphistegina lessonii*, *Bolivina striatula* and *Peneroplis pertusus* are the most abundant species. Other species like *Hauerina pacifica* and *Sorites orbiculus* occur in minimal proportions

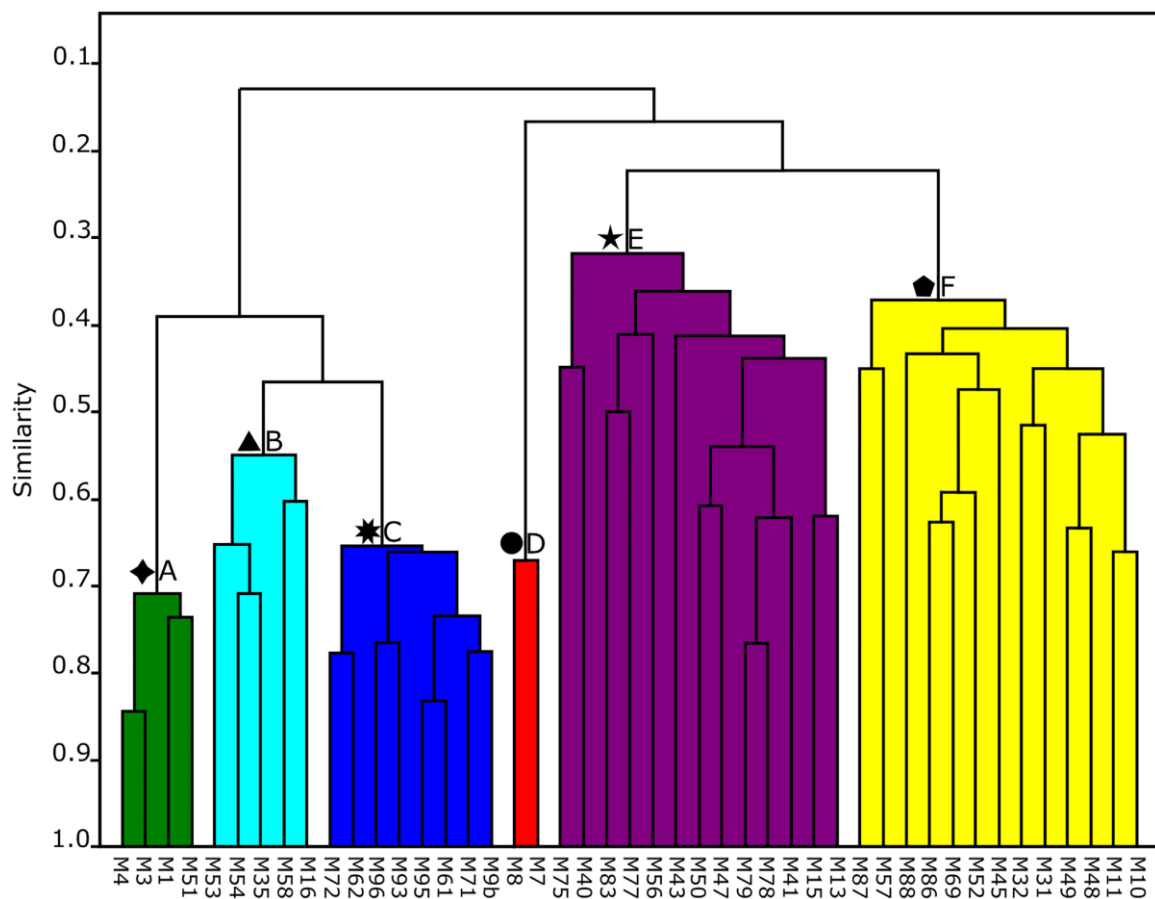


Fig 5. Q-mode cluster diagram of sample sites exhibiting the presence of 6 major cluster groups.

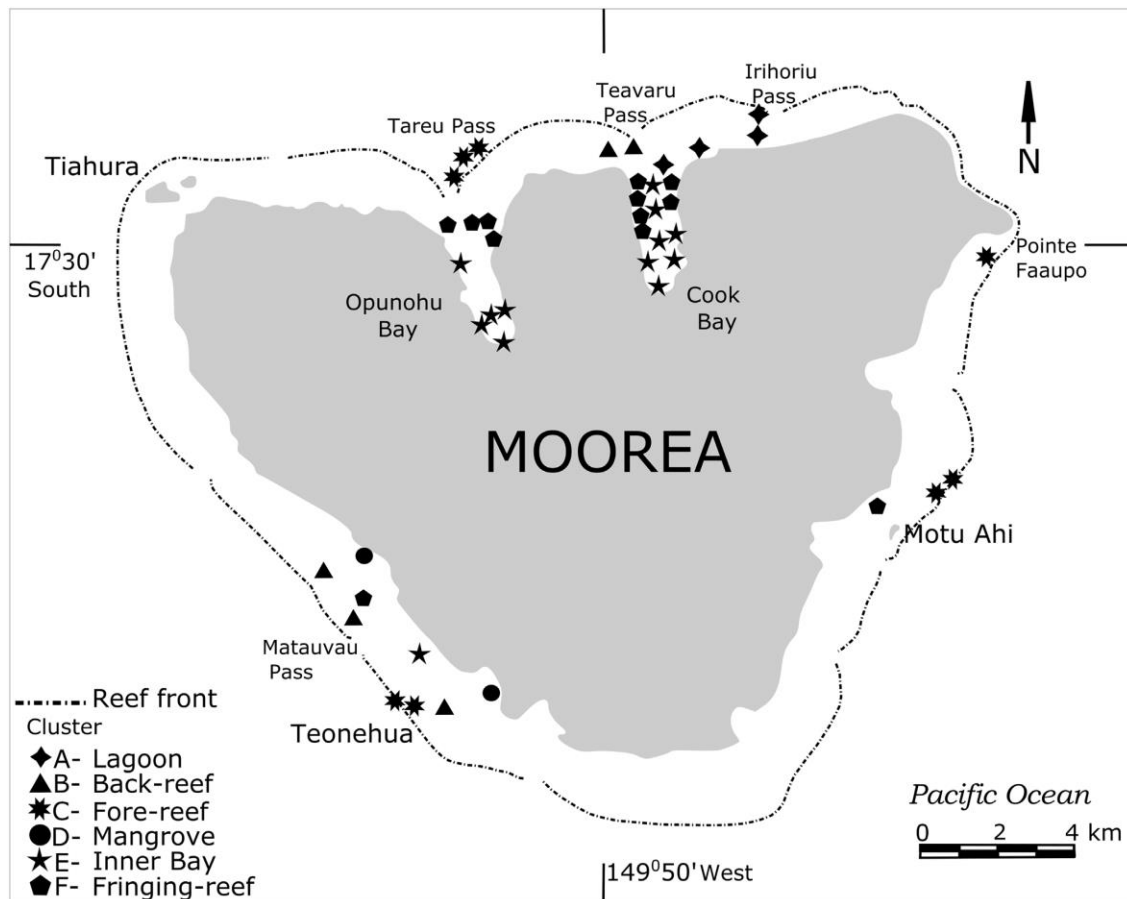


Fig 6. Map showing locations of the clusters stations. The symbols represent the clusters defined in Fig 5.

Cluster B (Back-reef)

Cluster B is associated with back-reef slopes and contain sample sites from the Teavaru Pass at Cook's Bay, and from Teonehua and Matakavau in the southwest. The cluster contains a diverse assemblage of 135 species of foraminifera including thick-shelled miliolids and various symbiont-bearing taxa (*Ampistegina* spp., *Sorites orbiculus*, *Peneroplis* spp.). The back-reef assemblages are characterized by frequent occurrences of *Homotrema rubra*, *Amphistegina lessonii*, *Millettiana millettii*, *Peneroplis pertusus*, *Miliolinella oceanica*, *Quinqueloculina seminula* and *Q. poeyana*. Species of *Elphidium*, *Bolivina* and *Ammonia* occur in minimal quantities.

Cluster C (Fore-reef)

Cluster C includes all sites from fore-reef to 30m depth and reef-top habitats. A total of eight samples belong to this cluster: three from fore-reef sites near the Tareu Pass, three from reef-top stations near Motu Ahi and two from Teonehua. This cluster consists of 175 species of benthic foraminifera (including back-reef taxa). They are characterized by higher abundances of *Amphistegina lessonii* and other symbiont-bearing foraminifera (*Heterostegina depressa*, *Sorites*

orbiculus, *Peneroplis* spp.). *Amphistegina lessonii* accounted for 43%, *Eponides repandus* for 5%, *Sorites orbiculus* for 4%, *Anomalinella rostrata* for 3% and *Heterostegina depressa* for 2% of all specimens recovered from these sites. Specimens of *Homotrema rubra* are also prominent within this cluster. Other smaller foraminifera accounted for 19%.

Cluster D (Mangroves)

Cluster D is associated with coastal mangrove sites from around Teonehua. The foraminiferal assemblages of this cluster are characterized by higher abundances of *Quinqueloculina* and several stress-tolerant taxa. Quinqueloculinids constitute more than 60% at these sites followed by *Ammonia tepida* (17%), *Elphidium advenum* (5%), *Elphidium clavatum* and *Bolivina striatula* (2% respectively). *Peneroplis pertusus* is the only symbiont-bearing taxon present at these sites. The cluster houses a diverse assemblage of 41 species of benthic foraminifera. All of these foraminifera have come to live together in the mangroves since the plants were introduced to Moorea in 1937. The foraminifera were not introduced with the mangroves as all of them live in other assemblages elsewhere on Moorea. In that sense, Cluster D is not a natural assemblage with a long history at Moorea.

Cluster E (Inner Bay)

Cluster E is associated with the shallow inner inlets of Opunohu and Cook's Bays. Opportunistic taxa constitute the majority of individuals recorded in this cluster (Table 1 and 2). *Ammonia tepida* (12%), *Bolivina striatula* (13%), *Quinqueloculina* cf. *Q. semireticulosa* (9%), *Elphidium advenum* (6%) and *Nonionoides grateloupi* (3%) are among the most prominent in this habitat. *Quinqueloculina* is represented by 48 species and they constitute 25% of all specimens. Species of *Bolivina* make up 16%, while species of *Ammonia* and *Elphidium* are present with 12% and 11% respectively.

Cluster F (Fringing reefs)

Most of the samples in this cluster come from coastal fringing reef sites present in Opunohu and Cook's Bays and fringing reef sites near Teonehua. The assemblages within this cluster are characterized by the presence of larger foraminifera including *Borelis schlumbergeri*, *Amphistegina lessonii*, *Peneroplis pertusus* and *Heterostegina depressa*. Smaller miliolids are particularly abundant with *Quinqueloculina* accounting for 19% of the total assemblage. The agglutinated species *Textularia foliacea foliacea* and *T. foliacea oceanica* accounted for 3% and 2% respectively. *Hauerina pacifica* is the most abundant species within this cluster with 13% and is present at all sample sites. The cluster includes a total of 250 species of benthic foraminifera.

2.3.4 Principal Component Analysis (PCA)

The principal component analyses, based on percent abundance data of the 13 most frequent genera (which make up ~75% of the total population of foraminifera counted; Table 3), revealed a separation of two major habitats along the axis (Fig 7A). The first habitat group includes assemblages from fore-reef, back-reef and lagoon sites and the second is associated with taxa from the inner bays, mangroves and fringing reefs. The taxa are shown as vectors and their lengths represent the importance of individual genera as calculated by their eigenvalue. While the reefal sites are characterized by amphisteginids, *Homotrema* and *Sorites*, the nearshore mangrove, bay and fringing reef sites are dominated by the abundance of smaller miliolids and stress tolerant taxa like *Ammonia*, *Elphidium* and *Bolivina*. The *Amphistegina* vector is strongly related to the reefal sites and Clusters A, B and C where they represent the most abundant symbiont-bearing larger foraminifera. *Quinqueloculina* was the most abundant genus in nearshore mangrove settings and at some inner bay inlet sites. Samples from the inner Cook's Bay and the mangrove sites at Teonehua contain abundant *Quinqueloculina* up to 51%. At Opunohu Bay, quinqueloculinids reach values of 35%. A similar pattern emerged when factor 1 and 3 were considered (Fig 7B) showing that assemblages differ along two major axis.

2.3.5 Ternary diagrams

As an independent line of evidence, percent abundances of wall structural types were calculated for each site and plotted in a standard ternary diagram (Fig 8). The resulting graph shows that percent abundances of wall structural types fall into two site-specific groups with back- and fore-reef and lagoon sites dominated by hyaline perforate taxa which contain few agglutinated species. These environments are equivalent to the sample sites present in Clusters A, B and C. The diagram further shows that samples from the inner bay, the fringing reefs and mangrove areas are generally characterized by a higher percentage of porcellaneous miliolids and a larger numbers of agglutinated specimens. Within the environmental fields of standard ternary diagrams provided by Murray (1991), the mangrove sites fall within the hyposaline lagoon while the fringing reefs and the bay inlets mostly plot at the upper end of a normal marine lagoon. The agglutinated taxa have their highest numbers within the inner bays and the fringing reef areas of Opunohu and Cook's Bays and represent the sites that are associated with Clusters E and F. Generally the clusters range between a normal marine and a hyposaline lagoon with a few samples outside the normal range. This is typical of warm tropical reefal and lagoonal settings (Murray 1991).

Table 3: Abundance records of selected genera of benthic foraminifera included in the Principal Component Analyses (PCA).

Sample sites	<i>Ammonia</i>	<i>Amphistegina</i>	<i>Bolivina</i>	<i>Elphidium</i>	<i>Hauerina</i>	<i>Homotrem</i>	<i>Mikolinella</i>	<i>Peneroplis</i>	<i>Quinqueloculina</i>	<i>Schlumbergerina</i>	<i>Sorites</i>	<i>Textularia</i>	<i>Triloculina</i>
M1	5	47	1	1	16	302	2	21	23	7	13	4	3
M3	5	32	4	10	7	211	9	5	26	4	5	1	0
M4	5	23	0	0	1	228	1	0	2	0	5	0	0
M7	67	3	13	48	19	0	0	18	332	0	1	0	4
M8	88	0	2	16	3	0	1	4	200	0	0	0	0
M9b	0	137	0	0	0	78	0	0	0	0	7	0	0
M10	2	0	13	52	53	0	5	11	78	0	2	0	0
M11	9	2	11	30	74	0	15	7	62	0	2	5	0
M13	59	2	33	40	13	0	5	0	60	0	2	2	14
M15	98	0	42	59	7	0	5	3	143	1	0	3	8
M16	9	55	4	13	3	62	13	7	70	16	7	2	4
M31	4	2	10	27	55	3	52	24	36	2	7	4	10
M32	6	2	0	2	118	0	28	25	66	5	11	6	36
M35	1	3	6	4	10	112	17	17	22	4	10	0	11
M40	125	0	109	126	0	0	0	0	84	0	0	18	0
M41	27	0	77	44	0	0	0	0	78	0	0	6	3
M43	5	0	48	124	0	0	0	0	58	0	0	4	0
M45	10	3	10	32	17	0	11	7	49	5	7	67	11
M47	28	0	133	9	0	0	2	0	49	0	0	20	1
M48	1	1	12	3	33	0	2	5	61	2	2	17	10
M49	2	3	9	6	47	0	4	7	96	12	8	24	19
M50	9	0	79	10	3	0	6	0	100	0	0	24	6
M51	5	0	49	0	0	295	0	0	8	0	0	0	0
M52	3	5	0	9	42	0	5	3	41	29	6	28	7
M53	0	8	0	1	7	90	30	10	40	48	18	0	1
M54	2	21	2	0	15	115	19	7	50	0	13	1	1
M56	2	0	22	22	2	0	19	5	180	0	0	4	15
M57	1	1	1	0	51	3	14	7	96	8	6	0	5
M58	0	43	1	6	1	76	12	4	75	3	35	0	0
M61	2	247	0	0	0	84	0	4	7	0	18	0	0
M62	0	134	2	1	6	51	1	6	30	2	27	0	1
M69	6	0	0	5	27	18	29	5	45	24	6	42	35
M71	2	173	0	0	0	105	1	0	6	24	23	0	0
M72	0	132	0	0	13	72	7	12	34	7	41	1	4
M75	178	0	9	24	0	0	2	0	18	0	0	0	15
M77	9	3	10	27	7	0	31	2	128	0	2	6	11
M78	12	0	79	14	0	0	0	0	69	0	0	16	20
M79	2	0	70	27	0	0	0	0	78	0	0	28	16
M83	6	22	20	4	16	0	2	2	111	1	0	2	16
M86	3	51	1	0	30	17	4	9	57	22	15	27	29
M87	1	6	18	8	10	9	14	6	113	3	5	40	4
M88	1	60	5	13	61	1	4	13	54	38	22	25	1
M93	0	127	0	0	3	130	6	3	22	7	7	0	5
M95	0	251	0	0	1	76	8	4	20	18	1	4	0
M96	0	101	0	1	4	64	6	5	20	10	4	1	3
Total	800	1700	905	818	775	2202	392	268	2997	302	338	432	329

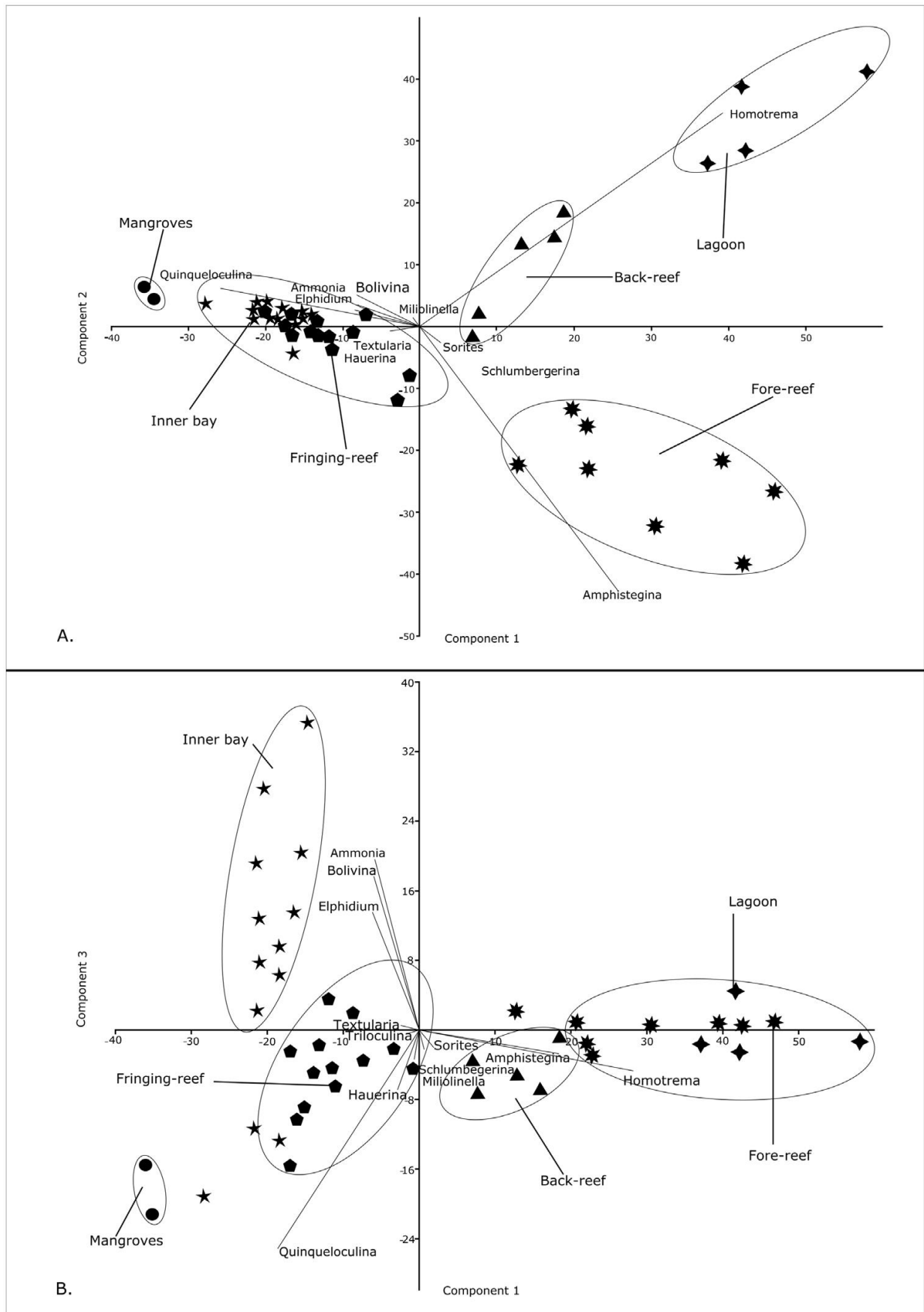


Fig. 7: Principal Component Analysis (PCA) of the foraminifera fauna showing a) principal components 1 and 2, and b) principal components 1 and 3. The symbols represent the clusters as defined in Fig 5.

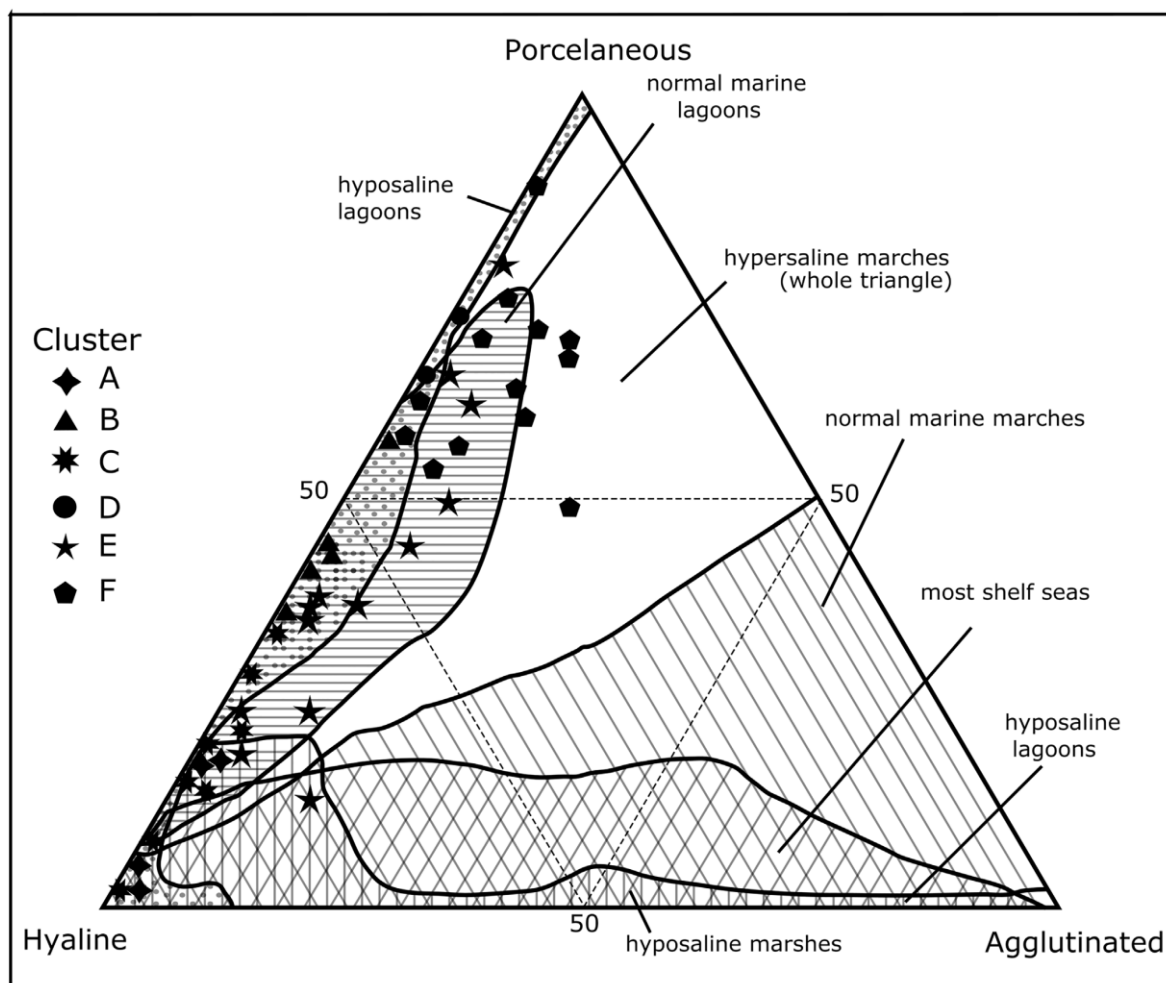


Fig. 8: Ternary diagram showing percent abundances of wall structural types (porcellaneous, hyaline-perforate and agglutinated foraminifera) of individual sample sites around Moorea (Murray 1991). The symbols represent the clusters groups as defined in Fig 5.

2.3.6 FORAM-Index (FI)

In our samples the average FI in sediments was 3.1 ± 1.3 . In Cook's Bay, the average FI value is comparatively low (2.1), at least in the innermost bays, and it is dominated by stress-tolerant opportunistic taxa such as *Ammonia*, *Bolivina*, *Elphidium*, and *Nonionoides*. Some symbiont-bearing taxa were present including *Amphistegina lessonii*, *Peneroplis pertusus* and *Sorites orbiculus*. At a few sites in Cook's Bay the larger benthic foraminifera constitute up to 9 percent of the samples (M11, M35, M49, M52). FI values lower than 2, indicating an environment not suitable for reef accretion (Hallock *et al.* 2003) were common in the innermost parts of both Cook's and Opunohu Bays and at nearshore sites around Teonehua. In Opunohu and Cook's Bays FI values gradually increase from the innermost parts to the fringing reefs and to the fore-reefs (Fig 9). Calculation of the FI values around the reef-top and the fore-and back-reef areas revealed much higher values ranging from 5.4 to 6.5 at Tareu, from 6.6 to 6.9 at Motu Ahi, and up to 7.7 at Teonehua.

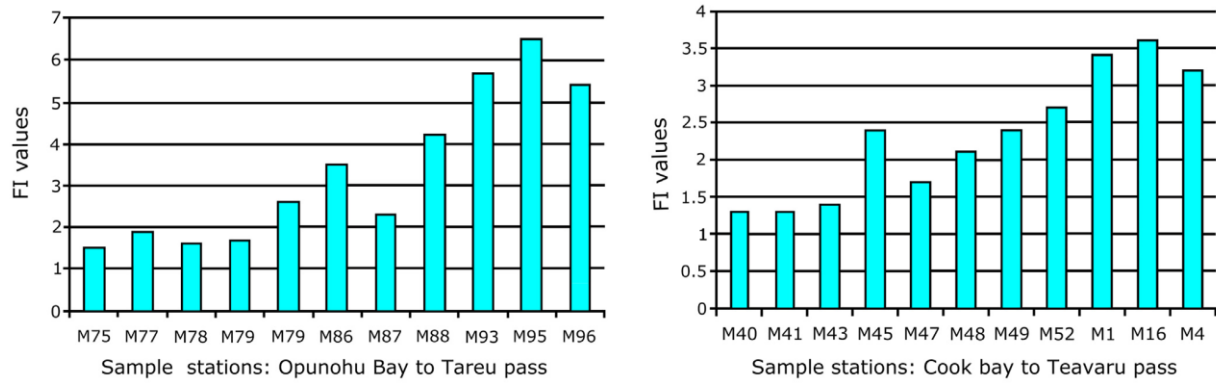


Fig. 9: FI values plotted along transects in Opunohu and Cook's Bays showing indices rising from the innermost bays towards the reefal sites.

2.4 Discussion

2.4.1 Foraminifera Diversity

Coral reefs and lagoons of the western Pacific Ocean contain extremely diverse assemblages of benthic foraminifera (Langer and Lipps 2006, Langer and Lipps 2003, Makled and Langer 2011, Debenay et al. 2015). The reefal environments of Moorea also harbor particularly diverse assemblages of benthic foraminifera that rival those found elsewhere in the Indo-Pacific except for the absence of certain large symbiont-bearing taxa. At least 422 species belonging to agglutinated, perforate-hyaline and imperforate-porcellaneous groups, including some larger symbiont-bearing taxa, occur on the island. This species richness more than doubles the number of taxa previously documented from Moorea. The number includes 380 species found in our study and an additional 42 from Langer and Lipps (2006). In a study that formed an integral part of this research project, Vénec-Peyré (1985a) identified within the French Polynesian Islands 182 species belonging to 39 families of foraminifera.

The total number of benthic foraminifera around Moorea is significantly higher than the number of corals reported from French Polynesia at large (Adjeroud 1997, Richard 1985, Caley and Schluter 1997), and this is likely due to the large number of habitats sampled during this campaign. The shallow nearshore habitats around mangrove trees contain almost 100 species (Langer and Lipps 2006), indicating that the waters of the Society archipelago harbor a wealth of species that remain to be discovered. Among the total of 380 species are 130 hyaline perforate, 217 porcellaneous imperforate and 33 agglutinated taxa. While 217 species of porcellaneous miliolids occur at Moorea, only 101 species are present in the Papuan lagoon system (Haig 1988). The greater abundance of miliolids at Moorea is far higher than expected considering the location of the lagoon at Papua New Guinea in the heart of the hotspot of diversity in the coral triangle (Langer and Lipps 2003, Haig 1988). No calcarinids, which are

common constituents of the highly diverse coral triangle environments (see also Vénec-Peyré 1991, 1985a; Marie 1970, Langer and Hottinger 2000, Fujita and Omori 2015, Lobegeier 2002), are present at Moorea.

The diversity of foraminiferal biotas is reflected in high Fisher α diversity indices. These values are highest around reefal sites, in particular within the fringing reefs, where bay and reefal biotas occur together. The Fisher α index generally increases in the number of species from the inner bay towards the open ocean (Fig 4), thus confirming a trend that was previously recognized along transects in the lagoon at Madang, Papua New Guinea (Langer and Lipps 2003, 2006). Species richness along transects at Moorea also increases from the shore towards the reef barrier, but individual sites vary considerably (Vénec-Peyré 1991). Similar patterns of distribution around Moorea were also observed for macrophytes (Payri 1987), fish (Galzin 1987) and molluscs (Richard 1982). The highest number of species—77, are in front of the fringing reefs at the outer margins of the two major bays. There, foraminifera from organic-rich inner bay sites, mangroves, *Paspallum* and *Hibiscus* habitats in addition to fringing reefs and channel habitats amalgamate. Therefore, we attribute this to the imbrications of habitats and amalgamation of biotas that occurs along this part of the bays. At Moorea, the richest environments occur in those areas that offer a greater variety of biotopes (Vénec-Peyré 1991).

Foraminiferal assemblage composition differed significantly among habitats. At the reefal sites (Clusters A, B and C), *Amphistegina lessonii* is the dominant taxon with abundances of up to 64%. They are particularly prominent at the fore-reef sites of Terau Pass at the entrance of Opunohu Bay, a site that is typical of other fore-reef habitats on the island (Vénec-Peyré 1991). Because of their abundance, ubiquity, significant carbonate production and ability to modify the composition of carbonate sediments, amphisteginid foraminifera are considered environmental engineers (Langer 2008b). Amphisteginids domination in reefal environments (Vénec-Peyré 1991, Fujita and Omori 2015, Sournia 1976, Bicchi and Debenay 2002) may be due to their ability to tolerate higher wave energy. Other species frequently found in reefal habitats were *Homotrema rubra*, *Anomalinella rostrata*, *Eponides repandus*, *Heterostegina depressa*, with few *Schlumbergerina alveoliniformis*, *Sorites orbiculus* and *Peneroplis pertusus*. *Schlumbergerina alveoliniformis* was more abundant in back-reef habitats, and thus exhibit environmental preferences that were also reported at Tahiti (Fujita and Omori 2015). Apparently, some of these taxa flourish particularly well in reefal sites (Debenay 2012, Langer and Lipps 2003, Hayward et al. 1999, Haig, 1988). As such, the foraminiferal assemblages from reefs at Moorea share similar distributions to those of other western Pacific tropical islands. As

very good indicators of reefal habitats, they preserve ecologic information useful in comparative analyses over decadal periods and long-term paleoecological studies.

Quinqueloculina, with over 90 species, strongly affect the configuration of sites within the cluster groups (Fig 6) forming the bulk of the lagoonal and nearshore assemblages (M7-8, M15, M49, M50, M56, M83, M87). Clusters E and F show numerically abundant and similar proportions of *Quinqueloculina* indicative of back-reef lagoonal habitats (Murray 1991). *Quinqueloculina seminula* and *Q. cf. Q. semireticulosa* are the most abundant miliolids, and they occur in almost all samples, especially within Opunohu and Cook's Bays. The miliolids in total accounted for 45% of all the foraminifera in the lagoon. This pattern is similar to other Pacific islands and other Indo-Pacific reef-lagoonal settings (Makled and Langer 2011, Parker and Gischler 2011).

Agglutinated taxa accounted for 4% of all the foraminifera counted. *Textularia foliacea foliacea* and *T. foliacea oceanica* are most abundant in the fringing-reef and bay habitats and both accounted for 1.2% of the total foraminifera assemblage. Symbiont-bearing taxa generally decrease in the abundance from the reef sites towards the lagoon and the inner bay habitats. Stress tolerant species of *Bolivina*, *Ammonia*, *Elphidium* and *Nonionoides* occur in greater numbers within inner portions of the mangrove-surrounded bay inlets that are covered by dark fine-grained and low-oxygen sediments (up to 69%). These species are typical of hypo- to normal salinity lagoons (Hallock et al. 2003, Lipps and Langer 1999, Debenay 2000, Scott et al. 2001). Dark, organic-rich sediments dominate the inner bays creating ideal conditions for such assemblages, probably because of increased numbers of bacteria. Anthropogenic activities including sewage disposal, fish farming, and uncontrolled tourism contribute to an expansion of these areas. To what degree individual factors control specific abundances and the composition of the inner bay assemblages remains to be determined. The specificity of inner bay foraminiferal associations is, however, important for monitoring ecologic changes and reconstruction of paleoenvironments.

At both Moorea and Madang (PNG), larger symbiont-bearing foraminifera and agglutinated species are either extremely rare or absent in the innermost harbor and bays where species of *Ammonia* and *Elphidium* constitute almost the entire foraminiferal fauna (Langer and Lipps 2003). However, in Cook's and Opunohu Bays, *Bolivina* and *Nonionoides* are abundant; these two taxa tolerate low-oxygen conditions in sediments rich in organic material (Hallock et al. 2003, Bernhard 1986, Haig 1993).

The cluster diagram (Fig 5) revealed a distribution that centers on environmental factors characterizing individual habitats and substrate types. Sites with similar conditions are grouped

together and tend to harbor assemblages dominated by specific species and genera. Concentration ratios quantified these observations as demonstrated by the Principal Component Analysis (PCA) and ternary plot analyses (Figs 7 and 8). Thick-shelled, symbiont-bearing taxa with robust tests, including *Amphistegina*, *Sorites*, *Parasorites* and *Heterostegina*, accounted for the largest proportions in reefal habitats. *Amphistegina* had the highest concentration of the larger benthic foraminifera near reef-top and back- and fore-reef sites. Robust tests are particularly resistant to abrasion and enhance their accumulation in carbonate environments (Martin 1986). Miliolid species of *Quinqueloculina* were found in all habitats but abundances were notably higher in near-shore and lagoonal environments characterized by phytal vegetation. The dominance of smaller non-symbiont bearing miliolids in phytal substrates also occur in lagoonal habitats of Scilly Atoll (Vénec-Peyré 1984), Papua New Guinea (Langer and Lipps 2003, Haig 1988), New Caledonia (Debenay 2012, Fujita and Omori 2015, Debenay 2000), Bazaruto, E-Africa (Langer et al. 2013) and the Caribbean (Brasier 1975).

Each cluster group contains numerically abundant indicator species or genera that do not occur in high abundances in other faunal clusters. This implies low horizontal transport rates within the reef, lagoon and bay habitats, and signifies that faunal mixing among the cluster groups is limited. Foraminiferal death assemblages are mostly autochthonous and thus preserve environmental information that is useful in paleoecologic and ecologic interpretations.

2.4.2 FORAM-Index (FI)

The FORAM Index, based on total assemblages, indicate a general rising FI towards the reef barrier as reflected in the abundance and taxonomic richness of larger symbiont-bearing foraminifera. Highest total species richness values occur, however, at the fringing reefs along the outer margins of the two major bays due to imbrication of foraminiferal habitats from nearshore, reefal, mangrove, bay channel and fringing reefs. The FI of total assemblages from Moorea accord with live reef assemblages (Barbosa et al. 2009, Koukousioura et al. 2011, Carilli and Walsh 2012, Kelmo and Hallock 2013), indicating that the water quality at most back- and fore-reef sites supports calcifying symbiosis and suitable for reef carbonate accretion. Moderate to low FI were recorded at nearshore and lagoonal sites of the N-coast between Irihoriu Pass and Teavaru (FI 2.0-3.6). These areas have low coral cover and branching corals with smaller colonies, probably resulting from greater anthropogenic impacts (Juhász *et al.* 2010)

Moorea underwent severe bleaching events in 1982, 1983 and every 2–5 years since 1991 (Gleason 1993, Traçon et al. 2011) as well as natural disturbances resulting in spatio-temporal heterogeneity in coral reef cover and recruitment (Gleason 1993; Hoegh-Guldberg and

Salvat 1995; Adjeroud 1997; Adjeroud et al. 1997; Adjeroud et al. 2007a, 2007b; Penin et al. 2007), although the reefs recovered in 10 to 12 years (Salvat 1987; Salvat et al. 2008). The FI indicate that most fringing reefs and back and fore-reef sites are favorable for reef growth. The low FI recorded at the innermost bays sites reflect both the dark organic-rich, fine grained substrate and the coverage of mangrove stands. In addition, small rivers enter the bays at their southern ends, form small delta-like fans, and are sources of agricultural, sewage and nutrient runoff. At least in Opunohu Bay, the FI rise to higher levels at the outer bay margin, while at Cook's Bay, the values indicate a continuous impact on the composition of foraminiferal assemblages. Increased runoff, nutrient loading, reef destruction, and a future rise of tourism in these areas will certainly be of concern, impacting reefal growth outside the bays and possibly affecting carbonate accretion of the reef barrier protecting the island of Moorea. These impacts will be enhanced by climate warming, ocean acidification and sea level rise anticipated in the next several decades.

2.5 Conclusions

This study together with those of Vénec-Peyré (1991, 1985a, 1985b) constitutes the most extensive investigation yet of the foraminifera from shallow-water nearshore and reefal environments around Moorea. A total of 422 (380 from our study) species has been recorded, a number that more than doubles previously documented inventories of species counts. The benthic foraminifera around Moorea have large-scale spatial distribution patterns of habitat specific assemblages. These habitat preferences are also reflected in abundance patterns of individual species, genera and functional groups. Diversity gradients generally increase from bay inlets to the reef barrier, but highest species richness is in fringing reefs, an area that represents a mosaic of habitats.

The abundance of functional groups of foraminifera (symbiont-bearing, heterotrophic, opportunistic) together with Foraminiferal Index (FI) calculations identified environments suitable and critical to support calcifying symbiosis and carbonate accretion. FI indicate that the innermost bays and some outer bay fringing reef habitats are under direct natural and anthropogenic influences.

While Moorean reefal foraminifera deserve more scientific attention, particularly acquisition of more quantitative data, our findings are sufficient for monitoring rising influences of natural events and anthropogenic activities. Future changes can be compared with our baseline data from 1992 and the development of those changes over time can be determined by collecting dead specimens from particular time periods. In addition, as global warming, anoxia

and acidification of the oceans increase, foraminifera can provide rapid indication of these world-wide changes as well as local ones such as pollution, impacts on reefs due to industrial development and tourist activities. Foraminifera are easily collected and the indices, diversity and abundances are easily determined in the laboratory.

Chapter 3

Shallow-water nearshore benthic foraminifera assemblages from Gabon

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Abstract

The Gulf of Guinea is a hotspot of marine diversity, with unique biotas. We provide the first survey of shallow-water foraminifera from nearshore coastal waters of Gabon, an area from which modern benthic foraminifera are virtually unknown. We document the composition of benthic assemblages and assess their biogeographic relation to adjacent faunal provinces. Our analysis survey documents that shallow-water sediments harbor abundant and relatively diverse assemblages of symbiont-bearing and other smaller foraminifera. The 39 species recorded from nearshore coastal waters off Gabon contrast with lower diversity assemblages previously documented from offshore hydrocarbon drilling waste disposal sites. The assemblages of benthic foraminifera recovered suggest a deeply-rooted species diversity, where the true number of foraminiferal taxa present in Gabonese's pristine waters remains yet to be discovered. The composition of foraminiferal biotas found off Gabon shows them to be distinct from faunas recorded from off Namibia and South Africa, indicating the presence of a marine biogeographic barrier.

3.1 Introduction

The warm equatorial waters off Gabon provide habitat for diverse communities of marine animals and plants. They are part of the Guinea Current Large Marine Ecosystem (GCLME,) situated along the Atlantic coast of western central Africa (McGlade et al. 2002; Friedlander et al. 2014). They are home to threatened species including significant population of West African manatees, manta rays, hammerhead-, tiger- and whale sharks, and its beaches represent some of the world's most important nesting grounds for leatherback turtles. However, offshore exploration activities, undersea pipelines and the discharge drill cuttings, often contaminated with drilling fluid, are a threat to the pristine diversity of Gabon's marine ecosystems. Balancing environmental and economic interests in a country where the oil sector accounts for more than 50% of the gross domestic product and 80% of exports is a major challenge. To protect its pristine environment for the future, the country recently decided to

create a large network of marine parks that safeguards more than 20 percent of Gabon's territorial waters (Friedlander et al. 2014).

The coastal regions of Gabon are among the most biologically productive regions of the oceans driven by seasonal upwelling and the supply of large quantities of dissolved and particulate organic matter from the Congo and Ogooué River (Voituriez and Herbland 1982; McGlade et al. 2002; Lœuff and Cosel 1998). The resulting nutrient-rich waters fuel productive food webs and rich fishery resources that are crucial to coastal populations. To date, however, the marine biodiversity of Gabon's shallow water biotas has been poorly documented. Previous studies have explored biotic communities from the continental margins near hydrocarbon exploration sites or fishery resources along the shelf and slope (Sibuet and Vangriesthcin 2009; Bianchi 1992; Friedlander et al. 2014 and references therein). Studies on the shallow sub- and intertidal microbiota are virtually lacking. Here we report on the first scientific survey of modern coastal shallow benthic foraminifera from non-impacted sites of Gabon. We have examined the structure and diversity of communities of benthic foraminifera from six sites in the Gabon Estuary (Port Michel Marine), the Pongara National Park (Point Denise) and from Petit Loango to determine the species richness and composition of benthic assemblages from non-impacted sites. We compare them with the low-diversity communities reported by Durrieu et al. (2006) and Duchemin et al. (2008) from off Port Gentil (Gabon), a location that was used to discharge drilling waste from oil platforms. Particular attention has been paid to the presence of symbiont-bearing foraminifera as indicators of pollution and eutrophication and as biogeographic index taxa. Finally, the structure, composition and species richness of benthic foraminiferal assemblages is compared to tropical shallow-water assemblages from tropical reef sites of the eastern coast of Africa (Langer et al. 2013a) and to nearshore shallow-water foraminiferal assemblages from Namibia and South Africa.

3.2 Material and Methods

The coastal areas of Gabon are situated on the west coast of Africa, straddling the equator of the tropical Atlantic. True coral reef structures are not known from Gabon but scleractinian corals have been reported (Laborel 1974; Friedlander et al. 2014). Sediment samples were collected in April 2013 from depths < 2 m by snorkeling and filling plastic bags with substrata from the top 2 cm. All samples were dried, transported to the laboratory and washed over 63 µm sieves. The sampling sites (Fig. 1 and Table 1) are located within the Gabon estuary off Libreville (sites 1-3), off the Point Denise peninsula facing the Atlantic Ocean (site 4) and in front of the Iguéla Lagoon in the Petit Loango National Park (sites 5-6).

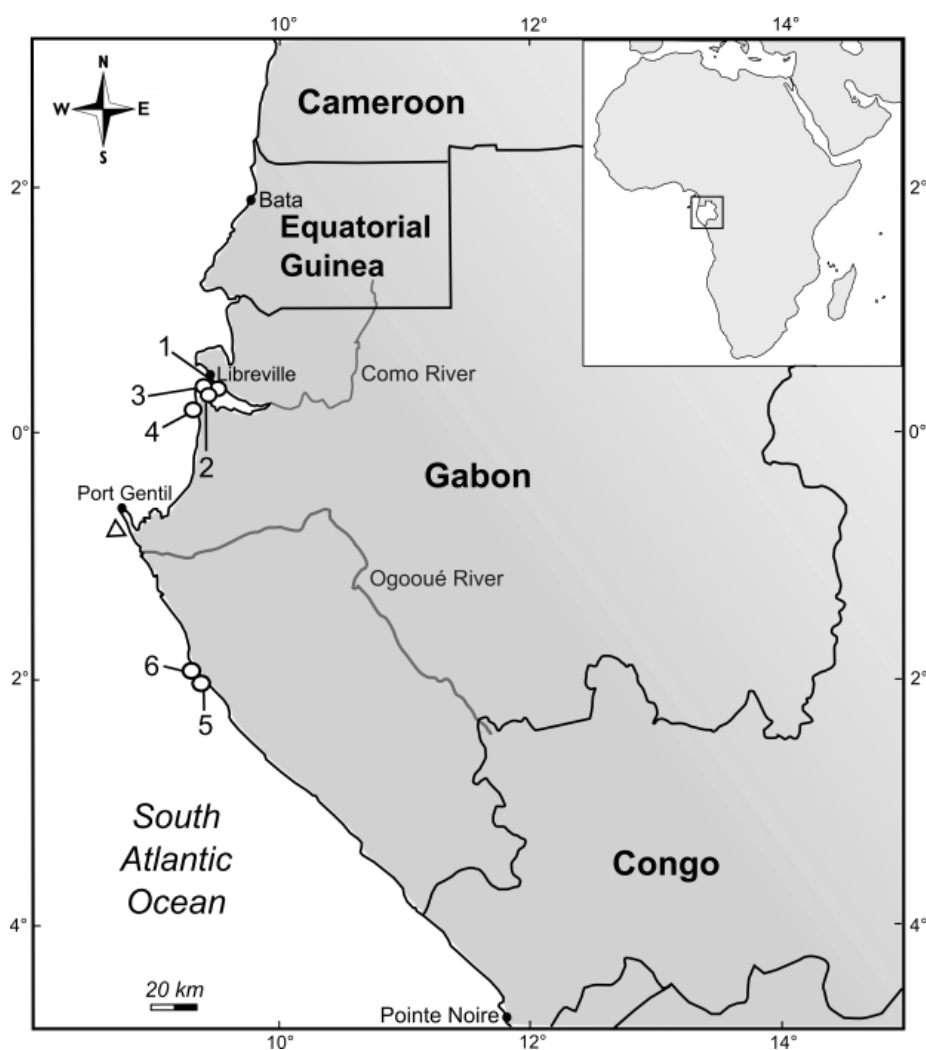


Fig. 1: Location of nearshore collection areas along the coastline of Gabon showing the position of the sampling sites (for details see Tbl. 1).

Between 159 and 712 individuals of benthic foraminifera were picked from each sample. Sediment samples mostly consisted of coarse- to medium-grained sand and a few fragments of bivalves, gastropods and benthic foraminifera. Foraminifera were identified to species level, documented by SEM microscopy and assembled into a catalogue of taxa (pl. 1–3). For the identification of benthic foraminiferal species and higher orders, our taxonomic and systematic arrangement follows the arrangement of Loeblich and Tappan (1988) and Langer et al. (2013). A complete list of all species with abundance data is provided in Table 3. The structure of benthic foraminiferal assemblages from individual sites was examined by analyzing percent abundances of 1. individual species groups, 2. wall structural types, 3. key functional groups including symbiont-bearing taxa and diversity indices including Fisher α , Shannon-H, dominance and total species richness (Tbl. 2).

3.3 Results

Quantitative faunal analyses and species-level identification of the foraminiferal assemblages from coastal sites of Gabon revealed the following results (Tbl. 2 and 3, pl. 1-3). Examination of 1800 specimens recovered from six shallow-water sites off Gabon yielded a total of 39 species of benthic foraminifera belonging to 19 genera. The composition of foraminiferal assemblages comprises 14 porcelaneous, 19 hyaline-perforate and 6 agglutinated species. Perforate foraminifera are most abundant (63.5-100%) followed by agglutinate (<22.7%) and porcellaneous miliolid individuals (<13.9%; see Tbl. 2). Fisher alpha diversity indices range between 1.1 and 6.0 in individual samples. Shannon (H) values vary between 0.24 and 2.10 and dominance values range between 0.18 and 0.91. Foraminifera were abundant at all sites analyzed and contained moderately diverse assemblages of benthic foraminifera. The total species richness recorded generally ranges between 7 and 21. Particularly high abundances were noted at the Port Michel Marine site but species richness at this station was particularly low. Only seven taxa of benthic foraminifera were recorded here and the assemblage was dominated by *Ammonia* spp. (see below).

Table 1: Sample site information for the collection localities at Port Michel Marine, Point Denise and from nearshore collection areas of the Petit Loango National Park (Gabon, Atlantic Ocean).

Site #	Locality	Latitude	Longitude	Depth (m)	Collection Date
1	Port Michel Marine / Libreville	N 0°20'35.50'	E 9°28'29.37'	1	09/April/2013
2	Point Denise / Libreville	N 0°20'49.42'	E 9°21'20.02'	1.5	10/April/2013
3	Point Denise / Libreville	N 0°20'45.90'	E 9°21'18.99'	2	10/April/2013
4	Point Denise / Turtle Beach	N 0°20'06.82'	E 9°20'08.33'	2	10/April/2013
5	Petit Loango National Park 1	S 1°52'56.84'	E 9°16'25.22'	1	15/March/2013
6	Petit Loango National Park 2	S 1°52'57.66'	E 9°16'26.30'	1	15/March/2013

Among the species recovered are three taxa that house diatom endosymbionts (*Amphistegina lessonii*, *A. papillosa* and *Pararotalia* cf. *P. nipponica*). Percent abundances of benthic symbiont-bearing foraminifera vary significantly and were found to range between 0.6-49.6percent. Highest values were recorded at the Petit Loango sites (49.2-49.6%). At all other sites symbiont-bearing taxa constitute less than 2.4% of the foraminiferal assemblages. Maximum values of amphisteginid foraminifera were found with peak abundances at Petit Loango (45.3%; site 1) while specimens of *Pararotalia* occur in high numbers at Petit Loango site 2 (44.1%). Peak abundances of symbiont-bearing foraminifera contrast with percent abundances of ammoniid foraminifera. Specimens of the genus *Ammonia* occur with high

percentages within the Gabon estuary near Libreville (>32.2%). The highest percentage was recorded at the Port Michel Marine where specimens of *Ammonia* constitute 95.6% of the foraminiferal assemblage (see Tbl. 2 and 3). Larger symbiont-bearing foraminifera are virtually absent at this site ($\leq 1\%$). Elphidiid foraminifera, known to sequester diatom plastids, attain percent abundances of up to 41.1%. The highest values were recorded at both Point Denise (21.5%-37.6) and Turtle Beach (21.6%; Tbl. 2). Abundances of non-symbiont-bearing porcellaneous taxa were found to range between 9.0 and 13.9%. No miliolid taxa, however, were recorded at the innermost sample site at Port Michel Marine (Gabon estuary).

3.4 Discussion

3.4.1 Composition of nearshore assemblages

Today only a few works have been published on shallow benthic foraminifera off tropical western Africa (see Mikhalevich 1983, 2008; Debenay and Basov 1993; Debenay and Redois 1997). This study represents the first scientific survey of nearshore shallow benthic foraminifera from coastal waters off Gabon. Examination of sediment samples recovered from shallow coastal environments off Gabon yielded a moderately diverse assemblage of benthic foraminifera. Apart from some typical shallow water taxa (*Elphidium*, *Ammonia*), foraminiferal assemblages possibly comprise some new and endemic species that were previously not reported (given here in open nomenclature). Among them is a presumably novel species of *Elphidium*, *Elphidium* cf. *E. fimbriatulum* (Cushman), a relatively abundant taxon that previously has not been described. The species is characterized by prominent sutures, numerous ponticuli spanning interocular spaces, tubercles, a peripheral keel, multiple openings on the apertural face and a prominent umbilical plug (pl.3, figs. 22-25). The species has been found to be most abundant within the Gabon estuary off Libreville, reaching up to 21.4% (site 3, Tbl. 3).

The foraminiferal assemblages analyzed also include three species of symbiont-bearing foraminifera (*Amphistegina lessonii*, *A. papillosa* and *Pararotalia* cf. *P. nipponica*). *Amphistegina* spp. are generally indicative of warm temperate tropical waters and have been reported from several other western African locations north of the equator (Larsen 1982, Debenay and Basov 1993; Debenay and Redois 1997). Water temperature is among the prime factors regulating their distribution (Langer et al. 2012, 2013b) although winter temperatures of 14°C are tolerated by species of the genus *Amphistegina* (Zmiri et al. 1974; Mouanga and Langer 2014). Amphisteginids are widely used as environmental indicators and are prolific producers to tropical reef carbonates (Hallock 2000, 2012; Hallock et al. 2003; Langer et al. 2013).

Table 2: Quantitative faunal analyses of foraminiferal assemblages from Gabon (Atlantic Ocean). Numerical data include percent abundances of porcellaneous miliolid, hyaline and agglutinate foraminiferal specimens, relative amount of elphidiid and (*) symbiont-bearing taxa (%) among foraminiferal biotas, and diversity and dominance indices of individual samples

	Site 1 Port Michel Marine	Site 2 Pointe Denise	Site 3 Point Denise	Site 4 Turtle Beach	Site 5 Petit Loango	Site 6 Petit Loango
Porcellaneous Miliolid %	0.0	21.5	11.4	21.1	13.6	9.2
Hyaline %	100	65.5	83.8	58.1	74.5	68.5
Agglutinate %	0.0	13.0	3.3	20.7	8.5	22.7
No. of species	7	17	21	16	20	19
No. of Genera	4	10	11	11	13	15
Fisher α	1.078	4.822	6.008	4.04	5.232	4.534
Shannon (H)	0.2412	2.102	1.88	2.052	1.939	2.031
Dominance_D	0.9154	0.1804	0.2571	0.181	0.2425	0.2302
<i>Ammonia</i> spp. %	95.6	32.2	40.5	29.5	11.5	2.4
<i>Elphidium</i> spp. %	3.2	21.5	37.6	21.6	0	0.7
<i>Amphistegina</i> spp. % (*)	0.1	0.6	1.0	2.2	45.1	5.1
<i>Pararotalia</i> cf. <i>P. nipponica</i> % (*)	1.0	0	0	0	4.3	44.1
Symbiont-bearing Foraminifera % smaller miliolids %	1.1 0.0	0.6 11.9	1.0 3.6	2.2 13.9	49.4 9.0	49.2 8.8

Our recordings indicate that amphisteginid foraminifera were particularly abundant at one site offshore the Petit Loango National Park (up to 45.3%; Tbl. 2). The collection site off Petit Loango (sites 5-6) is situated off the Iguéla Lagoon, an estuarine region with vast mangrove habitats where nutrient input allows excess of organic matter to accumulate. In such environments, water transparency is usually insufficient to support abundant occurrences of symbiont-bearing foraminifera so that stress-tolerant taxa like *Ammonia* spp. or *Elphidium* spp., which constitute substantial percentages of the foraminiferal assemblages, are dominant (Renema 2006; Hallock 2012). The faunal composition and abundance of *Ammonia* spp. at Port Michel Marine (95.6% at site #1), located deep in the Gabon estuary, shows a typical assemblage for such a nutrient-loaded setting. The high abundance of *Amphistegina* and *Pararotalia* at the sites of Petit Loango suggests, however, that runoff from the Iguéla Lagoon exerts a limited effect, promoting the hypothesis that the pristine waters offshore may have more diverse assemblages. To date, we have identified 39 species belonging to 19 genera. The number of species appears to be comparatively low, but given the very shallow samples sites (<2m) and limited habitats and samples examined so far, the true diversity of shallow-water foraminiferal taxa present in non-polluted areas off Gabon is likely to be much higher than our initial survey suggests.

Moderately to high diverse assemblages of shallow benthic foraminifera were also reported by Adegoke et al. (1976), Haake (1980), Larsen (1982), Debenay and Basov (1983), Mikhalevich (2008), Reymond et al. (2014, among others) from various sites along the northwestern coast of Africa (Nigeria, Mauretania). In a first trial biogeographic survey, Debenay and Basov (1983) listed a total of 774 species of foraminifera from the entire shelf and slope of West Africa (Strait of Gibraltar to South Africa). Similarly, Mikhalevich (1983, 2008)

reported diverse assemblages of 176 species of benthic foraminifera from depths between 0 and 69 m from the western-equatorial Africa between the Strait of Gibraltar and the Niger estuary. This supports the view that foraminiferal taxonomic richness from shallow waters of western Africa may be similar to high diversity assemblages reported from tropical areas along the eastern coast of Africa (e.g. Heron-Allen and Earland 1915; Langer et al. 2013a; Langer unpubl. data). A comprehensive and large-scale survey, however, is required to strengthen this hypothesis.

In the only other studies currently available on recent foraminifera from Gabon, Durrieu et al. (2006) and Duchemin et al. (2008) reported on living benthic taxa from shallow sites (<30m) around oil and drill cutting disposal sites off Port Gentil (Gabon). They used foraminifera as bio-indicators to assess the impact of discharged drill mud, cuttings and oil-based drill fluids on benthic communities at disposal sites near oil platforms. In the immediate vicinity (≤ 250 m) of the disposal sites, they reported that living foraminifera were present in very low quantities with extremely low species richness or fully absent. Nonetheless, they concluded that the absence of foraminifera is a minor response to oil drill disposal activities and that the residual hydrocarbons present in the sediments have lost most of their toxicity. The absence of living foraminifera near the drill charge disposal sites was suspected to be due to "the fact that the Van Veen grab did not adequately sample the sediment surface". The low density and species number of foraminifera was rather attributed to natural eutrophication resulting from river runoff of the nearby Ogooué River. However, foraminifera from the mouth of the Ogooué River were neither examined by Durrieu et al. (2006) nor Duchemin et al. (2008). Nonetheless, they concluded that the environmental impact of the discharge of drill mud, cuttings and oil-based drill fluids was very minor (or even completely absent), despite the fact that their sampling was conducted 12 years after drilling waste was discharged.

The findings of our study that shallow-water nearshore coastal sediments yield diverse assemblages of benthic foraminifera contrast markedly with the conclusions reached by Durrieu et al. (2006) and Duchemin et al. (2008). They are in agreement, however, with large-scale surveys by Mikhalevich (1983, 2008) and Debenay and Basov (1993), showing that shallow shelf and coastal areas in the western tropical Atlantic are generally rich in species of benthic foraminifera (see also Haake 1980; Debenay and Redois 1997). The low-diversity assemblages reported from drilling waste disposal sites also contrast with studies that show diverse assemblages of foraminifera in eutrophic biofacies in deltaic sediments off the Niger or Orange River mouth (Martin 1981; Dublin-Green 1994; Schmidt-Sinns 2008; Adegoke et al. 1976).

Table 3: Quantitative foraminiferal species contributions from samples collected at nearshore localities off Gabon. The total contribution of each species is presented as a percentage of the total assemblage (* denotes species that were recorded from southern Africa (Namibia to Cape Town) and * is for species that were recorded from tropical shallow sites of eastern Africa.

	Site 1 Port Michel Marine	Site 2 Pointe Denise	Site 3 Point Denise	Site 4 Turtle Beach	Site 5 Petit Loango	Site 6 Petit Loango
<i>Spirolectinella</i> sp. 1	0.0	0.0	0.5	1.4	7.7	11.9
<i>Spirolectinella</i> sp. 2	0.0	0.6	0.0	0.0	0.4	0.0
<i>Tetragonostomia rhombiformis</i>	0.0	13.8	4.2	20.7	7.3	6.4
<i>Textularia</i> cf. <i>T. porrecta</i>	0.0	0.0	0.0	0.0	0.4	3.1
<i>Textularia sagittula</i> * ^x	0.0	0.0	0.0	0.5	0.4	0.0
<i>Textularia conica</i> ?	0.0	0.6	0.0	0.0	0.0	1.0
<i>Adelosina</i> sp.1	0.0	0.0	0.0	0.5	0.0	0.3
<i>Quinqueloculina</i> cf. <i>Q. araucana</i>	0.0	0.0	0.5	0.0	0.0	0.0
<i>Quinqueloculina</i> cf. <i>Q. atlantica</i>	0.0	0.0	0.5	1.0	0.4	0.0
<i>Quinqueloculina</i> cf. <i>Q. cuiveriana</i>	0.0	0.0	0.5	0.0	0.9	0.0
<i>Quinqueloculina</i> cf. <i>Q. laevigata</i> * ^x	0.0	0.0	0.0	2.4	0.0	0.0
<i>Quinqueloculina multimarginata</i> * ^x	0.0	0.0	0.0	0.0	0.4	0.0
<i>Quinqueloculina</i> sp. 1	0.0	0.0	0.0	0.0	0.0	0.0
<i>Quinqueloculina</i> sp. 2	0.0	0.6	0.0	0.0	0.0	0.0
<i>Quinqueloculina</i> sp. 3	0.0	0.0	0.5	0.0	0.0	0.0
<i>Quinqueloculina</i> sp. 4	0.0	1.3	0.5	1.0	1.7	1.0
<i>Quinqueloculina stalkerii</i> *	0.0	0.0	0.5	0.0	0.0	0.0
<i>Quinqueloculina vulgaris</i>	0.0	8.8	0.5	6.7	5.1	7.5
<i>Siphonaperta</i> cf. <i>S. macbeathi</i>	0.0	1.3	0.0	2.4	0.4	0.0
<i>Spiroloculina</i> cf. <i>S. nitida</i>	0.0	0.0	0.0	0.0	0.0	0.3
<i>Ammonia aoteana</i> ?	0.0	0.6	0.0	0.0	0.0	0.0
<i>Ammonia parkinsoniana</i> * ^x	95.6	35.2	44.3	32.2	11.5	2.4
<i>Amphistegina lessonii</i> * ^x	0.1	0.6	1.0	2.4	44.9	5.1
<i>Amphistegina papillosa</i> * ^x	0.0	0.0	0.0	0.0	0.4	0.0
<i>Anomalinaella rostrata</i> * ^x	0.0	0.0	0.0	0.5	0.9	0.0
<i>Brizalina striatula</i> * ^x	0.0	0.0	0.5	0.0	0.0	0.0
<i>Cibicides</i> sp. 1	0.0	0.0	0.0	0.0	0.0	0.7
<i>Cibicidoides pachydermi</i>	0.0	0.0	0.0	0.0	0.0	3.4
<i>Cibicidoides wuellerstorfi</i> * ^x	0.0	1.3	1.0	0.0	0.4	3.1
<i>Elphidium advenum maorium</i>	2.1	1.3	4.2	0.0	0.0	0.0
<i>Elphidium</i> cf. <i>E. fimbriatulum</i>	0.3	10.7	21.4	12.0	0.0	0.0
<i>Elphidium gunteri</i>	0.4	10.1	6.3	10.6	0.0	0.3
<i>Elphidium magellanicum</i> ^x	0.0	0.0	1.0	0.0	0.0	0.0
<i>Elphidium williamsoni</i> * ^x	0.4	1.9	8.3	1.0	0.0	0.3
<i>Eponides repandus</i> * ^x	0.0	6.9	1.0	4.8	10.7	7.5
<i>Neoepionides procerus</i>	0.0	0.0	0.0	0.0	1.3	1.0
<i>Nonion fabum</i> ^x	0.0	4.4	2.1	0.0	0.4	0.7
<i>Pararotalia armata</i> ?	1.0	0.0	0.0	0.0	4.3	44.1
<i>Rosalina</i> cf. <i>R. bradyi</i>	0.0	0.0	0.5	0.0	0.0	0.0

The effects of drilling waste discharge from oil and gas platforms on benthic biotas has recently been summarized by Ellis et al. (2012), showing persistent and large-scale impacts on benthic macroscopic communities at distances of up to 20 km. Ellis et al. (2012) also showed that the discharge of oil-based fluids, as released off Gabon, has had large-scale (out to 6 km)

and persistent (decadal time scale) impacts on benthic communities. A few studies have addressed changes in the structure of foraminiferal assemblages to determine the impact of hydrocarbon drilling activities (Locklin and Maddocks 1982; Ernst et al. 2006; Morvan et al. 2004; Denoyelle et al. 2010; Sabeau et al. 2009). All studies documented so far showed that environmental perturbations resulting from oil drilling discharges resulted in a loss of benthic foraminiferal biodiversity, alterations of foraminiferal assemblage structures and shifts in abundances and functional groups of foraminifera (e.g. infauna versus epifauna).

The number of active offshore platforms has increased substantially over the last decades and the demand for hydrocarbons is predicted to increase in the future. The cumulative impact of increased numbers of oil platforms in the world's oceans calls for intensified monitoring the impact of drilling waste discharge on benthic communities. Denoyelle et al. (2010) have shown that adding foraminiferal studies to the more commonly used macrofaunal approaches may provide higher resolution, and a more detailed and discriminative tool for environmental monitoring.

3.4.2 Biogeographical distributions

The shallow-water species composing benthic foraminiferal assemblages in coastal waters off equatorial Gabon differ markedly from tropical foraminiferal biotas of eastern Africa (e.g. Heron-Allen and Earland 1915; Langer et al. 2013a). The cold waters off South Africa and the Benguela Current represent a major biogeographic barrier where migration is impeded and gene flow is limited. This has largely prevented the tropical biotas from the warm Indian Ocean to colonize the tropical coasts of western Africa (Teske et al. 2011; Friedlander et al. 2014). Seasonal upwelling and the input of freshwater and sediments from the Congo and Ogooué rivers constitute an additional barrier that separates biotas in close geographic proximity (southwestern Africa and Gulf of Guinea; Lœuff and van Cosel 1998). Consequently, the marine biotas of the Gulf of Guinea are unique and true coral reefs, as widely present on the eastern coast of tropical Africa, are absent from this region (Roberts et al. 2002).

The lack of typical tropical faunal constituents is also reflected in the low number of symbiont-bearing species of foraminifera that are indicative of oligotrophic tropical warm waters (Langer and Hottinger 2000). Only three species of larger symbiont-bearing foraminifera were record off Gabon (*Amphistegina lessonii*, *Amphistegina* sp., and *Pararotalia* cf. *P. nipponica*), while more than 10 species of LBF characterize the coastal waters off Mozambique, Tanzania and Kenia (Heron-Allen and Earland 1915; Braga 1961; Pereira 1979; Langer et al. 2013a). Both *Amphistegina* and *Pararotalia* are known to tolerate somewhat colder and more

nutrient-rich waters (Langer and Hottinger 2000; Langer 2008a; Langer et al. 2013) as present off Gabon.

The position and oceanographic features separating the Gulf of Guinea from areas of close proximity have created a hotspot of diversity, unique biotic faunas and a high degree of endemism (Roberts et al. 2002). The smaller benthic foraminifera reported in this study also differ markedly from shallow-water assemblages recorded from coastal regions of Namibia, Angola or the Atlantic coast of South Africa (compare Martin 1981; Toefy et al. 2005; Langer and Schmidt-Sinns 2006a,b; Schmidt-Sinns 2008). Our initial survey shows that only about 30% of all species documented here were previously recorded from Atlantic coastal sites between Cape Town and southern Angola and the western Indian Ocean (compare Heron-Allen and Earland 1915 and Langer et al. 2013b; see Tbl. 3). This lends further support to a potent biogeographic barrier, separating the tropical Gulf of Guinea from the cold-water ecosystems of southern Africa.

3.5 Conclusions

The study presented here is a first survey of foraminifera from very shallow coastal sites in Gabonese waters. The benthic foraminiferal assemblages are diverse. The diversity of foraminiferal species recovered from the limited number of coarse-grained samples suggests that the true diversity of shallow benthic species may be significantly higher. The presence of abundant symbiont-bearing taxa, in addition to the species richness recorded, indicate, that the coastal sites investigated remained largely unaffected by offshore drilling activities. The shallow-water benthic foraminiferal assemblages from equatorial Gabon differ markedly from tropical foraminiferal biotas of southern Africa, implying a biogeographic barrier that separates biotas in close geographic proximity. The recent creation of a large-scale system of Marine National Parks in territorial waters off Gabon will create a vast marine reserve that provides future protection for its pristine waters and Gabonese livelihoods.

PLATES

PLATE 1: Scanning electron micrographs of agglutinate and miliolid foraminifers from nearshore coastal sites off equatorial Gabon (E Atlantic Ocean; scale bar = 100 μm except where otherwise stated).

1, 2: *Spiroplectinella* sp.1.

3, 4: *Spiroplectinella* sp.2.

5, 6: *Textularia* cf. *T. porrecta* Brady.

7: *Textularia sagittula* DeFrance.

8, 10: *Tetragonostomina rhombiformis* Mikhalevich.

11, 12: *Textularia conica*? d'Orbigny.

13, 14: *Siphonaperta* cf. *S. macbeathi* (Vella).

15, 18: *Quinqueloculina* sp.1.

19, 20: *Quinqueloculina multimarginata* Said.

21: *Quinqueloculina* cf. *Q. laevigata* d'Orbigny.

2, 23: *Quinqueloculina* cf. *Q. stalker*i Loeblich and Tappan.

24: *Quinqueloculina* sp. 2 (scale bar = 50 μm).

25: *Quinqueloculina* sp.3.

26, 27: *Quinqueloculina* cf. *Q. araucana* d'Orbigny (scale bar = 50 μm).

28-30: *Quinqueloculina* cf. *Q. atlantica* (Boltovskoy).

31, 32: *Adelosina* sp.1.

33, 34: *Spiroloculina* cf. *S. nitida* d'Orbigny.

PLATE 1

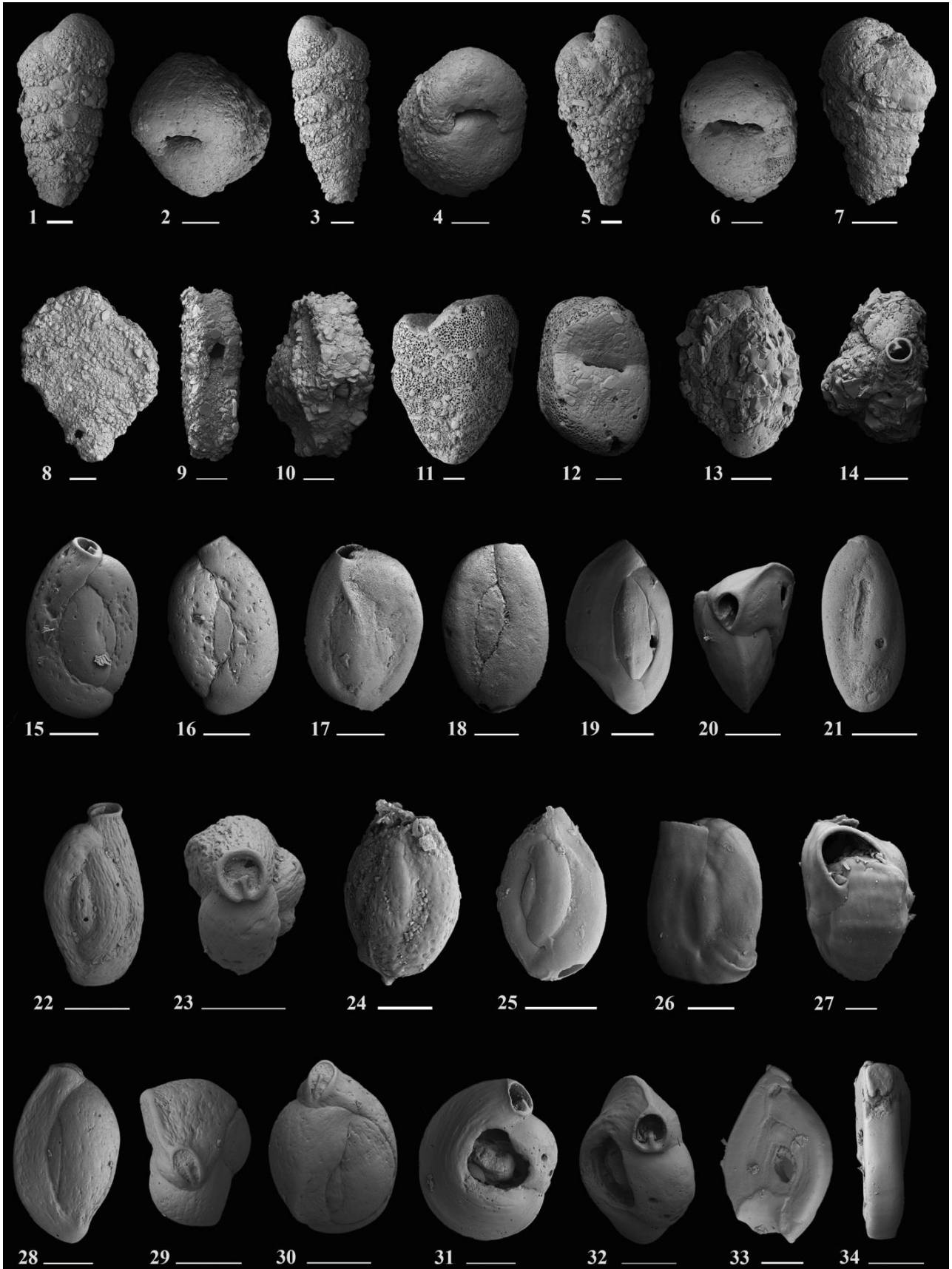


PLATE 2: Scanning electron micrographs of miliolid and hyaline foraminifers from nearshore coastal sites off equatorial Gabon (E Atlantic Ocean; scale bar = 100 μm except where otherwise stated).

1-6: *Quinqueloculina* cf. *Q. cuiveriana* d'Orbigny.

7-10: *Quinqueloculina* sp.4.

11, 12: *Quinqueloculina vulgaris* d'Orbigny.

13: *Brizalina striatula* Cushman (scale bar = 50 μm).

14-16: *Eponides repandus* Fichtel and Moll.

17, 18: *Cibicides* sp.1.

19, 20: *Rosalina* cf. *R. bradyi* (Cushman) (scale bar = 50 μm).

21-23: *Cibicidoides wuellerstorfi* Schwager.

24-27: *Cibicidoids pachyderma* (Rhezak).

28-31: *Amphistegina lessonii* d'Orbigny.

PLATE 2

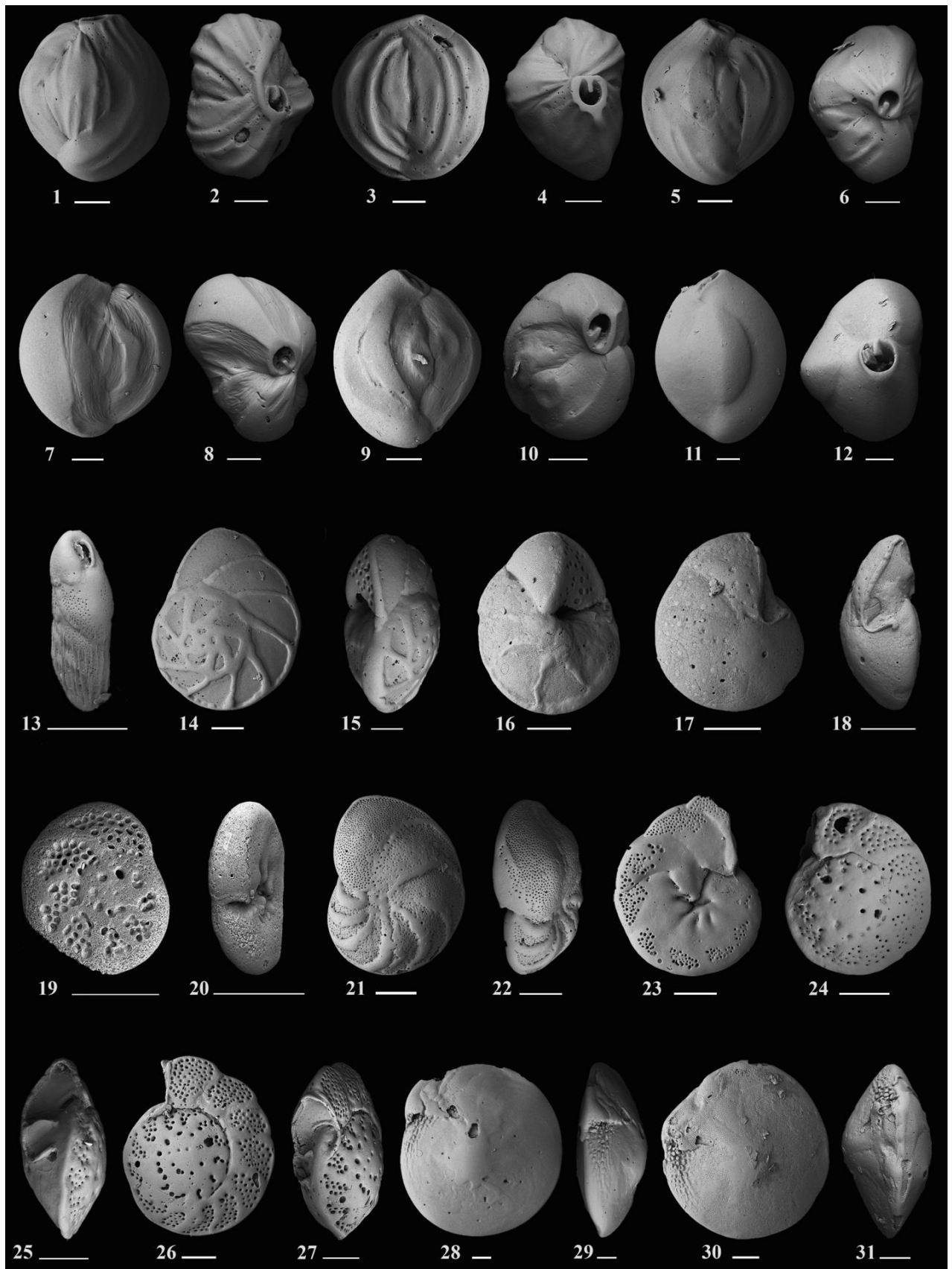


PLATE 3: Scanning electron micrographs of hyaline foraminifers from nearshore coastal sites off equatorial Gabon (E Atlantic Ocean; scale bar = 100 μm except where otherwise stated).

1, 2: *Nonion fabum* Fichtel and Moll.

3: *Anomalinella rostrata* (Brady).

4-6: *Pararotalia* cf. *P. nipponica*.

7-12: *Ammonia parkinsoniana* d'Orbigny.

13-16: *Ammonia aoteana*? Finlay.

17, 18: *Neoeponides procerus* (Brady).

19-21: *Elphidium advenum maorium* Hayward.

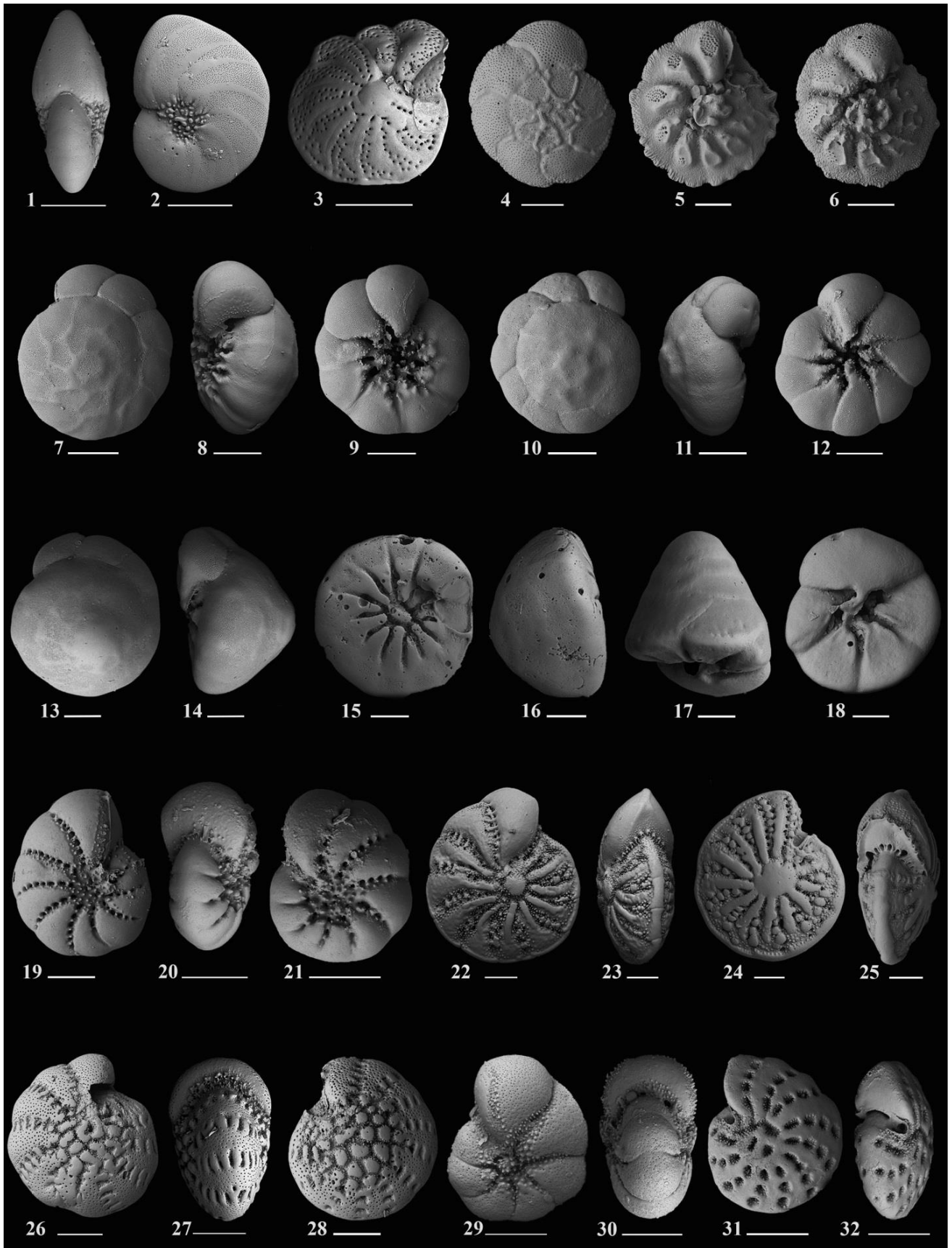
22-25: *Elphidium* cf. *E. fimbriatulum* (Cushman).

26-28: *Elphidium gunteri* Cole.

29, 30: *Elphidium magellanicum* Heron-Allen and Earland (scale bar = 50 μm).

31, 32: *Elphidium williamsoni* Haynes.

PLATE 3



Chapter 4

Assemblages of recent intertidal mangrove foraminifera from the Akanda National Park, Gabon: sea level proxies preserved in faunal assemblages

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Abstract

The composition and vertical zonation of modern benthic foraminifera was studied at two intertidal mangrove environments in the Akanda National Park, Gabon. Foraminifera inhabiting the muddy substrates were found to represent a unique assemblage and are distinct from other nearshore biotas. A total of twenty-one benthic species were recorded. Numerical analyses of faunal assemblages indicate that the distribution of taxa is vertically constrained, divided into two faunal zones that are elevation dependent. A low-diverse agglutinated foraminiferal assemblage, dominated by *Ammotium salsum* and *Ammobaculites pseudospirale*, was found to characterize the elevated landward field area in muddy substrates around *Avicennia germinans* mangroves. The assemblage is composed of agglutinated taxa only and is indicative for High Mean Water Neap Tide elevations. A moderately diverse assemblage of agglutinated and calcareous foraminifera was recovered from around *Rhizomosa racemose* stands and represents biotas at Mean Low Water Neap Tide elevation. The assemblage is dominated by species of *Miliammina*, *Arenoporella mexicana*, *Ammotium salsum* and *Astrononion stelligerum*. The species richness of individual assemblages was found to be tide-related and reveals a strong trend of decreasing diversity moving up the shore. These distributions resemble typical intertidal zonation patterns in mangroves and estuaries and highlight their potential for sea level reconstructions. The study constitutes the first survey of mangrove foraminifera from Gabon.

4.1 Introduction

The coastal areas of Gabon are situated on the west coast of Africa, straddling the equator of the tropical Atlantic. Mangroves are widespread along the entire coastline of Gabon and primarily concentrated along long-shore tidal lagoons, open deltaic and estuarine embayments. Gabon's mangrove ecosystems house more than 25% of the protected mangroves on Africa's continent (Corcoran et al. 2007). They serve as nurseries of a large number of marine organisms and play an enormous role in coastal protection, fisheries, timber products, as

sites for migratory birds and in the countries strategy to preserve biodiversity and to encourage sustainable ecotourism (Quammen 2003; Vande Weghe 2005; Corcoran et al. 2007). The Akanda National Park is situated along the Atlantic coast of western central Africa and mainly comprises mangrove, mudflats and tidal beach habitats. It is located north of Libreville, the rapidly growing capital with an estimated one million inhabitants.

The Atlantic waters off the Akanda NP estuary are part of the Guinea Current Large Marine Ecosystem (GCLME,) situated along the Atlantic coast of western central Africa (McGlade et al. 2002; Friedlander et al. 2014). Waters entering the Akanda NP embayment enter through Mondah Bay which in turn is fed by a number of smaller rivers and creeks (Fig. 1). The coastal waters of Gabon are among the most productive in the region, driven by seasonal upwelling and the supply of large quantities of dissolved and particulate organic matter from the Congo and Ogooué River (Voituriez & Herbland 1982; Lœuff & Cosel 1998; McGlade et al. 2002). The nutrient-loaded waters fuel productive food webs and rich fishery resources that are crucial to coastal populations. Despite its high productivity and importance for ecosystem, little is known about Gabon's invertebrate and microfauna in mangrove habitats. Studies on the shallow sub- and intertidal microbiota are virtually lacking. Previous studies have explored biotic communities from the continental margins near hydrocarbon exploration sites or fishery resources along the shelf and slope (Bianchi 1992; Sibuet & Vangriesheim 2009; Friedlander et al. 2014 and references therein). Here we provide the first scientific survey of modern intertidal benthic foraminifera from mangrove areas of Gabon. We have examined the composition, diversity and structure of benthic communities from sites within the Akanda National Park and compare them to coastal assemblages that were recently reported from non-mangrove shallow-water habitats (Langer et al. 2016). The objectives of this study were to provide the first record of foraminiferal mangrove communities from Gabon, to determine the general characteristics of the microfauna, and to compare and contrast the assemblages to biotas from other mangrove ecosystems of northwestern Africa. In addition, sampling was conducted at different intertidal elevations to quantitatively analyze the vertical distribution of individual species to assess their potential as sea-level indicators.

4.2 Material and Methods

Sediment samples from the Akanda National Park were collected in 2015 by hand at low tide from the top 2cm within the mangroves habitats. The sampling sites are located deep within the Mondah Bay mangrove embayment facing the Atlantic Ocean (Fig. 1). Sampling sites were selected to provide information on the benthic foraminiferal assemblages at different tidal

elevations. They represent mud flats within *Avicennia germinans* mangrove trees at a Mean High Water Neap tide site (MHWN; Site 1) and a channel location within dense *Rhizophora racemose* stands representing a Mean Low Water Neap tide station (MLWN; Site 2, Table 1 and Figs. 2 & 3). The tidal range here is 2.3 m.

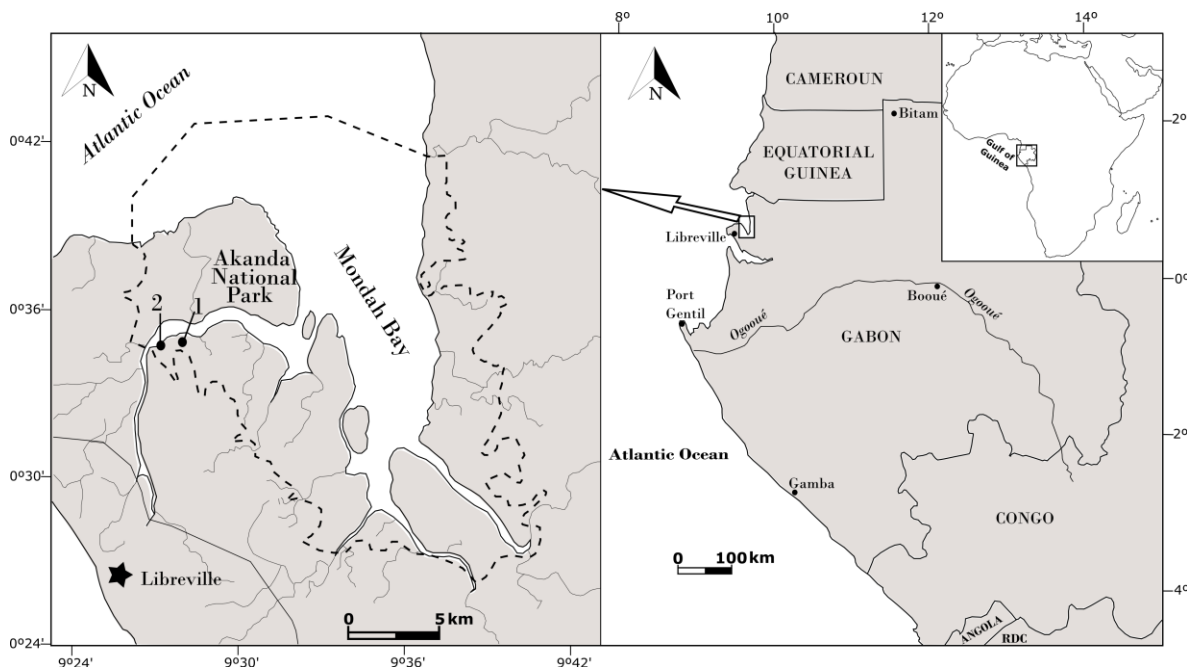


Fig. 1: Sample locations within the Akanda National Park, NE of Libreville, Gabon.

The sample material was dried, taken to the laboratory and washed over 63 μm mesh sieves. Sediment samples mostly consisted of medium to fine grained muddy sand and a few fragments of bivalves, and gastropods. The quantitative analysis focused total assemblages (living and dead), to reduce a potential bias of seasonality. Our samples are thus time-averaged, and as such provide an effective means of defining habitats (Glenn-Sullivan and Evans 2001). The analysis of total assemblages has been more accurate for paleoenvironmental interpretations (Scott and Medioli 1980b; Gehrels 1994; Hayward et al. 1999a; Horton 1999; Langer and Lipps 2003; Tobin et al. 2005; Langer et al. 2012; Mouanga and Langer 2014, 2016; Shaw et al. 2016). Figure 1 and Table 1 provide details of the sample sites within the Akanda National Park, northeast of Libreville inside the Mondah Bay mangrove embayment system.

Table 1: Sample sites information for localities in the Akanda National Park (Gabon).

Site #	Locality	Latitude	Longitude	Habitat	Tidal Elevation	Dominant Mangroves
1	Akanda NP	N 0°34'52.99"	E 9°27'20.88"	Mud Flats	MHWN	<i>Avicennia germinans</i>
2	Akanda NP	N 0°34'44.48"	E 9°27'05.45"	Channel Margin	MLWN	<i>Rhizophora racemosa</i>

All taxa were identified to species level, whenever possible, and individuals of each species were counted. The composition of benthic foraminiferal communities from each site was examined by analyzing percent abundances with reference to individual species groups, wall

structural types and diversity indices including Fisher α , Shannon-H, dominance and total species richness (Table 2). Images of representative species were taken by Scanning Electron Microscope (SEM) and arranged into catalogue of taxa (Figs. 4-6) using Adobe Photoshop CS6. For the identification of benthic foraminiferal species and higher orders our taxonomic and systematic arrangement follows the arrangement of Loeblich and Tappan (1988), and identifications of Debenay (1990), Debenay et al. (2002) and Langer et al. (2016). All species are illustrated on Plates (Figs. 4-6) and a complete list of all species with percent abundance data is provided in Table 2.

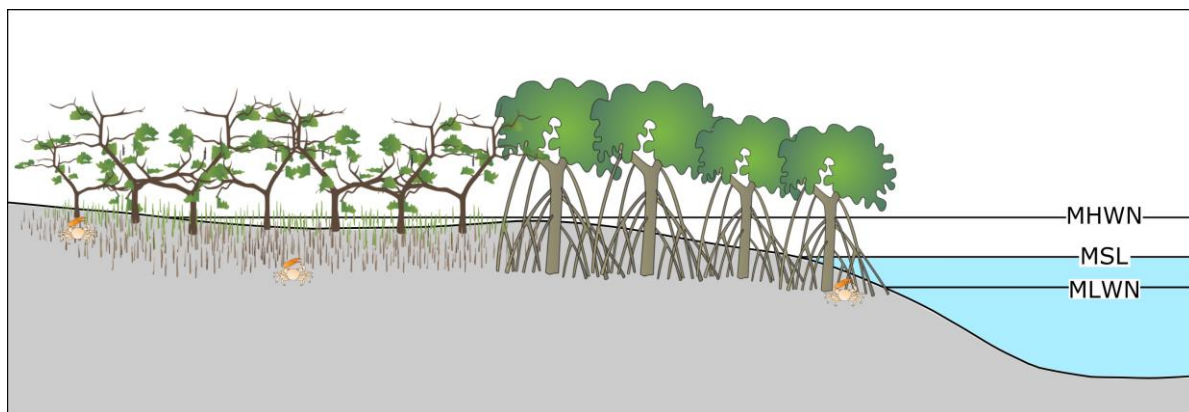


Fig. 2: *Avicennia germinans* mangrove trees at a Mean High Water Neap tide and *Rhizophora racemosa* stands representing a Mean Low Water Neap tide station (Selected images from Tracey Saxby, Dieter Tracey and Jane Thomas, IAN/UMCES, ian.umces.edu/imagelibrary/).

4.3 Results

The sediments yielded abundant benthic foraminifera and are characterized by low to moderate species richness. A total of 2155 foraminifera were recovered (Table 2). The foraminiferal assemblages contained a total of 21 species and belong to 16 genera. The assemblages are predominantly agglutinated (83.1%) while the perforate taxa make 16.9%. Miliolid foraminifera were not recovered. Fisher α diversity indices range between 0.95 and 3.20 in individual samples (Table 2). Shannon (H) values vary between 0.60 and 2.03 and dominance values range between 0.66 and 0.17. Species richness ranges between 5 and 21 and genera between 4 and 16. Larger symbiont-bearing foraminifera were not recovered.

The *Avicennia germinans* locality (Site 1), representing a MHWN tidal elevation, is dominated by two agglutinated species: *Ammotium salsum* and *Ammobaculites pseudospirale*. They constitute 79.6 and 18.2 % of the entire faunal assemblage at this site (see Table 2). Species of *Miliammina* (*Miliammina fusca* and *M. petila*) and *Textularia porrecta* were found to be rare at this locality and make up less than 1.4 % at site 1. The assemblage at this locality is composed of agglutinated foraminifera only and characterized by low species richness (5 taxa). No other foraminifera were recorded here.



Fig. 3: Dense stands of *Rhizophora racemosa* and *Avicennia germinans* mangrove trees with stilt roots and pneumatophores along channels and on mud flats at low tide within the Akanda National Park.

The MLWN channel site location at the base of the *Rhizophora racemose* mangrove roots (Site 2) is characterized by moderate species richness. A total of 21 species were recovered at this site representing both agglutinated and hyaline perforate taxa (77.9 and 22.1%, respectively). Again, *Ammotium salsum* was found to be the dominant species (29.3%) followed by *Miliammina petila* (17.8%), *Astrononion stelligerum* (16%), *Miliammina fusca* (11.5%), *Arenoporella mexicana* (10.4%) and *Ammonia tepida?* (4.4%). Percent abundances of all other species recovered at this site range between 0.1 and 2.4%. Foraminiferal species richness recorded at the sampling locations revealed strong tide-related trends. This concerns both generic and specific diversity, and the composition of assemblages, whereby the moderately diverse agglutinated/calcareous fauna from low-lying MLWN areas is replaced by a low-diverse assemblage at MHWN that is composed of a few agglutinated taxa only.

4.4 Discussion

The distribution and composition of foraminifera assemblages from two intertidal mangrove sites within the Akanda National Park (Gabon) were investigated to provide an initial survey of the diversity and assess their potential as proxies for past sea level changes. This study represents the first scientific survey of benthic foraminifera from mangrove environments of

Gabon. The assemblages recovered document the presence of a highly specialized fauna with more than 21 species and provide additional evidence that the shallow coastal waters of Gabon house a diversified fauna of benthic foraminifera (Langer et al. 2016).

Table 2. Quantitative faunal analysis of foraminiferal assemblages from mangrove localities at Akanda NP (Gabon). Numerical data include percent abundances of hyaline and agglutinated foraminiferal specimens, diversity and dominance indices of individual samples.

	Akanda1	Akanda1 (%)	Akanda2	Akanda 2 (%)
<i>Ammoastuta salsa</i>	0	0.0	5	0.3
<i>Ammobaculites pseudospirale</i>	92	18.2	37	2.4
<i>Ammodiscus siliceus</i>	0	0.0	1	0.1
<i>Ammonia tepida?</i>	0	0.0	73	4.4
<i>Ammonia</i> sp. 1	0	0.0	1	0.1
<i>Ammotium</i> aff. <i>A. cassis</i>	0	0.0	7	0.4
<i>Ammotium salsum</i>	402	79.6	484	29.3
<i>Arenoparella mexicana</i>	0	0.0	173	10.4
<i>Astrononion stelligerum</i>	0	0.0	264	16.0
<i>Elphidium</i> cf <i>E. selseyense</i>	0	0.0	2	0.2
<i>Elphidium advenum maorium</i>	0	0.0	24	1.5
<i>Gaudryina</i> sp.	0	0.0	1	0.1
<i>Haplophragmoides wilberti</i>	0	0.0	22	1.3
<i>Miliammina fusca</i>	7	1.4	190	11.5
<i>Miliammina petila</i>	2	0.4	295	17.8
<i>Reophax</i> sp.	0	0.0	1	0.1
<i>Scherochorella</i> sp.	0	0.0	5	0.3
<i>Sorosphaera</i> sp. 1	0	0.0	1	0.1
<i>Textularia porrecta</i>	2	0.4	13	0.7
<i>Textularia</i> sp. 1	0	0.0	16	0.9
<i>Trochammina inflata</i>	0	0.0	35	2.1
Total no. of individuals	505	100	1650	100
No. of species	6	-	20	-
No. of genera	4	-	16	-
Hyaline-perforate foraminifera%	0	-	22.1	-
Agglutinated foraminifera %	100	-	77.9	-
Dominance_D	0.6645	-	0.1716	-
Shannon H	0.6080	-	2.038	-
Fisher α	0.9565	-	3.202	-
Hyaline-perforate %	0	-	22.1	-

Quantitative faunal analyses of foraminiferal assemblages from MLWN and MHWN tide locations within the mangrove habitats revealed significant faunal differences. These differences concern the abundance of species (species richness), the composition of assemblages, percent abundances of individual taxa and wall structural types. The datasets obtained can be broadly divided into an agglutinated assemblage, which is characteristic for mudflats at high elevation around *Avicennia germinans* (MHWN), and an agglutinated/hyaline perforate assemblage which is prominent at lower elevations (MLWN). The assemblages of foraminifera contain low to moderate diverse communities of benthic taxa with markedly higher species richness at the MLWN tide location along the channel margin below the *Rhizophora*

racemose mangrove trees (Site 2). The elevated MHWN tide sampling site within pneumatophores of the mangrove *Avicennia germinans*, in turn, revealed a low-diverse assemblage of foraminifera, where only two species constitute 97.8% of the entire faunal assemblage. The vertical distributions of foraminiferal faunal assemblages resemble typically recorded intertidal zonation patterns, whereby agglutinated taxa dominate at MHWN salt-marsh and mangrove environments (de Rijk & Troelstra, 1997; Horton et al. 1999b; Horton et al. 2003; Edwards et al. 2004). The combined occurrence of agglutinated and calcareous taxa, including *Ammonia* spp. and *Elphidium* spp., however is indicative of lower MLWN elevations Rijk & Troelstra 1997; Horton et al. 1999b; Woodroffe et al. 2005; Shaw et al. 2016; Debenay et al. 2002).

Comparative studies concerning the distribution of intertidal foraminiferal assemblages for the purpose of environmental proxies along western Africa allow a direct comparison of our findings. Using recent foraminiferal assemblages to identify the distribution of individual taxa relative to environmental stress, Debenay (1990) found *Ammotium salsum* to be the most tolerant taxon in paralic environments of western Africa and that diversity of taxa decreases with distance from the sea. In mangrove areas from French Guiana, *Ammoastuta salsa* together with *Ammotium salsum*, *Miliammina fusca* and *Arenoporella mexicana* were found to be the dominant species in *Avicennia germinans* and *Rhizophora racemose* mangrove forests (Debenay et al. 2002). In general, agglutinated species of foraminifera are the dominant components of mangrove foraminiferal assemblages. However, calcareous species of *Ammonia*, *Elphidium*, and *Criboelphidium* were also reported from other tropical mangrove swamps: Florida (Phleger 1966), Puerto Rico (Culver 1990), New Zealand (Hayward & Hollis 1994), Brazil (Zaninetti et al. 1977, 1979), Australia (Woodroffe et al. 2005), French Polynesia (Langer & Lipps 2006; Fajemila et al. 2015). In most places, these taxa are generally restricted to the outer mangrove swamps or to sites with lower elevation. Low pH and the availability of calcium were also suggested to strongly control the presence of calcareous tests in mangrove habitats (Debenay et al. 2002; Woodroffe et al. 2005).

Changes of foraminiferal assemblages with elevation were recorded in numerous mid-latitude, temperate nearshore marsh environments showing that individual taxa are highly accurate sea-level indicators with narrow vertical ranges and ecological requirements (Scott and Medioli 1978, 1980a, 1986; Hayward et al. 1999, 2004). Studies on the vertical distribution in tropical intertidal mangrove environments, however, are few and include among others the works of Scott et al. 1990, Hayward et al. 1999b, 2004, Debenay 1990, Debenay et al. 2000, 2002, Javaux 1999, Javaux and Scott 2003, Horton et al. 2003, 2005, and Woodroffe et al. 2005.

General themes that emerged from these studies were that 1.) foraminiferal species richness decreases with increasing elevation and environmental stress and 2.) that the numerical abundance and proportion of agglutinated foraminifera increases with elevation and distance from the coast (Adegoke et al. 1976; Debenay 1990; Debenay & Guillou 2002; Langer and Lipps 2006; Woodroffe et al. 2005; Horton et al. 2003, 2005).

The foraminiferal assemblage analysis provided here shows that two faunal zones can be recognized. A Mean High Water Neap Tide assemblage characterized by low diversity and high relative abundances of *Ammotium salsum* and *Ammobaculites pseudospirale* and a moderately diverse MLWN Tide assemblage composed of agglutinated and calcareous foraminifera. The faunal assemblages are vertically constrained and differ in species richness and numerical abundance and composition of individual taxa. Similar patterns and vertical zonations within *Rhizopora* and *Avicennia* mangrove stands were previously reported by Woodroffe et al. (2005) from tropical mangrove communities on the central Great Barrier Reef coastline and from paralic environments of West Africa and French Guinea (Debenay 1990; Debenay et al. 2002). Similarities in assemblage composition and numerical abundance patterns of individual taxa in the tidal frame attest that sea-level signals are preserved in mangrove foraminifera from Gabon and highlight their potential for reconstructions of past sea-level changes.

The fauna recovered from the mangrove habitats of the Mondah embayment of the Akanda National Park differs fundamentally from other shallow-water nearshore communities of benthic foraminifera that were recently reported from coastal environments of Gabon. Langer et al. (2016) have shown that most open coastal environments of Gabon contain moderately diverse assemblages of benthic foraminifera including abundant larger symbiont-bearing, smaller miliolid, and mostly perforate hyaline taxa. Agglutinated foraminifera, the dominant constituents in the mangrove environments at Akanda (>77.9%), were found to be of minor importance in open coastal settings and generally remained below 20%. The study provided here thus shows, that mangrove communities contain a unique set of species that are distinct from other shallow open coastal foraminiferal biotas of Gabon.

4.5 Conclusions

This study investigated the composition of intertidal benthic foraminiferal communities from the Akanda National Park (Gabon), and represents the first survey of species present in mangrove communities of Gabon. The mangrove biotas are moderate to low diverse and harbor unique assemblages of species that differ from other nearshore coastal environments of Gabon. Two faunal zones were identified and reveal a quantifiable relationship with elevation. The

presence of numerically abundant indicator taxa, the composition assemblages and the trend of species richness indicate the potential of foraminiferal biotas for reconstructions of sea level changes in this region.

Figure 4: Scanning electron micrographs of agglutinate foraminifers from Akanda mangroves, Gabon (scale bar = 100 μm except where otherwise stated).

1-4: *Sorosphaera* sp.

5: *Ammodiscus siliceous* (Terquem)

6: *Scherochorella* sp.

7-9: *Miliammina fusca* (Brady)

10-13: *Miliammina petila* Saunders

14, 15: *Reophax* sp.

16-18: *Ammobaculites pseudospirale* (Williamson)

19, 20: *Ammoastuta salsa* Cushman and Brönnimann

21, 22: *Ammotium* aff. *A. cassis* (Parker)

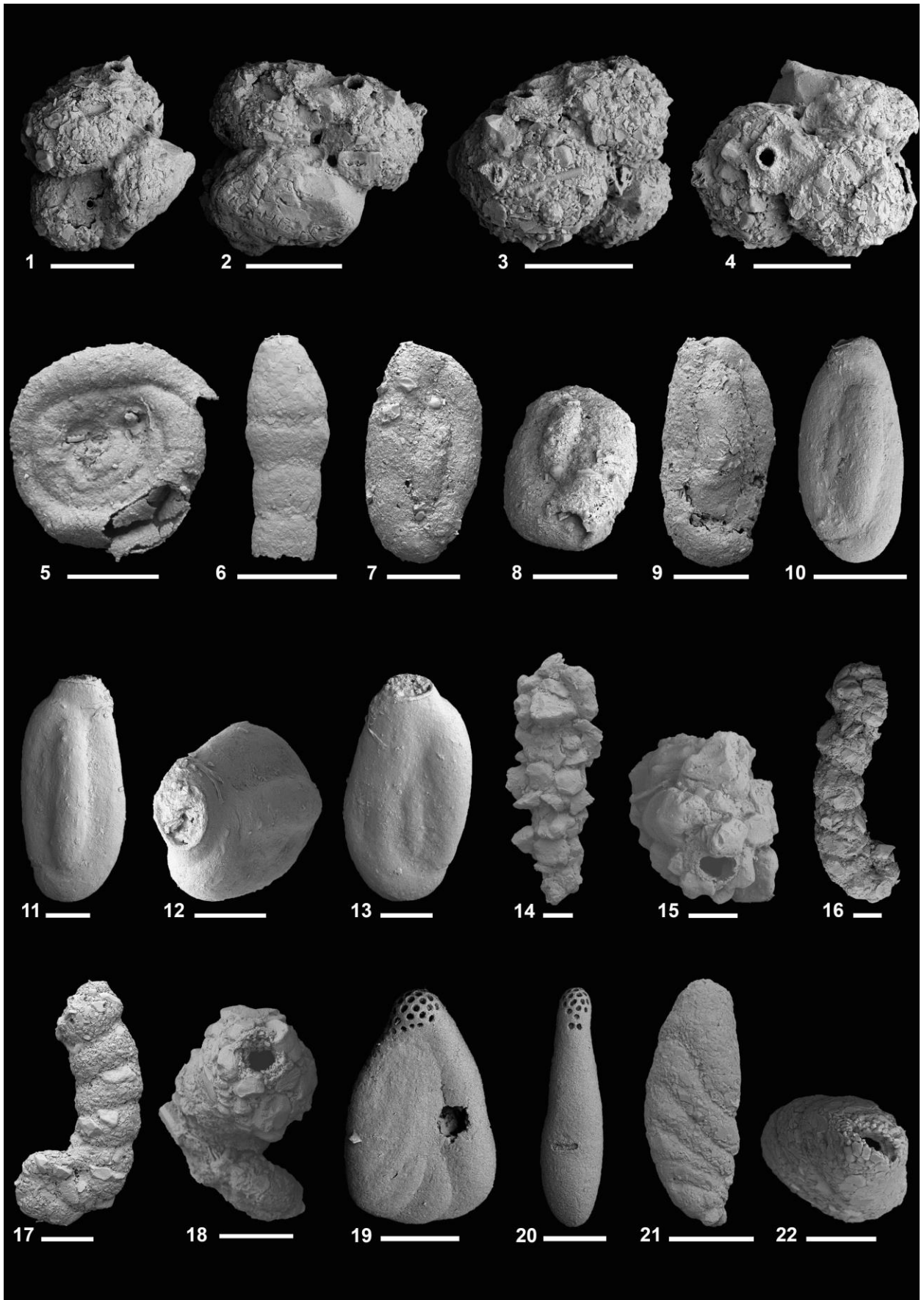


Fig. 4

Figure 5: Scanning electron micrographs of agglutinate and hyaline foraminifers from Akanda mangroves, Gabon (scale bar = 100 μm except where otherwise stated).

1-5: *Ammotium salsum* (Cushman and Brönnimann)

6, 7: aberrant specimens

8-12: *Trochammina inflata* (Montagu)

13-15: *Arenoparella mexicana* (Kornfeld)

16-18: *Textularia porrecta* Brady

19-21: *Textularia* sp.

22-24: *Haplophragmoides wilberti* Andersen.

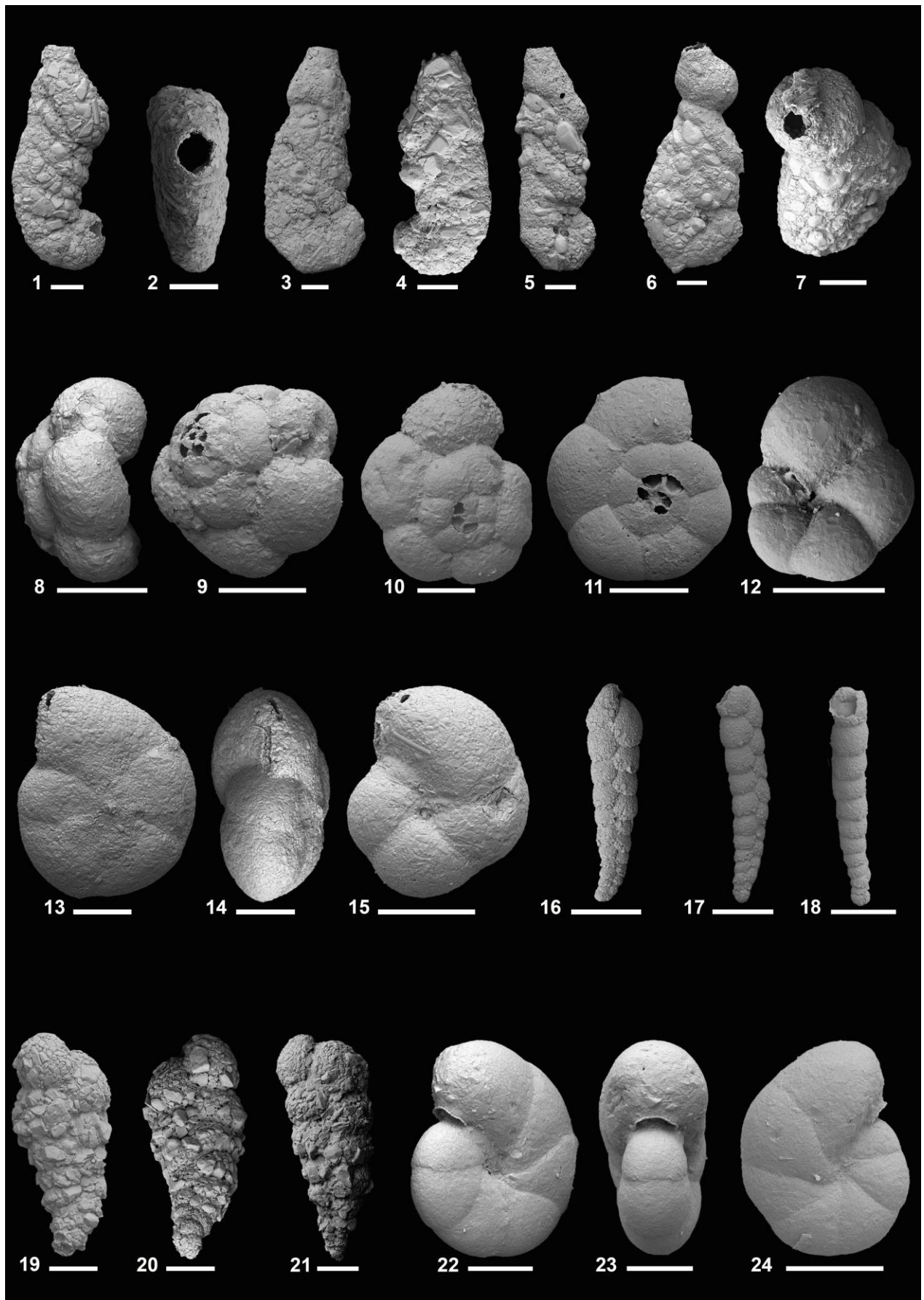


Fig. 5

Figure 6. Scanning electron micrographs of hyaline foraminifers from Akanda mangroves, Gabon (scale bar = 100 μ m except where otherwise stated).

1-5: *Astrononion stelligerum* (d'Orbigny)

6-8: *Ammonia tepida*?

9. *Ammonia* sp. 1

10: *Elphidium* cf. *E. selseyensi* Heron-Allen and Earland

11-20: *Elphidium advenum maorium* Hayward.

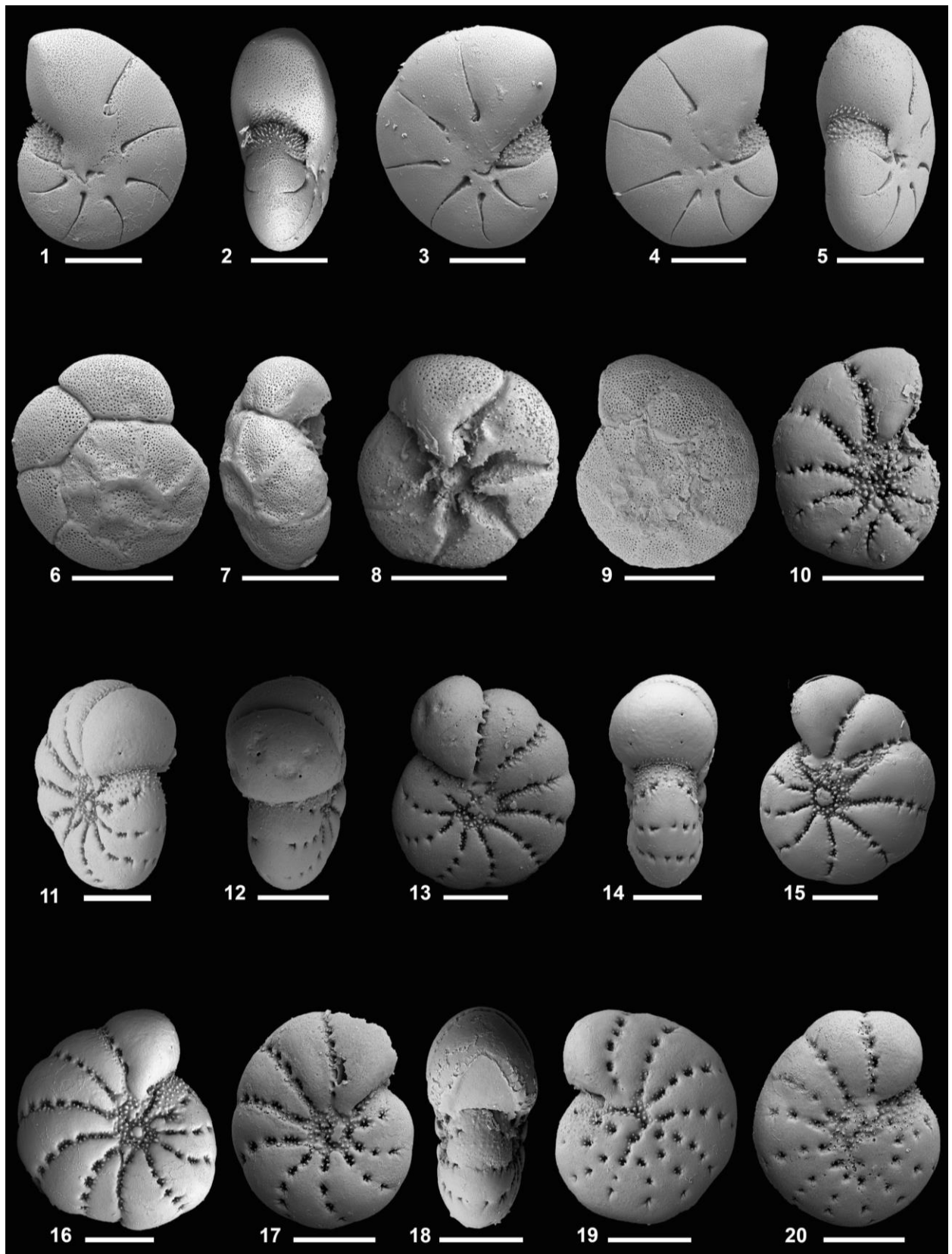


Fig. 6

Chapter 5

Ecosystem Indicators: Foraminifera, Thecamoebians and Diatoms from the Ologe Lagoon, Nigeria

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Abstract

The Ologe Lagoon in southwestern Nigeria is a natural habitat located closely to both residential and industrial estates. The lagoon is heavily affected by effluents of agricultural and industrial runoff including organochlorine compounds and heavy metals (chloropesticides, DDT and polychlorinated biphenyls, cadmium, manganese, zinc, copper, lead, iron and nickel). Ologe Lagoon is situated in a semi-isolated position and its brackish waters traverse several creeks and lagoons before it reaches the Atlantic Ocean. The lagoon experiences minor tidal but noticeable salinity and pH variations during the rainy season. During the dry season, however, the waters have a comparatively long resident time where sediments act as sink and aggregate contaminants over time. Investigations on benthic foraminifera, thecamoebian and diatom species were carried out to document the current status, composition, spatial distribution, and response of microfaunal assemblages to environmental stressors within the lagoon. The benthic foraminifer assemblage is composed of four highly specialized agglutinated species of *Ammotium salsum*, *Miliammina fusca*, *Ammobaculites dilatatus* and *Ammobaculites* aff. *A. exiguus*. They are present at all sample sites with varying abundances. The high abundance of *Ammotium salsum* is considered an indication of environmental stress. Thecamoebian species of *Diffflugia oblonga*, *Diffflugia proteiformis* and *Pontigulasia compressa* were also recorded in varying proportions and generally represent less than one percent of the total foraminifera/thecamoebian assemblage. The presence of marine brackish-water larger siliceous diatoms of *Actinoptychus* and *Campylodiscus* species indicates an interaction between the lagoon and the marine waters although on the minimal scale with regards to actual salinity ranges. The faunal assemblages recovered are characterized by low species richness and alpha diversity indices and are typical of shallow, marginal marine hyposaline environments. Numerical abundances and spatial distribution patterns suggest taxon-specific habitat preferences and highlight their potential for environmental monitoring studies.

5.1 Introduction

Changes in human land use, the runoff of industrial effluents along with a rapid population increase have placed pressure on many coastal and nearshore ecosystems. Biomonitoring activities play a key role in developing our understanding of how human activities and pressures affect marine environments and associated biotas. Because of their widespread distribution, narrow ecological tolerance ranges and high reproductive rates, foraminifera respond fast to environmental changes and have been established as high-resolution proxies for biomonitoring (e.g. Alve, 1995; Murray and Alve, 2002; Frontalini and Coccioni, 2011; Schönfeld et al. 2012). Pollution of nearshore coastal environments in Nigeria has long been subject of environmental concern, jeopardizes biodiversity and poses significant risk to human health and socio-economic development. However, little effort has been made in Nigerian coastal waters to utilize meiofauna components as bioindicators of environmental change. The lack of such baseline data has made it difficult to determine the nature and magnitude of biodiversity changes in response to stressors. Here we provide an initial survey on benthic foraminifera, thecamoebians and diatoms to document the composition, species richness and spatial distribution of microfaunal assemblages and to assess their potential as environmental indicators within the Ologe Lagoon (SW Nigeria).

The Ologe Lagoon is situated in the immediate neighborhood of Lagos, the rapidly growing capital of Nigeria with an estimated population of 16 million inhabitants. The urbanized surroundings of the lagoon are industrialized areas on the southwestern coast. It is a production center for manufacturing ranging from food processing to pharmaceuticals. The partially treated effluents from most of these industries are directly discharged into canals and streams that eventually flow into the lagoon. The fast population growth and urbanization of the Lagos region (United Nations, 2004) modified water usage and drainages within the area. Over the past decades, the anthropogenic impact on the natural habitat of the Ologe Lagoon has increased from both industrial and residential estates (Clarke et al. 2008; Samuel et al. 2015). Ologe Lagoon is well known for fishing activities, but industrial effluents and the accumulation of heavy metals in the water have made the lagoon a sink for pollutants with severe consequences for aquatic food consumption (WHO, 2008; Samuel et al. 2015).

Studies on Nigerian lagoons and creeks date back to the late 50s and have been a continues routine especially in terms of ecological responses and interactions of macro- and micro-faunal assemblages with environmental and hydrodynamic variables (Webb and Hill, 1958; Sandison, 1966; Sandison and Hill, 1966; Adegoke, 1975; Asseez et al. 1974; Clark et al. 2004, 2008; Kumolu-Johnson and Ndimele, 2012). Previous foraminiferal studies were carried out in the

coastal waters and within the neritic environments of southern Nigeria (Fayose, 1970; Adegoke et al. 1976; Dublin-Green, 1994; Olayiwola and Odebode, 2013). However, few of these studies have focused on the interactions between marine and fresh water systems with respect to foraminifera assemblages.

The Ologe Lagoon (Fig. 1) has recently received attention with studies covering pollution, macrobenthos, heavy metal accumulation, sedimentology and general ecology (Clark et al. 2004, 2008; Kumolu-Johnson and Ndimele, 2012; Imoobe, 2008; Samuel et al. 2015). Onuoha et al. (2010) studied phytoplankton diversity within the Ologe Lagoon. They recorded a total of 119 species belonging to five algal groups. Clark et al. (2008) investigated the dynamics of Desmidiacean populations with regards to identification, diversity and the influence of physical and chemical parameters on their temporal abundance and spatial distribution. They identified eight Desmidiacean assemblages.

Several studies have utilized foraminifera and thecamoebians for biomonitoring within aquatic bodies opposite the oceans. They have become a verifiable first-hand tool in ecological management and control studies. Foraminifera and thecamoebians have a documented record as proxies for environmental change (e.g. Saunders, 1958; Bartlett, 1966; Madeira-Falcetta, 1974; Culver, 1990; Scott and Leckie, 1990; Asioli et al. 1996, Debenay et al. 1998, Scott et al. 2001; Duleba and Debenay, 2003; Hallock et al. 2003; Reinhardt et al. 2005; Eichler et al. 2006; Langer and Lipps, 2006; Pereira et al. 2006; Katarina 2007; Qin et al. 2013; Eichler et al. 2015; Fajemila et al. 2015; Delaine et al. 2015; Langer et al. 2016a,b). Their use as bio-indicators in correlation with hydrographic parameters provides important information for the exploration of lagoonal water resources with regards to ecological limits. The study provided here is the first investigation that includes three groups of microorganisms within the Ologe Lagoon (foraminifera, thecamoebians and diatoms), to provide a baseline for future environmental monitoring.

5.2 Materials and Methods

The Ologe Lagoon is a hyposaline, brackish water system connected to the Atlantic Ocean by strings of channels leading to the Lagos harbor (Fig. 1). It is located between latitudes 6° 26'N to 6° 30'N and longitudes 3° 01'E to 3° 07'E. Ologe Lagoon has a total surface area of 9.4km², and is the smallest of nine lagoons that parallel to the Atlantic coast (Webb and Hill, 1958; Sandison, 1966; Sandison and Hill, 1966; Adegoke, 1975). The lagoon is a catchment area of the Owo, Imede, Opunu and Ilo rivers and characterized by shallow depths, mud flats and sand bars. The waters of Ologe Lagoon drain through Elete Creek, through which it

connects to other rivers and lagoons before it reaches Lagos harbor and finally the Atlantic Ocean.

The Ologe Lagoon is separated from the ocean by the Badagry barrier sand and connected to the Lagos harbour through a major tributary running almost parallel to the coast (Fig. 2b). It classifies as a hyposaline choked lagoon, with salinity fluctuations between $0.10 \pm 0.01\text{‰}$ in the raining season and $0.30 \pm 0.041\text{‰}$ in the dry season (Kumolu-Johnson and Ndimele 2012). Therefore, the steady freshwater input from River Owo coupled with stagnation of the lagoon waters keep the lagoon salinity low, irrespective of the season of the year. The relatively long water residence times may lead to eutrophication, accumulation of pollutants, and sediment infilling (Kjerfve, 1994). The lagoon is surrounded by rooted mangrove trees having dense undergrowth of shrubs and grasses and coconut palm trees (*Cocos nucifera*; Fig. 2). At the rear, mangroves form overhangs towards the Lake. The mangrove forests of Nigeria are the largest in Africa and are the third largest in the world (Macintosh and Ashton, 2003). They are dominated by *Rhizophora racemosa* Meyer which forms a significant percentage in the total mangrove cover of southern Nigeria (Savory, 1953).

Sampling was carried out in April 2013 at 7 stations within the study area. Sediments were collected by boat using a Van Veen grab sampler and filling plastic bags with substrata from the top 2cm. All samples were dried, transported to the laboratory and washed over standard sieves for micropaleontological research (Langer et al. 2016b). The locations of individual sampling sites are shown in Fig. 1 and precisely georeferenced via GPS (Table 1). Sediment samples consisted of dark, organic rich mud and fine to coarse-grained siliceous sand containing some fragments of gastropods, bivalves.

Foraminifera, thecamoebians and diatoms were identified to species level wherever possible, documented by SEM microscopy and assembled into a catalogue of taxa (Plates 1, 2). Between 370 and 430 individuals of benthic foraminifera were picked from each sample. For the identification of benthic foraminiferal species and higher orders, our taxonomic and systematic arrangement follows the arrangement of Loeblich and Tappan (1988), Mikhalevich (1983, 2008), Debenay and Basov (1993), Debenay and Redois (1997), Langer et al. (2013, 2016b) and Thissen and Langer (2016). For thecamoebians we followed Scott et al. (2001). Identification of the diatoms is based on Hendeby (1957) and Round et al. (1990).

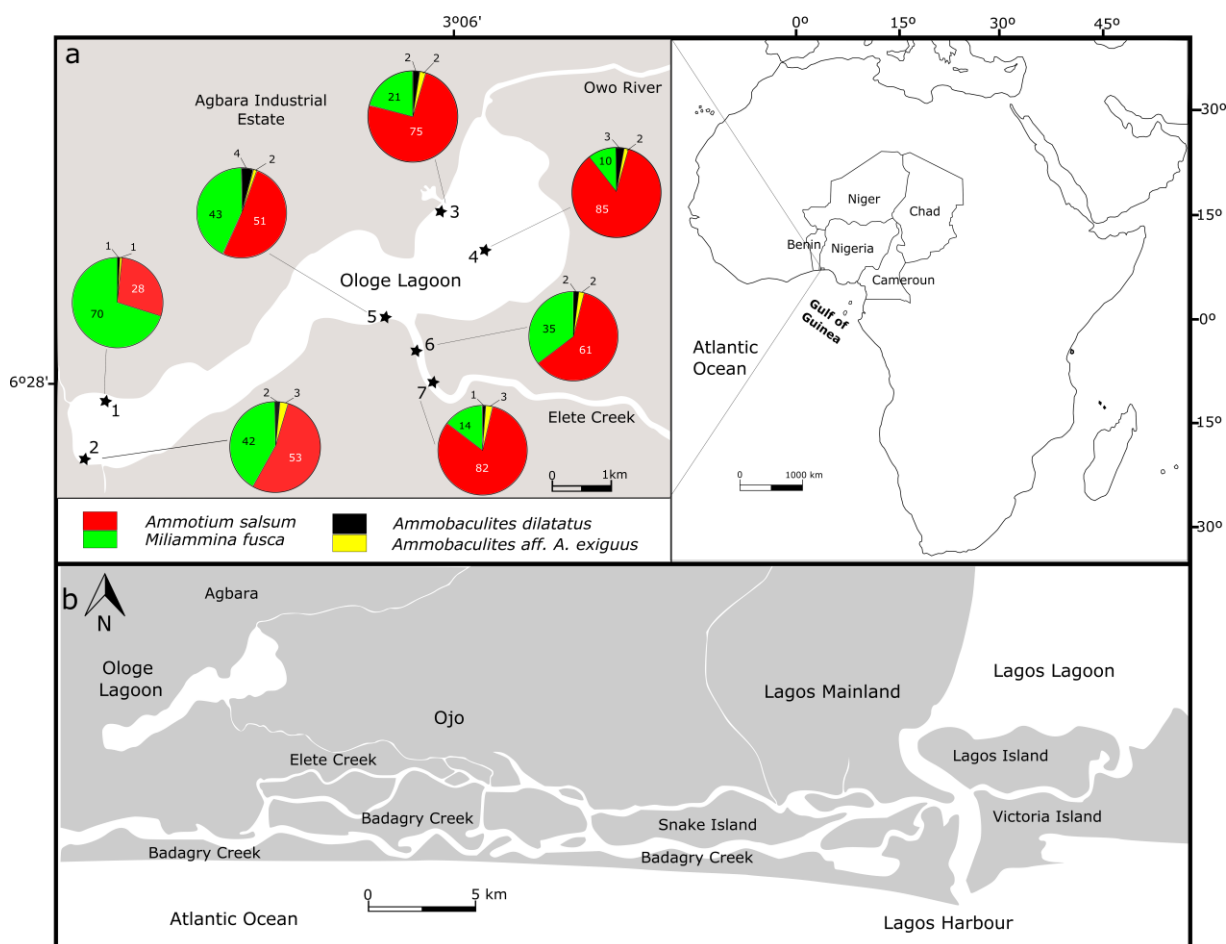


Fig. 1: a.) Location of sampling sites within the Ologe Lagoon. Circle diagrams show percent abundances of individual foraminiferal taxa present in the lagoon. b.) Aerial view of Ologe Lagoon with reference to the Elete and Badagry Creek river systems, Lagos harbor and the Lagos Lagoon.

The compositions and structure of benthic foraminiferal communities from individual sites was examined by analyzing the percent abundances of individual species and diversity indices including Fisher α , Shannon_H, Dominance_D, total species richness and Principal Component Analysis (PCA) using the PAST3 software (Table 2; Hammer et al. 2001). The foraminiferal number (FN) per gram of treated sediment sample was also calculated for all the sites (Schott, 1955; Ingle, 1967; Table 2).

Table 1: Sample site information within Ologe lagoon, southwestern Nigeria.

Site #	Latitudes	Longitudes	DEPTH (m)	Material	Collection date
1	N 06° 26' 44"	E 003° 02' 32"	2.4	organic mud	10/April/2013
2	N 06° 27' 16"	E 003° 02' 47"	2	muddy sand	10/April/2013
3	N 06° 28' 34"	E 003° 06' 14"	2.8	muddy sand	13/April/2013
4	N 06° 28' 59"	E 003° 05' 52"	1.8	organic mud	13/April/2013
5	N 06° 28' 00"	E 003° 05' 11"	7.4	organic mud	12/April/2013
6	N 06° 27' 40"	E 003° 05' 30"	3.8	organic mud	12/April/2013
7	N 06° 27' 24"	E 003° 05' 44"	4.8	muddy sand	12/April/2013

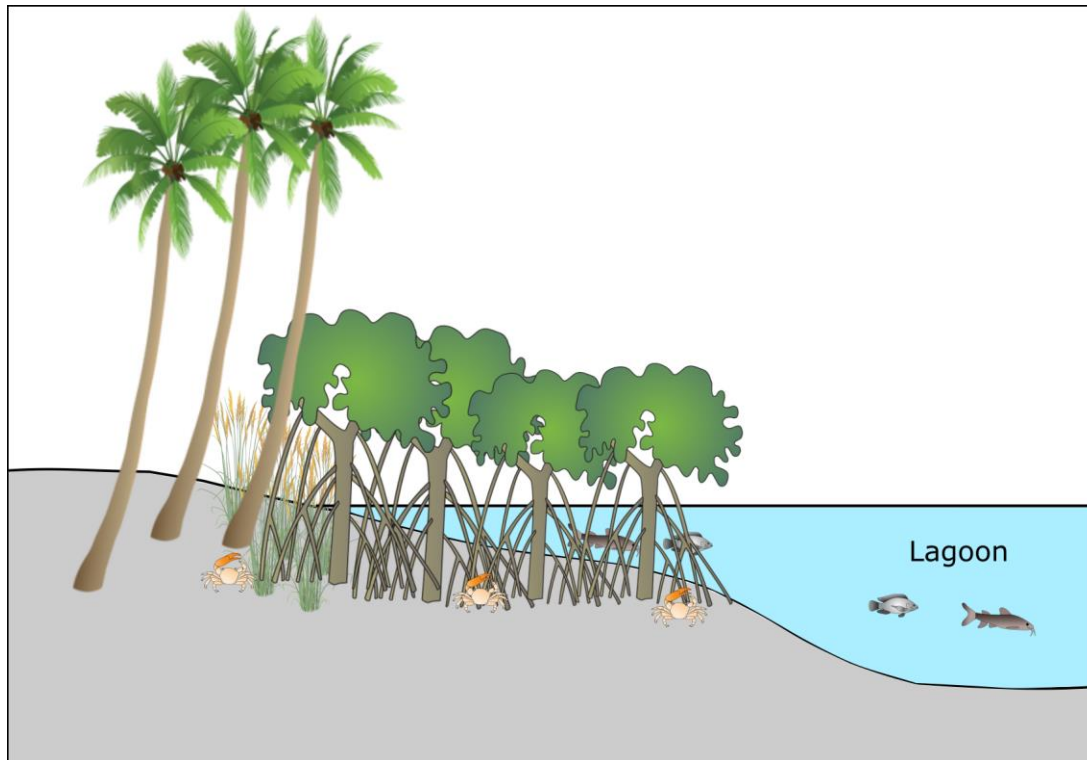


Fig. 2: Schematic diagram of the Lagoon showing mangroves, shrubs and coconut palm trees (images from Tracey Saxby, Kate Moore, Dieter Tracey, Integration and Application Network, University of Maryland Center for Environmental Science (ian.umces.edu/imagelibrary/)).

5.3 Results

A total of 2899 foraminifera were recovered from the sediments collected from the Ologe Lagoon sites. The foraminiferal fauna was found to contain a highly specialized, low-diverse assemblage of agglutinated foraminifera composed of four species only. They include: *Ammobaculites dilatatus*, *Ammobaculites* aff. *A. exiguus*, *Ammotium salsum* and *Miliammina fusca*. The species were present at all the sites but with variable proportions.

Numerical analysis of foraminifera revealed that the highest abundance of foraminifera occurs at Site 3 which is closest to the major tributary (Owo River, Fig. 1a, Table 1). The area around the Owo River mouth is characterized by high percent abundances of *Ammotium salsum*, where it constitutes up to 85% of the total assemblage (site 3 and 4). High numerical values of *Ammotium salsum* were also recorded within Elete Creek, the river that drains the lagoonal waters towards the Lagos Lagoon and finally to the Ocean (site 6 and 7, Fig. 1a, Table 2). All sampling sites with high percentage records of *Ammotium salsum* were found to correlate with low abundances of *Miliammina fusca*. Percent abundances of *Miliammina fusca* were found to be highest at site 1 and 2m where it represents between 41.9 and 70.2%. These sites are located at the southwesternmost end of the lagoon and have the largest distance to the Owo tributary. *Ammobaculites dilatatus* and *Ammobaculites* aff. *A. exiguus*, were found with low percent

abundances and reach maximum values of 4.15% and 2.95, respectively. *Ammobaculites dilatatus* was found to be most frequent near the transition between the Lagoon and Elete Creek (site 5, Fig. 1a, Table 2). Both species of *Ammobaculites* were found to be particularly rare at site 1 where they constitute less than 1% of the total assemblage. The numerical abundance and distribution of individual species within the lagoon and Elete Creek is reflected in the Principal Component Analysis where *Miliammina fusca* and *Ammotium salsum* occur as antagonists (Fig. 3).

Table 2: Numerical analysis of agglutinated foraminifera, thecamoebians and diatoms from Ologe Lagoon, Nigeria. Data include percent abundances of species, diversity and dominance indices and total number of foraminifera, thecamoebians and diatoms for individual samples.

	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7
Foraminifera							
Taxa_S	4	4	4	4	4	4	4
Fisher_alpha	0.6098	0.6267	0.6209	0.6242	0.6093	0.6131	0.6100
Dominance_D	0.5726	0.4630	0.6039	0.7374	0.4510	0.6909	0.4948
Shannon_H	0.6831	0.8704	0.7109	0.5396	0.8972	0.5862	0.8252
<i>Ammobaculites dilatatus</i> %	0.69	1.62	2.31	2.91	4.16	0.96	1.86
<i>A. aff. A. exiguus</i> %	0.93	2.97	2.06	1.58	1.38	2.64	2.09
<i>Ammotium salsum</i> %	28.14	53.51	74.81	85.15	51.16	81.77	60.83
<i>Miliammina fusca</i> %	70.24	41.9	20.82	10.36	43.3	14.63	35.22
Total # (specimens/g sediment)	810.7	1188.4	1394.3	947.4	313.2	725.2	948.5
Thecamoebians							
<i>Diffflugia oblonga</i> %	66.67	9.52	54.76	16.00	41.67	79.81	21.43
<i>Diffflugia proteiformis</i> %	11.11	14.29	14.29	8.00	16.67	3.85	21.43
<i>Pontigulasia compressa</i> %	22.22	76.19	30.95	76.00	41.67	16.35	57.14
Total # of specimens	9	21	42	25	12	104	14
Diatoms							
<i>Actinoptychus senarius</i> (# of Ind.)	32	188	234	11	-	-	16
<i>Campylodiscus echeneis</i> (# of Ind.)	41	45	61	29	-	8	12
<i>Actinoptychus senarius</i> %	44	81	79	28	-	0	57
<i>Campylodiscus echeneis</i> %	56	19	21	72	-	100	43

The standardized total foraminiferal number (FN) per gram of dry sediment (>63 μm) range between 313 and 1394 (site 3, Table 2). It is higher at shallow sites and lowest at the deepest site (site 5). Fisher α diversity indices were low (0.60 and 0.62, Table 2). Shannon (H) values vary between 0.53 and 0.89 and dominance values varied between 0.45 and 0.73. Thecamoebians were found to be less abundant and also occur as low diversity biotas and with variable proportions (Table 2). A total of three species were recovered from all samples: they include *Diffflugia oblonga*, *Diffflugia proteiformis* and *Pontigulasia compressa*. Thecamoebians were found to be most frequent at site 3, 4 and 6 and thus track the abundance record of

Ammotium salsum, which had maximum values near the Owo River tributary and in the Elete Creek. *Diffflugia oblonga* was found to be the most abundant taxon followed by *Pontigulasia compressa*.

The sediment deposits in the lagoon and within Elete Creek were also found to contain significant amounts of diatoms. Similar to foraminifera and thecamoebians, the diatom assemblage is characterized by low-diversity consisting of two species only. They include *Actinoptychus senarius* and *Campylodiscus echeneis*. These are large silicate diatoms that are common taxa of the brackish - freshwater coastal environments, and not restricted to marine environments (Hendey, 1957; Pouličková and Jahn, 2007). *Actinoptychus* and *Campylodiscus* were found to be most abundant at site 3 which is closest to the Owo River. No diatoms or particularly low abundances of both taxa were recorded near the transition between the Lagoon and Elete Creek (site 5, 6, and 7; Fig. 1 and Table 2).

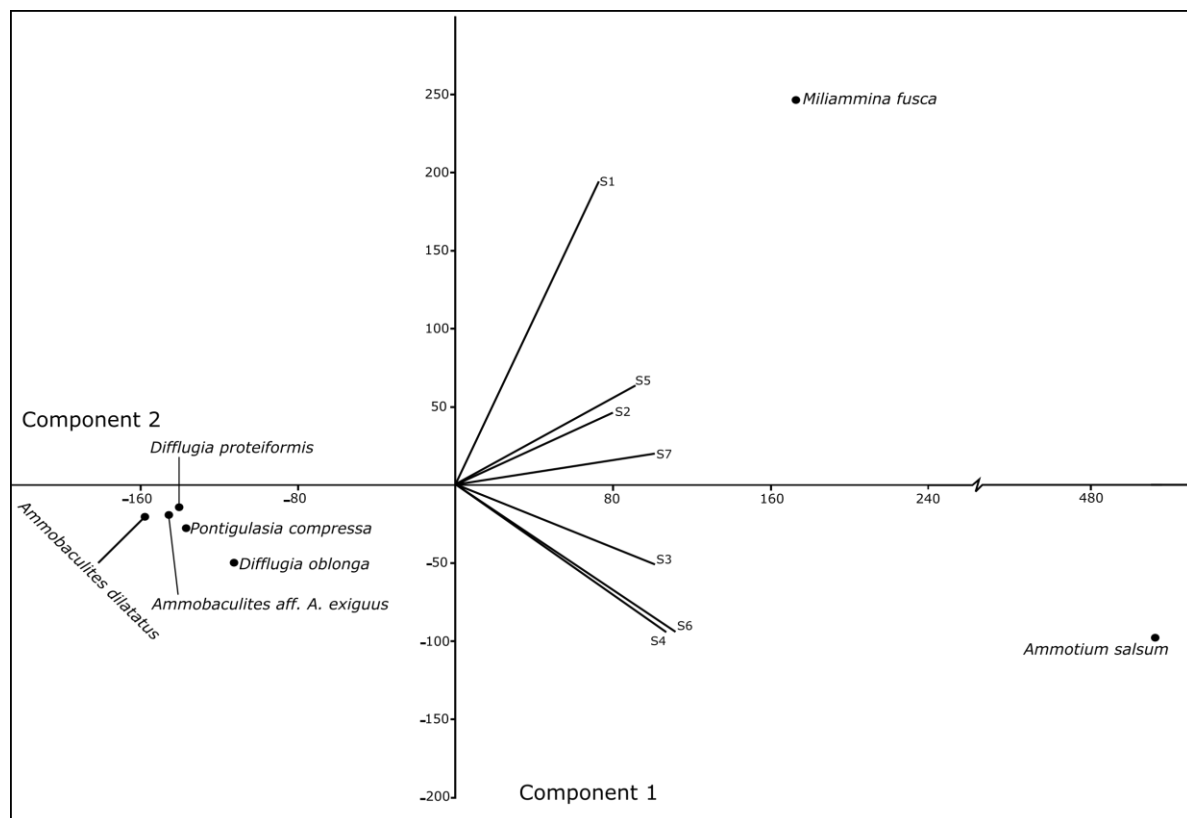


Fig. 3: Principal components 1 and 2 showing the antagonistic distribution and dominance of *Miliammina fusca* and *Ammotium salsum* at all the sample sites. Analysis is based on percent abundances of individual taxa.

5.4 Discussion

5.4.1 Foraminiferal assemblage

The composition, spatial distribution and diversity of foraminifera and thecamoebian assemblages from the Ologe Lagoon were studied to assess their potential as proxies for environmental monitoring. The faunal assemblages were found to be low diverse and are composed of highly specialized taxa. The fauna recovered differs fundamentally from other shallow-water nearshore communities of benthic foraminifera that were reported from coastal environments of Nigeria and Gabon (Adegoke, 1975; Adegoke et al. 1976; Langer et al. 2016a,b). The spatial distribution of selected species display habitat preferences as recorded by their numerical abundance. *Ammotium salsum* was found to be particularly abundant towards the upper sites of the lagoon, where there is greater input of organic carbon and effluents, especially from the Owo River (Fig. 1a, Table 2). It is less prominent at site 1 and 2 where *Miliammina fusca* was recorded with considerably higher percentages. Site 1 and 2 are several kilometers away from the Owo River mouth. In addition, the spatial distribution of *Ammotium salsum* correlates with high concentrations of heavy metals and organic carbon recorded within the lagoon (Clarke et al. 2008; Kumolu-Johnson and Ndimele, 2012; Samuel et al. 2015). This suggests that stress tolerance and threshold limits of *Ammotium salsum* are higher than in all other species of foraminifera present within Ologe Lagoon. Similarly, Debenay (1990) and Debenay et al. (1989) have reported that *Ammotium salsum* is the most resistant species both to contrasting salinities and other anthropogenic factors. In the Casamance upper estuary setting (Senegal), which is subjected to high evaporation during the dry season, *Ammotium salsum* was reported to tolerate extremely high salinity conditions ultimately resulting in a monospecific faunal assemblage. In the Ebrie Lagoon (Ivory Coast), which is virtually isolated from the ocean and characterized by low salinity organic-rich sediments, *Ammotium salsum* was found to be the most common and abundant species (Debenay et al. 1989; Debenay, 1990).

The presence of *Miliammina fusca* is equally important. It trailed behind *Ammotium salsum* in abundance except for the sites that have the largest distance to the Owo River (Fig. 1a, Table 2). *Miliammina fusca* was also reported from the Ogun estuary (Nigeria), occurring together with *Miliammina earlandi* in minimal proportions (Asseez et al. 1974). In the hypersaline Casamance estuary, *Miliammina fusca* disappears in the dry season due to salinity increases leaving the habitat for an *Ammotium salsum*-*Ammonia beccarii* assemblage. The species reappears during the rainy season when salinity becomes lower whereby it replaces *Ammonia beccarii* (Debenay, 1990). This type of high contrast salinity

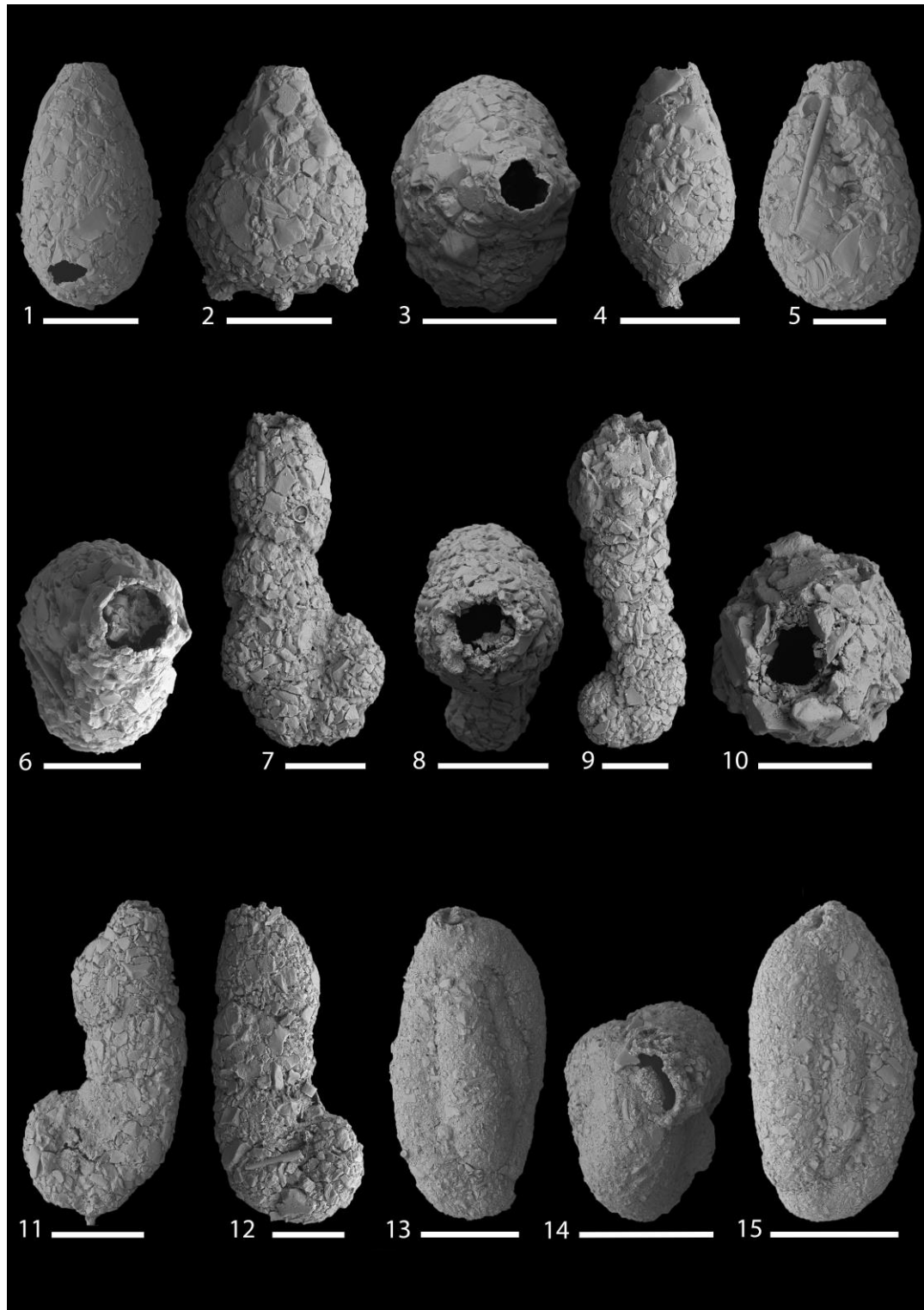


Plate 1: **Thecamoebians (1-6):** 1: *Diffflugia oblonga* Ehrenberg; 2-4: *Diffflugia proteiformis* Lamarck; 5, 6: *Pontigulasia compressa* Carter; **Foraminifera (7-15):** 7, 8: *Ammobaculites dilatatus* Cushman; 9, 10: *Ammobaculites* aff. *A. exiguus* Cushman and Brönnimann; 11, 12: *Ammotium salsum* (Cushman and Brönnimann), 13-15: *Miliammina fusca* (Brady)

changes do not occur within the Ologe Lagoon. Because of their abundance and widespread distribution at all latitudes, *Ammotium salsum* and *Miliammina fusca* were considered as representative species of marshes and other habitats where the influence of fresh water is

significant (Murray, 1971; Asseez et al. 1974; Boltovskoy, 1984; Debenay et al. 2000; Horton et al. 2003). The antagonistic spatial abundance patterns of *Ammotium salsum* and *Miliammina fusca* suggest species-specific tolerance levels to yet to be determined factors of environmental stress. These may concern pollution by heavy metals, organochlorine compounds, or agricultural or industrial runoff that affect the quality of shallow-water ecosystems (e.g. Alve, 1995b; Le Cadre and Debenay, 2006; Armynot du Châtelet et al. 2011). The antagonistic distribution also argues in favor of autochthonous assemblages and may thus retain information regarding the original community structure (Hayward et al. 1999; Langer and Lipps, 2006).

The faunal assemblage within the lagoon show some similarities to other brackish water, upper estuary assemblages where the influence of tides is minimal (Scott et al. 1980; Eichler et al. 2006). The biotas are composed of abundant agglutinated foraminifera characterized low species richness and alpha indices. Low-diversity assemblages of foraminifera are typical of shallow hypohaline, marginal marine environments (Scott and Medioli, 1980; Scott et al. 1980; Debenay, 1990; Debenay and Guillou, 2002; Debenay et al. 2000, 2006; Barbosa et al. 2005; Armynot du Châtelet et al. 2009; Nagy et al. 2011; Leipnitz et al. 2014). For most common species of foraminifera, salinity of about 3 ‰ has been considered as the lower limit of tolerance (Debenay, 1990; Hayward and Hollis, 1994; Scott et al. 2001). This threshold limit explains the low foraminiferal species richness that characterizes Ologe Lagoon. Past foraminiferal studies have indicated that the spatial distribution of foraminifera in hyposaline coastal lagoonal environments is a direct function of the amount of fresh water input, pH, tidal regime, salinity and the availability of calcium carbonate (Debenay, 1990; Debenay and Guilou 2002).

The total number of foraminifera per gram sediment (FN) is fairly similar at the shallowest sample sites (Table 2). Generally, a minimal or insignificant decrease was recorded with increasing water depth. *Ammotium salsum* (Pl. 1, figs. 11-12) and *Miliammina fusca* (Pl. 1, figs. 13-15) are species that are very common in areas of lower than normal salinities (Murray, 1991; Hayward et al. 1999; Debenay et al. 1998; Scott et al. 2001; Eichler et al. 2006). These two species dominate in the Ologe Lagoon, with antagonistic proportions that are more favorable for *Ammotium salsum* towards the industrialized area near the Owo tributary. The lagoonal setting is vividly an *Ammotium – Miliammina* habitat as further substantiated by the PCA (Fig. 3). At the mouth of the tributaries that flow into the Lagos harbor (Fig. 2b), there is an indication of increasing marine influence with the increasing abundances of calcareous species as salinity becomes more favorable (Asseez et al. 1974; Adegoke, 1975; Phillips et al. 2012). Comparable scenarios were observed in different lagoons and estuaries in French Guinea,

along the western coast of Africa, Canada and Brazil (Scott et al. 1980; Debenay, 1990; Debenay et al. 1989, 1997, 2001; Miranda and Kjerfve, 2002; Eichler et al. 2006).

5.4.2 Thecamoebian assemblage

The thecamoebians occur in all the samples in varying proportions. Although their abundances are lower, *Diffflugia proteiformis* (Pl. 1, figs. 1-3), *D. oblonga* (Pl. 1, fig. 4) and *Pontigulasia compressa* (Pl. 1, figs. 5, 6) are characteristics of lower salinities in both temperate mangroves and tropical and subtropical mangroves and also indicative of low oxygen habitats (Scott et al. 1980; Scott and Medioli, 1980; Kliza, 1994; Jennings et al. 1995; Asioli et al. 1996; Patterson et al. 1996; Charman, 2001; Wang and Chappell, 2001; Duleba and Debenay, 2003; Reinhardt et al. 2005; Eichler et al. 2006; Katarina, 2007; Qin et al. 2013). *Diffflugia oblonga*, which is particularly tolerant to environmental stress (Asioli et al. 1996), is present at almost all sample sites. It was recorded with high abundance at Site 6, similar to *Ammotium salsum*. It is assumed that they both share similar environmental parameters at this site. Apparently, the concentration of heavy metals, especially Cu (Samuel et al. 2015), does not restrict their distribution within the Ologe Lagoon.

5.4.3 Diatoms

The lagoon is characterized by the presence of two larger brackish water diatoms *Actinoptychus senarius* (Pl. 2, figs. 1-6) and *Campylodiscus echeneis* (Pl. 2, figs. 7-9). Both are large diatoms which are common in marine and associated environments. More importantly, the availability of silica for the building of their tests in this oligo-saline environment might have encouraged their bloom. Their presence confirms a considerable interaction between the lagoon water and the highly saline marine water from the Atlantic Ocean although on the minimal scale with regards to actual salinity ranges. The nature and duration of such interaction will be of high priority in further studies. These indicator species have been recorded world-wide from coastal and lagoonal habitats including shallow mesohaline inland saline lakes in Africa, and importantly in some West African ports (Mills, 1932; Hendey, 1957; Archibald, 1983; Foged, 1984; Gasse, 1986; Krammer and Lange-Bertalot, 1988; Round et al. 1990; Flower, 1993; Carvalho et al. 1995; Clarke et al. 2004; Pouličková and Jahn, 2007).

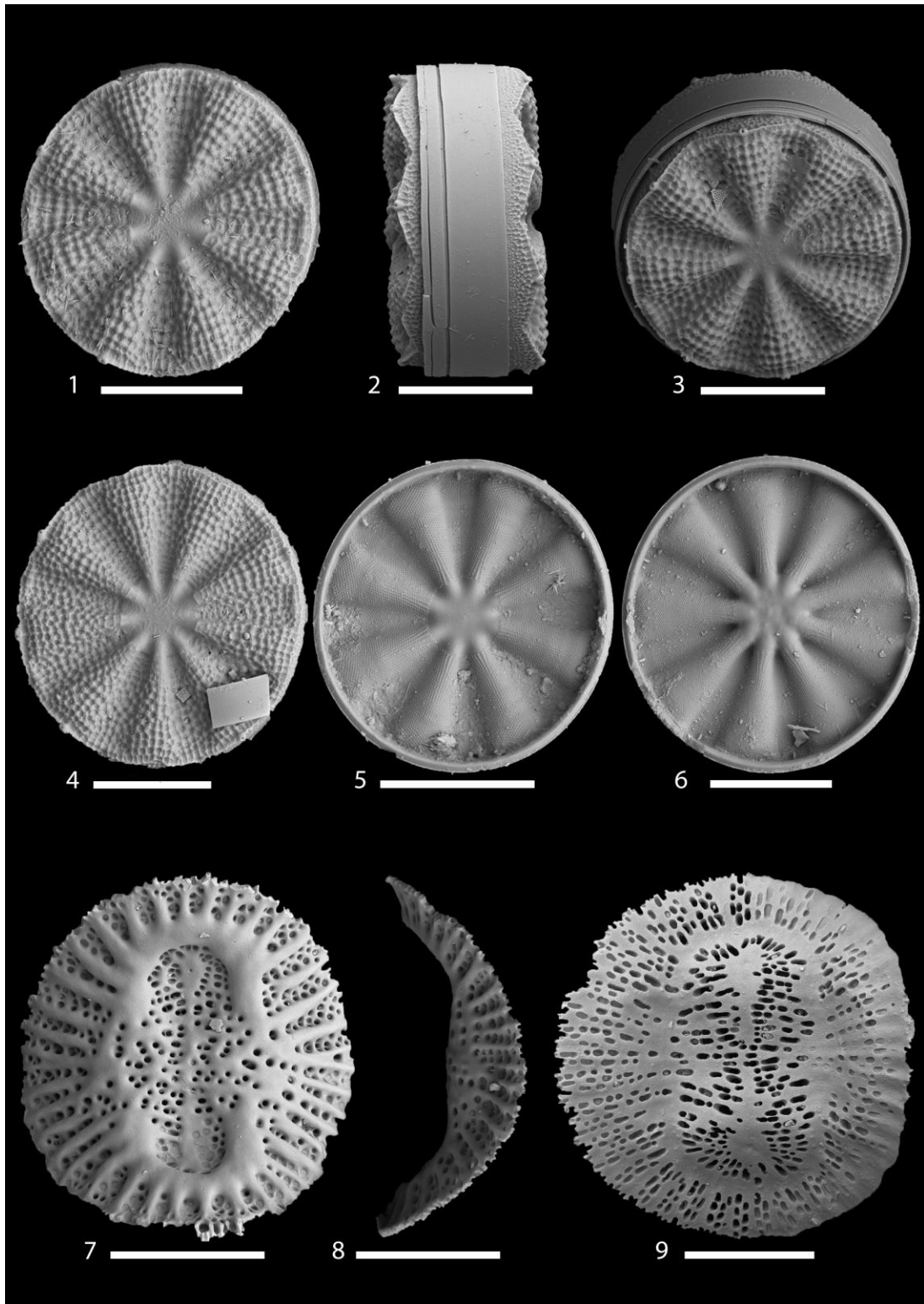


Plate 2: 1-6: *Actinoptychus senarius* Ehrenberg; 7-9: *Campylodiscus echeneis* Ehrenberg.

5.5 Conclusions

Ologe Lagoon is currently undergoing rising anthropogenic threats. This study examined the composition, species richness and spatial distribution of foraminifera, thecamoebian and diatom assemblages indicating the current situation of the lagoon. The lagoonal biotas are low

diverse and harbor unique assemblages of species that differ from other nearshore coastal environments in this region. Quantitative analyses of total faunas show the presence of distinctive species associations. Habitat preferences are indicated for selected species as documented by numerical abundance records, spatial distribution patterns and principal component analysis. The resulting patterns of distribution are interpreted to be a function of differential susceptibility and individual tolerance levels and highlight the potential of meiofauna studies as tool for environmental biomonitoring.

Chapter 6

Shallow-water benthic Foraminifera from the Island of Moorea (Society Islands, French Polynesia)

Olugbenga T. Fajemila, Martin R. Langer (In prep.)

Abstract

Three hundred and sixty-four species of shallow-water benthic foraminifera were documented from the reef-lagoon settings of Moorea, French Polynesia. These settings include inner-bays, fringing reefs, lagoon, coastal mangrove, and back- and fore-reefs. The number of taxa differs from one habitat to another with the fringing reefs recording the highest of 250 species. The fringing reef habitat is characterized by the presence of larger foraminifera including *Borelis schlumbergeri*, *Amphistegina lessonii*, *Peneroplis pertusus* and *Heterostegina depressa*. It is further characterized by abundant smaller miliolids with *Quinqueloculina* species accounting for about 19%. The mangrove habitat recorded 41 species which are not a natural assemblage because of the introduced nature of the mangroves. The fore-reef, back-reef and the lagoon habitats yielded 175, 135 and 100 benthic foraminifera species respectively. Generally, the symbiont-bearing benthics are very common and abundant within the reefal environment. *Amphistegina lessonii* is the most abundant making more than 50% at all the reefal sites. The inner-bay environments host more of the opportunistic taxa as result of nutrient dumping from rivers flowing into the bays. Species of *Ammonia*, *Bolivina*, *Elphidium*, *Nonionoides* and *Quinqueloculina* are very prominent in this habitat. The foraminifera species were systematically described and presented in 39 Plates of Scanning Electron Microscopy images. This is the first complete survey and documentation benthic reef foraminifera from Moorea, Society Islands.

6.1 Introduction

Moorea (134 km² in area) is a perfect environment for coral health and reef management studies (e.g. Endean and Cameron 1990; Jokiel and Coles 1990; Cameron et al. 1991; Done et al. 1991; Gleason 1993, 1996; Harmelin-Vivien 1994; Hoegh-Guldberg and Salvat 1995; Adjeroud 1997; Hodgson 1999; Bessat and Buigues 2001; Adjeroud et al. 2002; Adjeroud et al. 2007 a, b; Penin et al. 2007; Juhasz 2010). Most of these studies are usually concerned with habitat assessment and monitoring with respect to climatic and anthropogenic influences on corals. The island has a standing history of Coral health studies by the presence of the French

(CRIOBE - *Centre de Recherches Insulaires et Observatoire de l'Environnement*) and American (Gump) marine stations which have been a point of visit to many researchers over the years.

6.1.1 Oceanography

French Polynesia is situated within the western flank of the oligotrophic Southeast Pacific Ocean gyre that has its center in the Easter Island zone. This is the Earth's largest system of ocean gyre. It is mostly inactive and contains little marine life (D'Hondt et al. 2009; Fischer et al. 2009). This ocean current is bounded at the north by the equatorial zone (Fig. 1). Movement of surface water masses inside the gyre is anti-clockwise and directly sustained by the trade wind stress (Levitus, 1982). The temperature and salinity of the waters around the French Polynesia is maintained by the Equatorial Counter Current (ECC) which runs along the South Pacific Convergence Zone (SPCZ) and brings warm, low-salinity waters originating from the Solomon Sea axis toward French Polynesia. This may decrease surface salinity to 35.5 PSU during the peak of the summer rainy season; but generally along the Tropic of Capricorn, seawater temperature is around 21°C in winter, largely above the 18°C lower lethal limit for tropical reef-building corals (Delcroix and Henin, 1991; Rougerie et al. 1997).

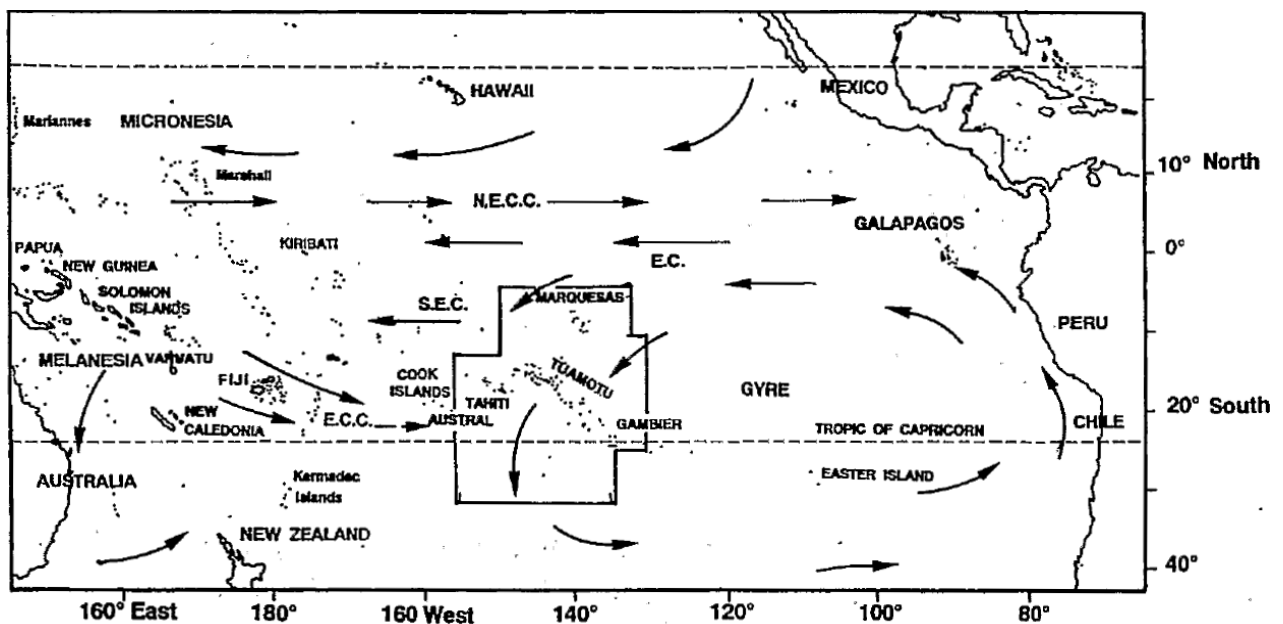


Fig. 1: Map of the Intertropical Pacific. Tahiti (Society Island) is bathed by the oligotrophic oceanic gyre centered in the Easter Island zone. Currents flow westward and counter currents flow eastward. Abbreviations: E.C., Equatorial Current; S.E.C., South Equatorial Current; N.E.C.C., North Equatorial Counter Current; E.C.C., Equatorial Counter Current (after Rougerie et al. 1997)

6.1.2 Biogeographic significance of Moorea

The warm shallow waters of the lagoon-reef settings of Moorea, French Polynesia (Fig. 2; 17°30S, 149°50W) is relatively high in foraminifera diversity (Véneç-Peyré 1991; Langer and

Lipps 2006; Fajemila et al. 2015). The different habitats from the Mangrove to the reef settings harbour significant habitat specific foraminifera assemblages which is invariably a reflection of the ecologic parameters that make up each habitat (Langer and Lipps, 2006; Fajemila et al. 2005). Despite the numerous literatures on tropical benthic foraminifera from the Pacific islands only a few have detailed description of the lagoon-reef settings foraminifera assemblage. The number of available data decreases as you move away from the western Coral Triangle hotspot eastwards. Therefore, the benthic foraminifera record becomes scanty especially towards the Society Islands which are approximately a stepping stone into the low diversity eastern portion of the Pacific. Langer and Hottinger (2000) tried to bridge the gaps in the biogeographic ranges of some selected larger benthic foraminifera but the biogeographic significance of Moorea was left to speculation until it was defined by Fajemila et al. 2015. Makled and Langer (2011) documented 104 species of benthic foraminifera from the shallow-water lagoonal sediments of the Caroline Islands (about 2,800km north of the Great Barrier Reef). This is remarkably high with regards to the few numbers of sample materials worked upon.

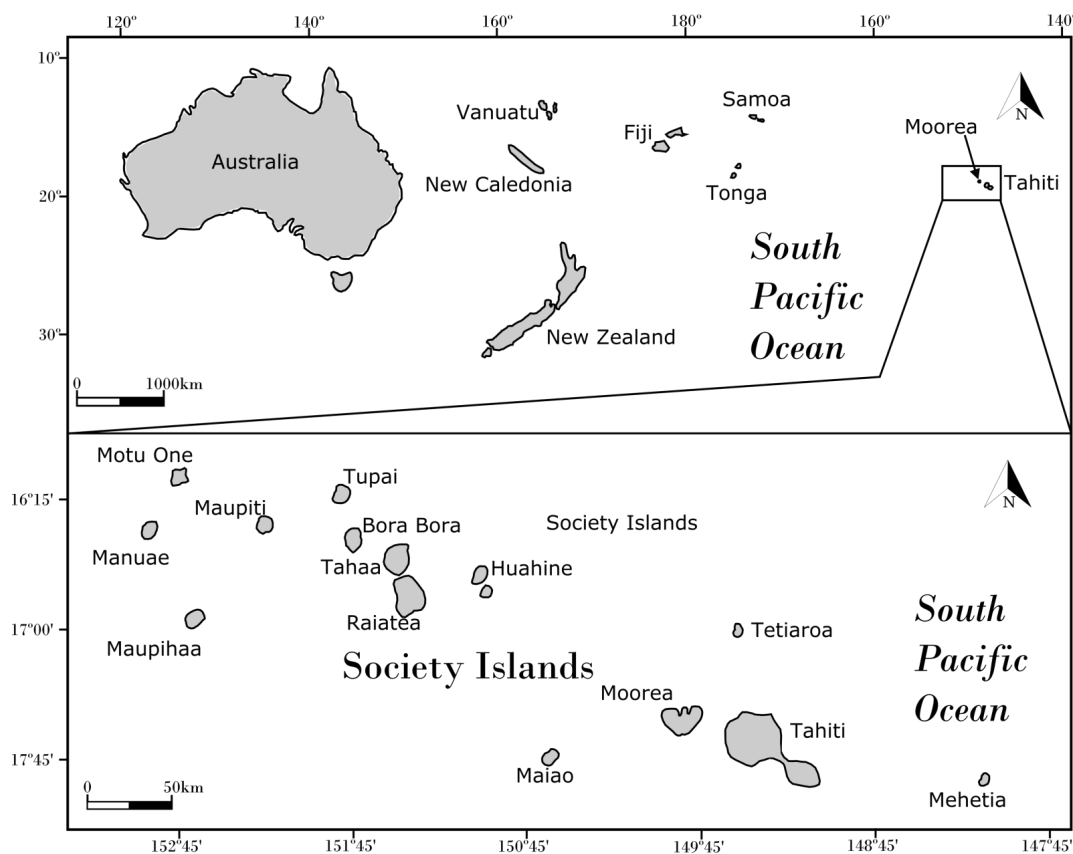


Fig. 2: Moorea, Society Islands (French Polynesia), South Pacific.

Many Pacific islands have seen heavy patronage of ‘foraminiferologists’ (e.g. Haig 1979; 1988a, b; 1993; Langer and Lipps 2003; Renema 2006, 2008; Fujita et al. 2014; Fujita and Omori 2015). Many quantitative data from these regions and a few qualitative descriptions of

the foraminifera species have been carried out especially in the western Pacific Coral Triangle Hotspot (CTH) (e.g. Haig 1988, 1993; Cushman 1921; Graham and Militante 1959; Hofker 1968; Hughes 1977; Langer 1992; Loeblich and Tappan 1994; Langer and Lipps 2003; Debenay 1985, 1988, 2012; Makled and Langer 2011). Vénec-Peyré (1984, 1987, 1988 and 1991) deserves lots of credits in laying down the early foundations in studies of foraminifera around Moorea and the Society Islands. By 1985, she had documented more than 180 species from the French Polynesia in general. The large-scale survey of Fajemila et al. (2015) further examined the diversity of benthic foraminifera and how ocean-lagoon systems interaction has affected their distribution with respect to ecologic, then anthropogenic considerations. Moorea, which is a strong link between the high diversity region of the western Pacific Coral Triangle hotspot and the less diverse eastern Pacific, is of higher interest considering its position on the diversity gradient and the understanding of the distribution of foraminifera species at large (Langer and Lipps 2003; Fajemila et al. 2015). The data generated helps in removing the eastern limits towards arriving at a more wholistic and refined biogeographic map of symbiont-bearing benthic species as was achieved by Langer and Hottinger (2000) and Lobegeier (2002).

Many published works were used for comparison with foraminifera from Moorea. These include Papua New Guinea (Haig 1979, 1988a, 1988b, 1993; Langer and Lipps 2003), Philippines (Cushman 1921; Graham and Militante 1959), Samoa (Cushman, 1924), Marshall Islands (Cushman et al. 1954; Todd 1960), Mariana Islands (Todd 1960, Matsumaru and Matsuo 1976), Jakarta (Hofker 1968), Solomon Islands (Hughes 1977), New Caledonia (Debenay 1985, 1988, 2012), Banda Arc Region (von Marle 1989), Moorea (Venec-Peyré 1985, 1991) Ryukyu Islands (Hatta and Ujie 1992), Timor Sea (Loeblich and Tappan 1994), Caroline Islands (Makled and Langer 2011), Raja Ampat, Papua (Förderer and Langer 2016). This is the first Atlas of reef foraminifera from the French Polynesia.

6.2 Materials and Methods

Forty-five surface sediment samples were selected within the reefal, lagoonal and mangrove settings of Moorea in October and November of 1992. This comprises the bays, lagoons, and back- and fore-reef habitats. Samples were collected by filling plastic bags (20x40 cm) with substrata from the top 2cm while Scuba diving and snorkeling. The sampling sites cover a depths range from 0-40m and are widely distributed around the Island (Fig. 3; Table 1.). All samples were washed over 63µm mesh sieves and dried at 50°C.

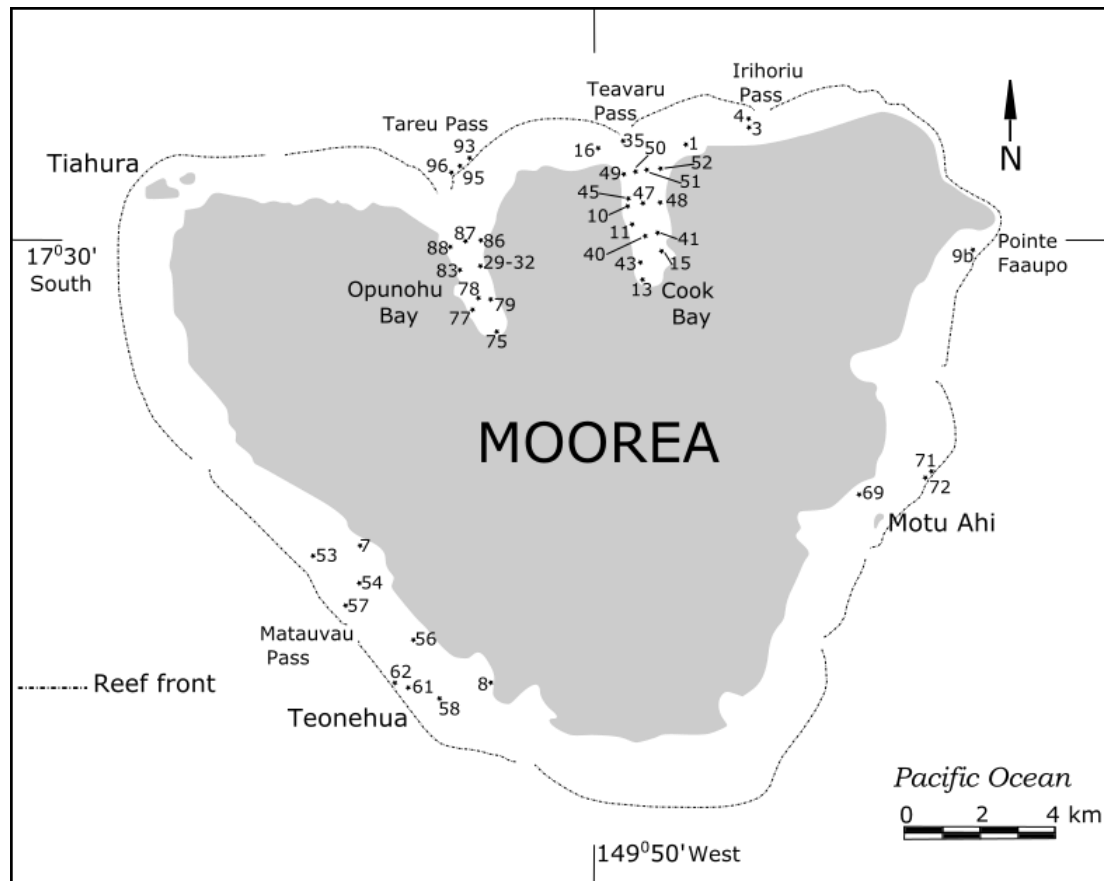


Fig. 3: Moorea with sample sites.

Foraminifera were picked from each sample and individuals of each species were counted. More than 17000 individuals were picked and identified to species level when possible; individuals in each species were also counted. Images of representative species were taken by Scanning Electron Microscope (SEM) and arranged into 39 plates using the Adobe Photoshop CS6. For supraspecific identification we follow Loeblich and Tappan (1987) and modifications proposed by Hottinger et al. (1993). For species identifications, we have applied the concepts of the nearest complete faunal studies from the Sahul Shelf (Loeblich and Tappan 1994), off Malaysia west of New Guinea (Millett 1898-1904), the Great Barrier Reef (Baccaert 1987), Madang Lagoon and Chuuk Atoll (Langer and Lipps, 2003; Makled and Langer, 2011), New Caledonia (Debenay 2012), and Ningaloo (Reef Parker 2009). Each foraminifera species is described and the corresponding synonyms were duly cited within the systematic section. Moreover, the arrangement of the foraminifera species within each plate presented strictly follows the order depicted by Loeblich and Tappan (1987, 1994), Makled and Langer (2011) and Langer et al. (2013). The elements of the structural presentation in terms of diversity and distribution of the various foraminifera species and genera have already been presented and discussed in Fajemila et al. (2015).

Table 1: Sample sites information

Sample No	Location		Depth (m)	Collection date
	Latitude	Longitude		
Lagoon				
M1	17° 28' 53.96" S	149° 48' 55.67" W	8 – 10	October 1992
M3	17° 28' 36.49" S	149° 47' 59.91" W	1.5	October 1992
M4	17° 28' 31.02" S	149° 48' 00.02" W	1	October 1992
M51	17° 29' 01.85" S	149° 49' 16.53" W	20	October 1992
Back-reef				
M16	17° 28' 57.96" S	149° 49' 54.73" W	3	October 1992
M35	17° 28' 58.07" S	149° 49' 26.67" W	2.5	October 1992
M53	17° 33' 24.12" S	149° 53' 11.43" W	1-1.4	October 1992
M54	17° 33' 47.14" S	149° 52' 41.24" W	1.4	October 1992
M58	17° 35' 15.52" S	149° 51' 42.40" W	1.4	October 1992
Fore-reef				
M9b	17° 30' 10.14" S	149° 45' 40.19" W	20	October 1992
M61	17° 35' 10.39" S	149° 52' 01.11" W	20-25	October 1992
M62	17° 35' 04.42" S	149° 52' 11.39" W	20-25	October 1992
M71	17° 32' 25.53" S	149° 45' 50.31" W	20	October 1992
M72	17° 32' 33.89" S	149° 45' 59.66" W	20	October 1992
M93	17° 28' 49.43" S	149° 51' 08.23" W	12	October 1992
M95	17° 29' 03.78" S	149° 51' 26.33" W	22	October 1992
M96	17° 29' 05.72" S	149° 51' 28.35" W	20	October 1992
Mangrove				
M7	17° 33' 21.26" S	149° 52' 39.47" W	0-0.5	October 1992
M8	17° 33' 02.70" S	149° 51' 08.71" W	0-0.5	October 1992
Bay inlets				
M13	17° 30' 21.29" S	149° 49' 19.95" W	1.5	October 1992
M15	17° 30' 04.87" S	149° 49' 04.03" W	3	October 1992
M40	17° 29' 59.57" S	149° 49' 15.90" W	10	October 1992
M41	17° 29' 57.90" S	149° 49' 08.45" W	10 – 15	October 1992
M43	17° 30' 15.68" S	149° 49' 23.40" W	6	October 1992
M47	17° 29' 26.54" S	149° 49' 17.87" W	15 – 20	October 1992
M50	17° 29' 10.35" S	149° 49' 26.16" W	20 – 25	October 1992
M56	17° 34' 19.16" S	149° 52' 01.39" W	3.6	October 1992
M75	17° 30' 01.20" S	149° 51' 04.32" W	1.4	October 1992
M77	17° 30' 42.00" S	149° 51' 20.43" W	20	October 1992
M78	17° 30' 33.77" S	149° 51' 17.32" W	24.5	October 1992
M79	17° 30' 34.84" S	149° 51' 07.45" W	20	October 1992
M83	17° 30' 22.85" S	149° 51' 27.00" W	14	October 1992
Fringing-reef				
M10	17° 29' 43.24" S	149° 49' 28.84" W	0.5	October 1992
M11	17° 29' 55.20" S	149° 49' 24.34" W	2 - 2.5	October 1992
M31	17° 30' 15.69" S	149° 51' 12.83" W	1.4	October 1992
M32	17° 30' 15.69" S	149° 51' 12.83" W	1.4	October 1992
M45	17° 29' 29.40" S	149° 49' 31.02" W	0.5-2.5	October 1992
M48	17° 29' 27.46" S	149° 49' 08.07" W	0.5-2.5	October 1992
M49	17° 29' 11.57" S	149° 49' 39.62" W	8 – 10	October 1992
M52	17° 29' 09.77" S	149° 49' 06.10" W	10-15	October 1992
M57	17° 34' 01.56" S	149° 52' 49.55" W	1.3	October 1992
M69	17° 32' 47.19" S	149° 46' 42.45" W	2.5	October 1992
M86	17° 29' 51.61" S	149° 51' 16.16" W	0.5-2.5	October 1992
M87	17° 29' 52.23" S	149° 51' 28.67" W	38	October 1992
M88	17° 29' 55.90" S	149° 51' 43.21" W	0.5-2.5	October 1992

6.3 Results

Forty-five samples from Moorea yielded more than 16000 individuals. Further probe resulted in a total of 364 species (see list in Appendix II) and 140 genera of benthic foraminifera. This comprises of 31 agglutinated, 211 porcellaneous and 122 hyaline-perforate species. Nine genera of the larger symbiont-bearing benthic foraminifera were recorded. They are *Amphistegina*, *Heterostegina*, *Sorites*, *Peneroplis*, *Amphisorus*, *Assilina*, *Borelis*, *Parasorites* and *Coscinospira* in order of abundance. They are very prolific within the back-and-fore-reef habitats with declining population towards the bays and nearshore environments where eutrophication is more pronounced. These are calcium carbonate producers and are very essential component of the coral community. This assemblage is similar to those documented in other parts of the Pacific (Hallock 1981 1984, 1999; Langer et al. 1997; Langer and Hottinger 2000, Langer and Lipps 2003, Langer and Lipps 2006, Makled and Langer 2011; Langer et al. 2013, Fujita and Omori 2015). This reduction in the number of species/taxa of the symbiont-bearing larger benthic foraminifera is expected because of the intermediate position of Moorea, east of the high diversity hotspot. Other foraminifera include moderately abundant taxa of *Ammonia*, *Anomalinella*, *Bolivina*, *Bolivinelina*, *Cymbaloporetta*, *Elphidium*, *Elongobula*, *Fursenkoina*, *Hopkinsina*, *Loxostomina*, *Nonionoides*, *Nubeculina*, *Planispirillina*, *Porosonion*, *Pseudoschlumbergerina*, *Quinqueloculina*, *Rosalina*, *Sagrinella*, *Textularia*, *Tremptophalus* and *Triloculina*. These and all other foraminifera species are described in the systematic paleontology section and also figured in the respective plates.

Generally, within the Cook's bay, there is significant domination of the opportunistic taxa which includes *Ammonia*, *Bolivina*, *Elphidium*, *Nonionoides* and smaller miliolids. *Quinqueloculina* spp. accounted for 26% of the total foraminifera assemblage within the inner bay section of the Cook's bay while other non-dominant species accounted for another 27%. The Opunohu Bay is also a reflection of the distribution in Cook's Bay except for *Fursenkoina schreibersiana* which accounted for 3% of the population. The inner bays produced assemblages which are typical of environments with high nutrient supply thereby giving rise to more opportunistic taxa. *Amphistegina lessonii* could only account for about 2% in Opunohu Bay and is very rare in Cook's Bay sites.

The back- and fore-reef habitats show significant increase in the number of the symbiont-bearing foraminifera. *Amphistegina lessonii* dominated the assemblage with more than 50% at most reef sites. Other benthics such as *Eponides repandus*, *Schlumbergerina alveoliniformis* and *Anomalinella rostrata* occurred in higher numbers in association with the symbiont-bearing taxa. *Homotrema rubra* is very common at the back reef sites but decreases

towards the fore-reef sites and totally absent at the inner bays sites. The mangrove sites are dominated by smaller miliolids with many *Quinqueloculina* spp (63%). Moreover, it is a suitable habitat for *Ammonia tepida* which accounted for 18% of the total population. The fringing reef sites house the greatest numbers of foraminifera with more than 250 species. It is influenced by the lagoon as well as the bay sites. These are sites located around the Cook and Opunohu's Bay entrances, adjacent to land. There is abundant smaller miliolids and significant agglutinated taxa. The presence of *Borelis schlumbergeri*, *Peneroplis arietina* and *Heterostegina depressa* were recorded as well as *Textularia* spp. *Amphistegina lessonii* is most abundant species within this habitat.

6.4 Systematic Paleontology

We have identified the benthic foraminifera to species level wherever possible and the detailed descriptions and arrangement of the species strictly follows the order depicted by Loeblich and Tappan (1987, 1994), Makled and Langer (2011) and Langer et al. (2013). For easier morphological comparisons, all the species are illustrated by scanning electron microscopy (SEM) and arranged into 39 plates.

Family **Reophacidae** Cushman, 1910

Genus **Reophax** de Montfort, 1808

Reophax communis Lacroix, 1930

Pl. 1, fig. 1

1930 *Reophax communis* - Lacroix, p. 4; figs 5-7.

1939 *Reophax communis* Lacroix - Cushman and McCulloch, p. 68, pl. 3, fig. 12.

1981 *Reophax communis* Lacroix - McCulloch, p. 8, pl. 1, figs. 14, 21, 24 (not 20, 22, 23)

2012 *Reophax communis* Lacroix - Debenay, p. 90, 255.

Test is small and uniformly increasing in size with chamber addition (7-8); sutures depressed; initial stage is indistinct and probably uniserial; wall roughly agglutinated; aperture terminal with no neck.

Reophax sp. 1

Pl. 1, figs. 2, 3.

Test is small, elongate with no distinct chamber arrangement; wall agglutinated, rough and comprised mostly of flattened arenaceous materials; aperture is terminal and clearly defined by a broad neck.

Family **Lituolidae** de Blainville, 1827

Genus **Ammobaculites** Cushman, 1919

Ammobaculites exiguus Cushman and Brönnimann, 1948

Pl. 1, figs. 4, 5.

1948 *Ammobaculites exiguus* - Cushman and Brönnimann, p. 38; pl. 7, figs 7-8.

1998 *Ammobaculites exiguus* Cushman and Brönnimann - Debenay *et al.*; pl. 1, figs 6, 11.

1999 *Ammobaculites exiguus* Cushman and Brönnimann - Hayward *et al.* p. 85; pl. 1, figs 19-20.

2012 *Ammobaculites exiguus* Cushman and Brönnimann - Debenay p. 74, 256.

Test small, elongate, initial portion planispirally coiled, chamber addition later became rectilinear; wall agglutinated with coarse grains; aperture is terminal and rounded.

Ammobaculites sp. 1

Pl. 1, figs. 6, 7.

Test small and rapidly increased in size with chamber addition; initial stage indistinct; sutures depressed; wall agglutinated, rough and composed of larger arenaceous grains; aperture is terminal and rounded..

Ammobaculites sp. 2

Pl. 1, figs. 8-10.

Test small and uniformly increasing in size with chamber addition; wall agglutinated and rough and composed of larger arenaceous grains; aperture is terminal and shows no distinct apertural neck.

Genus **Ammomarginulina** Wiesner, 1931

Ammomarginulina ensis Wiesner, 1931

Pl. 1, fig. 11.

1931 *Ammomarginulina ensis* - Wiesner, p. 97.

2010 *Ammomarginulina ensis* Wiesner - Hayward *et al.* p. 139, pl. 4, figs. 27, 28.

2012 *Ammomarginulina ensis* Wiesner - Debenay, p. 76, 256.

Test flattened, with a planispiral initial stage, it uncoiled later showing oblique sutures which are not well defined; wall coarsely arenaceous with rough surface; aperture terminal on a distinct neck.

Family **Acupeinidae** Brönnimann and Zaninetti, 1984

Genus **Acupeina** Brönnimann and Zaninetti, 1984

Acupeina triperforata (Millett, 1899a)

Pl. 1, figs. 12, 13.

1899a *Haplophragmium agglutinans* d'Orbigny var. *triperforata* - Millett, p. 358, pl. 5, figs. 2/a, b.

1948 *Haplophragmium salsum* - Cushman and Bronnimann, p. 16, pl. 3, figs. 10-13.

1965 *Lituola salsa* (Cushman and Bronnimann) - Brönnimann and Zaninetti, p. 608, figs. 1-3.

1988 *Acupeina triperforata* (Millett) - Loeblich and Tappan, pl. 71, figs. 5 and 6.

1992 *Acupeina triperforata* (Millett) - Brönnimann *et al.* p. 16, pl. 2, figs. 10, 11.

2012 *Acupeina triperforata* (Millett) - Debenay, p. 74, 257.

Test streptospiral in the initial stage and later uncoiling and rectilinear; gradual increase in size as more chambers are added; wall finely agglutinated with a single layer of thickness; sutures are radial, curved and depressed initially and nearly straight in adult stages; aperture is terminal and multiple, most times with three openings.

Family **Haddoniidae** Saidova, 1981

Genus **Haddonia** Chapman, 1898

Haddonia sp. 1

Pl. 1, figs. 14-16.

1993 *Haddonia* sp. A - Hottinger *et al.* p. 30, pl. 3, figs. 4-12

2011 *Haddonia* sp? Makled and Langer, p. 234, fig. 2/2-7

Test large, relatively coarsely agglutinated; initial chambers indistinct but later additions are uniserially attached; sutures are straight, distinct and depressed; aperture looks rounded and terminal in the adult stage.

Family **Spiroplectamminidae** Cushman, 1927

Genus **Spiroplectinella** Kisel'man, 1972

Spiroplectinella sp. 1

Pl. 1, fig. 17.

Test free, small, coarsely agglutinated with large grains; initial chambers indistinct but later additions are uniserially attached; sutures indistinct; aperture terminal.

Family **Haplophragmoididae** Maync, 1952

Genus **Haplophragmoides** Cushman, 1910

Haplophragmoides sp. 1

Pl. 1, figs. 18, 19.

Test small, planispirally enrolled, involute, compressed and biumbilicate, chambers inflated and margin distinctly lobulate; wall thin, with moderately coarse agglutinate, exterior slightly rough; aperture an elongate low equatorial slit at the base of the apertural face, with a slight lip.

Family **Trochamminidae** Schwager, 1877

Genus **Paratrochammina** Brönnimann, 1979

Paratrochammina cf. P. simplissima (Cushman and McCulloch, 1948)

Pl. 1, figs. 20-24.

1939 *Trochammina pacifica* var. *simplex* - Cushman and McCulloch, p. 104; pl. 11, figs 4/a-c.

1948 *Trochammina pacifica* var. *simplissima* - Cushman and McCulloch, new name, p. 76.

1994 *Paratrochammina simplissima* (Cushman and McCulloch) - Loeblich and Tappan, p. 23, pl. 24, figs. 1-12.

2009 *Paratrochammina simplissima* (Cushman and McCulloch) - Parker, p. 17, figs. 14/a-c.

2012 *Paratrochammina cf. simplissima* (Cushman and McCulloch) - Debenay, p. 87, 258.

Test trochospirally coiled with rounded periphery; 4-5 chambers in the last formed coil; sutures are slightly depressed and distinct; wall agglutinated, mostly with roughly equidimensional smaller grains of arenaceous materials; aperture single, interiomarginal, extending over the margin of the penultimate chamber across the umbilicus.

Paratrochammina sp. 1

Pl. 1, fig. 25.

Test free; chambers are trochospirally coiled with 5 chambers in the last formed coil; sutures are slightly depressed and distinct; wall agglutinated but finely finished. It has the texture of *Paratrochammina simplissima* but more 'rectangularly' built.

Genus **Trochammina** Parker and Jones, 1859

Trochammina inflata (Montagu, 1808)

Pl. 1, figs. 26-28.

1808 *Nautilus inflatus* - Montagu, p. 81; pl. 18, fig. 3.

1859 *Trochammina inflata* (Montagu) - Parker and Jones, p. 347.

1980 *Trochammina inflata* (Montagu) - Scott and Mediolio, p. 44; pl. 3, figs 12-14; pl. 4, figs 1-3.

2002 *Trochammina inflata* (Montagu) - Debenay *et al.*; pl. 1, figs 20, 21.

2009 *Trochammina inflata* (Montagu) - Parker fig 18.

2012 *Trochammina inflata* (Montagu) - Debenay, p. 101, 258.

Test trochospiral, agglutinated, with inflated chambers; sutures radially depressed and distinct; chambers visible on the spiral side; wall smoothly finished; aperture interiomarginal, umbilical-extraumbilical arch with narrow bordering lip.

Subfamily **Rotaliammininae** Saidova, 1981

Genus **Siphotrochammina** Saunders, 1957

Siphotrochammina lobata Saunders, 1957

Pl. 1, figs. 29-35.

1957 *Siphotrochammina lobata* - Saunders, p. 9; pl. 3, figs. 1, 2.

1988 *Siphotrochammina lobata* Saunders - Loeblich and Tappan, p. 124, pl. 193, figs. 1-3.

1992 *Siphotrochammina lobata* Saunders - Brönnimann *et al.* p. 21, pl. 4, figs. 1, 2.

2006 *Siphotrochammina lobata* Saunders - Debenay and Luan, pl. 1, figs. 28, 29.

2012 *Siphotrochammina lobata* Saunders - Debenay, p. 94, 259.

Test free, trochospiral with ovate chambers and rounded periphery, increasing in size away from the initial chambers; sutures depressed, distinct and slightly curved; wall finely agglutinated; aperture is interiomarginal at the end of a siphon-like lobe projecting from the umbilical margin of the chamber.

Family **Verneuilinidae** Cushman, 1911

Genus **Caronia** Brönnimann, Whittaker and Zaninetti, 1992

Caronia exilis (Cushman and Brönnimann, 1948)

Pl. 2, figs. 1-4.

1948 *Gaudryina exilis* - Cushman and Brönnimann, p. 40; pl. 7, figs 15, 16.

1992 *Caronia exilis* (Cushman and Brönnimann) - Brönnimann *et al.* p. 30; pl. 2, figs 1, 2, 5; pl. 17, figs. 1-6.

2002 *Caronia exilis* (Cushman and Brönnimann) - Debenay *et al.*; pl. 1, fig. 7.

2012 *Caronia exilis* (Cushman and Brönnimann) - Debenay, p. 77, 259.

Test coarsely agglutinated with closely packed partially globular chambers; initially triserial, later become biserial with additional chamber growth; sutures depressed and have subhorizontal orientation; aperture interiomarginal elongate arch at the base of the last added chamber.

Family **Prolixoplectidae** Loeblich & Tappan, 1985

Genus **Eggerelloides** Haynes, 1973

Eggerelloides scabrus (Williamson, 1858)

Pl. 2, figs. 5-7.

1858 *Bulimina scabra* - Williamson, p. 65, pl. 5, figs. 136, 137.

1922b *Verneuilina scabra* (Williamson) - Cushman, p. 55

1937 *Eggerella scabra* (Williamson) - Cushman, p. 50, pl. 5, fig. 10

1987 *Eggerelloides scabrus* (Williamson 1858) - Loeblich and Tappan, p. 170, pl. 189, figs. 5-7.

Test subconical, trochospiral, initial stage with 4-5 chambers, later with three chambers per whorl; chamber size gradually increases as they are added; wall agglutinated; aperture semilunate arch in the middle of apertural face, bothered by a rim.

Family **Textulariidae** Ehrenberg, 1838

Genus **Sahulia** Loeblich and Tappan, 1985

Sahulia cf. S. barkeri (Hofker, 1978)

Pl. 2, figs. 8, 9.

1978 *Textularia barkeri* - Hofker, p. 27; pl. 1, fig. 3.

1992a *Sahulia barkeri* (Hofker) - Hatta and Ujié, p. 57, pl. 2, figs. 2/a, c.

1993 *Sahulia barkeri* (Hofker) - Hottinger *et al.* p. 33, pl. 8, figs. 7-11.

1994 *Sahulia barkeri* (Hofker) - Loeblich and Tappan, p. 27, pl. 32, figs. 1-8.

2009 *Sahulia barkeri* (Hofker) - Parker, p. 35, figs. 28/a-d.

2012 *Sahulia barkeri* (Hofker) - Debenay, p. 92, 263.

Test agglutinated, biserial throughout and forming a cone, breadth and length almost equal and almost triangular in lateral view; sutures slightly inclined; aperture a low and nearly straight slit at the center of the partially smooth flattened terminal face.

Sahulia sp. 1

Pl. 2, figs. 10, 11.

Test small, agglutinated, biserial, cone-like, almost as wide as high, subtriangular in lateral view; sutures slightly inclined; apertural face broadly oval; aperture a low and nearly straight slit at the center of the flattened apertural face.

Sahulia sp. 2

Pl. 2, figs. 12, 13.

Test biserial, cone-like, almost two time high as wide, subtriangular in lateral view; sutures slightly inclined; aperture a low and nearly straight slit almost at the center of the smooth flattened terminal face.

Genus **Textularia** DeFrance, 1824

Textularia foliacea Heron-Allen and Earland, 1915

Pl. 2, figs. 14, 15.

1915 *Textularia foliacea* – Heron-Allen and Earland, p. 628, pl. 47, figs. 17-20.

1932 *Textularia foliacea* Heron-Allen and Earland - Cushman, p. 8, pl. 1, figs. 6-10.

1949 *Textularia foliacea* Heron-Allen and Earland - Said, p. 6, pl. 1, fig. 9

1979 *Textularia foliacea* Heron-Allen and Earland - Halicz and Reiss, p. 301, pl. 2, figs. 4-9, 12-13

1992a *Textularia foliacea* Heron-Allen and Earland - Hatta and Ujiie, p. 59, pl. 2, figs. 7a-b

1993 *Textularia foliacea* Heron-Allen and Earland - Hottinger et al. p. 37, pl. 13, figs. 15-18, pl. 14, figs. 1-5

1998 *Textularia foliacea* Heron-Allen and Earland - Haunold and Piller, p. 13, pl. 1, fig. 14

2011 *Textularia foliacea* Heron-Allen and Earland - Makled and Langer, p. 234, fig. 2/17, 18.

2012 *Textularia foliacea* Heron-Allen and Earland - Debenay, p. 97, 264.

Test agglutinated, coarse and heterogeneous, elongate, biserial, narrowly compressed with rounded periphery but broadly triangular in lateral view, gradually increases in size as more chambers are added; sutures depressed and indistinct; aperture a low arch at the base of the last chamber.

Textularia oceanica Heron-Allen and Earland, 1915

Pl. 2, fig. 16.

1932 *Textularia foliacea* Heron-Allen and Earland var. *oceanica* Cushman - Cushman, p. 8, pl. 1, figs. 11-12

1940 *Textularia foliacea* Heron-Allen and Earland var. *oceanica* Cushman - Lalicker and McCulloch, p. 128, pl. 14, fig. 12.

1959 *Textularia foliacea* Heron-Allen and Earland var. *oceanica* Cushman - Graham and Militante, p. 28, pl. 2, fig. 4.

1993 *Textularia foliacea* Heron-Allen and Earland var. *oceanica* Cushman - Hottinger et al, p. 37, pl. 14, figs. 12-16.

1994 *Textularia foliacea* Heron-Allen and Earland var. *oceanica* Cushman - Loeblich and Tappan, pl. 40, 15-17.

Test agglutinated, very coarse and heterogeneous, club shaped, biserial and rapidly increasing in size with additional added chambers; sutures faintly depressed, curved and inclined; aperture a low basal arch at the base of the last chamber.

Textularia candeina d'Orbigny, 1839

Pl. 2, figs. 17-20.

1839a *Textularia candeiana* - d'Orbigny, p. 143, pl. 1, figs. 25-27.

1900a *Textularia sagittula* var. *candeiana* d'Orbigny - Milletti, p. 68-69, pl. 7, fig. 12.

1977 *Textularia candeiana* d'Orbigny - Le Calvez, p. 15-16, pl. 16, figs. 1-3, 25-27.

1994 *Textularia secasensis* Lalicker and McCulloch - Loeblich and Tappan, p. 29, pl. 39, figs. 8-14.

1995 *Textularia candeiana* d'Orbigny - Yassini and Jones, p. 75, figs. 102, 103.

2009 *Textularia candeiana* d'Orbigny - Parker, p. 44, figs. 34/a-f.

2012 *Textularia candeiana* d'Orbigny - Debenay, p. 96, 263.

Test agglutinated, coarsely arenaceous, early portion very narrow and compressed, but later chambers enlarging rapidly and get more inflated at much later chamber additions. Sutures are fairly distinct and depressed. The aperture is a very broad, very low arch at base of final chamber, bordered by a narrow lip on the upper margin.

Textularia agglutinans d'Orbigny, 1839

Pl. 2, figs. 21-26.

1839a *Textularia agglutinans* - d'Orbigny, p. 144; pl. 1, figs 17-18, 32-34.

1884 *Textularia agglutinans* d'Orbigny - Brady, pl. 363, figs. 1, 2.

1899b *Textularia agglutinans* d'Orbigny - Millet, p. 562.

1915 *Textularia agglutinans* d'Orbigny - Heron-Allen and Earland, p. 626.

1949 *Textularia agglutinans* d'Orbigny - Said, p. 5, pl. 1, fig. 3.

1977a *Textularia agglutinans* d'Orbigny - Le Calvez, p. 13

1991 *Textularia agglutinans* d'Orbigny - Cimerman and Langer, p. 21, pl. 10, figs. 1, 2.

1992 *Textularia agglutinans* d'Orbigny - Hatta and Ujiie, p. 58, pl. 2, figs. 3/a, b

1993 *Textularia agglutinans* d'Orbigny - Hottinger et al. p. 36, pl. 13, figs. 1-9

1994 *Textularia agglutinans* d'Orbigny - Loeblich and Tappan, p. 27, pl. 33, figs. 8-12

1998 *Textularia agglutinans* d'Orbigny - Haunold and Piller, p. 13, pl. 1, fig. 12

2012 *Textularia agglutinans* d'Orbigny - Debenay, p. 95, 263.

2013a *Textularia agglutinans* d'Orbigny - Langer *et al.* fig. 4/8.

Test coarsely agglutinated, elongate, gradually increasing increasing in width and height toward the apertural end rather uniformly, inflated chambers in the later stages, distinct depressed sutures and rounded periphery. In terminal view this it is sub-circular to circular in shape. Aperture an elongate slit in a well-marked depression of the inner margin of the last-formed chamber

Textularia sp. 1

Pl. 2, fig. 27.

Test, elongate, gradually but slowly increasing increasing in width and height, wall coarsely agglutinated; chambers do not appear inflated in any stage, distinct depressed sutures and rounded periphery.

Textularia sp. 2

Pl. 2, figs. 28-30.

Test coarsely agglutinated, elongate, largely heterogeneous arenaceous grain-sizes, gradually increasing increasing in width and height but become larger toward the apertural end, distinct depressed sutures and rounded periphery; aperture an elongate low arch basal slit in last-formed chamber

Textularia sp. 3

Pl. 2, figs. 31-34.

Test coarsely agglutinated, heterogeneous arenaceous grains, rapid increase in width toward the apertural end; inflated last chambers in the later stages, sutures indistinct and rounded periphery; apertural view sub-rounded to rounded in shape; aperture an elongate, slightly curved slit in a well-marked depression of the inner margin of the last-formed chamber.

Textularia sp. 4

Pl. 3, figs. 1-3.

Test agglutinated, long and narrow, gradually increasing in width as more chambers are added; sutures are faintly distinct and curved but nearly horizontal towards the periphery; aperture a short slip in a well-marked depression of the inner margin of the last-formed chamber.

Textularia sp. 5

Pl. 3, figs. 4-7.

Test agglutinated, distinct larger arenaceous grains, globular, increasing rapidly toward the apertural end; sutures indistinct. It is rounded in terminal view; aperture a curved slit at the base of the last chamber.

Textularia sp. 6

Pl. 3, figs. 8.

Test coarsely agglutinated, heterogeneous arenaceous grains, gradual increase in width toward the apertural end; chambers somewhat inflated in the later stages; sutures distinct and depressed; aperture an elongate, slightly curved slit on the last-formed chamber.

Genus **Septotextularia** Cheng and Zheng, 1978

Septotextularia rugosa Cheng and Zheng, 1978

Pl. 3, fig. 9.

1884 *Textularia rugosa* (Reuss) - Brady, p. 363, pl. 42, figs. 23, 24

1959 *Gaudryina* (*Siphogaudryina*) *rugulosa* Cushman - Graham and Militante, p. 30, pl. 2, figs. 11/a-b

1985 *Septotextularia rugosa* Cheng and Zheng - Loeblich and Tappan, p. 207, pl. 15, figs. 1-7

1987 *Gaudryina rugulosa* Cushman - Baccaert, p. 32, pl. 11, figs. 2, 3

2009 *Septotextularia rugosa* Cheng and Zheng - Parker, p. 39, figs. 29-31.

2011 *Septotextularia rugosa* Cheng and Zheng - Makled and Langer, p. 234, figs. 2/27-30

2012 *Septotextularia rugosa* Cheng and Zheng - Debenay p. 93, 265.

Test large, up to 2 mm in length, biserial, agglutinated, have thick walls and multiple septulae partitioning the chambers, the lower margin of each chamber deeply incised just anterior to the septa, and with about four backward directed projections on each chamber that overlap the sutures; aperture a low arch at the base of the last chamber.

Family **Pseudogaudryina** Loeblich and Tappan, 1985

Genus **Pseudogaudryina** Cushman, 1936

Pseudogaudryina sp. 1

Pl. 3, figs. 10, 11.

Test agglutinated, medium sized, subpyramidal in shape but triangular in lateral view, flattened apertural view; possesses heterogeneous arenaceous grains; sutures are indistinct; aperture basal slit with indistinct narrow lip.

Family **Valvulinidae** Berthelin, 1880Genus **Clavulina** d'Orbigny, 1826**Clavulina pacifica** Cushman, 1924

Pl. 3, figs. 12-21

1884 *Clavulina angularis* d'Orbigny - Brady, p. 396, pl. 48, figs. 22-241924 *Clavulina pacifica* - Cushman, p. 22, pl. 6, figs. 7-111960 *Clavulina pacifica* Cushman - Barker, pl. 48, figs. 22-241987 *Clavulina pacifica* Cushman - Baccaert, p. 35, pl. 11, figs. 7-81994 *Clavulina pacifica* Cushman - Loeblich and Tappan, pl. 47, figs. 11-152009 *Clavulina pacifica* Cushman - Parker, p. 26, figs. 21, 22.2011 *Clavulina pacifica* Cushman - Makled and Langer, p. 236, fig. 3/7-102012 *Clavulina pacifica* Cushman - Debenay, p. 78, 262.

Test agglutinated, finely arenaceous, elongated, with triserial initial portion becoming uniserial at about one third from the pointed apical end; test triangular in cross section; chambers slightly inflated and strongly curved backwards at each corner; sutures distinct in the triserial portion, depressed in the uniserial part; apertural face slightly convex; aperture central, rounded with a simple toothplate.

Family **Planispirillinidae** Piller, 1978Genus **Conicospirillinoides** Cheng and Zheng, 1978**Conicospirillinoides sp. 1**

Pl. 3, figs. 22-26.

2012 *Conicospirillinoides* sp. 2 - Debenay, p. 192, 283.

Test planoconvex, rounded at the margin, thick, and in much more overlapping whorls on the flattened side that therefore becomes more convex; regular pattern of ornamentation on the flattened side; spines produced on the peripheral margin (unlike *C. semidecoratus*); aperture at the end of the tubular chamber at the periphery.

Conicospirillinoides sp. 2

Pl. 3, figs. 27-29.

2012 *Conicospirillinoides* sp. 1 - Debenay, p. 192, 283.

Test more rounded, thicker, convex, with many overlapping whorls on the flattened side.

Genus **Planispirillina** Bermudéz, 1952**Planispirillina cf. P. tuberculatolimbata** Chapman, 1900

Pl. 3, figs. 30-32.

1900 *Spirilina tuberculato-limbata* - Chapman, p. 11, pl. 1, figs. 8a-c1959 *Spirilina tuberculatolimbata* Chapman - Graham and Militante, p. 103, pl. 16, figs. 4-51992 *Spirilina tuberculatolimbata* Chapman - Hatta and Ujiie, Japan, p. 163, pl. 20, fig. 1/a-c.2009 *Spirilina* cf. *P. tuberculatolimbata* Chapman - Parker, p. 74, fig. 55.

Test shows three to four rows of fine pseudopores in the wall between the raised spiral sutures on the dorsal side and evolute coiling on the ventral side with radially arranged tubercles.

Remarks: Our specimen differs from Chapman's specimen which shows partial involute and randomly arranged tubercles.

Planispirillina sp. 1

Pl. 4, figs. 1, 2.

1994 *Planispirillina spinigera* (Chapman) –Loeblich and Tappan, p. 35, pl. 51, figs. 7-9
 2013a *Planispirillina spinigera* (Chapman) – Langer et al. figs. 4.17-18

Test shows three to four rows of fine pseudopores in the wall between the raised spiral sutures on the dorsal side and involute coiling on the ventral side with randomly arranged tubercles.

Planispirillina sp. 2

Pl. 4, figs. 3-5.

Test is thick with a slightly raised ridge that marks out the suture on the ventral side. The periphery is flattened with roundly acute edges, and slopes gently inward towards the dorsal side. The dorsal view does not show any distinct ornamentation or depression.

Family **Spirillinidae** Reuss and Fritsch, 1861

Genus **Spirillina** Ehrenberg, 1843

Spirillina grosseperforata Zheng, 1979

Pl. 4, figs. 6-9.

1994 *Spirillina grosseperforata* Zheng - Loeblich and Tappan, p. 36, pl. 53, figs. 1-8

2012 *Spirillina grosseperforata* Zheng - Debenay, p. 232, 282, pl. 19

2016 *Spirillina grosseperforata* Zheng - Thiesen and Langer, pl. 11, figs. 4-6.

Test circular in outline with the proloculus at the center. Chambers are added in a planispiral tube coil which enlarges gradually away from the proloculus. Coarsely perforated on the spiral side, roughly ornamented with transverse ridges and not perforated on the umbilical side. Sutures depressed and distinct. Periphery subacute. Aperture at open end of the tube.

Spirillina sp. 1.

Pl. 4, figs. 10-14.

1993 *Spirillina* sp. B - Hottinger *et al.* p. 75, pl. 86

2012 *Spirillina* sp. 3 - Debenay p. 233, 283.

Test circular in outline with the proloculus at the center; chambers are added in a planispiral flattened coil which enlarges gradually away from the proloculus; coarsely and randomly perforated on both spiral and umbilical sides. Sutures depressed and distinct; periphery subacute; aperture at open end of the tube.

Spirillina sp. 2.

Pl. 4, figs. 15-21

1993 *Spirillina* sp. A - Hottinger *et al.* p. 75, pl. 86

Test circular in outline with the proloculus at the center; chambers are added in a planispiral flattened coil which enlarges gradually away from the proloculus; coarsely and randomly perforated on spiral side; perforations are concentrated along the sutures on the umbilical sides; sutures depressed and distinct; periphery subacute; aperture at open end of the tube.

Family **Cornuspiridae** Schultze, 1854

Genus **Cornuspira** Schultze, 1854

Cornuspira planorbis Schultze, 1854

Pl. 4, figs. 22-24.

1854 *Cornuspira planorbis* Schultze, p. 4, pl. 2, fig. 21.

1987 *Cornuspira planorbis* Schultze - Loeblich and Tappan, p. 310, pl. 322, figs 7, 8

1994 *Cornuspira planorbis* Schultze - Loeblich and Tappan, p. 37, pl. 56, figs. 1- 7.

2009 *Cornuspira planorbis* Schultze - Parker, p. 95, figs. 67/a-c

2012 *Cornuspira planorbis* Schultze – Debenay, p. 105, 266.

2013 *Cornuspira planorbis* Schultze - Langer *et al.* p. 161, fig. 4/19

Test circular, large proloculus and simple undivided planispiral, evolute, second chamber; calcareous imperforate wall, aperture at the open end of the tube.

Cornuspira sp. 1

Pl. 4, figs. 25-28.

Test circular, large proloculus and simple divided planispiral, evolute, chambers; calcareous imperforate wall, aperture at the open end of the tube.

Family **Nubeculariidae** Jones, (in Griffith and Henfrey, 1875)

Genus **Nubeculina** Cushman, 1924

Nubeculina advena Cushman, 1924

Pl. 4, figs. 29-31.

1924 *Nubeculina advena* - Cushman, p. 53, pl. 19, figs. 1-41987 *Nubeculina divaricata* Brady var. *advena* Cushman - Baccaert, pl. 13, figs. 6-81988 *Nubeculina advena* Cushman - Haig, p. 228, pl. 3, figs. 5-71994 *Nubeculina advena* Cushman - Loeblich and Tappan, p. 38, pl. 59, figs. 1-122009 *Nubeculina advena* Cushman - Parker, p. 148, figs. 104, 105.2011 *Nubeculina advena* Cushman - Makled and Langer, p. 236, fig. 3/14-192012 *Nubeculina advena* Cushman - Debenay, p. 112, 267.

Test elongate, coarsely agglutinated with porcelaneous cement and a distinct porcelaneous neck; initial stage chambers are hardly visible followed by irregularly arranged chambers with distinct sutures. Aperture is terminal at the end of the neck with an everted peristomal lip and few teeth pointing inwards.

Family **Fischerinidae** Millett, 1898

Genus **Planispirinella** Wiesner, 1931

Planispirinella exigua (Brady, 1879)

Pl. 4, figs. 32-35.

1879 *Hauerina exigua* - Brady, pt. 2, p. 267.1884 *Planispirina exigua* (Brady) - Brady, p. 196, pl. 12, figs. 1-4, text figs. 5, 6.1931 *Planispirinella exigua* (Brady) - Wiesner, p. 69.1958 *Planispirinella exigua* (Brady) - Collins, p. 3741987 *Planispirinella exigua* (Brady) - Baccaert, p. 36, pl. 12, figs. 1-21987 *Planispirinella exigua* (Brady) - Loeblich and Tappan, p. 317, pl. 329, figs. 13-161988 *Planispirinella exigua* (Brady) - Haig, p. 228, pl. 3, figs. 10-12

Test strongly compressed, wall imperforate, smooth; aperture terminal, slit-like, at the end of the final chamber. This is quite different from the small, low aperture of *Planispirinella involuta* Collins 1958.

Planispirinella sp. 1

Pl. 5, figs. 1-3.

Test strongly compressed, flattened with no visible thickness at the center, wall imperforate, smooth; aperture terminal, low, at the end of the final chamber. Circular in outline, with involute chambers. Alar extensions reaching to the center of the test.

Genus **Glomulina** Rhumbler, 1936

Glomulina? sp. 1

Pl. 5, figs. 4, 5.

Test small, free, globular; periphery rounded; wall smooth, imperforate, opaque milky white; chambers consist of a large proloculus with a subsequent chamber forming an arch and tightly embracing; aperture terminal, subsemicircular, low arch opening without a tooth.

Genus **Vertebralina** d'Orbigny, 1826

Vertebralina striata d'Orbigny, 1826

Pl. 5, figs. 6-8.

1826 *Vertebralina striata* - d'Orbigny, p. 2831987 *Vertebralina striata* - d'Orbigny - Baccaert, p. 45, pl. 14, figs. 9-111988 *Vertebralina striata* d'Orbigny - Haig, p. 235, pl. 11, figs. 25, 26

- 1994 *Vertebralina striata* d'Orbigny - Loeblich and Tappan, p. 39, pl. 60, figs. 1-7.
 2009 *Vertebralina striata* d'Orbigny - Parker, p. 379, fig. 274
 2011 *Vertebralina striata* d'Orbigny - Makled and Langer, p. 236, fig. 3/20
 2012 *Vertebralina striata* d'Orbigny - Debenay, p. 139, 267.
 2013 *Vertebralina striata* d'Orbigny - Langer *et al.* p. 161, fig. 4/20.
 2016 *Vertebralina striata* d'Orbigny - Thiesen and Langer, pl. 3, figs. 4, 5.

Test porcelaneous, strongly compressed, rounded periphery. Chamber arrangement slightly trochospiral and involute in initial stages. Surface ornamentation shows longitudinal, diverging and anastomosing costae which could vary in relief from almost smooth to heavily striated. Aperture an elongated, distal, subelliptical, assymetrical slit with a thick peristomal everted lip.

Genus **Wiesnerella** Cushman, 1933

Wiesnerella auriculata (Egger, 1893)

Pl. 5, figs. 9-11.

- 1893 *Planispirina auriculata* - Egger, p. 245, pl. 3, figs. 13-15.
 1987 *Wiesnerella auriculata* (Egger) - Baccaert, p. 41, pl. 13, figs. 3-5
 1988 *Wiesnerella auriculata* (Egger) - Haig, p. 235, pl. 11, figs. 32-33.
 1993 *Wiesnerella auriculata* (Egger) - Hottinger *et al.* p. 43, pl. 24, figs. 1-4.
 1994 *Wiesnerella auriculata* (Egger) - Loeblich and Tappan, p. 39, pl. 62, figs. 1-3
 2009 *Wiesnerella auriculata* (Egger) - Parker, p. 384, fig. 275, 276.
 2011 *Wiesnerella auriculata* (Egger) - Makled and Langer, p. 236, fig. 3/21.
 2012 *Wiesnerella auriculata* (Egger) - Debenay, p. 140, 267.

Test calcareous imperforate, smooth, flattened, ovate in lateral view, quinqueloculine, periphery carinate; nearly planispiral chamber arrangement with two chambers in a coil. Aperture terminal, rounded with a broad peristomal lip, turned towards the less overlapping side of the test.

Family **Nubeculariidae** Jones, (in Griffith and Henfrey, 1875)

Genus **Nodophthalmidium** Macfadyen, 1939

Nodophthalmidium antillarum (Cushman, 1922)

Pl. 5, figs. 12-16.

- 1922 *Articulina antillarum* Cushman, p. 71, pl. 12, fig. 5
 1944 *Nodophthalmidium antillarum* (Cushman) - Cushman and Todd, p. 65, pl. 11, fig. 3.
 1949 *Nodophthalmidium antillarum* (Cushman) - Said, p. 20, pl. 2, fig. 3.
 1993 *Nodophthalmidium antillarum* (Cushman) - Hottinger *et al.* p. 44, pl. 23, figs. 4-7, text fig. 2.
 2011 *Nodophthalmidium antillarum* (Cushman) - Makled and Langer, p. 237, fig. 4/15, 16.

Test calcareous imperforate, proloculus is followed by a tubular planispirally enrolled chamber followed in turn by rectilinearly arranged subcylindrical chambers with flaring distal end. Aperture terminal, rounded with a broad, raised, turned outward lip. Ornamentation several longitudinal thick costae.

Family **Ophthalmidiidae** Wiesner, 1920

Genus **Spirophthalmidium** Cushman, 1927

Spirophthalmidium aff. S. prolixum Loeblich and Tappan, 1994

Pl. 5, figs. 17-19.

- 1988 *Spirophthalmidium* sp. Haig, p. 235, pl. 10, figs. 25-27.
 1994 *Spirophthalmidium prolixum* Loeblich and Tappan, p. 41, pl. 64, figs. 6-8

Test narrow, elongate, slightly flattened, slightly twisted, periphery rounded, chambers broad, tapering toward the aperture, sutures indistinct; wall calcareous, porcelaneous; aperture rounded, produced at the end of a distinct neck.

Spirophthalmidium scabrum Loeblich and Tappan, 1994

Pl. 5, figs. 20-22.

- 1994 *Spirophthalmidium scabrum* Loeblich and Tappan, p. 41, pl. 64, figs. 4, 5.
 2012 *Spirophthalmidium scabrum* Loeblich and Tappan - Debenay, p. 135, 268.

Test small, proloculus followed by flexostyle, and then by planispirally enrolled chambers of a half-coil in length, chambers somewhat overlapping earlier ones, widest at the base, and tapering toward the aperture to about one-third that diameter; wall imperforate, surface appearing warty with numerous tiny projections; aperture rounded, at the end of a produced neck with short bifid tooth.

Spirophthalmidium sp. 1

1988 *Spirophthalmidium* sp. Haig, p. 235, pl. 10, fig. 23.

Test narrow, elongate, flattened, twisted, periphery rounded, chambers broad, tapering toward the aperture, sutures indistinct; wall calcareous, porcellaneous; aperture rounded, produced at the end of a distinct neck with an obvious lip.

Genus **Edentostomina** Collins, 1958

Edentostomina cultrata (Brady, 1881)

Pl. 5, figs. 23-26.

1881 *Miliolina cultrata* - Brady, p. 45

1884 *Miliolina cultrata* Brady - Brady, p. 161, pl. 5, figs. 1, 2

1958 *Edentostomina cultrata* (Brady) - Collins, p. 371.

1959 *Quinqueloculina cultrata* (Brady) - Graham and Militante, p. 44, pl. 5, figs. 8/a-c

1987 *Edentostomina cultrata* (Brady) - Baccaert, p. 39, pl. 12, figs. 3 a-c

1988 *Edentostomina cultrata* (Brady) - Haig, p. 218, pl. 1, figs. 15-17

1994 *Edentostomina cultrata* (Brady) - Loeblich and Tappan, p. 40, pl. 63, figs. 8-12

2012 *Edentostomina cultrata* (Brady) - Debenay, p. 106, 268.

Test compressed, calcareous imperforate, smooth, planispirally enrolled, ovate in outline, with a carinate periphery; chambers narrow and elongate, rapidly enlarging, one-half coil in length, all chambers visible from both sides of the test; aperture terminal, oval, with an everted lip produced on a short thick neck.

Edentostomina sp. 1

Pl. 5, figs. 27, 28.

Test elongate, planispiral, somewhat compressed, calcareous imperforate, smoothly finished; peripheral margin carinate; chambers narrow and elongate, rapidly enlarging, all chambers visible from both sides of the test; aperture terminal, circular, produced with an everted lip on a long narrow neck.

Family **Spiroloculinidae** Wiesner, 1920

Genus **Adelosina** d'Orbigny, 1826

Adelosina laevigata d'Orbigny, 1826

Pl. 5, figs. 29-32.

1826 *Adelosina laevigata* d'Orbigny, p. 303

1846 *Adelosina laevigata* d'Orbigny - d'Orbigny, p. 302, pl. 20, figs. 22-24

1886 *Adelosina laevigata* d'Orbigny - Schlumberger, p. 549, pl. 16, figs. 19-21, text fig. 6.

1987 *Adelosina laevigata* d'Orbigny - Loeblich and Tappan, p. 328, pl. 337, figs. 5-12

1994 *Adelosina laevigata* d'Orbigny - Loeblich and Tappan, p. 41, pl. 64, figs. 9, 10.

Test proloculus followed by planispirally enrolled and involute second chamber with distal end produced in a neck. Wall calcareous imperforate, porcellaneous, smooth, striate or costate. Aperture terminal, rounded produced on a neck with a tooth.

Adelosina sp. 1

Pl. 5, figs. 33-35.

Test planispirally enrolled, proloculus visible; wall calcareous imperforate, porcellaneous, smooth, with few longitudinal striate at the neck and aboral regions of the test; aperture terminal, rounded produced on a neck with a bifid tooth.

Genus **Spiroloculina** d'Orbigny, 1826

Spiroloculina angulata Cushman, 1917

Pl. 6, figs. 1-4.

- 1917 *Spiroloculina grata* Terquem var. *angulata* - Cushman, p. 36, pl. 7, fig. 5
 1944 *Spiroloculina angulata* Cushman - Cushman and Todd, p. 50, pl. 7, figs. 18-22
 1987 *Spiroloculina angulata* Cushman - Haig, p. 234, pl. 10, figs. 1-7
 2011 *Spiroloculina angulata* Cushman - Makled and Langer, p. 236, fig. 3/22-27.
 2012 *Spiroloculina angulata* Cushman - Debenay, p. 132, 268.

Test porcelaneous, biloculine, evolute, with both ends of the chambers projecting; chambers are angular in cross-section, subrectangular in end view and slightly biconcave; chambers distinct, increasing rapidly but rather evenly in size as added; ornamentation composed of longitudinal costae mostly parallel to the periphery; aperture at the end of a cylindrical neck with a thin peristomal lip and a bifid tooth.

Spiroloculina antillarum d'Orbigny, 1839

Pl. 6, figs. 5-8.

- 1839 *Spiroloculina antillarum* d'Orbigny - d'Orbigny, p. 166, pl.v9, figs. 3, 4.
 1944 *Spiroloculina antillarum* d'Orbigny - Cushman and Todd, p. 44, pl. 6, figs. 28-32
 1977 *Spiroloculina antillarum* d'Orbigny - Le Calvez, p. 91
 1986 *Spiroloculina antillarum* d'Orbigny - Debenay, p. 23, pl. 6, fig. 8.
 1993 *Spiroloculina antillarum* d'Orbigny - Hottinger *et al.* p. 45, pl. 24, figs. 15-17; pl. 25, figs. 1, 2.
 2009 *Spiroloculina antillarum* d'Orbigny - Parker, p. 341, figs. 246, 247.
 2011 *Spiroloculina antillarum* d'Orbigny - Parker and Gischler, p. 43, pl. 2, figs. 1, 2.
 2012 *Spiroloculina antillarum* d'Orbigny - Debenay, p. 132, 269.
 2013a *Spiroloculina antillarum* d'Orbigny - Langer *et al.* p. fig. 4/23

Test elongate, porcelaneous, biloculine, ovate to fusiform in lateral view; slightly biconcave, chambers nearly circular in cross section, but with subangular shoulders between the peripheral and lateral walls; sutures distinct, surface ornamented by longitudinal costae, often continuous, extending from the aboral end to the aperture, sometimes anastomosing; aperture circular at the end of a cylindrical neck with a weak peristomal lip and a small distinctly bifid tooth.

Spiroloculina cf. S. caduca Cushman, 1922a

Pl. 6, figs. 9-12.

- 1922a *Spiroloculina caduca* - Cushman, p. 61, pl. 11, figs 3, 4.
 1944 *Spiroloculina caduca* Cushman - Cushman and Todd, p. 46, pl. 7, figs. 1, 2.
 2012 *Spiroloculina caduca* Cushman - Debenay p. 132, 269.

Test longer than broad, porcelaneous, biloculine, evolute, much compressed, periphery keeled, acute; chambers distinct, increasing rapidly in side with new additions; sutures slightly depressed, surface appears smooth but with few irregular, raised costae, more or less oblique in position. Base slightly extended; aperture at the end of a cylindrical neck provided with a simple tooth.

Spiroloculina communis Cushman and Todd, 1944

Pl. 6, figs. 13-16.

- 1944 *Spiroloculina communis* - Cushman and Todd, p. 63, pl. 9, figs. 4-5, 7-8
 1949 *Spiroloculina communis* Cushman and Todd - Said, p. 14, pl. 1, fig. 37
 1988 *Spiroloculina communis* Cushman and Todd - Zheng, p. 237, pl. 2, figs. 15, 16; text-fig. 54.
 1992a *Spiroloculina communis* Cushman and Todd - Hatta and Ujiie, p. 63, pl. 5, figs. 4/a-c
 1993 *Spiroloculina* aff. *S. communis* Cushman and Todd - Hottinger *et al.* p. 45, pl. 25, figs. 10-15
 1997 *Spiroloculina communis* Cushman and Todd - Cherif *et al.* p. 262, pl. 2, figs. 13, 14
 1999 *Spiroloculina communis* Cushman and Todd - Hayward *et al.* p. 108, pl. 6, figs. 8, 9.
 2012 *Spiroloculina communis* Cushman and Todd - Debenay, p. 133, 269.

Test porcelaneous, strongly built, biconcave, biloculine, evolute, periphery with sharp edges, sutures distinct, wall smooth to slightly ornamented by longitudinal microstriae, Aperture subcircular with a bifid tooth, situated at the end of a cylindrical neck with slightly peristomal lip.

Spiroloculina cf. S. communis Cushman and Todd, 1944

Pl. 6, figs. 17-19.

Test porcelaneous, small, slightly biconcave, biloculine, evolute, periphery with acute edges, sutures distinct, wall rough; aperture subcircular with a bifid tooth, situated at the end of a short neck with slightly peristomal lip.

Spiroloculina aff. S. convexa Said, 1949

Pl. 6, figs. 20-22.

- 1949 *Spiroloculina communis* Cushman and Todd, var. *convexa* - Said, p. 15, pl. 1, fig. 38.
 1993 *Spiroloculina convexa* Said - Hottinger *et al.* p. 45, pl. 26, figs. 1-4.
 2012 *Spiroloculina convexa*, Said - Debenay p. 133, 269.

Test porcellaneous, ovate to fusiform in outline, chambers subtrapezoidal in transverse section deeply biconcave, with a fairly convex peripheral wall separated from the lateral ones by acute shoulders; wall is rough and partly agglutinated; aperture is terminal at the end of a rounded neck, bordered by a peristomal lip and a small bifid tooth.

Spiroloculina corrugata Cushman and Todd, 1944

- Pl. 6, figs. 23-25.
 1944 *Spiroloculina corrugata* - Cushman and Todd, p. 51, 61, pl. 8, figs. 22-25.
 1993 *Spiroloculina corrugata* Cushman and Todd - Hottinger *et al.* p. 46, pl. 26, figs. 5-9.
 1994 *Spiroloculina corrugata* Cushman and Todd - Loeblich and Tappan, p. 43 pl. 65, figs. 4-7.
 2012 *Spiroloculina corrugata* Cushman and Todd - Debenay p. 133, 269.

Test porcellaneous, biloculine, elongated fusiform and slightly biconcave; wall rounded and chambers increasing gradually; ornamentation elongated and partly irregular costae, arranged at an angle to the margin; sutures are not distinct because of the strong ornamentation; aperture terminal at the end of a neck, lined with costae, bordered by a peristomal lip and provided with a bifid tooth.

Spiroloculina mayori Cushman, 1924

- Pl. 6, figs. 26-31.
 1924 *Spiroloculina mayori* - Cushman, p. 56, pl. 20, figs. 5, 6.
 1944 *Spiroloculina mayori* Cushman - Cushman and Todd, p. 56, pl. 8, figs. 1-6
 1954 *Spiroloculina mayori* Cushman - Cushman, Todd and Post, p. 336, pl. 84, fig. 15.
 2012 *Spiroloculina mayori* Cushman - Debenay, p. 134, 269.

Test elongate, central part of test is very much depressed, side of chambers sharply keeled; wall surface ornamented with minute ribs; apertural end is much extended and slender, flattened internally; phialine lip with a bifid tooth; sutures fairly distinct.

Spiroloculina samoensis Cushman, 1924

- Pl. 6, figs. 32, 33.
 1924 *Spiroloculina planissima* (Lamarck) var. *samoensis* - Cushman, p. 58; pl. 21, figs 9, 10.
 1944 *Spiroloculina samoensis* Cushman - Cushman and Todd, p. 56, pl. 8, fig. 8.
 2011 *Spiroloculina samoensis* Cushman - Makled and Langer, p. 236, fig. 3/47-50
 2012 *Spiroloculina samoensis* Cushman - Debenay, p. 134, 269.

Test strongly compressed, depressed conical section, tapering neck and a flattened periphery leading to a sharply keeled margin; chambers increasing rapidly with additional ones; wall porcellaneous and ornamented with fine raised costae, oblique and anastomosing; aperture terminal at the end of the neck, with a small lip and a bifid tooth.

Spiroloculina scrobiculata Cushman, 1921

- Pl. 6, figs. 34, 35.
 1921 *Spiroloculina scrobiculata* Cushman, p. 406, pl. 81, fig. 1.
 1944 *Spiroloculina scrobiculata* Cushman - Cushman and Todd, p. 55, pl. 7, figs. 28, 29.
 1994 *Spiroloculina scrobiculata* Cushman - Loeblich and Tappan, p. 44, pl. 67, figs. 10-16

Test elliptical in face view and composed of numerous chambers, each circular in transverse section, sutures deep; rapid increase in chamber size resulting in biconcave test; aperture at the end of a cylindrical neck with a slightly everted lip and a short bifid tooth; wall surface irregularly reticulate with very fine markings.

***Spiroloculina* sp. 1**

- Pl. 6, figs. 36-38.
 Test porcellaneous, biloculine, evolute and slightly depressed at the center portion; wall rounded, smooth, and chambers increasing gradually; ornamentation weak costae, sutures are indistinct. arranged at an angle to the margin; sutures indistinct; aperture terminal at the end of a neck and provided with a bifid tooth

***Spiroloculina* sp. 2**

- Pl. 7, figs. 1-5.

Test porcellaneous, biloculine, elongated fusiform and slender; wall rounded and chambers increasing gradually, with the earlier chamber becoming disoriented towards horizontality as more chambers are added; wall surface is rough and could be slightly agglutinated in adult stage; sutures are distinct; chambers are narrow and almost equal in width but could get inflated at the aboral end; subrectangular in top view but with rounded margins; aperture terminal at the end of a neck bordered by a peristomal lip and provided with a bifid tooth.

Spiroloculina sp. 3

Pl. 7, figs. 6-10.

Test porcellaneous, biloculine, elongated fusiform but with a conspicuously broad width and subrectangular in top view; wall surface is rough; peripheral margin acute; chambers increasing rapidly as more are added, last chambers get bulky at the middle but tapers towards both the oral and aboral ends; sutures are distinct and depressed; aperture terminal at the end of a slender, rounded neck, with peristomal rim and a bifid tooth.

Spiroloculina sp. 4

Pl. 7, figs. 11-13.

2009 *Spiroloculina* sp. 2 - Parker, p. 352, fig. 257.

Test porcellaneous, biloculine, elongate, small and biconcave; subrectangular in top view; chambers are narrow and long; with almost even width, slightly robust at the aboral end, broadest at the periphery; wall is smoothly finished but with weak costae; sutures are depressed and distinct; aperture is produced on a long neck with a single, short, bifid tooth.

Spiroloculina sp. 5

Pl. 7, figs. 14, 15.

Test compressed, depressed central section, tapers towards both oral and aboral region; peripheral margin acute; chambers increasing steadily with additional ones; wall porcellaneous and ornamented with numerous, fine, raised costae, oblique and anastomosing; aperture terminal at the end of the neck.

Family **Trilocularenidae** Mikhalevich and Kaminski, 2008

Genus **Falsagglutinella** Loeblich and Tappan, 1994

Falsagglutinella angularis Loeblich and Tappan, 1994

Pl. 7, figs. 16-18.

1994 *Falsagglutinella angularis* - Loeblich and Tappan, p. 45, pl. 69, figs. 12-14.

Test small with triloculine chamber arrangement, rounded periphery, depressed sutures, wall surface agglutinated but not in the neck region; aperture rounded and terminal on a produced neck.

Family **Hauerinidae** Schwager, 1876

Genus **Agglutinella** El-Nakhal, 1983

Agglutinella sp. 1

Pl. 7, figs. 19.

Test is small, elongate, triloculine with a rough, agglutinated wall surface; sutures fairly distinct; aperture terminal at the end of a short neck.

Genus **Schlumbergerina** Munier-Chalmas, 1882

Schlumbergerina alveoliniformis (Brady, 1879)

Pl. 7, figs. 20, 21.

1884 *Miliolina alveoliniformis* - Brady, p. 181, pl. 8, figs. 15-20.

1988 *Schlumbergerina alveoliniformis* (Brady) - Haig, p. 234, pl. 9, figs. 18, 19.

1994 *Schlumbergerina alveoliniformis* (Brady) - Loeblich and Tappan, p. 46, pl. 72, figs. 9-11.

2009 *Schlumbergerina alveoliniformis* (Brady) - Parker, p. 326, figs 237/a-h.

2012 *Schlumbergerina alveoliniformis* (Brady) - Debenay, p. 130, 280.

Test fusiform, evolute tubular chambers with miliolid coiling arranged in an irregular quinqueloculine pattern; sutures distinct and slightly depressed; wall porcelaneous but covered with agglutinated materials; aperture terminal, rounded and composed of trematophores with rounded openings.

Genus **Siphonaperta** Vella, 1957

Siphonaperta hallocki Förderer and Langer, 2016

Pl. 7, figs. 22-24.

2016 - Förderer and Langer, p. 13, fig. 6/a-f.

Test ovate, porcelaneous, about two times longer than broad; wall covered with finely agglutinated grains; periphery carinate to subacute; chamber arrangement quinqueloculine with five chambers visible from the exterior; sutures slightly curved, incised and depressed; chambers angular in oral view; aboral end rounded and produced; oral end becoming more slender and leading into a short produced neck; aperture terminal, a wide circular opening with a short T-shaped, bifid tooth, that reaches about one third of the apertural diameter, surrounded by a slightly thickened and everted peristomal rim.

Siphonaperta cf. S. hallocki Förderer and Langer, 2016

Pl. 7, figs. 25-27.

2016 - Förderer and Langer, p. 13, fig. 6/a-f.

Test quinqueloculine, ovate in lateral view; chambers twisted and curved, with the ultimate and penultimate chambers nearly equal in width from aboral to oral ends; wall roughly finished; peripheral margins strongly acute; aperture oval, produced at the end of a short thick neck, with a peristomal lip and a short tooth which could be bifid.

Siphonaperta pittensis (Albani, 1974)

Pl. 7, figs. 28-31.

1974 *Quinqueloculina pittensis* - Albani, p. 33, 35, pl. 1, figs. 1-3

1993 *Siphonaperta pittensis* (Albani) - Hottinger *et al.* p. 63, pl. 64, figs. 1-6

1997 *Quinqueloculina pittensis* Albani - Haig, p. 272, fig. 4/ 2, 3.

1998 *Siphonaperta pittensis* (Albani) - Haunold and Piller, p. 15, pl. 3, fig. 9

2009 *Quinqueloculina pittensis* Albani - Parker, p. 236, figs. 169-171.

2013a *Siphonaperta pittensis* (Albani) - Langer *et al.* figs. 4/33-34

Test quinqueloculine, ovate to subcircular in side view; peripheral margins are rounded; chamber sides convex; sutures depressed and distinct; wall porcelaneous, surface roughly finished with agglutinated grains incorporated into the wall; aperture terminal, rounded, at the end of a short neck with a peristomal lip and a tooth with T-shape termination.

Siphonaperta cf. S. pittensis (Albani, 1974)

Pl. 7, figs. 32-35.

Test elongate, almost two time higher than wide; peripheral margins rounded; chamber sides convex; sutures depressed and distinct; wall porcelaneous, surface roughly finished with agglutinated grains incorporated into the wall; aperture terminal, semicircular, with a peristomal lip and a T-shaped tooth.

Siphonaperta sp. 1

Pl. 8, figs. 1, 2.

Test almost one and half time as long as wide; peripheral margins rounded; chamber sides convex; sutures depressed; wall porcelaneous, surface roughly finished with large agglutinated grains incorporated into the wall; aperture terminal, semicircular, with a slightly peristomal lip and a bifid tooth.

Genus **Inaequalina** Luczkowska, 1971

Inaequalina sp. 2.

Pl. 8, figs. 3.

Test is elongate, about two times higher than broad, with oral and aboral ends produced, coiling is regularly planispiral with depressed and distinct sutures; chambers are distinct and rounded, and do not overlap or wrap around one another; aperture rounded, terminal at the end of an equally rounded neck with a simple tooth.

Genus **Hauerina** d'Orbigny, 1839

Hauerina fragilissima (Brady, 1884)

Pl. 8, figs. 4-7.

1884 *Spiroloculina fragilissima* - Brady, p. 149, pl. 9, figs. 12-14

- 1917 *Hauerina fragilissima* (Brady) - Cushman, p. 64, pl. 24, fig. 4.
 1924 *Hauerina fragilissima* (Brady) - Cushman, p. 68, pl. 25, figs. 2, 3.
 1988 *Hauerina fragilissima* (Brady) - Haig, p. 220, pl. 2, figs. 3-4

Test much compressed, nearly circular, early chambers quiqueloculine, while later ones which make up the adult test spiroloculine; periphery rounded, sutures slightly depressed; wall thin and opalescent; aperture cribrate.

Hauerina aff. H. fragilissima (Brady, 1884)

Pl. 8, figs. 8-14.

- 1975 *Hauerina fragilissima* (Brady) - Ponder, p. 14, text figs. 28-50
 1987 *Hauerina fragilissima* (Brady) - Baccaert, p. 144, pl. 63, figs. 1-3
 2009 *Hauerina fragilissima* (Brady) - Parker, p. 107, figs 75a-g.
 2012 *Hauerina fragilissima* (Brady) - Debenay p. 108

Test partly involute, highly compressed discoid shape; wall delicately thin and opalescent, the sutures appearing as conspicuous white lines; uneven surface texture; aperture terminal with a trematophore.

Hauerina pacifica Cushman, 1917

Pl. 8, figs. 15-25.

- 1917 *Hauerina pacifica* - Cushman, p. 64, pl. 21, fig. 2
 1975 *Hauerina pacifica* Cushman - Ponder, p. 19, textfigs. 51-68
 1987 *Hauerina pacifica* Cushman - Baccaert, p. 145, pl. 63, figs. 4-6
 1988 *Hauerina pacifica* Cushman - Haig, p. 220, pl. 2, figs. 5-7
 2009 *Hauerina pacifica* Cushman - Parker, p. 109, figs 76a-c; 77a-m; 78a-j.
 2012 *Hauerina pacifica* Cushman -Debenay p. 108

Test robust, regular to irregularly suboval in front view, less compressed, early quinqueloculine chamber arrangement, almost becoming planispiral with two whorls during ontogeny; periphery angular to acute; wall roughly textured with weak ribbed ornaments; aperture cribrate, with full trematophore in specimens with planispiral latter chambers.

Genus **Pseudolachlanella** Langer, 1992

Pseudolachlanella angusteoralis (Wiesner, 1923)

Pl. 8, figs. 26-28.

- 1923 *Lachlanella angusteoralis* - Wiesner, p. 73, pl. 14, fig. 184.

Test large, somewhat flattened; wall smooth, porcelaneous, sometimes translucent; aperture long narrow slit, with a long tooth with thickened rounded end tip, almost filling the whole aperture

Pseudolachlanella eburnea (d'Orbigny, 1839)

Pl. 8, figs. 29-31.

- 1839a *Triloculina eburnea* - d'Orbigny, p. 180, pl. 10, figs. 21-23.
 1977 *Triloculina eburnea* d'Orbigny - Le Calvez, p. 104, pl. 20, figs.1-4.
 1987 *Quinqueloculina oblonga* (Montagu) subsp. *eburnea* (d'Orbigny) - Baccaert, p. 98; pl. 46, fig. 3.
 1988 *Quinqueloculina* cf. *Q. incisura* (Todd) - Haig, p. 233; pl. 6, figs 13.
 2009 *Quinqueloculina eburnea* (d'Orbigny) - Parker, figs. 143, 144, 145.
 2012 *Pseudolachlanella eburnea* (d'Orbigny) Debenay p. 115

Test slightly compressed, a little bit longer than broad, cryptocrystalline. Wall smooth and polished, periphery rounded, aboral end strongly overlapping preceding chambers; aperture distinct elongate slit which is almost filled completely by a long simple tooth.

Pseudolachlanella slitella Langer, 1992

Pl. 8, figs. 32-35.

- 1957 *Triloculina incisura* Todd, p. 308, pl. 86, fig. 18.
 1988 *Quinqueloculina* cf. *Q. incisura* (Todd) - Haig, p. 233, pl. 6, figs. 11-14.
 1992 *Pseudolachlanella slitella* - Langer, p. 90, pl. 2, figs. 4-6.
 2012 *Pseudolachlanella slitella* Langer - Debenay p. 115, 275.

Test free, elongated, periphery subrounded; wall smooth, calcareous imperforate; chambers one half coil in length, early stage cryptoquineloculine, latter nearly planispiral; aperture narrow, curved, elongate slit with parallel sides, provided with a long slender tooth with thickened ending.

Pseudolachlanella sp. 1

Pl. 9, figs. 1-7.

Test elongate, subquadrate, more than two times higher than wide, triloculine; wall roughly finished with numerous microstriae; Chambers slightly compressed; periphery rounded; aperture strongly lachlanella, terminal, produced at the end of a short neck and provided with a thick lip and long tooth which thickens at the tip end. The tooth almost goes through the total length of the lachlanella aperture.

Genus **Quinqueloculina** d'Orbigny, 1826

Quinqueloculina agglutinans d'Orbigny, 1839

Pl. 9, figs. 9-11.

1839a *Quinqueloculina agglutinans* - d'Orbigny, p. 195, pl. 12, figs 11-13.

1929 *Quinqueloculina agglutinans* d'Orbigny - Cushman, p. 22, pl. 1, fig. 1.

1959 *Quinqueloculina agglutinans* d'Orbigny - Graham and Militante, p. 41, pl. 4, fig. 10.

1971 *Quinqueloculina agglutinans* d'Orbigny - Bock et al. p. 16, pl. 4, figs 3-5.

1977a *Quinqueloculina agglutinans* d'Orbigny - Le Calvez, p. 54, pl. 7, figs 1, 2 (lectotype), 3, 4, 11-13.

1988 *Quinqueloculina agglutinans* d'Orbigny - Haig, p. 223, pl. 4, figs. 12-14

2009 *Quinqueloculina* cf. *Q. agglutinans* d'Orbigny - Parker, p. 175, figs. 124, 125.

Test longer than broad, quinqueloculine, with broadly rounded periphery. Wall composed of agglutinated arenaceous materials externally and roughly finished; sutures faintly distinct; aperture lachlanella with a slightly everted lip and a bifid tooth.

Quinqueloculina cf. **Q. angulariniformis** McCulloch, 1977

Pl. 9, figs. 12-14.

1977 *Quinqueloculina angulariniformis* McCulloch, p. pl. 213, figs. 7-9.

Test free, calcareous, compressed, subfusiform, quinqueloculine, sutures distinct and depressed, chambers subquadrate and quite symmetrical from the aboral end to the oral end; periphery slightly depressed between keeled acute margins; wall ornamented with weakly developed, fine, longitudinal costate; aperture terminal at the end of a short rectangular neck with a peristomal lip and a tooth.

Quinqueloculina arenata Said, 1949

Pl. 9, figs. 15-18.

1949 *Quinqueloculina arenata* - Said, Red Sea, p. 9, pl. 1, fig. 25.

1971 *Quinqueloculina ammophila* Parr - Rasheed, p. 20-21, pl. 2, figs 4a-c.u

1987 *Quinqueloculina anguina* Terquem var. *arenata* Said - Baccaert, p. 77, pl. 37, figs. 1-5.

1988 *Quinqueloculina arenata* Said - Haig, p. 233, pl. 4,

1994 *Agglutinella arenata* (Said); Loeblich and Tappan, p. 45, pl. 69, figs. 6-11, pl. 70, figs. 10-15, pl. 74, figs. 10-13.

2009 *Quinqueloculina arenata* Said - Parker, p. 179, figs. 126-128.

2012 *Quinqueloculina arenata* Said - Debenay, p. 119, 270.

Test slender, quinqueloculine, periphery rounded, externally agglutinated and roughly finished; Sutures are greatly obscured by the coarsely agglutinated wall; aperture rounded, terminal at the end of a distinct neck provided with a short tooth and slightly everted lip.

Quinqueloculina barnadi Rasheed, 1971

Pl. 9, figs. 19-26.

1971 *Quinqueloculina barnardi* - Rasheed, p. 26, 27, pl. 2, fig. 1.

1977 *Quinqueloculina bubnanensis* - McCulloch, p. 483, pl. 210, fig. 19, pl. 212, fig. 16.

1988 *Quinqueloculina barnadi* Rasheed - Haig, p. 233, pl. 4, figs. 18-20.

1997 *Quinqueloculina barnadi* Rasheed - Haig, fig. 3/23, 24.

2001 *Quinqueloculina barnadi* Rasheed - Lobegeier, p. 291, pl. 7, figs. 4-9.

2009 *Quinqueloculina barnadi* Rasheed - Parker figs. 129, 130

2012 *Quinqueloculina barnadi* Rasheed - Debenay, p. 119, 270.

Test robust, oval in lateral view, peripheral margins are acutely rounded to rounded; wall porcelaneous with numerous microstriae; sutures slightly depressed but very distinct; aperture lachlanella, compressed, with a long simple tooth.

Remarks: Some of our specimens show smaller *lachlanella* aperture.

Quinqueloculina cf. Q. bassensis (Parr, 1945)

Pl. 9, figs. 29-31.

1945 *Triloculina bassensis* - Parr, p. 198, pl. 8, figs. 7/a-c

2009 *Quinqueloculina bassensis* (Parr) - Parker, p. 184, figs. 131/a-g

Test elongate, quinqueloculine, with slightly compressed chambers, subrectangular in oral view; sutures slightly depressed; wall rough with numerous pits which could be caused to abrasion; Aperture subrounded and produced on a slightly raised neck, with a thickrim and a slender tooth which could be bifid.

Quinqueloculina carinastriata Wiesner, 1923

Pl. 9, figs. 32-35.

1974 *Quinqueloculina poeyana carinata* - Albani, Australia, p. 35, pl. 1, figs. 4-6 .

1987 *Quinqueloculina poeyana carinata* Albani - Baccaert, p. 101, pl. 47, figs. 4, 5.

1988 *Quinqueloculina carinastriata* Wiesner - Haig, p. 225, pl. 5, fig. 9, 10.

1991 *Adelosina carinatastriata* Wiesner - Cimerman and Langer, p. 28, pl. 20, figs. 1-4.

1994 *Quinqueloculina funafutiensis* (Chapman) - Loeblich and Tappan, p. 49, pl. 77, figs. 13-20.

2005 *Adelosina carinatastriata* Wiesner - Debenay et al. p. 330, fig. 1/14, 15.

2009 *Quinqueloculina carinastriata* Wiesner - Parker, p. 188, figs. 133, 134.

2012 *Quinqueloculina carinastriata* Wiesner - Debenay, p. 120, 271.

Test small, oval in outline, subtriangular in cross section, periphery subrounded and ornamented by thick elevated costae which are slightly oblique, very distinct and visible; chambers rapidly increasing in size; aperture slightly oval, produced on a distinct short neck with a peristomal lip and a short simple tooth.

Quinqueloculina aff. Q. carinata (Wiesner, 1923)

Pl. 10, figs. 1-3.

1923 *Quinqueloculina carinata* (Wiesner), p. 74, pl. 19, fig. 189.

1993 *Cycloforina (?) carinata* (Albani) - Hottinger *et al.* pl. 32, figs. 1-9.

Test elongate, quinqueloculine; wall strongly ornamented with numerous high-relief longitudinal ridges which runs through the entire test to the lip region; both the oral and aboral ends are slightly produced; sutures depressed and distinct; aperture subcircular, with thick everted lip, produce at the end of a distinct short neck with a short stem bifid tooth.

Quinqueloculina collumnosa Cushman, 1922

Pl. 10, figs. 4-7.

1922a *Quinqueloculina collumnosa* Cushman, p. 65; pl. 10, fig. 10.

1929a *Quinqueloculina collumnosa* Cushman - Cushman, p. 27, pl. 3, figs. 2/a-c.

2012 *Quinqueloculina collumnosa* Cushman - Debenay, p. 121, 271.

Test elongate, slightly longer than broad, periphery acute and projecting, the last formed chamber extending out beyond the outline of the test at both ends; chambers wavy; wall smooth but could also contain some agglutinated materials. Aperture rounded, with a lip and a tooth, at the end of distinct narrow neck.

Quinqueloculina corrugata (Collins, 1958)

Pl. 10, figs. 8, 9.

1958 *Massilina corrugata* - Collins, p. 362; pl. 2, figs. 11, 12.

1978 *Massilina corrugata* Collins - Cheng and Zheng, p. 177, pl. 6 -12.

1988 *Quinqueloculina corrugata* Collins - Haig, p. 233; pl. 5, figs 15-17.

1994 *Lachlanella corrugata* (Collins) - Loeblich and Tappan, p. 46, pl. 75, figs. 4-6.

Test quinqueloculine, elongated, periphery truncated; sutures depressed; Wall roughly finished, irregular, transversely corrugate with series of alternating excavations; aperture *Lachlanella*, slightly produced and recurved, with a slightly everted lip and a long tooth that may be bifid at the tip.

Quinqueloculina cf. Q. crassicarinata sp. 1 Collins, 1958

Pl. 10, figs. 10-15.

1958 *Quinqueloculina crassicarinata* - Collins, p. 359; pl. 2, fig. 6.

1987 *Quinqueloculina crassicarinata* Collins - Baccaert, p. 84, pl. 39, figs. 3-5.

1988 *Quinqueloculina crassicarinata* Collins - Haig, p. 233, pl. 5, figs. 18-20,

1994 *Quinqueloculina crassicarinata* Collins - Loeblich and Tappan, p. 48, pl. 77, figs. 4-12.

2012 *Quinqueloculina crassicarinata* Collins - Debenay p. 121, 271.

Test stout, subcircular in lateral view, triangular in top view; periphery acute; wall smoothly finished; aperture circular, terminal, produced on a short neck, with an everted apertural lip and a short T-shaped tooth.

Quinqueloculina cf. Q. crassicarinata sp. 2 Collins, 1958

Pl. 10, figs. 16-21.

Test elongate, length almost twice as broad, triangular in top view, periphery bluntly acute; wall smoothly finished, aperture terminal, circular, produced on a neck with everted lip and a simple tooth.

Quinqueloculina curta Cushman, 1917

Pl. 10, figs. 22-28.

1917 *Quinqueloculina disparalis* var. *curta* Cushman, p. 49, pl. 14, fig. 2/a-c.

1959 *Quinqueloculina curta* Cushman - Graham and Militante, p. 44, pl. 5, fig. 9/a-c

Test calcareous, porcellaneous, almost as broad as long, broadly triangular in oral view; wall ornamented with strong longitudinal costate; periphery rounded but truncated by several costae; aperture terminal, subcircular, wide, with everted lip and a simple tooth with thick termination.

Quinqueloculina cuvieriana d'Orbigny, 1839

Pl. 10, figs. 29-35.

2009 *Quinqueloculina cuvieriana* d'Orbigny- Parker (Fig. 136f-j)

Test porcellaneous, robust, almost as broad as long, triangular in top view, wall has very finely striate wall texture; the striae run from along the entire length of the test. Periphery is sharply acute. The aperture is terminal, subcircular to lachlanella, with everted lip and a simple tooth.

Quinqueloculina cf. Q. cuvieriana d'Orbigny, 1839

Pl. 11, figs. 1-4.

1839a *Quinqueloculina cuvieriana* - d'Orbigny, p. 190, pl. 11, figs. 19-21

1977 *Quinqueloculina cuvieriana* d'Orbigny- Le Calvez, p. 70, p. 7 1, figs 1, 2, fig. 3 (lectotype).

1994 *Quinqueloculina cuvieriana* d'Orbigny- Loeblich and Tappan, p. 48, pl. 78, figs. 1-3, ?7-9, not 4-6.

Test robust, length almost as broad, subcircular in lateral view, triangular in top view, periphery bluntly acute; wall smoothly finished, aperture is circular produced on a very short neck, everted lip and a simple tooth.

Quinqueloculina cf. Q. delicatula Vella, 1957

Pl. 11, figs. 5-7.

1957 *Quinqueloculina delicatula* - Vella, p. 27, pl. 4, figs. 77-79.

1999 *Quinqueloculina delicatula* Vella - Hayward *et al.* p. 102, pl. 4, figs. 23, 24.

2009 *Quinqueloculina delicatula* Vella - Parker, p. 195; figs 137a-g.

Test elongate with angular peripheral margins; margins acutely rounded or truncate; basal end broadly rounded and slightly produced; sutures distinct; apertural end produced and truncated with a short neck; wall roughly textured, matte and has agglutinated grains superficially attached; aperture rounded, provided with a thickened rim and a small bifid tooth.

Quinqueloculina cf. Q. differens McCulloch, 1977

Pl. 11, figs. 8-12.

1977 *Quinqueloculina differens* - McCulloch, p. pl. 209, fig. 2; pl. 212, fig. 2.

Test elongate, small, subfusiform, slightly twisted, quinqueloculine; wall ornamented with numerous microstriae giving it a rough outlook; Chambers somewhat compressed; periphery subrounded; aperture terminal with a perisotomal lip, produced at the end of the last chamber and provided with a bifid tooth.

Quinqueloculina distorta (Cushman, Todd and Post, 1954)

Pl. 11, figs. 13-18.

1949 *Quinqueloculina bradyana* Cushman – Said, p. 9, pl. 1, fig. 22

1954 *Quinqueloculina distorquata* (Cushman) - Cushman, Todd and Post, p. 333, pl. 83, fig. 27.

1988 *Quinqueloculina distorquata* Cushman - Haig, p. 233, pl. 5, figs. 26-28

1993 *Siphonaperta distorquata* (Cushman) - Hottinger *et al.* p. 63, pl. 62, figs. 4-9, pl. 63, figs. 1-6

1998 *Siphonaperta distorquata* (Cushman) - Haunold and Piller, p. 15, pl. 3, fig. 7

2009 *Quinqueloculina distorquata* (Cushman) - Parker, 195, figs. 138/a-f, 139/a-i.

2012 *Quinqueloculina distorquata* (Cushman) - Debenay, p. 122, 271.

2013a *Siphonaperta distorquata* (Cushman) - Langer *et al.* fig. 4/32

Test quinqueloculine, nearly as long as broad, subelliptical in lateral view, initial end bluntly pointed, apertural end with a short neck, periphery acute or slightly keeled; test rough, covered by agglutinated materials chambers longitudinally distorted, giving it its irregular shape; chambers are enlarging rapidly as added; sutures are indistinct except for the keel of the preceding chamber; aperture terminal, rounded with a slightly everted lip and a bifid tooth.

Quinqueloculina cf. Q. distorquata sp. 1 (Cushman, Todd and Post, 1954)

Pl. 11, figs. 19-24.

1993 *Lachlanella* sp. A - Hottinger *et al.* p. 52, pl. 38, figs. 1-8

2009 *Quinqueloculina cf. Q. distorquata* Cushman - Parker, p. 197, figs. 140, 141.

Test quinqueloculine, slightly flattened; chambers distorted and twisted; periphery truncated; distinctly carinated, in places with irregular knob-like thickenings; aperture lachlanella, terminal with a thick peristomal lip and a long, thin bifid tooth.

Quinqueloculina cf. Q. distorquata sp. 2 (Cushman, Todd and Post, 1954)

Pl. 11, figs. 25, 26.

Test ovate, quinqueloculine, periphery carinate, oral and rounded aboral ends slightly produced; wall roughly finished with numerous unevenly striate, matte; chambers slightly inflated; sutures distinct, depressed; aperture subrounded, terminal, produced on short neck.

Quinqueloculina eamesii (Rasheed, 1971)

Pl. 11, figs. 27-32.

1971 *Triloculina eamesii* - Rasheed, p. 36, 37, pl. 12, fig. 1.

1988 *Quinqueloculina eamesii* (Rasheed) - Haig, pl. 6, figs. 1-4

2009 *Quinqueloculina eamesii* (Rasheed) - Parker, p. 199, fig. 142/a-c.

Test elongate, fusiform, almost two times higher than wide, calcareous; sutures slightly depressed; five chambers visible from the exterior; periphery rounded; wall roughly finished; aperture rounded, terminal at the end of a short neck with a thickened peristomal rim and simple tooth.

Quinqueloculina exmouthensis Parker, 2009

Pl. 11, figs. 33-35.

1993 *Cycloforina collumnosa* (Cushman) – Hottinger *et al.* p. 49, pl. 32, figs. 10-15

1998 *Cycloforina collumnosa* (Cushman) – Haunold and Piller, p. 16, pl. 3, fig. 13.

2009 *Quinqueloculina exmouthensis* – Parker, p. 207, figs. 146/a-h

2011 *Quinqueloculina exmouthensis* Parker – Parker and Gischler, p. 43, pl. 2, figs. 10-12

2012 *Quinqueloculina exmouthensis* Parker; Debenay p. 122, 272.

Test stout, elongate, quinqueloculine, one and a half to two times higher than broad, broadly oval in lateral view; periphery truncated, oral end produced with a fairly long neck while the aboral end rounded. Five distinct chambers are shown from the top view. Wall smoothly finished; aperture terminal, circular.

Quinqueloculina exsculpta (Heron-Allen and Earland, 1915)

Pl. 11, figs. 36.

1898a *Miliolina boschiana* (d'Orbigny) - Millett, p. 267, pl. 6, figs. 1a-b

1915 *Miliolina exsculpta* - Heron-Allen and Earland, p. 567, pl. 42, figs. 23-26.

1979 *Quinqueloculina exsculpta* (Heron-Allen and Earland) - Whittaker and Hodgkinson, p. 25, pl. 1, figs. 11, 12.

1988 *Quinqueloculina exsculpta* (Heron-Allen and Earland) - Haig, p. 233, pl. 6, figs. 5-7.

2009 *Quinqueloculina exsculpta* (Heron-Allen and Earland) - Parker, p. 210, figs. 149/a-k.

2012 *Quinqueloculina exsculpta* (Heron-Allen and Earland) – Debenay p. 122, 272.

Test elongated, quinqueloculine; chambers inflated, sutures could be deeply excavated as the case may be; wall smoothly finished; aperture produced on a neck that could be long and curved especially in adults, ovate, provided with a very short, bifurcate tooth.

Quinqueloculina funafutiensis (Chapman, 1901)

Pl. 12, figs. 1-7.

1901 *Miliolina funafutiensis* - Chapman, p. 178, pl. 19, figs. 6, 6a.

1988 *Quinqueloculina carinatasriata* (Wiesner) - Haig, pl. 5, figs. 6-8.

1994 *Quinqueloculina funafutiensis* (Chapman) - Loeblich and Tappan, p. 49, pl. 77, figs. 13-20.

Test small, elongated, subtriangular in cross section, periphery subrounded and ornamented by thick elevated costae which are slightly oblique, very distinct and visible; peripheral margin acute, with a costae; chambers rapidly increasing in size; aperture rounded, produced on a long neck with a peristomal lip and a short simple tooth.

Quinqueloculina granulocostata Germeraad, 1946

Pl. 12, figs. 8-11.

1884 *Miliolina linneana* (d'Orbigny) – Brady, p. 174, pl. 6, figs. 15, 17-20

1946 *Quinqueloculina granulocostata* - Germeraad p. 63, pl. 6, figs. 15-20.

1949 *Quinqueloculina sulcata* d'Orbigny - Said, p. 11, pl. 1, fig. 20

1977 *Quinqueloculina* cf. *Q. granulocostata* Germeraad - McCulloch, p. 491, pl. 215, fig. 16; pl. 216, fig. 1.

1982 *Quinqueloculina granulocostata* Germeraad - Levy et al. p. 136, pl. 2, fig. 6

1988 *Quinqueloculina granulocostata* Germeraad - Haig, p. 226, pl. 6, figs. 8-10.

1993 *Pseudotriloculina* (?) *granulocostata* (Germeraad) – Hottinger *et al.* p. 55, pl. 46, figs. 7-12

1994 *Massilina granulocostata* (Germeraad) - Loeblich and Tappan, p. 47, pl. 75, figs. 19-21, pl. 79, figs. 1-12

2009 *Quinqueloculina granulocostata* Germeraad - Parker, p. 211, figs. 150, 151.

2012 *Quinqueloculina granulocostata* Germeraad - Debenay, p. 123, 272.

Test quinqueloculine, elongate, with prominent costate running the entire length of the test, three on the peripheral margin, two of them making carinated shoulders that reach the aboral end of the chamber and join towards the aperture; aperture subcircular, slightly produced, with a peristomal lip, but not in all cases provided with a clearly defined tooth.

Remarks: Most of the specimens are juvenile and the costae are not so much pronounced like in the adult stages. Loeblich and Tappan 1994 (pl. 79, figs. 1-12) shows similar specimens except for those that are bicarinate. Some of the Moorea specimens do not also show well formed tooth.

Quinqueloculina inaequalis Cushman, 1921

Pl. 12, figs. 12-17.

1921 *Massilina inaequalis* - Cushman, p. 72, pl. 17, figs. 12, 13.

1929 *Massilina inaequalis* Cushman - Cushman, pt. 6, p. 38, pl. 7, figs. 6/a-c.

1932 *Massilina inaequalis* Cushman - Cushman, pl. 8, figs. 6, 7.

1954 *Massilina inaequalis* Cushman - Graham and Millitante, p. 36, pl. 3, figs. 13, 14.

2012 *Quinqueloculina inaequalis* Cushman - Debenay, p. 123, 272.

Test much elongate, initial chambers quinqueloculine while the later ones spiroloculine and elongate. Subrectangular in top view; wall surface polished but with numerous fine, linear depressions. Sutures are depressed and distinct. Aperture terminal at the end of a thick neck, with a bifid tooth.

Remarks: Cushman points out that the species is spiroloculina in the adult stage. Our specimen do not show spiroloculina at the adult stage, likewise the specimen of Debenay.

Quinqueloculina cf. Q. laevigata d'Orbigny, 1839

Pl. 12, figs. 18-21.

1839 *Quinqueloculina laevigata* - d'Orbigny, p. 143, pl. 3, figs. 32, 33.

1923 *Miliolina laevigata* (d'Orbigny) - Wiesner, p. 55, pl. 8, figs. 94-96.

1929 *Quinqueloculina laevigata* - Cushman, p. 30, pl. 4, fig. 3.

1991 *Quinqueloculina laevigata* - Cimermann and Langer, p. 33, pl. 33, figs. 8-11.

Test elongate, truncated at the apertural end, rounded at the aboral end; periphery rounded, aperture terminal, produced on a broad short neck with a tooth and short bifid termination.

Quinqueloculina lamarckiana d'Orbigny, 1839

Pl. 12, figs. 22, 23.

1839 *Quinqueloculina lamarckiana* - d'Orbigny, p. 189, pl. 11, figs. 14, 15.

1884 *Quinqueloculina lamarckiana* d'Orbigny - Brady, p. 10, pl. 5, fig. 12/a-c.

1929 *Quinqueloculina lamarckiana* d'Orbigny - Cushman, p. 26, pl. 2, fig. 6/a-c.

Test nearly as broad as long, chambers distinct, sutures slightly depressed; periphery strongly acute but not carinate; chambers triangular in top view; wall smooth and shiny; aperture terminal but not with a distinct lip

Quinqueloculina lizardi Baccaert, 1987

Pl. 12, figs. 24-28.

1987 *Quinqueloculina oblonga* subsp. *lizardi* - Baccaert, p. 100; pl. 46, figs 6a-b; pl. 47, fig. 1.

2012 *Quinqueloculina lizardi* Baccaert - Debenay p. 123, 272.

2009 *Quinqueloculina* sp. 21- Parker, p. 319, figs. 232/a-i.

Test elongate, compressed, elliptical in lateral view, quinqueloculine, 3-5 chambers visible; test surface strongly pitted with rounded to irregular elongate shallow excavations; periphery could be acute angled in the juvenile stages; aperture terminal, slightly compressed, with a small simple tooth.

Quinqueloculina neostriatula Thalmann, 1950

Pl. 12, figs. 29-35.

1915 *Miliolina undulata* (d'Orbigny) - Heron-Allen and Earland, p. 573, pl. 43, figs. 5-8

1932 *Quinqueloculina striatula* - Cushman, p. 27, pl. 7, figs. 3-4

1950 *Quinqueloculina neostriatula* - Thalmann, p. 45

1987 *Quinqueloculina neostriatula* Thalmann - Baccaert, p. 91; pl. 43, figs 1-6.

1988 *Quinqueloculina neostriatula* Thalmann - Haig, p. 234, pl. 6, figs. 22-25

2009 *Quinqueloculina neostriatula* Thalmann - Parker, p. 225, figs. 162, 163.

2012 *Quinqueloculina neostriatula* Thalmann - Debenay p. 124

Test slightly longer than broad, the periphery of the chambers subacute to subrounded; chambers are distinct and triangular in section; sutures distinct, only slightly depressed; wall ornamented with numerous faint microstriae to more prominent longitudinal anastomosing costate, slightly oblique to the periphery of the chamber; aperture large, broad, crescent shaped, with perisotomal lip, and a small low bifid tooth

Quinqueloculina cf. Q. neostriatula Thalmann, 1950

Pl. 13, figs. 1-3.

2009 *Quinqueloculina neostriatula* Thalmann - Parker, p. 225, figs. 162, 163.

Test calcareous, with three chambers visible in lateral view; periphery rounded; chambers slightly inflated; sutures distinct; wall porcelaneous, surface roughly finished with numerous microstriae; aperture semicircular, terminal at the end of the last chamber, provided with an everted rim and wide tooth.

Quinqueloculina ningalooensis Parker, 2009

Pl. 13, figs. 4-8.

2009 *Quinqueloculina ningalooensis* - Parker, p. 229, figs. 164/a-g, 165/a-k, 166/a-j.

Test small, quinqueloculine, almost two times higher than wide; peripheral margin rounded; chambers slightly inflated, about same width along length, with rounded periphery; sutures indistinct, depressed; wall coarsely finished; aperture terminal, very slightly produced, circular, with slightly thickened peristomal lip, and a short bifid tooth with short bifid extensions.

Quinqueloculina aff. Q. montyi Baccaert, 1987

Pl. 13, figs. 9-14.

1987 *Quinqueloculina montyi* - Baccaert, p. 104, pl. 48, figs. 5-7.

2009 *Quinqueloculina* sp. 1 - Parker, p. 288, figs. 211/a-c.

Test ovate in lateral view, slightly higher than wide, calcareous, quinqueloculine; chambers slightly inflated, and almost semicircular in apertural view; wall ornamented with very pronounced, low, rounded and sometimes anastomosing costae running longitudinally and fading out towards the oral and aboral ends; aperture semicircular bordered by a peristomal lip provided with a short bifid tooth.

Quinqueloculina parkeri (Brady, 1881)

Pl. 13, figs. 15-25.

- 1884 *Miliolina parkeri* - Brady, p. 177; pl. 7, figs 14a-c.
 1917 *Quinqueloculina parkeri*, (Brady) - Cushman, pl. 15, fig. 3.
 1921 *Quinqueloculina parkeri*, (Brady) - Cushman, p. 440, pl. 86, fig. 4/a-c
 1988 *Quinqueloculina parkeri* (Brady) - Haig, p. 234; pl. 6, figs 30-33.
 1994 *Lachlanella parkeri* (Brady) - Loeblich and Tappan, p. 47, pl. 74, figs. 1-6.
 2009 *Quinqueloculina parkeri* (Brady) - Parker, p. 233, figs 167/a-g; 168/a-j.
 2012 *Quinqueloculina parkeri* (Brady) - Debenay p. 124,

Test elongate, robust, quinqueloculine, periphery subacuate, aboral end produced; wall surface with pronounced transverse ridges or crenulations; aperture terminal, rectangular, lachlanella, produced on a raised neck, with a simple long tooth with thickened ending.

Quinqueloculina aff. *Q. parvagguta* Vella, 1957

Pl. 13, figs. 26-35.

- 1957 *Quinqueloculina parvagguta* - Vella, p. 27; pl. 4, figs 71-73.
 1988 *Quinqueloculina* cf. *pittensis* Albani - Haig, p. 234; pl. 7, figs 9-11.
 1994 *Quinqueloculina parvagguta* Vella - Loeblich and Tappan, p. 49; pl. 80, figs 1-9.
 2012 *Quinqueloculina parvagguta* Vella - Debenay p. 125, 273.

Test ovate in lateral view, subtriangular in oral view; wall roughly agglutinated, distinct chambers; sutures slightly distinct and depressed due to the agglutination; aperture subrounded, produced on a short cylindrical neck provided with a short bifid tooth.

Quinqueloculina cf. *Q. patagonica* d'Orbigny, 1839

Pl. 14, figs. 1-8.

- 1839 *Quinqueloculina patagonica* - d'Orbigny, p. 74, pl. 4, figs. 14-16.
 1994 *Quinqueloculina latidentella* - Loeblich and Tappan, p. 49; pl. 80, figs 10-12.
 2009 *Quinqueloculina latidentella* Loeblich and Tappan - Parker, p. 217, fig. 154/a-f; fig. 155/a-g.

Test elongate, about two times longer than wide, robust, quinqueloculine, periphery margins rounded, aboral end produced; wall smooth but with little agglutinated materials; sutures distinct and depressed; aperture terminal, circular to semicircular, produced on a raised neck, with a simple long bifid tooth.

Remarks: this species is in-between *Q. patagonica* and *Q. latidentella*.

Quinqueloculina philippinensis Cushman, 1921

Pl. 14, figs. 9-19.

- 1921 *Quinqueloculina kerimbatica* (Heron-Allen and Earland) var. *philippinensis* Cushman, p. 438, pl. 89, figs. 2, 3.
 1959 *Quinqueloculina kerimbatica* (Heron-Allen and Earland) var. *philippinensis* Graham and Militante, p. 55, pl. 8, figs. 1-3.
 1974c *Quinqueloculina philippinensis* Cushman - Ponder, p. 243-250.
 1988 *Quinqueloculina philippinensis* Cushman - Haig, pl. 7, figs. 1-8.

Test quinqueloculine, elongate to subcircular to elliptical in lateral view, subacuate to rounded periphery; wall surface pitted with regular reticulations which could be entire, faint or worn out in older specimens; aperture terminal at the end of a neck, with a slightly everted thin lip and a simple bifid tooth.

Quinqueloculina poeyana d'Orbigny, 1839

Pl. 14, figs. 20-30.

- 1839a *Quinqueloculina poeyana* - d'Orbigny, p. 191, pl. 11, figs. 25-27
 1929 *Quinqueloculina poeyana* d'Orbigny - Cushman, p. 31, pl. f, fig. 2/a-c, specimens examined.
 1977 *Quinqueloculina poeyana* d'Orbigny - Le Calvez, p. 82, pl. 14, figs. 1, 2 (neotype), figs. 3, 4.
 1997 *Quinqueloculina poeyana* d'Orbigny - Haig, p. 272, fig. 4; 4, 5.
 2009 *Quinqueloculina poeyana* d'Orbigny - Parker, p. 237, fig. 173/a-g

Test elongate, quinqueloculine, almost two times as broad as long; rounded periphery; chambers slightly inflated; sutures are distinct; wall surface smooth with regular longitudinal costae; aperture terminal at the end of a neck, with a slightly everted thin lip and a simple bifid tooth.

Quinqueloculina polygona d'Orbigny, 1839

Pl. 14, figs. 31-33.

1839a *Quinqueloculina polygona* - d'Orbigny, in de la Sagra, p. 198; pl. 12, figs 21-23.

1921 *Quinqueloculina polygona* d'Orbigny - Cushman, p. 66, pl. 16, figs. 3, 4.

1929a *Quinqueloculina polygona* d'Orbigny - Cushman, p. 28, pl. 3, fig. 5/a-c.

1932 *Quinqueloculina polygona* d'Orbigny - Cushman, p. 25, pl. 6, fig. 6.

2012 *Quinqueloculina polygona* d'Orbigny - Debenay p. 125, 273.

Test longer than broad, quinqueloculine, chambers distinct; slightly concave at the periphery between the two keels; sutures slightly depressed; surface usually dull but with numerous fine linear depressions; aperture circular at the end of a short distinct neck with a peritomal lip and a bifid tooth.

Quinqueloculina aff. Q. polygona d'Orbigny, 1839

Pl. 14, figs. 34-36.

Test quinqueloculine, almost twice long as wide, somewhat compressed laterally, chambers distinct; peripheral margin acute; sutures slightly depressed and indistinct; wall covered with agglutinated material, matte, but with few longitudinal costae; aperture semi-circular at the end of a short distinct neck with a peritomal lip and a simple tooth.

Quinqueloculina cf. Q. polygona d'Orbigny, 1839

Pl. 15, figs. 1-3.

1932 *Quinqueloculina polygona* d'Orbigny - Cushman, p. 25; pl. 6, fig. 6.

2012 *Quinqueloculina polygona* d'Orbigny - Debenay p. 125, 273.

Test elongated, almost three times wide as long, quinqueloculine, subrectangular in oral view with four distinct acute edges; sutures distinct and depressed; wall nearly smooth, with numerous arenaceous materials; chambers compressed, flattened; aperture subrounded, terminally produced at the end of a distinct neck with a short bifid tooth.

Quinqueloculina cf. Q. pusilla McCulloch, 1977

Pl. 15, figs. 4-7.

1977 *Quinqueloculina pusilla* - McCulloch, p. 503, pl. 216, fig. 9.

Test elongate and slender, fusiform, about two times higher than wide, quinqueloculine; wall roughly finished with numerous arenaceous materials; Chambers inflated and gradually increasing in size from the proloculus; periphery rounded; aperture terminal, produced at the end of a short neck and provided with a bifid tooth.

Quinqueloculina quinquecarinata (Collins, 1958)

Pl. 15, figs. 8-19.

1958 *Quinqueloculina quinquecarinata* - Collins, p. 360, pl. 2, fig. 8

1987 *Quinqueloculina quinquecarinata* Collins - Baccaert, p. 103, pl. 48, figs. 1-2

1988 *Quinqueloculina quinquecarinata* Collins - Haig, p. 234, pl. 7, figs. 21-25

1993 *Cycloforina quinquecarinata* (Collins) - Hottinger et al. p. 49, pl. 33, figs. 7-15.

2009 *Quinqueloculina quinquecarinata* Collins - Parker, p. 248, figs. 176, 177.

2012 *Quinqueloculina quinquecarinata* Collins - Debenay p. 125, 273.

Test small, elongate, quinqueloculine; sutures depressed and distinct; chambers distinct with sharply acute and carinate peripheral margins; wall smooth and glossy; aperture produced at the end of a short neck with a somewhat thick lip and a bifid tooth.

Quinqueloculina aff. Q. quinquecarinata (Collins, 1958)

Pl. 15, figs. 20-25.

Test free, calcareous, quinqueloculine, nearly as broad as long; sutures distinct and depressed, chambers compressed, slightly produced at the aboral end; periphery strongly acute but not carinate; wall smoothly finished and shiny; aperture subcircular, terminal at the end of the last chamber with a thick rim and a short bifid tooth.

Quinqueloculina cf. Q. rugosa d'Orbigny, 1826

Pl. 15, figs. 26-29.

1826 *Quinqueloculina rugosa* - d'Orbigny, p. 302; no. 24.

1917 *Quinqueloculina rugosa* d'Orbigny - Cushman, p. 53.

1921 *Quinqueloculina rugosa* d'Orbigny - Cushman, p. 429, pl. 100, fig. 6/a-c.

1971 *Quinqueloculina rugosa* d'Orbigny - Rasheed, p. 22, 23, pl. 4, fig. 1.

1988 *Quinqueloculina cf. Q. rugosa* d'Orbigny - Haig, p. 234; pl. 8, figs 1-5.

2012 *Quinqueloculina* cf. *Q. rugosa* d'Orbigny - Debenay, p. 126, 273.

Test longer than broad, sutures depressed and chambers distinct; wall being conspicuously pitted and rugose, not from accretion of extraneous material but likely to abrasion; aperture subrounded with thick rim and a slender bifid tooth, produced at the end of a distinct neck.

Quinqueloculina seminula (Linnaeus, 1758)

Pl. 15, figs. 30-37.

1758 *Serpulum seminulum* - Linnaeus, p. 76, not figured.

1964 *Quinqueloculina seminula* (Linné) - Loeblich and Tappan, fig. 349, nos 1a-c.

1994 *Quinqueloculina incisa* Vella - Loeblich and Tappan, p. 49; pl. 80, figs 13-15.

2009 *Quinqueloculina seminula* (Linnaeus) - Parker p. 251, figs 180a-l; 181a-j; 182a-f.

2012 *Quinqueloculina seminula* (Linnaeus) - Debenay p. 126, 273.

Test elongate, ovate in lateral view, cryptoquinqueloculine to quinqueloculine; periphery rounded; chambers slightly inflated aborally; sutures slightly depressed; wall smooth, glossy and polished; aperture arched without a neck, provided with a bifid tooth and a thick rim.

Quinqueloculina aff. Q. semiplicata (McCulloch, 1977)

Pl. 16, figs. 1-3.

1977 *Quinqueloculina semiplicata* - McCulloch, p. 507, pl. 217, figs. 7-8, 11, 13, 17, p. 218, figs. 1, 13

1993 *Cycloforina semiplicata* (McCulloch) - Hottinger et al. p. 49, pl. 34, figs. 1-8

1998 *Cycloforina semiplicata* (McCulloch) - Haunold and Piller, p. 16, pl. 3, fig. 16

Test elongate, quinqueloculine, almost two times higher than broad; periphery rounded, somewhat serrate; wall rough and faintly agglutinated, ornamented by columns of horizontal to slightly inclined grooves, collumns forming sinous margins of chambers; aperture rounded, terminal on a short neck with a simple bifid tooth.

Quinqueloculina sidebottomi (Rasheed, 1971)

Pl. 16, figs. 4-12.

1971 *Triloculina sidebottomi* - Rasheed, p. 38-39, pl. 6, fig. 4

1988 *Quinqueloculina sidebottomi* (Rasheed) - Haig, p. 234, pl. 8, figs. 10-14

2009 *Quinqueloculina sidebottomi* Rasheed - Parker, Fig. 184a-c

2013 *Cycloforina sidebottomi* Rasheed - Langer et al. pl. 4, fig. 37.

Test small, cryptoquinqueloculine, rounded periphery; three chambers visible in the final whorl; wall ornamented with numerous costae which runs through the entire test to the lip region, but could be few in others; sutures depressed; aperture rounded with a thick lip, produce at the end of a distinct short neck provided with a simple tooth.

Quinqueloculina cf. Q. sidebottomi (Rasheed, 1971)

Pl. 16, figs. 13-17.

2013 *Cycloforina sidebottomi* Rasheed - Langer et al. pl. 4, fig. 37

Test small, cryptoquinqueloculine, rounded periphery; wall smoothly finished; sutures depressed; aperture rounded with a thick inverted lip, produce at the end of a distinct short neck provided with a simple tooth.

Quinqueloculina cf. Q. socorroensis McCulloch, 1977

Pl. 16, figs. 18-23.

1977 *Quinqueloculina socorroensis* - McCulloch, p. 508, pl. 215, figs. 10, 15.

1988 *Quinqueloculina sulcata* d'Orbigny - Haig, pl. 8, figs. 20, 21, not figs. 18, 19, specimens examined.

1992a *Quinqueloculina polygona* d'Orbigny - Hatta and Ujiie, p. 68, pl. 8, figs 5a, b.

2009 *Quinqueloculina* cf. *Q. socorroensis* McCulloch - Parker, figs. 185/a-d, 186/a-f.

Test slender, not robust, elongate, almost four times longer than broad, with straight and angular edges, the aboral and oral ends are produced; wall surface is roughly finished and ornamented by longitudinally aligned striae; aperture subcircular, at the end of a long neck, thick rim and a bifid tooth.

Quinqueloculina subcuneata Cushman, 1921

Pl. 16, figs. 24-26.

1921 *Quinqueloculina crassa* d'Orbigny var. *subcuneata* - Cushman p. 423; pl. 89, figs 4a-c.

- 1929 *Quinqueloculina crassa* d'Orbigny var. *subcuneata* Cushman - Cushman, p. 30; pl. 5, figs 1a-c.
 1932 *Quinqueloculina crassa* d'Orbigny var. *subcuneata* Cushman - Cushman, p. 21; pl. 5, figs 8a-c.
 1966 *Quinqueloculina subcuneata* Cushman - Todd, p. 130; pl. 17, fig. 6.
 2012 *Quinqueloculina subcuneata* Cushman - Debenay p. 126, 273.

Test short, almost as long as broad, slightly inflated, subcircular, subtriangular in top view; chambers distinct with five visible externally; periphery sharp angled; wall ornamented with raised costae almost parallel to one another within the chambers; aperture an oval arch with a simple tooth thickened at the tip.

Quinqueloculina subpolygona Parr 1945

- Pl. 16, figs. 27-35.
 1945 *Quinqueloculina subpolygona* - Parr, p. 196, pl. 12, figs. 2/a-c.
 1999 *Quinqueloculina subpolygona* Parr - Hayward *et al.* p. 104, pl. 5, figs. 11-13.
 2009 *Quinqueloculina subpolygona* Parr - Parker, p. 262, figs. 191/a-j, 192/a-l.
 2012 *Quinqueloculina subpolygona* Parr - Debenay, p. 127, 273.

Test elongate, somewhat compressed, about 2 times as long as broad; chambers with a quadrangular periphery; aperture subquadrangular, *Lachlanella* type, with a peristomal lip, provided with a long narrow tooth with a small bifid end and produced on a very short neck.

Quinqueloculina cf. Q. subpolygona Parr 1945

- Pl. 16, figs. 36-38.
 2009 *Quinqueloculina subpolygona* Parr - Parker, p. 262, figs. 191/a-j, 192/a-l.
 2012 *Quinqueloculina subpolygona* Parr - Debenay, p. 127, 273.

Test elongate, nearly twice as long as broad, biconcave in oral view, initial chambers quinqueloculine, later chambers spiroloculine, last chambers almost similar in width; periphery acute angled, rectangular in oral view; wall rough, covered with agglutinated materials; aperture subquadrangular, produced on a short neck with thick rim and a bifid tooth.

Quinqueloculina cf. Q. tantabiddyensis? Parker, 2009

- Pl. 17, figs. 1-4.
 2009 *Quinqueloculina tantabiddyensis* Parker, p. 265, figs. 192/a-j; 193/a-h, 194/a-l, 195/a-f.

Test elongate, quinqueloculine, almost three times higher than wide, roundly triangular in crosssection; wall smooth; oral end truncated, aboral end rounded; periphery rounded; sutures depressed and distinct; aperture produced, high arch, with peristomal lip, provided with a simple bifid tooth.

Remarks: our specimen lack the *Lachlanella*-type aperture described originally by Parker 2009.

Quinqueloculina transversistriata (Brady, 1881)

- Pl. 17, figs. 5-7.
 1881 *Miliolina transversistriata* - Brady, p. 45; pl. 4, fig. 6.
 1884 *Miliolina transversistriata* Brady - Brady, p. 177, pl. 4, figs. 6a-c
 1915 *Miliolina transversistriata* Brady - Heron Allen and Earland, p. 566, pl. 42, figs. 17-20
 1957 *Triloculina transversistriata* (Brady) - Todd, p. 288, pl. 85, figs. 16 a-b
 1958 *Quinqueloculina transversistriata* (Brady) - Collins, p. 370
 1988 *Quinqueloculina transversistriata* (Brady) - Haig, p. 234; pl. 8; figs 22-24.
 2011 *Pitella transversistriata* (Brady) - Makled and Langer, figs. 6/17-21.
 2012 *Quinqueloculina transversistriata* (Brady) - Debenay, p. 127, 274.

Test elongate, laterally compressed, more than two times longer than broad; periphery subacute; wall surface ornamented by numerous obliquely transverse costae; surface could also be smooth; aperture produced on a short neck, rounded, with a slightly thickened rim and a small simple tooth.

Quinqueloculina vandiemeniensis Loeblich and Tappan, 1994

- Pl. 17, figs. 8-11.
 1994 *Quinqueloculina vandiemeniensis* - Loeblich and Tappan, p. 51; pl. 83, figs 1-3.
 2009 *Quinqueloculina vandiemeniensis* Loeblich and Tappan - Parker, p. 277; figs. 201a-h; 202a-k; 203a-j.
 2012 *Quinqueloculina vandiemeniensis* Loeblich and Tappan - Debenay p. 128.

Test quinqueloculine, small, elongate, with nearly parallel sides and subacute periphery, subrectangular in outline. Sutures depressed; wall calcareous, porcelaneous, smooth, oral and aboral ends truncated: aperture terminal, with thickened rim, not produced, provided with a short, thick bifid tooth.

Quinqueloculina zhengi Parker, 2009

Pl. 17, figs. 12-21.

1957 *Quinqueloculina fusiformis* Petri, p. 36, pl. 1, figs. 10, 11.

1979 *Quinqueloculina fusiformis* Zheng, p. 126, 206, pl. 5, figs. 7a-d, tf. 3.

1993 *Quinqueloculina fusiformis* Zheng - Ujiie and Rifardi, p. 122, p l. 1, fig. 5.

2009 *Quinqueloculina zhengi* Parker, p. 285, figs. 206, 207.

2012 *Quinqueloculina zhengi* Parker - Debenay p. 128, 274.

Test quinqueloculine, small, elongate, about two times higher than wide, ovate in lateral view, triangular in cross-section; oral and aboral end slightly produced, periphery carinate, typically becoming bicarinate towards the oral and aboral ends; ultimate and penultimate chambers are bicarinate; sutures depressed and curved; aperture terminal, subrounded and produced at the end of a distinct neck with an everted lip and a slender bifid tooth.

Quinqueloculina. cf. Q. zhengi Parker, 2009

Pl. 17, figs. 22-28.

2009 *Quinqueloculina zhengi* Parker, p. 285, figs. 206, 207.

Test small, quinqueloculine, slightly compressed, with carinated periphery; wall roughly finished with numerous fine striae; sutures depressed; Chamber distinct, and moderately enlarging; aperture rounded, produced at the end of a distinct neck, with a peristomal rim and a bifid tooth.

Quinqueloculina sp. 1

Pl. 17, figs. 29, 30.

Test large, quinqueloculine; chambers distinct, twisted and curved, slightly inflated and elongated at both the aboral to oral ends; wall roughly finished; periphery subacute to subrounded; sutures depressed; aperture rounded, produced at the end of a distinct neck that is tilted, with short bifid tooth.

Quinqueloculina sp. 2

Pl. 17, figs. 31-34.

Test small, twice as long as wide, quinqueloculine; sutures slightly distinct and slightly depressed; wall nearly smooth, with numerous oblique micro striae; chambers compressed and flattened, with sharply acute periphery; aperture rectangularly elongated, terminally produced at the end of a flattened neck with a long simple tooth.

Quinqueloculina sp. 3

Pl. 18, figs. 1-3.

Test free, calcareous, compressed, subfusiform, quinqueloculine, subrectangular in oral view; sutures distinct and depressed; chambers slightly inflated, symmetrical from the aboral end to the oral end; wall rough, ornamented with numerous micro striae; periphery slightly rounded; aperture compressed, subrounded, terminal at the end of a distinct neck with a peristomal lip and a long tooth.

Quinqueloculina sp. 4

Pl. 18, figs. 4, 5.

Test free, calcareous, quinqueloculine, a little longer than thick rim and a short bifid tooth. broad; sutures distinct and depressed, chambers inflated; periphery margin strongly acute to rounded; wall smoothly finished and shiny; aperture subcircular, terminal at the end the last chamber with a

Quinqueloculina sp. 5

Pl. 18, figs. 6-8.

2012 *Quinqueloculina* sp. 1 - Debenay, p. 128, 274.

Test quinqueloculine, longer than broad, elliptical in side view, somewhat compressed; sutures fairly distinct, chambers polygonal in section; periphery keeled, the keel dichotomously branching towards the aboral end; periphery concave between the keels; wall smooth; aperture subcircular at the end of a short neck, and with a short, anvil-shaped tooth.

Quinqueloculina sp. 6

Pl. 18, figs. 9-11.

Test free, calcareous, quinqueloculine, sutures slightly distinct and depressed; chambers distinct and compressed; periphery rounded at the penultimate chamber but keeled at the last chamber; wall ornamented with many oblique well developed, longitudinal costate; aperture oval, terminal at the end of a short neck with a short simple tooth.

Quinqueloculina sp. 7

Pl. 18, figs. 12-14.

Test free, almost equal in height and width, calcareous, quinqueloculine, sutures slightly distinct and depressed, oval in oral view; chambers distinct and compressed, two last chambers increasing rapidly in size; periphery rounded; wall smoothly finished; aperture oval, terminal at the end of a short neck with a simple tooth.

Quinqueloculina sp. 8

Pl. 18, figs. 15-17.

Test oval in lateral view, almost two times higher than wide, quinqueloculine, sutures slightly distinct and depressed; chambers inflated; periphery rounded but ornamented with low relief longitudinal costae which terminate at the neck and aboral ends; aperture terminal, produced on a broad short neck with a short tooth with large bifid termination.

Quinqueloculina sp. 9

Pl. 18, figs. 18-23.

Test small, subfusiform, quinqueloculine, three chambers visible; wall smoothly finished; Chambers somewhat compressed; periphery subrounded; aperture terminal with a thick lip, produced at the end of the last chamber and provided with a bifid tooth.

Quinqueloculina sp. 10

Pl. 18, figs. 24-26.

Test small, quinqueloculine; wall roughly finished with numerous pits; Chambers slightly inflated and distinct; periphery rounded; aperture terminal, produced at the end of a short neck and provided with a small bifid tooth.

Quinqueloculina sp. 11

Pl. 18, figs. 27-29.

Test elongate, robust, about two times higher than wide, quinqueloculine; wall smoothly finished with faint striae; Chambers inflated; periphery rounded; aperture terminal produced at the end of a tapering short neck and provided with a small bifid tooth.

Quinqueloculina sp. 12

Pl. 18, figs. 30-32.

Test elongate, subquadrate, more than two times higher than wide, quinqueloculine, calcareous; sutures slightly depressed; chambers distinct and slightly compressed; periphery subacute; wall roughly finished; aperture subrounded, terminal at the end of a short neck with a thickened peristomal rim and simple tooth that thickens at the end tip.

Quinqueloculina sp. 13

Pl. 18, figs. 33-35.

Test elongate, about three times higher than wide, quinqueloculine, subtriangular in apertural view, oral and aboral ends produced, periphery acute; wall matte, covered in thin anastomosing striae; sutures distinct and depressed; aperture rounded, terminal on a short neck with a thick lip and a slightly bifid tooth.

Quinqueloculina sp. 14

Pl. 19, figs. 1-4.

1988 *Quinqueloculina* sp. C - Haig, p. 230, pl. 9, figs. 7-9

2009 *Quinqueloculina* sp. 13 - Parker, p. fig. 225.

Test elongate, quinqueloculine, almost two times higher than broad, subtriangular in oral view; oral and aboral ends produced; chambers slightly inflated; wall roughly finished; sutures slightly slightly depressed, broadly curved; aperture terminal, oval, produced on short neck, with everted peristomal lip and a short slightly bifid tooth.

Quinqueloculina sp. 15

Pl. 19, figs. 5-7.

1951b *Quinqueloculina* cf. *agglutinans* d'Orbigny - Asano, p. 2, figs. 4, 5.

1988 *Quinqueloculina agglutinans* d'Orbigny - Haig, p. 233, pl. 4, figs. 12-14.

1994 *Agglutinella agglutinans* (d'Orbigny) - Loeblich and Tappan, p. 44, pl. 70, figs. 1-9.

1997 *Quinqueloculina agglutinans* d'Orbigny; Haig, p. 271, not figured, specimens examined.

2009 *Quinqueloculina* sp. 2 - Parker, p. 175, fig. 212.

Test quinqueloculine, slightly higher than wide, ovate in lateral view, broadly triangular in oral view, periphery broadly rounded, oral end truncated, aboral end produced and rounded;; chambers inflated at the aboral end; sutures indistinct, concealed by the coarse agglutinated grains; ; wall coarsely agglutinated with large rounded agglutinated grains incorporated into the wall structure; aperture low arch-shaped , with smooth peristomal rim that is slightly thickened, with tooth; tooth T- shaped, short, less than half of aperture height.

Quinqueloculina sp. 16

Pl. 19, figs. 8-10.

Test elongate, quinqueloculine, almost two times higher than broad; periphery margin acutely rounded, somewhat serrate; wall rough and faintly agglutinated, ornamented by columns of vertical to slightly inclined grooves, columns forming sinuous margins of chambers; aperture rounded, terminal on a short neck with a simple bifid tooth

Quinqueloculina sp. 17

Pl. 19, figs. 11-13.

2012 *Quinqueloculina bradyana* Cushman - Debenay p. 120, 271.

Test small, slightly longer than broad, chambers angular, slightly plicated laterally; aperture lachlanella, terminal with a slightly everted lip and a simple tooth.

Quinqueloculina sp. 18

Pl. 19, fig. 14.

Test small, elongated, quinqueloculine; chambers inflated, sutures slightly distinct; wall smooth; aperture produced on a short curved neck, rounded, provided with a very short, bifurcate tooth.

Quinqueloculina sp. 19

Pl. 19, figs. 15-17.

Test longer than broad, quinqueloculine, chambers distinct; wall very coarsely costate with somewhat irregular contour, aperture rounded at the end of a short strongly costate neck, slightly everted rim and provided with a bifid tooth.

Quinqueloculina sp. 20

Pl. 19, figs. 18-19.

Test very small, almost as long as broad, quinqueloculine, chambers indistinct; wall covered with agglutinate materials, wavy costate with irregular contour.; aperture rounded at the end of the last chamber, with slightly thickened rim and a tooth.

Quinqueloculina sp. 21

Pl. 19, figs. 20, 21.

Test robust, length almost as broad, triangular in top view, periphery margin bluntly acute; wall matte, roughly finished, show somewhat fine striae up to the neck region, with coarse-grained agglutinated materials; aperture is circular produced on a very short neck, finished with an everted lip and a simple tooth.

Quinqueloculina sp. 22

Pl. 19, figs. 22-24.

Test elongate, laterally slightly compressed, more than two times longer than broad; peripheral margin carinate; wall surface smooth; aperture produced on a short neck, rounded, with a slightly thickened rim and a small simple tooth.

Quinqueloculina sp. 23

Pl. 19, figs. 25-31

Test elongate, almost three time higher than wide, quinqueloculine, sutures slightly distinct and depressed; periphery slightly concave between the raised costae, some specimen show fewer costae; wall ornamented with longitudinal costae from the aboral end to the apertural end; aperture terminal, produced on a broad short neck with a short tooth with large bifid termination. This is probably a new species.

Genus *Affinetrina* Luczkowska, 1972

Affinetrina sp. 1

Pl. 19, figs. 32, 33.

Test free, porcelaneous imperforate, quinqueloculine, laterally compressed; chambers one-half coil in length, slightly inflated, sutures slightly depressed but distinct; periphery rounded; wall ornamented with numerous microstriae giving it a rough appearance; aperture terminal, lachlanella type with peristomal lip and a long simple tooth.

Genus **Miliolinella** Wiesner, 1931

Miliolinella australis (Parr, 1932)

Pl. 19, figs. 34-36.

1932 *Quinqueloculina australis* - Parr, p. 7, pl. 1, fig. 8.

1954 *Miliolinella australis* (Parr) - Cushman, Todd and Post, p. 334, pl. 84, figs. 3, 4.

1957 *Miliolinella australis* (Parr) - Todd, p. 286, pl. 87, fig. 15.

1974a *Miliolinella australis* (Parr) - Ponder, p. 127-133, pl. 1, figs 1-5, pl. 2, figs. 1-5, pl. 3, figs. 1-12.

1987 *Miliolinella australis* (Parr) - Baccaert, p. 137, pl. 60, figs. 6, 7.

1988 *Miliolinella australis* (Parr) - Haig, p. 224, pl. 2, fig. 14.

2009 *Sigmamiliolinella australis* (Parr) - Parker, p. 330, figs. 239/a-c

Test, robust, sigmoiline, subcircular lateral view; periphery broadly rounded; Chambers semicircular in shape and slightly inflated; wall covered partially by calcite coating; aperture is terminal with a thick lip and a flaplike tooth.

Remarks: Parker (2009) placed this species in *Sigmamiliolinella australis* because of the sigmoiline chamber arrangement.

Miliolinella cf. M. circularis (Bornemann, 1855)

Pl. 20, fig. 1.

1855 *Triloculina circularis* - Bornemann, p. 349, pl. 19, fig. 4.

1994 *Miliolinella heligmateira* - Loeblich and Tappan, p. 51, pl. 89, figs. 16-18.

2009 *Miliolinella circularis* (Bornemann) - Parker, p. 120, figs. 85/a-c.

Test milioline, almost perfectly circular in lateral view; three chambers visible in lateral view; wall smooth and translucent; aperture a low arch, with flap-shaped tooth in front of the aperture.

Miliolinella labiosa (d'Orbigny, 1839)

Pl. 20, figs. 2-4.

1839a *Triloculina labiosa* - d'Orbigny, p. 178, pl. 10, figs. 12-14.

1954 *Triloculina labiosa* (d'Orbigny) - Cushman, Todd and Post, p. 334, pl. 84, figs. 5, 6.

1988 *Miliolinella labiosa* (d'Orbigny) - Zheng, p. 250, pl. 22, fig. 8.

1994 *Miliolinella labiosa* (d'Orbigny) - Loeblich and Tappan, p. 52, pl. 87, figs. 10-12.

2012 *Miliolinella labiosa*, (d'Orbigny) - Debenay p. 109, 275.

Test much wider than high, irregular in outline, surface largely composed of the two last-formed chambers; chambers often somewhat irregular; periphery rounded; surface smooth but dull; aperture irregular, a sinuous arch, with a smoothly finished narrow bordering lip but without a true tooth.

Miliolinella oceanica (Cushman, 1932)

Pl. 20, figs. 5-7.

1932 *Triloculina oceanica* Cushman, 1932, p. 54, pl. 12, fig. 3.

1974 *Miliolinella oceanica* (Cushman) - Ponder, p. 133-137, pl. 4, figs. 1-5; pl. 5, figs. 1-11.

1988 *Miliolinella oceanica* (Cushman) - Haig, p. 224, pl. 2, figs. 16-18.

2009 *Miliolinella oceanica* (Cushman) - Parker, p. 120, fig. 86/a-h.

2013 *Miliolinella oceanica* (Cushman) - Langer et al. fig. 5/42.

Test higher than wide, quinqueloculine coil; wall roughly finished; sutures slightly depressed; chambers are angular; aperture miliolinella-like.

Miliolinella pilasensis McCulloch, 1977

Pl. 20, figs. 8-13.

1977 *Miliolinella pilasensis* - McCulloch, p. 566, pl. 238, fig. 16.

1994 *Triloculina pilasensis* (McCulloch) - Loeblich and Tappan, p. 57, pl. 99, figs 1-9.

2012 *Miliolinella pilasensis* McCulloch - Debenay p. 110.

Test robust, subcircular in lateral view, somewhat compressed; periphery rounded; sutures depressed and distinct; last formed chamber strongly inflated at its initial end, tapered towards the aperture; wall imperforate, smooth and polished; aperture a low arch with an apertural flap that leaves only a long narrow opening.

Miliolinella subrotunda (Walker and Boys, 1784)

Pl. 20, figs. 14-17.

1784 *Serpula subrotunda dorso elevata* - Walker and Boys, p. 2, pl. 1, fig. 4

1808 *Vermiculum subrotundum* - Montagu, p. 521, pl. 1, fig. 4.

1923 *Miliolina subrotunda* (Walker and Boys) - Wiesner, p. 69, pl. 13, figs. 165-169

1964 *Miliolinella subrotunda* (Montagu) - Loeblich and Tappan, p. 466, pl. 350, figs. 1-3.

1988 *Miliolinella labiosa* (d'Orbigny) - Haig, pl. 2, fig. 15

2009 *Miliolinella subrotunda* (Montagu) - Parker, p. 124, figs. 88/a-j, figs. 89/a-g.

2012 *Miliolinella subrotunda* (Montagu) - Debenay, p. 110, 275.

Test milioline, 3-4 inflated chambers visible, strongly overlapping previous ones, arranged almost planispirally in adults; wall smooth, sometimes translucent; aperture somewhat triangular in profile, low and broad flap-shaped tooth in front of the aperture, that may lack in some specimens.

Miliolinella cf. M. subrotunda (Walker and Boys, 1784)

Pl. 20, figs. 18, 19.

Test milioline, somewhat twisted; wall covered partially by calcite coating; aperture somewhat large, with low and broad flap-shaped tooth in front of the aperture.

Miliolinella sp. 1

Pl. 20, figs. 20, 21.

Test milioline, robust, subcircular in lateral view; wall smooth, sometimes translucent; aperture a low arch, broad flap-shaped tooth in front of the aperture.

Miliolinella sp. 2

Pl. 20, figs. 22, 23.

Test milioline, subcircular in lateral view, somewhat compressed; wall smooth, sometimes translucent; aperture a low arch, broad flap-shaped tooth in front of the aperture.

Miliolinella sp. 3

Pl. 20, figs. 24-26.

Test free, calcareous, initial quinqueloculine; sutures depressed and distinct; wall smooth, thin, imperforate; three chambers visible on each side; aperture curved, semicircular opening filled in part by a flaplike tooth.

Genus **Pseudomassilina** Lacroix, 1938.

Pseudomassilina cf. P. australis (Cushman, 1932)

Pl. 20, figs. 27-29.

1932 *Massilina australis* - Cushman, p. 32, pl. 8, fig. 2.

1987 *Pseudomassilina australis* (Cushman) - Loeblich and Tappan, p. 341, pl. 349, figs. 20-22.

Test flattened, initial quinqueloculine; wall calcareous imperforate, smooth, planispirally enrolled, with a carinate periphery; chambers broad, flattened and elongate, rapidly enlarging; all chambers visible from both sides of the test; aperture terminal, oval, with an everted lip produced at the end of the last chamber.

Genus **Pseudotriloculina** Cherif, 1970

Pseudotriloculina cf. P. limbata (d'Orbigny, 1826)

Pl. 20, figs. 30-32.

1949 *Quinqueloculina limbata* d'Orbigny - Said, pl. 2, fig. 14.

1993 *Pseudotriloculina* sp. B - Hottinger, p. 57, pl. 49, figs. 1-7.

2013 *Pseudotriloculina* sp. C - Makled and Langer, p. 239, fig. 5/35-37.

Test small, flattened, calcareous; sutures faint; Chambers are indistinct; wall smoothly finished, carinated by two to three longitudinal costae; periphery subacute; aperture rounded produced on a short neck with a thick everted lip and a bifid tooth. The tooth is characterized by a short stem and a u shaped bifid extensions.

Pseudotriloculina cf. P. oblonga (Montagu, 1803)

Pl. 21, figs. 1-7.

1803 *Vermiculium oblongum* - Montagu p. 522, pl. 14, fig. 9.

1988 *Quinqueloculina* cf. *Q. oblonga* Montagu - Haig, p. 234; pl. 6, figs 26-29.

2012 *Quinqueloculina* cf. *Q. oblonga* Montagu - Debenay p. 124, 272.

Test elongate, quinqueloculine, subelliptical in lateral view, oval in cross section; sutures faintly depressed and distinct; wall smooth and shiny; aperture terminal, ovate, without an everted lip and provided with a bifid tooth with long base and short branches.

***Pseudotriloculina subgranulata* (Cushman, 1918)**

Pl. 21, figs. 8-14.

1918 *Triloculina subgranulata* Cushman, p. 290; pl. 96, fig. 4.

1987 *Triloculina linneiana* d'Orbigny var. *subgrabulata* Cushman - Baccaert, p. 129, 130; pl. 58, figs 1, 2.

1993 *Pseudotriloculina subgranulata* (Cushman) – Hottinger et al. p. 56, pl. 47, figs. 8-13, pl. 48, figs. 1-8.

1998 *Pseudotriloculina subgranulata* (Cushman) – Haunold and Piller, p. 19, pl. 5, fig. 8

2009 *Quinqueloculina subgranulata* (Cushman) - Parker, p. 259, figs. 187/a-j

2011 *Pseudotriloculina subgranulata* (Cushman) - Makled and Langer, fig. 5/25-30.

2012 *Pseudotriloculina subgranulata* (Cushman) – Debenay, p. 116, 276, pl. 7

Test large, cryptoquinqueloculine, three chambers visible laterally; sutures distinct and depressed; chambers are slightly inflated; wall finely granular with surface undulations; periphery rounded; aperture large, subrounded, with thickened peristomal lip and a large bifid tooth.

***Pseudotriloculina* cf. *T. sommeri* (Tinoco, 1955)**

Pl. 21, figs. 15-17.

1955 *Triloculina sommeri* Tinoco, p. 24, pl. 2, figs. 8, 9.

1988 *Quinqueloculina akneriana* d'Orbigny - Zheng, p. 192, pl. 3, figs. 12, 13, pl. 4, figs. 1-3, pl. 6, fig. 4, pl. 23, figs. 7, 8, pl. 30, figs. 1, 2, text fig. 9.

1994 *Triloculina sommeri* Tinoco - Leoblich and Tappan, p. 56, pl. 84, figs. 1-12.

Test subcircular in lateral view, somewhat compressed; three chambers visible in lateral view; sutures faintly depressed; wall smooth; aperture subcircular, with a simple tooth.

***Pseudotriloculina* sp. 1**

Pl. 21, figs. 18-21.

Test calcareous, two chambers visible laterally; periphery rounded; sutures slightly depressed; wall porcelaneous, surface slightly rough; aperture roughly subquadrate, terminal at the end of the last chamber, provided with a bifid tooth.

***Pseudotriloculina* sp. 2**

Pl. 21, figs. 22-24.

Test calcareous, three chambers visible laterally; periphery rounded; sutures slightly depressed; wall porcelaneous, surface smooth; aperture roughly subquadrate, terminal at the end of the last chamber, provided with a bifid tooth.

***Pseudotriloculina* sp. 3**

Pl. 21, figs. 25-27.

1932 *Triloculina oblonga* d'Orbigny - Cushman, p. 50, pl. 11, figs. 10/a-c.

1959 *Triloculina oblonga* d'Orbigny - Graham and Militante, p. 56, pl. 8, figs. 8, 9.

Test elongate, more than two times longer than broad, triloculine arrangement with three chambers always visible with the last formed chamber broadest near the initial end and longer than the preceeding ones; sutures slightly depressed; periphery rounded; wall smooth and usually polished; aperture oval with a long narrow tooth with bifid termination.

***Pseudotriloculina* sp. 4**

Pl. 21, figs. 28, 29.

Test calcareous, two chambers visible laterally; periphery rounded; sutures slightly depressed; wall porcelaneous, surface slightly rough; aperture roughly subquadrate, terminal at the end of the last chamber, provided with a u-shaped bifid tooth.

***Pseudotriloculina* sp. 5**

Pl. 21, figs. 30-32.

Test free, porcelaneous imperforate, quinqueloculine, laterally compressed; chambers one-half coil in length, slightly inflated, sutures slightly depressed but distinct, periphery rounded, aperture terminal, subcircular, with a very thick peristomal lip and a short simple tooth.

Pseudotriloculina sp. 6

Pl. 21, figs. 33-36.

Test small, slightly compressed laterally, about two times as wide as long, elliptical in lateral view, elongated with a rounded periphery; five chambers visible; wall imperforate, ornamented by numerous, deep, longitudinal grooves; aperture terminal, circular, produced on a short neck, provided with a short T-shaped tooth

Pseudotriloculina sp. 7

Pl. 22, figs. 1-3.

Test porcelaneous, almost two times higher than wide, oval in apertural view; chambers arranged in triloculine pattern, with three visible in lateral view; periphery rounded, wall surface with anastomosing microstriae giving the test a rough appearance; aperture U-shaped, bordered by a thickened peristomal lip and provided with a short bifid tooth

Pseudotriloculina? sp. 8

Pl. 22, figs. 4, 5.

Test large, elongated; wall smooth, porcelaneous; three chambers visible on the lateral side; aperture semicircular, with a thickened lip but no tooth.

Genus **Pyrgo** Defrance, 1824

Pyrgo denticulata (Brady, 1884)

Pl. 22, figs. 6, 7.

1884 *Biloculina ringens* (Lamarck) var. *denticulata* - Brady, p. 143; pl. 3, figs. 4, 5.

1987 *Pyrgo denticulata* (Brady) - Baccaert, p. 113; pl. 51, figs. 5, 6; pl. 52, fig. 1.

1988 *Pyrgo denticulata* (Brady) - Haig, p. 233, pl. 3, fig. 28.

2009 *Pyrgo denticulata* (Brady) - Parker, p. 168, figs. 119/a-h.

2012 *Pyrgo denticulata* (Brady) - Debenay, p. 117, 276.

Test biloculine, involute, sub-circular in outline, with a carinate peripheral margin and a serrated aboral margin; wall smooth; aperture at the end of the last chamber, ovate, provided with a broadly T-shaped tooth with prominent lateral extensions and a narrow stem.

Pyrgo phlegeri Andersen, 1961

Pl. 22, figs. 8-10.

1961 *Pyrgo phlegeri* - Andersen, p. 38, pl. 8, fig. 1.

1993 *Pyrgo phlegeri* Andersen - Hottinger *et al.* p. 57, pl. 50, figs. 7-12.

2012 *Pyrgo phlegeri* Andersen - Debenay, p. 117, 277.

Test biloculine, oval; periphery subacute, sutures faintly depressed; wall imperforate, smooth; aperture low and wide at the end of the last chamber, provided with a peristomal lip and tooth which has a broad base with prominent lateral extensions.

Pyrgo sarsi (Schlumberger, 1891)

Pl. 22, figs. 11-13.

1891 *Biloculina sarsi* - Schlumberger, p. 166, pl. 9, figs. 55-59; text-figs. 10-11.

1921 *Biloculina sarsi* Schlumberger - Cushman, p. 471, pl. 97, fig. 1; text-figs. 48-50.

1988 *Pyrgo sarsi* (Schlumberger) - Zheng, p. 229; pl. 12, figs. 6-10; pl. 13, figs. 1, 2; pl. 31, figs. 19-22; text-fig. 46.

1994 *Pyrgo sarsi* (Schlumberger) - Loeblich and Tappan, p. 54, pl. 94, figs. 1-9.

2012 *Pyrgo sarsi* (Schlumberger) - Debenay, p. 117, 277.

Test nearly circular in laterally, ends slightly truncated; periphery acute angled, somewhat produced; wall smooth; aperture broad, with the broadly T-shaped tooth, with prominent lateral extensions and a narrow stem.

Pyrgo striolata (Brady, 1884)

Pl. 22, figs. 14-19.

1884 *Biloculina ringens* (Lamarck) var. *striolata* - Brady, p. 143, pl. 3, figs. 7-8.

1915 *Biloculina ringens* (Lamarck) var. *striolata* Brady - Heron-Allen and Earland, p. 551

- 1917 *Biloculina denticulata* Brady var. *striolata* Brady – Cushman, p. 80, pl. 33, figs. 2-3
 1929 *Pyrgo denticulata* (Brady) var. *striolata* (Brady) – Cushman, p. 69, pl. 18, fig. 5
 1993 *Pyrgo striolata* (Brady) (s.l.) – Hottinger *et al.* p. 57, pl. 51, figs. 5-11

Test biloculine, involute in the adult stage, subrectangular; sutures distinct and depressed, sigmoidal in lateral view; wall smooth but ornamented with highly variable distinct longitudinal costae; aperture low and wide at the end of the last chamber, provided with a peristomal lip and tooth which has a broad base with prominent lateral extensions.

Pyrgo cf. P. striolata (Brady, 1884)

Pl. 22, figs. 20-22.

- 1917 *Biloculina denticulata* Brady var. *striolata* Brady – Cushman, p. 80, pl. 33, figs. 2-3
 1929 *Pyrgo denticulata* (Brady) var. *striolata* (Brady) – Cushman, p. 69, pl. 18, fig. 5
 1993 *Pyrgo striolata* (Brady) (s.l.) – Hottinger *et al.* p. 57, pl. 51, figs. 5-11

Test biloculine, involute; sutures distinct and depressed, sigmoidal in lateral view; wall smooth; aperture low and wide at the end of the last chamber, provided with a peristomal lip and tooth which has a broad base with prominent lateral extensions

Pyrgo sp. 1

Pl. 22, figs. 23, 24.

2012 *Pyrgo* sp. 3 - Debenay, p. 118, 277.

Test biloculine, ovate, elongate, tapering gradually to the apertural end, somewhat truncate; chambers somewhat obliquely added; periphery rounded, sutures depressed; wall imperforate, smooth; aperture elliptical provided with a flattened T-shaped tooth with a thick base.

Genus **Triloculina** d'Orbigny, 1826

Triloculina cf. T. assymetrica Said, 1949

Pl. 22, figs. 25-28.

- 1949 *Triloculina asymmetrica* - Said, p. 18, pl. 2, fig. 11.
 1993 *Triloculina asymmetrica* Said - Hottinger *et al.* p. 64, pl. 66, figs. 4-9.
 1998 *Triloculina asymmetrica* Said - Haunold and Piller, p. 20, pl. 6, fig. 2.
 2013 *Triloculina trigonula* (Lamarck) - Langer *et al.* p. 167, pl. 6, figs. 39, 40.

Test longer than wide, triloculine, shows three visible chambers; periphery broadly convex and the angles rounded; broadly twisted in end view; sutures distinct, slightly depressed; wall smooth; aperture terminal, rounded with a bifid tooth

Triloculina barnardi Rasheed, 1971

Pl. 22, figs. 29-31.

- 1971 *Triloculina terquemiana* (Brady) var. *barnardi* - Rasheed, p. 37; pl. 10, fig. 3.
 1988 *Triloculina barnardi* Rasheed - Haig, p. 235; pl. 11, figs 19-21.
 2009 *Triloculina barnardi* Haig - Parker, p. 358, figs 260a-m.
 2012 *Triloculina barnardi* Haig - Debenay, p. 136, 277.

Test longer than broad, triloculine, with sharp carinae; wall surface ornamented by low longitudinal costae that is strong; wall smooth and polished; aperture roughly triangular, produced on a short neck, with an everted lip and an elongate tooth which is bifurcated at the tip.

Triloculina cf. T. barnardi Rasheed, 1971

Pl. 22, figs. 32-35.

Test longer than broad, triloculine; wall surface ornamented by low longitudinal costae that is strong on the initial chambers; wall smooth and polished; aperture roughly triangular, produced on a short neck, with a slightly everted lip and an elongate tooth that is thickened at the tip.

Triloculina bicarinata d'Orbigny, 1839

Pl. 23, figs. 1-3.

- 1839a *Triloculina bicarinata* - d'Orbigny, in De la Sagra, p. 158, pl. 10, figs. 18-20.
 1992a *Triloculina bicarinata* d'Orbigny - Hatta and Ujiié, p. 73, pl. 11, figs. 8/a-b.
 2012 *Triloculina bicarinata* d'Orbigny - Debenay p. 136, 278.

Test slightly longer than broad, triloculine; sutures faintly depressed and distinct; chambers distinct with a truncate periphery; wall ornamented by reticulate pits; aperture elongated, with slightly everted lip and a tooth with bifid termination slightly extending above the outline of the aperture.

Triloculina earlandi Cushman, Todd and Post, 1954

Pl. 23, figs. 4-7.

1954 *Triloculina earlandi* - Cushman, Todd and Post, p. 338; pl. 85, fig. 3.

1988 *Triloculina funafutiensis* (Chapman) - Haig, p. 235; pl. 11, figs 22-24.

1992a *Triloculina earlandi* Cushman - Hatta and Ujiié, p. 73, pl. 12, figs. 1/a-c.

2009 *Triloculina earlandi* Cushman - Parker, p. 362, figs. 262/a-h.

2012 *Triloculina earlandi* Cushman - Debenay p. 136, 278.

Test, more than two times longer than broad, fusiform, with three visible chambers; periphery broadly rounded; wall smooth, matte, with longitudinal fine costate; aperture subcircular to ovate at the end of a broad neck, provided with a thickened lip and a short bifid tooth.

Triloculina elongotricarinata Debenay, 2012

Pl. 23, figs. 8-11.

2012 *Triloculina elongotricarinata* - Debenay, p. 136.

Test slender, elongate, more than two times longer than broad, triloculine arrangement with three chambers always visible, triangular in oral view; acute margins; wall smooth and polished; aperture high-arch shaped, provided with a long thin tooth with a short bifid termination.

Triloculina fichteliana d'Orbigny, 1839

Pl. 23, figs. 12-16.

1839a *Triloculina fichteliana* - d'Orbigny, in De la Sagra, p. 171, pl. 9, figs. 8-10.

1915 *Miliolina fichteliana* (d'Orbigny) - Heron-Allen and Earland, p. 560

1977 *Triloculina fichteliana* d'Orbigny - Le Calvez, p. 106

1993 *Triloculina fichteliana* d'Orbigny - Hottinger et al. p. 65, pl. 66, figs. 10-15

1998 *Triloculina fichteliana* d'Orbigny - Haunold and Piller, p. 20, pl. 6, fig. 3

2012 *Triloculina fichteliana* d'Orbigny - Debenay, p. 137, 278.

2013a *Triloculina fichteliana* d'Orbigny - Langer *et al.* figs. 6/30, 31.

Test small, ovate in lateral view; periphery broadly rounded; chambers distinct, three visible in the adult stage; sutures slightly depressed; wall ornamented by regular, well-spaced longitudinal costae; aperture ovate, produced at the end of the last chamber with a slightly everted peristomal lip and a narrow tooth with thickened or bifid termination.

Triloculina cf. T. fichteliana sp. 1 d'Orbigny, 1839

Pl. 23, figs. 17-21.

Test small, ovate in lateral view; periphery broadly rounded; chambers distinct, three visible in the adult stage; sutures depressed and distinct; wall smooth, ornamented by few well-spaced longitudinal costae; aperture semicircular, produced at the end of the last chamber with everted lip and a narrow tooth with thickened or bifid termination.

Triloculina cf. T. fichteliana sp. 2 d'Orbigny, 1839

Pl. 23, figs. 22-24.

Test triloculine, calcareous, somewhat compressed, with rounded angles; periphery rounded; sutures slightly depressed; wall porcelaneous, surface smooth, with numerous, regular, distinct longitudinal costate; aperture roughly semicircular, terminal at the end of the last chamber, provided with a bifid tooth.

Triloculina kawea Förderer and Langer 2016

Pl. 23, figs. 25-35.

2016 *Triloculina kawea* - Förderer and Langer, p. 11, fig. 5.

Test triloculine, calcareous, roughly triangular in end view, with rounded angles; three chambers are visible in lateral view; sutures slightly depressed; wall porcelaneous, matte, roughly finished, covered with numerous microstriae; aperture slightly elongated and subquadrate, terminal at the end of the last chamber, provided with a thick rim and a moderately long tooth with a thick end.

Triloculina cf. T. lalibertadensis McCulloch, 1977

1977 *Triloculina lalibertadensis* - McCulloch, p. 555, pl. 221, fig. 15.

Pl. 24, figs. 1-3.

Test medium size, triloculine, subequilateral triangular in end view, with acute angles; sutures depressed and distinct; wall thin, white, porcelaneous, imperforate; last formed chamber wider than long, forming narrow, uniform overhang for preceeding two chambers; aperture low, long arch terminal to slightly ventral in position; tooth broad, low, shallow, slightly bifid at corners; tooth filling about half of apertural opening.

Triloculina littoralis Collins, 1958

Pl. 24, figs. 4-11.

1918a *Miliolina limbata* (d'Orbigny) - Sidebottom, p. 7, pl. 1, figs. 16, 17.

1958 *Triloculina littoralis* Collins, p. 369, pl. 3, fig. 12.

1959 *Triloculina linneana* d'Orbigny.-Graham and Militante, p. 55, pl. 8, fig. 7.

1971 *Triloculina sidebottomi* Rasheed, p. 38, pl. 6, fig. 4.

1991 *Quinqueloculina boueana* d'Orbigny -Van Marle, p. 64, pl. 3, fig. 8.

1992 "*Triloculina littoralis*" Collins - Levy *et al.* p. 124, pl. 2, figs. 5, 6.

1987 *Triloculina littoralis* Collins - Baccaert, p. 130, pl. 58, figs. 3/a, b.

1994 *Triloculina littoralis* Collins - Loeblich and Tappan, p. 55, pl. 95, figs. 11-13

Test small, cryptoquinqueloculine, rounded periphery; three chambers visible in the final whorl; wall ornamented with numerous costae which runs through the entire test to the lip region, but could be few in others; sutures depressed; aperture rounded with a thick peristomal lip, produce at the end of a distinct short neck provided with a simple tooth.

Triloculina cf. T. rotunda Schlumberger, 1893

Pl. 24, figs. 12-14.

1826 *Triloculina rotunda* - d'Orbigny, p. 299, no. 4.

1893 *Triloculina rotunda* d'Orbigny - Schlumberger, p. 206; pl. 1, figs 48-50.

1958 *Triloculina rotunda* d'Orbigny - Le Calvez and Le Calvez, p. 192; pl. 6, figs 57-58.

Test slightly longer than wide, broadly rounded; chambers rotund with the two last chambers making up most of the visible test surface; sutures very slightly depressed; surface of the test smooth and shining; aperture rounded, with a slightly thickened lip and a short protruding bifid tooth.

Triloculina serrulata McCulloch, 1977

Pl. 24, figs. 15-21.

1977 *Triloculina serrulata* - McCulloch, p. 558, pl. 225, figs. 1-2, 4

1993 *Triloculina serrulata* McCulloch - Hottinger *et al.* p. 65, pl. 67, figs. 1-9

1998 *Triloculina serrulata* McCulloch - Haunold and Piller, p. 20, pl. 6, fig. 4

2011 *Triloculina serrulata* McCulloch - Parker and Gischler, p. 43, pl. 3, figs. 13-15

2012 *Triloculina serrulata* McCulloch - Debenay, p. 137, 278,

2013a *Triloculina serrulata* McCulloch - Langer *et al.* fig. 6/32

Test small, triloculine, broadly ovate in lateral view, roughly triangular in end view; peripheral margins slightly convex, separated from the lateral walls by strongly protruding carinate shoulders; wall matte, covered with very fine, longitudinal and anastomosing microstriae; aperture terminal, subcircular and produced on a short neck with a thick peristomal lip and a bifid tooth.

Triloculina cf. T. striatotrigonula Parker and Jones, 1865

Pl. 24, figs. 22-24.

1865 *Triloculina striatotrigonula* - Parker and Jones, p. 438.

1999 *Triloculina striatotrigonula* Parr - Hayward *et al.* p. 105; pl. 5, figs 25, 26.

2012 *Triloculina striatotrigonula* Parker and Jones - Debenay, p. 138, 278.

Test ovate in lateral view; periphery broadly rounded; chambers distinct, three visible in the adult stage; sutures slightly depressed; wall numerously ornamented by regular, longitudinal costae; aperture rounded to circular, produced at the end of the last chamber with a bifid tooth.

Triloculina cf. T. tricarinata (d'Orbigny, 1826)

Pl. 24, figs. 25-28.

1826 *Triloculina tricarinata* - d'Orbigny, p. 299.

- 1884 *Miliolina tricarinata* d'Orbigny - Brady, p. 165; pl. 3, figs 17 a-c.
 1993 *Triloculina tricarinata* d'Orbigny - Hottinger *et al.* p. 65; pl. 68, figs 7-12.
 1994 *Triloculina tricarinata* d'Orbigny - Loeblich and Tappan, p. 56; pl. 96, figs 1-7.
 2009 *Triloculina tricarinata* d'Orbigny - Parker, p. 368, figs. 265/a-k.
 2012 *Triloculina tricarinata* d'Orbigny - Debenay 138, 278.

Test triloculine, somewhat longer than broad with three visible chambers in the adult; chambers triangular in end view with isometric straight sides; acute to carinate margins; wall smooth, often polished; aperture low-arch-shaped provided with large T-shaped bifid tooth.

Triloculina trigonula (Lamarck, 1804)

Pl. 24, figs. 29-31

- 1804 *Miliolites trigonula* - Lamarck, p. 351
 1884 *Miliolina trigonula* (Lamarck) - Brady, pl. 3, figs. 15-16
 1915 *Miliolina trigonula* (Lamarck) - Heron-Allen and Earland, p. 561
 1932 *Triloculina trigonula* (Lamarck) - Cushman, p. 56, pl. 13, fig. 1
 1993 *Triloculina trigonula* (Lamarck) - Hottinger *et al.* p. 66, pl. 69, figs. 1-10
 1998 *Triloculina trigonula* (Lamarck) - Haunold and Piller, p. 20, pl. 6, fig. 6
 2012 *Triloculina trigonula* (Lamarck) - Debenay, p. 138, 278.
 2013a *Triloculina trigonula* (Lamarck) - Langer *et al.* figs. 6/39, 40.

Test longer than wide, triloculine, adult shows three visible chambers; periphery broadly convex and the angles rounded; broadly triangular in end view; sutures distinct; wall smooth; aperture terminal, rounded with a large bifid tooth.

Triloculina cf. T. trigonula (Lamarck, 1804)

Pl. 24, figs. 32-35.

- 2009 *Triloculina trigonula* (Lamarck) - Parker, p. 366, figs. 266/a-k, 267/a-k.

Test longer than wide, triloculine, three chambers visible; periphery broadly rounded; sutures distinct; wall smooth; aperture terminal, elongated with a long tooth thickened at the bifid tip.

Triloculina triquetrella Loeblich and Tappan, 1994

Pl. 25, figs. 1-4.

- 1994 *Triloculina triquetrella* - Loeblich and Tappan, p. 56, pl. 96, figs. 8-10.
 2009 *Triloculina triquetrella* Loeblich and Tappan - Parker, p. 369, figs. 268, 269.

Test triloculine, calcareous, triangular in end view, with carinate angles; chambers overlapping the previous chamber at the base; wall porcelaneous, surface smooth; aperture oval, terminal on a distinct neck, with flared rim, provided with a bifid tooth.

Triloculina cf. T. triquetrella Loeblich and Tappan, 1994

Pl. 25, figs. 5-7.

Test triloculine, calcareous, triangular in end view, with carinate angles; chambers overlapping the previous chamber at the base; sutures distinct; wall porcelaneous, surface smooth with faint longitudinal costate; aperture roughly circular, terminal at the end of the last chamber, provided with a thick rim and a thick stem bifid tooth.

Triloculina sp. 1

Pl. 25, figs. 8-11.

Test triloculine, calcareous, triangular in end view, with rounded angles; chambers slightly inflated with three visible in lateral view; sutures distinct; wall porcelaneous, surface smooth with faint longitudinal costate; aperture rounded, terminal at the end of the last chamber, provided with a thick rim and a short bifid tooth.

Triloculina sp. 2

Pl. 25, figs. 12-14.

Test triloculine, calcareous, only two chambers are visible in lateral view, triangular in end view, with acute angles; sutures slightly depressed; wall porcelaneous, surface smooth, with regular, distinct longitudinal costate; aperture oval, terminal at the end of the last chamber, provided with a bifid tooth.

Triloculina sp. 3

Pl. 25, figs. 15-17.

Test triloculine, calcareous, with three chambers visible in lateral view; with rounded angles; chambers slightly inflated; sutures distinct; wall porcelaneous, surface roughly finished; aperture large, triangular, terminal at the end of the last chamber, provided with an everted rim but no distinct tooth.

Genus **Mesosigmoilina** Zheng, 1981

Mesosigmoilina minuta (Zheng, 1979)

Pl. 25, fig. 18.

1979 *Pseudosigmoilina minuta* - Zheng, p. 129, text-fig. 6, pl. 7, figs. 2, 3.

1994 *Spirophthalmidium prolixum* Loeblich and Tappan, p. 41, pl. 64, figs. 6-8.

2009 *Mesosigmoilina minuta* (Zheng) - Parker, p. 115, figs. 81/a-d

Test small, narrow, elongate, flattened, delicate, slightly twisted, periphery angular, bordered by a thin prominent carina; chambers broadest at the base and tapering toward the aperture; wall calcareous, porcelaneous; aperture rounded, produced at the end of a distinct neck.

Genus **Pseudoschlumbergerina** Cherif, 1970

Pseudoschlumbergerina ovata (Sidebottom, 1904)

Pl. 25, figs. 19-21.

1904 *Sigmoilina ovata* - Sidebottom, p. 6, fig. 1, pl. 2, figs. 12, 13.

1973 *Quinqueloculina (Pseudoschlumbergerina) ovata* (Sidebottom) - Cherif, p. 94, pl. 13, fig. 9, pl. 15, figs. 3, 4.

1993 *Pseudoschlumbergerina ovata* (Sidebottom) - Hottinger et al. p. 55, pl. 46, figs. 1-6.

2013 *Pseudoschlumbergerina ovata* (Sidebottom) - Langer et al. fig.7/1.

Test porcellaneous, subelliptical in lateral view, polygonal in oral view, initial arrangement indistinctly quinqueloculine but later sigmoiline; periphery subangular; wall covered with fine irregular microstriae; chambers somewhat compressed, about seven chambers are visible from the exterior; aperture terminal, arch shaped, with peristomal lip and a bifid tooth with broad stem.

Genus **Sigmella** Azbel' and Mikhalevich, in Mikhalovich 1983

“**Sigmella sp**”

Pl. 25, figs. 22-28.

Test free, calcareous, quinqueloculine, sutures distinct and depressed, chambers inflated, rounded and twisted, the penultimate chamber rises above the aperture in lateral view; periphery rounded; wall ornamented with many weakly developed, longitudinal costate which run from the aboral end to the oral end; aperture subcircular, terminal at the end the last chamber with a short bifid tooth.

Genus **Sigmoihauerina** Zheng, 1979

Sigmoihauerina involuta (Cushman, 1946)

Pl. 25, figs. 29-31.

1946 *Hauerina involuta* - Cushman, p. 13, pl. 2, figs. 25-28

1972 *Pseudohauerina occidentalis involuta* (Cushman) - Ponder, p. 149, textfigs. 4, 7-8, 9A, 11, 12A, 13A, 16

1987 *Pseudohauerina occidentalis involuta* (Cushman) - Baccaert, p. 146, pl. 63, figs. 7 a-b, pl. 64, figs. 1-2

1988 *Pseudohauerina involuta* (Cushman) - Haig, p. 228, pl. 3, figs. 16-18

1994 *Sigmoihauerina involuta* (Cushman) - Loeblich and Tappan, p. 58, pl. 100, figs. 8-12

2009 *Pseudohauerina involuta* (Cushman) - Parker, p. 158, figs. 112/a-i.

2011 *Sigmoihauerina involuta* (Cushman) - Makled and Langer, fig.6/38-42.

2012 *Pseudohauerina involuta* (Cushman) - Debenay, p. 114, 280.

Test subcircular in lateral view, compressed, initial stage milioline, later planispiral with usually more than two chambers per whorl, distinctly involute; wall ornamented with slightly curved ribs that correspond to the internal septula and numerous longitudinal striae; aperture terminal, with trematophore.

Genus **Sigmoilinella** Zheng, 1979

Sigmoilinella tortuosa Zheng, 1979

Pl. 25, figs. 32-34.

1979 *Sigmoilinella tortuosa* - Zheng, p. 130, 131, 208, 209, pl. 7, fig. 4, text fig. 7.

1988 *Quinqueloculina* cf. *Q. columnosa* Cushman - Haig, p. 233, pl. 5, figs. 11-14.

1997 *Sigmoilinella tortuosa* Zheng - Haig p. 273, fig. 4, nos 20, 21.

2009 *Sigmoilinella tortuosa* Zheng - Parker, p. 330, figs 242/a-j.

2012 *Sigmoilinella tortuosa* Zheng - Debenay, p. 131, 279.

Test compressed, sigmoiline, twisted, calcareous; wall ornamented by two important peripheral carinae and few other non-prominent carinae; wall smoothly finished but could contain some other arenaceous materials attached to it: aperture terminal produced on a long neck, with short and small slightly bifid tooth

Sigmoilinella sp. 1

Pl. 26, figs. 1-5.

Test compressed, sigmoiline, slightly twisted, calcareous; wall ornamented by several prominent longitudinal costae; aperture terminal produced on a short raised neck, with a slightly everted lip.

Genus **Sigmoilinita** Seiglie, 1965

Sigmoilinita costata (Schlumberger, 1893)

Pl. 26, figs. 6-8.

1893 *Sigmoilina costata* - Schlumberger, p. 61, pl. 1, figs. 51, 52.

1958 *Sigmoilina costata* Schlumberger - Le Calvez J and Y, p. 20, pl. 7, figs. 69, 70.

1991 *Sigmoilinita costata* (Schlumberger) - Cimerman and Langer, p. 47, pl. 45, figs. 1-6.

2012 *Sigmoilinita costata* (Schlumberger) - Debenay, p. 131, 279.

Test fusiform in lateral view and sigmoid in horizontal section, slightly compressed; chambers of uniform diameter, arranged in a sigmoid pattern, later tending to become planispiral; periphery rounded; sutures distinct, very slightly depressed; wall ornamented by numerous longitudinal costae; aperture subcircular, produced on a distinct neck, with a peristomal rim and a short tooth.

Genus **Spirosigmoilina** Parr, 1942

Spirosigmoilina bradyi Collins, 1958

Pl. 26, figs. 9, 10.

1884 *Spiroloculina crenata* Karrer - Brady, p. 156, pl. 10, figs. 24-26.

1915 *Spiroloculina crenata* (Karrer) - Heron-Allen and Earland, p. 557, pl. 39, figs. 6-8

1917 *Massilina crenata* (Karrer) - Cushman, p. 57, pl. 20, figs. 2/a, c.

1958 *Spirosigmoilina bradyi* - Collins, p. 365.

1960 *Hauerina speciosa* (Karrer - Barker, p. 20, pl. 10, figs. 24-26

1988 *Spirosigmoilina bradyi* Collins - Haig plate 11, fig 1-6.

2009 *Spirosigmoilina bradyi* Collins - Parker, p. 357, figs. 259/a-f.

2011 *Spirosigmoilina bradyi* Collins - Makled and Langer, figs. 7/5, 6.

2012 *Spirosigmoilina bradyi* Collins - Debenay, p. 135, 279.

Test subcircular in laterar view, somewhat flattened; early chambers arranged in a sigmoiline coil, central part raised; later chambers narrow and low, planispirally arranged, each chamber one-half coil in length; wall ornamented by regulate crenulation; aperture a simple terminal opening with a short simple tooth.

Spirosigmoilina parri Collins, 1958

Pl. 26, figs. 11, 12.

1958 *Spirosigmoilina parri* - Collins, p. 365, pl. 3, figs. 3, 4.

1988 *Spirosigmoilina parri* Collins - Haig, p. 235, pl. 11, figs. 7-10.

1994 *Spirosigmoilina parri* Collins - Loeblich and Tappan, p. 58, pl. 102, figs. 9-17; pl. 103, figs 1-5.

2012 *Spirosigmoilina parri* Collins - Debenay, p. 135, 279.

Test subcircular, flattened; early chambers sigmoiline, leading to a raised central portion; later chambers compressed, planispirally arranged, each chamber one-half coil in length; wall matte; aperture rounded, terminal at the end of the last formed chamber with a peristomal lip and a short simple tooth.

Genus **Articulina** d'Orbigny, 1826

Articulina pacifica Cushman, 1944

Pl. 26, figs. 13, 14.

1944a *Articulina pacifica* - Cushman, p. 17, pl. 14, figs. 14-18

- 1959 *Articulina pacifica* Cushman - Graham and Militante, p. 34, pl. 3, fig. 6
 1987 *Articulina pacifica* Cushman - Baccaert, p. 151, pl. 66, fig. 2
 1988 *Articulina pacifica* Cushman - Haig, p. 218, pl. 1, figs. 9, 10.
 2009 *Articulina pacifica* Cushman - Parker, p. 90, figs. 64/a-e.
 2012 *Articulina pacifica* Cushman - Debenay, p. 104, 280.

Test initially milioline, latter with a few vase-shaped chambers laterally compressed; wall surface covered with prominent longitudinal costae, usually 13 to 15; apertural terminal, provided with a very prominent everted lip.

Articulina queenslandica Collins, 1958

- Pl. 26, figs. 17, 18.
 1958 *Articulina queenslandica* - Collins, p. 366, pl. 3, figs. 8-10
 1987 *Articulina queenslandica* Collins - Baccaert, p. 153, pl. 66, figs. 4
 2012 *Articulina queenslandica* Collins - Debenay, p. 104, 280.

Test elongate initially milioline with later uniserial chamber additions, widened at the base; wall porcelaneous, ornamented with 4 or 5 longitudinal costae on the first uniserial chamber, and could more with additional chambers; aperture terminal, rounded, with a narrow everted lip.

Articulina sagra d'Orbigny, 1839

- Pl. 26, figs. 15, 16.
 1839a *Articulina sagra* - d'Orbigny, p. 183, pl. 9, figs. 23-26.
 1915 *Articulina sagra* d'Orbigny - Heron-Allen and Earland, p. 585, pl. 45, figs. 22-25.
 1917 *Articulina sagra* d'Orbigny - Cushman, p. 59, pl. 22, figs. 7, 8.
 1994 *Articulina mucronata* (d'Orbigny) - Loeblich and Tappan, p. 59, pl. 104, figs. 1-4.
 2012 *Articulina sagra* d'Orbigny - Debenay, p. 104, 280.

Test elongate, compressed, initially milioline, and later ones usually two or three in linear series, increasing progressively in size; wall furnished with longitudinally costate; aperture narrowly elliptical, with a thick projecting everted lip.

Genus **Sigmoilopsis** Finlay 1947

Sigmoilopsis elliptica? (Galloway and Wissler, 1927)

- Pl. 26, figs. 19-21.
 1927 *Sigmoilina elliptica* - Galloway and Wissler, p. 39; pl. 7, figs. 2/a-b.
 1995 *Sigmoilopsis elliptica* (Galloway and Wissler) - Yassini and Jones p. 92, figs. 148-150.
 1999 *Sigmoilopsis elliptica* (Galloway and Wissler) - Hayward *et al.* p. 104, pl. 5, figs. 16-18.
 2012 *Sigmoilopsis elliptica* (Galloway and Wissler) - Debenay, p. 131, 279.

Test elongate, fusiform; chambers tubular, cylindrical, rapidly enlarging; wall covered with a layer of arenaceous matter which could be pitted; aperture rounded, terminal at the end of a cylindrical neck, with a thickened lip.

Genus **Miliola** Lamarck, 1804

Miliola sublineata (Brady, 1884)

- Pl. 26, figs. 22-24.
 1884 *Miliolina circularis* (Bornemann) var. *sublineata* - Brady, p. 169; pl. 4, figs. 7/a-c.
 1898b *Miliolina circularis* (Bornemann) var. *sublineata* Brady - Millett, p. 501, pl. 11, figs. 4/a, b.
 1988 *Miliola sublineata* (Brady) - Haig, p. 220, pl. 2, figs. 10, 11.
 1992a *Cribromiliolinella milletti* (Cushman) - Hatta and Ujiié, p. 69, pl. 9, figs. 4, 5.
 2011 *Miliola sublineata* (Brady) - Makled and Langer, figs. 5/9-11.
 2012 *Miliola? Sublineata* (Brady) - Debenay, p. 109, 280.

Test rounded in outline, elliptical in oral view, three chambers visible in lateral view; periphery rounded; chambers spirally arranged; sutures depressed and distinct; wall ornamented with thin, numerous, somewhat irregular longitudinal costae, pitted; aperture terminal, cribrate.

Family **Riveroinidae** Saidova, 1981

Genus **Pseudohauerinella** McCulloch, 1981

Pseudohauerinella dissidens (McCulloch, 1977)

Pl. 26, figs. 25, 26.

1915 *Spiroloculina crenata* Karrer - Heron- Allen and Earland, p. 557, pl. 41, figs. 6-81977 *Pseudohauerina dissidens* - McCulloch, p. 237, pl. 102, fig. 7.1981 *Pseudohauerinella dissidens* (McCulloch) - McCulloch, p. 6.1993 *Pseudohauerinella dissidens* (McCulloch) - Hottinger *et al.* p. 67, pl. 74, figs. 1-8.1998 *Pseudohauerinella dissidens* (McCulloch) - Haunold and Piller, p. 21, pl. 6, fig. 152012 *Pseudohauerinella dissidens* (McCulloch) - Debenay, p. 114, 281.2013 *Pseudohauerinella dissidens* (McCulloch) - Langer *et al.* figs. 7/11, 12.

Test small, porcellaneous, lenticular in lateral view, polygonal in end view, quinqueloculine with gradually increasing angle between successive chambers; sutures depressed; Wall covered by longitudinal, irregular microstriae and possessing irregularly distributed pits; aperture terminal at the end of the last chamber, truncated, produced with a thick peristomal lip and a bifid tooth.

Pseudohauerina orientalis (Cushman, 1946)

Pl. 26, figs. 27, 28.

1946 *Hauerina orientalis* - Cushman, p. 43; pl. 10, figs 16-17.1988 *Pseudohauerina orientalis* (Cushman) - Haig, p. 228, pl. 3, figs. 19, 20.1994 *Hauerina orientalis* (Cushman) - Loeblich and Tappan, p. 60, pl. 76, figs. 12-14.2009 *Pseudohauerina orientalis* (Cushman) - Parker, p. 162, figs. 113, 114.2011 *Pseudohauerina orientalis* (Cushman) - Makled and Langer, figs. 7/1-4.2012 *Pseudohauerina orientalis* (Cushman) - Debenay, p. 114, 281.2013 *Pseudohauerina orientalis* (Cushman) - Langer *et al.* figs. 7/9, 10.

Test oval in outline, robust, less compressed, initial chambers inflated and quinqueloculine, later partially evolute planispiral additions with usually more than two chambers per whorl; wall covered with fine, more intense reticulate ornament, with transverse ribs that correspond internally to septula that partially divide the chambers; aperture cribrate trematophore, but not fully developed, lyre-shaped in juveniles.

Pseudohauerina sp. 1

Pl. 26, fig. 29

Test compressed, initial chambers show milioline chamber arrangement, later ones either embracing and extending in to the center to hide the previously formed chambers or becoming elongate and more or less encircling the periphery; ornamentation strong transverse or radial crenulations crossed by numerous fine longitudinal striae which in this case are strongly abraded ; aperture terminal with a trematophore.

Family **Alveolinidae** Ehrenberg, 1839Genus **Borelis** de Monfort 1808**Borelis schlumbergeri** (Reichel, 1937)

Pl. 26, figs. 30-32.

1880 *Alveolina boscii* DeFrance - Möbius, p. 79, pl. III, fig. 11915 *Alveolina boscii* (DeFrance) - Heron-Allen and Earland, p. 6061937 *Nealveolina pygmaea* (Hanzawa) *schlumbergeri* - Reichel, p. 110, pl. 10, figs. 1-3.1977 *Borelis schlumbergeri* (Reichel) - Hottinger, p. 93, figs. 29/a-h.1984 *Borelis schlumbergeri* (Reichel) - Reiss and Hottinger, p. 215, fig. G101993 *Borelis schlumbergeri* (Reichel) - Hottinger *et al.* p. 68, pl. 75, figs. 1-17.1997 *Borelis schlumbergeri* (Reichel) - Haig, p. 270, fig. 3/16.1998 *Borelis schlumbergeri* (Reichel) - Haunold, Baal and Piller, p. 156, pl. 1, figs. 1-32012 *Borelis schlumbergeri* (Reichel) - Debenay, p. 104, 281.2013 *Borelis schlumbergeri* (Reichel) - Langer *et al.* fig. 7/14

Test porcelaneous, planispiral, involute, elongate along the coiling axis; wall ornamented by low, wavy ridges situated along the chamberlet sutures, and by indistinct pustules between the ridges; 4-6 chambers per whorl separated by depressed sutures; apertures terminal, one basal row of circular to irregularly quadrangular apertures on the apertural face; each aperture with thickened rim; a rectangular to faintly bifid mask hides partly each apertural opening.

Family **Peneroplidae** Schultze, 1854

Genus **Coscinospira** Ehrenberg, 1839

Coscinospira hemprichi Ehrenberg, 1839

Pl. 26, figs. 33, 34.

1839 *Coscinospira hemprichi* - Ehrenberg, p. 131, pl. 2, fig. 2.

1993 *Coscinospira hemprichi* Ehrenberg - Hottinger *et al.* p. pl. 77, figs. 1-3

2012 *Coscinospira hemprichi* Ehrenberg - Debenay, p. 106, 281.

2013 *Coscinospira hemprichi* Ehrenberg - Langer *et al.* fig. 7/15.

Test porcelaneous, planispirally coiled, with a very shallow umbilical pit; sutures depressed; chambers slightly inflated; wall surface including the shallow umbilical depression is covered with strong acute ribs, perpendicular to the sutures, alternating irregularly from one chamber to the other; the ribs fuse with the peristomes of the multiple aperture that occupy the center of the apertural face.

Genus **Euthymonacha** Loeblich and Tappan, 1994

Euthymonacha polita (Chapman, 1900)

Pl. 27, figs. 1, 2.

1900 *Peneroplis (Monalysidium) polita* - Chapman, p. 4, pl. 1, fig. 5.

1987 *Monalysidium politum* Chapman - Baccaert, p. 61, pl. 110, fig. 8.

1994 *Euthymonacha polita* (Chapman) - Loeblich and Tappan, p. 61, pl. 110, fig. 8.

2009 *Euthymonacha polita* (Chapman) - Parker, p. 103, figs. 72, 73.

2012 *Euthymonacha polita* (Chapman) - Debenay, p. 107, 281.

Test small, porcelaneous, with no initial coil, made up of somewhat irregular row of loosely attached cylindrical chambers, typically of uniform size; sutures deeply incised and distinct and straight; numerous pseudopores aligned parallel to the longitudinal axis giving a striated appearance; aperture terminal with an everted, crenulated lip that extends beyond the test.

Genus **Monalysidium** Chapman, 1900

Monalysidium acicularis (Batsch, 1791)

Pl. 27, figs. 3-7.

1791 *Nautilus (Lituus) acicularis* - Batsch, p. 3, 6, pl. 6, figs. 16/a, b.

1993 *Monalysidium acicularis* (Batsch) - Hottinger *et al.* p. 70, pl. 78, figs. 1-14.

2009 *Monalysidium acicularis* (Batsch) - Parker, p. 138, figs. 98, 99.

2012 *Monalysidium acicularis* (Batsch) - Debenay, 111, 281.

Test porcelaneous, initial stage planispiral, biconvex with chambers somewhat compressed, latter uniserial, cylindrical, long and thin; wall with longitudinal costae separated by irregular rows of large pseudopores; aperture terminal, with crenulations folding irregularly inwards, forming a dendritic pattern that slightly extends beyond the test.

Genus **Peneroplis** de Montfort 1808

Peneroplis arietina (Batsch, 1791)

Pl. 27, figs. 9-13.

1791 *Nautilus (Lituus) arietinus* Batsch, p. 4, pl. 6, fig. 15c.

1884 *Peneroplis arietinus* (Batsch) - Brady, p. 204, pl. 13, figs. 16, 17.

1930 *Spirolina arietina* (Batsch) - Cushman, p. 43, pl. 15, figs. 4, 5.

1933 *Spirolina arietina* (Batsch) - Cushman, p. 62, pl. 19, figs. 4, 5.

1987 *Peneroplis arietina* (Batsch) - Baccaert, p. 60, pl. 19, figs. 3/a-c; pl. 20, figs. 1-4; pl. 21, figs. 1/a-c.

Test compressed, early portion planispiral coil, become uniserial in later stages; sutures distinct; wall ornamented with numerous low costae perpendicular to the sutures and parallel to the coiling direction; aperture terminal, multiple, consisting of a series of independent pores in the central portion of the apertural face.

Family **Soritidae** Ehrenberg, 1839

Genus **Parasorites** Seiglie and Rivera, 1977

Parasorites orbitolitoides (Hofker, 1930)

Pl. 27, figs. 14-19.

1930 *Praesorites orbitolitoides* - Hofker, p. 149, pl. 55, figs. 8, 10; pl. 57, figs. 1-5; pl. 61, figs. 3-14.1988 *Parasorites orbitolitoides* (Hofker) - Haig, p. 228, pl. 3, figs. 8, 9.1992a *Parasorites orbitolitoides* (Hofker) - Hatta and Ujjié, p. 80, pl. 17, figs. 1, 2; pl. 18, figs. 1, 2.2012 *Parasorites orbitolitoides* (Hofker) - Debenay, p. 113, 282.

Test calcareous, porcelaneous, discoidal, flattened; wall thickness hardly increased towards the periphery; initial stage planispiral, later chambers annular, subdivided into one layer of chamberlets by alternating radial partitions; wall smooth and polished; apertures small, round, numerous in one row at the periphery.

Parasorites cf. P. orbitolitoides (Hofker, 1930)

Pl. 27, figs. 20-24.

2009 *Parasorites* cf. *P. orbitolitoides* (Hofker) - Parker, p. 149, figs. 106, 107.

Test calcareous, porcelaneous, discoidal, flattened; wall thickness hardly increased towards the periphery; initial stage distinctly planispiral or peneropline, later chambers annular, subdivided into one layer of chamberlets by radial partitions; wall smooth and polished; apertures sub-circular to elongate, oriented perpendicular to the plane of the test are in a medial row, typically bordered by a thin peristomal rim.

Genus **Sorites** Ehrenberg, 1839**Sorites orbiculus** (Forskål, 1775)

Pl. 27, figs. 25-30.

1775 *Nautilus orbiculus* - Forskål, p. 125.1840 *Sorites orbiculus* (Forskål) - Ehrenberg, pl. 3, fig. 21984 *Sorites orbiculus* Ehrenberg - Reiss and Hottinger, p. 205, figs. 65/a-d1991 *Sorites orbiculus* Ehrenberg - Cimerman and Langer, p. 50, pl. 51, figs. 1-51992 *Sorites orbiculus* (Forskål) - Hatta and Ujjié, p. 80, pl. 17, figs. 5a-6b, pl. 18, figs. 5, 6.1993 *Sorites orbiculus* (Forskål) - Hottinger et al. p. 72, pl. 83, figs. 1-131994 *Sorites orbiculus* (Forskål) - Loeblich and Tappan, p. 63, pl. 112, figs. 6-81998 *Sorites orbiculus* (Forskål) - Haunold, Baal and Piller, p. 156, pl. 2, figs. 1-32012 *Sorites orbiculus* (Forskål) - Debenay, p. 131, 282.2013a *Sorites orbiculus* Ehrenberg - Langer et al. fig. 7/20

Test discoidal, biplanar, relatively thin; chamberlets addition is annular concentric, giving the sutures a characteristic scalloped appearance; wall smooth; apertures ovate or 8-shaped, bordered with a small rim, usually one on each side of the chamberlets, positioned in a medial row on the peripheral surface.

Family **Valvulaminidae** Loeblich and Tappan, 1987Genus **Discorinopsis** Cole, 1941**Discorinopsis aguayoi** (Bermudez, 1935)

Pl. 28, figs. 1-3.

1935 *Discorbis aguayoi* - Bermudez, p. 204, pl. 15, figs. 10-14.1953 *Discorinopsis aguayoi* (Bermudez) - Phleger, et al. p. 7, pl. 4, figs. 23, 24.1963 *Trichohyalus aguayoi* (Bermudez) - Bermudez and Seiglie, p. 176, pl. 26, fig. 4.2003 *Discorinopsis aguayoi* (Bermudez) - Javaux and Scott, p. 14, fig. 6, no 1, 2.2012 *Discorinopsis aguayoi* (Bermudez) - Debenay, p. 194, 262

Test low trochospiral, auriculate; spiral side convex, umbilical side flattened to concave; umbilical face partially covered with a spongy mass of shell material; sutures limbate, imperforate, strongly curved on the spiral side, obscured on the umbilical side; wall coarsely perforate; aperture a series of openings through the shell material that obscured the umbilical side.

Family **Vaginulinidae** Reuss, 1861Genus **Lenticulina** Lamarck, 1804

Lenticulina sp. 1

Pl. 28, figs. 4, 5.

Test hyaline, planispiral, involute, biconvex, robust, subcircular in outline; periphery bluntly rounded with a narrow keel; 5 chambers visible in the final whorl (although our specimen is broken); umbilical region flush and transparent; sutures flush and limbate, gently curved; apertural face truncated, slightly depressed, with a thick limbate margin; presence of equatorial slit on the apertural face.

Family **Lagenidae** Reuss, 1861

Genus **Lagena** Walker and Jacob, 1798

Lagena spicata Cushman and McCulloch, 1950

Pl. 28, figs. 6, 7.

1950 *Lagena sulcata* var. *spicata* - Cushman and McCulloch, p. 360, pl. 48, figs 3, 7.

1995 *Lagena striata paucistriata* - Yassini and Jones, p. 106, 107, figs. 323-325.

1999 *Lagena spicata* Cushman and McCulloch - Hayward *et al.* p. 116, pl. 7, figs. 4, 5.

2012 *Lagena spicata* Cushman and McCulloch - Debenay, p. 152, 289.

Test rounded to flask-shaped with an elongate neck; wall ornamented with very strong numerous longitudinal costae sometimes continuing up the apertural neck; basal end possesses a definite spine; neck cylindrical or tapering; aperture terminal, rounded, bordered with a phialine lip.

Lagena strumosa Reuss, 1858

Pl. 28, figs. 8.

1858 *Lagena striata strumosa* - Reuss, p. 434.

1993 *Lagena strumosa* Reuss - Hottinger *et al.* pl. 90, figs. 18-25.

1995 *Lagena striata strumosa* Reuss - Yassini and Jones, p. 107, figs. 321, 322, 326, 327, 330, 331.

2012 *Lagena strumosa* Reuss - Debenay, p. 153, 289.

Test globular, robust, flask-shaped, with an elongate neck; basal end with a definite spine; surface covered with fine longitudinal striae which do not continue to the neck region, the neck shows several irregular annuli and fine spines; aperture terminal at the end of the neck, with a distinct expanded lip.

Genus **Procerolagena** Puri, 1954

Procerolagena oceanica (Albani, 1974)

Pl. 28, figs. 9, 10.

1974 *Lagena oceanica* - Albani, p. 37, pl. 1, figs 7, 10, 11.

1993 *Lagena oceanica* Albani - Hottinger *et al.* p. 78, pl. 90, figs. 9-11.

1994 *Pygmaeosestron oceanicum* (Albani) - Loeblich and Tappan, p. 80, pl. 144, figs. 4-7.

2012 *Procerolagena oceanica* (Albani) - Debenay, 160, 290.

Test club-shaped with a long, tapering, almost cylindrical neck, largest width close to the base; wall ornamented by a few distinct raised costae limited to the truncated basal portion of the test; base provided with a number of short spines; aperture rounded (although our specimen is broken close to the aperture), at the end of the neck, surrounded by a thick phialine lip.

Genus **Krebsina** McCulloch, 1981

Krebsina subtenuis (Cushman, 1936)

Pl. 28, figs. 11, 12.

1884 *Bolivina tenuis* - Brady, p. 419; pl. 52, fig. 29.

1936 *Bolivina subtenuis* - Cushman, p. 57; pl. 8, fig. 10.

1994 *Krebsina subtenuis* (Cushman) - Loeblich and Tappan, p. 82, pl. 146, figs. 12-16.

2012 1994 *Krebsina subtenuis* (Cushman) - Debenay, p. 174, 291.

Test strongly compressed, trochospiral, thin, elliptical in outline, slightly convex on both sides; peripheral margin acute; chambers few in number, long, curved, obliquely set; aperture on the oblique face of the terminal chamber, surrounded by radiating lines.

Family **Glandulinidae** Reuss, 1860

Genus **Euglandulina** McCulloch, 1977

Euglandulina striatula (Cushman, 1917)

Pl. 28, figs. 13-18.

1917 *Nodosaria (Glandulina) laevigata* d'Orbigny var. *striatula* - Cushman, p. 653.

1921 *Nodosaria (Glandulina) laevigata* d'Orbigny var. *striatula* - Cushman, p. 186; pl. 33, fig. 2.

1977 *Euglandulina striatula* (Cushman) - McCulloch, p. 14, pl. 96, fig. 17.

1994 *Euglandulina striatula* (Cushman) - Loeblich and Tappan, p. 96, pl. 168, figs. 1-5.

2012 *Euglandulina striatula* Loeblich and Tappan - Debenay, p. 164, 296.

Test elongated, tapering at both ends, spindle-shaped, circular in cross section; widest at about midpoint; apertural end rounded; sutures horizontal and flush, hardly visible; lastformed chamber more than half the entire length of the test, tapering towards the aperture; wall strongly ornamented by longitudinal costae; aperture radiate.

Euglandulina sp. 1

Pl. 28, figs. 19-21.

Test small, unilocular, tapering at both ends, circular in cross section; basal part apiculate; wall ornamented by faint costae; aperture radiate.

Family **Ellipsolagenidae** Silvestri, 1923

Genus **Oolina** d'Orbigny, 1839

Oolina aff. O. stellula Loeblich and Tappan, 1994

Pl. 28, figs. 22, 23.

1994 *Reussoolina stellula* - Loeblich and Tappan, p. 81, pl. 144, figs. 9-12.

2012 *Oolina stellula* (Loeblich and Tappan) - Debenay, p. 156, 295.

Test small, unilocular, flask-shaped, widest towards basal end; wall calcareous, hyaline, smooth, plain without ornamentation; aperture radiate, slightly produced but without a distinct neck

Genus **Fissurina** Reuss, 1850

Fissurina lucida (Williamson, 1848)

Pl. 28, figs. 24-26.

1848 *Entosolenia marginata* (Montagu) var. *lucida* - Williamson, p. 17, pl. 2, fig. 17.

1994 *Fissurina lucida* (Williamson) - Hayward and Triggs, pl. 1, figs. 17/q, w.

1994 *Fissurina lucida* (Williamson) - Loeblich and Tappan, p. 90, pl. 156, figs. 1-3.

1995 *Fissurina lucida* (Williamson) - Yassini and Jones, p. 124, fig. 873.

2012 *Fissurina lucida* (Williamson) - Debenay, p. 147, 292.

Test pear-shaped, somewhat compressed; periphery rounded; wall smooth, clear and translucent in the central part; test compressed towards the aperture; aperture terminal, long narrow slit.

Genus **Palliolatella** Patterson and Richardson 1987

Palliolatella cf. P. fasciata carinata (Sidebottom, 1906)

Pl. 28, figs. 27, 28.

1906 *Lageria fasciata* (Egger) var. *carinata* - Sidebottom, p. 7, pl. 1, fig. 17.

1968 *Fissurina fasciata carinata* (Sidebottom) - Albani, p. 105, pl. 8, fig. 17.

1994 *Duplella trinalmarginata* - Loeblich and Tappan, p. 88, pl. 154, figs 4-8.

1995 *Fissurina fasciata carinata* (Sidebottom) - Yassini and Jones, p. 123, figs. 399, 400, 404, 429.

2012 *Palliolatella fasciata carinata* (Sidebottom) - Debenay, p. 157, 293.

Test compressed, circular outline; periphery bordered by a narrow keel; lateral surfaces contain numerous random pits which are bounded by two narrow peripheral costae that interrupt at each end of the test; aperture fissurine, not produced.

Buchnerina aff. B. lacunata (Burrows and Holland, in Jones 1895)

Pl. 28, figs. 29, 30.

- 1895 *Lagena lacunata* - Burrows and Holland in Jones, p. 205, pl. 7, figs. 12/a, b.
 1968 *Fissurina lacunata* (Burrows and Holland) - Albani, eastern Australia, p. 105, pl. 8, fig. 16.
 1989 *Palliolatella lacunata* (Burrows and Holland) - Albani and Yassini, p. 394, figs. 5/g, h.
 1994 *Cerebrina lacunata* (Burrows and Holland) - Loeblich and Tappan, p. 76, pl. 135, figs. 8-15.
 2009 *Cerebrina lacunata* (Burrows and Holland) - Parker, p. 395, figs. 284/a-l, 285/a-i.
 2012 *Cerebrina lacunata* (Burrows and Holland) - Debenay, p. 142, 289.

Test compressed, subcircular in outline, except the slightly produced apertural end; periphery surrounded by a prominent central keel with two raised lateral keels; central part of the test with coarse pits vertically aligned; aperture ovate and produced with a short entosolenian tube.

Buchnerina sp. 1

Pl. 28, figs. 31-33.

Test elongate, ovate, laterally compressed; periphery tricarinate with not so much pronounced central keel and two closely placed secondary keels; wall smooth, covered with faint irregular anastomosing costae; aperture produced on a distinct neck, rounded.

Buchnerina sp. 2

Pl. 28, figs. 34, 35.

Test elongate, ovate, laterally compressed; periphery tricarinate with a central keel and two closely placed secondary keels; a third more central annular ridge enclosed the central area of the test, which is finely perforated; aperture produced on a distinct neck, rounded.

Family **Bolivinitidae** Cushman, 1927

Genus **Abditodendrix** Paterson, 1985

Abditodendrix rhomboidalis (Millett, 1899)

Pl. 29, figs. 1, 2.

- 1899b *Textularia rhomboidalis* - Millett, p. 559, pl. 7, fig. 4.
 1992b *Brizalina? rhomboidalis* (Millett) - Hatta and Ujjié, p. 172, pl. 26, fig. 2.
 1994 *Tortoplectella rhomboidalis* (Millett) - Loeblich and Tappan, p. 113, pl. 216, figs. 1-6.
 2009 *Abditodendrix rhomboidalis* (Millett) - Parker, p. 427, figs. 308/a-i.
 2012 *Abditodendrix rhomboidalis* (Millett) - Debenay, p. 170, 299.

Test biserial, triangular in lateral view, rhomboidal in apertural view; periphery obliquely twisted, sides slightly concave, especially in the later stage; Sutures thickened and raised; chambers rapidly increasing in size as added; large scattered pores except for a narrow imperforate region adjacent to the aperture; aperture an areal slit, commencing a slight distance above the base of the rhomboid apertural face and extending obliquely upward, bordered by a distinct lip which curves inwards at both sides of the aperture.

Family **Bolivinidae** Glaessner, 1937

Genus **Bolivina** d'Orbigny, 1839

Bolivina striatula Cushman, 1922

Pl. 29, figs. 3-5.

- 1922a *Bolivina striatula* - Cushman, p. 27, pl. 3, fig. 10
 1987 *Brizalina (?) striatula* (Cushman) - Baccaert, p. 183, pl. 74, figs. 3-5
 1991 *Brizalina striatula* (Cushman) - Cimerman and Langer, p. 60, pl. 62, figs. 6-9
 1993 *Brizalina striatula* (Cushman) - Hottinger et al. p. 92, pl. 112, figs. 3-8
 1998 *Brizalina striatula* (Cushman) - Haunold and Piller, p. 24, pl. 8, fig. 13
 2009 *Bolivina striatula* Cushman - Parker, p. 433, figs. 313/a-h.
 2012 *Bolivina striatula* Cushman - Debenay, p. 171, 298.

Test elongate, gradually increasing in size from the somewhat rounded initial end to the broad apertural end; chambers numerous, distinct, slightly inflated; sutures very slightly depressed and distinct; initial portion of the test less compressed than the later stages; early portion of the test with numerous longitudinal striations occupying sometimes more than half the length of the test; final chambers being smooth, sometimes punctate; aperture elongated, narrow at the base and wide at the upper portion, one side with a thick rim, the other smooth and bending inwards to form the toothplate

Bolivina aff. B. striatula Cushman 1922

Pl. 29, figs. 6, 7.

Test small, biserial; chambers few; wall smooth, but perforated; chambers low, becoming higher as added, periphery rounded; sutures distinct, depressed, strongly oblique; aperture elongate, arched, in the median plane, at the base of the last-formed chamber.

Bolivina variabilis (Williamson, 1858)

Pl. 29, figs. 8-10.

1858 *Textularia variabilis* - Williamson, p. 76; pl. 6, figs 162, 163.

1994 *Bolivina variabilis* (Williamson) - Loeblich and Tappan, p. 111, pl. 216, figs. 7-15.

1995 *Bolivina doniezi* Cushman and Wickenden - Yassini and Jones, p. 129, figs. 520, 521, 525.

2009 *Bolivina variabilis* (Williamson) - Parker, p. 434, figs. 315/a-k

2012 *Bolivina variabilis* (Williamson) - Debenay, p. 172, 298.

Test elongate, variable in size; test gradually enlarging as added, periphery rounded to subcarinate; chambers numerous, slightly inflated; sutures indistinct, somewhat obscured by the rough ornamentation; unevenly pitted wall texture, pores surrounded by ridges forming a polygonal pattern; aperture a broad loop bordered by a thick rim, with a distinct toothplate.

Family **Bolivinellidae** Hayward, 1980

Genus **Bolivinella** Cushman, 1927

Bolivinella elegans Parr, 1932

Pl. 29, figs. 11, 12.

1884 *Textularia folium* Parker and Jones - Brady, p. 357, pl. 42, figs 4-5.

1932 *Bolivinella elegans* - Parr, after Brady, p. 223-224.

1959 *Bolivinella elegans* Parr - Graham and Militante, p. 78, pl. 12, figs. 8, 9a, b.

1994 *Rugobolivinella elegans* (Parr) - Loeblich and Tappan, p. 113, pl. 220, figs. 1-6.

2009 *Bolivinella elegans* Parr - Parker, p. 436, figs. 316/a-f.

2012 *Rugobolivinella elegans* Debenay, p. 177, 299.

Test compressed, fan-shaped, biserial; initial small chambers, later ones narrow, moderately recurved and increasing rapidly in width as added; sutures with thin raised ridges which connect with the medial rib; medial rib straight, single from the proloculus to one third of the test and branching upward into two medial ribs separated by a sinuose medial groove; periphery acute; terminal face truncate, with almost parallel sides tapering toward the periphery; aperture cribrate, situated around the suture between the two last chambers sometimes with a somewhat larger opening on the suture. Our specimen does not show the expected spinose projections at the chamber margins, probably broken off.

Family **Cassidulinidae** d'Orbigny, 1839

Genus **Globocassidulina** Voloshinova, 1960

Globocassidulina crassa (d'Orbigny, 1839)

Pl. 29, figs. 13, 14.

1839c *Cassidulina crassa* - d'Orbigny, p. 56, pl. 7, figs. 18-20.

1983 *Globocassidulina crassa* (d'Orbigny) - Nomura, p. 37, pl. 3, figs. 9, 10; pl. 6, fig. 17; pl. 18, figs. 3-5.

2012 *Globocassidulina crassa* (d'Orbigny) - Debenay, p. 239, 300.

Test biserial, planispirally enrolled biserial plane; test small and slightly compressed; periphery nearly circular, consisting of lobes, with last chamber slightly extended; peripheral margin rounded; chambers moderately inflated, gradually increasing in size as added; about 4 pairs of chambers in the last whorl; sutures distinct, gently curved; wall smooth, distinctly perforated; aperture an elongate slit parallel to the suture, with a short branch extending into the apertural face (areal branch); aperture bordered by an apertural ridge along its lower margin, a narrow lip along its upper margin, and a cristate tooth near the areal branch.

Globocassidulina subglobosa (Brady 1881)

Pl. 29, figs. 15-17.

1881 *Cassidulina subglobosa* - Brady, p. 60.

- 1884 *Cassidulina subglobosa* Brady - Brady, p. 430, pl. 54, figs. 17a-c.
 1921 *Cassidulina subglobosa* Brady - Cushman, p. 171, pl. 22, fig. 2.
 1966 *Globocassidulina subglobosa* (Brady) - Belford, p. 149, pl. 25, figs. 11-16.
 1983 *Globocassidulina subglobosa* (Brady) - Nomura, p. II 20; pl. 2, figs. 8/a-c, 9; pl. 13, figs. 5, 6.
 2012 *Globocassidulina subglobosa* (Brady) - Debenay, p. 239, 300.

Test biserial, planispirally enrolled biserial plane; test globular, periphery broadly rounded, not lobulate, last chamber somewhat projecting; sutures indistinct; wall coarsely perforated, with depressed pore margins, apertural face imperforate with faint striations radiating from the aperture; aperture a narrow elongate opening extending almost orthogonally over the apertural face; a small lip is present on one margin, and a narrow tooth extends along the opposite side.

Family **Stainforthiidae** Reiss, 1963

Genus **Cassidelina** Saidova, 1975

Cassidelina? sp. 1

Pl. 29, figs. 18-20.

Test small, elongate, tapers towards the initial end; chambers robust and inflated; sutures distinct and depressed; wall smooth, ornamented with few longitudinal costae, punctate; aperture terminal, rounded, at the end of the last chamber with thick rim.

Family **Siphogenerinoididae** Saidova, 1981

Genus **Hopkinsinella** Bermúdez and Fuenmayor, 1966

Hopkinsinella glabra (Millett, 1903)

Pl. 29, figs. 21-25.

- 1903a *Uvigerina auberiana* d'Orbigny var. *glabra* - Millett, p. 268, pl. 5, figs. 8, 9.
 1993 *Hopkinsinella glabra* (Millett) - Haig, 170, pl. 1, figs. 15-17.
 1994 *Hopkinsinella glabra* (Millett) - Loeblich and Tappan, p. 118, pl. 232, figs. 1-11.
 2012 *Hopkinsinella glabra* (Millett) - Debenay, p. 174, 301.

Test elongate, somewhat twisted, laterally compressed, biserial; sutures oblique and depressed; height increases relatively as chambers are added; wall smooth; aperture terminal with the last added chamber, on a short neck, surrounded by a recurved rim.

Family **Bolivinitidae** Cushman, 1927

Genus **Loxostomina** Sellier de Civrieux, 1969

Loxostomina limbata (Brady, 1884)

Pl. 29, figs. 25-27.

- 1884 *Bolivina limbata* - Brady, p. 419; pl. 52, figs 26-28,
 1915 *Bolivina limbata* Brady - Heron-Allen and Earland, p. 646
 1987 *Loxostomina (?) limbatum* (Brady) - Baccaert, p. 264-265; pl. 106, fig. 11.
 1994 *Loxostomina limbata* (Brady) - Loeblich and Tappan, p. 119; pl. 233, figs 1-8.
 2009 *Loxostomina limbata* (Brady) - Parker, p. 456; figs 329a-k, 330a-h
 2011 *Loxostomina limbata* (Brady) - Makled and Langer, figs. 8/30-35
 2012 *Loxostomina limbata* (Brady) - Debenay, p. 175, 302.

Test elongate, compressed, gradually tapering to the rather bluntly rounded apical end, often somewhat twisted, thickest along the median line, thinning toward the lateral margins, which are slightly rounded; wall calcareous, smooth, punctate; sutures thickened and limbate, only slightly depressed; early biserial chambers ornamented by a few strong costae; aperture terminal, elongate-oval, surrounded by a distinct thickened lip.

Loxostomina mayori (Cushman, 1922)

Pl. 29, figs. 29, 30.

- 1922 *Bolivina mayori* - Cushman, p. 27, pl. 3, figs. 5, 6.
 1937 *Loxostoma mayori* (Cushman) - Cushman, p. 195, pl. 22, figs. 16-21.
 1942 *Loxostoma mayori* (Cushman) - Cushman, p. 38, pl. II, figs. 1, 2.
 1960 *Loxostomum* sp. Brady - Baker, p. 108, pl. 53, figs. 14, 15.

- 1969 *Loxostomina mayori* (Cushman) - Sellier de Civrieux, p. 163, pl. 7, figs. 1,2, pl. 8, figs. 5-9.
 1976 *Loxostomina mayori* (Cushman) - Sellier de Civrieux, p. 30, pl. 29, figs. 4-10
 1987 *Loxostomina mayori* (Cushman) - Loeblich and Tappan, p. 516, pl. 567, figs. 6-10.
 1994 *Loxostomina mayori* (Cushman) - Loeblich and Tappan, p. 119, pl. 233, figs. 9-14.

Test elongate, somewhat compressed, nearly uniform width; chambers numerous, distinct; sutures depressed; wall thin, translucent, coarsely punctate, ornamented with few longitudinal costae; aperture terminal, elongate, extending nearly across the peripheral end of the last formed chamber with a slightly projecting lip.

Rectobolivina? sp. 1

Pl. 29, figs. 31, 32.

Test elongate, tubular, initial end broadly rounded; periphery slightly lobulate; chambers distinct; sutures slightly limbate, flush with the surface; wall smooth, very finely perforate; apertural face terminal rounded.

Genus **Sagrinella** Saidova, 1975

Sagrinella convallaria (Millett, 1900)

Pl. 29, figs. 33-35.

- 1900b *Bolivina convallaria* - Millett, p. 544; pl. 4, figs. 6/a-b.
 1958 *Loxostomum convallarium* (Millett) - Collins, p. 395, pl. 5, fig. 2.
 1959 *Loxostomum convallarium* (Millett) - Graham and Militante, p. 83, pl. 12, fig. 27
 1954 *Loxostomum convallarium* (Millett) - Cushman, Todd and Post, p. 353, pl. 88, figs. 4, 5.
 1993 '*Sagrina*' gr. *convallaria* (Millett) - Haig, p. 170, pl. 2, figs. 10-18.
 1993 *Sagrinella convallaria* (Millett) - Hottinger *et al.* p. 98, pl. 122, figs. 8-11.
 1994 *Sagrinella convallaria* (Millett) - Loeblich and Tappan, p. 120, pl. 236, figs. 1-8.
 2012 *Sagrinella convallaria* (Millett) - Debenay, p. 178, 302.

Test elongate, straight, biserial, tapering towards the initial end; periphery serrated; chambers numerous, inflated, with the peripheral margin acute; wall punctate; sutures deeply sunk; apertural end greatly projecting; aperture terminal, large and variable in form.

Genus **Saidovina** Haman, 1984

Saidovina carinata (Millett, 1900)

Pl. 29, figs. 36-38.

- 1900b *Bolivina karreriana* Brady var. *carinata* - Millett, p. 546, pl. 4, fig. 8.
 1911 *Bolivina karreriana* Brady var. *carinata* Millett - Cushman, p. 41, fig. 66.
 1921 *Bolivina karreriana* Brady var. *carinata* Millett - Cushman, p. 132, pl. 27, fig. 1.
 1959 *Loxostomum karrerianum* (Brady) var. *carinatum* (Millett) - Graham and Militante, p. 83, pl. 12, figs. 28, 29.
 1994 *Saidovina carinata* (Millett) - Loeblich and Tappan, p. 121, pl. 237, figs. 1-8

Test laterally compressed, tapering; wall calcareous, ornamented by longitudinal raised costae, occasionally branching or anastomosing, continued even on the last-formed chamber; aperture reaching to the preceding chamber instead of remote from it, and with the lateral borders distinctly carinate; the aperture is more elongate with a long tooth-like projection.

Saidovina karreriana (Brady 1881)

Pl. 30, figs. 1-4.

- 1881 *Bolivina karreriana* - Brady, p. 58.
 1884 *Bolivina karreriana* Brady - Brady p. 424, pl. 53, figs. 19-21
 1911 *Bolivina karreriana* Brady - Cushman, p. 40, fig. 65
 1937 *Loxostoma karreriana* (Brady) - Cushman, p. 184, pl. 21, fig. 17
 1994 *Saidovina karreriana* (Brady) - Loeblich and Tappan, p. 121, pl. 236, figs. 16-20.

Test elongate, tapering, the apical end occasionally rounded; chambers inflated; sutures much depressed; wall calcareous, ornamented by longitudinal raised costae, occasionally branching or anastomosing, continued even on the last-formed chamber; aperture broadly oval, subterminal, occasionally with a small tooth projecting into the orifice, bordered with a raised lip.

Saidovina sp. 1

Pl. 30, figs. 5-7.

Test elongate, laterally compressed; chambers increasing gradually as added, slightly inflated; sutures much depressed; wall ornamented by longitudinal raised costae, occasionally branching or anastomosing, continued even on the last-formed chamber; aperture a longitudinal slit, bordered with a thin lip.

Genus **Sagrinopsis** Sellier de Civrieux, 1969

Sagrinopsis fimbriata (Millett, 1900)

Pl. 30, fig. 8.

1900a *Bigenenerina fimbriata* Millett, p. 72, pl. 1, figs. 2-4.

1994 *Sagrinopsis fimbriata* (Millett) - Loeblich and Tappan, p. 122, pl. 239, figs. 1-10.

2009 *Sagrinopsis fimbriata* (Millett) - Parker, p. 465, figs. 335/a-e.

Test elongate, subcircular to ovate in cross section, later stage somewhat compressed; biserial to uniserial chamber arrangement with early stage triserial; sutures prominent, raised and ornamented with characteristic deep pits; aperture elongated oval, terminal.

Genus **Siphogenerina** Schlumberger, in Milne-Edwards 1882.

Siphogenerina raphana (Parker and Jones, 1865)

Pl. 30, figs. 9, 10.

1865 *Uvigerina (Sagrina) raphanus* Parker and Jones, p. 364, pl. 18, figs. 21-24.

1884 *Sagrina raphanus* (Parker and Jones) – Brady, p. 585, pl. 75, figs. 21-24

1915 *Sagrina raphanus* (Parker and Jones) – Heron-Allen and Earland, p. 677.

1924 *Siphogenerina raphanus* (Parker and Jones) - Cushman, p. 28, pl. 8, figs 1, 2.

1962 *Siphogenerina raphanus* (Parker and Jones) - Graham and Militante, p. 124, p. 87, pl. 13, fig. 8.

1992 *Rectobolivina raphana* (Parker and Jones) - Hatta and Ujiie, p. 174, pl. 26, figs. 11-12

1994 *Siphogenerina raphana* (Parker and Jones) - Loeblich and Tappan, p. 123, pl. 240, figs. 1-11.

2009 *Siphogenerina raphana* (Parker and Jones) - Parker, p. 469, figs. 338/a-j.

2012 *Siphogenerina raphana* (Parker and Jones) - Debenay, p. 169, 302.

2013a *Rectobolivina raphana* (Parker and Jones) - Langer *et al.* figs. 7/27-28

Test elongate, cylindrical, tapering slightly toward the initial end; initial end rounded, oral end convex and broad; early chambers biserially arranged, later uniserial and rectilinear for most of the test; chambers of the uniserial section broader than long; sutures distinct; wall ornamented by many well developed longitudinal costae with regular spacing and running the full length of the test; aperture rounded with a prominent rim.

Siphogenerina striata (Schwager, 1866)

Pl. 30, figs. 11, 12.

1866 *Dimorphina striata* Schwager, p. 251, pl. 7, fig. 99.

1893 *Siphogenerina (Sagrina) striata* (Schwager) - Egger? p. 316, pl. 9, figs. 32, 34, 35, 64, 65.

1913 *Siphogenerina (Sagrina) striata* (Schwager) - Cushman, p. 107, pl. 47, figs. 4, 5.

1921 *Siphogenerina striata* (Schwager) - Cushman, pl. 56, fig. 5

1960 *Siphogenerina striata* (Schwager) - Baker, p. 158, pl. 75, fig. 26.

Test elongate, cylindrical, tapering slightly toward the initial end; sutures depressed, marking well defined limits even in the costae; wall ornamented by numerous well developed longitudinal costae that are less independent of the chambers, with regular spacing and running the full length of the test to the aperture; aperture rounded with a prominent rim.

Siphogenerina sp. 1

Pl. 30, figs. 13, 14.

Test elongate, cylindrical, tapering slightly toward the initial end; sutures slightly depressed; wall ornamented by few well developed, wavy, longitudinal costae that are somewhat anastomosing; aperture terminal, rounded with a prominent rim at the end of the last chamber.

Genus **Allassoida** Loeblich and Tappan, 1994

Allassoida virgula (Brady, 1879)

Pl. 30, figs. 15-17.

1879 *Sagrina virgula* - Brady, p. 275, pl. 8, figs. 19-21.

1924 *Siphogenerina virgula* (Brady) - Cushman, p. 29, pl. 8, figs. 3, 4.

1994 *Allassoida virgula* (Brady) - Loeblich and Tappan, p. 121, pl. 238, figs. 1-11.

2011 *Siphogenerina virgula* (Brady) - Makled and Langer, figs. 8/36-38.

2012 *Allasoida virgula* (Brady) - Debenay 162, 302.

Test elongate, composed of numerous inflated chambers, slightly tapering towards the initial end; early stage trochospiral, becoming uniserial abruptly with 4-5 gradually enlarging chambers; the uniserial portion make the most of the test; wall hispid; aperture large, with a broad everted lip having backward pointing acicular spines at the border.

Family **Buliminidae** Jones, (in Griffith and Henfrey, 1875)

Genus **Bulimina** d'Orbigny, 1826

Bulimina sp. 1

Pl. 30, figs. 18, 19.

Test elongate, triserial : chambers slightly inflated, strongly overlapping; suture constricted; wall calcareous, surface of chambers smooth; proximal margin of chambers undercut and bearing prominent spines; aperture elongate, loop-shaped, bordered by a distinct lip and a prominent tooth plate.

Family **Buliminellidae** Hofker, 1951

Genus **Buliminella** Cushman, 1911

Buliminella elegantissima (d'Orbigny, 1839)

Pl. 30, fig. 20.

1839c *Bulimina elegantissima* - d'Orbigny, p. 51, pl. 7, figs. 13, 14.

1995 *Buliminella elegantissima* (d'Orbigny) - Yassini and Jones, p. 144, figs. 638-640 and 643-645.

1998 *Buliminella elegantissima* (d'Orbigny) - Debenay *et al.* pl. 4, figs. 2, 3.

1999 *Buliminella elegantissima* (d'Orbigny) - Hayward *et al.* p. 133, pl. 9, figs. 18, 19.

2012 *Buliminella elegantissima* (d'Orbigny) - Debenay p. 188, 303.

Test elongate, fusiform, a high trochospiral coil of only 2-3 whorls of numerous elongate chambers, the last whorl taking about two-third of the test; sutures slightly curved, almost parallel to the axis of the test, slightly depressed; wall finely perforate, surface smooth; aperture a loop in the depressed face of the final chamber with a high rim and a simple internal toothplate.

Family **Uvigerinidae** Haeckel, 1894

Genus **Trifarina** Cushman, 1923

Trifarina bradyi Cushman, 1923

Pl. 30, figs. 21-23.

1923 *Trifarina bradyi* - Cushman, p. 99, pl. 22, figs. 3-9.

1987 *Trifarina bradyi* Cushman - Loeblich and Tappan, p. 526, pl. 574, figs. 10-13.

1994 *Trifarina bradyi* Cushman - Loeblich and Tappan, p. 128, pl. 251, figs. 6-16.

2012 *Trifarina bradyi* Cushman - Debenay, p. 183, 304.

Test elongate, triangular in transverse section, slightly tapering toward either end, often somewhat twisted; carinae at three angles, thin and fairly high, running from oral to aboral ends; chambers distinct, earlier portion irregularly twisted; sutures distinct but not depressed; wall thin, translucent, punctate, smooth; aperture terminal, central, at the end of a short tubular neck, usually with a phialine lip and a toothplate.

Family **Reussellidae** Cushman, 1933

Genus **Fijiella** Loeblich and Tappan, 1962

Fijiella simplex (Cushman, 1929)

Pl. 30, figs. 24, 25.

1929b *Trimosina simplex* - Cushman, p. 158, text fig. 2.

1991 *Fijiella simplex* (Cushman) - Revets, p. 4, pl. 2, figs 1-4.

1994 *Fijiella simplex* (Cushman) - Loeblich and Tappan, p. 129, pl. 252, figs. 5, 6.

2009 *Fijiella simplex* (Cushman) - Parker, p. 449, figs. 323/a-m.

2012 *Fijiella simplex* (Cushman) - Debenay, p. 180, 304.

Test medium sized, triangular in both side and end views, peripheral margin acute, carinate, spinose, straight or somewhat lobulate; chambers triserial throughout, uniformly increasing in size as added; sutures distinct, not depressed, very slightly limbate, rather evenly curved; wall calcareous, coarsely perforate, especially along the borders, smooth, fairly thick but translucent; apertural face slightly convex, fairly smooth; aperture a narrow slit partially covered with a curved, denticulate lip and provided with a large perforated toothplate that forms rounded supplementary openings on the central part of the apertural face

Genus **Reussella** Galloway, 1933

Reussella pacifica Cushman and McCulloch, 1948

Pl. 30, figs. 26, 27.

1948 *Reussella pacifica* Cushman and McCulloch, p. 251, pl. 31, fig. 6.

1987 *Reussella "simplex"* (Cushman) - Baccaert, p. 190, pl. 75, figs. 3-5.

2009 *Reussella pacifica* Cushman and McCulloch - Parker, p. 463, figs. 333/a-c.

2012 *Reussella pacifica* Cushman and McCulloch - Debenay p.182, 304.

Test elongate, triangular in transverse section, the sides somewhat concave, periphery acute with a distinct, somewhat blunt spine at the basal angle of each chamber projecting outward and somewhat backward; chambers distinct, not inflated, increasing gradually and rather evenly in size as added; sutures distinct, nearly straight, slightly limbate; wall translucent, distinctly perforate; aperture a small, opening at the inner margin of the last formed chamber.

Family **Trimosinidae** Saidova, 1981

Genus **Mimosina** Millett, 1900

Mimosina affinis Millett, 1900

Pl. 30, figs. 28, 29.

1900b *Mimosina affinis* - Millett, p. 548, pl. 4, fig. 11.

1993 *Mimosina affinis* Millett - Hottinger *et al.* p. 104, pl. 133, figs. 9-12; pl. 134, figs. 1-3.

2012 *Mimosina affinis* Millett - Debenay p. 180, 305.

Test elongate, triserial; chambers slightly inflated, strongly overlapping, punctate, last chamber almost half of test; suture slightly constricted: wall calcareous, distinctly perforate, with fine longitudinal ribs; aperture a wide and low basal arch, with a second ovate opening that is nearly terminal, each bordered by a narrow imperforate lip

Mimosina spinulosa Millett, 1900

Pl. 30, figs. 30-34.

1900 *Mimosina spinulosa* - Millett, p. 548.

1993 *Trimosina* gr. *spinulosa* (Millett) - Haig, p. 170, pl. 4, figs. 19-23.

1987 *Trimosina milletti* Cushman - Loeblich and Tappan, p. 528, pl. 576, figs. 5, 6.

Test elongate, triserial in the early stage, later, tending to become biserial, chambers, subglobular and inflated, sutures depressed; wall coarsely and densely perforated, ornamented with thin, short ridges running parallel to each other; aperture a wide and low basal arch, with a second ovate opening that is nearly terminal, each bordered by a narrow imperforate lip.

Family **Fursenkoinidae** Loeblich and Tappan, 1961

Genus **Fursenkoina** Loeblich and Tappan, 1961

Fursenkoina schreibersiana (Czjzek, 1848)

Pl. 30, figs. 35-40.

1848 *Virgulina schreibersiana* - Czjzek, p. 147, pl. 13, figs. 18-21.

1937 *Virgulina schreibersiana* Czjzek - Cushman, p. 13, pl. 2, figs. 11-20.

1994 *Fursenkoina schreibersiana* (Czjzek) - Loeblich and Tappan, p. 131, pl. 257, figs. 1-12.

1996 *Fursenkoina schreibersiana* (Czjzek) - Revets, p. 12, pl. 8, figs. 5-8.

2012 *Fursenkoina schreibersiana* (Czjzek) - Debenay p. 174, 306.

Test elongate, slightly compressed, periphery broadly rounded, initial portion strongly twisted; chambers inflated, twisted obliquely, longer than wide; sutures distinct and depressed; wall smooth, thin, finely perforate; aperture elongate, with a thin lip, often failing to reach the base of the apertural face, but continuing onto the terminal end of the test.

Genus **Sigmavirgulina** Loeblich and Tappan, 1957

Sigmavirgulina tortuosa (Brady, 1881)

Pl. 31, figs. 1, 2.

1881 *Bolivina tortuosa* - Brady, p. 57.

1960 *Sigmavirgulina tortuosa* (Brady) - Baker, p. 108, pl. 52, figs. 31, 32.

1987 *Sigmavirgulina tortuosa* (Brady) - Loeblich and Tappan, p. 531; pl. 579, figs 1-5.

1999 *Sigmavirgulina tortuosa* (Brady) - Hayward *et al.* p. 136, pl. 9, figs. 30, 31.

2009 *Sigmavirgulina tortuosa* (Brady) - Parker, p. 466, figs. 337/a-f.

2012 *Sigmavirgulina tortuosa* (Brady) - Debenay p. 179, 306.

Test small, elongate, twisted; periphery margins carinate; sutures flush; wall coarsely perforated; aperture slit-shaped with thick rim, bisected by a toothplate.

Family **Bagginidae** Cushman, 1927

Genus **Baggina** Cushman, 1926b

Baggina philippinensis (Cushman, 1921)

Pl. 31, figs. 3-5.

1921 *Pulvinulina philippinensis* - Cushman, p. 331, pl. 58, fig. 2.

1994 *Baggina philippinensis* (Cushman) - Loeblich and Tappan, p. 134, pl. 265, figs. 1-6.

2012 *Baggina philippinensis* (Cushman) - Debenay, p. 187, 307.

Test globular, low trochospiral; chambers inflated and rapidly enlarging per whorl; last formed chamber making almost half of the test volume; periphery broadly rounded; sutures distinct, slightly depressed, radial and curve; wall smooth, glassy, punctate; but with an imperforate area on the umbilical side just above the aperture; aperture broad umbilical opening at the base of the apertural face.

Family **Cancrisidae** Chapman, Parr and Collins, 1934

Genus **Cancris** de Montfort, 1808

Cancris auriculus (Fichtel and Moll, 1798)

Pl. 31, figs. 6-9.

1798 *Nautilus auricula* - Fichtel and Moll, p. 108, pl. 20

1921 *Pulvinulina auricula* (Fichtel and Moll) - Cushman, p. 329, pl. 69, figs. 6a-c

1959 *Cancris auriculus* (Fichtel and Moll) - Graham and Militante, p. 91, pl. 23, figs. 18 a-b

1974 *Cancris auriculus* (Fichtel and Moll) - Lutze, p. 29, pl. 6, figs. 108-109

1987 *Cancris auriculus* (Fichtel and Moll) - Baccaert, p. 197, pl. 78, figs. 1/a-d

1994 *Cancris auriculus* (Fichtel and Moll) - Loeblich and Tappan, p. 134, pl. 265, figs. 7-10.

2009 *Cancris* cf. *C. auriculus* (Fichtel and Moll) - Parker, p. 522, figs. 371/a-i.

2012 *Cancris auriculus* (Fichtel and Moll) - Debenay, p. 189, 307.

Test elongate, auriculate in outline, biconvex, dorsal side slightly convex; peripheral margin acute, carinated; chambers arranged trochospirally, increasing rapidly in size; sutures arched, slightly depressed and strongly recurved backward at the periphery on the spiral side, more depressed and nearly radial on the umbilical side; wall thin and smooth, translucent, finely perforate, except a semicircular region on the septal face; aperture a narrow slit at the base of the last chamber on the umbilical side, with a broad apertural flap extending over the umbilicus.

Genus **Valvulineria** Cushman, 1926b

Valvulineria aff. V. minuta (Schubert, 1954)

Pl. 31, figs. 10-12.

1884 *Discorbina rugosa* (d'Orbigny) - Brady, p. 652, pl. 91, fig. 4 (not pl. 87, fig. 3).

1904 *Discorbina rugosa* (d'Orbigny) var. *minuta* Schubert, p. 420.

- 1954 *Valvulineria minuta* (Schubert) - Parker, p. 527, pl. 9, figs. 4-6.
 1994 *Valvulineria minuta* (Schubert) - Loeblich and Tappan, pl. 268, figs. 4-9
 2012 *Valvulineria minuta* (Schubert) - Debenay, p. 215, 307.

Test trochospiral, subcircular in lateral view; periphery broadly rounded; spiral side evolute with about two visible whorls, umbilical side involute, deep umbilicus; about 8 chambers in the last whorl; sutures distinct and depressed, gently curved; umbilical end of latter chambers extending over the umbilical depression into flaps; wall smooth, finely punctate; aperture an arched slit at the base of the apertural face, extending beneath the umbilical flap.

Family **Eponididae** Hofker, 1951

Genus **Eponides** De Montfort, 1808

Eponides repandus (Fichtel and Moll, 1798)

Pl. 31, figs. 13-18.

1798 *Nautilus repandus* – Fichtel and Moll, p. 35, pl. 3, figs. a-d

1915 *Pulvinulina repanda* (Fichtel and Moll) - Heron-Allen and Earland, p. 713

1984 *Eponides repandus* (Fichtel and Moll) - Rögl and Hansen, p. 31, pl. 2, figs. 5-7, pl. 3, figs. 2, 3, textfig. 9

1992 *Eponides repandus* (Fichtel and Moll) - Hatta and Ujiie, p. 179, pl. 30, figs. 1/a-c, 2

1993 *Eponides repandus* (Fichtel and Moll) - Hottinger et al. p. 106, pl. 137, figs. 1-10

1994 *Eponides repandus* (Fichtel and Moll) - Loeblich and Tappan, p. 136, pl. 268, figs. 10-13

1995 *Eponides cribrorrepandus* (Asano and Uchio) - Yassini and Jones, p. 157; figs 779-780.

2009 *Eponides repandus* (Fichtel and Moll) - Parker, p. 603; figs. 429/a-f.

2012 *Eponides repandus* (Fichtel and Moll) - Debenay, p. 196, 307.

Test almost equally biconvex, peripheral margin acute, often slightly lobulated, carinate; chambers distinct, not inflated, increasing rather evenly in size as added, with about 5-7 chambers per whorl, the ventral side somewhat truncated; sutures distinct, limbate on both surfaces, the dorsal ones gently curved, ventral ones nearly radial; wall smooth except for the slightly raised sutures on the dorsal side, finely perforate; aperture a broad low interiomarginal arch extending from the umbilicus to the periphery, often with a few supplementary areal openings.

Genus **Poroeponides** Cushman, 1944

Poroeponides lateralis (Terquem, 1878)

Pl. 31, figs. 19-21.

1878 *Rosalina lateralis* - Terquem, p. 25, pl. 2, fig. 11

1944b *Poroeponides lateralis* (Terquem) - Cushman, p. 34, pl. 4, figs. 23/a-b.

1993 *Poroeponides lateralis* (Terquem) - Hottinger et al. p. 107, pl. 138, figs 1-9.

2012 *Poroeponides lateralis* (Terquem) - Debenay, p. 210, 308.

Test trochospiral, biconvex, oval in lateral view, evolute on the spiral side and involute on the umbilical side; sutures limbate, curved and oblique on the spiral side, but depressed, curved, nearly radial on the umbilical side; Umbilical region depressed, partially closed by a small umbilical flap from each chamber; primary aperture interiomarginal, extraumbilical, composed of an elongate, narrow slit extending at the base of the ultimate chamber from the umbilicus to the peripheral keel and bordered above by a narrow lip, supplementary rounded areal openings scattered over the apertural face.

Family **Heleninidae** Loeblich and Tappan, 1987

Genus **Helenina** Saunders, 1961

Helenina sp. 1

Pl. 31, figs. 22-25.

Test small, low trochospiral, both sides flattened, periphery rounded, peripheral margin lobulate; test composed of two whorls visible on the spiral side; chambers enlarging gradually, 7 in the final whorl; sutures curved, oblique, depressed, on both sides; large overlapping umbilical flaps of successive chambers closing the umbilicus; wall distinctly perforate, surface smooth; aperture an extra-umbilical interiomarginal slit bordered by a lip, supplementary infrasutural apertural slits present on both sides.

Genus **Rhaptohelenina** Clark, 1993

Rhaptohelenina sp. 1

Pl. 31, figs. 26-28.

Test small, low trochospiral, subcircular in lateral view, wider breadth, biconvex, spiral side evolute, umbilical side involute, with a narrow umbilicus; periphery rounded, weakly lobulate; chambers increasingly inflated as added; sutures flush; wall thick, smooth, finely perforate, but with large pores along the periphery of the spiral side; aperture multiple with primary aperture a low arch on the umbilical side running from the umbilicus about two third of way to periphery, then curving obliquely upwards; secondary apertures consist of large sutural openings on both sides of the test.

Family **Discorbidae** Ehrenberg, 1838

Genus **Rotorbis** Sellier de Civrieux, 1977

Rotorbis auberii (d'Orbigny, 1839)

Pl. 31, figs. 29-31.

1839 *Rosalina auberii* d'Orbigny, p. 94, pl. 4, figs. 5-8

1922a *Discorbis mira* Cushman, p. 39, pl. 6, figs. 10, 11.

1977 *Discorbis auberii* (d'Orbigny) - Le Calvez, p. 77, pl. 9, figs. 5-8.

1987 *Discorbis mira* (Cushman) - Baccaert, p. 198, pl. 78, figs. 2-5.

1988 *Neoeponides auberii* (d'Orbigny) - Loeblich and Tappan, p. 558, pl. 605, figs. 5-7.

1994 *Rotorbis auberii* (d'Orbigny) - Loeblich and Tappan, p. 137, pl. 278, figs. 1-11.

2009 *Rotorbis cf. R. auberii?* (d'Orbigny, 1839) - Parker, p. 728, figs. 513/a-h

2012 *Rotorbis auberii* (d'Orbigny) - Debenay, p. 212, 309.

Test small, low trochospiral, oval in lateral view, dorsal side evolute forming a low cone, ventral side involute, nearly flat; periphery acute angled and keeled; chambers crescent shaped on the spiral side; sutures arched, flush, spiral suture limbate; wall coarsely punctate on both sides, with pores almost arranged in rows parallel to the sutures on the spiral side; aperture a low interiomarginal arch, partially hidden by a low lip running from the umbilicus nearly to the peripheral keel with a supplementary re-entrant.

Family **Rosalinidae** Reiss, 1963

Genus **Neoconorbina** Hofker, 1951a

Neoconorbina sp. 1

Pl. 31, figs. 32-35.

Test trochospiral, dome shaped, planoconvex; spiral side conical with a rounded apex; umbilical side flat, peripheral edge acute; 5-7 long and narrow chambers in the last whorl; flattened side ornamented with moderately large tubercles near the centre and riblets radiating to the periphery, obscuring the radiate sutures between chambers; wall coarsely perforate on the conical side, finely perforate on the flattened side; aperture on the flattened side, hardly recognisable.

Neoconorbina sp. 2

Pl. 32, figs. 1-4.

Test subcircular, trochospiral, flattened; periphery acute keeled; sutures curve, depressed on the umbilical side, slightly limbate on the spiral side; chambers crescent shaped, both on the spiral and umbilicus side; wall coarsely perforate on both sides; aperture umbilical.

Genus **Rosalina** d'Orbigny, 1826

Rosalina bradyi (Cushman, 1915)

Pl. 32, figs. 5-9.

1884 *Discorbina globularis* d'Orbigny - Brady, p. 643, pl. 86, figs. 8/a-c

1915 *Discorbina globularis* d'Orbigny - Heron-Allen and Earland, p. 694, pl. 51, figs. 36-39

1915 *Rosalina globularis* d'Orbigny var. *bradyi* - Cushman, p. 12, pl. 8, fig. 1.

1960 *Rosalina bradyi* (Cushman) - Barker; pl. 86, figs. 8a-c.

1991 *Rosalina bradyi* (Cushman) - Cimerman and Langer, p. 66, pl. 71, figs. 1-5

1993 *Rosalina bradyi* (Cushman) - Hottinger *et al.* p. 110, pl. 142, figs. 11, 12; pl. 143, figs. 1-6

1994 *Rosalina bradyi* (Cushman) - Ujiie and Hatta, p. 14, pl. 3, fig. 4

1999 *Rosalina bradyi* (Cushman) - Hayward *et al.* p. 142, pl. 11, fig. 1.

2012 *Rosalina bradyi* (Cushman) - Debenay, p. 211, 310.

Test flat, trochospiral, evolute and slightly convex on the spiral side, flat to slightly concave on the umbilical side; periphery rounded; sutures limbate, curved back at the periphery; umbilical side with the chambers more or less inflated; last-formed chamber with a more or less bifid indentation extending inward from umbilical region; spiral surface coarsely perforated, umbilical surface smooth and imperforate; aperture a low interiomarginal arch on the umbilical side, with narrow bordering lip.

Rosalina floridana (Cushman, 1922)

Pl. 32, figs. 10-14.

1922a *Discorbis floridana* Cushman, p. 39, pl. 5, figs 11, 12.

1971 *Rosalina floridana* (Cushman) - Schnitker, p. 210, pl. 5, fig. 19.

1993 *Rosalina floridana* (Cushman) - Sgarrella and Moncharmont-Zei, p. 218, pl. 17, fig. 6

2012 *Rosalina floridana* (Cushman) - Debenay 211, 310.

Test rotaliform, periphery subacute, dorsal much convex, ventral side concave, somewhat umbilicate; chambers comparatively few, 5 or 6 in the last-formed coil; wall coarsely punctate on the dorsal side, on the ventral side punctate near the periphery, but on the inner concave portion smooth, with very fine punctate; sutures in the initial portion slightly limbate, those of the later portion not limbate, rather indistinct, very slightly depressed; aperture an elongate, arched opening at the base of the last-formed chamber, opening on the umbilicate area, often with a slight, thin lip.

Rosalina globularis d'Orbigny, 1826

Pl. 32, figs. 15-17.

1826 *Rosalina globularis* - d'Orbigny, p. 271, pl. 13, figs 1-4.

1884 *Discorbina globularis* (d'Orbigny) - Brady, p. 643, pl. 86, fig. 13.

1992 *Rosalina globularis* d'Orbigny - Hansen and Revets, p. 177, pl. 6, figs 4-6, 9.

2009 *Rosalina globularis* d'Orbigny - Parker, p. 718, figs. 504/a-l.

2012 *Rosalina globularis* d'Orbigny - Debenay, 211, 310.

Test rotaliform, dorsal side much convex and evolute, ventral side concave and involute; chambers few with 5 or 6 in the last coil; peripheral margin broadly rounded; sutures on spiral side curved and depressed, on umbilical side somewhat indistinct; umbilicus open; chambers with a triangular folium and hook-shaped sutural notches; on the dorsal side coarsely punctate, on the ventral side punctate near the periphery, but on the inner concave portion smooth, with very fine punctate; aperture interiomarginal with a low lip in the peripheral-most region, aperture continues to umbilicus, under the folium.

Rosalina sp. 1.

Pl. 32, figs. 18-21.

Test compressed, umbilical side flattened with slightly depressed umbilicus and circular umbilical plug, spiral side slightly convex, lateral outline ovate and non lobate, peripheral margins rounded; coiling low trochospiral, evolute on spiral side, partially evolute on umbilical side; chambers low and narrow, arcuate on spiral side; suture curved backwards, raised and limbate on the spiral side, straightened, radial and flush on the umbilical side; wall smooth, coarsely perforate on the spiral side, imperforate on the umbilical side; aperture interiomarginal, extending under the folium with a thin lip on the upper margin.

Rosalina sp. 2

Pl. 32, figs. 22-24.

Test compressed, umbilical side flattened with much depressed umbilicus, spiral side slightly convex; peripheral margins subacute to subrounded; coiling low trochospiral, evolute on spiral side; suture curved backwards, raised and limbate on the spiral side; wall coarsely perforate on the spiral side, imperforate on the umbilical side but with a central plug; aperture a low interiomarginal slit, bordered by a thickened lip.

Genus **Rotorboides** Sellier de Civrieux, 1977

Rotorboides granulosus (Heron-Allen and Earland, 1915)

Pl. 32, figs. 25-28.

1915 *Discorbina valvulata* var. *granulosa* Heron-Allen and Earland, p. 695

1987 *Rotorboides granulosus* (Heron-Allen and Earland) - Loeblich and Tappan, p. 561, pl. 609, figs. 5-7

2012 *Rotorboides granulosus*, (Heron-Allen and Earland, 1915) - Debenay, p. 213, 310.

Test free, low trochospiral, nearly circular in lateral view; periphery broadly rounded; spiral side convex, evolute, 6-9 chambers in final whorl separated by limbate sutures, umbilical side flattened; umbilical chamber wall drawn-out and covering the umbilical surface by fusing with plates of earlier chambers; spiral side coarsely perforated,

more or less ornamented by an anastomosing, imperforate network; umbilical side imperforate; aperture a low interiomarginal slit, extending almost to periphery, bordered by a thickened lip continuous with the drawn-out umbilical chamber wall.

Genus **Tretomphalus** Möbius 1880

Tretomphalus bulloides (d'Orbigny, 1839)

Pl. 32, figs. 29-32.

1839 *Rosalina bulloides* d'Orbigny, p. 98, pl. 3, figs. 2-5.

1880 *Tretomphalus bulloides* (d'Orbigny) - Möbius, p. 98, pl. 10, figs. 6-9.

1981 *Tretomphalus bulloides* (d'Orbigny) - Venec-Peyre, p. 124, 126, 127, pl. 3, fig. 3; pl. 4, figs. 3, 4.

1985 *Rosalina (Tretomphalus) bulloides* (d'Orbigny) - Banner *et al.* p. 164, pl. 1, figs. 1-5.

1993 *Tretomphalus bulloides* (d'Orbigny) - Hottinger *et al.* p. 112, pl. 146, figs. 1-7.

2009 *Tretomphalus bulloides* (d'Orbigny) - Parker, p. 748, figs. 523/a-h, 524/a-l.

Test free, subglobular, early chambers rotaliform, 4 to 5 chambers in the last coil; wall coarsely perforate, forming a cap to which is attached a large final "balloonchamber"; final chamber subspherical, with coarse perforations on the ventral side, and within a "float-chamber" with numerous rimmed rounded openings at the base.

Family **Bronnimanniidae** Loeblich and Tappan, 1984

Genus **Bronnimannia** Bermudez, 1952

Bronnimannia haliotis (Heron-Allen and Earland, 1924)

Pl. 32, figs. 33-35.

1924 *Discorbina haliotis* - Heron-Allen and Earland, p. 173, pl. 13, figs. 99-101.

1965 *Bronnimannia haliotis* (Heron-Allen and Earland) - Todd, p. 27, pl. 5, fig. 2.

1994 *Bronnimannia haliotis* (Heron-Allen and Earland) - Loeblich and Tappan, p. 141, pl. 287, figs. 7-12.

2012 *Bronnimannia haliotis* (Heron-Allen and Earland) - Debenay, p. 188, 311.

Test low trochospiral, oval in lateral view, and somewhat biconcave, prominent in the last-formed chambers; periphery rounded, without prominent imperforate keel; spiral side is very finely perforate while the umbilical side is uniformly imperforate; initial coil on this imperforate surface appears to stand apart from the final whorl of chambers; aperture a low, interiomarginal slit beneath the umbilical flap.

Family **Glabratellidae** Loeblich and Tappan, 1964

Genus **Murrayinella** Farias, 1977

Murrayinella murrayi (Heron-Allen and Earland, 1915)

Pl. 33, figs. 1, 2.

1915 *Rotalia murrayi* Heron-Allen and Earland, p. 721, pl. 53, figs. 27-34.

1997 *Murrayinella murrayi* (Heron-Allen and Earland) - Haig, p. 277, figs. 7/11, 12.

2009 *Murrayinella* cf. *M. murrayi* (Heron-Allen and Earland) - Parker, p. 657, figs. 464/a-k.

2012 *Murrayinella murrayi* (Heron-Allen and Earland) - Debenay, p. 202, 312.

Test small, trochospirally enrolled, unequally biconvex; chambers inflated to globular; wall calcareous, perforate rugose to dense hispid surface; spiral side evolute, gently convex, umbilical side involute, highly convex; about 4 to 6 rapidly enlarging chambers in the last whorl; periphery broadly rounded, lobulated; umbilicus closed; sutures deeply depressed, oblique on the spiral side, almost radial on the umbilical side; aperture an extraumbilical umbilical slit-shaped opening, obscured by the ornament.

Family **Buliminoididae** Seiglie, 1970

Genus **Elongobula** Finlay, 1939

Elongobula milletti (Cushman, 1933)

Pl. 33, figs. 3, 4.

1933b *Buliminella milletti* Cushman, p. 78, pl. 8, figs. 5, 6.

1942 *Buliminella milletti* Cushman - Cushman, p. 7, pl. 3, figs. 3, 4.

2009 *Elongobula milletti* (Cushman) - Parker, p. 446, figs. 321/a-h.

2012 *Elongobula milletti* (Cushman) - Debenay, p. 194,

Test small, enrolled trochospirally, tapering, initial end bluntly rounded or pointed; diameter increases toward the apertural end; chambers distinct, four or more making up the last whorl, slightly inflated; sutures flush with the surface or slightly depressed, especially the spiral suture, slightly limbate; wall smooth, very finely perforate; apertural face broadly rounded with numerous radial grooves running into the depressed area at the center; aperture a semielliptical opening at the base of the apertural face which is nearly covered by a large apertural flap flush with apertural face.

Elongobula parallela (Cushman and Parker, 1931)

Pl. 33, figs. 5-8.

1931 *Buliminella parallela* Cushman and Parker, p. 13, pl. 3, figs. 15/a-c.

1969 *Buliminoides parallela* (Cushman and Parker) - Seiglie, p. 330, pl. 1, figs. 1-5.

1993 *Elongobula parallela* (Cushman and Parker) - Revets, p. 262, pl. 3, figs. 10-13.

1994 *Floresina durrandi* Revets - Loeblich and Tappan, p. 126, pl. 245, figs. 1-6.

2009 *Elongobula parallela* (Cushman and Parker) - Parker, p. 446; figs. 322/a-l.

2012 *Elongobula parallela* (Cushman and Parker) - Debenay, p. 194, 313.

Test elongate, tubular, both ends broadly rounded; periphery slightly lobulate; chambers distinct, in 3 or more whorls; sutures slightly limbate, flush with the surface; wall smooth, very finely perforate, ornamented with faint anastomosing costate over the lower parts of the test; apertural face terminal with radial grooves; aperture central, partially hidden by a broad flap.

Family **Siphoninidae** Cushman, 1927

Genus **Siphonina** Reuss, 1850

Siphonina tubulosa Cushman, 1924

Pl. 33, figs. 9-12.

1924 *Siphonina tubulosa* Cushman, p. 40, pl. 13, figs 1-2.

1965 *Siphonina tubulosa* Cushman - Todd, p. 22, pl. 15, fig. 4.

1992b *Siphonina tubulosa* Cushman - Hatta and Ujjié, p. 186, pl. 35, figs. 1, 2.

2009 *Siphonina tubulosa* Cushman - Parker, p. 731, figs. 515/a-i.

2012 *Siphonina tubulosa* Cushman - Debenay, p. 213, 313.

Test free, low trochospiral, compressed, circular in outline, keeled; last formed whorl consisting of 3-4 chambers; sutures somewhat depressed, oblique; sutures radial and depressed on the umbilical side; umbilicus closed: wall finely perforate, surface ornamented with few raised conical projections, this is also observed at the periphery; aperture elliptical, just above the base of the final chamber and nearly equatorial in position, produced on a compressed short tubular neck and bordered with a phialine lip.

Family **Discorbinellidae** Sigal, 1952

Genus **Discorbinella** Cushman and Martin, 1935

Discorbinella bertheloti (d'Orbigny, 1839)

Pl. 33, figs. 13-15.

1839b *Rosalina bertheloti* d'Orbigny, p. 135, pl. 1, figs. 28-30.

1884 *Discorbinella bertheloti* (d'Orbigny) - Brady, p. 650, pl. 89, figs. 10-12 (ZF 1384).

1993 *Discorbinella bertheloti* (d'Orbigny) - Hottinger *et al.* p. 114, pl. 150, figs. 1-4.

1994 *Discorbinella bertheloti* (d'Orbigny) - Loeblich and Tappan, p. 147, pl. 309, figs. 13-15.

1999 *Discorbinella bertheloti* (d'Orbigny) - Hayward *et al.* p. 152, pl. 14, figs. 1-3.

2012 *Discorbinella bertheloti* (d'Orbigny) - Debenay, p. 194, 314.

Test compressed but not flattened, plano-convex; spiral side convex, involute to slightly advolute; umbilical side flat to concave, involute to slightly advolute; peripheral outline nearly circular to slightly elliptical, peripheral margin carinated; flat side with shallow umbilicus and folia on the last 3-4 chambers; chambers 6-8 in the final whorl, slightly inflated on convex side, increasing in size gradually and then rapidly for the last 3-4; sutures depressed, curved and slightly thickened on both sides; wall smooth, distinctly and regularly perforate on both sides; aperture equatorial to interiomarginal, broadly arch-shaped with a thickened lip, with supplementary posterior foliar openings.

Family **Cibicididae** Cushman, 1927

Genus **Cibicides** Montford, 1808

Cibicides mabahethi Said, 1949

Pl. 33, figs. 16-22.

1949 *Cibicides mabahethi* Said, p. 42, pl. 4, fig. 20.

1993 *Cibicides mabahethi* Said - Hottinger *et al.* p. 115, pl. 151, figs. 6-12.

2012 *Cibicides mabahethi* Said - Debenay, p. 190, 315.

Test low trochospiral, planoconvex to slightly biconvex; spiral side evolute, umbilical side involute, prominently convex, with a broad imperforate umbilical knob; peripheral outline becoming slightly lobulate in adult; peripheral margin acute, carinated; sutures curved on both sides, slightly limbate on the spiral side and slightly depressed on the umbilical side; wall coarsely perforated on the spiral side, perforations scattered, mostly along the sutures, on the umbilical side; aperture extraumbilical equatorial, provided with a thick rim and extending into a supplementary spiral aperture remaining open in the last few chambers.

Remarks: Specimens depicted by Hottinger *et al.* 1993 and Debenay 2012 show some perforations on the umbilical side. This feature was not described originally by Said 1949.

Cibicides phillipensis Collins, 1974

Pl. 33, figs. 23-29.

1974 *Cibicides phillipensis* - Collins, p. 49, pl. 4, figs. 41/a-c.

2009 *Cibicides phillipensis* Collins - Parker, p. 532, figs. 377/a-c.

Test trochospiral, plano-convex, bluntly-keeled, and somewhat lobulated in the later chambers; spiral side flat or slightly convex; umbilicate side is involute with about seven chambers in the final whorl; wall coarsely perforate, sutures slightly depressed; all chambers visible; sutures limbate and flush; wall coarsely perforate; aperture a short arched slit with a narrow imperforate lip, reaching periphery on the involute side, together with a very slow narrow slit along the spiral suture which is visible only in the last chamber.

Cibicides pseudolobatus Perelis and Reiss, 1975

Pl. 33, figs. 30-35.

1975 *Cibicides pseudolobatus* - Perelis and Reiss, p. 77, pl. 4, figs. 1-7.

1993 *Cibicides pseudolobatus* Perelis and Reiss - Hottinger *et al.* p. 116, pl. 153, figs. 1-6.

2012 *Cibicides pseudolobatus* Perelis and Reiss - Debenay, p. 190, 315.

Test trochospiral, plano-convex, spiral side flattened and evolute, involute and convex on the umbilical side; Sutures depressed, radial, curved backward at the periphery, on the spiral side broadly limbate; peripheral margin acute, carinate; peripheral outline faintly lobulate; wall coarsely perforate on the spiral side, less dense but coarse on the umbilical side; aperture interiomarginal, extraumbilical-equatorial, bordered by a lip and extending onto the spiral side where it remains open in the last few chambers.

Genus **Lobatula** Fleming, 1828

Lobatula lobatula Walker and Jacob, 1798

Pl. 34, figs. 1-3.

1798 *Nautilus lobatulus* - Walker and Jacob in Kanmacher, p. 642, pl. 14, fig. 36.

1884 *Truncatulina lobatula* d'Orbigny - Brady, p. 660, pl. 92, fig. 10; pl. 93, figs. 1, 4, 5; pl. 115, figs. 4, 5.

1951a *Cibicides lobatulus* (Walker and Jacob) - Asano, p. 17, figs. 36-38.

1994 *Lobatula lobatula* (Walker and Jacob) - Loeblich and Tappan, p. 150, pl. 316, figs. 8-11; pl. 319, figs 1-7.

2012 *Lobatula lobatula* (Walker and Jacob) - Debenay, p. 201, 315.

Test trochospiral with a strongly variable morphology; spiral side flat, sutures thickened, depressed to slightly limbate, oblique and curved backward at the periphery; umbilical side gently convex with depressed sutures radial around the slightly depressed umbilicus, periphery rounded to angular or carinate; peripheral outline lobulate; wall coarsely perforate, except keel, apertural lip and area bordering the aperture; aperture an interiomarginal, equatorial arch, bordered by a lip and extending onto the spiral side beneath a narrow folium.

Lobatula mayori (Cushman, 1924)

Pl. 34, figs. 4-7.

1924 *Truncatulina mayori* - Cushman, p. 39, pl. 12, figs. 3, 4.

1993 *Cibicides* (?) *mayori* (Cushman) - Hottinger *et al.* p. 116; pl. 152, figs. 1-6.

2012 *Lobatula mayori* (Cushman) - Debenay, p. 201, 315.

Test trochospiral, planoconvex, compressed, evolute and flattened on spiral side, involute and convex on umbilical side; last chambers weakly lobulate, peripheral margin acute with a carina; 6-8 chambers in the last coil; sutures depressed and distinct, radial to slightly curved on umbilical side; on spiral side curved, broadly limbate and in last chambers; wall coarsely perforated on spiral side, much more perforated on the last chambers of umbilical side; aperture interiomarginal, extraumbilicalequatorial with thick rim, extending into a supplementary spiral aperture with rim, remaining open in the last few chambers.

Family **Planorbulinidae** Schwager, 1877

Genus **Planorbulina** d'Orbigny 1826

Planorbulina sp. 1

Pl. 34, figs. 8-10.

Test planoconvex, spiral side flattened, umbilical side convex; outline slightly lobulate, peripheral margin acutely rounded and non carinate; coiling initially a cibicidid-like low trochospiral coil, later chambers added irregularly in a single plane; chambers slightly inflated; wall smooth, translucent, irregularly perforate throughout. sutures slightly depressed, slightly depressed on the umbilical side; aperture a low equatorial slit that extends from half way down the apertural face over the periphery to the suture on the spiral side, bordered on the upper margin by a thin lip; supplementary apertures are low slits along the sutures of both the spiral and umbilical sides of the test, bordered on the upper margin by a thin lip.

Planorbulina sp. 2

Pl. 34, figs. 11, 12.

Test flattened, planoconvex, spiral side flattened, umbilical side convex; peripheral margin acutely rounded and non carinate; coiling initially a cibicidid-like low trochospiral coil, later chambers added in a single plane; wall smooth, translucent, irregularly perforate throughout; sutures slightly depressed and straight on both sides; aperture a low equatorial slit.

Family **Cymbaloporidae** Cushman, 1927

Genus **Cymbaloporella** Cushman, 1927

Cymbaloporella tabellaeformis (Brady, 1884)

Pl. 34, figs. 13-17.

1884 *Cymbalopora tabellaeformis* - Brady, p. 637, pl. 102, figs 15-18.

1928 *Cymbaloporella tabellaeformis* (Brady) - Cushman, p. 288, pl. 44, figs. 7/a, b.

1960 *Cymbaloporella tabellaeformis* (Brady) - Baker, p. 210, pl. 102, figs. 15-18

1965 *Cymbaloporella tabellaeformis* (Brady) - Todd, p. 38, pl. 19, fig. 5.

1987 *Cymbaloporella tabellaeformis* (Brady) - Baccaert, p. 224, 225, pl. 90, figs. 1-5.

1993 *Cymbaloporella tabellaeformis* (Brady) - Hottinger *et al.* p. 119; pl. 159, figs. 1-6.

2009 *Cymbaloporella tabellaeformis* (Brady) - Parker, p. 548, figs. 389/a-j, 390/a-e.

2012 *Cymbaloporella tabellaeformis* (Brady) - Debenay, p. 235, 316.

Test compressed, early chambers trochoid, later ones in annular series; evolute on the spiral side, involute on the umbilical one; chambers elongated at the periphery, giving a tabular appearance to the test, with a nearly plane spiral side; umbilical side centrally depressed; wall calcareous, coarsely perforate on the spiral side, more finely so on the umbilical side; apertures numerous small openings surrounded by a produced rim along the umbilical side sutures.

Genus **Cymbaloporetta** Cushman, 1928

Cymbaloporetta sp. 1

Pl. 34, figs. 18, 19.

Test high conical cymbaloporetta-like earlier portion, without the balloon chamber; wall coarsely and densely perforated in the initial stage, the umbilical side is imperforate; umbilical side shows numerous lateral apertures.

Cymbaloporetta sp. 2

Pl. 34, figs. 20-25.

Test low conical cymbaloporetta-like earlier portion and a rounded bulging balloon chamber; initial *Cymbaloporetta* like stage slightly convex, slightly protruding out all around the balloon chamber; wall coarsely and densely perforated in the initial stage, somewhat less so in the balloon chamber that is, however, distinctly perforated; numerous large rimmed openings at the base of the balloon chamber.

Cymbaloporetta sp. 3

Pl. 34, figs. 26-28.

Test small, low trochospiral evolute on the spiral side, involute on the umbilical one; five chambers visible on the umbilical side; wall distinctly perforate on the spiral side, umbilical side imperforate with radial sutures and having lateral apertures with thick rim, arranged opposite one another; sutures indistinct on the spiral side; later chambers added in cycles, being mushroom-shaped in outline on the umbilical side.

Genus **Millettiana** Banner, Pereira and Desai, 1985

Millettiana milletti (Heron-Allen and Earland, 1915)

Pl. 34, figs. 29-31.

1903b *Cymbalopora bulloides* - Millett, p. 697, pl. 7, figs 4/a-c.

1915 *Cymbalopora milletti* - Heron-Allen and Earland, p. 689, pl. 51, figs. 32-35.

1993 *Millettiana milletti* (Heron-Allen and Earland) - Hottinger *et al.* p. 120, pl. 160, figs. 9-13.

2009 *Millettiana milletti* (Heron-Allen and Earland) - Parker, p. 640, figs. 452/a-k, 453/a-g.

2012 *Millettiana milletti* (Heron-Allen and Earland) - Debenay, 244, 317.

Test small, high domed, trochospiral and strongly spiro-convex; chambers crescent shaped on the spiral side, triangular on the umbilical side; wall distinctly perforate on the spiral side, umbilical side imperforate with radial sutures; sutures limbate on the spiral side; later chambers added in cycles, being mushroom-shaped in outline on the umbilical side, and having lateral apertures; the planktic stage has a balloon chamber, which, when fusing with the enclosed float chamber produces branching tubes, reflected externally as vermicular ridges; float chambers with irregularly distributed holes, each surrounded by a prominent rim.

Family **Acervulinidae** Schultze, 1854

Genus **Acervulina** Schultze, 1854

Acervulina mabahethi (Said, 1949)

Pl. 35, figs. 1-14.

1949 *Planorbulina mabahethi* - Said, p. 44, pl. 4, fig. 26, holotype examined.

1993 *Acervulina mabahethi* (Said) - Hottinger *et al.*, p. 122, 123, pl. 165, figs. 1-7; pl. 166, figs. 1-8

1997 *Acervulina mabahethi* (Said) - Haig, p. 275, fig. 5/26, specimens examined

2009 *Acervulina mabahethi* (Said) - Parker, p. 475, figs. 342/a-j, 343/a-i.

2012 *Acervulina mabahethi* (Said) - Debenay, p. 234, 317.

Test attached, low trochospiral, cibicidid-like forms with globular final chambers and thickly rimmed apertures, later chambers added irregularly, either in irregular cycles on a flattened substrate, or in irregular directions, according to the shape of the substrate; these have a distinct opening to the proloculus on the spiral side which corresponds to an opening in the proloculus on the attached side of adult specimens; wall thick, coarsely perforate, with interpore ridges; all apertures are restricted to sutural positions; main apertures on opposite sides of the chambers in a peripheral position, with a thickened peristomal rim; supplementary apertures in the depressed sutures, with an arched peristome.

Genus **Planogypsina** Bermúdez, 1952

Planogypsina acervalis (Brady, 1884)

Pl. 35, figs. 15-17.

1884 *Planorbulina acervalis* - Brady, p. 657, pl. 92, fig. 4.

1987 *Planorbulina acervalis* Brady - Baccaert, p. 220, pl. 88, figs. 1-3.

1993 *Planogypsina acervalis* (Brady) - Hottinger *et al.* p. 125, pl. 169, figs. 1-9; pl. 170, figs 1-8.

2009 *Planogypsina acervalis* (Brady) - Parker, p. 697, figs. 490/a-d; 491/a-i.

2012 *Planogypsina acervalis* (Brady) - Debenay, p. 246, 317.

Test large, attached, irregularly discoidal, the shape depends substrate, and preferably flattened substrate; attached side flattened, free side more or less convex; peripheral margin acute; periphery lobulate; chambers nearly

isometric, subglobular, inflated, added evenly in all directions on a flat substrate, with the addition of minute chambers on the free surface of the test; chambers may be added irregularly and in several layers in specimens that are restricted in growth by the substrate; wall coarsely perforated, ventral lateral chamberlet walls smooth, perforated by coarse loosely spaced pores; each chamber has two arched apertures bordered by a rim at the contact with previous chambers, and a large number of peripheral, tubular apertures; small sutural apertures open on both sides of the test.

Genus **Sphaerogypsina** Galloway, 1933

Sphaerogypsina globula (Reuss, 1848)

Pl. 35, figs. 18, 19.

1848 *Cerriopora globulus* - Reuss, p. 33, pl. 5, fig. 7.

1860 *Orbitolina concava* Lamarck var. *vesicularis* - Parker and Jones, p. 31, 38.

1993 *Sphaerogypsina globulus* (Reuss) - Hottinger *et al.* p. 128, pl. 173, figs. 1-10.

2009 *Sphaerogypsina globula* (Reuss) - Parker, p. 736, figs. 517/a-j.

2012 *Sphaerogypsina globula* (Reuss) - Debenay, p. 249, 317.

Test large, spherical to subspherical, sometimes irregularly shaped, constructed of many layers of small, polygonal and closely packed chambers; neighboring chambers belonging respectively to the ultimate and penultimate layers are, with respect to each other, out of level for half their height in radial direction; upper surface of the chambers coarsely perforate; septa thick, elevated and imperforate; apertures multiple consisting of small rounded openings or small slits at the base of the free chamber walls.

Family **Homotrematidae** Cushman, 1927

Genus **Homotrema** Hickson, 1911

Homotrema rubra (Lamarck, 1816)

Pl. 35, fig. 20.

1816 *Millepora rubra* - Lamarck, p. 202.

1993 *Homotrema rubra* (Lamarck) - Hottinger *et al.* p. 128, pl. 174, figs. 1-6; pl. 175, figs. 1-8.

1994 *Homotrema rubrum* (Lamarck) - Loeblich and Tappan, p. 154, pl. 335, figs 1-4.

2009 *Homotrema rubra* Lamarck - Parker, p. 626, figs. 444/a-i, 445/a-c, 446/a-e.

2012 *Homotrema rubra* (Lamarck) - Debenay, p. 241, 318.

Test very large, attached, generally arborescent with erected branches; test red in color; early chambers in spiral or clustered arrangement, later in numerous layers; upper chamber wall coarsely perforate, surrounded by an imperforate rim that is the elevated portion of the imperforate intercameral walls; apertures at the end of the branches, with sponge spicules glued into the tubular peristomal extension of the aperture.

Family **Epistomariidae** Hofker, 1954

Genus **Monspeliensina** Glacon and Lys 1968

Monspeliensina sp. 1

Pl. 35, figs. 21-22.

Test small, spiral side convex, peripheral margin broadly rounded; coiling low trochospiral, evolute on the spiral side, involute on the umbilical side; chambers gradually in size rapidly; sutures depressed and incised, straight and slightly radial; wall smooth, hyaline, on umbilical side densely coarsely perforate, on spiral side smooth and imperforate; aperture an extraumbilical interiomarginal slit; infrasutural apertures on spiral side a slit shaped openings parallel to the suture, in earlier whorls becoming closed.

Family **Amphisteginidae** Cushman, 1927

Genus **Amphistegina** d'Orbigny, 1826

Amphistegina lessonii d'Orbigny, 1826

Pl. 35, figs. 24-29.

1826 *Amphistegina lessonii* - d'Orbigny, p. 304.

1978 *Amphistegina lessonii* d'Orbigny - Larsen, p. 225, pl. 5, figs. 8, 9, 11, 12; pl. 7, fig. 2.

1993 *Amphistegina lessonii* d'Orbigny - Hottinger *et al.* p. 132, pl. 184, figs. 1-11; pl. 185, figs. 1-7.

2009 *Amphistegina lessonii* d'Orbigny - Parker, p. 498, figs. 355/a-d.

2012 *Amphistegina lessonii* d'Orbigny - Debenay, p. 215, 318.

Test low trochospiral, lenticular, dorsal side more convex than the umbilical side; peripheral margin acute; spiral side varying from involute to partially evolute, umbilical side involute; umbo small, flush, transparent and imperforate; chambers about 12-16 in the last whorl, broad and low, strongly curved back at the periphery; umbilical side shows star-shaped supplementary chamberlets arranged in a pattern that extends about two thirds of the distance from the umbilicus to the periphery; test smooth, except the papillate area; apertural face angled near the margin; aperture situated on the umbilical side, extending almost to the periphery, slitlike and interiomarginal, with a narrow overhanging lip ornamented by a single row of papillae.

Amphistegina cf. A. papillosa Said, 1949

Pl. 35, figs. 30-34.

1949 *Amphistegina radiata* (Fichtel and Moll) var. *papillosa* - Said, p. 39, pl. 4, fig. 12.

1976 *Amphistegina papillosa* Said - Larsen, p. 8, pl. 4, figs. 1-5; pl. 7, fig. 4; pl. 8, fig. 4.

1992b *Amphistegina papillosa* Said - Hatta and Ujiié, p. 196, pl. 42, fig. 3.

1999 *Amphistegina papillosa* Said - Hayward *et al.* p. 157, pl. 15, fig. 7.

2012 *Amphistegina papillosa* Said - Debenay, p. 216, 319.

Test very low trochospiral, flat, lenticular, biconvex, subcircular in outline; peripheral margin acute but not keeled; wall ornamented with very few raised pustules on both sides; aperture small, rounded, opening slightly toward the umbilical side, but nearly peripheral in position, surrounded by a small subcircular field of pustules.

Family **Nonionidae** Schultze, 1854

Genus **Haynesina** Banner and Culver, 1978

Haynesina depressula (Walker and Jacob, 1798)

Pl. 36, figs. 1-5.

1798 *Nautilus depressulus* - Walker and Jacob, p. 641, fig. 33.

1997 *Haynesina depressula depressula* (Walker and Jacob) - Hayward *et al.* p. 98, pl. 19, figs. 4-7.

1999 *Haynesina depressula* (Walker and Jacob) - Hayward *et al.* p. 158, pl. 15, figs. 10, 11.

2012 *Haynesina depressula* (Walker and Jacob) - Debenay, p. 222, 319.

Test subcircular, laterally compressed, rounded to lobulate in outline; peripheral margin rounded; slightly inflated involute chambers in final whorl; sutures curved backwards, slightly depressed in early portion, becoming deeply depressed; umbilicus large, star shaped, extends along the sutures; wall finely perforate with numerous tubercles along the sutures, in the umbilical depression and around the aperture; aperture a series of openings at the base of the last chamber.

Genus **Nonion** Montfort, 1808

Nonion subturgidum (Cushman, 1924)

Pl. 36, figs. 6, 7.

1924 *Nonionina subturgida* - Cushman, p. 47, pl. 16, fig. 2.

1994 *Nonion subturgidum* (Cushman) - Loeblich and Tappan, p. 158, pl. 343, figs. 1-9.

2000 *Nonion subturgidum* (Cushman) - Revets, p. 371, pl. 4, figs. 31, 32.

2009 *Nonion* cf. *N. subturgidum* (Cushman) - Parker, p. 671, figs. 474/a-j.

2012 *Nonion subturgidum* (Cushman) - Debenay, p. 227, 319.

Test free, bilaterally symmetrical, laterally compressed, last formed coil about 10 chambers, increasing somewhat in length as added, periphery rounded, apertural face rounded truncate, sutures distinct, slightly depressed and flushed at periphery; wall finely punctate, slightly umbilicate; depressed umbilical area often filled with secondary material; aperture at the base of the last-formed chamber on the median line.

Nonion sp. 1

Pl. 36, figs. 8-10.

Test elongated, bilaterally symmetrical, compressed, last-formed coil composed of 10 chambers, gradually increasing in length as added; periphery rounded; sutures slightly depressed but flush towards the peripheral margin; apertural face broadly rounded; wall smooth, very finely perforate; aperture an equatorial slit at the base of the last-formed chamber.

Nonion sp. 2

Pl. 36, figs. 11-14.

Test small, bilaterally symmetrical, slightly compressed, nearly as wide as long, last-formed coil composed of 10 chambers, gradually increasing in length as added; periphery broadly rounded; sutures slightly depressed but flush towards the peripheral margin; apertural face broadly rounded; wall smooth, very finely perforate; aperture an equatorial slit at the base of the last-formed chamber.

Genus **Nonionoides** Saidova, 1975

Nonionoides grateloupi (d'Orbigny, 1839)

Pl. 36, figs. 15-21.

1839a *Nonionina grateloupi* - d'Orbigny, p. 46, pl. 6, figs 6-7.

1939 *Nonion grateloupi*, (d'Orbigny) - Cushman, p. 21, pl. 6, figs. 1-7.

1992b *Nonionoides grateloupi* (d'Orbigny) - Hatta and Ujiié, p. 196, pl. 43, fig. 1.

1994 *Nonionoides grateloupi* (d'Orbigny) - Loeblich and Tappan, p. 158, pl. 342, figs. 1-5.

2009 *Nonionoides grateloupi* (d'Orbigny) - Parker, p. 675, figs 475/a-h.

2012 *Nonionoides grateloupi* (d'Orbigny) - Debenay, p. 227, 320.

Test planispiral, mostly involute, compressed laterally, low trochospiral, composed of tall, narrow chambers; periphery rounded; chambers numerous, usually 10 to 12 in the last-formed coil in adults, chambers increasing rapidly in length, especially in the last few chambers; sutures distinct, slightly depressed; wall translucent, smooth, finely perforate with hispid ornament in the umbilical depression; aperture equatorial slit, at the base of the lastformed chamber extending from the suture on the umbilical side to a short way along the spiral suture on the spiral side.

Genus **Pseudononion** Asano, 1936

Pseudononion granulumbilicatum Zheng, 1979

Pl. 36, figs. 22, 23.

1979 *Pseudononion granulumbilicatum* - Zheng, p. 229, pl. 25, fig. 9.

1994 *Pseudononion granulumbilicatum* Zheng - Loeblich and Tappan, p. 158, pl. 344, figs. 5-10.

2012 *Pseudononion granulumbilicatum* Zheng - Debenay, p. 210, 320.

Test laterally compressed, broadly auriculate in outline, periphery rounded, slightly lobulate; two whorls visible on the dorsal side; umbilical side involute, umbilical area depressed; chambers slightly inflated, low and broad, gradual increase in size as added, about 8 in the final whorl; sutures depressed and distinct; umbilical end of chambers slightly curved outwards, coarsely granulated, forming a serrate rim around the umbilicus; wall thin, finely perforated, surface smooth; aperture an arched slit at the base of the last chamber, extending from the umbilicus to the spiral side.

Family **Almaenidae** Myatlyuk, in Rauzer-Chernousova and Fursenko 1959

Genus **Anomalinella** Cushman, 1927

Anomalinella rostrata (Brady, 1881)

Pl. 36, figs. 24-28.

1881 *Truncatulina rostrata* - Brady, p. 65.

1915 *Truncatulina rostrata* Brady - Heron-Allen and Earland, p. 709, pl. 52, figs. 33-36.

1992 *Anomalinella rostrata* (Brady) - Hatta and Ujiié, p. 197, pl. 43, fig. 3.

1994 *Anomalinella rostrata* (Brady) - Loeblich and Tappan, p. 160, pl. 349, figs. 1-8.

2012 *Anomalinella rostrata* (Brady) - Debenay, p. 217, 320.

Test lenticular, planispiral, involute; chambers gradually enlarging in the final whorl; sutures raised, imperforate; periphery margin angular, carinate, with a less elevated second keel paralleling the periphery a slight distance to one side of the median plane; wall coarsely perforate except keels; aperture a low arch at the base of the last chamber, with protruding bordering lip, supplementary aperture consisting of an elongate slit on the periphery between the two keels, those of earlier chambers secondarily closed.

Family **Heterolepidae** Gonzales-Donoso, 1969

Genus **Anomalinoides** Brotzen 1942

Anomalinoides sp. 1

Pl. 36, figs. 29-31.

Test moderately small, concavoconvex, umbilical side depressed, spiral side convex, peripheral margins subacute, slightly angular, outline slightly lobulate; coiling low trochospiral, evolute on spiral side, partially involute on umbilical side; wall with a few random large perforations on the spiral side, imperforate on the umbilical side; chambers 8 to eleven in final whorl, subquadratic in shape, slightly higher than long, slightly inflated on the umbilical side, increasing in size gradually; sutures flush to slightly depressed, curved and slightly sigmoidal on the umbilical side and slightly curved and oblique on the spiral side; aperture extends from the half-way along apertural face on the umbilical side over the periphery and along the entire length of the spiral side of the chamber, bordered on the upper margin by a thickened lip; spiral side aperture of previous two to three chambers remains open.

Anomalinoides sp. 2

Pl. 36, figs. 32-35.

Test small, trochospiral, subcircular in lateral view; periphery broadly rounded; spiral side evolute with about two visible whorls, umbilical side involute; about 7 chambers in the last whorl; sutures distinct and slightly depressed, gently curved; umbilical end of latter chambers extending over the umbilical depression into flaps; wall smooth, finely punctate; aperture an extraumbilical interiomarginal slit, extending beneath the umbilical flap.

Family **Gavelinellidae** Hofker, 1951Genus **Anomalinulla** Saidova, 1975**Anomalinulla glabrata** (Cushman, 1924)

Pl. 37, figs. 1-3.

1924 *Anomalina glabrata* - Cushman, p. 39; pl. 12, figs 51993 *Anomalinulla glabrata* (Cushman) - Hottinger *et al.* p. 139, pl. 197, figs. 6-11.1995 *Melonis asymmetrica* - Yassini and Jones, p. 170, figs. 915, 918, 919.2009 *Anomalinulla glabrata* (Cushman) - Parker, p. 508, figs. 361/a-l.2012 *Anomalinulla glabrata* (Cushman) - Debenay, p. 187, 321.

Test biconvex, low trochospiral, laterally compressed; periphery broadly rounded; all chambers visible from the dorsal side; umbilical side slightly convex with a distinctly excavated umbilicus; sutures flush, becoming slightly depressed between the last few chambers; wall smoothly finished and evenly perforate on the spiral side, but imperforate on the apertural face; aperture a curved opening at the base near the periphery and ventral angle of the last formed chamber, bordered by a lip that continues into a small folium.

Anomalinulla sp. 1

Pl. 37, figs. 4-7.

Test low trochospiral, with flattened sides; umbilicus slightly depressed; sutures flush; wall smooth and perforate on both sides; aperture an equatorial slit that starts a short way along the chamber on the spiral side and extends to the spiral suture on the umbilical side of the test; aperture bordered by a lip that continues into a small folium; apertures of the previous chambers remaining open for most of the last whorl.

Genus **Hanzawaia** Asano 1944**Hanzawaia grossepunctata?** (Earland, 1934)

Pl. 37, figs. 8-10.

1934 *Cibicides grossepunctatus* - Earland, p. 184, pl. 8, figs. 39-41.1994 *Hanzawaia grossepunctata* (Earland) - Loeblich and Tappan, p. 164, pl. 364, figs. 9-13; pl. 365, figs. 1-13.2001 *Hanzawaia grossepunctata* (Earland) - Szareck, p. 147, pl. 26, figs. 6, 7.2012 *Hanzawaia grossepunctata* (Earland) - Debenay, p. 198, 322.

Test low trochospiral, subcircular laterally, planoconvex; chambers numerous, enlarging rapidly as added; sutures depressed, and slightly curved back at the periphery; periphery subangular; umbilical side involute, convex with clear central boss; spiral side flattened, partially evolute with apertural flap from each chamber extending centrally over earlier whorls; wall coarsely perforate; aperture interiomarginal and equatorial.

Family **Rotaliidae** Ehrenberg, 1839Genus **Ammonia** Brünnich, 1772

Ammonia convexa (Collins, 1958)

Pl. 37, figs. 11-14.

1958 *Streblus convexus* - Collins, p. 414, pl. 5, figs. 10/a-c.1987 *Ammonia convexa* (Collins) - Baccaert, p. 232, pl. 94, figs. 4-6.1993 *Ammonia convexa* (Collins) - Hottinger *et al.* p. 142, pl. 201, figs. 1-14.1994 *Ammonia tepida* (Cushman) - Loeblich and Tappan, p. 165, pl. 371, figs. 1-3, not figs 4-10.2004 *Ammonia convexa* (Collins) - Hayward *et al.*, p. 262, pl. 2, fig. T13; pl. 3, fig. T13; pl. 4, fig. T13.2012 *Ammonia convexa* (Collins) - Debenay, p. 185, 322.

Test slightly biconvex, low trochospiral; spiral side evolute, umbilical side involute; peripheral margin acutely rounded; about 10 chambers in the last whorl, only the last ones slightly inflated; slightly raised sutures, curved on the spiral side, nearly radial on the umbilical side; long furrows along last few radial sutures on umbilical side, and very large umbilical plug; wall smooth; aperture an arch at the base of the apertural face.

Ammonia tepida (Cushman, 1926)

Pl. 37, figs. 15-18.

1926b *Rotalia beccarii* (Linnaeus) var. *tepida* - Cushman, p. 79, pl. 1.1987 *Ammonia* (?) *tepida* (Cushman) - Baccaert, p. 233, pl. 94, fig. 7; pl. 95, figs 1-3.2004 *Ammonia tepida* (Cushman), molecular type T - Hayward *et al.*, p. 262, pl. 2, fig. T; pl. 3, fig. T; pl. 4, fig. T2009 *Ammonia* cf. *A. tepida* (Cushman) - Parker, p. 492, figs. 352/a-m.2012 *Ammonia tepida* (Cushman) - Debenay, p. 185, 186, 323.

Test small, almost equally biconvex, low trochospiral, the dorsal side slightly more than the ventral; chambers 6 or 7 in the last-formed whorl; peripheral margin rounded, lobulated periphery; sutures slightly limbate above, ventrally much depressed; umbilicus deep, toward the umbilicus the chambers separated, forming angular, open spaces; wall smooth, finely punctate; aperture, a narrow slit beneath the inner angle of the last-formed chamber, often supplemented by a nearly circular, small opening near the base of the ventral face of the last-formed chamber.

Family **Elphidiidae** Galloway, 1933Genus **Porosonion** Putrya in Voloshinova, 1958**Porosonion sp. 1**

Pl. 37, figs. 19-24.

2012 *Porosonion* sp. 1 - Debenay, p. 230, 325.

Test small, planispirally enrolled, partly evolute, slightly elongated, laterally compressed with flattened sides; peripheral margins rounded; sutures depressed around the umbilicus, but flush at the periphery, slightly curved backward; 6-9 slightly inflated chambers in the last whorl, enlarging regularly as added, with a foliar extension in the depressed umbilici; umbilici, depressed sutures, base of the apertural face and foliar extensions highly ornamented by pustules and minute spines; wall smooth, transparent, coarsely perforate, except for the middle part of the apertural face; aperture a row of openings along the base of the apertural face, mostly covered by ornamentation.

Genus **Elphidium** Montfort, 1808**Elphidium botaniense** Albani, 1981

Pl. 37, figs. 25-28.

1981 *Elphidium botaniense* - Albani, p. 155, figs. 4j, n.1995 *Elphidium botaniense* Albani - Yassini and Jones, p. 176; figs. 1030-1033.1997 *Elphidium advenum botaniense* Albani - Hayward *et al.* p. 66, pl. 3, figs 1-4.2009 *Elphidium botaniense* Albani - Parker, p. 572, figs. 404/a-h.2012 *Elphidium botaniense* Albani - Debenay, p. 218, 324.

Test biconvex, broadly circular in outline, slightly lobulate at the peripheral margin; periphery acute, with a strong rounded keel; 10-12 chambers in the last whorl; sutures depressed and strongly curved backward; sutural bridges almost the same length as the width of the visible chamber wall; umbilical area with rounded umbilical boss and fine papillae; wall smooth and glassy; aperture a row of multiple openings along the base of the final chamber.

Elphidium clavatum Cushman, 1930

Pl. 37, figs. 29-31.

- 1930 *Elphidium incertum* (Williamson) var. *clavatum* - Cushman, p. 20, pl. 7, fig. 10.
 1997 *Elphidium excavatum clavatum* Cushman - Hayward *et al.* p. 76, pl. 9, figs. 1-4.
 2012 *Elphidium clavatum* Cushman - Debenay, p. 219, 324.

Test small to medium-sized, involute, broadly subcircular in outline, but slightly lobulated in later stage; test laterally compressed with almost parallel sides; peripheral margin broadly rounded; about 10 slightly inflated and gently curved chambers in the last whorl; sutures depressed with few moderately short sutural bridges; umbilical area usually with fine papillae; wall finely perforated, papillae along the sutures and in the umbilical area; aperture a series of basal pores, somewhat obscured by small pustules.

Elphidium lene (Cushman and McCulloch, 1940)

Pl. 37, figs. 32-34.

- 1940 *Elphidium incertum* (Williamson) var. *lene* - Cushman and McCulloch, p. 170, pl. 19, figs. 2, 4.
 1997 *Elphidium lene* Cushman and McCulloch - Hayward *et al.* p. 84, pl. 13, figs. 1-8.
 2009 *Elphidium lene* Cushman and McCulloch - Parker, p. 579, figs. 408/a-h, 409/a-i.
 2012 *Elphidium lene* Cushman and McCulloch - Debenay, p. 220, 324.

Test planispirally enrolled, laterally compressed; periphery slightly lobulate, broadly rounded; chambers broad, somewhat inflated, 9-10 in the last whorl; sutures slightly curved with many short septal bridges; apertural face typically high; chambers with foliar projections that partially cover the umbilicus; wall finely perforated, smooth and glassy; aperture an equatorial slit at the base of the last chamber.

Elphidium maorium Hayward, 1997

Pl. 37, fig. 35.

- 1997 *Elphidium maorium* - Hayward *et al.* p. 69, pl. 4, figs. 11-16; pl. 5, figs. 1-5.
 2012 *Elphidium maorium* (Hayward) - Debenay, p. 220, 324.

Test small, smoothly circular outline, last portion lobulate; profile biconvex with sides flat and parallel centrally; periphery acutely rounded with a thickened area along the periphery that may be slightly keeled; 11 slightly inflated chambers in the last whorl; sutures slightly curved backward towards periphery, with a few narrow septal bridges; umbilical area with a small solid circular boss; fine papillae in the sutures, the umbilical area and along the aperture; wall finely perforate; aperture a series of small openings at the base of the apertural chamber

Elphidium milletti (Heron-Allen and Earland, 1915)

Pl. 38, figs. 1-4.

- 1915 *Polystomella milletti* - Heron-Allen and Earland, p. 735, pl. 53, figs. 38-42.
 1987 *Parrellina milletti* (Heron-Allen and Earland) - Baccaert, p. 245-246, pl. 100, figs. 4, 5; pl. 101, fig. 1.
 1993 *Parrellina?* cf. *P.?* *milletti* (Heron-Allen and Earland) - Hottinger *et al.* p. 152, pl. 218, figs. 5-9; pl. 219, figs. 1-4.
 2009 *Elphidium milletti* (Heron-Allen and Earland) - Parker, p. 582, figs. 411/a-i; 412/a-f.
 2012 *Elphidium milletti* (Heron-Allen and Earland) - Debenay, p. 221, 325.

Test medium sized, planispirally enrolled, laterally compressed with flattened sides almost parallel; chambers somewhat inflated, leading to a slightly lobulate periphery; peripheral margin more rounded; sutures depressed with short and broad sutural bridges; umbilicus depressed; wall ornamented with beads that coalesce and form short raised ridges; on later chambers, discontinuous raised ridges are aligned obliquely to the test periphery in a chevron pattern; apertural face covered with short spines; aperture at the base of the last chamber, obscured by the spines

Elphidium oceanicum Cushman, 1933

Pl. 38, figs. 5-7.

- 1933 *Elphidium oceanicum* - Cushman, p. 49, pl. 12, figs. 7a, b.
 1995 *Cribronionion schmitti* (Cushman and Wickenden) - Yassini and Jones, p. 179, fig. 1040.
 1997 *Elphidium oceanicum* Cushman - Hayward *et al.* p. 88; pl. 15, figs 1-5.
 2009 *Elphidium oceanicum* Cushman - Parker, p. 586, figs. 413/a-e, 414/a-j.
 2012 *Elphidium oceanicum* Cushman - Debenay, p. 221, 325.

Test small, nearly circular in lateral view; periphery broadly rounded; umbilical region depressed, and often with dense hispid ornament; chambers distinct, increasing rapidly in width, last ones somewhat inflated, leading to a lobulate periphery, usually about 9 in the last whorl; sutures slightly depressed, with short flush sutural bridges; wall translucent, very finely perforate; aperture consisting of one or more openings at the base of the apertural face, obscured by the ornamentation.

Elphidium cf. E. pseudonodosum Cushman, 1939

Pl. 38, figs. 8-10.

1939 *Elphidium pseudonodosum* Cushman, p. 50, pl. 13, fig. 12.

2016 *Elphidium pseudonodosum* Cushman - Langer unpublished data

Test large, biconvex, circular in outline, with umbilical boss irregularly pitted; periphery surrounded by a thin narrow carina; chambers numerous; sutures slightly curved backwards, with numerous sutural bridges; base of each chamber merging with the umbilical boss; aperture a row of multiple openings along the base of the final chamber

Elphidium cf. E. sagrum (d'Orbigny, 1839)

Pl. 38, figs. 11-14.

1839 *Polystomella sagra* - d'Orbigny, p. 55, pl. 6, figs. 19, 20.

1918 *Polystomella sagra* d'Orbigny - Cushman, p. 75, pl. 26, figs. 5/a, b.

1930 *Elphidium sagrum* (d'Orbigny) - Cushman, p. 24, pl. 9, figs. 5, 6.

2016 *Elphidium sagrum* (d'Orbigny) - Langer Unpublished data

Test involute, equally biconvex, lenticular; periphery subcircular, somewhat lobulated in the last-formed portion; sides convex; peripheral margin acutely rounded, often with a blunt keel; chambers numerous, somewhat inflated, especially in the lastformed portion, gently curved backward; sutures depressed, with sutural bridges only about onethird the width of the chamber; umbilical region usually with a boss; wall smooth, translucent, very finely perforate, ornamented by numerous small pustules around the aperture, the sutures and the umbilical boss; aperture a series of rounded pores, at the base of the apertural face.

Elphidium simplex Cushman, 1933

Pl. 38, figs. 15, 16.

1933 *Elphidium simplex* - Cushman, p. 52, pl. 12, figs. 8, 9.

1939 *Elphidium simplex* Cushman - Cushman, p. 62, pl. 17, fig. 10.

1960 *Elphidium simplex* Cushman - Asano, p. 200, pl. 22, fig. 4.

1992 *Elphidium simplex* Cushman - Azazi, pl. 1, figs. 20, 21.

1994 *Elphidium simplex* Cushman - Loeblich and Tappan, p. 170, pl. 385, figs. 1-12.

Test nearly circular in lateral view, periphery rounded, becoming very slightly lobulated in the later portion in side view, umbilical region occupied by a large flat boss; chambers numerous, distinct, 10 to 12 in the last-formed coil, of rather uniform shape, increasing very slightly in size as added, the later ones slightly inflated; sutures distinct, depressed, rather strongly curved, retral processes often indistinct, but usually visible, especially in the later chambers; aperture one or more openings at the base of the apertural face.

Elphidium toddi n.sp. Langer et al

Pl. 38, figs. 17, 18.

2016 *Elphidium toddi* Langer Unpublished data

Test large, circular in outline, strongly biconvex, with a very large, unpitted umbilical boss; periphery acute with a narrow rounded keel; chambers numerous, about 30 in the last whorl; apertural face very low; sutures almost straight, radial; sutural bridges extending on the chamber wall, resulting in continuous ridges parallel to the periphery; aperture a row of multiple openings along the base of the final chamber.

Elphidium tongaensis (Cushman, 1931)

Pl. 38, figs. 19-21.

1931b *Ozawaia tongaensis* - Cushman, p. 80, pl. 10, figs. 7-10.

1997 *Elphidium advenum tongaense* (Cushman) - Hayward *et al.* p. 70; pl. 5, figs. 13-18.

2012 *Elphidium tongaensis* (Cushman) - Debenay, p. 221, 325.

Test medium sized, planispirally enrolled, somewhat evolute, laterally compressed, slightly lobulated outline; sides flat to slightly concave, periphery acutely rounded; 10-12 somewhat inflated chambers in the last whorl; sutures depressed, moderately curved backwards, marked by numerous narrow septal bridges; umbilicus large, partly filled with a solid semicircular boss; wall finely perforated, fine papillae in the umbilical area and in the sutures; aperture made up of numerous openings at the base of the apertural face.

Elphidium williamsoni Haynes, 1973

Pl. 38, figs. 22-25.

1973 *Elphidium williamsoni* - Haynes, p. 207, pl. 24, fig. 7; pl. 25, figs. 6, 9; pl. 27, figs. 1-3.

- 1993 *Elphidium williamsoni* Haynes - Hottinger *et al.* p. 150, pl. 215, figs. 1-5.
 1997 *Elphidium excavatum williamsoni* Haynes - Hayward *et al.* p. 78, pl. 10, figs. 1-8.
 2009 *Elphidium cf. E. williamsoni* Haynes - Parker, p. 591, figs. 418/a-1, 419/a-e.
 2012 *Elphidium williamsoni* Haynes - Debenay, p. 221, 325.

Test medium sized, planispiral, laterally compressed, chambers numerous, could be more than 11; outline evenly rounded, with last chambers slightly inflated, leading to a somewhat lobulate periphery; sutures flush, becoming slightly depressed between latter chambers, interrupted at the periphery; sutural bridges numerous, as long as chamber width; umbilicus simple, depressed, partially filled with the irregular ends of chambers; aperture at the base of the last chamber, often obscured by tuberculate ornaments.

Elphidium cf. E. williamsoni Haynes, 1973

Pl. 38, figs. 26-28.

- 1973 *Elphidium williamsoni* - Haynes, p. 207, pl. 24, fig. 7; pl. 25, figs. 6, 9; pl. 27, figs. 1-3.
 1993 *Elphidium williamsoni* Haynes - Hottinger *et al.* p. 150, pl. 215, figs. 1-5.
 1997 *Elphidium excavatum williamsoni* Haynes - Hayward *et al.* p. 78, pl. 10, figs. 1-8.
 2009 *Elphidium cf. E. williamsoni* Haynes - Parker, p. 591, figs. 418/a-1, 419/a-e.
 2012 *Elphidium williamsoni* Haynes - Debenay, p. 221, 325.

Test small sized, planispiral, laterally compressed, chambers numerous, could be more than 10; outline evenly rounded, with last chambers slightly inflated, leading to a somewhat lobulate periphery; sutures distinct, numerous sutural bridges; umbilicus simple, slightly depressed, partially filled with the irregular ends of chambers; aperture at the base of the last chamber, with few tuberculate ornaments.

Family **Nummulitidae** de Blainville, 1827

Genus **Operculina** d'Orbigny, 1826

Operculina ammonoides (Gronovius, 1781)

Pl. 38, figs. 29-36.

- 1781 *Nautilus ammonoides* - Gronovius, p. 282, pl. 19, figs. 5, 6.
 1993 *Assilina ammonoides* (Gronovius) - Hottinger *et al.* p. 154, pl. 222, figs. 1-8; pl. 223, figs. 1-14; pl. 224, figs. 1-8; pl. 225, figs. 1-9.
 2000 *Operculina ammonoides* (Gronovius) - Hohenegger *et al.* p. 18, pl. 2, figs. 7-12; pl. 5, figs. 7-12.
 2009 *Assilina ammonoides* (Schröter) - Parker, p. 515, figs. 367/a-j.
 2012 *Operculina ammonoides* (Gronovius) - Debenay, p. 228, 326.

Test large, compressed, planispiral, evolute, flaring; chambers flat, curved, irregular in size, shape and number; sutures raised, imperforate, curved backwards at the peripheral end; ornamented with low pustules that are higher in the umbilical region; peripheral chord distinct; aperture at the base of the apertural face concealed under a mask structure.

Genus **Heterostegina** d'Orbigny, 1826

Heterostegina curva Moebius 1880

Pl. 39, figs. 1-3.

- 1893 *Heterostegina curva* Moebius - Egger, p. 434, pl. 20, figs. 26-33.
 1933 *Heterostegina curva* Moebius - Cushman, p. 59, pl. 17, figs. 1-5.
 1977 *Heterostegina curva* Moebius - McCulloch, p. 228, pl. 99 figs. 5, 6.

Test complanate, slightly inflated, marginate, periphery subacute, chambers numerous, involute, the central portion much thickened but smooth and not umbonate, marginal edge slightly grooved with faint lines, chambers undivided centrally, with the branching usually at the periphery; aperture at the base of the last chamber.

Heterostegina depressa d'Orbigny, 1826

Pl. 38, figs. 4-7.

- 1826 *Heterostegina depressa* - d'Orbigny, p. 305, pl. 17, figs. 5-7.
 1933 *Heterostegina depressa* d'Orbigny - Cushman, p. 57, pl. 16, figs. 4-9.
 1993 *Heterostegina depressa* d'Orbigny - Hottinger *et al.* p. 157, pl. 228, figs. 1-11; pl. 229, figs. 1-8; pl. 230, fig. 9.
 1994 *Heterostegina depressa* d'Orbigny - Loeblich and Tappan, p. 171; pl. 389, figs. 1-6; pl. 390, figs. 1-3.

- 2003 *Heterostegina depressa* d'Orbigny - Renema, p. 355, 356, figs. 30/a, b.
2011 *Heterostegina depressa* d'Orbigny - Makled and Langer, fig. 10/14.
2012 *Heterostegina depressa* d'Orbigny - Debenay, p. 222, 326.

Test complanate, the early portion usually somewhat involute and thickened, later portion very thin and flaring, early chambers only slightly divided, becoming increasingly so in the later stages; periphery thin and rounded with a thickened shell margin produced by numerous longitudinal anastomosing grooves and adjacent imperforate elongated ridges (marginal cord); chambers elongate, curved, numerous, divided into chamberlets by transverse partitions usually alternating in adjacent chambers; sutures distinct, slightly limbate, not raised but occasionally very slightly depressed in the adult, strongly curved, often somewhat sigmoid; aperture at the base of the final chamber masked by a thick shell deposit, together with a series of pores along the apertural face.

Family **Bagginidae** Cushman, 1927

Genus **Criobaggina** McCulloch, 1977

Criobaggina reniformis (Heron-Allen and Earland, 1915)

Pl. 38, figs. 8-11.

1915 *Discorbina reniformis* - Heron-Allen and Earland, p. 696, pl. 52, figs. 7-14.

1977 *Criobaggina socorroensis* - McCulloch, p. 342, pl. 201, figs. 3-5.

1978 *Latecella reniformis* (Heron-Allen and Earland) - Cheng and Zheng, p. 260, pl. 19, figs. 4/a-q, 6/a-c; pl. 22, fig. 11.

2009 *Criobaggina reniformis* (Heron-Allen and Earland) - Parker, p. 546, figs. 388/a-k.

2012 *Criobaggina reniformis* (Heron-Allen and Earland, 1915) - Debenay, p. 235, 307.

Test reniform to nearly spherical, with a broadly rounded periphery; chambers low trochospiral coil of about two whorls; sutures flush and indistinct; wall coarsely perforated, area adjacent to the umbilicus at the base of the apertural face imperforate; aperture a curve slit in the middle or slightly to one side of the edge of the test.

Unassigned genus

Genus **Stictogongylus** Loeblich and Tappan, 1994

Stictogongylus rugata (Heron-Allen and Earland, 1928)

Pl. 39, figs. 12-14.

1928 *Sphaeridia rugata* - Heron Allen and Earland, p. 295, pl. 3, figs. 38-43.

1994 *Stictogongylus vandiemenensis* - Loeblich and Tappan, p. 171, pl. 392, figs. 1-8.

2009 *Stictogongylus rugata* (Heron Allen and Earland) - Parker, p. 740, figs. 519/a-g, 520/a-f.

2012 *Stictogongylus rugata* (Heron-Allen and Earland) - Debenay, p. 161, 326.

Test small, globular, small trochospiral early stage, followed by a thick walled inflated final chamber that makes up 90% of the test; sutures indistinct, test appearing unilocular; wall irregularly ridged with many fine pores, except for the apical region which appears smooth and has a few larger openings arranged in an incomplete spiral pattern.

Genus 1 sp. 1

Pl. 39, figs. 15-17.

2009 Genus 1 sp. 1 - Parker, p. 758, fig. 531/a-h

Test small, subcircular in outline, low trochospiral, spiral side slightly convex; sutures flush and slightly depressed; umbilical side partially evolute, with with apertural flap from later chambers, sutures radial and depressed; periphery rounded; wall calcareous, few coarse perforations; aperture an equatorial and interiomarginal arch.

PLATE 1

Scale bar is 100µm for all magnifications except otherwise stated.

1: *Reophax communis* Lacroix, 50um

2, 3: *Reophax* sp. 1

4, 5: *Ammobaculites exiguus*, (Cushman & Brönnimann) 5 (50um)

6, 7: *Ammobaculites* sp. 1 50um

8-10: *Ammobaculites* sp. 2 50um

11: *Ammomarginulina ensis* 50um

12, 13: *Acupeina triperforata*, (Millett)

14-16: *Haddonina* sp. 1

17: *Spiroplectinella* sp. 1

18, 19: *Haplophragmoides* sp. 1

20-24: *Paratrochammina* cf. *P. simplissima*, (Cushman & McCulloch)

25: *Paratrochammina* sp. 1

26-28: *Trochammina inflata* (Montagu)

29-35: *Siphotrochammina lobata* (Saunders)

PLATE 1

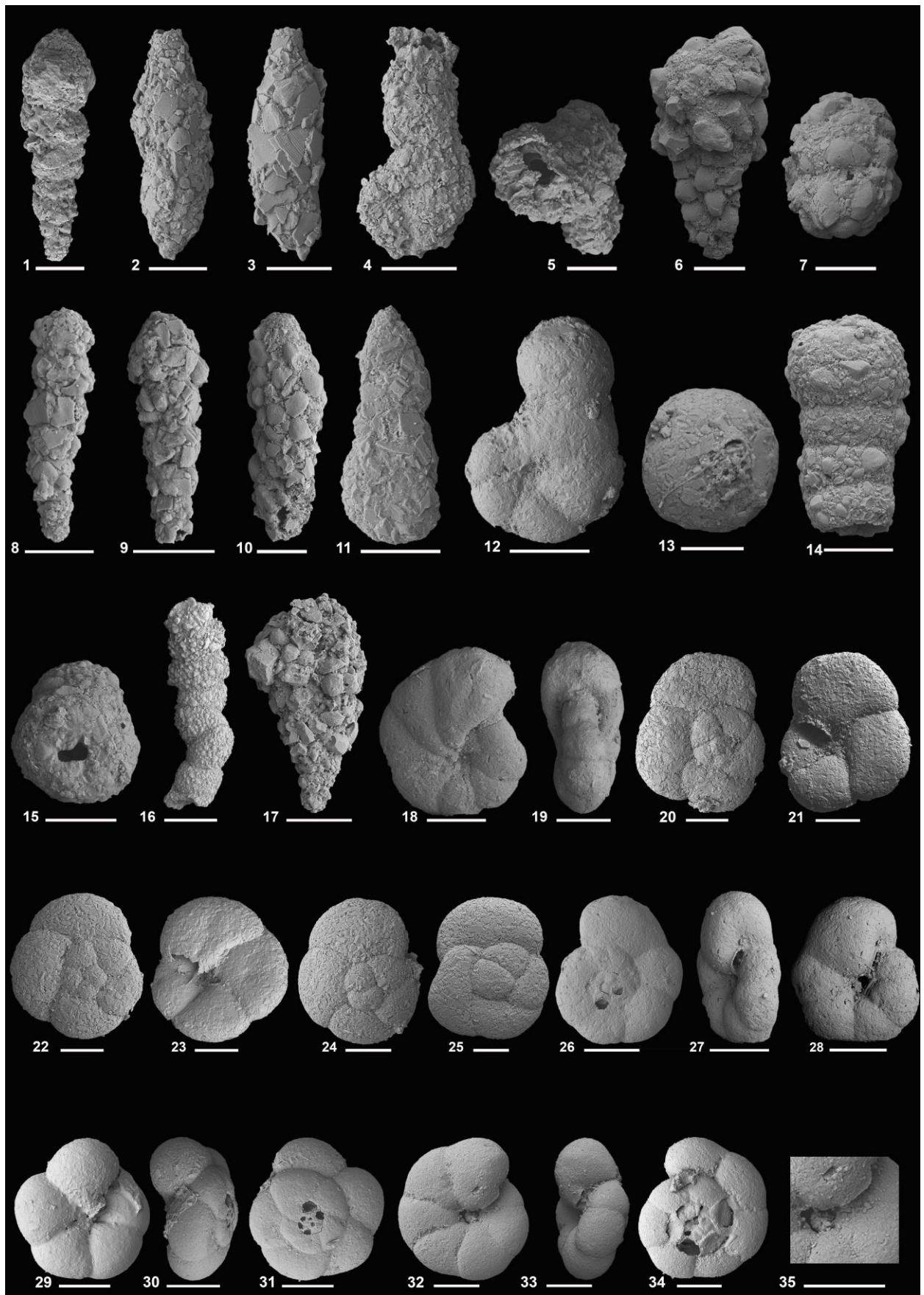


PLATE 2

Scale bar is 100µm for all magnifications except otherwise stated.

1-4: *Caronia exilis* (Cushman & Brönnimann)

5-7: *Eggerelloides scabrus* (Williamson)

8, 9: *Sahulia* cf. *S. barkeri* (Hofker)

10, 11: *Sahulia* sp. 1.

12, 13: *Sahulia* sp. 2.

14-19: *Textularia agglutinans* d'Orbigny

20-23: *Textularia candeina* d'Orbigny

24, 25: *Textularia foliacea* Cushman

26: *Textularia oceanica* Cushman

27: *Textularia* sp. 1

28-30: *Textularia* sp. 2

31-34: *Textularia* sp. 3

PLATE 2

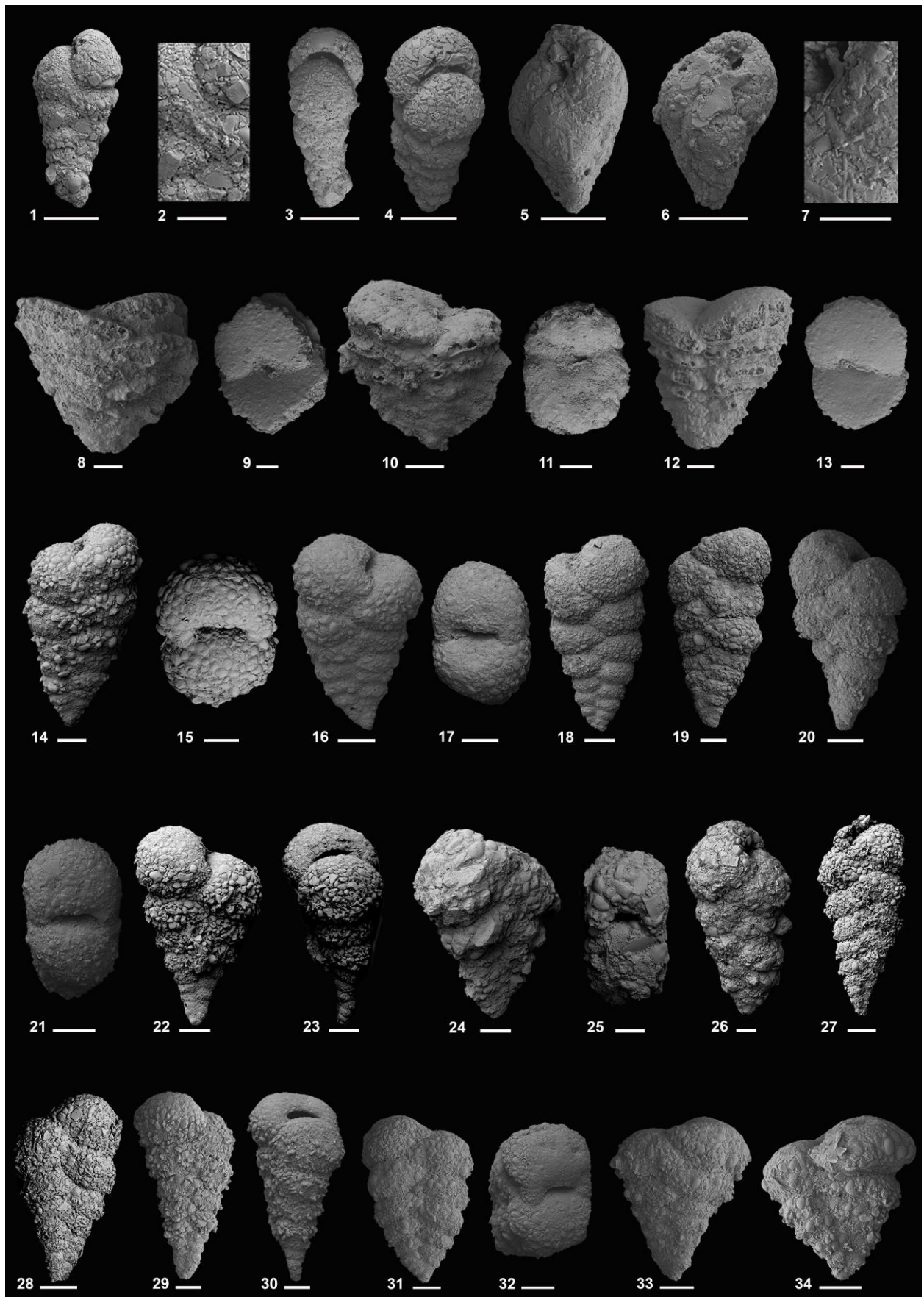


PLATE 3

Scale bar is 100µm for all magnifications except otherwise stated.

1-3: *Textularia* sp. 4

4-7: *Textularia* sp. 5

8: *Textularia* sp. 6

9: *Septotextularia rugosa?* Cheng and Zheng, 200µm.

10, 11: *Pseudogaudryina* sp. 1

12-21: *Clavulina pacifica* Cushman

22-26: *Conicospirillinoides* sp. 1

27-29: *Conicospirillinoides* sp.2.

30-32: *Planispirillina* cf. *P. tuberculatolimbata* (Chapman)

PLATE 3

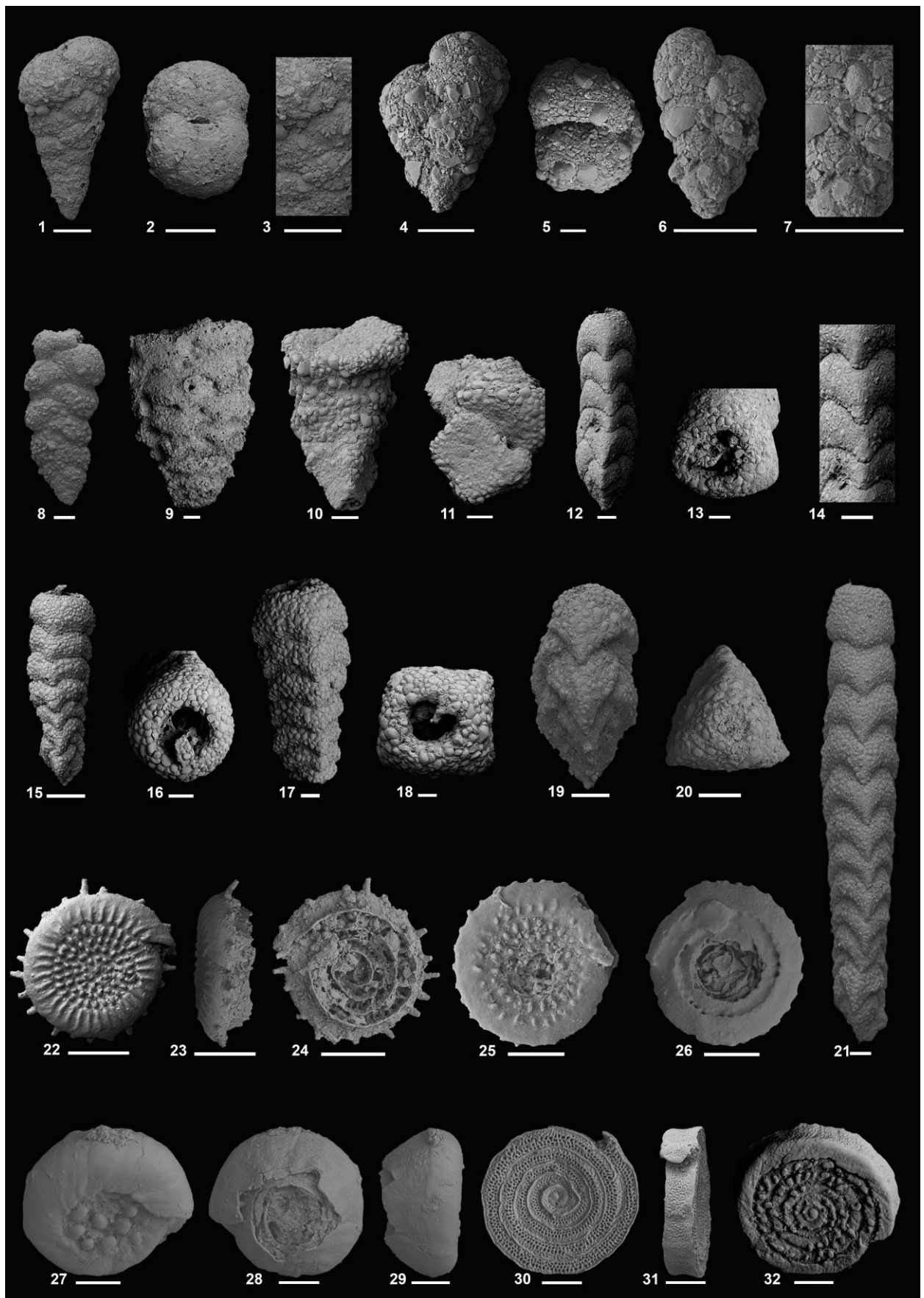


PLATE 4

Scale bar is 100µm for all magnifications except otherwise stated.

1, 2: *Planispirillina* sp. 1

3-5: *Planispirillina* sp. 2

6-9: *Spirillina groseperforata* Zheng.

10-14: *Spirillina* sp. 1

15-21: *Spirillina* sp. 2

22-24: *Cornuspira planorbis*, Schultze,

25-28: *Cornuspira* sp. 1

29-31: *Nubeculina advena*, Cushman, 500µm

32-35: *Planispirinella exigua* (Brady)

PLATE 4

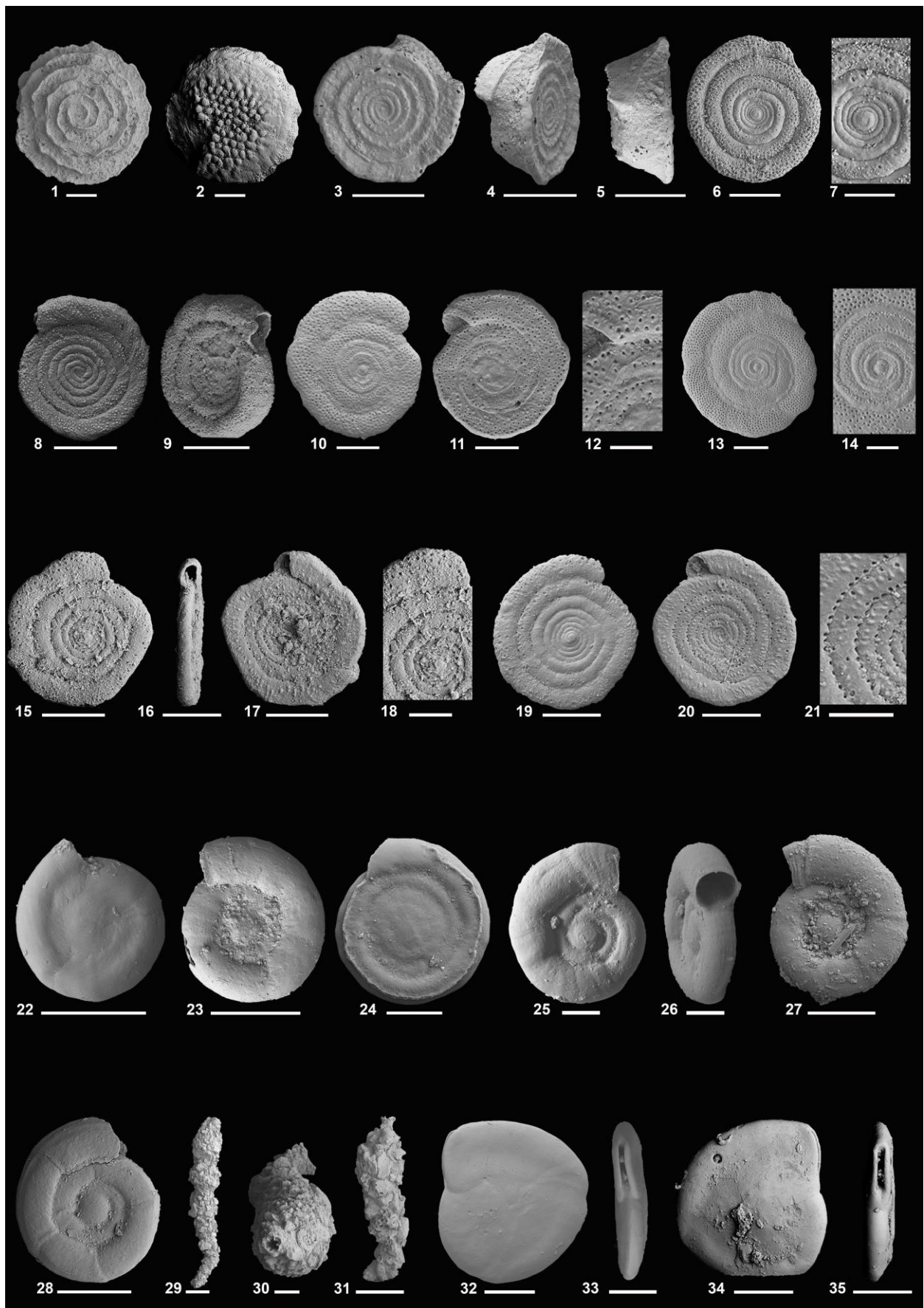


PLATE 5

Scale bar is 100µm for all magnifications except otherwise stated.

1-3: *Planispirinella* sp. 1

4, 5: *Glomulina?* sp. 1

6-8: *Vertebralina striata* d'Orbigny

9-11: *Wiesnerella auriculata* (Egger)

12-16: *Nodophthalmidium antillarum*, (Cushman, 1922) 12-14, 16 (50µm)

17-19: *Spirophthalmidium* aff. *S. prolixum* Loeblich and Tappan

20-22: *Spirothalmidum scabrum* Loeblich & Tappan, 1994 50µm

23-26: *Edentostomina cultrata* Brady

27, 28: *Edentostomina* sp. 1

29-32: *Adelosina laevigata* (d'Orbigny)

33-35: *Adelosina* sp. 1

PLATE 5

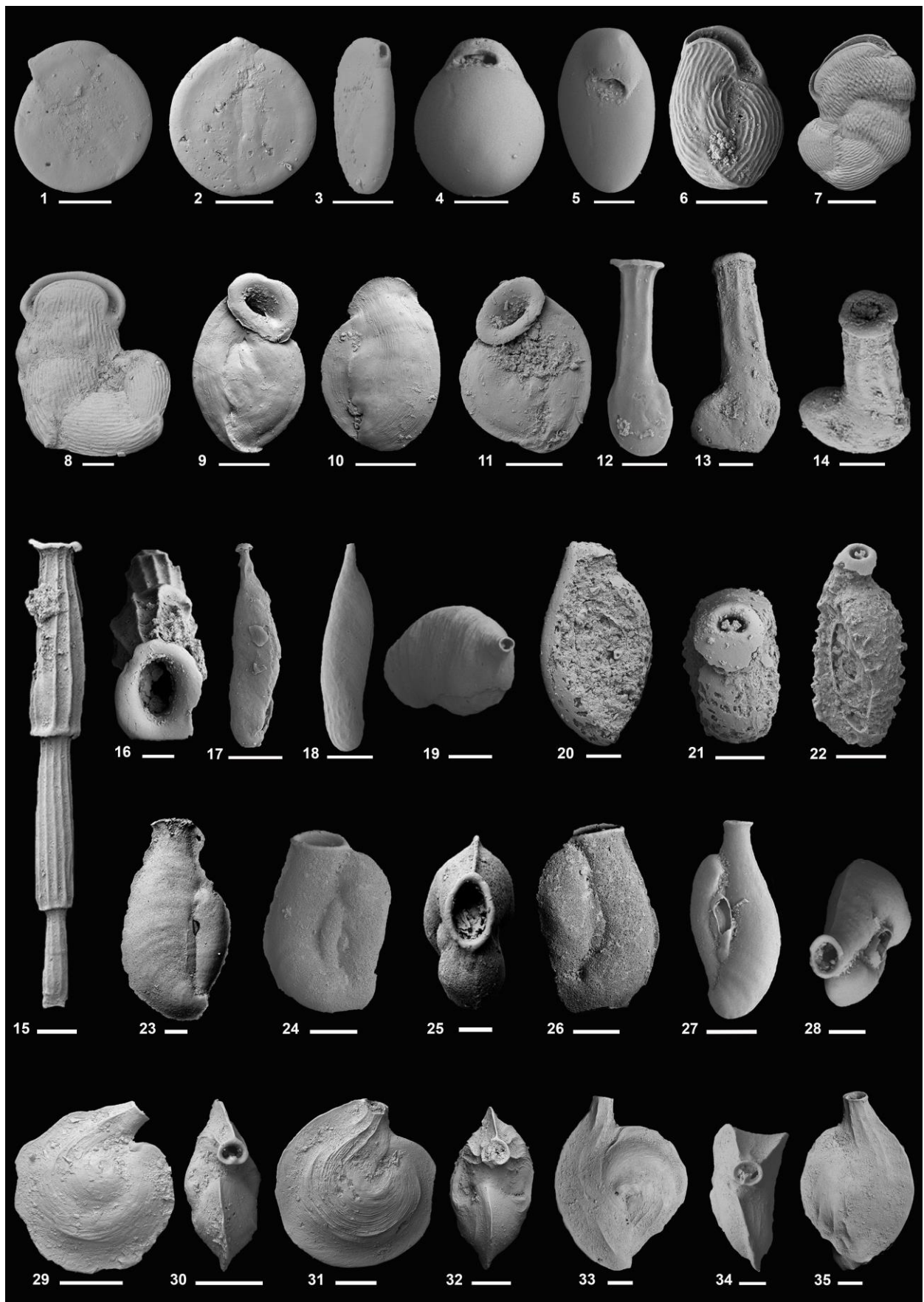


PLATE 6

Scale bar is 100µm for all magnifications except otherwise stated.

1-4: *Spiroloculina angulata* Cushman

5-8: *Spiroloculina antillarum* d'Orbigny

9-12 *Spiroloculina* cf. *S. caduca* Cushman

13-16: *Spiroloculina communis* Cushman & Todd

17-19: *Spiroloculina* cf. *S. communis* Cushman & Todd

20-22: *Spiroloculina convexa* Said

23-25: *Spiroloculina corrugata* Cushman & Todd

26-31: *Spiroloculina mayori* Cushman

32, 33: *Spiroloculina samoensis* Cushman

34, 35: *Spiroloculina scrobiculata* Cushman

36-38: *Spiroloculina* sp. 1.

PLATE 6

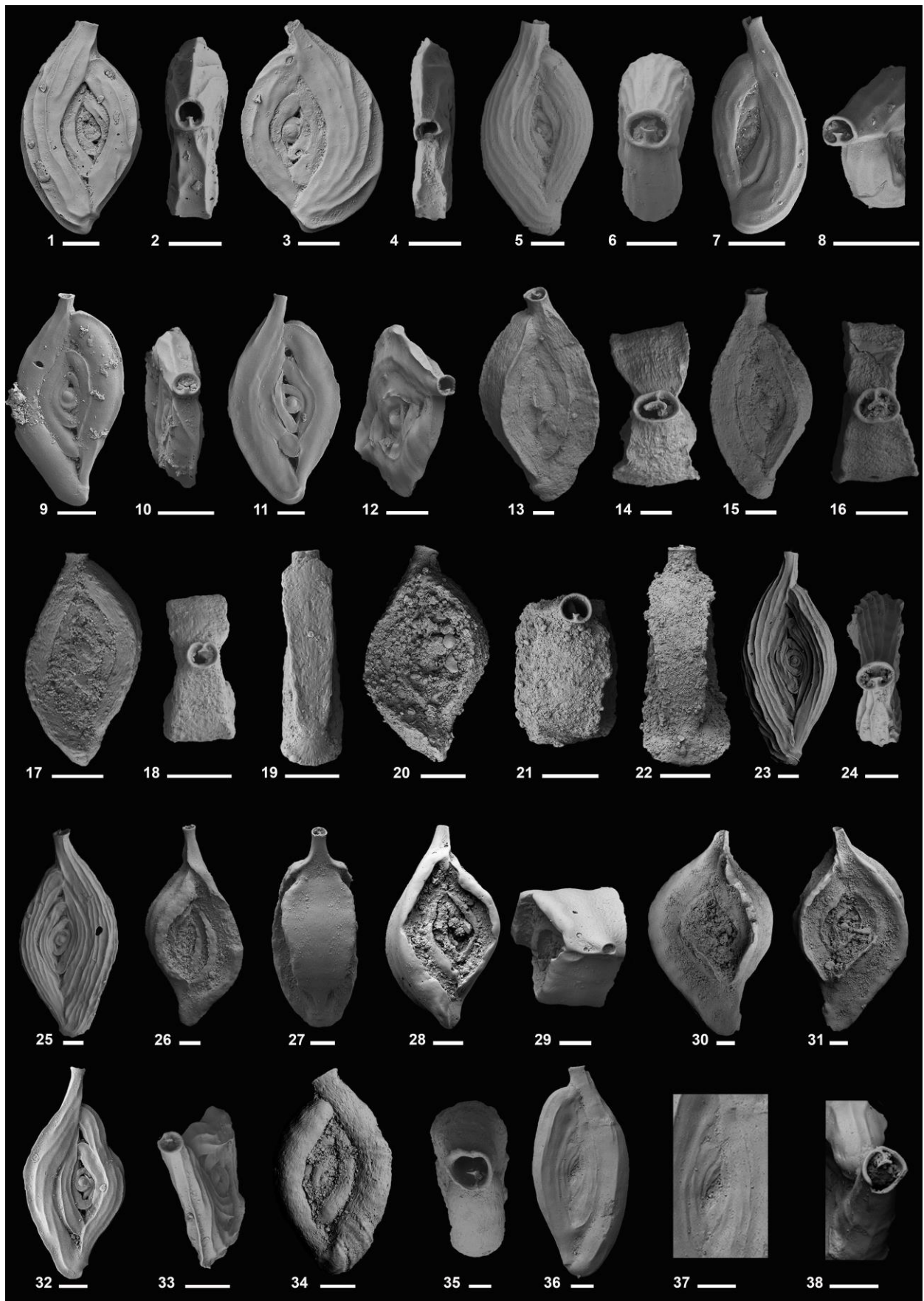


PLATE 7

Scale bar is 100µm for all magnifications except otherwise stated.

1-5: *Spiroloculina* sp. 2

6-10: *Spiroloculina* sp. 3

11-13: *Spiroloculina* sp. 4.

14, 15: *Spiroloculina* sp. 5 50µm

16-18: *Falsagglutinella angularis* Loeblich & Tappan

19: *Agglutinella* sp. 1

20, 21: *Schlumbergerina alveoliniformis* (Brady)

22-24: *Siphonaperta hallocki* Förderer and Langer

25-27: *Siphonaperta* cf. *S. hallocki* Förderer and Langer

28-31: *Siphonaperta pittensis* (Albani)

32-35: *Siphonaperta* cf. *S. pittensis* (Albani)

PLATE 7

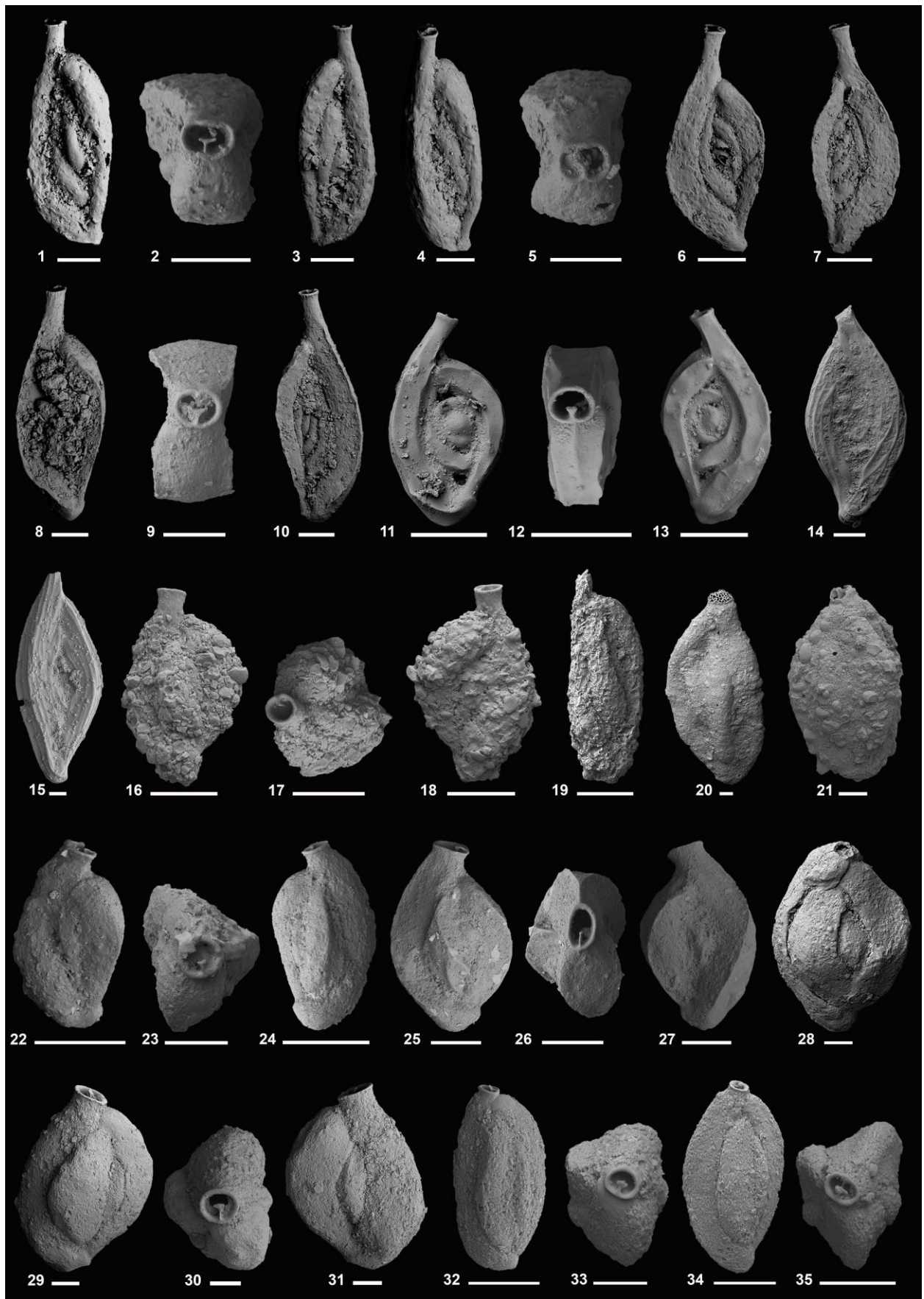


PLATE 8

Scale bar is 100µm for all magnifications except otherwise stated.

1, 2: *Siphonaperta* sp. 1

3: *Inaequalina* sp. 1

4-7: *Hauerina fragilissima* (Brady)

8-14: *Hauerina* aff. *H. fragilissima* (Brady)

15-25: *Hauerina pacifica* Cushman

26-28: *Pseudolachlanella angusteoralis* (Wiesner)

29-31: *Pseudolachlanella eburnea* (d'Orbigny)

32-35: *Pseudolachlanella slitella* Langer

PLATE 8

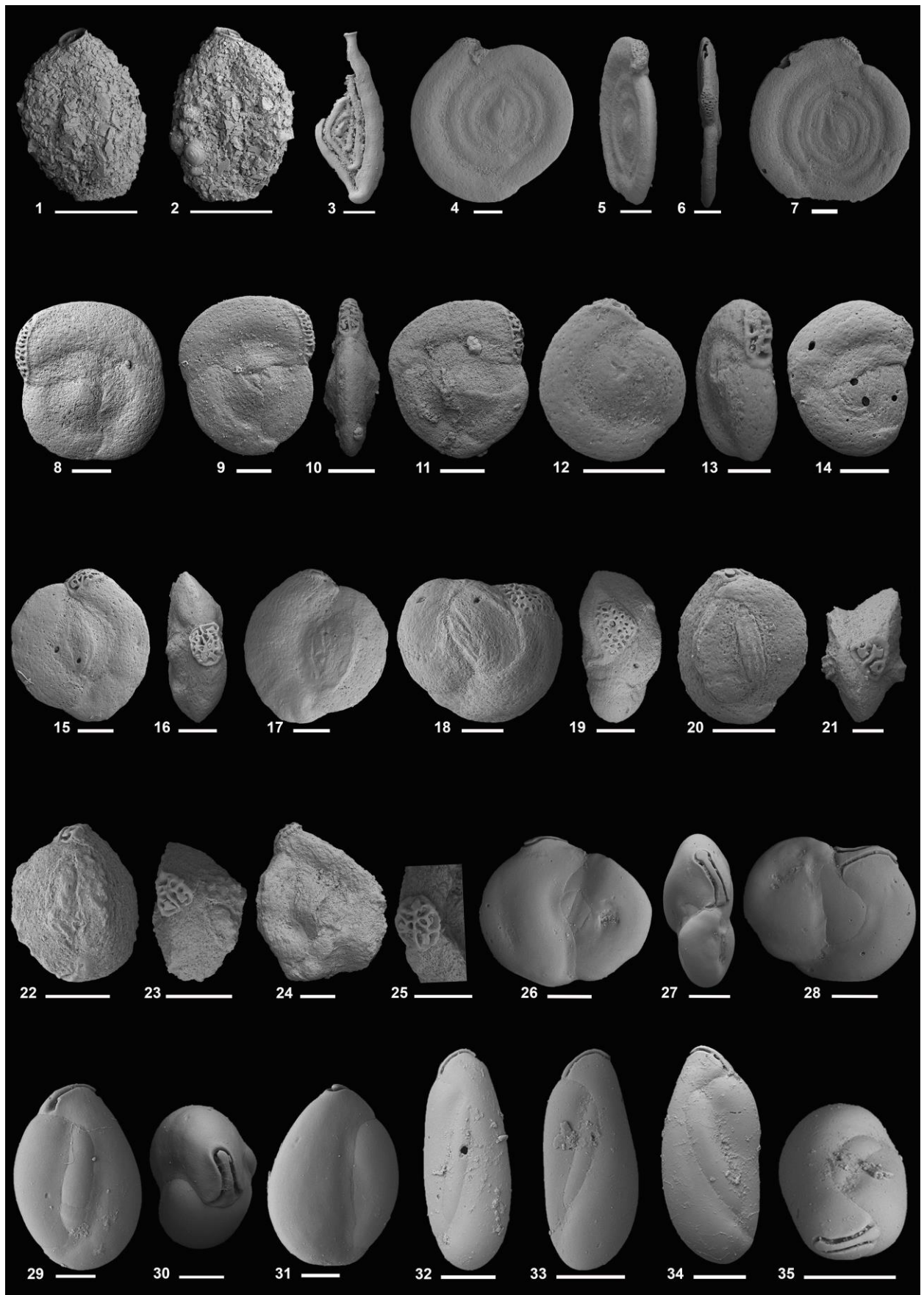


PLATE 9

Scale bar is 100µm for all magnifications except otherwise stated.

1-7: *Pseudolachlanella* sp. 1

8-11: *Quinqueloculina agglutinans* d'Orbigny

12-14: *Quinqueloculina angulariformis* McCulloch,

15-18: *Quinqueloculina arenata* Said

19-28: *Quinqueloculina barnadi* (d'Orbigny)

29-31: *Quinqueloculina* cf. *Q. bassensis* (Parr)

32-35: *Quinqueloculina carinatastriata* Wiesner

PLATE 9

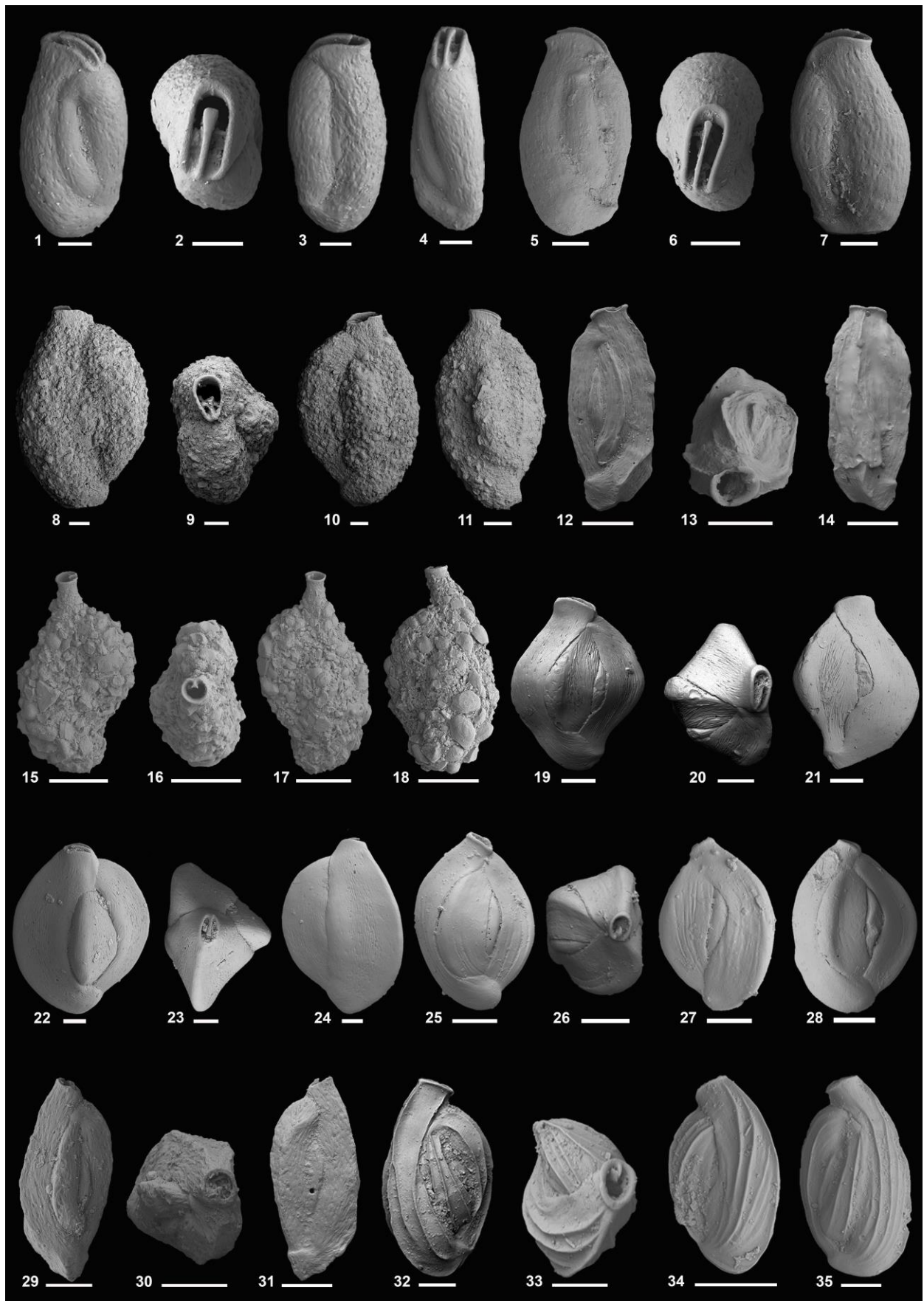


PLATE 10

Scale bar is 100µm for all magnifications except otherwise stated.

1-3: *Quinqueloculina* aff. *Q. carinata* d'Orbigny

4-7: *Quinqueloculina collumnosa* Cushman

8, 9: *Quinqueloculina corrugata* (Collins)

10-15: *Quinqueloculina* cf. *Q. crassicarinata* sp. 1 Collins

16-21: *Quinqueloculina* cf. *Q. crassicarinata* sp. 2 Collins

22-28: *Quinqueloculina curta* Cushman

29-35: *Quinqueloculina cuvieriana* d'Orbigny

PLATE 10

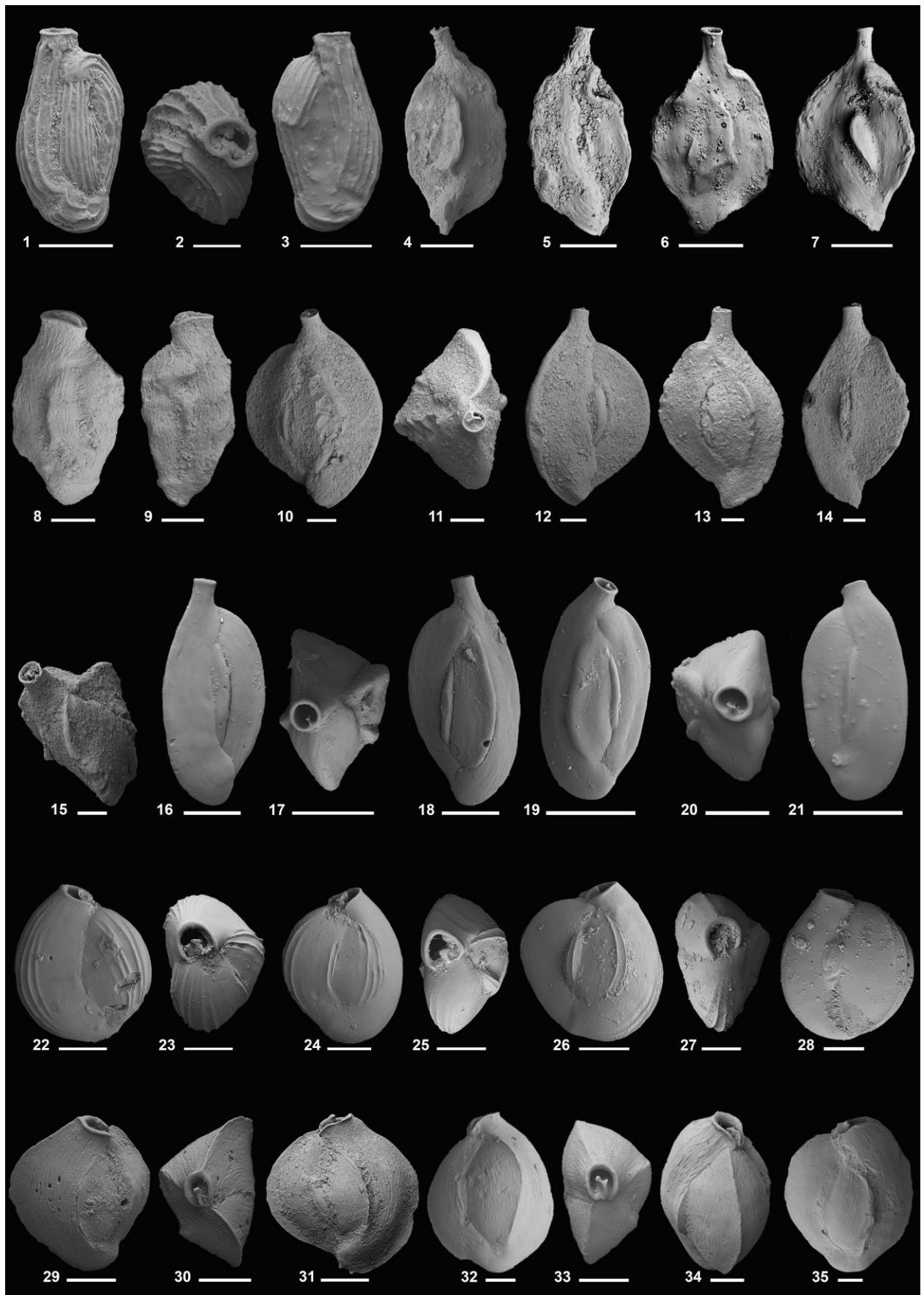


PLATE 11

Scale bar is 100µm for all magnifications except otherwise stated.

1-4: *Quinqueloculina* cf. *Q. cuvieriana* d'Orbigny

5-7: *Quinqueloculina* cf. *Q. delicatula* Vella

8-12: *Quinqueloculina* cf. *Q. differens* McCulloch

13-18: *Quinqueloculina distorta* Cushman

19-24: *Quinqueloculina* cf. *Q. distorta* sp. 1 Cushman

25, 26: *Quinqueloculina* cf. *Q. distorta* sp. 2 Cushman

27-32: *Quinqueloculina eamesii* (Rasheed)

33-35: *Quinqueloculina exmouthensis* Parker

36: *Quinqueloculina exsculpta* (Heron-Allen and Earland)

PLATE 11

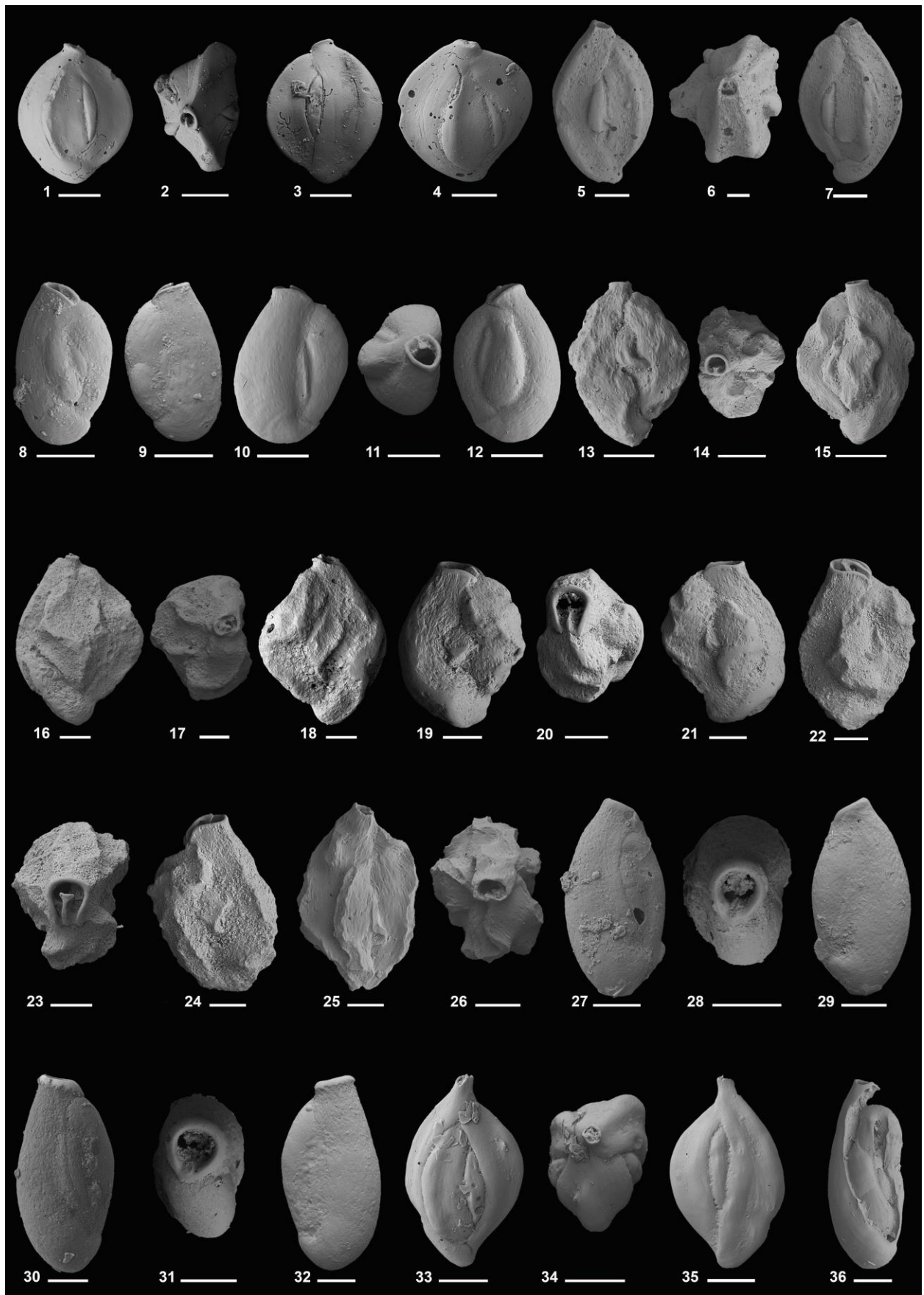


PLATE 12

Scale bar is 100µm for all magnifications except otherwise stated.

1-7: *Quinqueloculina funafutiensis* (Chapman)

8-11: *Quinqueloculina* cf. *Q. granulocostata* Germeraad

12-17: *Quinqueloculina inaequalis* Cushman

18-21: *Quinqueloculina* cf. *Q. laevigata* d'Orbigny

22, 23: *Quinqueloculina lamarckiana* d'Orbigny

24-28: *Quinqueloculina lizardi* Baccaert

29-35: *Quinqueloculina neostriatula* Thalmann

PLATE 12

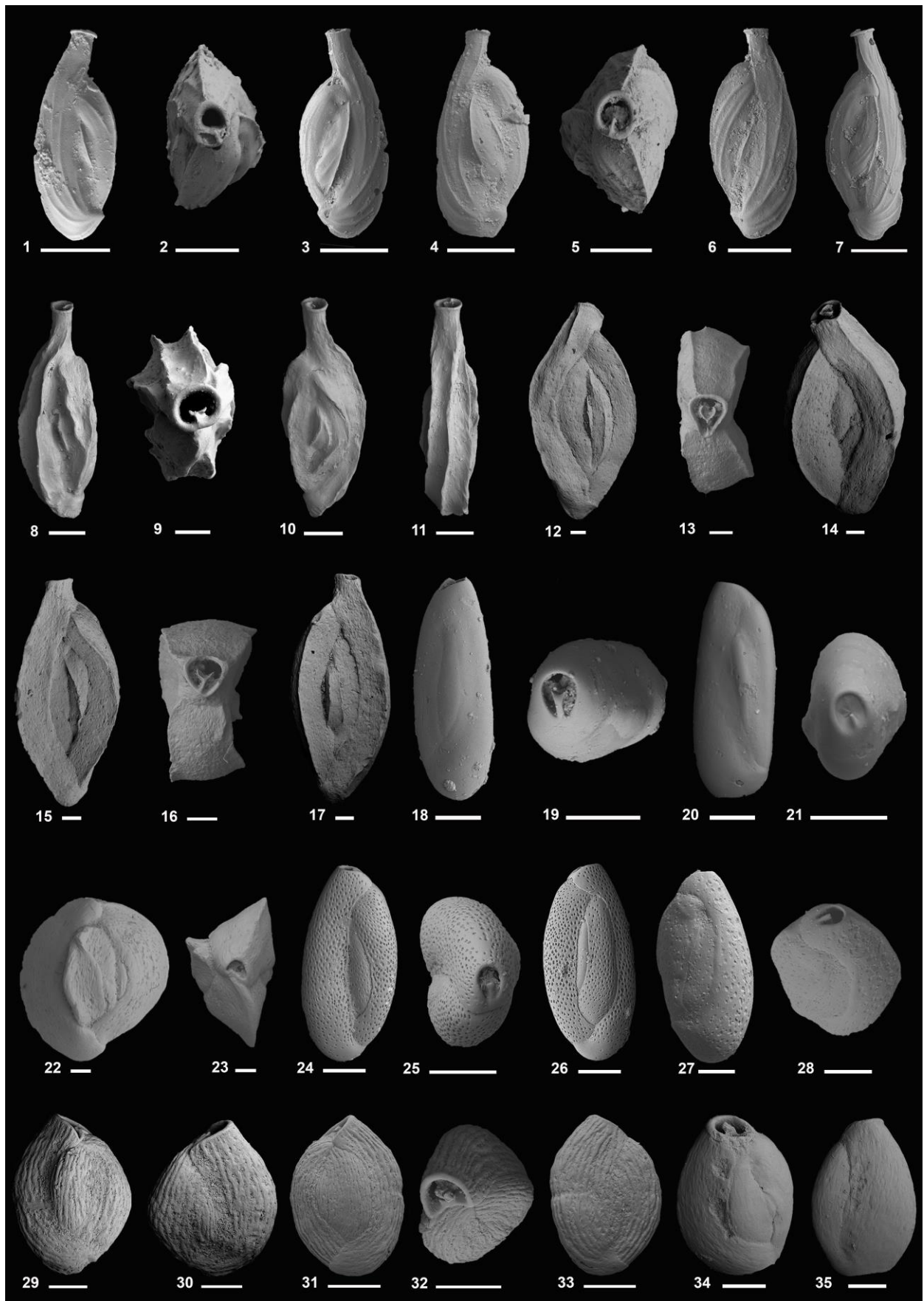


PLATE 13

Scale bar is 100µm for all magnifications except otherwise stated.

1-3: *Quinqueloculina* cf. *Q. neostriatula* Thalmann

4-8: *Quinqueloculina ningalooensis* Parker

9-14: *Quinqueloculina montyi* Baccaert

15-25: *Quinqueloculina parkeri* (Brady)

26-35: *Quinqueloculina* aff. *Q. parvaggluta* Vella

PLATE 13

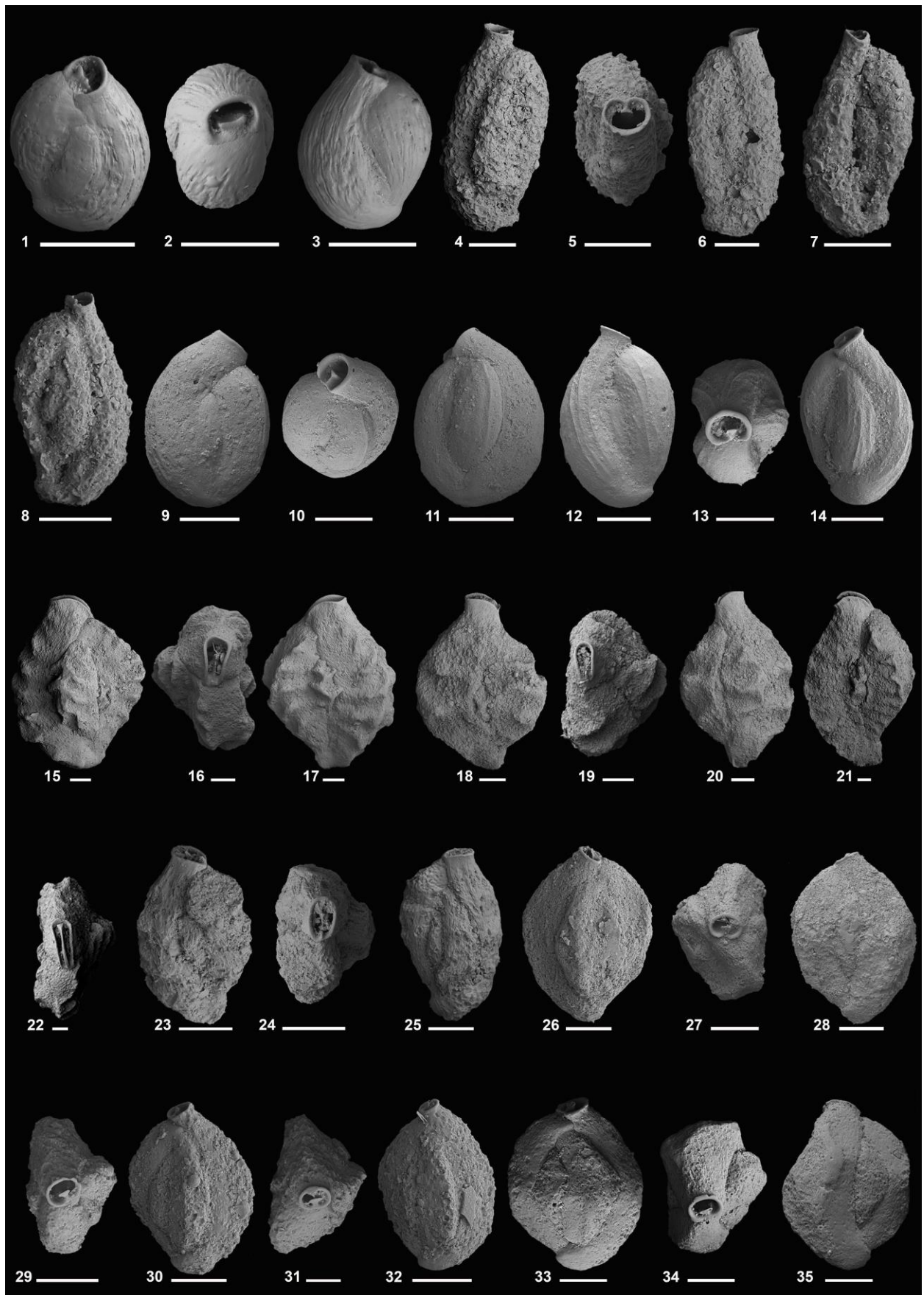


PLATE 14

Scale bar is 100µm for all magnifications except otherwise stated.

1-8: *Quinqueloculina patagonica* d'Orbigny

9-19: *Quinqueloculina philippinensis* Cushman

20-30: *Quinqueloculina poeyana* d'Orbigny

31-33: *Quinqueloculina polygona* d'Orbigny

34-36: *Quinqueloculina* aff. *Q. polygona* d'Orbigny

PLATE 14

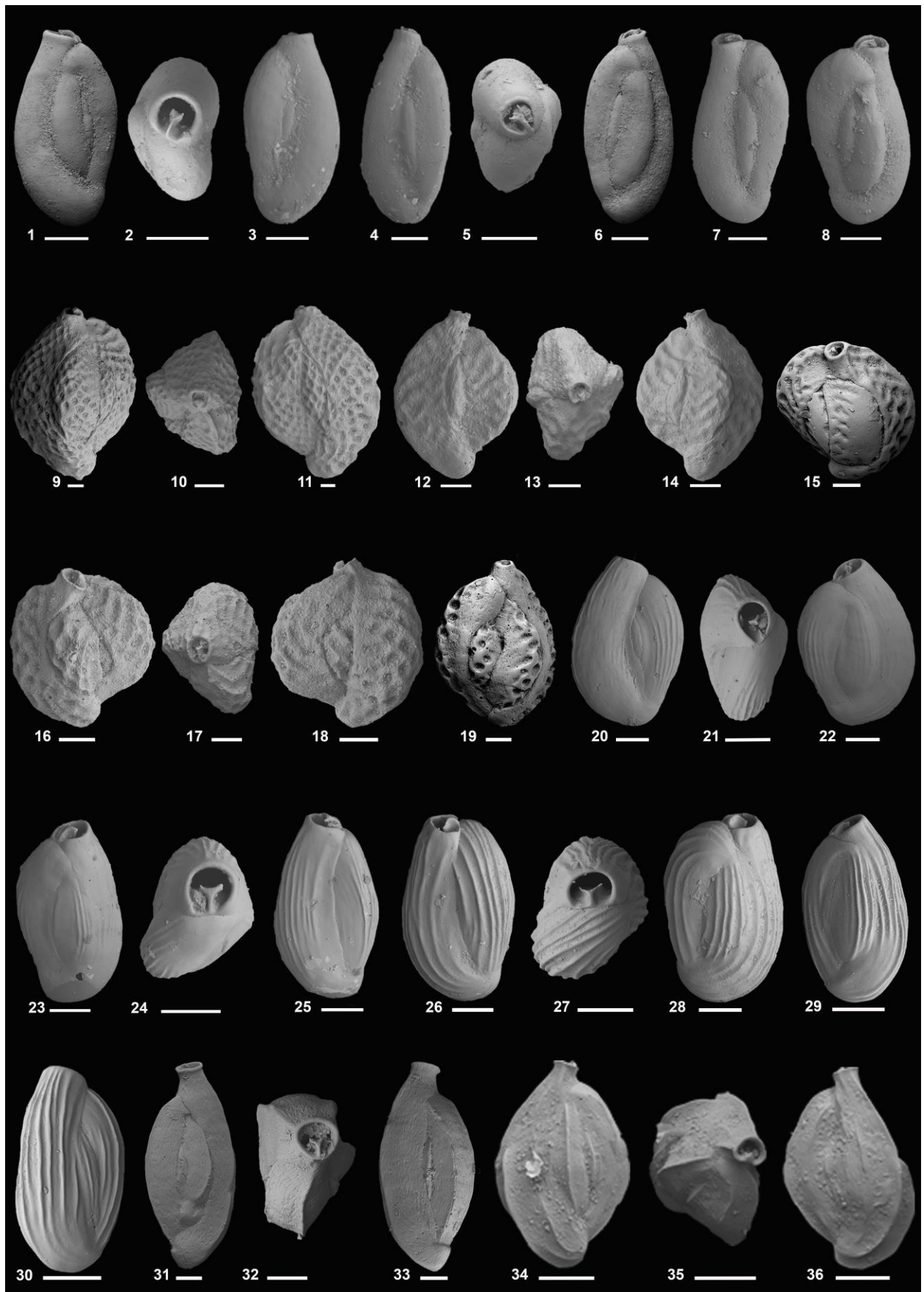


PLATE 15

Scale bar is 100µm for all magnifications except otherwise stated.

1-3: *Quinqueloculina* cf. *Q. polygona* d'Orbigny

4-7: *Quinqueloculina pusilla* d'Orbigny

8-19: *Quinqueloculina quinquecarinata* (Collins)

20-25: *Quinqueloculina* aff. *Q. quinquecarinata* (Collins)

26-29: *Quinqueloculina* cf. *Q. rugosa* d'Orbigny

30-37: *Quinqueloculina seminula* Linnaeus

PLATE 15

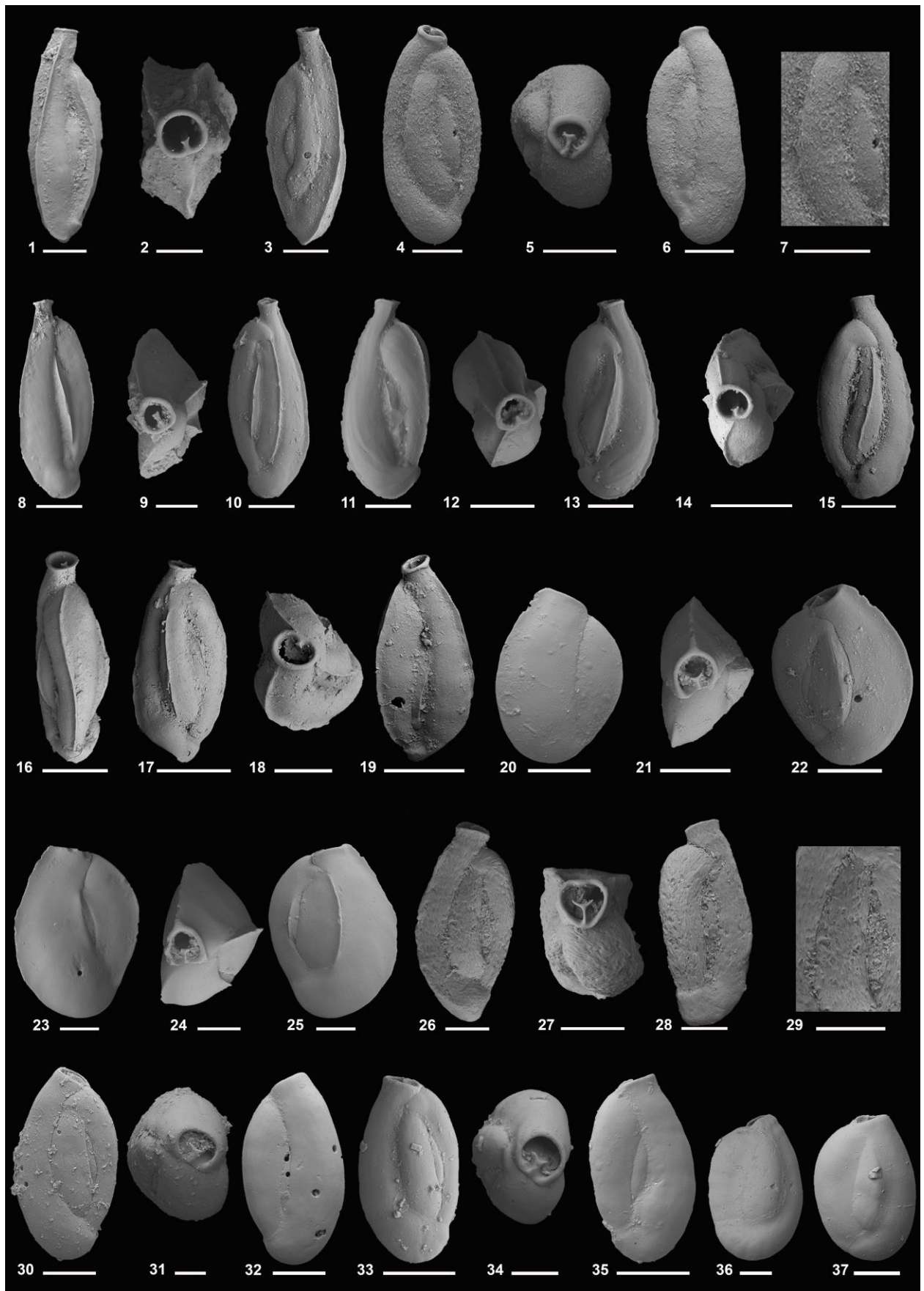


PLATE 16

Scale bar is 100µm for all magnifications except otherwise stated.

1-3: *Quinqueloculina* aff. *Q. semiplicata* (McCulloch)

4-12: *Quinqueloculina sidebottomi* (Rasheed)

13-17: *Quinqueloculina* cf. *Q. sidebottomi* (Rasheed)

18-23: *Quinqueloculina* cf. *Q. socorroensis* McCulloch

24-26: *Quinqueloculina subcuneata* Cushman

27-35: *Quinqueloculina subpolygona* Parr

36-38: *Quinqueloculina* cf. *Q. subpolygona* Parr

PLATE 16

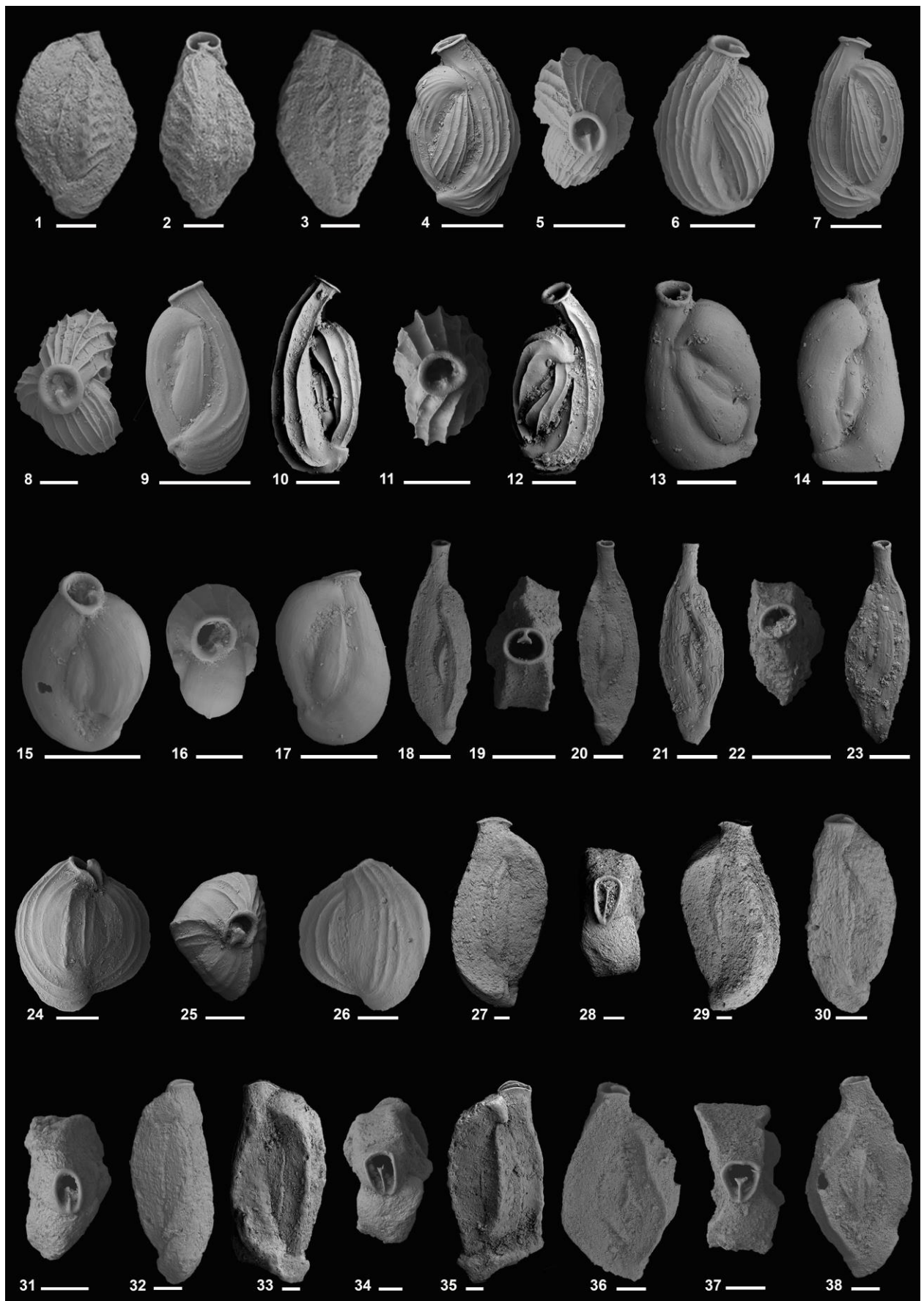


PLATE 17

Scale bar is 100µm for all magnifications except otherwise stated.

1-4: *Quinqueloculina* cf. *Q. tantabiddyensis?* Parker

5-7: *Quinqueloculina transversestriata* (Brady)

8-11: *Quinqueloculina vandiemeniensis* Loeblich and Tappan

12-21: *Quinqueloculina zhengi* Parker

22-28: *Quinqueloculina* cf. *Q. zhengi* Parker

29, 30: *Quinqueloculina* sp. 1

31-34: *Quinqueloculina* sp. 2

PLATE 17

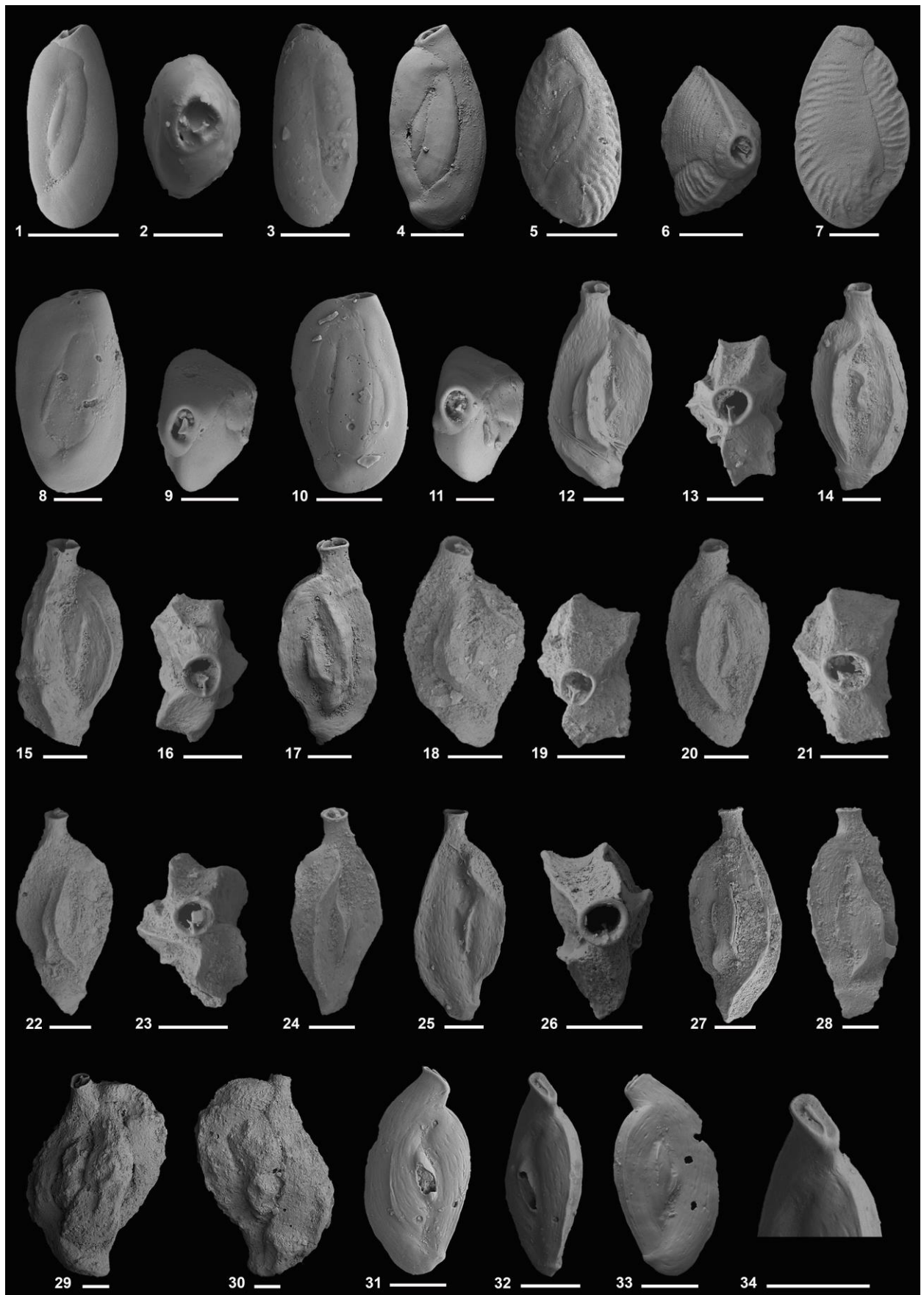


PLATE 18

Scale bar is 100µm for all magnifications except otherwise stated.

1-3: *Quinqueloculina* sp. 3

4, 5: *Quinqueloculina* sp. 4

6-8: *Quinqueloculina* sp. 5

9-11: *Quinqueloculina* sp. 6

12-14: *Quinqueloculina* sp. 7

15-17: *Quinqueloculina* sp. 8

18-23: *Quinqueloculina* sp. 9

24-26: *Quinqueloculina* sp. 10

27-29: *Quinqueloculina* sp. 11

30-32: *Quinqueloculina* sp. 12

33-35: *Quinqueloculina* sp. 13

PLATE 18

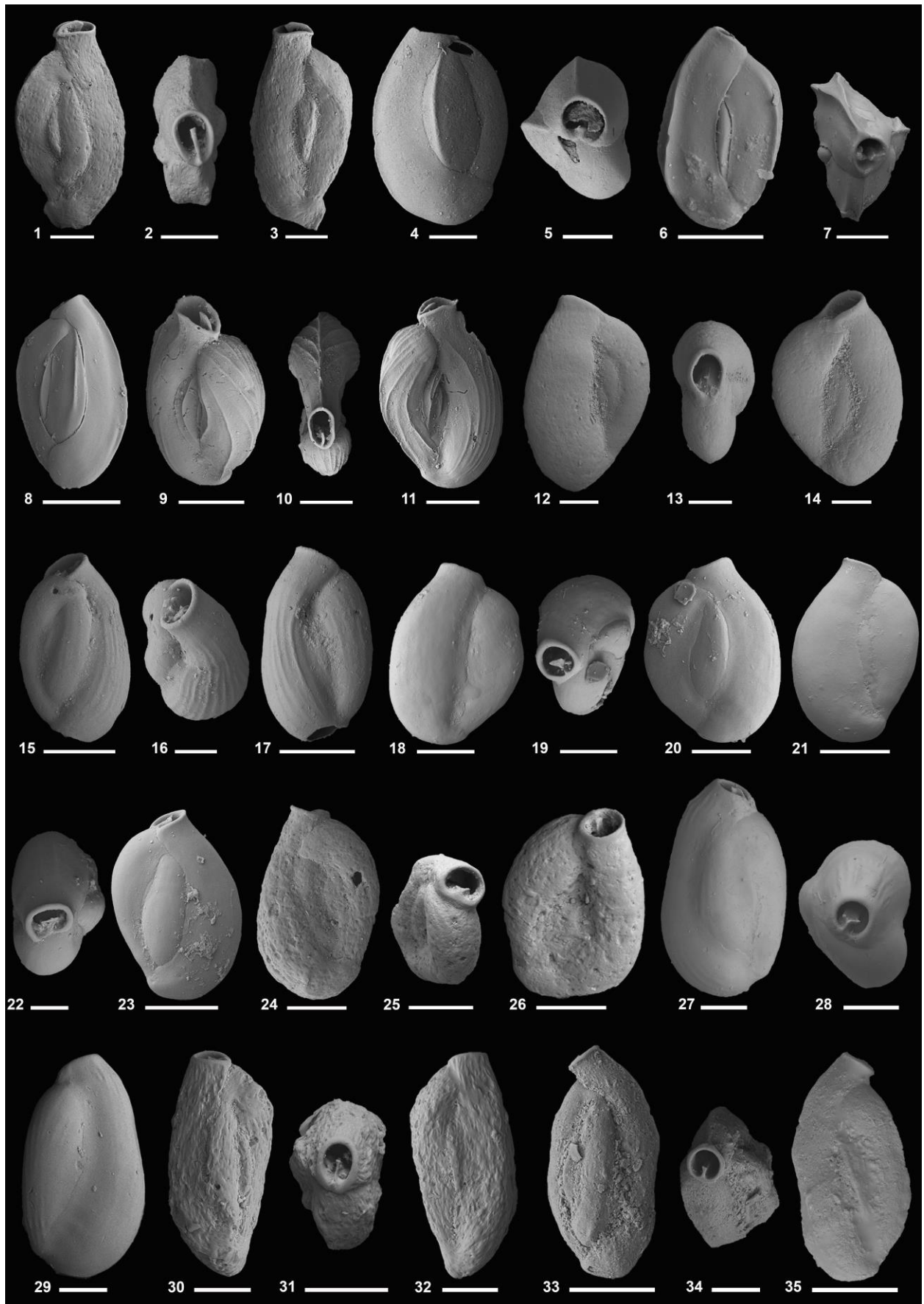


PLATE 19

Scale bar is 100µm for all magnifications except otherwise stated.

1-4: *Quinqueloculina* sp. 14

5-7: *Quinqueloculina* sp. 15

8-10: *Quinqueloculina* sp. 16

11-13: *Quinqueloculina* sp. 17

14: *Quinqueloculina* sp. 18

15-17: *Quinqueloculina* sp. 19

18, 19: *Quinqueloculina* sp. 20

20, 21: *Quinqueloculina* sp. 21

22-24: *Quinqueloculina* sp. 22

25-31: *Quinqueloculina* sp. 23

32, 33: *Affinetrina* sp. 1

34-36: *Miliolinella australis* (Parr)

PLATE 19

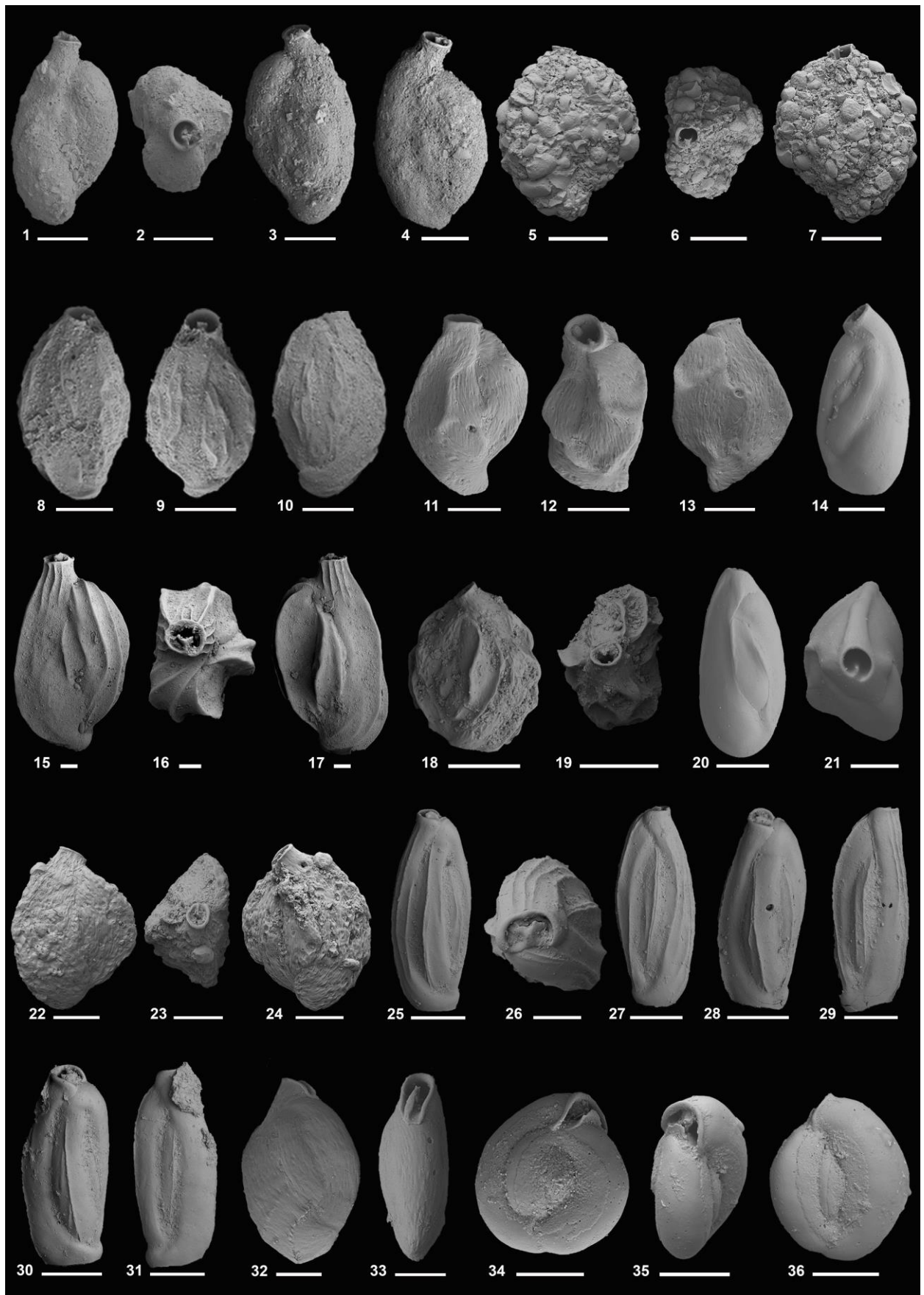


PLATE 20

Scale bar is 100µm for all magnifications except otherwise stated.

1: *Miliolinella* cf. *M. circularis* (Bornemann)

2-4: *Miliolinella labiosa* (d'Orbigny)

5-7: *Miliolinella oceanica* (Cushman)

8-13: *Miliolinella pilasensis* McCulloch,

14-17: *Miliolinella subrotunda* (Walker and Boys)

18, 19: *Miliolinella* cf. *M. subrotunda* (Walker and Boys)

20, 21: *Miliolinella* sp. 1

22, 23: *Miliolinella* sp. 2

24-26: *Miliolinella* sp. 3

27-29: *Pseudomassilina* cf. *P. australis* (Cushman)

30-32: *Pseudotriloculina* cf. *P. limbata*

PLATE 20

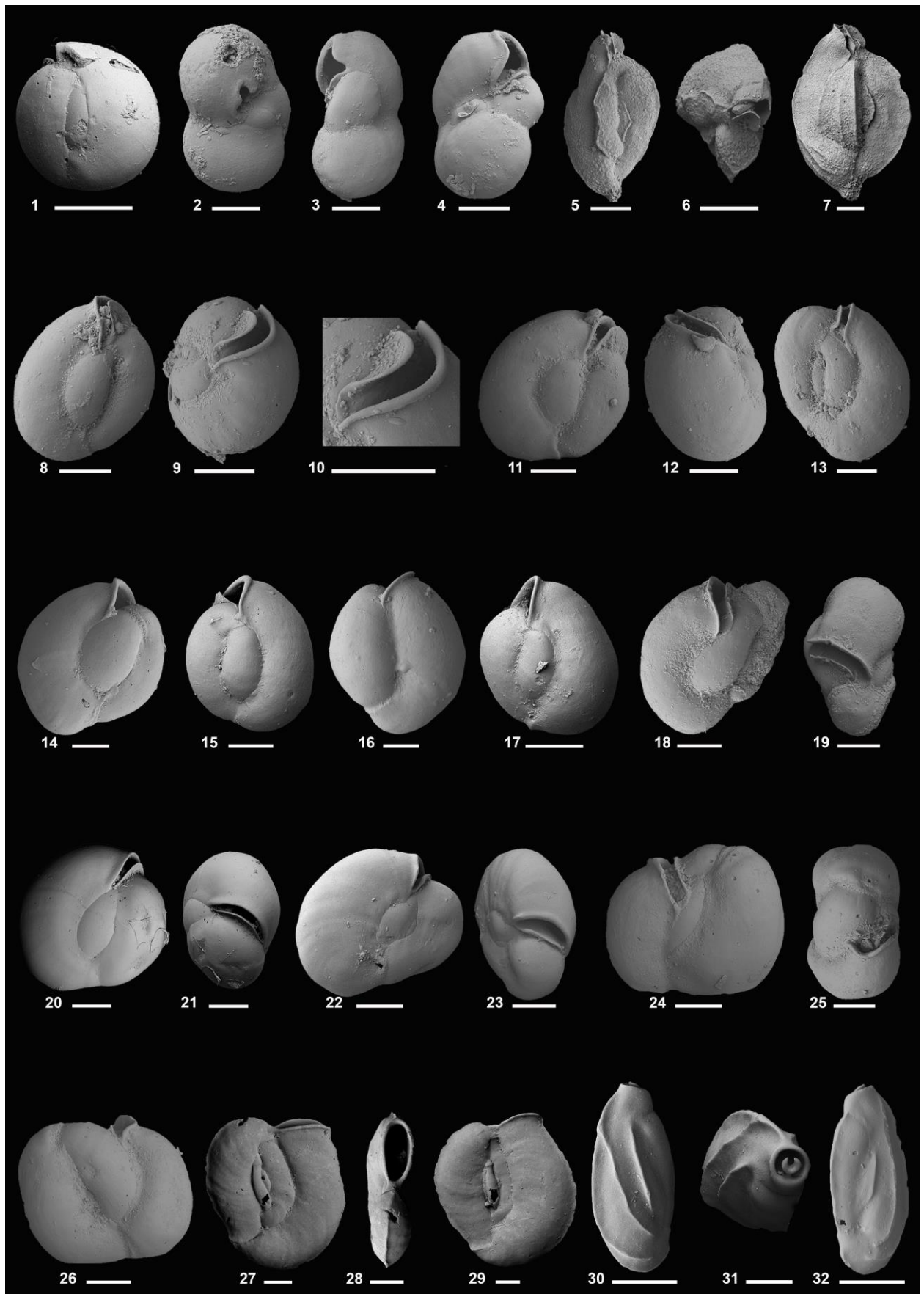


PLATE 21

Scale bar is 100µm for all magnifications except otherwise stated.

1-7: *Pseudotriloculina* cf. *P. oblonga* (Montagu)

8-14: *Pseudotriloculina subgranulata* (Cushman)

15-17: *Pseudotriloculina* cf. *T. sommeri* (Tinoco)

18-21: *Pseudotriloculina* sp. 1

22-24: *Pseudotriloculina* sp. 2

25-27: *Pseudotriloculina* sp. 3

28, 29: *Pseudotriloculina* sp. 4

30-32: *Pseudotriloculina* sp. 5

33-36: *Pseudotriloculina* sp. 6

PLATE 21

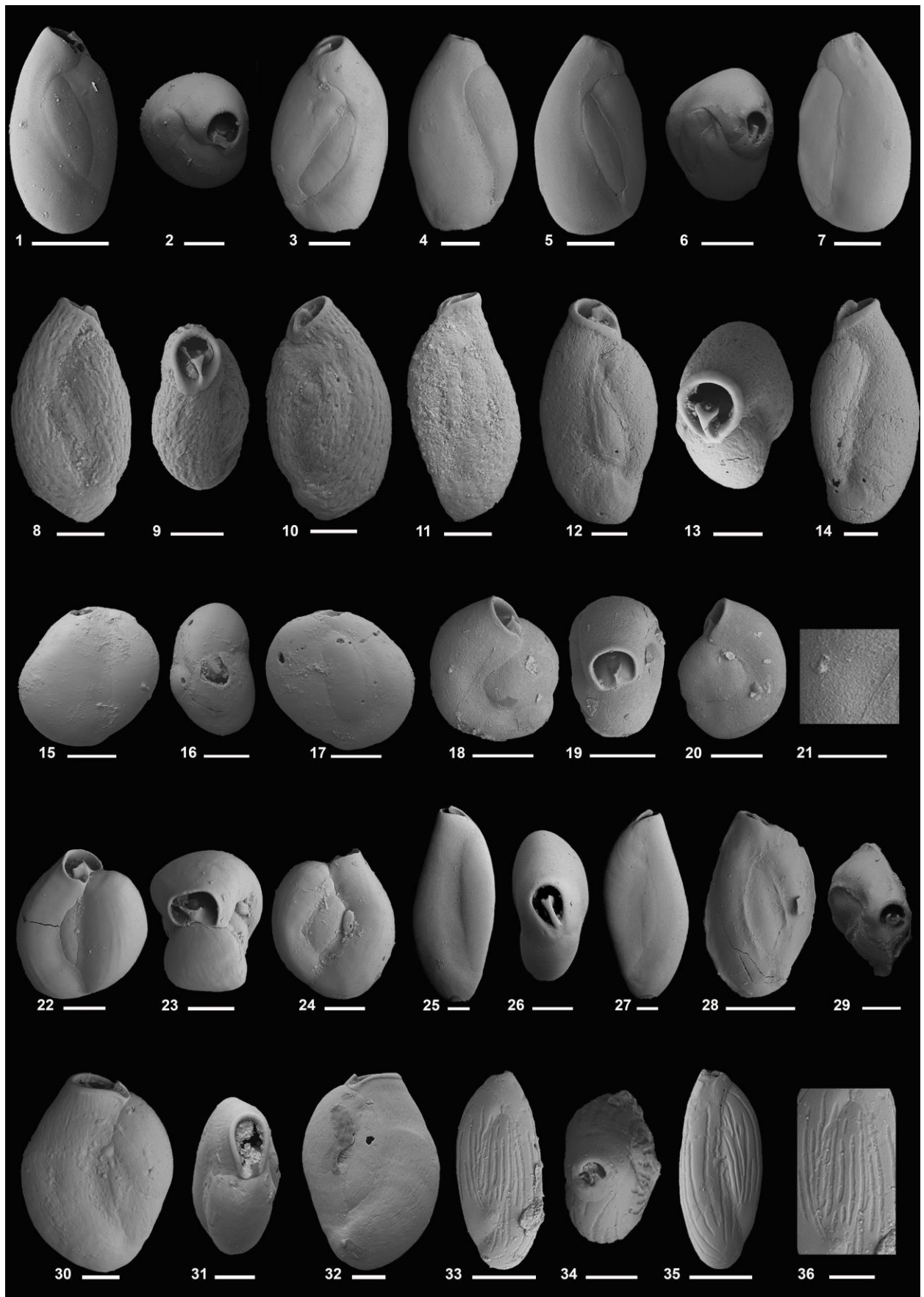


PLATE 22

Scale bar is 100µm for all magnifications except otherwise stated.

1-3: *Pseudotriloculina* sp. 7

4, 5: *Pseudotriloculina?* sp. 8

6, 7: *Pyrgo denticulata* (Brady)

8-10: *Pyrgo phlegeri* Andersen

11-13: *Pyrgo sarsi* (Schlumberger)

14-19: *Pyrgo striolata* (Brady)

20-22: *Pyrgo* cf. *P. striolata* (Brady)

23, 24: *Pyrgo* sp. 1

25-28: *Triloculina* cf. *T. assymetrica* Said

29-31: *Triloculina barnadi* Rasheed

32-35: *Triloculina* cf. *T. barnadi* Rasheed

PLATE 22

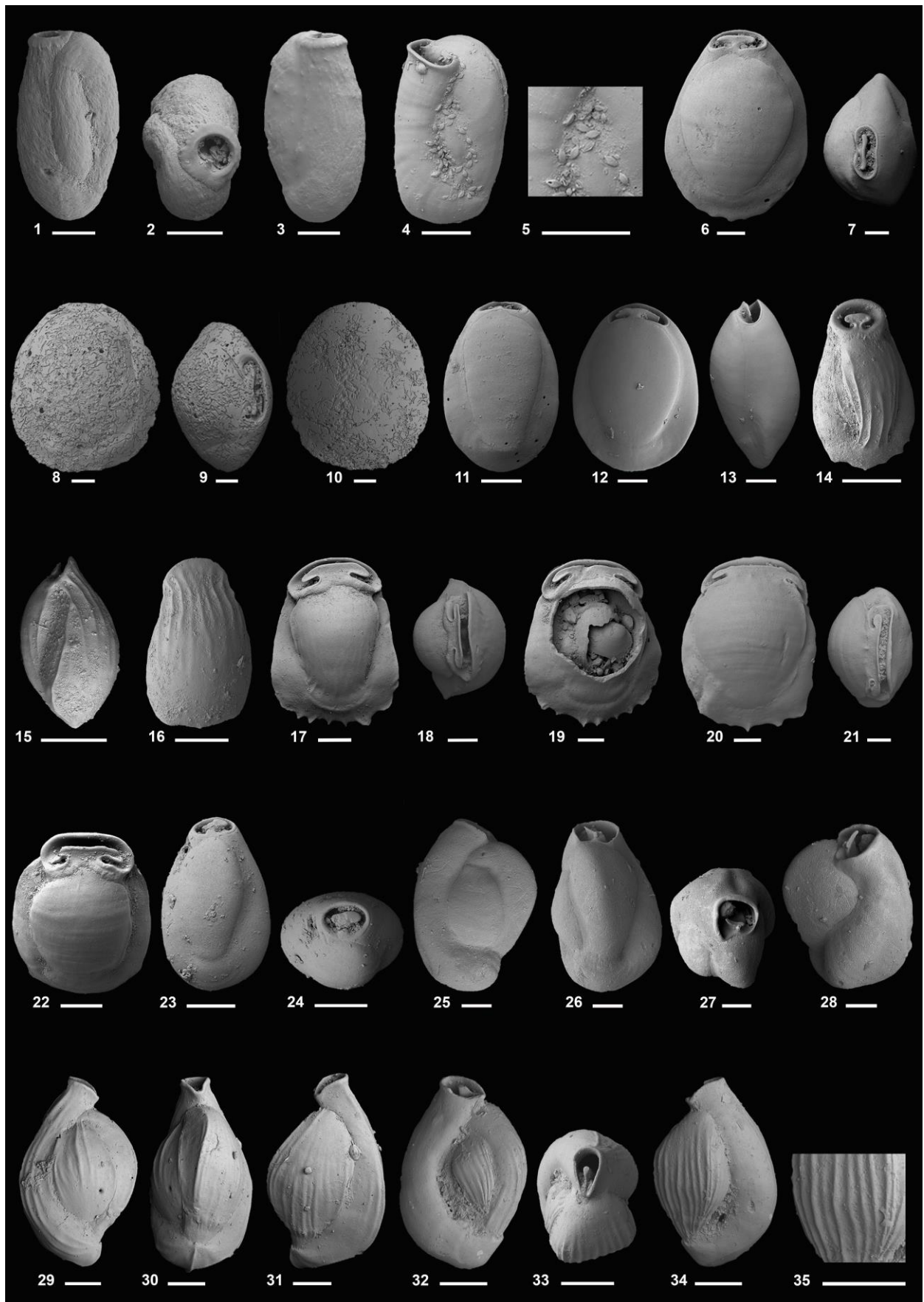


PLATE 23

Scale bar is 100µm for all magnifications except otherwise stated.

1-3: *Triloculina bicarinata* d'Orbigny

4-7: *Triloculina earlandi* Cushman

8-11: *Triloculina elongotricarinata* Debenay

12-16: *Triloculina fichteliana* d'Orbigny

17-21: *Triloculina* cf. *T. fichteliana* sp. 1, d'Orbigny

22-24: *Triloculina* cf. *T. fichteliana* sp. 2, d'Orbigny

25-35: *Triloculina kawea* Förderer and Langer

PLATE 23

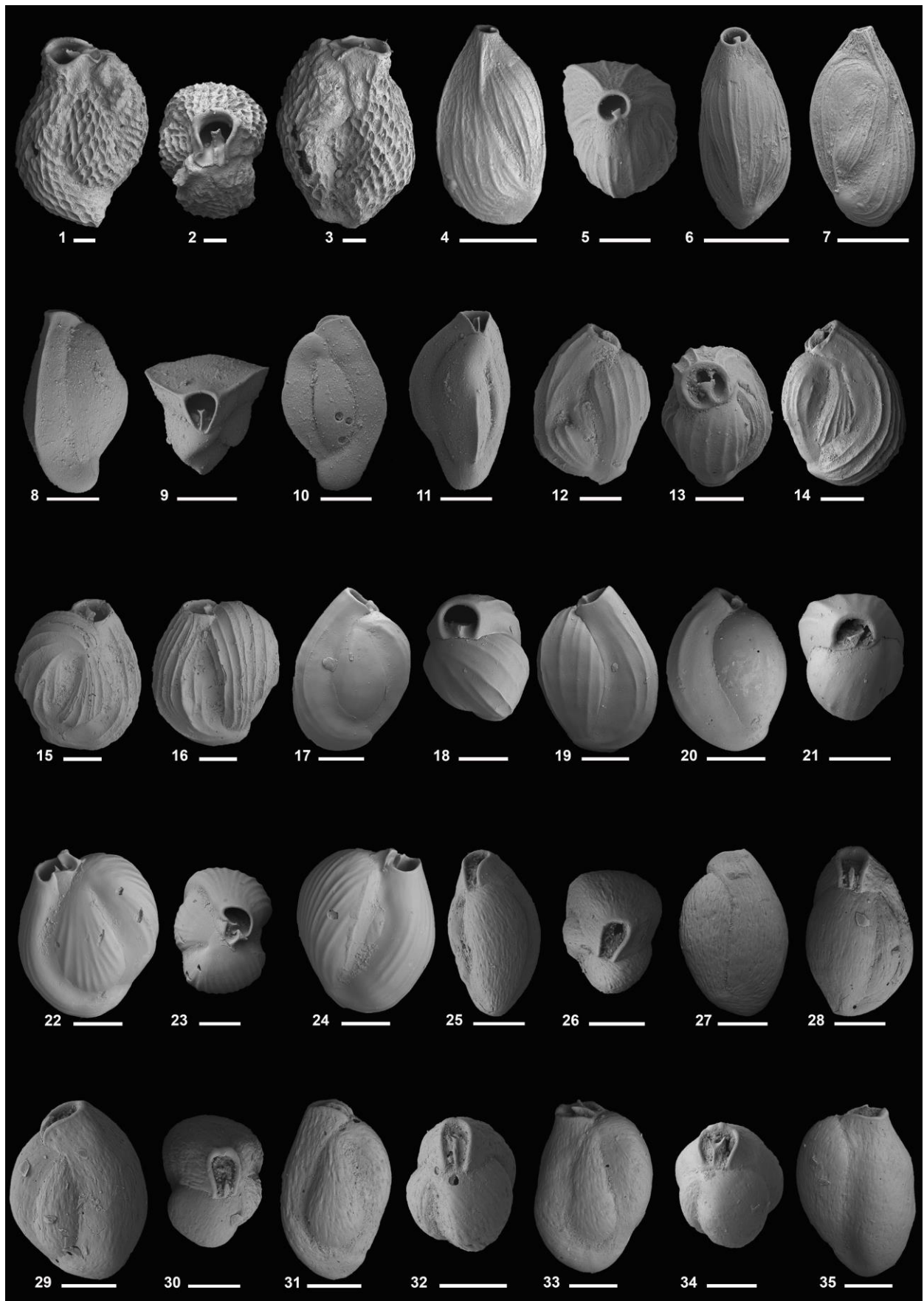


PLATE 24

Scale bar is 100µm for all magnifications except otherwise stated.

1-3: *Triloculina* cf. *T. lalibertadensis* McCulloch

4-11: *Triloculina littoralis* Collins

12-14: *Triloculina* cf. *T. rotunda* Schlumberger

15-21: *Triloculina serrulata* McCulloch

22-24: *Triloculina* cf. *T. striatotrigonula* Parker & Jones

25-28: *Triloculina* cf. *T. tricarinata* d'Orbigny

29-31: *Triloculina trigonula* (Lamarck)

32-35: *Triloculina* cf. *T. trigonula* (Lamarck)

PLATE 24

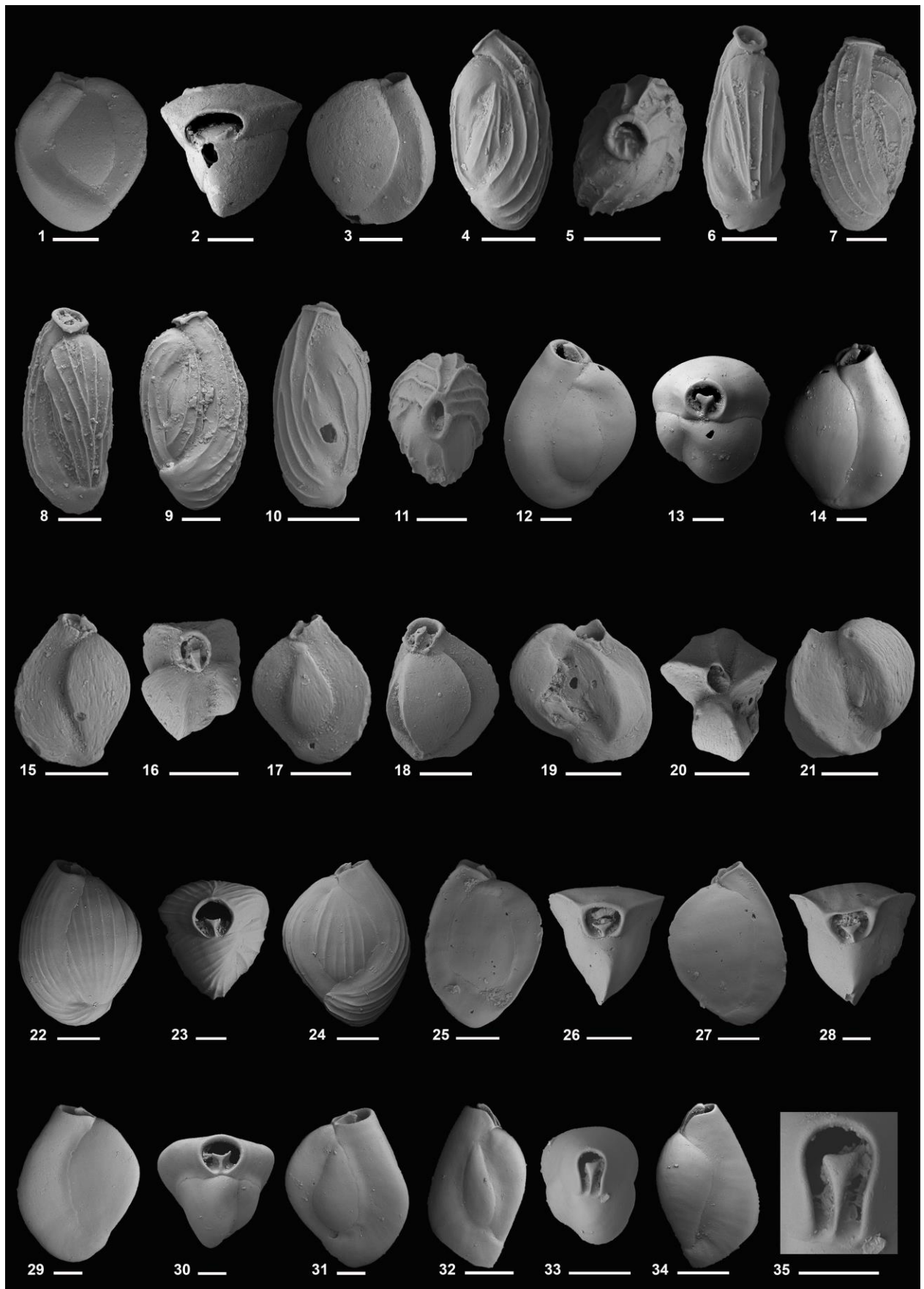


PLATE 25

Scale bar is 100µm for all magnifications except otherwise stated.

1-4: *Triloculina triquetrella* Loeblich and Tappan

5-7: *Triloculina* cf. *T. triquetrella* Loeblich and Tappan

8-11: *Triloculina* sp. 1

12-14: *Triloculina* sp. 2

15-17: *Triloculina* sp. 3

18: *Mesosigmoilina minuta* (Zheng)

19-21: *Pseudoschlumbergerina ovata* (Sidebottom)

22-28: *Sigmella* sp.

29-31: *Sigmoihauerina involuta* (Cushman)

32-34: *Sigmoilinella tortuosa* Zheng

PLATE 25

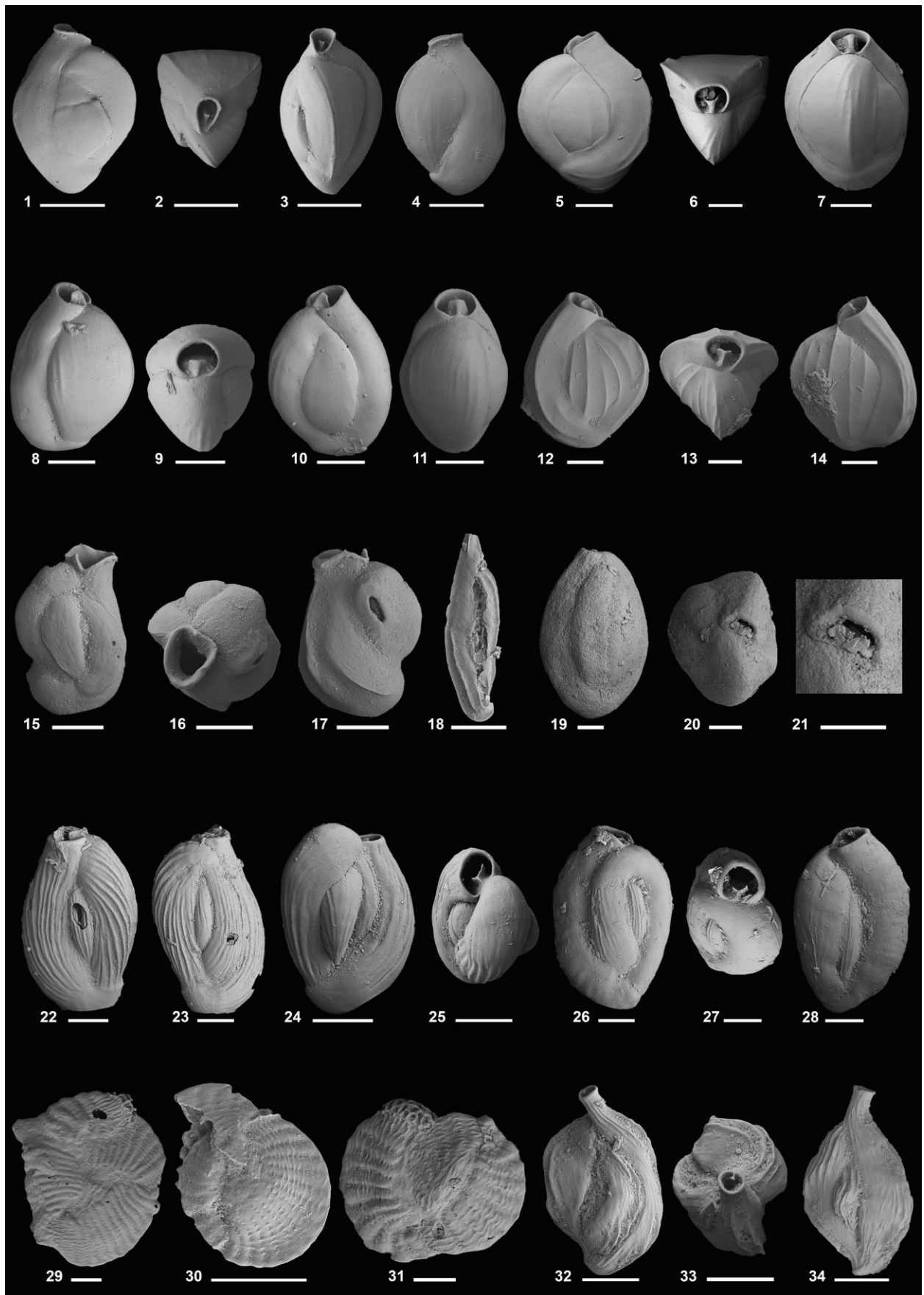


PLATE 26

Scale bar is 100µm for all magnifications except otherwise stated.

1-5: *Sigmoilinella* sp. 1

6-8: *Sigmoilinita costata* (Schlumberger)

9, 10: *Spirosigmoilina bradyi* Collins

11, 12: *Spirosigmoilina parri* Collins

13, 14: *Articulina pacifica* Cushman

15, 16: *Articulina sagra* d'Orbigny

17, 18: *Articulina queenslandica* Collins

19-21: *Sigmoilopsis elliptica?* (Galloway and Wissler)

22-24: *Miliola sublineata* (Brady)

25, 26: *Pseudohauerinella dissidens* (McCulloch)

27, 28: *Pseudohauerina orientalis* (Cushman)

29: *Pseudohauerina* sp. 1

30-32: *Borelis schlumbergeri* (Reichel)

33, 34: *Coscinospira hemprichi* Ehrenberg

PLATE 26

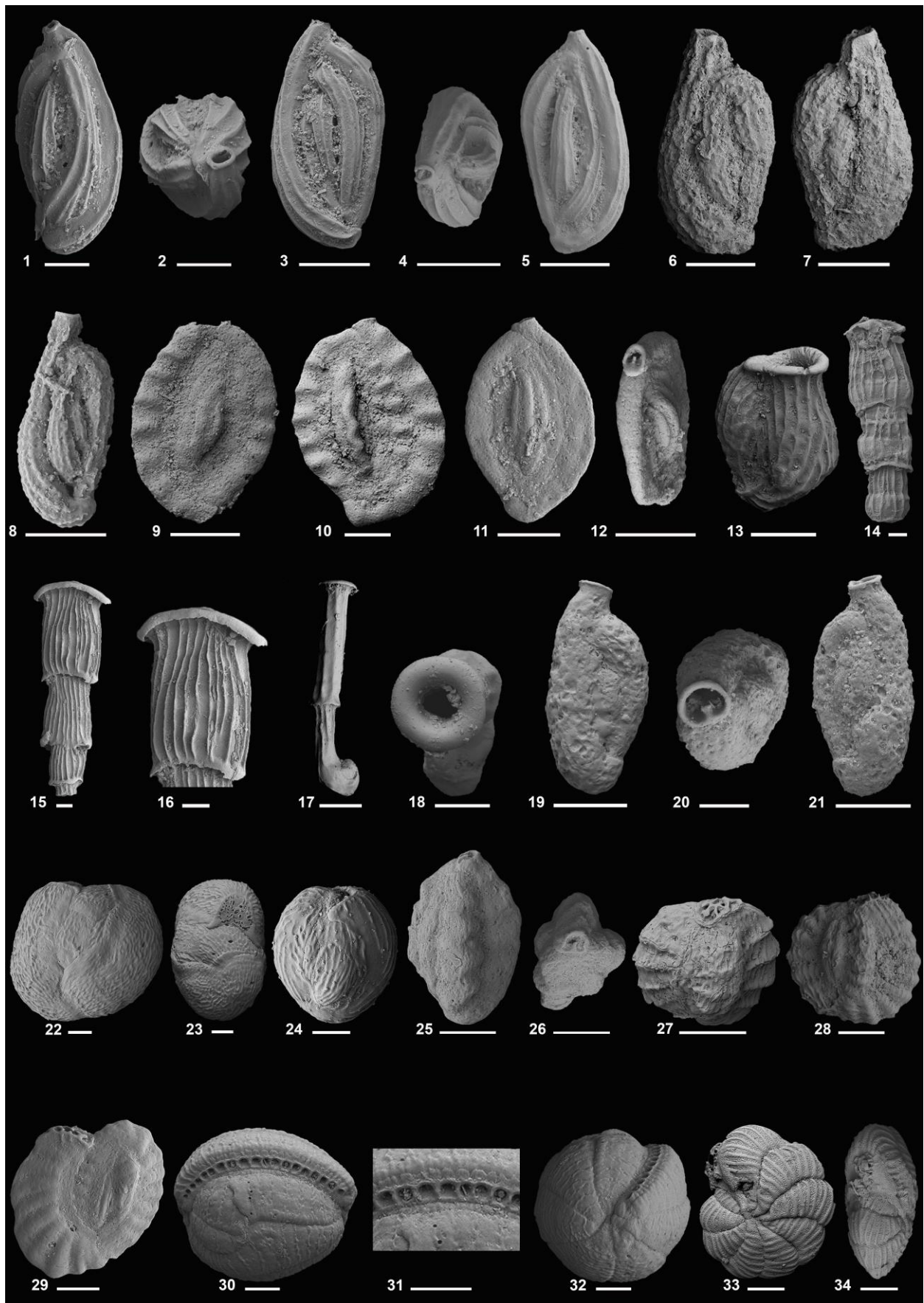


PLATE 27

Scale bar is 100µm for all magnifications except otherwise stated.

1. 2: *Euthymonacha polita* (Chapman)

3-7: *Monalysidium acicularis* (Batsch)

8-13: *Peneroplis arietina* (Batsch)

14-19: *Parasorites orbitolitoides* (Hofker)

20-24: *Parasorites cf. P. orbitolitoides* (Hofker)

25-30: *Sorites orbiculus* (Forskål)

PLATE 27

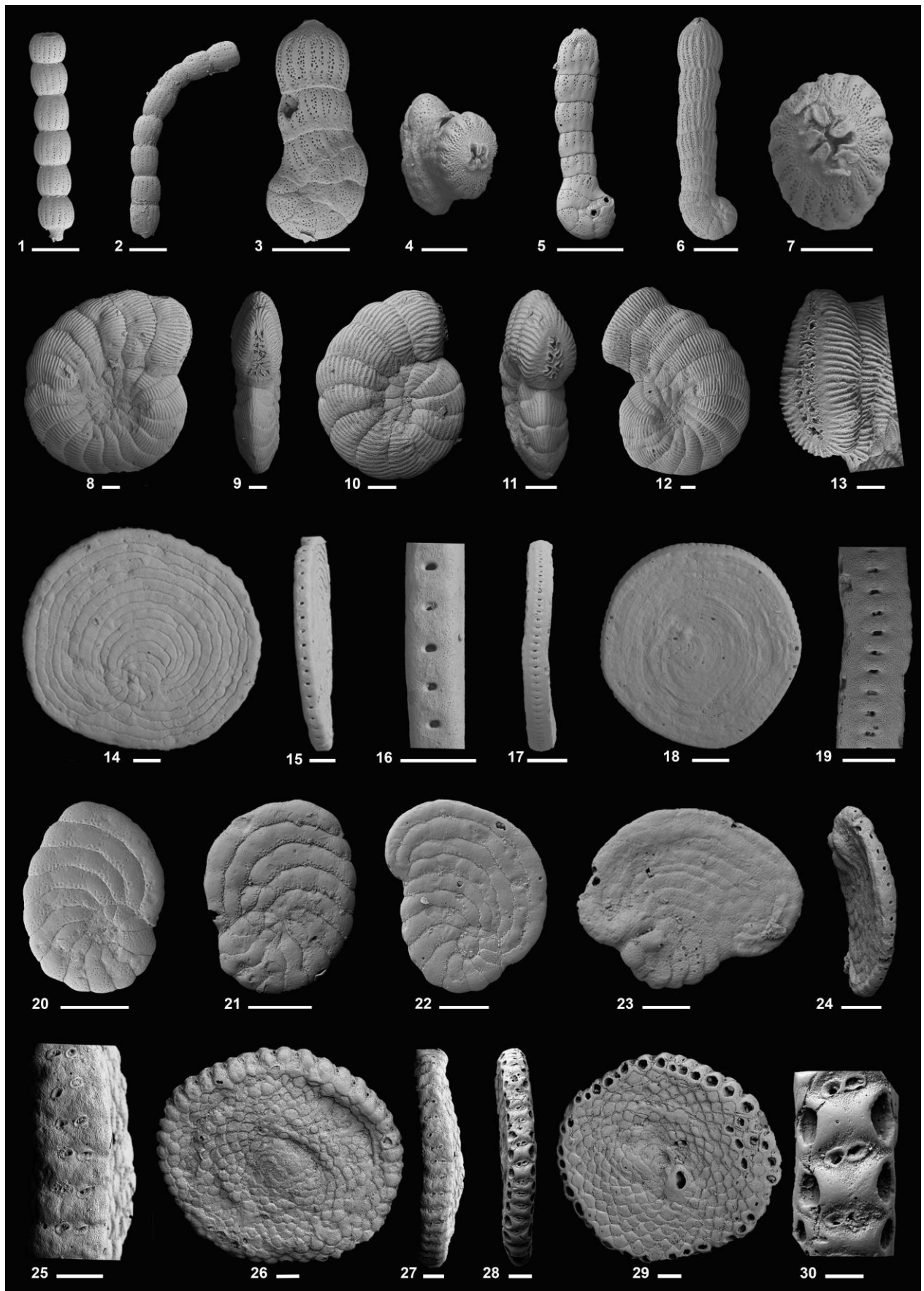


PLATE 28

Scale bar is 100µm for all magnifications except otherwise stated.

1-3: *Discorinopsis aguayoi* (Bermudez)

4, 5: *Lenticulina* sp.

6, 7: *Lagena spicata* Cushman & McCulloch

8: *Lagena strumosa* Reuss

9, 10: *Procerolagena oceanica* (Albani)

11, 12: *Krebsina subtenuis* (Cushman)

13-18: *Euglandulina striatula*

19-21: *Euglandulina* sp. 1

22, 23: *Oolina* aff. *O. stellula* (Loeblich & Tappan)

24-26: *Fissurina lucida* Williamson

27, 28: *Palliolatella fasciata carinata* (Sidebottom)

29, 30: *Buchnerina lacunata* (Burrows & Holland) (50µm)

31-33: *Buchnerina* sp. 1.

34, 35: *Buchnerina* sp. 2.

PLATE 28

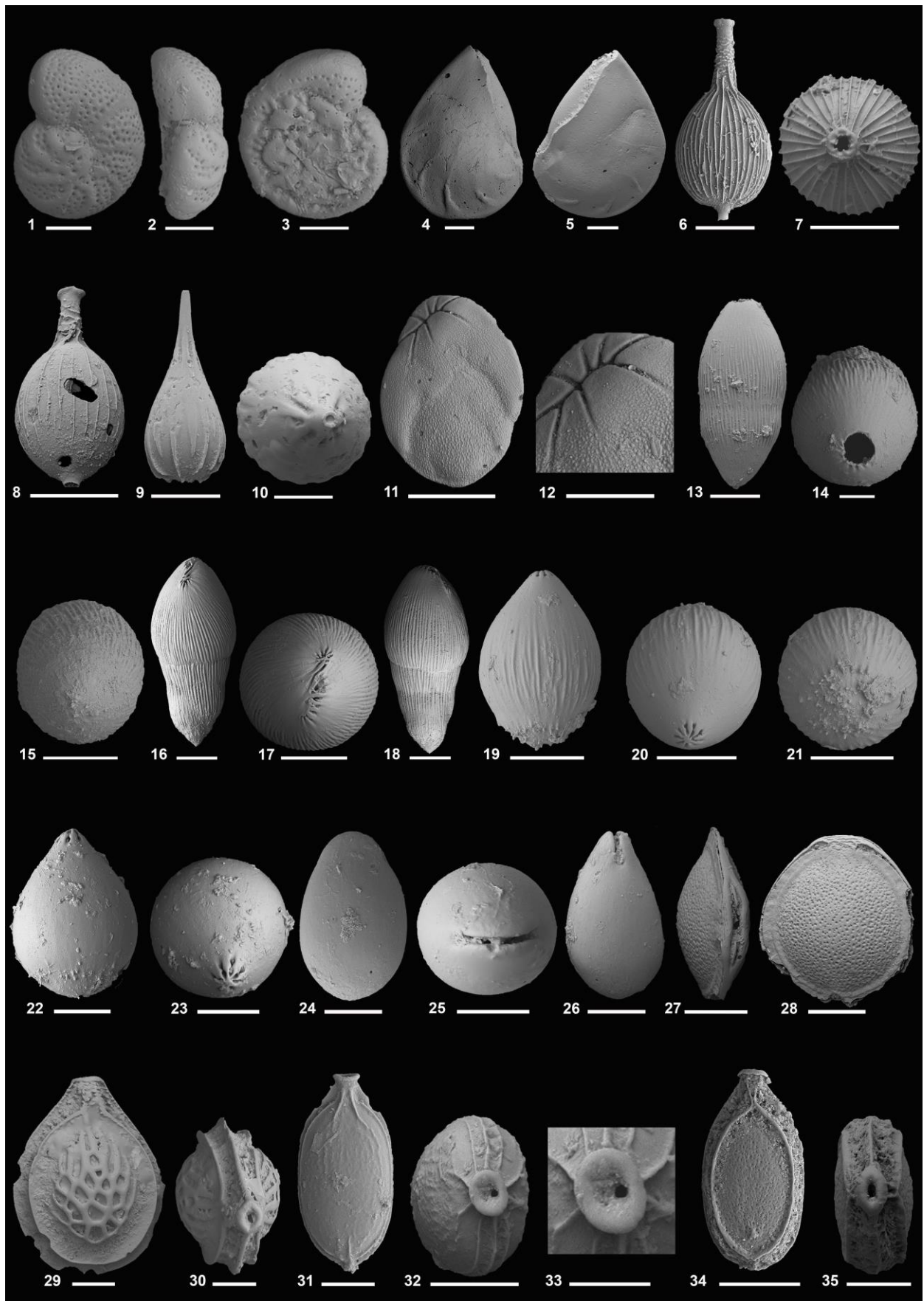


PLATE 29

Scale bar is 100µm for all magnifications except otherwise stated.

1, 2: *Abditodentrix rhomboidalis* (Millett)

3-5: *Bolivina striatula* Cushman

6, 7: *Bolivina* aff. *B. striatula* Cushman

8-10: *Bolivina variabilis* (Williamson)

11, 12: *Bolivinella elegans* Parr

13, 14: *Globocassidulina crassa*, (d'Orbigny) (50µm)

15, 17: *Globocassidulina subglobosa* (Brady) 13, 14 (50µm)

18-20: *Cassidelina* sp. 1

21-25: *Hopkinsinella glabra* (Millett) 10, 11(50µm)

26-28: *Loxostomina limbata* (Brady)

29, 30: *Loxostomina mayori* (Cushman)

31, 32: *Rectobolivina?* sp. 1

33-35: *Sagrinella convallaria* (Millett)

36-38: *Saidovina carinata* (Millett)

PLATE 29

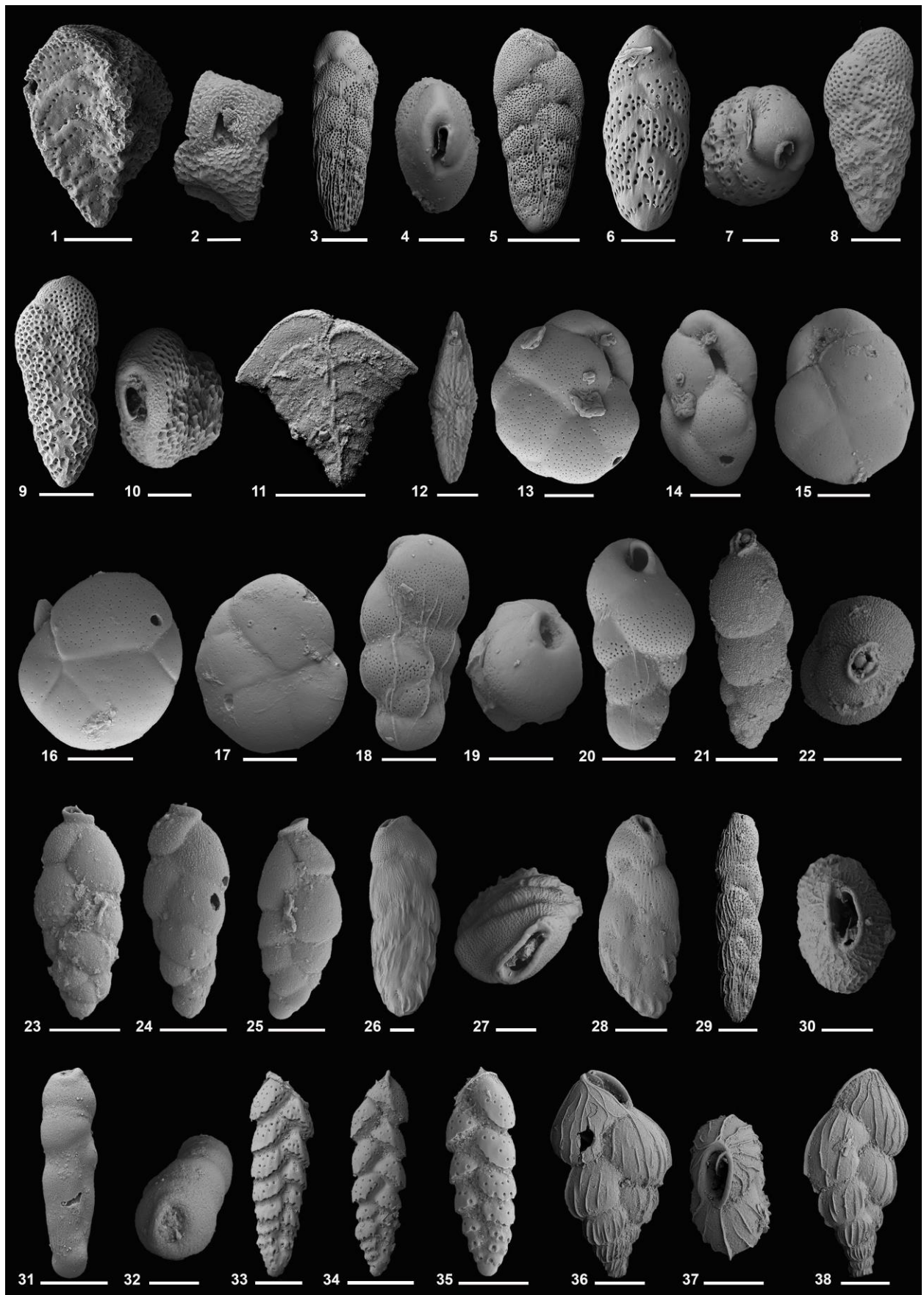


PLATE 30

Scale bar is 100µm for all magnifications except otherwise stated.

1-4: *Saidovina karrerianum* Collins

5-7: *Saidovina* sp. 1

8: *Sagrinopsis fimbriata* (Millett) (50µm)

9, 10: *Siphogenerina raphana*, (Parker & Jones,)

11, 12: *Siphogenerina striata* (Schwager)

13, 14: *Siphogenerina* sp. 1

15-17: *Alasoida virgula* (Brady)

18, 19: *Bulimina* sp. 1 (50µm)

20: *Buliminella elegantissima* (d'Orbigny)

21-23: *Trifarina angulosa* Cushman

24, 25: *Fijiella simplex* (Cushman)

26, 27: *Reussella pacifica* Cushman & McCulloch

28, 29: *Mimosina affinis* (50µm)

30-34: *Mimosina spinulosa* Millett

35-40: *Fursenkoina schreibersiana* (Czjzek) (50µm)

PLATE 30

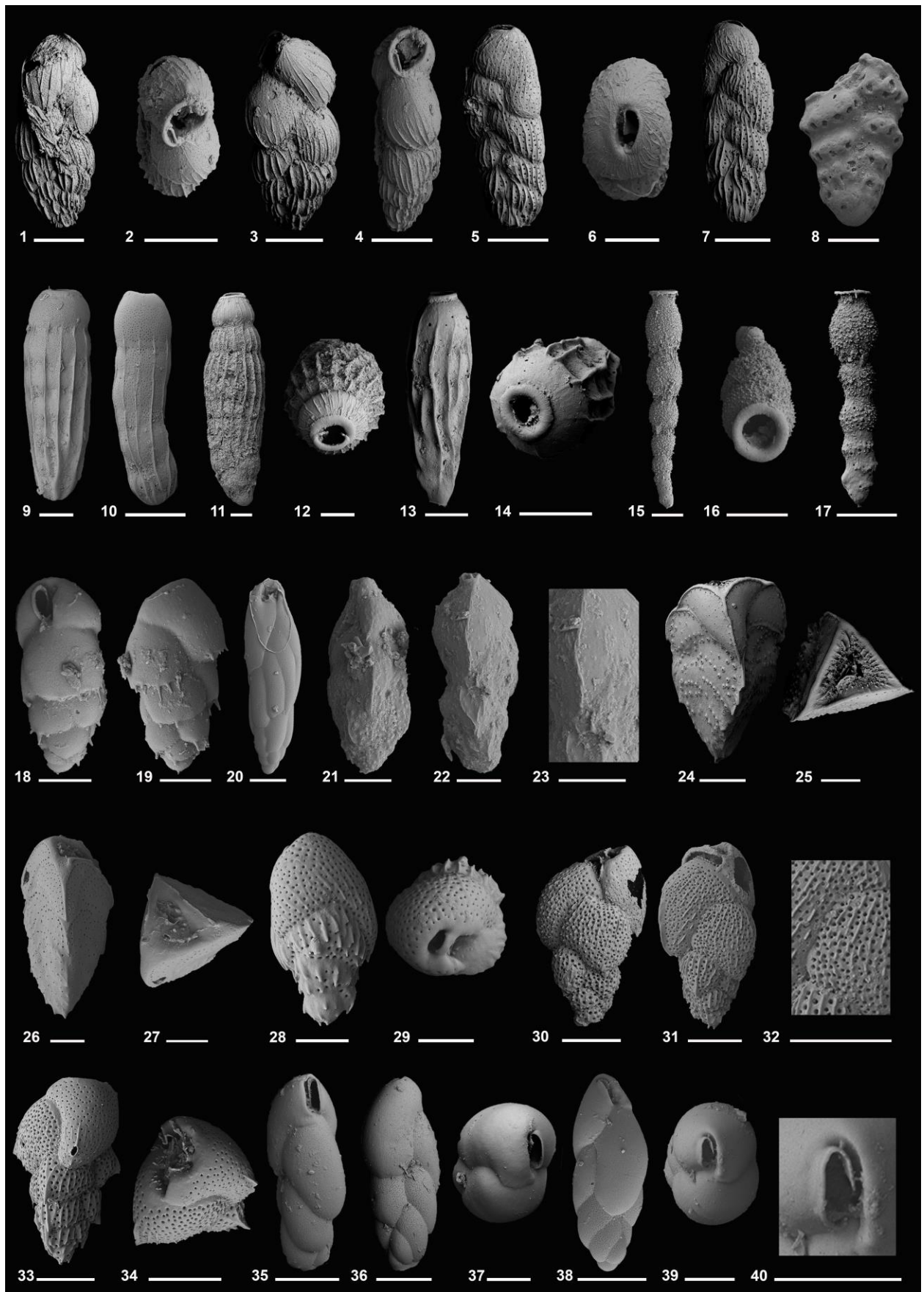


PLATE 31

Scale bar is 100µm for all magnifications except otherwise stated.

1, 2: *Sigmavirgulina tortuosa* (Brady)

3-5: *Baggina phillipinensis* (Cushman)

6-9: *Cancris auriculus* (Fichtel and Moll)

10-12: *Valvulineria* aff. *V. minuta* (Schubert)

13-18: *Eponides repandus* (Fichtel and Moll)

19-21: *Poroeponides lateralis* (Terquem)

22-25: *Helenina* sp. 1

26-28: *Rhaptohelenina* sp. 1

29-31: *Rotorbis auberii* (d'Orbigny)

32-35: *Neoconorbina* sp. 1.

PLATE 31

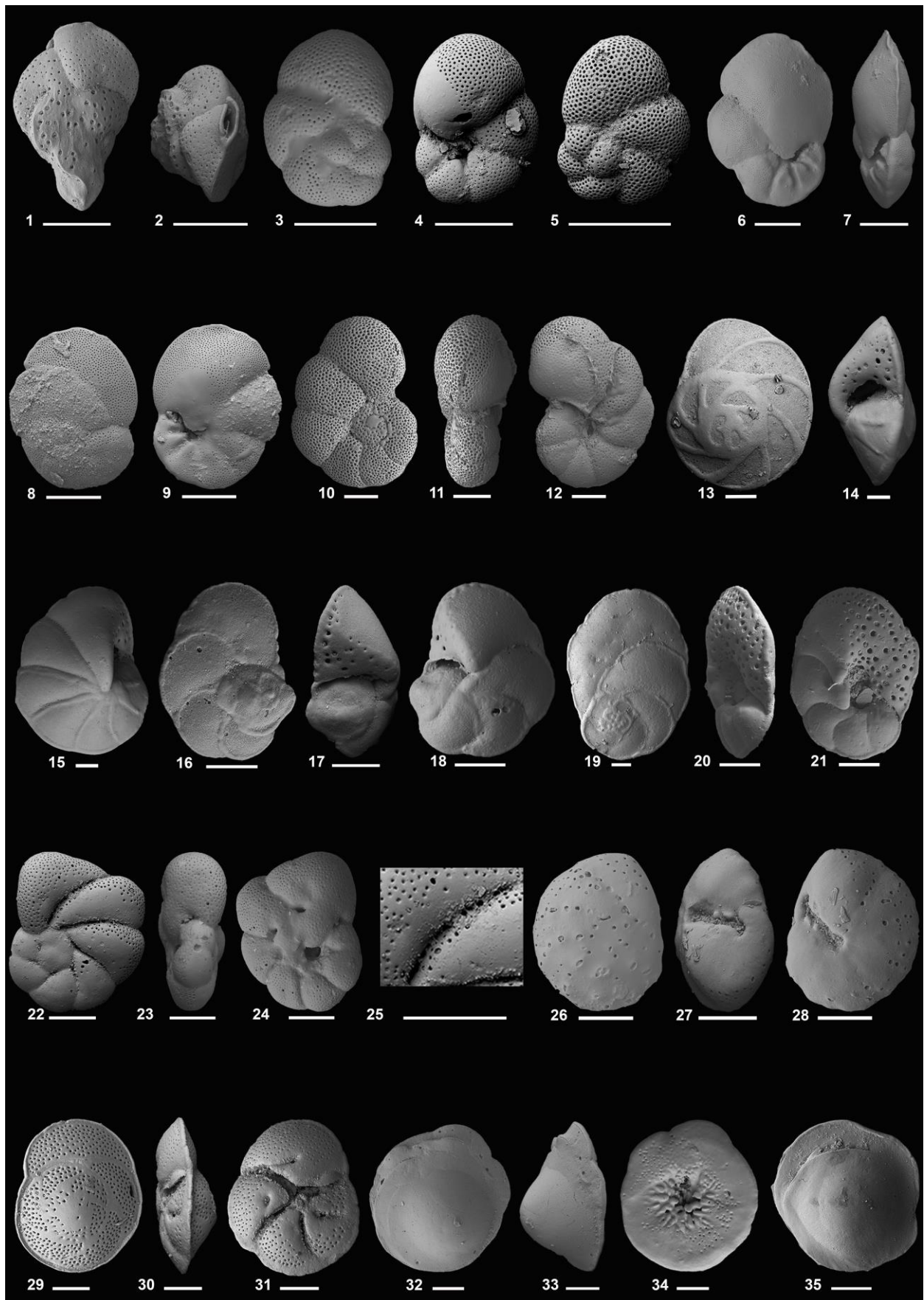


PLATE 32

Scale bar is 100µm for all magnifications except otherwise stated.

1-4: *Neoconorbina* sp. 2

5-9: *Rosalina bradyi* (Cushman)

10-14: *Rosalina floridana* (Cushman)

15-17: *Rosalina globularis* d'Orbigny

18-21: *Rosalina* sp. 1.

22-24: *Rosalina* sp. 2

25-28: *Rotorboides granulatus* (Heron-Allen and Earland)

29-32: *Tretomphalus bulloides* (d'Orbigny)

33-35: *Bronnimannia haliotis* (Heron-Allen and Earland)

PLATE 32

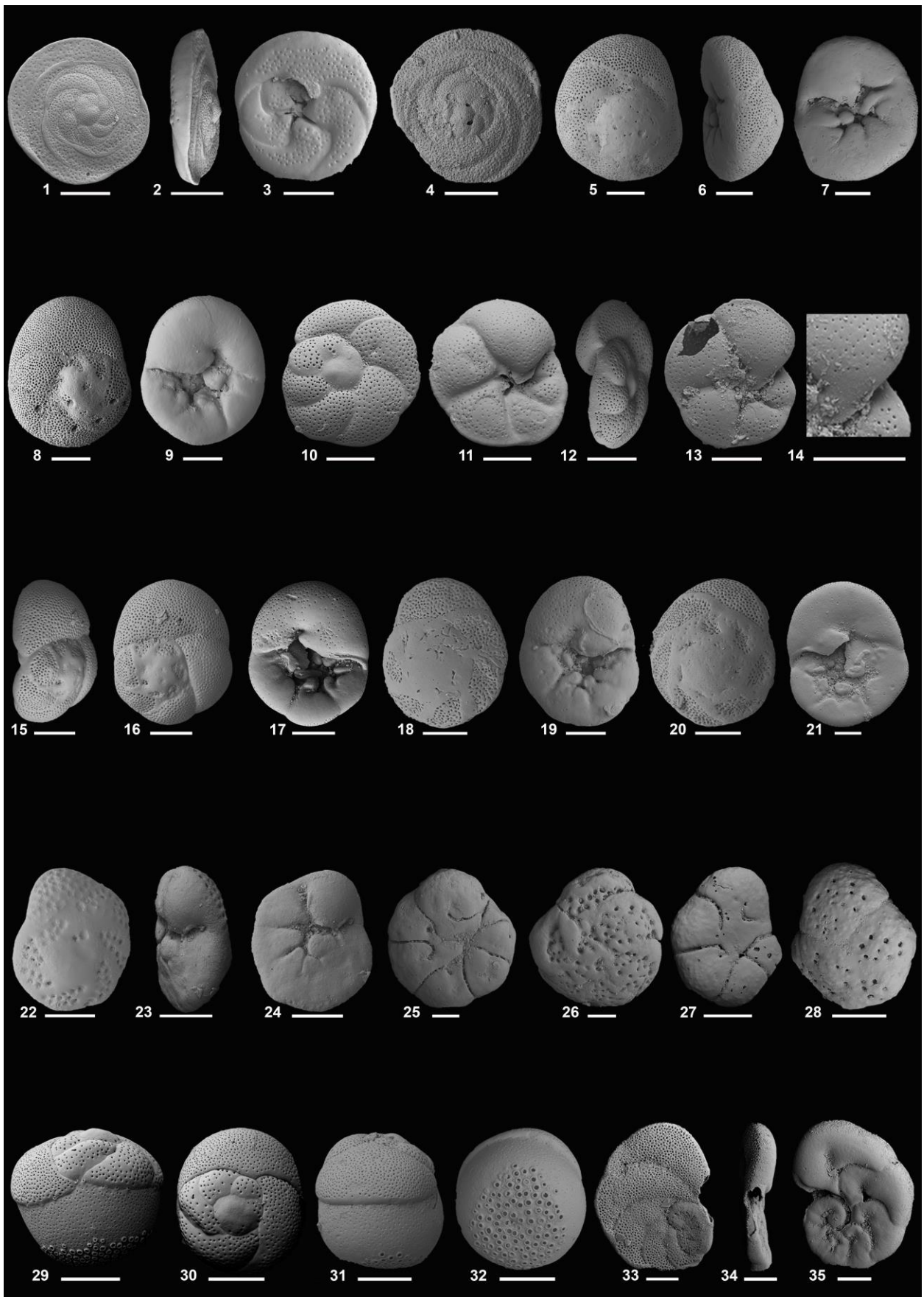


PLATE 33

Scale bar is 100µm for all magnifications except otherwise stated.

1, 2: *Murrayinella murrayi* (Heron-Allen and Earland)

3, 4: *Elongobula milletti* (Cushman) 3 (50µm)

5-8: *Elongobula parallela*, (Cushman and Parker) 5 (50µm)

9-12: *Siphonina tubulosa* Cushman

13-15: *Discorbinella bertheloti* (d'Orbigny)

16-22: *Cibicides mabahethi* Said

23-29: *Cibicides phillipinensis* Collins

30-35: *Cibicides pseudolobatulus* Perelis & Reiss

PLATE 33

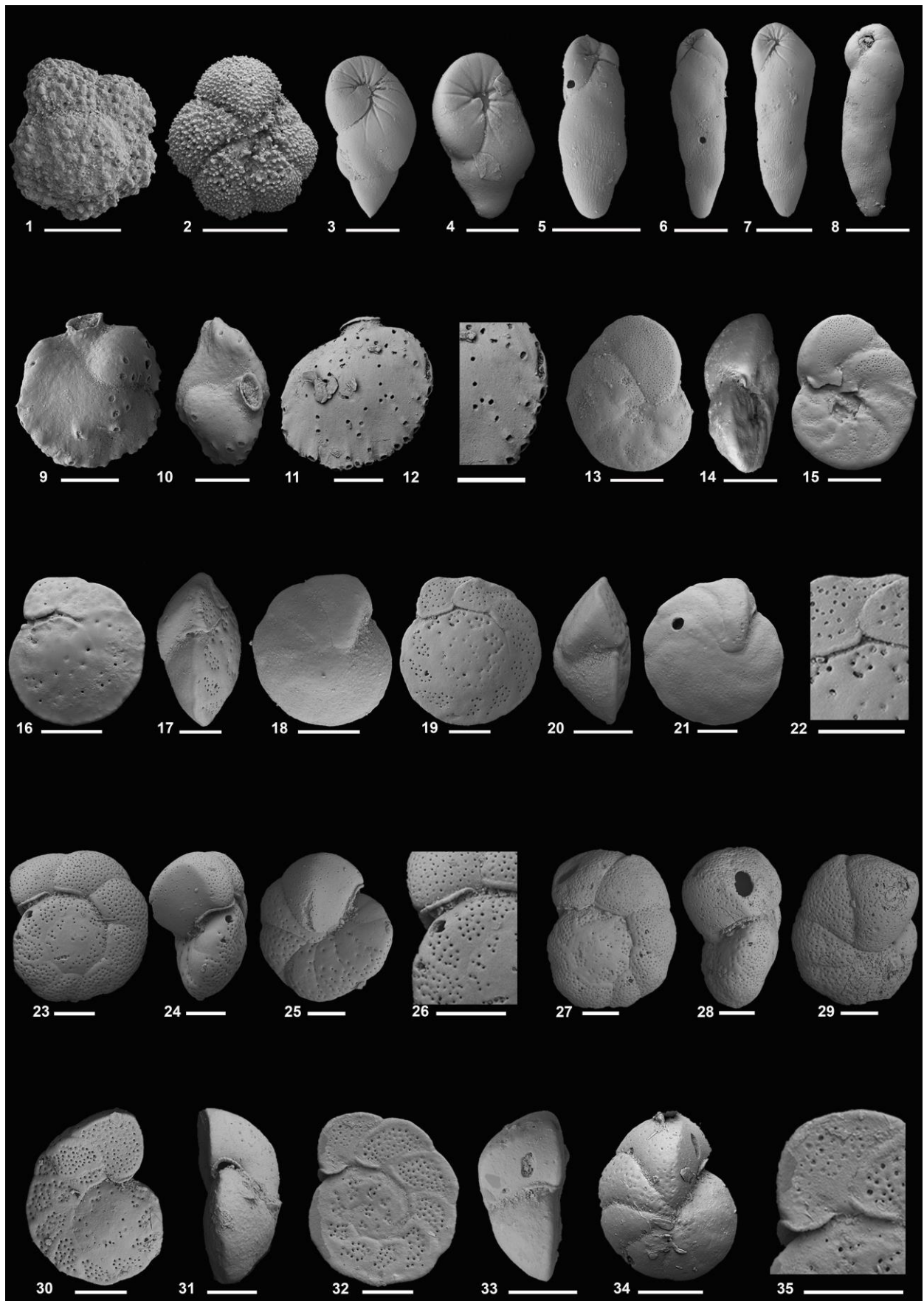


PLATE 34

Scale bar is 100µm for all magnifications except otherwise stated.

1-3: *Lobatula lobatula* (Walker and Jacob)

4-7: *Lobatula mayori* (Cushman)

8-10: *Planorbulina* sp. 1

11, 12: *Planorbulina* sp. 2

13-17: *Cymbaloporella tabellaeformis* (Brady)

18, 19: *Cymbaloporetta* sp. 1,

20-25: *Cymbaloporetta* sp. 2.

26-28: *Cymbaloporetta* sp. 3.

29-31: *Millettiana milletti* (Heron-Allen and Earland)

PLATE 34

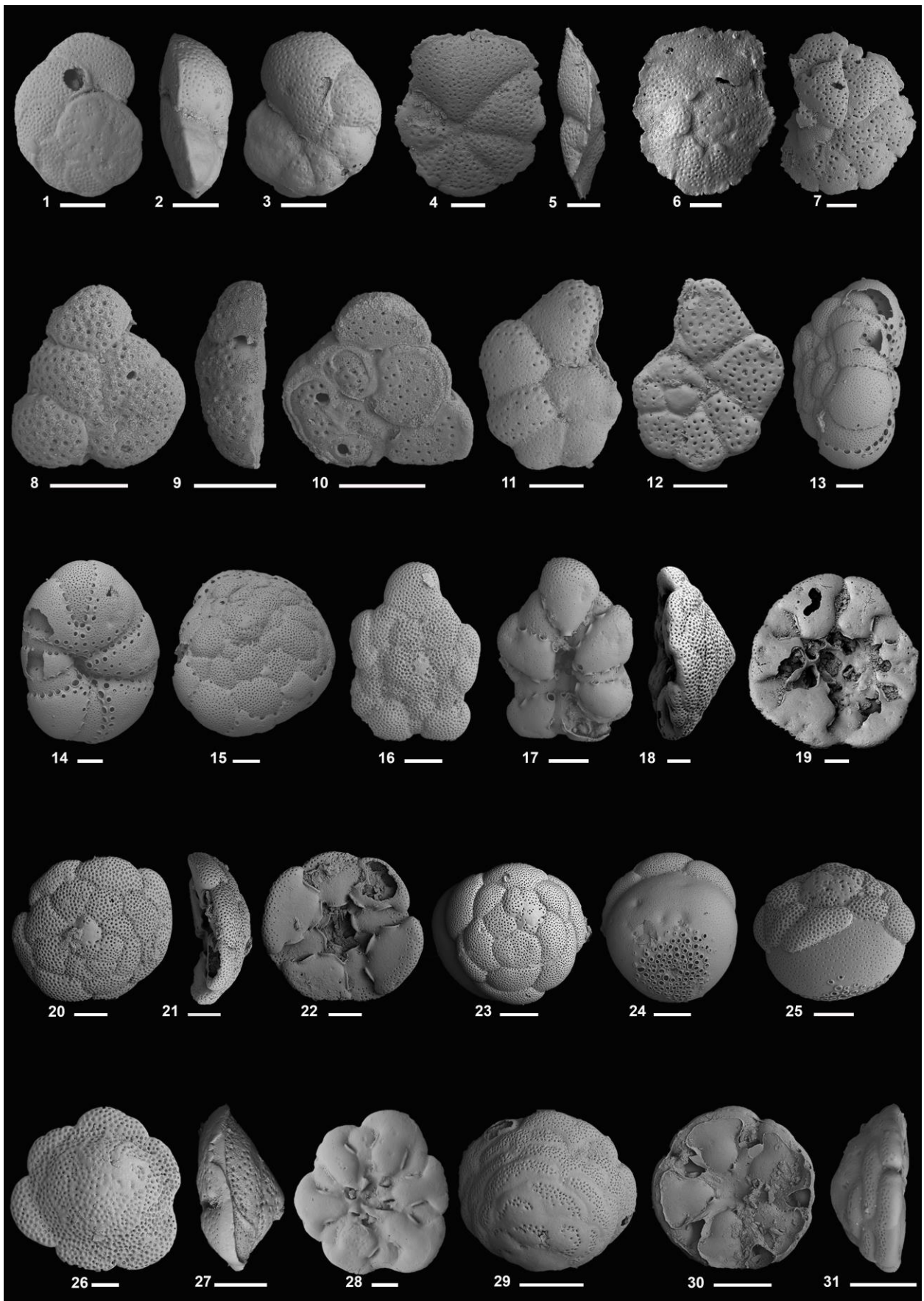


PLATE 35

Scale bar is 100µm for all magnifications except otherwise stated.

1-14: *Acervulina mabahethi* (Said)

15-17: *Planogypsina acervalis*, (Brady)

18, 19: *Sphaerogypsina globula* (Reuss)

20: *Homotrema rubra* (Lamarck)

21-23: *Monspensilina* sp.1

24-29: *Amphistegina lessonii* d'Orbigny

30-34: *Amphistegina* cf. *A. papillosa* Said

PLATE 35

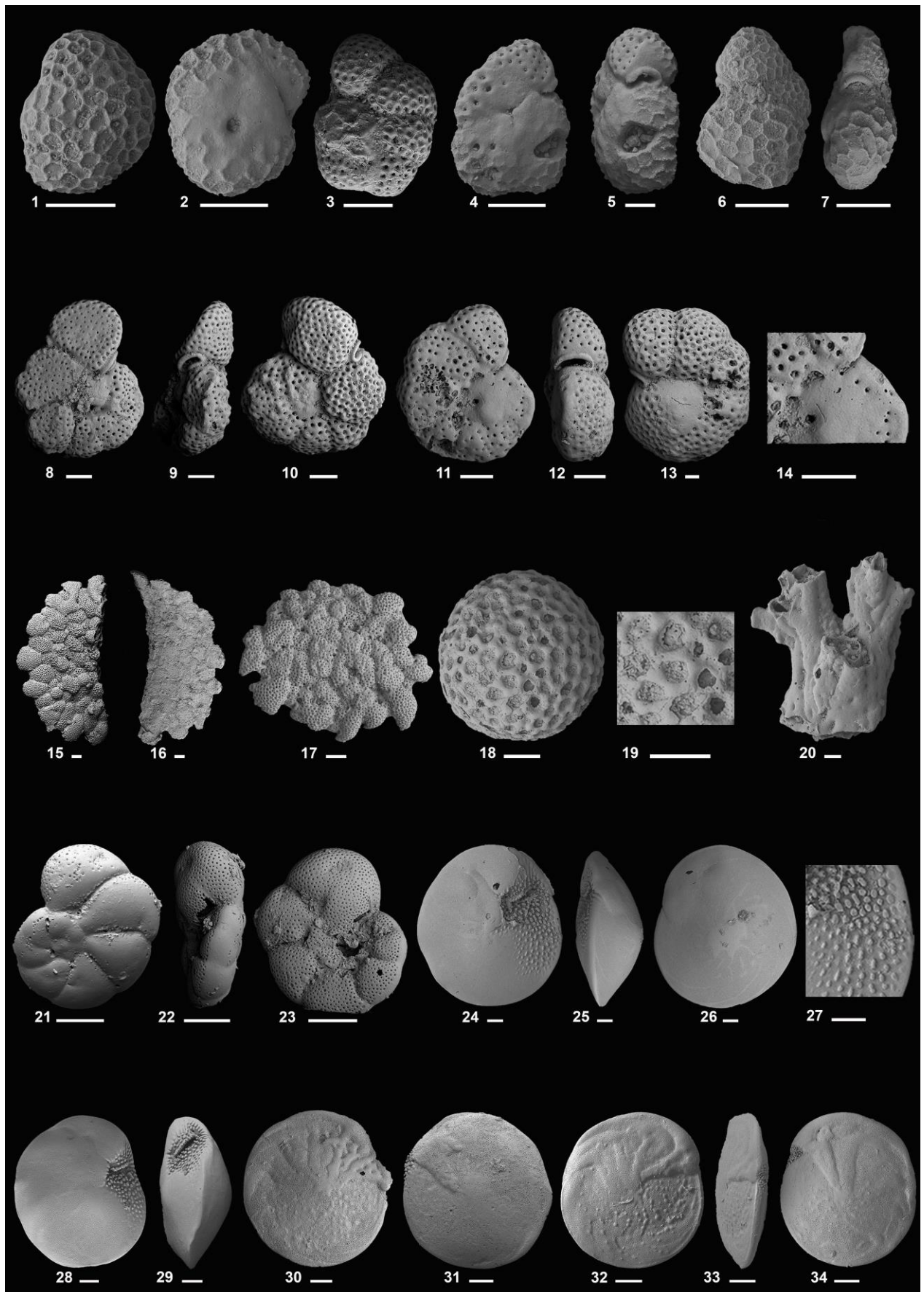


PLATE 36

Scale bar is 100µm for all magnifications except otherwise stated.

1-5: *Haynesina depressula* (Walker & Jacob)

6, 7: *Nonion subturgidum* Loeblich & Tappan

8-10: *Nonion* sp. 1

11-14: *Nonion* sp. 2

15-21: *Nonionoides grateloupi* (d'Orbigny)

22, 23: *Pseudononion granulumbilicatum* Zheng

24-28: *Anomalinella rostrata* (Brady)

29-31: *Anomalinoides* sp. 1

32-35: *Anomalinoides* sp. 2

PLATE 36

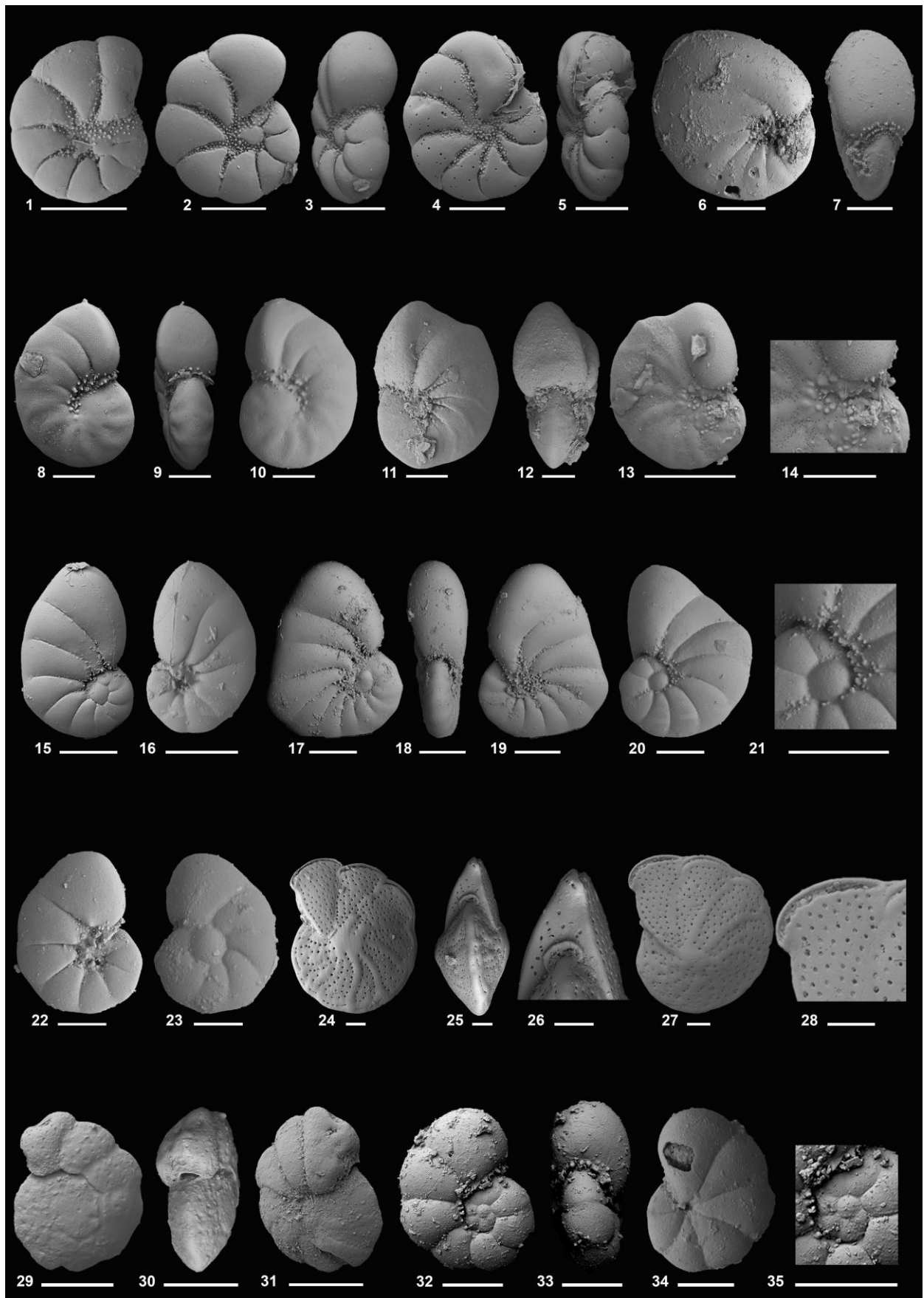


PLATE 37

Scale bar is 100µm for all magnifications except otherwise stated.

1-3: *Anomalinulla glabrata* (Cushman)

4-7: *Anomalinulla* sp. 1

8-10: *Hanzawaia grosepunctata?* (Earland)

11-14: *Ammonia convexa* Collins

15-18: *Ammonia tepida* (Cushman)

19-24: *Porosononion* sp. 1

25-28: *Elphidium botaniense* Albani

29-31: *Elphidium Clavatum* Cushman

32-34: *Elphidium lene* Cushman & McCulloch 32, 33 (50µm)

35: *Elphidium maorium* Hayward

PLATE 37

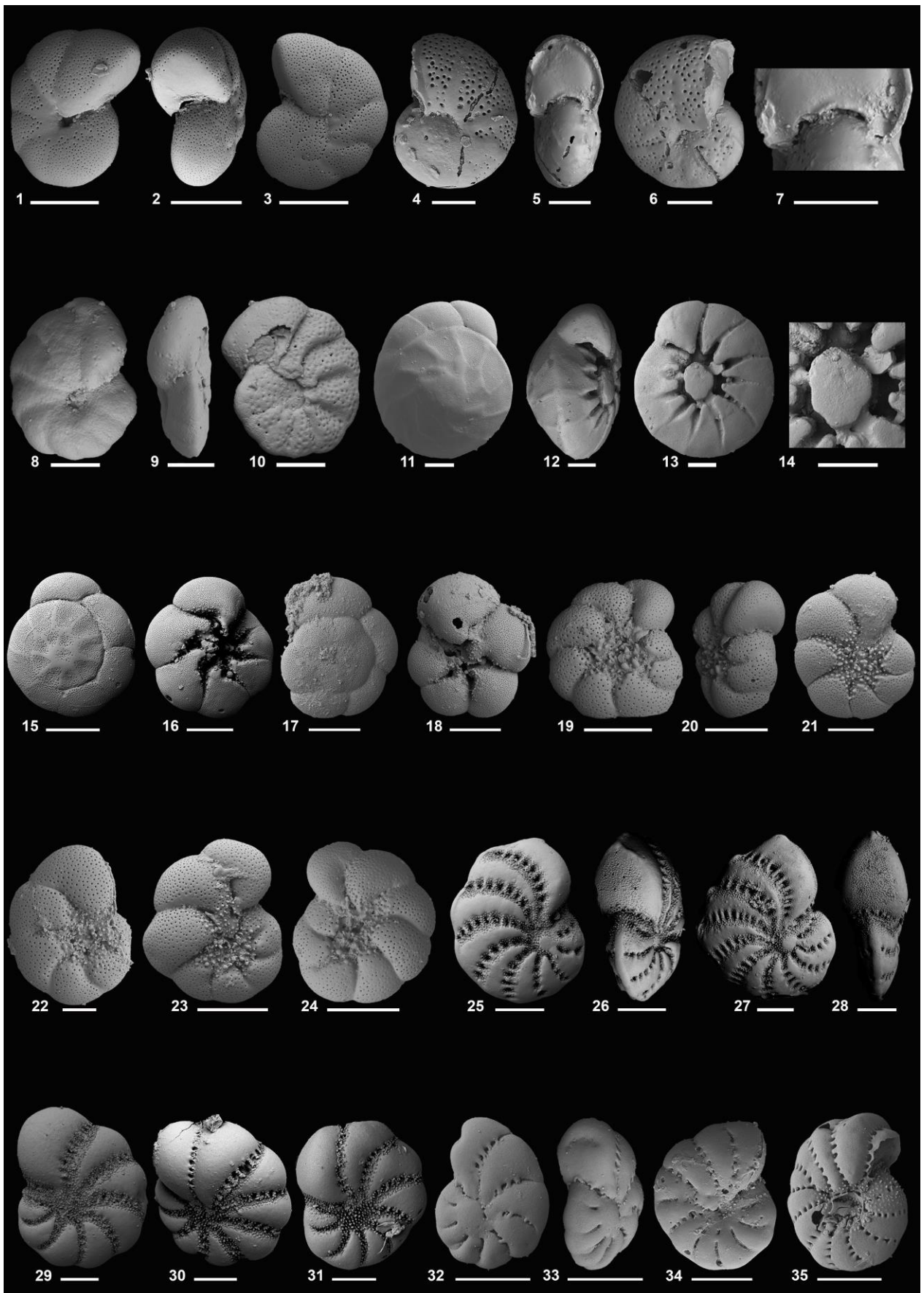


PLATE 38

Scale bar is 100µm for all magnifications except otherwise stated.

1-4: *Elphidium milletti* (Heron-Allen & Earland)

5-7: *Elphidium oceanicum* Cushman

8-10: *Elphidium* cf. *E. pseudonodosum* Langer

11-14: *Elphidium* cf. *E. sagrum* (d'Orbigny)

15, 16: *Elphidium simplex* Cushman

17, 18: *Elphidium toddi* Langer

19-21: *Elphidium tongaensis* (Cushman)

22-25: *Elphidium williamsoni* Haynes

26-28: *Elphidium* cf. *E. williamsoni* Haynes

29-36: *Assilina ammonoides* (Gronovius).

PLATE 38

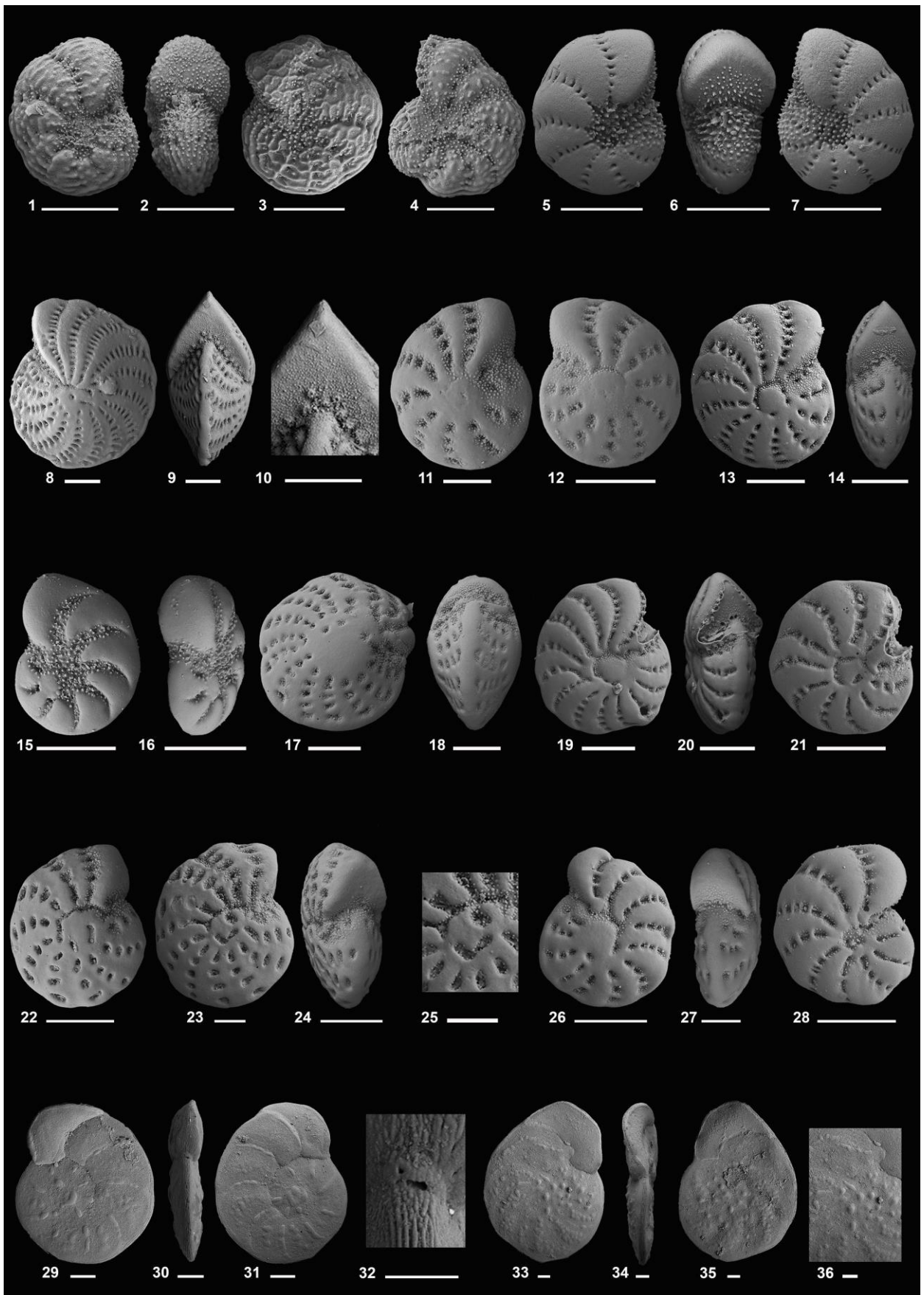


PLATE 39

Scale bar is 100µm for all magnifications except otherwise stated.

1-3: *Heterostegina curva* Moebius.

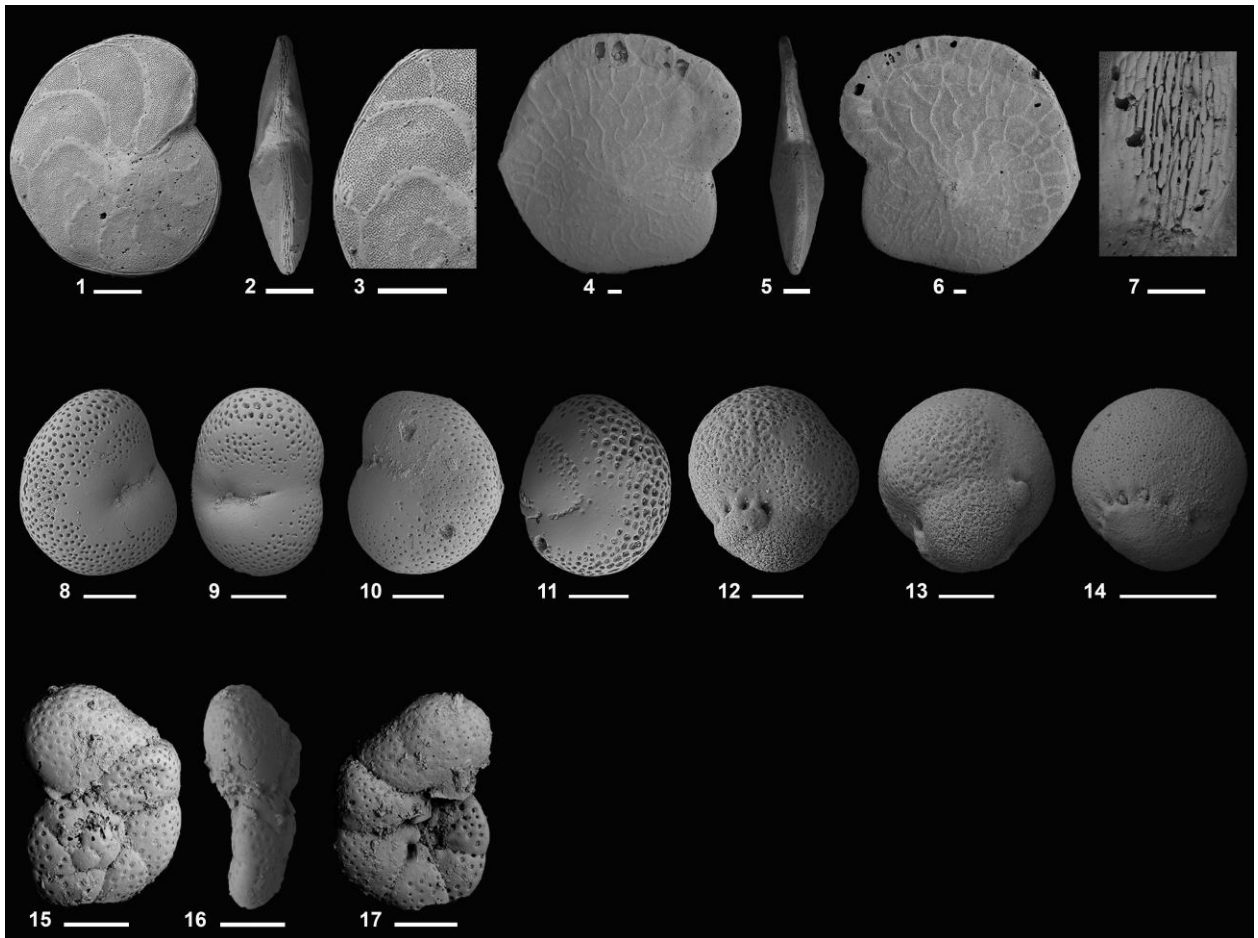
4-7: *Heterostegina depressa* d'Orbigny

8-11: *Cibrobaggina reniformis* (Heron-Allen & Earland) (50µm)

12-14: *Stictogongylus rugata* (Heron-Allen & Earland) (50µm)

15-17: Genus 1 sp. 1

PLATE 39



7. Conclusion

The foraminifera assemblage cutting across reefal and lagoonal sites were studied in Moorea Island, Polynesia. This is the most extensive investigation of benthic foraminifera from shallow-water nearshore and reefal environments around Moorea. A total of 364 species has been recorded; a number that more than doubles previously documented inventories of species counts. The benthic foraminifera around Moorea have large-scale spatial distribution patterns of habitat specific assemblages which can be used to find oil reservoirs in fossil reef settings. These habitat preferences are also reflected in abundance patterns of individual species, genera and functional groups. Diversity gradients generally increase from bay inlets to the reef barrier, but highest species richness is in fringing reefs, an area that represents a mosaic of habitats. The abundance of functional groups of foraminifera (symbiont-bearing, heterotrophic, opportunistic) together with Foraminiferal Index (FI) calculations identified environments suitable and critical to support calcifying symbiosis and carbonate accretion. FI indicate that the innermost bays and some outer bay fringing reef habitats are under direct natural and anthropogenic influences. While Moorean reefal foraminifera deserve more scientific attention, particularly acquisition of more quantitative data, our findings are sufficient for monitoring rising influences of natural events and anthropogenic activities. Future changes can be compared with our baseline data from 1992 and the development of those changes over time can be determined by collecting dead specimens from particular time periods. In addition, as global warming, anoxia and acidification of the oceans increase, foraminifera can provide rapid indication of these worldwide changes as well as local ones such as pollution, impacts on reefs due to industrial development and tourist activities.

In a similar manner, the shallow coastal sites in Gabonese waters also yielded benthic foraminiferal communities with diverse assemblages of modern benthic foraminiferal representing a diversified and unique community structure. The presence of abundant symbiont-bearing taxa, in addition to the species richness recorded, indicate, that the coastal sites investigated remained largely unaffected by offshore drilling activities. The shallow-water benthic foraminiferal assemblages from equatorial Gabon differ markedly from tropical foraminiferal biotas of southern Africa implying a biogeographic barrier that separates biotas in close geographic proximity. Moreover, the composition and vertical zonation of modern benthic foraminifera was studied at two intertidal mangrove environments in the Akanda National Park, Gabon. A total of twenty-one benthic foraminiferal species were recorded and numerical analyses indicate two faunal zones that are restricted to elevation. The muddy substrate around *Avicennia germinans* mangroves is characterized with low-diverse agglutinated foraminiferal

assemblage, dominated by *Ammotium salsum* and *Ammobaculites pseudospirale*. This assemblage is composed of agglutinated taxa only and is indicative for High Mean Water Neap Tide elevations. A moderately diverse assemblage of agglutinated and calcareous foraminifera was recovered from around *Rhizomosa racemose* stands and represents biotas at Mean Low Water Neap Tide elevation. The assemblage is dominated by species of *Miliammina*, *Arenoporella mexicana*, *Ammotium salsum* and *Astrononion stelligerum*. The study is the first survey of mangrove foraminifera from Gabon.

The investigation of foraminifera, thecamoebians and diatoms within the Ologe Lagoon settings of southwestern Nigeria revealed that the lagoon is currently undergoing rising anthropogenic threats. The composition, species richness and spatial distribution of foraminifera, thecamoebian and diatom assemblages indicating the current situation of the lagoon were adequately documented. The diversity is low but harbor unique assemblages of species that differ from other nearshore coastal environments in this region. Habitat preferences are indicated for selected species as documented by numerical abundance records, spatial distribution patterns and principal component analysis. The potential of meiofauna studies as tool for environmental biomonitoring was highlighted by the resulting patterns of distribution which in turn is attributed to proximity and tolerance levels of individual species.

8. References

- Adegoke, O. S. 1975. Foraminifera fauna of the polyhaline lagoons of the Gulf of Guinea. *Journal of Mining and Geology* 12, 1 - 8.
- Adegoke, O. S., Omatsola, M. E., Salami, M. B. 1976. Benthic Foraminifera Biofacies, off the Niger Delta. *Maritime Sediments Special Publication*, 1: 279-292.
- Adjeroud, M. 1997. Factors influencing spatial patterns on coral reefs around Moorea, French Polynesia. *Mar Ecol-Prog Ser.* 159: 105–119.
- Adjeroud, M., Augustin, D., Galzin, R., Salvat, B. 2002. Natural disturbances and interannual variability of coral reef communities on the outer slope of Tiahura (Moorea, French Polynesia): 1991 to 1997. *Mar Ecol Prog Ser.* 237: 121–131.
- Adjeroud, M., Chancerelle, Y., Schrimm, M., Perez, T., Lecchini, D., Galzin, R., Salvat, B. 2005. Detecting the effects of natural disturbances on coral assemblages in French Polynesia: A decade survey at multiple scales. *Aquat Living Resour.* 18: 111–123.
- Adjeroud, M., Penin, L., Carroll, A. 2007a. Spatio-temporal heterogeneity in coral recruitment around Moorea, French Polynesia: Implications for population maintenance. *J Exp Mar Biol Ecol.* 341: 204–218.
- Adjeroud, M., Pratchett, M. S., Kospartov, M. C., Lejeusne C., Penin, L. 2007b. Small-scale variability in the size structure of scleractinian corals around Moorea, French Polynesia: patterns across depths and locations. *Hydrobiol.* 589: 117–126.
- Albani, A. D., 1968. Recent Foraminiferida from Port Hacking, New South Wales. *Contributions from the Cushman Laboratory for Foraminiferal Research*, 19: 85-119.
- Albani, A. D. 1974. New benthonic foraminiferida from Australianwaters. *Journal of Foraminiferal Research*, 4 35-37.
- Albani, A. D. 1981. Pleistocene foraminifera from Botany Bay, New South Wales. *Alcheringa*, 5: 147-160.
- Albani, A. D., Yassini, I. 1989. Taxonomy and distribution of shallow-water lagenid Foraminiferida from the southeastern coast of Australia. *Australian Journal of Marine and Freshwater Research*, 40: 369-401.
- Alve, E. 1991. Benthic foraminifera reflecting heavy metal pollution in Sørkjord, Western Norway. *Journal of Foraminiferal Research* 34, 1641–1652.
- Alve, E. 1995. Benthic foraminifera response to estuarine pollution: a review. *Journal of Foraminiferal Research* 25, 190-203.
- Alve, E., Nagy, J., 1986. Estuarine foraminiferal distribution in Sandebukta, a branch of the Oslo Fjord *Journal of Foraminiferal Research*, v. 16, p. 261-284.
- Andersen, H. V. 1961. Genesis and paleontology of the Mississippi River mudlumps, Part II. Foraminifera of the mud lumps, lower Mississippi River delta. *Louisiana Department of Conservation. Geological Bulletin* 35: 1-208,

- Archibald, R. E. M. 1983. The diatoms of the Sundays and Great Fish Rivers in the Eastern Cape Province of South Africa. *Bibliotheca Diatomologica* 1, 1-362.
- Armstrong, H.A., Brasier, M. D. 2005. Microfossils – Blackwell Publishing, Oxford, 279pp.
- Armynot du Châtelet, E., Degré, D., Sauriau, P.-G., Debenay, J.-P. 2009. Distribution of living benthic foraminifera in relation with environmental variables within the Aiguillon cove (Atlantic coast, France): improving knowledge for paleoecological interpretation. *Bulletin de la Société Géologique de France* 180, 93-104.
- Asano, K. 1936. Fossil foraminifera from Muraoka-mura, Kamakura-gori, Kanagawa Prefecture. *Journal of the Geological Society of Japan*, 43: 603-615.
- Asano, K. 1951a. "Part 13: Anomalinidae". In Stach L. W. (ed.): *Illustrated catalogue of Japanese Tertiary smaller foraminifera*, Tokyo, Hosokawa Printing Co: 12-19.
- Asano, K. 1951b. "Part 6: Miliolidae". In Stach L. W. (ed.): *Illustrated catalogue of Japanese Tertiary smaller foraminifera*, Tokyo, Hosokawa Printing Co: 1-20.
- Asioli, A., Medioli, F. S., Patterson, R. T. 1996. Thecamoebians as a tool for reconstruction of paleoenvironments in some Italian lakes in the foothills of the southern Alps (Orta, Varese and Candia). *Journal of Foraminiferal Research* 26, 248-263.
- Assez, L. O., Fayose, E. A., Omatsola, M. E. 1974. Ecology of the Ogun River estuary, Nigeria. *Palaeogeography, Palaeoclimatology and Palaeoecology* 16, 243–260.
- Azazi, G. 1992. Recent seafloor benthonic foraminiferal analysis from the Gulf of Suez, Egypt, in Y. Takayanagi and T. Saito, eds., *Studies in Benthic Foraminifera. Proceedings of the Fourth International Symposium on Benthic Foraminifera, Sendai, Japan, 1990*, Tokai University Press, p. 135-149.
- Baccaert, J. 1987. Distribution patterns and taxonomy of benthic Foraminifera in die Lizard Island Reef Complex, northern Great Barrier Reef, Australia. Université de Liège - C.A.P.S. *Laboratoire de Biosédimentologie*.
- Baker, A. C., Glynn, P. W., Riegl, B. 2008. Climate change and coral reef bleaching: an ecological assessment of long-term impacts, recovery trends and future outlook. *Estuar Coast Shelf Sci.*; 80: 435–471.
- Bandy, O. L., Ingle, J. C., Resig, J. M. 1964a. Foraminiferal trends, Laguna Beach outfall area, California. *Limnol. Oceanog.*, 9, 1: 112-123.
- Bandy, O. L., Ingle, J. C., Resig, J. M. 1964b. Foraminifera, Los Angeles County outfall area, California: *Ibid.*, 9, 1: 124-137.
- Bandy, O. L., Ingle, J. C., Resig, J. M. 1964c. Facies trends, San Pedro Bay, California: *Soc. Amer., Bull.*, 75, 5: 403-423.
- Bandy, O. L., Ingle, J. C., Resig, J. M. 1965a. Foraminiferal trends, Hyperion outfall, California. *Limnol. Oceanog.*, 10, 3:314-332.
- Bandy, O. L., Ingle, J. C., Resig, J. M. 1965b. Modification of foraminiferal distribution by the Orange County outfall, California: *Ocean Sci. and Ocean Eng.*, June, 1965: 55-76

- Banner, F. T., Culver, S. J. 1978. Quaternary *Haynesina* n. gen. and Paleogene *Protelphidium* Haynes; their morphology, affinities and distribution. *J. Foram. Res.* 8: 177-207.
- Banner, F. T., Pereira, C. 1981. A temporal and spatial analysis of foraminiferal diversity from the fringing reefs of Mombasa, East Africa. In: Neale JW, Brasier MD (eds.) *Microfossils from Recent and Fossil Shelf Seas*. Ellis Horwood, Chichester, UK: 350–366.
- Banner, F. T., Pereira, C. P. G., Desai, D. 1985. "Tretomphaloid" float chambers in the Discorbidae and Cymbaloporidae. *Journal of Foraminiferal Research* 15: 159-174.
- Barbosa, C. F., Prazeres, M., de Freitas, Ferreira, B. P., Seoane, J. C. S. 2009. Foraminiferal assemblage and reef check census in coral reef health monitoring of East Brazilian margin. *Marine Micropaleontol.* 73: 62–69.
- Barbosa, C. F., Scott, D. B., Seoane, J., Turcq, B. 2005. Foraminiferal zonation as base lines for Quaternary sea-level fluctuations in south-southeastern Brazilian mangroves and marshes. *Journal of Foraminiferal Research* 35, 22-43.
- Barbosa, C. F., Suguio, K., 1999. Bio-sedimentary facies of a subtropical microtidal estuary - An example from southern Brazil. *Journal of Sedimentary Research.* v. 69, p. 576–587.
- Barker, R. W. 1960. Taxonomic notes on the species figured by H. B. Brady in his report on the foraminifera dredged by the H. M. S. Challenger during the years 1873-1876. *Society of Economic Paleontologists and Mineralogists, Special Publication*, 9: 1- 240.
- Bartlett, G. A. 1966. Distribution and abundance of foraminifera and thecamoebian in Miramichi River and Bay. *Bedford Institute of Oceanography, Report* 66 (2), 104pp.
- Bates, J. M., Spencer, R. S. 1979. Modification of foraminifera trends by the Chesapeake-Elizabeth outfall, Virginia Beach, Virginia. *Journal of Foraminiferal Research*, v. 9, p. 125-140.
- Batsch, A. I. G. C. 1791. Sechs Kupfertafeln mit Conchylien des Seesandes, gezeichnet und gestochen von A.J.G.K. Batsch. Jena.
- Battistini, R., Gayet, J., Jouannic, C., Labracherie, M., Peybouquet, J. P., Pujol, C., Pujos-Lamy, A., Turon, J. L. 1976. Etude des sédiments de la microfaune des Iles Glorieuses (Canal de Mozambique). *Cahiers du Office de la Recherche Scientifique et Technique Outre-mer, Série Geologie* 8: 147– 171.
- Belford, D. J. 1966. Miocene and Pliocene foraminifera from Papua and New Guinea. *Bureau of Mineral Resources (Australia) Bulletin*, 79: 1-306.
- Bermudez, P. J. 1935. Foraminiferos de la Costa Norte de Cuba. *Memorias de la Sociedad Cubana de Historia Natural 'Felipe Poey'* 9: 129-224.
- Bermudéz, P. J. 1952. Estudio sistematico de los foraminiferos rotaliformes. *Boletin de Geologia Venezuela* 2(4): 1-230.
- Bermudez, P. J., Fuenmayor, A. N. 1966. Consideraciones sobre los sedimentos del Mioceno medio al Reciente de las costas central y oriental de Venezuela. Segunda parte. Los foraminiferos bentonicos. *Boletin de Geologia, Venezuela* 7:413-611.

- Bermudez, P. J., Seiglie, G. A. 1963. Estudio sistematico de los foraminiferos del Golfo de Cariaco. *Boletin del Instituto Oceanografico. Universidad de Oriente. Cumana* 2(2): 1-267.
- Bernhard, J. M. 1986. Characteristic assemblages and morphologies of benthic foraminifera from anoxic organic-rich deposits: Jurassic through Holocene. *Journal of Foraminiferal Research* 16: 207–215.
- Bernhard, J. M., Sen Gupta, B. 1999. Foraminifera of oxygen-depleted environments. In Sen Gupta, B. (ed.) *Modern Foraminifera*. Kluwer Academic Publishers, Dordrecht, The Netherlands, pp200-216.
- Berthelin, G. 1880. Memoire sur les foraminiferes fossiles de l'Etage Albien de Moncley (Doubs). *Memoires de la society geologique de France, ser. 3* 1(5): 1-84.
- Bessat, F., Buigues, D. 2001. Two centuries of variation in coral growth in a massive *Porites* colony from Moorea (French Polynesia): a response of ocean-atmosphere variability from south central Pacific. *Palaeogeogr Palaeoclimat Palaeoecol.*175: 381–392.
- Bianchi, G. 1992. Study of demersal assemblages of the continental shelf and upper slope of Congo and Gabon, based on the trawl surveys of the RV “Dr. Fridtjoff Nansen”. – *Marine Ecology Progress Series* 85: 9–23.
- Bicchi, E., Debenay, J-P., Page, J. 2002. Relationship between benthic foraminiferal assemblages and environmental factors in atoll lagoons of the central Tuamotu Archipelago (French Polynesia). *Coral Reefs* 21: 275–290.
- Blainville, H. M. Ducrotay de 1827: *Manuael dre malacology et de conchyliologie* (1825). Paris: F. G. Levrault.
- Bock, W.D., Lynts, G. W., Smith, S., Wright, R., Hay, W. W., Jones, J. I. 1971. A symposium of recent South Florida Foraminifera. *Memoirs of the Miami Geological Society I*, 1- 72
- Boltovskoy, E. 1984. Foraminifera of mangrove swamps. *Physis*, A 42 (102), 1-9.
- Boltovskoy, E., Scott, D. B., Medioli, F. S., 1991. Morphological variations of benthic foraminiferal test in response to changes in ecological parameters: a review. *Journal of Paleontology* 65, 175–185.
- Bornemann, J. G. 1855. Die mikroskopische Fauna des Septarienthones von Hermsdorf bei Berlin. *Zeitschrift der Deutschen Geologischen Gesellschaft*, 7: 307-371.
- Brady, H. B. 1879. Notes on some of the reticularian Rhizopoda of the Challenger Expedition. Part I. On new or little known arenaceous types, part II. Additions to the Knowledge of porcellaneous and hyaline types. *Quarterly Journal of Microscopical Science, new series*, 19: 20-63; 261-299.
- Brady, H. B. 1881. Notes on some of the reticularian Rhizopoda of the Challenger Expedition. part III. 1. Classification. 2. Further notes on new species. 3. Note on *Biloculina* mud. *Quarterly Journal of Microscopical Science, new series*, 21: 31-71.
- Brady, H. B. 1884. Report of the Foraminifera Dredged by H. M. S. Challenger during the years 1873-1876. *Reports of the Scientific Results of the Voyage of H. M. S. Challenger during the years 1873-187*, *Zoology*, 9: 1-814.

- Braga, M. 1961. Foraminiferos da costa de Mocambique. Publicações do Instituto de Zoologia “Dr. Augusto Nobre”. *Faculdade de ciências do Porto* 77: 1-208.
- Brasier, M. D. 1975. The ecology and distribution of recent foraminifera from the reefs and shoals around Barbuda, West Indies. *Journal of Foraminiferal Research* 5: 193–210.
- Brotzen, F. 1942. Die Foraminiferengattung *Gavelinella* nov. gen. und die Systematik der Rotaliiformes. *Arsbok Sveriges Geologiska Undersokning* 36(8): 1-60.
- Brönnimann, P. 1979. Recent benthonic foraminifera from Brasil Morphology and ecology Part IV: Trochamminids from the Campos shelf with description of *Paratrochammina* n. gen. *Paläontologische Zeitschrift* V. 53(1), pp 5–25.
- Brönnimann, P., Zaninetti, L. 1965. Note sur *Lituola salsa* (Cushman et Brönnimann, 1948), un foraminifère de la mangrove de l’île de la Trinité, W. I. *Archives Sciences, Genève*, 18 (3): 608-615.
- Brönnimann, P., Zaninetti, L. 1984. Agglutinated Foraminifera mainly Trochamminacea from the Baía de Sepetiba, near Rio de Janeiro, Brazil. *Revue de Paléobiologie, Genève*, 3: 63-115.
- Brönnimann, P., Whittaker, J. E., Zaninetti, L. 1992 – Brackish water foraminifera from mangrove sediments of southwestern Viti Levu, Fiji Islands, southwest Pacific. *Revue de Paléobiologie*, 11: 13-65
- Brünnich, M. T. 1772. M T. *Brünnich Zoologiae fundamenta*. Hafniae et Lipsiae: Grunde i Dyeloeren, 253 p.
- Buckley, D. A., E. Owens, C. T. Schafer, C. Vilks, R. E. Cranston, M. A. Rashid, F. J. E. Wagner, and D. A. Woalker. 1974. Canso Strait and Chedabucto Bay: Multidisciplinary study of the impact of man on the marine environment. Offshore Geology of Eastern Canada, *Geological Survey of Canada, Paper* 74–30, v. 1, p. 133–160.
- Caley, M. J., Schluter, D. 1997. The relationship between local and regional diversity. *Ecol.* 78: 30–80.
- Cameron, M. A., Endean, R., DeVantier, L. M. 1991. Predation on massive corals: are devastating population outbreaks of *Acanthaster planci* novel events? *Mar Ecol Prog Ser.* 75: 251–258
- Carilli, J., Walsh, S. 2012. Benthic foraminiferal assemblages from Kiritimati (Christmas) Island indicate human-mediated nutrification has occurred over the scale of decades. *Mar Ecol Prog Ser.* 456: 87–99.
- Carvalho, L. R., Sims, P. A., Battarbee, R. W., Cox, E. J., et al. 1995. *Campylodiscus clypeus* (Ehrenb.) Ehrenb. in inland saline lakes. In: Robertson, A.M., Hicks, S., Akerlund, A., Risberg, J., Hackens, T. (Eds), *Landscapes and life: studies in honour of Uwe Miller*, PACT 50, pp. 471-484.
- Chapman, F. 1898. On *Haddonina*, a new genus of the foraminifera from Torres Straits. *Journal of the Linnaean Society of London, Zoology*, 26: 452-456.

- Chapman, F. 1900. On some new and interesting foraminifera from the Funafuti Atoll, Ellice Islands. *Journal of the Linnaean Society of London, Zoology*, 28: 1-27.
- Chapman, F. 1901. Foraminifera from the lagoon at Funafuti. *Journal of the Linnaean Society of London, Zoology*, 28: 161-210.
- Chapman, F., Parr W. J., Collins, A. C. 1934. Tertiary foraminifera of Victoria, Australia. The Balcombian deposits of Port Philip; Part III. *Journal of the Linnaean Society of London, Zoology*, 38: 533-577.
- Charman, D. J. 2001. Biostratigraphic and palaeoenvironmental applications of testate amoebae. *Quaternary Science Reviews* 20, 1753–1764.
- Chasens, S. A. 1981. Foraminifera of the Kenya coastline. *Journal of Foraminiferal Research* 11: 191–202.
- Chazottes, V., Campion-Alsumard, T. Le., Peyrot-Clausade, M. 1995. Bioerosion rates on coral reefs: interactions between macroborers, microborers and grazers (Moorea, French Polynesia). *Palaeogeogr Palaeoclim Palaeoecol.* 113: 189–198.
- Cheng, T. C., Zheng S. Y. 1978. The recent foraminifera of the Xisha Islands, Guangdong Province, China, I. *Studia Marina Sinica*, 12: 149-227. [Chinese with summary and new genera and species in English]
- Cherif, O. H. 1970. Die Miliolacea del' Weslkusle von Naxos (Griechenland) und ihre Lebensbereiehe. Dissertation Facultitit Natur-und Geisteswissenschaften Technischen Universitiit Clausthal, 176 p
- Cherif, O. H. 1973. Zur Klassifizierung der Miliolinellinae (Foraminifera) // On the classification of Miliolinellinae (Foraminifera) In: *Neues Jahrbuch fuer Geologie und Palaeontologie Monatsheft, Stuttgart* (12): 709-718.
- Cimerman, F., Langer, M. R. 1991. Mediterranean foraminifera. *Slovenska Akademija Znanosti in Umetnosti, Ljubljana*, 1-118.
- Clark F. L., 1993 – Rhaptohelenina papuanensis, a new genus and species of benthic foraminifer from the Recent of the Papuan Platteau and Alexa Bank. *Journal of Paleontology*, 67: 899-901.
- Clarke, E. O., Anetekhai, M. A., Akin-Oriola, G. A., Onanuga, A. I. S., et al. 2004. The diatom (Bacillariophyta) diversity of an open access lagoon in Lagos, Nigeria. *Nigerian Journal of Research and Review in Science* 3, 70-77.
- Clarke, E. O., Olarinmoye, O. M., Owodeinde, F. G., Adeboyejo, A. O., et al. 2008. The dynamics of Desmidacean populations in Ologe Lagoon, Lagos, Nigeria. *Journal of Cell and Animal Biology* 2 (2), 21-30.
- Cole, W. S. 1941. Stratigraphic and paleontologic studies of wells in Florida. *Florida State Geological Survey, geological bulletin* 19: i-iv, 1-91.
- Collins, A. C. 1958. "Foraminifera". In: Great Barrier Reef Expedition 1928-1929. *British Museum of Natural History*, 6: 335-437.

- Collins, A. C. 1974. Port Phillip survey 1957-63 Foraminiferida. *Memoirs of the National Museum of Victoria*, 35: 1-61.
- Cooper, J.A.G., McMillan, I.K. 1987. Foraminifera of the Mgeni Estuary, Durban and their sedimentological significance. *South African Journal of Geology* 90: 489-498.
- Corcoran, E., Ravilious, C., Skuja, M. 2007. Mangroves of Western and Central Africa. – UNEP-WCMC Biodiversity Series 26: 96 pp, Cambridge.
- Culver, S. J. 1990. Benthic foraminifera of Puerto Rican mangrove-lagoon systems: Potential for paleoenvironmental interpretations. *Palaios* 5 (1), 34-51.
- Cushman, J. A. 1910. A monograph of the foraminifera of the North Pacific Ocean. Part 1. Astrorhizidae and Lituolidae. *Bulletin of the United States National Museum*, 71(1): 1-134.
- Cushman, J. A. 1911. A monograph of the foraminifera of the North Pacific Ocean. Part 2. Textulariidae. *Bulletin of the United States National Museum*, 71 (2): 1-108.
- Cushman, J. A. 1913b. A monograph of the foraminifera of the North Pacific Ocean. Pt. 3 - Lagenidae. *Bulletin of the United States National Museum*, 71 (3): 1-125.
- Cushman, J. A. 1915. A monograph of the foraminifera of the North Pacific Ocean. Part 5. Rotaliidae. *Bulletin of the United States National Museum*, 71 (5): 1-81.
- Cushman, J. A. 1917. A monograph of the foraminifera of the North Pacific Ocean. Part 6. Miliolidae. *Bulletin of the United States National Museum*, 104 (1): 1-111.
- Cushman, J. A. 1918. The foraminifera of the Atlantic Ocean, Part 1. Astrorhizidae. *Bulletin of the United States National Museum*, 104 (3): 1-143
- Cushman, J. A. 1919. Recent foraminifera from off New Zealand. *Proceedings of the United States National Museum*, 56: 593-640.
- Cushman, J. A. 1921. Foraminifera of the Philippine and adjacent seas. *Bulletin of the United States National Museum*, 100: 1-608.
- Cushman, J. A. 1922a. Shallow-water Foraminifera of the Tortugas region. *Publications of the Carnegie Institution of Washington*, no. 311, Department of Marine Biology Papers, 17: 1-85.
- Cushman, J. A. 1922b. The foraminifera of the Atlantic Ocean, Part 3. Textulariidae. *Bulletin of the United States National Museum*, 104 (3): 1-143.
- Cushman, J. A. 1922c. The foraminifera of the Byram calcareous marl at Byram, Mississippi. *Professional Papers U.S. Geological Survey*, 129-E: 87-152.
- Cushman, J. A. 1923. The foraminifera of the Atlantic Ocean, Part 4. Lagenidae. *Bulletin of the United States National Museum*, 104 (4): 1-228.
- Cushman, J. A. 1924. Samoan Foraminifera. *Publications of the Carnegie Institution of Washington*, no 342, Department of Marine Biology Papers, 21: 1-85.

- Cushman, J. A. 1926b. Recent foraminifera from Porto Rico. *Publications of the Carnegie Institution of Washington*, no. 344, Department of Marine Biology Papers, 23: 73-84.
- Cushman, J. A. 1927. An outline of a reclassification of the foraminifera. *Contributions from the Cushman Laboratory for Foraminiferal Research*, 3: 1-105.
- Cushman, J. A. 1928. Additional genera of the foraminifera. *Contributions from the Cushman Laboratory for Foraminiferal Research* 4: 1-8.
- Cushman J. A. 1929a. The foraminifera of the Atlantic Ocean, Part 6. Miliolidae, Ophthalmidiidae and Fischerinidae. *Bulletin of the United States National Museum*, 104 (6): 1-129.
- Cushman, J. A. 1929b. The genus *Trimosina* and its relationships to other genera of the foraminifera. *Contributions from the Cushman Laboratory for Foraminiferal Research*, 19: 155-159.
- Cushman, J. A. 1929c. Notes on the Foraminiferal Fauna of the Byram marl. *Contributions from the Cushman Laboratory for Foraminiferal Research*, 5: 40-48.
- Cushman, J. A. 1929d. A late Tertiary fauna of Venezuela and other related regions. *Contributions from the Cushman Laboratory for Foraminiferal Research*, 5: 77-101.
- Cushman, J. A. 1930. The foraminifera of the Atlantic Ocean, Part. 7: Nonionidae, Camerinidae, Peneroplidae, and Alveolinellidae. *Bulletin of the United States National Museum*, 104 (7): 1-79.
- Cushman, J. A. 1932. The foraminifera of the Tropical Pacific collections of the "Albatross", 1899-1900. Part 1. Astrorhizidae to Trochamminidae. *Bulletin of the United States National Museum*, 161: 1-88.
- Cushman, J. A. 1933a. The foraminifera of the Tropical Pacific collections of the "Albatross", 1899-1900. Part 2. Lagenidae to Alveolinellidae. *Bulletin of the United States National Museum*, 161: 1-79.
- Cushman, J. A. 1933b. Some new Recent foraminifera from the tropical Pacific. *Contributions from the Cushman Laboratory for Foraminiferal Research*, 9: 77-95.
- Cushman, J. A. 1936. New genera and species of the families Verneulinidae and Valvulinidae and of the subfamily Virgulininae. *Cushman Laboratory for Foraminiferal Research, Special Publication*, 6: 1-71.
- Cushman, J. A. 1937. A monograph of the foraminiferal family Valvulinidae. *Cushman Laboratory for Foraminiferal Research, Special Publication*, 8: 1-210.
- Cushman, J. A. 1939. A monograph of the foraminiferal family Nonionidae. *Professional Papers U.S. Geological Survey*, 191: 1-100.
- Cushman, J. A. 1942. The foraminifera of the tropical Pacific collections of the "Albatross", 1899-1900. Part 3, Heterohelicidae and Buliminidae. *Bull. U.S. Nat. Mus.*, 161: 1-67.
- Cushman, J. A. 1944a. The genus *Articulina* and its species. *Special Publications, Cushman Laboratory for Foraminiferal Research*, 10: 1-37.

- Cushman, J. A. 1944b. Foraminifera from the shallow water of the New England coast. *Special Publications, Cushman Laboratory for Foraminiferal Research*, 12: 1-37.
- Cushman, J. A. 1946. Upper Cretaceous Foraminifera of the Gulf Coastal region of the United States and adjacent areas. *Professional Papers U.S. Geological Survey*, 206: 1-241.
- Cushman, J. A., Brönnimann, P. 1948. Some new genera and species of Foraminifera from brackish water of Trinidad. *Contributions from the Cushman Laboratory for Foraminiferal Research*, 24: 15-21.
- Cushman, J. A., Martin, L. T. 1935. A new genus of foraminifera. *Discorbinella*. from Monterey Bay. California. *Contributions from the Cushman Laboratory for Foraminiferal Research* 11: 89-90.
- Cushman, J. A., Mcculloch, I. 1939. A report on some arenaceous Foraminifera. *Southern California University Publications, Allan Hancock Pacific Expedition, Los Angeles, California*, 6: 1-113.
- Cushman, J. A., Mcculloch, I. 1940. Some Nonionidae in the collections of the Allan Hancock Foundation. *Southern California University Publications, Allan Hancock Pacific Expedition, Los Angeles, California*, 6: 145-178.
- Cushman, J. A., Mcculloch, I. 1948. The species of *Bulimina* and related genera in the collections of the Allan Hancock Foundation. *Southern California University Publications, Allan Hancock Pacific Expedition, Los Angeles, California*, 6: 179-230.
- Cushman, J. A., Mcculloch, I. 1950. Reports on the collections obtained by Allan Hancock Expeditions of Velero III off the coast of Mexico, Central America, South America and Galapagos Islands in 1932-1941, and Velero IV in 1949. Some Lagenidae in the collections of the Allan Hancock Foundation. *Allan Hancock Pacific Expeditions*, 6: 295-364.
- Cushman, J. A., Parker, F. L. 1931. Recent foraminifera from the Atlantic coast of South America. *Proceedings of the United States National Museum*, 80: 1-24.
- Cushman, J. A., Todd, R. 1944. The genus *Spiroloculina* and its species. *Special Publications, Cushman Laboratory for Foraminiferal Research*, 11: 1-82.
- Cushman, J. A., Todd, R., Post, R. J. 1954. Recent foraminifera of the Marshall Islands, Bikini and nearby atolls, Part II, oceanography (biologic). *Professional Papers U.S. Geological Survey*, 260-H: 319-384.
- Czjzek, J. 1848. Beitrag zur Kenntniss der fossilen Foraminiferen des Wiener Beckens. *Haidinger's Natur-wissenschaftliche Abhandlungen, Wien*, 2 (1): 137-150.
- D'Hondt, S., Spivack, A. J., Pockalny, R., Ferdelman, T. G., Fischer, J. P., Kallmeyer, J., Abrams, L. J., Smith, D. C., Graham, D., Hasiuk, F., Schrum, H., Stancin, A. M. 2009. Subseafloor sedimentary life in the South Pacific Gyre. *Proceedings of the National Academy of Sciences*, 106(28), 11651-11656.
<http://www.pnas.org/content/106/28/11651.full>
- Dale, D. C., McMillan, I. K. 1998. Mud belt and middle shelf benthonic and planktonic foraminiferal assemblages and sedimentation processes compared through the Holocene

- succession at two tropical African (Sierra Leone) and two temperate African (Western offshore, South Africa) sites. *South African Journal of Science* 94: 319–340.
- Dale, D. C., McMillan, I. K. 1999. *On the Beach: A Field Guide to the Late Cenozoic Micropalaeontological History, Saldanha Region, South Africa*. De Beers Marine, Cape Town, South Africa: 127 pp.
- De Montfort, P. D. 1808. *Conchyliologie systématique et classification méthodique des coquilles*, t. 1. Paris, France, F. de Schoell ed.: 1-410.
- De Rijk, S., Troelstra, S. R. 1997. Salt marsh foraminifera from the Great Marshes, Massachusetts: environmental control. *Palaeogeography, Palaeoclimatology, Palaeoecology*, 130: 81–112.
- Debenay, J.-P. 1986. Recherche sur la sédimentation actuelle et les thanatocoenoses des Foraminifères de grande taille du lagon sud-ouest et de la marge insulaire sud de Nouvelle-Calédonie. *Paris, Orstom, Travaux et documents microédités*, 20 (3 vol.) : 1-200, 22 pl.
- Debenay, J.-P. 1990. Recent Foraminiferal Assemblages and their Distribution Relative to Environmental Stress in the Paralic Environments of West Africa (Cape Timiris to Ebrie Lagoon). *Journal of Foraminiferal Research*, 20 (3): 267-282.
- Debenay, J.-P. 2000. Foraminifers of paralic tropical environments. *Micropaleontology* 46(Supp 1):153–160.
- Debenay, J.-P. 2012. A guide to 1,000 Foraminifera from the Southwest Pacific New Caledonia. Marseille and Paris: IRD Éditions, Institut de recherche pour le développement Marseille and Publications Scientifiques du Muséum, Muséum National d'Histoire Naturelle.
- Debenay, J.-P., Basov, I. 1993. Distribution of Recent Benthic foraminifera on the West African shelf and slope. A synthesis. *Revue de Paléobiologie Genève* 12: 265-300.
- Debenay, J.-P., Bicchi, E., Goubert, E., Armynot du Châtelet, E. 2006. Spatial and temporal distribution of benthic foraminiferal assemblages in the Vie Estuary (Vendée, W France). *Estuarine, Coastal and Shelf Science* 67, 181-197.
- Debenay, J.-P., Duleba, W., Bonetti, C., Mello, E., et al. 2001. *Pararotalia cananeaensis* n. sp., indicator of marine influence and water circulation in Brazilian coastal and paralic environments. *Journal of Foraminiferal Research* 31, 152–163.
- Debenay, J.-P., Eichler, B. B., Duleba, W., Bonetti, C., Eichler-Coelho, P. 1998. Water stratification in coastal lagoons: its influence on foraminiferal assemblages in two Brazilian lagoons. *Marine Micropaleontology* 35, 67–89.
- Debenay, J.-P., Eichler, B. B., Guillou, J. J., Eichler-Coelho, P., et al. 1997. Comportement des peuplements de foraminifères et comparaison avec l'avifaune dans une lagune fortement stratifiée: La Lagoa da Conceição (S.C., Brésil). *Revue de Paléobiologie* 16 (1), 55-75.
- Debenay, J.-P., Guillou, J. J. 2002. Ecological transitions indicated by foraminiferal assemblages in paralic environments. *Estuaries*, 25: 1107-1120.

- Debenay, J.-P., Guillou, J. J., Redois, F., Geslin, E. 2000. Distribution trends of foraminiferal assemblages in paralic environments. A base for using foraminifera as bioindicators. – In Martin, R. E. (ed.), *Environmental Micropaleontology*: Kluwer Academic Publishers, New York, 39–67.
- Debenay, J.-P., Guiral, D., Parra M. 2002. Ecological factors acting on the microfauna in mangrove swamps. The case of foraminiferal assemblages in French Guiana. *Estuarine, Coastal and Shelf Science*, 55 (4): 509-533.
- Debenay, J.-P., Luan, B. T. 2006. Foraminiferal assemblages and the confinement index as tools for assessment of saline intrusion and human impact in the Mekong delta. *Revue de Micropaléontologie*, 49: 74-85.
- Debenay, J.-P., Marchand, C., Molnar, N., Aschenbroich, A., Meziane, T. 2015. Foraminiferal assemblages as bioindicators to assess potential pollution in mangroves used as a natural biofilter for shrimp farm effluents (New Caledonia). *Mar Poll Bull.* 93: 103–120.
- Debenay, J.-P., Millet, B., Angelidis, M. O. 2005. Relationships between foraminiferal assemblages and hydrodynamics in the Gulf of Kalloni, Greece. *Journal of Foraminiferal Research*, 35: 327-343.
- Debenay, J.-P., Pages, J., Diouf, P. S. 1989. Ecological zonation of the hyperhaline estuary of the Casamance River (Senegal): Foraminifera, zooplankton and abiotic variables. *Hydrobiologia* 174, 161-176.
- Debenay, J.-P., Redois, F. 1997. Recent foraminifera of the northern continental shelf of Senegal. *Revue de Micropaléontologie* 40: 15-38.
- Delcroix, T., Henin, C. 1991. Seasonal and interannual variations of sea surface salinity in the tropical Pacific Ocean. *J. Geophys. Res.*, 98: 22, 135-22, 150.
- Defrance J. L. M. 1824: Dictionnaire des Sciences Naturelles, vol. 32, moll-morf. Strasbourg: F. G. Levrault.
- Delesalle, B., Sournia, A. 1992. Residence time of water and phytoplankton biomass in coral reef lagoons. *Continent Shelf Res.* 12:939–949.
- Denoyelle, M., Jorissen, F. J., Martin, D., Galgani, F., Miné, J. 2010. Comparison of benthic foraminifera and macrofaunal indicators of the impact of oil-based drill mud disposal. *Marine Pollution Bulletin* 60: 2007–2021 doi: 10.1016/j.marpolbul.2010.07.024
- Dimiza, M.D., Koukousioura, O., Triantaphyllou, M.V., Dermitzakis, M.D., 2016. Live and dead benthic foraminiferal assemblages from coastal environments of the Aegean Sea (Greece): Distribution and diversity. *Revue de Micropaléontologie* 59, 19–32. doi.org/10.1016/j.revmic.2015.10.002
- Done, T. J., Dayton, P. K., Dayton, A. E., Stege, R. 1991. Regional and local variability in recovery of shallow coral communities: Moorea, French Polynesia and central Great Barrier Reef. *Coral Reefs.* 9: 183–192.

- Dostal, J., Dupuy, C., Liotard, J. M. 1982. Geochemistry and origin of basaltic lavas from Society Islands, French Polynesia (south central Pacific Ocean)
- Dublin-Green, C. O. 1994. Benthic foraminifera as pollution indicators in the Bonny Estuary Niger Delta. *Nigerian Institute for Oceanography and Marine Research Technical Paper* 95, 1-20.
- Duchemin, G., Mojtahid, M., Bicchi, E., Gaultier, M., Jorissen, F., Durrieu, J., Galgani, F., Cazes, L., Camps, R. 2008. New monitoring tool for assessing environmental impact of offshore drilling activities: benthic foraminifera. *Society of Petroleum Engineers paper* 111959, NICE, Avril 2008.
- Duleba, W., Debenay, J.-P. 2003. Hydrodynamic circulation in the estuaries of estação ecológica Juréia-Itatins, Brazil, inferred from foraminifera and thecamoebian assemblages. *Journal of Foraminiferal Research* 33 (1), 62-93.
- Duncan, R. A., McDougall, I. 1976. Linear volcanism in French Polynesia. *J. Volcanol. Geotherm. Res.* 1, 197-227.
- Durrieu, J., Mojtahid, M., Cazes, L., Galgani, F., Jorissen F., Camps, R. 2006. Aged drilled cuttings offshore Gabon: New methodology for assessing their impact. *Society of Petroleum Engineers paper* 98414, Abu Dhabi, UAE, April 2006.
- Eichler, P. P. B., Castelão, G. P., Pimenta, F. M., Eichler, B. B., et al. 2006. Foraminifera and thecamoebians as indicator of hydrodynamic process in a choked coastal lagoon, Laguna estuarine system, SC, Brazil. *Journal of Coastal Research* SI 39 (Proceedings of the 8th International Coastal Symposium), 1144 - 1148.
- Eichler, P. P. B., Rodrigues, A. R., Pereira, E. R. M., Eichler, B. B., et al. 2015. Foraminifera as environmental condition indicators in Todos os Santos Bay (Bahia, Brazil). *Open Journal of Ecology* 5, 326-342.
- Endean, R., Cameron, A. M. 1990. Trends and new perspectives in coral reef ecology. In: Dubinsky, Z. (ed.) *Ecosystems of the world, Vol 25, Coral Reefs*, pp. 469-492.
- Engle, V. D. 2000. Application of the indicator evaluation guidelines to an index of benthic condition for Gulf of Mexico estuaries. In: Jackson, L.E., Kurtz, J.C., Fisher, W.S.. editors. *Evaluation Guidelines for Ecological Indicators*. EPA/620/R-99/005, 3; U.S. Environmental Protection Agency, Research Triangle Park, Durham, NC; pp. 1-29.
- Earland, A. 1934. Foraminifera. Part III. The Falklands sector of the Antarctic (excluding South Georgia). *Discovery Reports*, 10: 1-208.
- Egger, J. G. 1893. Foraminiferen aus Meeresgrundproben, gelothet von 1874 bis 1876 von S. M. Sch. "Gazelle." *Abhandlungen der Bayerischen Akademie der Wissenschaften, Mathematisch- Physikalischen Klasse*, 18: 193-458.
- Ehrenberg, C. G. 1838. Über die blossen Auge unsichtbare Kalkthierchen und Kieselthierchen als Hauptbestandtheile der Kreidegebirge. Bericht über die zu Bekanntmachung geeigneten Verhandlungen der Königlichen Preussischen Akademie der Wissenschaften zu Berlin, p. 192-200.

- Ehrenberg, C. G. 1839. Über die Bildung der Kreidefelsen und des Kreidemergels durch unsichtbare Organismen. *Physikalisch abhandlungen der königlichen Akademie der Wissenschaften zu Berlin*: 59-147.
- Ehrenberg, C. G. 1843. Verbreitung und Einfluss des mikroskopischen Lebens in Süd- und Nord-Amerika. *Physikalische Abhandlungen der Königlichen Akademie der Wissenschaften zu Berlin*, 1841: 291- 446.
- El-Nakhal, H. A. A. 1983. *Agglutinella*, a new miliolid genus (Foraminiferida). *Journal of Foraminiferal Research* 13: 129-133.
- Edwards, R. J., Wright, A. J., van de Plassche, O. 2004. Surface distribution of salt-marsh foraminifera from Connecticut, USA: Modern analogues for high-resolution sea level studies: – *Marine Micropaleontology* 51: 1–21.
- Ellis, J., Fraser, G., Russel, J. 2012. Discharged drilling waste from oil and gas platforms and its effects on benthic communities. *Marine Ecology Progress Series* 456: 285-302.
- Ernst, S. R., Morvan, J., Geslin, E., Le Bihan, A., Jorissen, F. J. 2006. Benthic foraminiferal response to experimentally induced *Erika* oil pollution. *Marine Micropaleontology* 61: 76-93. doi: 10.1016/j.marmicro.2006.05.005
- Fajemila, O. T., Langer, M. R., Lipps, J. H. 2015. Spatial Patterns in the Distribution, Diversity and Abundance of Benthic Foraminifera around Moorea (Society Archipelago, French Polynesia). *PLoS ONE* 10(12): e0145752. doi: 10.1371/journal.pone.0145752
- Fajemila, O. T., Langer, M. R. 2016. Ecosystem Indicators: Foraminifera, Thecamoebians and Diatoms from the Ologe Lagoon, Nigeria. *Revue de Micropaléontologie*, <http://dx.doi.org/10.1016/j.revmic.2016.09.002>.
- Fayose, E. A. 1970. Preliminary account of the distribution of recent foraminifera off the Bight of Benin, Tarkwa Bay. *Bulletin de L'Institut Fondamental d'Afrique Noire* A (3), 594-606.
- Fichtel, L. von, Moll J. P. C. von. 1798. *Testacea microscopica, aliaque minuta ex generibus Argonauta et Nautilus, ad naturam picta et descripta (Microscopische und andere kleine Schalthiere aus den geschlechtern Argonaute und Schiffer)*. Vienna. Camesina.
- Finlay, H. J. 1939. New Zealand foraminifera; Key species in stratigraphy - No. 3. *Transactions and Proceedings of the Royal Society of New Zealand*, 69: 309-329.
- Finlay, H. J., 1947, New Zealand Foraminifera: Key species in stratigraphy-No.5. *New Zealand Journal of Science and Technology* 28:259-292,
- Fischer, R. A., Corbet, A. S., Williams, C. B. 1943. The relationship between the number of species and the number of individuals in a random sample of animal populations. *J. Anim. Ecol.* 12: 42–58.
- Fischer, J. P., Ferdelman T. G., D'Hondt, S., Røy, H., Wenzhöfer F. 2009. Oxygen penetration deep into the sediment of the South Pacific gyre. *Biogeosciences*, 6, 1467–1478.
- Fleming, J., 1828. A history of British animals, exhibiting the descriptive characters and systematic arrangement of the genera and species of Quadrupeds, Birds, Fishes. Mollusca and Radiata of the United Kingdom. Edinburgh: Bell and Bradfute. p. 226.

- Flower, R. J., 1993. Diatom preservation: experiments and observations on dissolution and breakage in modern and fossil material. In: Proceedings of the Twelfth International Diatom Symposium, Rennes, 1992 (H. van Dam, ed.), 473-484. Kluwer Academic Publishers, Dordrecht (*Hydrobiologia* 269/270).
- Forskal, P. 1775. *Descriptiones animalium*. Copenhagen. Hauniae, Carsten Niebuhr.
- Foged, N. 1984. Freshwater and littoral diatoms from Cuba. *Bibliotheca Diatomologica* 5, 1-124.
- Friedlander, A. M., Ballesteros, E., Fay, M., Sala, E. 2014. Marine Communities on Oil Platforms in Gabon, West Africa: High Biodiversity Oases in a Low Biodiversity Environment. *PLoS ONE* 9(8): e103709. doi: 10.1371/journal.pone.0103709
- Frontalini, F., Buosi, C., Da Pelo, S., Coccioni, R., Cherchi, A., Bucci, C. 2009. Benthic foraminifera as bio-indicators of trace element pollution in the heavily contaminated Santa Gilla lagoon (Cagliari, Italy). *Marine Micropaleontology*, 58; 858–877.
- Frontalini, F., Coccioni, R., 2008. Benthic foraminifera for heavy metal pollution monitoring: a case study from the central Adriatic Sea coast of Italy. *Estuarine, Coastal and Shelf Science* 76, 404–417.
- Frontalini, F., Coccioni, R., 2011. Benthic foraminifera as bioindicators of pollution: A review of Italian research over the last three decades. *Revue de Micropaléontologie*, 54 (2), 115-127.
- Fujita, K., Omori, A. 2015. Modern and Pleistocene large-sized benthic foraminifera from Tahiti, French Polynesia, collected during IODP Expedition 310. *Island Arc*. 24: 47–60.
- Galloway, J. J., 1933. *A Manual of Foraminifera*. Bloomington: Principia Press, xii + 483 p.
- Galloway J. J., Wissler S. G. 1927. Pleistocene Foraminifera from the Lomita quarry, Palos Verdes Hills, California. *Journal of Paleontology*, 1: 35-87.
- Galzin, R. 1987. Structure of fish communities of French Polynesian coral reefs. 11. Temporal scales. *Mar Ecol Prog Ser*. 41: 137–145
- Gasse, F. 1986. East African diatoms. *Bibliotheca Diatomologica* 11, 1-201.
- Gehrels, R. W. 1994. Determining relative sea-level change from salt-marsh foraminifera and plant zones on the Coast of Maine, USA. *Journal of Coastal Research*, 10: 990–1009.
- Germeraad, J. H. 1946. “Geology of central Ceram”. In Rutten L., Hotz W. (eds): *Geological, petrographical and paleontological results of explorations carried out from 1917 till 1919 in the Island of Ceram*, Bussy, J.H., Amsterdam: 7-135.
- Glaçon, G., Lys, M. 1968. Note préliminaire à une révision des espèces de *Monspeliensina*, nouveau genre de foraminifère accompagnant la transgression Miocène dans le Languedoc. *Compte Rendu Hebdomadaire des Séances de l'Académie des Sciences, Paris*, 267: 2302-2305.
- Gleason, M. G. 1993. Effects of disturbance on coral communities: bleaching in Moorea, French Polynesia. *Coral Reefs*. 12: 193–201

- Gleason, M. G. 1996. Coral recruitment in Moorea, French Polynesia: the importance of patch type and temporal variation. *J. Exp. Mar. Biol. Ecol.* 207: 79–101.
- Glaessner, M. F. 1937. Die Entfaltung der Foraminiferenfamilie Buliminidae. *Problemy Paleontologii, Paleontologicheskaya Laboratoriya Moskovskogo Gosudarstvennogo Universiteta* 2-3:411-422.
- Glenn-Sullivan, E. C., Evans, I. 2001. The effects of time-averaging and taphonomy on the identification of reefal sub-environments using larger foraminifera: Apo Reef, Mindoro, Philippines. – *Palaios*, 16: 399–408.
- Gonzales-Donoso, J. M. 1969. Donnees nouvelles sur la texture et la structure du test de quelques foraminiferes du Bassin de Grenade (Espagnc). *Revue de Micropaleontologie*, 12:3-8.
- Graham, J. J., Militante, P. J. 1959. Recent Foraminifera from the Puerto Galera area, Northern Mindoro, Philippines. School of Mineral Sciences, Stanford University, 170 pp.
- Griffith, J. W., Henfrey, A. 1875. *The Micrographic Dictionary*, vol. I, 3rd ed. London: van Voorst, p. 316-320.
- Gronovius L. T. 1781. *Zoophylacium Gronovianum* vol. 3. Lugduni Batavorum, T. Haak, Leiden, Netherlands: 241-380.
- Haake, F. W. 1980. Benthische Foraminiferen in Oberflächen-Sedimenten und Kernen des Ostatlantiks vor Senegal/Gambia (Westafrika) “*Meteor*” *Forschungs-Ergebnisse* 2: 121-128.
- Haig, D. W. 1979, Foraminifera from shore-line sediments, Motupore Island, Papua New Guinea. *Science in New Guinea*, v. 6, p. 138-143.
- Haig, D. W. 1988a. 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. 1988b. Distribution of miliolid foraminifera in marine sediments around Motupore Island, Papua New Guinea: *Science in New Guinea*, v. 14, p. 54-94.
- 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.
- Haig, D. W. 1997. Foraminifera from Exmouth Gulf, Western Australia. *Journal of the Royal Society of Western Australia*, 80: 263-280.
- Haeckel, E. 1894. *Systematische Phylogenie. Entwurf eines Natürlichen Systems der Organismen auf Grund ihrer Stammesgeschichte. Theil 1. Systematische Phylogenie der Protisten und Pflanzel*. Berlin: Georg Reimer. xv. 400 p.
- Halicz, R. 1979. Recent Textularidae from the gulif of Elat (‘Aqaba’), Red sea. *Revista Espanola de Micropaleontologia*, p. 295-320.
- Hallock, P. 1981. Production of carbonate sediments by selected large benthic foraminifera on two Pacific coral reefs: *Journal of Sedimentary Petrology* 51: 467–474.

- Hallock, P. 1988. 'The role of nutrient availability in bioerosion: consequences to carbonate buildups'. *Palaeogeography, Palaeoclimatology, Palaeoecology* 63, 275–291
- Hallock, P. 1999. Symbiont-bearing foraminifera. In: Sen Gupta BK (ed). *Modern Foraminifera*. Kluwer Academic Publishers, Dordrecht, The Netherlands: 123–139.
- Hallock, P. 2000. Symbiont-bearing foraminifera: harbingers of global change? *Micropaleontology*, 46(Suppl 1): 95-104.
- Hallock, P. 2000. Larger foraminifera as indicators of coral-reef vitality. In: Martin, R. (Ed.), *Marine Micropaleontology*. Kluwer, New York, pp. 121-150.
- Hallock, P. 2012. The FORAM Index revisited: usefulness, challenges and limitations. In: International Coral Reef Symposium, Cairns, Australia, 9–13, 2012; http://www.icrs2012.com/proceedings/manuscripts/ICRS2012_15F2.pdf.
- Hallock, P., Lidz, B. H., Cockey-Burkhard, E. M., Donnelly, K. B. 2003. Foraminifera as bioindicators in coral reef assessment and monitoring: the FORAM index. *Environmental Monitoring and Assessment* 81, pp. 221–238.
- Haman, D. 1984. *Saidovina*, new name for *Loxostomina* Saidova, 1975 (non Sellier de Civrieux, 1968 [sic, 1969] and the status of *Loxostomella* Saidova, 1975 (Foraminiferida). *Proceedings of the Biological Society of Washington* 97:419.
- Hammer, Ø., Harper, D. A. T., Ryan, P. D. 2001. PAST: Paleontological statistics software package for education and data analysis. *Palaeontologica Electronica* 4 (1), 1–9.
- Hansen, H. J., Revets, R. 1992. A revision and reclassification of the Discorbidae, Rosalinidae, and Rotaliidae. *Journal of Foraminiferal Research*, 22: 166-180.
- Harmelin-Vivien, M. L. 1994. The effects of storms and cyclones on coral reefs: a review. *J. Coastal Res. Spec. Issue* 12: 211-231
- Haslet, S. K. 2001. The Palaeoenvironmental implications of the distribution of intertidal foraminifera in a tropical Australian estuary: a reconnaissance study. *Australian Geographical Studies*, v. 39, p. 67-74.
- Hatta, A., Ujiie J. 1992a. Benthic foraminifera from Coral Seas between Ishigaki and Iriomote Islands, Southern Ryukyu Island Arc, Northwestern Pacific, Part 1, Systematic descriptions of Textulariina and Miliolina. *Bulletin of the College of Science, University of the Ryukyus*, 53: 49-119.
- Hatta, A., Ujiie J., 1992b. 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*, 54: 163-287.
- Haunold, T. G., Baal, C., Piller, W. E. . 1998. Larger Foraminifera. *Abhandlungen der Senckenbergischen Naturforschenden Gesellschaft* 548, 155-180.
- Haunold, Th. G., Piller, W.E. 1998. Smaller Foraminifera. In: Piller, W.E. & Haunold, Th. G. (eds.): The Northern Bay of Safaga (Red Sea, Egypt): An actuopalaeontological approach. V. *Foraminifera*. *Abh. senckenberg. Naturforsch. Ges.*, 548:11-153, Frankfurt/Main.

- Haynes, J. R., 1973 – Cardigan Bay foraminifera (cruises of the R. V. Antur, 1962-1964). *Bulletin of the British Museum (Natural History), Zoology*. Supplement 4: 1-245.
- Hayward, B. W., Hollis, C. J. 1994. Brackish foraminifera in New Zealand: a taxonomic and ecological review. *Micropaleontology*, 40(3): 185–222.
- Hayward, B. W., Grenfell, H. R., Scott, D. B. 1999a. Tidal range of marsh foraminifera for determining former sea-level heights in New Zealand. *New Zealand Journal of Geology and Geophysics*, 42: 395–413.
- Hayward, B. W., Grenfell, H. R., Reid, C. M., Hayward, K. A. 1999b. Recent New Zealand Shallow-Water Benthic Foraminifera: Taxonomy, Ecologic Distribution, Biogeography, and use in Paleoenvironmental Assessments. *Institute of Geological and Nuclear Sciences Monograph 21*, Lower Hutt, New Zealand: 264.
- Hayward, B. W., Scott, G. C., Grenfell, H. R., Carter, R., Lipps, J. H. 2004. Techniques for estimation of tidal elevation and confinement (~salinity) histories of sheltered harbours and estuaries using benthic foraminifera: examples from New Zealand. *The Holocene* 14: 218–232.
- Hayward, B. W., Grenfell, H. R., Reid, C. M., Hayward, K. A. 1999. Recent New Zealand shallow-water benthic foraminifera: taxonomy, ecologic distribution, biogeography, and use in paleoenvironmental assessment. Inst Geol Nucl Sci Ltd. *Monograph 21*: 1–258.
- Hayward, B. W., Brazier, R. C. 1980. Taxonomy and distribution of present-day *Bolivina*. *Journal of Foraminifera Research* 10:102-116.
- Hayward, B. W., Grenfell H. R., Reid C. M., Hayward K. A. 1999. Recent New Zealand shallow-water benthic foraminifera: taxonomy, ecologic distribution, biogeography, and use in paleoenvironmental assessment. *Institute of Geological and Nuclear Sciences monographs*, 21: 1-264.
- Hayward, B. W., Grenfell H. R., Sabaa A. T., Neil H. L., Buzas M. A. 2010. Recent New Zealand deep-water benthic foraminifera: taxonomy, ecologic distribution, biogeography, and use in paleoenvironmental assessment. *Institute of Geological and Nuclear Sciences monographs*, 26: 1-363.
- Hayward, B. W., Hollis C. J., Grenfell H. R. 1997 – Recent Elphidiidae (Foraminiferida) of the South-west Pacific and fossil Elphidiidae of New Zealand. *Institute of Geological and Nuclear Sciences monographs*, 16: 1-170.
- Hayward, B. W., Holzmann M., Grenfell H. R., Pawlowski J., Triggs C. M. 2004. Morphological distinction of molecular types in *Ammonia* - towards a taxonomic revision of the world's most commonly misidentified foraminifera. *Marine Micropaleontology*, 50: 237-271.
- Hayward, B. W., Triggs, C. M. 1994. Computer analysis of benthic foraminiferal associations in a tidal New Zealand inlet *Journal of Micropalaeontology*, 13: 103-117.

- Hendey, N. I. 1957. Marine diatoms from some West African ports. *Journal of Royal Microscopical Society* (Great Britain) 77 (1-2), 28-85.
- Heron-Allen, E., and A. Earland (1914) The Foraminifera of the Kerimba Archipelago (Portuguese East Africa), part I. *Transactions of the Zoological Society of London* **20/12**: 363-390.
- 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: 543-795.
- Heron-Allen, E., Earland, A. 1924. The Foraminifera of Lord Howe Island, South Pacific. *Journal of the Linnean Society, Zoology*, 35: 599-647.
- Heron-Allen, E., Earland, A. 1928. On the Pigididae, a new family of foraminifera. *Journal of the Royal Microscopical Society of London, series 3*, 48: 283-299.
- Hickson, S. J. 1911. On *Polytrema* and some allied genera. A study of some sedentary foraminifera based mainly on a collection made by Prof. Stanley Gardiner in the Indian Ocean. *Transactions of the Linnean Society of London, Zoology, series 2*, 14: 443-462.
- Hirshfield, H. I., Charmatz, R., Henson, L. 1968, 'Foraminifera in samples taken from Eniwetok Atoll in 1956', *Journal of Protozoology* 15, 497-502
- Hodgson, G. A. 1999. Global Assessment of Human Effects on Coral Reefs. *Mar Poll Bull.* 38: 345-355.
- Hoegh-Guldberg, O., Salvat, B. 1995. Periodic mass-bleaching and elevated sea temperatures: bleaching of outer reef slope communities in Moorea, French Polynesia. *Mar Ecol Prog Ser.* 121: 181-190.
- Hofker, J. 1930. The foraminifera of the Siboga Expedition; Part 2, families Astrorhizidae, Rhizamminidae, Reophacidae, Anomalinidae, Peneroplidae. *Siboga Expeditie, Monographie IVa*. Leiden. E. J. Brill: 79-170.
- Hofker, J. 1951. The foraminifera of the Siboga Expedition; Part 3. *Siboga Expeditie, Monographie IVb*. Leiden. E. J. Brill: 1-513.
- Hofker, J. 1954. Uber die Familie Epistomariidae (Foram.). *Palaeontographica* 105A: 166-206.
- Hofker, J., 1978. Biological results of the Snellius Expedition: The foraminifera collected in 1929 and 1930 in the eastern part of the Indonesian Archipelago. *Zoologische Verhandelingen Rijksmuseum van Natuurlijke Historie te Leiden*, 161: 1-69.
- Hohenegger, J. 2006. The importance of symbiont-bearing benthic foraminifera for West Pacific carbonate beach environments. *Marine Micropaleontology* 61: 4-39.
- Hohenegger, J., Yordanova, E., Hatta, A. 2000. Remarks of West Pacific Nummulitidae (Foraminifera). *Journal of Foraminiferal Research*, 30: 3-28.
- Hohenegger, J., Yordanova, E., Nakano, Y., Tatzreiter, F. 1999. Habitats of larger foraminifera on the upper reef slope of Sesoko Island, Okinawa, Japan. *Marine Micropaleontology* 36: 109-168

- Horton, B. P. 1999. The distribution of contemporary intertidal foraminifera at Cowpen Marsh, Tees Estuary, UK: Implications for studies of Holocene sea-level changes. *Palaeogeography, Palaeoclimatology, Palaeoecology*, 149: 127–149.
- Horton, B. P., Edwards, R. J., Lloyd, J. M. 1999. UK intertidal foraminiferal distributions: implications for sea-level studies. *Marine Micropaleontology*, 36: 205–223.
- Horton, B. P., Larcombe, P., Woodroffe, S. A., Whittaker, J. E., Wright, M. R., Wynn, C. 2003. Contemporary foraminiferal distributions of a mangrove environment, Great Barrier Reef coastline, Australia. Implications for sea-level reconstructions. *Marine Geology*, 198: 225–243.
- Horton, B. P., Whittaker, J. E., Thomson, K. H., Hardbattle, M. I., Kemp, A., Woodroffe, S. A., Wright, M. R. 2005. The Development of a Modern Foraminiferal Data Set for Sea-Level Reconstructions, Wakatobi Marine National Park, Southeast Sulawesi, Indonesia. *Journal of Foraminiferal Research* 35: 1–14.
- Hottinger, L. 1977. Distribution of larger Peneroplidae, *Borelis* and Nummulitidae in the Gulf of Elat, Red Sea. Utrecht. *Micropaleontological Bulletins*, 15: 35-110.
- Hottinger, L. 1997. Shallow benthic foraminiferal assemblages as signals for depth of their deposition and their limitations. *Bull. Soc. geol. France*, 4, pp. 491-505.
- Hottinger, L., Halicz, E., Reiss, Z. 1993. Recent foraminifera from the Gulf of Aqaba, Red Sea. Dela. Slovenska Akademija Znanosti in Umetnosti, razred za Naraslovne Vede Opera. Academia Scientiarum et Artium Slovenica, Classis IV, *Historia Naturalis* 33: 1–179.
- Imoobe, O. T. 2008. Variation in benthic macroinvertebrate assemblages in Ologe Lagoon, Nigeria. *African Journal of Aquatic Science* 33 (1), 45-50.
- Ingle, J. C. 1967. Foraminiferal biofacies variation and the Miocene-Pliocene boundary in Southern California. *Bulletin of American Paleontology* 236 (52), 217-394.
- Javaux, E. J. 1999. Benthic Foraminifera from the Modern Sediments of Bermuda: Implications for Holocene Sea-Level Studies: Dalhousie University, Nova Scotia, Canada, 625 p.
- Javaux, E. J., Scott, D. B., 2003. Illustration of recent benthic foraminifera in Bermuda and remarks on species distribution. *Palaeontologica electronica*, 6, 29 p.
- Jennings, A. E., Nelson, A. R., Scott, D. B., Aravena, J. C. 1995. Marsh foraminiferal assemblages in the Valdivia Estuary, south-Central Chile, relative to vascular plants and sea-level. *Journal of Coastal Research* 11 (1), 107-123.
- Jokiel, P. L., Coles, S. L. 1990. Response of Hawaiian and other Indo-Pacific reef corals to elevated temperature. *Coral Reefs* 8: 155–162
- Jones, T. R., 1895. The Crag Foraminifera. Part 2. *Monograph of the Palaeontographical Society London*, 230 (49): 73-210, pl. 5-7.
- Juhasz, A., Ho, E., Bender, E., Fong, P. 2010. Does use of tropical beaches by tourists and island residents result in damage to fringing coral reefs? A case study in Moorea French Polynesia. *Mar Poll Bull.* 60: 2251–2256.

- Katarina, H. 2007. Thecamoebians from the upper Vltava River (Šumava Mountains, Czech Republic): Species composition of assemblages vs. environment in streams. *Journal of Foraminiferal Research* 37 (4), 287-299.
- Kelmo, F., Hallock, P. 2013. Responses of foraminiferal assemblages to ENSO climate patterns on bank reefs of northern Bahia, Brazil: a 17-year record. *Ecol. Indic.* 30: 148–157. <http://dx.doi.org/10.1016/j.ecolind.2013.02.009>.
- Kisel'man, E. N. 1972. Verkhnemelovye i Paleotsenovye foraminifery novogo roda *Spiroplectinella*. Trudy Sibirskogo Nauchno-Issledovatel'skogo Instituta Geologii Geofiziki i Mineral'nogo Syr'ya (SNIIGGIMS) Ministerstva Geologii i Okhrany Nedr SSSR 146: 134–140, Novosibirsk.
- Kjerfve, B. 1994. Coastal lagoons. In: Kjerfve, B., (Ed), Coastal Lagoons Processes. Elsevier Science Publishers, 576pp.
- Kliza, D. A., Schroeder, A. C. J. 1994. Distribution of Arcellacea in freshwater lakes in Pond Inlet and Bylot Island, Northwest Territories. Abstracts with Programs. *Geological Society of America* 26 (7), 326.
- Koukousioura, O., Dimiza, M. D., Triantaphyllou, M. V., Hallock, P. 2011. Living benthic foraminifera as an environmental proxy in coastal ecosystems: a case study from the Aegean Sea (Greece, NE Mediterranean). *J Mar Syst.* 88:489–501.
- Krammer, K., Lange-Bertalot, H. 1988. Bacillariophyceae, 2. Teil: Bacillariaceae, Epithemiaceae, Surirellaceae. In: Ettl H, Gerloff J, Heynig H, Mollenhauer D (eds.) Freshwater flora of Central Europe, vol 2/2. Gustav Fischer Verlag, Stuttgart, New York.
- Kumolu-Johnson, C. A., Ndimele, P. E. 2012. Some aspects of the Limnology and Heavy metal content of water, sediment and *Oreochromis niloticus* (Linnaeus, 1758) from Ologe Lagoon, Lagos, Nigeria. *Research Journal of Environmental Toxicology* 6 (5), 210-221.
- Laborel, J. 1974. West African reef corals, and hypothesis on their origin. *Proceedings of the Second International Symposium on Coral Reefs' Brisbane* vol. 1: 425–443.
- Lacroix, E. 1930. Les Lituolides de plateau continental méditerranéen entre Saint-Raphael et Monaco. *Bulletin de l'Institut Océanographique Monaco*, 549: 547-550.
- Lalicker, C. G., Mcculloch I. 1940. Some Textulariidae of the Pacific Ocean. *Allan Hancock Pacific Expeditions*, 6 (6): 115-143.
- Lamarck, J. B. 1804. Suite des mémoires sur les fossils des environs de Paris. *Annales du Muséum national d'histoire naturelle*, 5 : 349-357.
- Lamarck, J. B. 1816. *Histoire naturelle des animaux invertébrés* 2. Paris, Verrière.
- Langer, M. R. 1992. New Recent foraminiferal genera and species from the lagoon at Madang, Papua New Guinea. *Journal of Micropalaeontology*, 11: 85-93.
- Langer, M. R. 1999. Origin of foraminifera: conflicting molecular and paleontological data? *Marine Micropaleontology* 38: 1–5.

- Langer, M. R. 2008a. Foraminifera from the Mediterranean and the Red Sea. In: Por, F. D. (Ed.), *Aqaba-Eilat, the Improbable Gulf: Environment, Biodiversity and Preservation*. Magnes Press, Jerusalem, pp. 399–417.
- Langer, M. R. 2008b. Assessing the contribution of foraminiferal protists to global ocean carbonate production. *J Eukary Microbiol.* 5: 163–169.
- Langer, M.R., Fajemila, O.T., Mannl, S., 2016. Assemblages of recent intertidal mangrove foraminifera from the Akanda National Park, Gabon: sea level proxies preserved in faunal assemblages. *Neues Jahrbuch für Geologie und Paläontologie, Abhandlungen* 281 (3), 327–338.
- Langer, M. R., Hottinger, L. 2000. Biogeography of selected “larger” foraminifera. *Micropaleontology* 46, suppl. 1: 105–126.
- Langer, M. R., Lipps, J. H. 2003. Foraminiferal distribution and diversity, Madang Reef and Lagoon, Papua New Guinea. *Coral Reefs*, 22: 143-154.
- Langer, M. R., Lipps, J. H. 2006. Assembly and persistence of foraminifera in introduced mangroves on Moorea, French Polynesia. *Micropaleontology*, 52(4): 343-355.
- Langer, M. R., Mouanga, G. H. 2016. Invasion of amphisteginid foraminifera in the Adriatic Sea. *Biological Invasions*, 18(5): 1335-1349. DOI 10.1007/s10530-016-1070-0
- Langer, M. R., Mouanga, G. H., Fajemila, O. T. 2016. Shallow-water nearshore benthic foraminifera assemblages from Gabon. *Micropaleontology*, 62(1): 69-80.
- Langer, M. R., Schmidt-Sinns, J. 2006a. Architecture, ontogenetic development and biogeographic distribution of *CribrroElphidium mirum*, a new species of benthic foraminifera from South Africa and Namibia (S-Atlantic Ocean). *Neues Jahrbuch für Geologie und Paläontologie, Monatshefte*, 11, pp. 667-682.
- Langer, M. R., Schmidt-Sinns, J. 2006b. Biogeography of modern benthic foraminifera from South Africa, Namibia and Mozambique. *Annales do Instituto de* 29: 686-687.
- Langer, M. R., Silk, M. T., Lipps, J. H. 1997. Global ocean carbonate and carbon dioxide production: the role of reef foraminifera. *Journal of Foraminifera Research* 27: 271–277.
- Langer, M. R., Thissen, J. M., Makled, W., Weinmann, A. E. 2013. The foraminifera from the Bazaruto Archipelago (Mozambique). *Neues Jahrbuch für Geologie und Paläontologie, Abhandlungen* 297, 155-170.
- Langer, M. R., Weinmann, A. E., Lötters, S., Bernhard, J. M., Rödder, D. 2013b. Climate-Driven Range Extension of *Amphistegina* (Protista, Foraminiferida): Models of Current and Predicted Future Ranges. *PLoS ONE* doi: <http://dx.plos.org/10.1371/journal.pone.0054443>
- Langer, M. R., Weinmann, A. E., Lötters, S., Rödder, D. 2012. “Strangers” in Paradise: Modeling the biogeographic range expansion of the foraminifera *Amphistegina* in the Mediterranean Sea. *Journal of Foraminiferal Research* 42: 234–244.
- Larsen, A. R. 1976. Studies of recent *Amphistegina*, taxonomy and some ecological aspects. *Israel Journal of Earth Sciences*, 25: 1-26.

- Larsen, A. R. 1978. Phylogenetic and paleobiogeographic trends in the foraminiferal genus *Amphistegina*. *Revista Española de Micropaleontología*, 10: 217-243.
- Larsen, A. R. 1982. Foraminifera from off the west coast of Africa. *Atlantide Report* 13, 49-149.
- Le Cadre, V., Debenay, J.-P. 2006. Morphological and cytological responses of *Ammonia* (foraminifera) to copper contamination: Implication for the use of foraminifera as bioindicators of pollution. *Environmental Pollution*, 143 (2), 304-317.
- Le Calvez, Y. (1965) Les foraminifères. In: Guilcher A, Berthois L, Le Calvez Y, Battistini R, Crosnier A (eds.) Les récifs coralliens et le lagon de l'île Mayotte (Archipel des Comores, Océans Indien). *Cahiers du Office de la Recherche Scientifique et Technique Outre-mer* 11: 181–201.
- Le Calvez, J., Le Calvez, Y. 1958. Répartition des foraminifères dans la baie de Villefranche. I Miliolidae. *Annales de l'Institut Océanographique*, Paris, 35: 159-234.
- Le Calvez, Y. 1977. Révision des foraminifères de la collection d'Orbigny. II - Foraminifères de l'île de Cuba. *Cahiers de Micropaléontologie*, 1977 (1): 1-127.
- Le Calvez, Y., Salvat, B. 1980. Foraminifères des récifs et lagons coralliens de Moorea, île de la Société. *Cah. Micropal.* 4: 1–15.
- Lee, J. J., Anderson, O. R. 1991. 'Symbiosis in Foraminifera', in: Lee, J.J. and Anderson, O.R.(eds.), *Biology of Foraminifera*, Academic Press, New York, pp. 157–220.
- Leipnitz, I. I., Ferreira, F., Jardim Leão, C., Armynot du Châtelet, E., et al. 2014. Foraminiferal and testate amoeba diversity, distribution and ecology in transitional environments of the Tramandaí Basin (Rio Grande do Sul, South Brazil). *Marine Biodiversity*, 44, 415-434.
- Lenhardt, X. 1991. Hydrodynamique des lagons d'atoll et d'île haute en Polynésie française. Coll études thèses. ORSTROM, Paris
- Levitus, S. 1982. Climatological atlas of the world ocean. NOAA Prof. Paper. U.S. Govt. Print. Off. Washington, D.C., 13, 173 pp.
- Levy, A., Mathieu, R., Poignant, A., Rosset-Moulinier, M. 1992, The Miliolacea with *Quinqueloculina* and *Triloculina* morphology from the Mediterranean, in Y. Takayanagi and T. Saito, eds. *Studies in Benthic Foraminifera. Proceedings of the Fourth International Symposium on Benthic Foraminifera, Sendai. 1990*. Tokai University Press, p. 117-125.
- Levy, A., Mathieu, R., Poignant, A., Rosset-Moulinier, M., Rouvillois, A. 1982. Données nouvelles sur *Rotalia trochidiformis* Lamarck (Foraminifera). Emendation du genre *Rotalia* Lamarck 1804. *Geologie Méditerranéenne* 9:33-41
- Licari, L., Mackensen, A. 2005. Benthic foraminifera off West Africa (1°N to 32°S): Do live assemblages from the topmost sediment reliably record environmental variability? *Marine Micropaleontology* 55: 205–233.
- Licari, L. N., Schumacher, S., Wenzhöfer, F., Zabel, M., Mackensen, A. 2003. Communities and microhabitats of living benthic foraminifera from the tropical east Atlantic: impact of different productivity regimes. *Journal of Foraminiferal Research* 33 (1), 10–31.

- Linnaeus, C. 1758. *Systema naturae per regna tria naturae, secundum classes, ordines, genera, species, cum characteribus, differentiis, synonymis, locis*. G. Engelmann, 10: 1-824.
- Lipps, J. H. 2011. Reef restoration - the good and the bad, a paleobiologic perspective. *Paleontol Soc Papers*. 17:139-152.
- Lipps, J. H., Langer, M. R. 1999. Benthic foraminifera from the meromictic Mecherchar Jellyfish Lake, Palau (western Pacific). *Micropaleontology*, 45: 278–284.
- Lobegeier, M. K. 2002. Benthic foraminifera of the family Calcarinidae from Green Island Reef, Great Barrier Reef Province. *Journal of Foraminiferal Research*, 32, p. 201-216,
- Lobegeier, M. 2001. Foraminiferal assemblages and their bulk contribution to carbonate sediment, Green Island Reef, Great Barrier Reef Province. Unpublished Ph.D. Thesis, James Cook University, Townsville, 457 p.
- Loeblich, A. R. Jr., Tappan, H., 1957. Eleven new genera of Foraminifera. *United States National Museum Bulletin*, 215: 223-232.
- Loeblich, A. R., Jr., Tappan, H. 1961. Suprageneric classification of the Rhizopodea. *Journal of Paleontology* 35:245-330.
- Loeblich, A. R., Jr., Tappan H. 1962. Six new generic names in the Mycetozoida (Trilehiidae) and Foraminiferida (Fischerinidae, Buliminidae, Caucasinidae and Pleurostomellidae), and a redescription of *Loxostomum* (Loxostomidae, new family). *Proceedings of the Biological Society of Washington* 75: 107-113.
- Loeblich, A. R. Jr., Tappan, H. 1964. "Protista 2: Sarcodinia, chiefly 'Thecamoebians' and Foraminiferida". In: *Treatise on Invertebrate Palaeontology*, Geological Society of America and University of Kansas Press, Lawrence, Kansas 2 vol.: 1-900.
- Loeblich, A. R., Jr., Tappan H. 1985. Some new and redefined genera of agglutinated foraminifera II. *Journal of Foraminiferal Research*, 15: 175-217.
- Loeblich, A. R., Jr., Tappan H. 1987. *Foraminiferal genera and their classification*. Van Nostrand Reinhold Company, New York, 1, 970 p., 2, 847 pl.
- Loeblich, A. R. Jr., Tappan, H. 1994. Foraminifera of the Sahul Shelf. *Cushman Foundation for Foraminiferal Research*, Special Publication 31: 1-661.
- Loeblich, A. R., Tappan, H. 1987. Foraminiferal genera and their classification. Van Nostrand Reinhold Co, New York, 2 vol., 970 + 847 pp.
- Loeblich, A. R., Tappan, H. 1994. Foraminifera of Sahul Shelf and Timor Sea. *Cushman Foundation Foraminiferal Research*, Special Publications 31: 1-237 pp.
- Loeuff, P. L., Von Cosel, R. 1998. Biodiversity patterns of the marine benthic fauna on the Atlantic coast of tropical Africa in relation to hydroclimatic conditions and paleogeographic events. *Acta Oecologica* 19: 309–321. doi: 10.1016/s1146-609x(98)80035-0
- Locklin, J. A., Maddocks, R. F. 1982. Recent foraminifera around petroleum production platforms on the southwest Louisiana shelf. *Gulf Coast Association of Geological Societies Transactions* 32: 377–397.

- Luczkowska, E., 1971. *Inaequalina* n. gen. (Foraminiferida, Miliolina) and its stratigraphic distribution. Nowy rodzaj *Inaequalina* (Foraminiferida, Miliolina) i jego zasięg stratygraficzny. *Rocznik Polskiego Towarzystwa Geologicznego* (1970) 40:439-443.
- Luiz, O. J., Madin, J. S., Robertson, D. R., Rocha, L. A., Wirtz, P., Floeter S. R. 2012. Ecological traits influencing range expansion across large oceanic dispersal barriers: Insights from tropical Atlantic reef fishes. *Proceedings of the Royal Society B: Biological Sciences* 279(1730):1033-40.
- Lutze, G. F. 1974. *Benthische Foraminiferen in Oberflächen-Sedimenten des Persischen Golfes*. Teil 1: Arten. Meteor Forschungsergebnisse, Deutsche Forschungsgemeinschaft, Reihe C Geologie und Geophysik, Gebrüder Bornträger, Berlin, Stuttgart, C17, 1-66.
- Macfadyen, W. A. 1939. On *Ophthalmidium*, and two new names for Recent foraminifera of the family Ophthalmidiidae. *Journal of the Royal Microscopical Society* 59:162-169.
- Madeira-Falsetta, M. 1974. Ecological distribution of thecamoebians and foraminifera associations in the mixohaline environments of the Southern Brazilian Littoral: *Anais da Academia Brasileira de Ciências* 46, 667-687.
- Makled, W. A., Langer, M. R. 2011. Benthic Foraminifera from the Chuuk Lagoon Atoll System (Caroline Islands, Pacific Ocean). *Neues Jahrbuch für Geologie und Paläontologie, Abhandlungen* 259: 231–249.
- Marie, P. A. 1940. Propos des foraminifères d'un sable de plage provenant de Tahiti. *Bull Mus Nat d'Hist Nat Ser 2*, 12: 348–50
- Martin, R. A. 1986. The habitat and distribution of *Archaias angulatus* (Fichtel and Moll) (Miliolidae, Soritidae) Northern Florida Keys. *Journal of Foraminiferal Research* 16: 201–206.
- Martin, R. A. 1981. Benthic foraminifera from the Orange-Lüderitz shelf southern African continental margin. Mar. Geosc. Unit, *University Cape Town Bulletin* 11: 1-75.
- Martin, R. A., Nesbitt, E. A. 2015. Foraminiferal evidence of sediment toxicity in anthropogenically influenced embayments of Puget Sound, Washington, U.S.A. *Marine Micropaleontology*, v. 121, p. 97–106
- Maync, W. 1950. The foraminiferal genus *Choffatella* SCHLUMBERGER in the Lower Cretaceous (Urgonian) of the Caribbean region (Venezuela, Cuba, Mexico and Florida).- *Ecologae geologicae Helvetiae, Basel*, vol. 42, n° 2, p. 529-547
- Maync, W. 1952. Critical taxonomic study and nomenclatural revision of the Lituolidae based upon the prototype of the family, *Lituola nautiloidea* Lamarck, 1804. - *Contr. Cushman Lab. foramin. Res., Sharon*, 3:35-56, plates 9-12.t
- McCulloch, I. 1977. *Qualitative observations on Recent foraminiferal tests with emphasis on the Eastern Pacific parts I, II, III*. University of Southern California, Los Angeles, 676 p., 200 pls.
- McCulloch, I. 1981. *Qualitative observations on Recent foraminiferal tests. Part IV, with emphasis on the Allan Hancock Atlantic Expedition collections*. University of Southern California, Los Angeles, 362 p., 72 pls.

- Mcglade, J. M., Cury, P., Koranteng, K. A., Hardman-Mountford, N. J. 2002. The Gulf of Guinea Large Marine Ecosystem: environmental forcing and sustainable development of marine resources. *Amsterdam: Elsevier Science*, 428 pp.
- McMillan, I. K. 1974. Recent and relict foraminifera from Agulhas Bank, South African Continental Margin. Unpublished Master thesis, University College Wales, Aberystwyth, Wales.
- McMillan, I. K. 1986. Cenozoic planktonic and larger foraminifera distributions around southern Africa and their implications for past changes of oceanic water temperatures. *South African Journal of Science* 82: 66–69.
- Michie, M. G. 1987. Distribution of foraminifera in a macrotidal tropical estuary: Port Darwin, Northern Territory of Australia: Australian. *Journal of Marine and Freshwater Research*, v. 38, p. 249-259.
- Mikhalevich, V. I. 1983. The bottom foraminifera from the shelves of the Tropical Atlantic. *Zoological Institute Russian Academy of Sciences, Leningrad*, 247 pp.
- Mikhalevich, V. I. 2008. Zoogeography of the bottom Foraminifera of the West-African Coast. *eEarth Discuss.*, 3: 1-9.
- Mikhalevich, V. I., Kaminski, M. A. 2008. Revised Systematics of the Schlumbergerinida (Phylum Foraminifera). In M.A. Kaminski & R. Coccioni (eds.), Proceedings of the Seventh International Workshop on Agglutinated Foraminifera. *Grzybowski Foundation Special Publication* 13: 157-166.
- Millett, F. W. 1898-1904. Report on the Recent Foraminifera of the Malay Archipelago collected by Mr. A. Durrand, F.R.M.S. *Journal of the Royal Microscopical Society*.;5: Parts 1–17
- Millett, F. W. 1898a. Report on the recent foraminifera of the Malay Archipelago collected by Mr A. Durrand, F.R.M.S. *Journal of the Royal Microscopical Society*, 1898: 258-269.
- Millett, F. W. 1898b. Report on the recent foraminifera of the Malay Archipelago collected by Mr A. Durrand, F.R.M.S, Part II. *Journal of the Royal Microscopical Society*, 1898: 497-513.
- Millett, F. W. 1898c. Report on the recent foraminifera of the Malay Archipelago collected by Mr A. Durrand, F.R.M.S, Part III. *Journal of the Royal Microscopical Society*, 1898: 607-614.
- Millett, F. W. 1898d. Additions to the list of foraminifera from the St. Erth Clay. *Transactions of the Royal Geological Society of Cornwall*, 12: 174-176.
- Millett, F. W. 1899a. Report on the recent foraminifera of the Malay Archipelago collected by Mr A. Durrand, F.R.M.S, Part V. *Journal of the Royal Microscopical Society*, 1899: 356-365.
- Millett, F. W. 1899b. Report on the recent foraminifera of the Malay Archipelago collected by Mr A. Durrand, F.R.M.S, Part VI. *Journal of the Royal Microscopical Society*, 1899: 556-564.

- Millett, F. W. 1900a. Report on the recent foraminifera of the Malay Archipelago collected by Mr A. Durrand, F.R.M.S, Part VIII. *Journal of the Royal Microscopical Society*, 1900: 273-281.
- Millett, F. W. 1900b. Report on the recent foraminifera of the Malay Archipelago collected by Mr A. Durrand, F.R.M.S, Part IX. *Journal of the Royal Microscopical Society*, 1900: 539-549.
- Millett, F. W. 1903a. Report on the Recent foraminifera of the Malay Archipelago collected by Mr A. Durrand, F.R.M.S Part XIV. *Journal of the Royal Microscopical Society*, 1903: 253-275.
- Millett, F. W. 1903b. Report on the Recent foraminifera of the Malay Archipelago collected by Mr A. Durrand, F.R.M.S Part XV. *Journal of the Royal Microscopical Society*, 1903: 685-704.
- Mills, F. W. 1932. Some diatoms from Warri, South Nigeria. *Journal of the Royal Microscopical Society* 52 (4), 383–394.
- Milne-Edwards, A. 1882. Rapport sur les travaux de la Commission chargée d'étudier la faune sous-marine dans les grandes profondeurs de la Méditerranée et de l'Océan Atlantique. *Archives des Missions Scientifiques et Littéraires*. Paris, ser. 3 (9): 1-59.
- Miranda Castro, B. M., Kjerfve, B. 2002. Princípios de Oceanografia Física de Estuários. *Sao Paulo, EDUSP* 42, 424pp.
- Möbius, K. A. 1880. "Foraminifera von Mauritius". In Möbius K. A., Richter, F., von Martens E. (eds): *Beiträge zur Meeresfauna der Insel Mauritius und der Seychellen*, Gutman, Berlin: 65-122.
- Monier, C. 1973. Note préliminaire sur les foraminifères benthiques du platier interne du grand récif de Tuléar (Madagascar). *Téthys* 5: 241–250.
- Montaggioni, L. F. 1981. Les associations de foraminifères dans les sédiments de récifaux de l'archipel des Mascareignes (Océan Indien). *Annales des Instituts d'Océanographie* 57: 41–62.
- Montagu, G. 1803. *Testacea Britannica, or natural history of British shells, marine, land, and fresh-water, including the most minute*. J. S. Hollis, Romsey, England.
- Montagu, G. 1808. *Testacea Britannica; supplement*. Exeter. England. J. S. Hollis. MONFORT D. de, 1808 – *Conchyliologie systématique et classification méthodique des coquilles*. Paris, Schoell.
- Morvan, J., Le Cadre, V., Jorissen, F. J., Debenay, J. P. 2004. Foraminifera as potential bio-indicators of the "Erika" oil spill in the Bay of Bourgneuf: Field and experimental studies. *Aquatic Living Resources* 17: 317–322. doi: 10.1051/alr:2004034
- Mouanga, G. H., Langer, M. R. 2014. At the front of expanding ranges: Shifting community structures at amphoteginid species range margins in the Mediterranean Sea. *Neues Jahrbuch für Geologie und Paläontologie, Abhandlungen* 271: 141–150. doi: 10.1127/0077-7749/2014/0381

- Moura, A. R. 1965. Foraminíferos da Ilha da Inhaca. In: Revista dos estudos gerais universitários de Moçambique. *Ciências Biológicas e Agronómicas* 2: 1–109.
- Munier-Chalmas, E., 1882. [La structure des Triloculines et des Quinqueloculines. *Bulletin de la Société Géologique de France* (1881-1882) ser. 3 10:424-425.
- Murray, J. W. 1968. Living Foraminifers of Lagoons and Estuaries. *Micropaleontology*, Vol. 14, No. 4, pp. 435-455.
- Murray, J. W. 1971. Living foraminiferids of tidal marshes: A review. *Journal of Foraminifera Research* 1, 153-161.
- Murray, J. W. 1973. Distribution and ecology of living benthic foraminiferids. New York: Crane Russak.
- Murray, J. W. 1991. Ecology and palaeoecology of benthic foraminifera. *Longman Scientific and Technical, London*, 397pp.
- Murray, J. W., Alve, E. 2002. Benthic foraminifera as indicators of environmental change: marginal-marine, shelf and upper-slope environments. In: Haslett, S.K. (Ed.), Quaternary Environmental Micropaleontology, Edward Arnold (Publishers) Limited, London, pp. 59–90.
- Nagy, J., Hess, S., Dypvik, H., Bjærke, T. 2011. Marine shelf to paralic biofacies of Upper Triassic to Lower Jurassic deposits in Spitsbergen. *Palaeogeography, Palaeoclimatology, Palaeoecology* 300, 138–151. doi: 10.1016/j.palaeo.2010.12.018.
- Neagu, T. 1982. Foraminifères récents de la zone du récif coralligène de l'île de Mbudya (Côte orientale de la Tanzanie). *Revista Española de Micropaleontología* 14: 99–136.
- Nomura, R. 1983. Cassidulinidae (Foraminiferida) from the Uppermost Cenozoic of Japan (Parts 1 and 2). *Tohoku University Science Reports, Sendai, Japan, 2nd series (Geology)*, 53: 1-101; 54: 1-93.
- Orbigny, A. d'. 1826. Tableau méthodique de la classe des Céphalopodes, 3e Ordre, Foraminifères. *Annales de Sciences Naturelles*, 7: 254-314.
- Orbigny, A. d'. 1839^a. « Foraminifères ». In de la Sagra R. (ed.): *Histoire physique, politique et naturelle de l'île de Cuba*, Paris, Arthus Bertrand: 1-224.
- Orbigny, A. d'. 1839^b. « Foraminifères des îles Canaries ». In: Barker-Web P., Berthelot S. (eds): *Histoire naturelle des îles Canaries*, Paris, Bethune, 2 (Zoologie) : 119-146.
- Orbigny, A. d'. 1839^c. *Voyage dans l'Amérique méridionale, foraminifères*. Levrault, Paris and Strasbourg, vol. 5, 86 p.
- Orbigny, A. d'. 1846. *Foraminifères fossiles du bassin tertiaire de Vienne (Autriche)*. Paris, Gide et Compe, 312 p.
- Olayiwola, M. A., Odebo, M. O. 2013. Statistical analysis of planktic foraminifera of the surface continental shelf sediments off southwestern Nigeria. *Ife Journal of Science* 15 (3), 575-590.

- Onuoha, P. C., Nwankwo, D. I., Vyverman, W. 2010. A checklist of phytoplankton species of Ologe Lagoon, Lagos southwestern Nigeria. *Journal of American Science* 6 (9), 297-302.
- Parker, J. H. 2009. Taxonomy of Foraminifera from *Ningaloo Reef*, Western Australia. *Association of Australasian Palaeontologists, Memoir* 36, 1-810.
- Parker, J. H., Gischler, E. 2011. Modern foraminiferal distribution and diversity in two atolls from the Maldives, Indian Ocean. *Marine Micropaleontology* 78: 30–49.
- Parker, W. C., Arnold, A. J. 1999. Quantitative methods of data analysis in foraminiferal ecology. In: Sen Gupta, BK., editor. *Modern Foraminifera*. Dordrecht: Kluwer, pp. 71–89.
- Parker, F. L. 1954. Distribution of the foraminifera in the north-eastern Gulf of Mexico. *Bulletin of the Museum of Comparative Zoology at Harvard College*, 111: 453-588.
- Parker, J. H. 2009. Taxonomy of Foraminifera from Ningaloo Reef, Western Australia. *Memoirs of the Association of Australasian Palaeontologists*, 36: 1-810.
- Parker, J. H., Gischler, E. 2011. Modern foraminiferal distribution and diversity in two atolls from the Maldives, Indian Ocean. *Marine Micropaleontology*, 78: 30-49.
- Parker, W. K., Jones, T. R. 1859. On the nomenclature of the foraminifera. II. On the species enumerated by Walker and Montagu. *Annals and Magazine of Natural History*, series 3, 4: 333-351.
- Parker, W. K., Jones T. R., 1860 – On the nomenclature of the foraminifera. 4 (continued). *Annals and Magazine of Natural History*, series 3, 4: 333-351.
- Parker, W. K., Jones T. R., 1865 – On some foraminifera from the North Atlantic and Arctic Oceans, including Davies Straits and Baffin’s Bay. *Philosophical Transactions of the Royal Society*, 155: 325-441.
- Parr, W. J. 1932. Victorian and South Australian foraminifera - *Proceedings of the Royal Society of Victoria*, 44, Part I: 1-14; Part II: 218-234.
- Parr, W. J. 1942. New genera of foraminifera from the Tertiary of Victoria. *Mining and Geological Journal* 2:361-363.
- Parr, W. J. 1945. Recent Foraminifera from Barwon Heads, Victoria. *Proceedings of the Royal Society of Victoria*, 56: 189-227.
- Patterson, R. T. 1985. *Abditodentrix*, a new foraminiferal genus in family Bolivinitidae. *Journal of Foraminiferal Research* IS: 138-140
- Patterson, R. T., Baker, T., Burbridge, S. M. 1996. Arcellaceans (Thecamoebians) as proxies of arsenic and mercury contamination in northeastern Ontario lakes. *Journal of Foraminiferal Research* 26 (2), 172-183.
- Payri, C. E. 1987. Zonation and seasonal variation of the commonest algae on Tiahura Reef (Moorea Island, French Polynesia). *Bot Mar.* 30: 141–149.
- Peltier, W. R. 2002. On eustatic sea level history: Last Glacial Maximum to Holocene: *Quaternary Science Reviews*, v. 21, p. 377-396.

- Penin, L., Adjeroud, M., Schrimm, M., Lenihan, H. S. 2007. High spatial variability in coral bleaching around Moorea (French Polynesia): patterns across locations and water depths. *C.R. Biologies*. 330: 171–181.
- Pereira, C. P. G. 1979. Foraminiferal distribution and ecology in the fringing reef complex of the coast, near Mombasa, Kenya. – *Unpubl. PhD thesis, University of Wales, Aberystwyth*, 480 pp.
- Pereira, E. R., Eichler, P. P. B., Eichler, B. B. 2006. Foraminifera as proxies in environmental diagnostic in Guanabara Bay, RJ. *Journal of Coastal Research* SI 39 (Proceedings of the 8th International Coastal Symposium), 1395 - 1398.
- Perelis, L., Reiss Z., 1975. Cibicididae from the Gulf of Elat. *Israel Journal of Earth Sciences*, 24: 73-96.
- Perry, C.T. 2003. Coral reefs in a high-latitude, siliciclastic barrier island setting: reef framework and sediment production at Inhaca Island, southern Mozambique. *Coral Reefs* 22: 485–497.
- Petri, S. 1957. Foraminíferos miocênicos da Formação Pirabas. *Boletim da Faculdade de Filosofia, Ciências e Letras, Universidade de São Paulo, São Paulo*, 216: 1-79.
- Phillips, O. A., Falana, A. O., Oláyíwolá, M. A. 2012. Assessment of environmental impact on benthic foraminiferal distribution in Lagos Lagoon, Nigeria. *Journal of Mining and Geology* 48 (1), 71–81.
- Phleger, F. B. 1976a. Holocene ecology in St. Lucia lagoon, Zululand based on foraminifera. *The St. Lucia scientific advisory council workshop meeting. Charters Creek, 15-17 February 1976*: 1– 8.
- Phleger, F. B. 1976b. Foraminiferal and ecological processes in St. Lucia Lagoon, Zululand. *1st International Symposium on benthonic foraminifera of continental margins. Maritime Sediments Special Publication 1*: 195–204.
- Phleger, F. B., Parker F. L., Peirson J. F. 1953. North Atlantic Foraminifera. *Reports Swedish Deep-Sea Expedition*, 7: 1-122.
- Pignatti J, Frezza V, Benedetti A, Carbone F, Accordi G, Matteucci R (2012) Recent foraminiferal assemblages from mixed carbonate-siliciclastic sediments of southern Somalia and eastern Kenya. *Italian Journal of Geoscience* 131: 47–65.
- Piller, W. 1978. Involutinacea (Foraminifera) der Trias und des Lias. *Beiträge zur Paläontologie von Österreich* 5: 1-64.
- Ponder, R. W. 1972. *Pseudohauerina*: a new genus of the Miliolidae and notes on three of its species. *Journal of Foraminiferal Research* 2: 145-156.
- Ponder, R. W. 1974a. The foraminiferal genus *Miliolinella* Wiesner, 1931, and its synonyms. *Micropaleontology* 20: 197-208.
- Ponder, R. W., 1974c. The ontogeny, morphology, taxonomy and distribution of the miliolid foraminiferan *Quinqueloculina philippinensis* Cushman, 1921. *Proceedings of the Linnean Society of New South Wales* 98:242-250.

- Ponder, R. W. 1975. Notes on the foraminiferal genus *Hauerina* and three of its species from North Queensland, Australia. *Journal of Natural History* 9: 1-28.
- Pouličková, A., Jahn, R. 2007. *Campylodiscus clypeus* (Ehrenberg) Ehrenberg ex Kützing: Typification, morphology and distribution. *Diatom Research* 22, 135-146.
- Puri, H. S. 1954. Contribution to the study of the Miocene of the Florida panhandle. *Bulletin Florida State Geological Survey* 36: 1-345
- Qin, Y., Fournier, B., Lara, E., Gu, Y., et al. 2013. Relationships between testate amoeba communities and water quality in Lake Donghu, a large alkaline lake in Wuhan, China. *Frontiers of Earth Science* 7, 1-9.
- Quammen, D. 2003. Africa's new parks. – In: National Geographic Magazine, September 2003. <http://ngm.nationalgeographic.com/ngm/0309/feature3/fulltext.html>.
- Rasheed, D. A. 1971. Some foraminifera belonging to Miliolidae and Ophalmidiidae from the Coral Sea, south of Papua (New Guinea), Part 2. *Journal of the Madras University, Section B*, 37-38: 19-68.
- Rauzer-Chernousova, D. M., Fursenko, A. V. 1959. eds.. *Osnovy Paleonologii, Obshchaya chast'*, Prosteyshie [Principles of Paleontology, part I, Protozoa]. Moscow: Akademiya Nauk SSSR. 368 p.
- Reichel, M. 1937. Étude sur les Alvéolines, II. *Schweizerische Paläontologische Abhandlung*, 59: 95-147.
- Reinhardt, E. G., Little, M., Donato, S., Findlay, D., et al. 2005. Arcellacean (thecamoebian) evidence of land-use change and eutrophication in Frenchman's Bay, Pickering, Ontario. *Environmental Geology* 47, 729–739.
- Reiss, Z. 1963. Reclassification of perforate foraminifera. *Bulletin of the Geological Survey of Israel* 35:1-111.
- Reiss, Z., Hottinger, L. 1984: The Gulf of Aqaba- Ecological Micropaleontology. *Ecological Studies* 50. Springer-Verlag, Berlin, 354p
- Renema, W. 2003. Foraminifera on reefs around Bali (Indonesia). *Zoologische Verhandelingen*, 345: 337-366.
- Renema, W. 2006. Habitat variables determining the occurrence of large benthic foraminifera in the Berau area (East Kalimantan, Indonesia). *Coral Reefs* 25: 351-359.
- Renema, W. 2008. Habitat selective factors influencing the distribution of larger benthic foraminiferal assemblages over the Kepulauan Seribu. *Marine Micropaleontology* 68: 286-298.
- Reuss, A. E., 1848. Die fossilen Polyparien des Wiener Tertiärbeckens. *Haidengers Naturwissenschaftliche Abhandlungen, Wien*, 2: 1-109.
- Reuss, A. E. 1850. Neues Foraminiferan aus den Schichten des österreichischen Tertiärbeckens. *Denkschriften der Kaiserlichen Akademie der Wissenschaften. Mathematisch-Naturwissenschaftliche Klasse*, 1: 365-390.

- Reuss, A. E. 1858. Ueber die Foraminiferen von Pietzpuhl. *Zeitschrift der Deutschen Geologischen Gesellschaft, Berlin*. 10, 433- 438.
- Reuss, A. E. 1860. Die Foraminiferen der Westphälischen Kreideformation. *Sitzungsberichte der K. Akademie der Wissenschaften in Wien. Mathematisch-Naturwissenschaftliche Classe* 40:147-238.
- Reuss, A. E. 1860. Die Foraminiferen der Westphälischen Kreideformation. *Sitzungsberichte der K. Akademie der Wissenschaften in Wien. Mathematisch-Naturwissenschaftliche Classe* 40:147-238.
- Reuss, A. E. 1861. Beiträge zur Kenntnis der tertiären Foraminiferen Fauna: *Sitzungsberichte der Kaiserlichen Akademie der Wissenschaften. Mathematisch-Naturwissenschaftliche Klasse in Wien*, 42: 355-370.
- Reuss, A. E., Fritsch, A. 1861. Verzeichniss von 100 Gypsmodellen von Foraminiferen, welche unter der Leitung des Prof. Dr. A. Reuss und Dr. Anton Fritsch gearbeitet wurden. Prague: Karl seyfried.
- Revs, S. A. 1993. The revision of the genus *Elongobula* Finlay 1939. *Journal of Foraminiferal Research*, 23: 254-266.
- Revs, S. A. 1996. The generic revision of five families of rotaliine foraminifera: Part I. The Bolivinitidae. *Cushman Foundation for Foraminiferal Research Special Publication*, 34: 1-55.
- Revs, S. A. 2000. Foraminifera of Leschenault Inlet *Journal of the Royal Society of Western Australia*, 83: 365–375.
- Reymond, C. E., Mateu-Vicens, G., Westphal, H. 2014. Foraminiferal assemblages from a transitional tropical upwelling zone in the Golfe d'Arguin, Mauritania. *Estuarine Coastal and Shelf Science* 148: 70-84. <http://dx.doi.org/10.1016/j.ecss.2014.05.034>
- Rhumbler, L. 1936. Rhizopoden der Kieler Bucht. gesammelt durch A. Remane, II Teil. (Ammodisculinidae bis einschl. Textulinidae). *Kieler Meeresforschungen* I: 179-242.
- Richard, G. 1982. Mollusques lagunaires et récifaux de Polynésie Française. Inventaire faunistique, bionomie, bilan quantitatif, croissance, production. D. Sci. Thesis, University of Paris. 1982
- Richard, G. 1985. Fauna and flora, a first compendium of French Polynesian sea-dwellers. *Proc 5th Int Coral Reef Congr.* 1: 379-520.
- Roberts, C. M., McClean, C. J., Veron, J. E. N, Hawkins, J. P., Allen, G. R., McCallister, D. E., Mittermeier, C. G., Schueler, F. W., Spalding, M., Wells, F., Vynne, C., Werner, T. B. 2002. Marine biodiversity hotspots and conservation priorities for tropical reefs. *Science* 295: 1280-1284. doi: 10.1126/science.1067728
- Rougerie, F., Fichez, R., Dejardin, P. 1997. Geomorphology and Hydrogeology of selected Islands of French Polynesia: Tikehau (Atoll) and Tahiti (Barrier Reef). In: Geology and Hydrogeology of Carbonate Islands. Developments in Sedimentology, 54, p. 475-502. Vacher, H. L. and Quinn T (Eds) Elsevier Science.

- Round, F. E., Crawford, R. M., Mann, D. G. 1990. The Diatoms. Biology and morphology of the genera. *Cambridge University Press*, Cambridge pp. 747.
- Rögl, F., Hansen, H. J. 1984. Foraminifera described by Fichtel & Moll in 1798. A revision of Testacea Microscopica. Appendix Testacea Microscopica alique minuta ex Generibus Argonauta et Nautilus. Reprint of original plates. *Neue Denkschriften des Naturhistorischen Museum in Wien 3:1-143*.
- Sabean, J. A., Scott, D. B., Lee, K., Venosa, A. D. 2009. Monitoring oil spill bioremediation using marsh foraminifera as indicators. *Marine Pollution Bulletin* 59:352-361. doi:10.1016/j.marpolbul.2009.08.013.
- Said, R. 1949. Foraminifera of the northern Red Sea. *Cushman Laboratory of Foraminiferal Research Special Publication*, 26: 1-44.
- Saidova, Kh. M. 1975. *Bentosyne foraminifery Tikhogo Okeana* [Benthonic foraminifera of the Pacific Ocean]. Institut Okeanologii im. P.P. Shirshova, Akademiya Nauk SSSR, Moskva. [Russian]
- Saidova Kh. M. 1981. *O sovremennomsostoyanii sistemy nadvidovykh taksonov Kaynozoykskikh bentosnykh foraminifer (On an up-to-date system of supraspecific taxonomy of Cenozoic benthonic foraminifera)*. Moscow, Institut Okeanologii P.P. Shirshova, Akademiya Nauk SSSR.
- Salvat, B. 1987. Dredging in coral reefs. In: Salvat B., editor. Human impacts on coral reefs: facts and recommendations. Antenne Museum EPHE, French Polynesia p. 166–184
- Salvat, B., Aubanel, A., Adjeroud, M., Bouisset, P., Calmet, D., Chancerelle, Y., Cochenec, N., Davies N., Fougerousse, A., Galzin, R., Lagouy, R., Lo, C., Monier, C., Ponsonnet, C., Remoissenet, G., Schneider, D., Stein, A., Tatarata, M., Villiers, L. 2008. Monitoring of French Polynesia coral reefs and their recent development. *Rev Ecol-La Terre La Vie*, 63: 145–177.
- Salvat, B., Vénec-Peyré, M. T. 1981. The living foraminifera of the Scilly Atoll lagoon (Society Island). *The Reef and Man, Proc Fourth Int Coral Reef Symp, Manila*, 2: 767–774.
- Samuel, O. B., Osibona, A. O., Chukwu, L. O. 2015. Study of heavy metals in the gastropod *Pachymelania aurita* (Muller, 1774), Sediment and Water from Ologe Lagoon, Southwestern Nigeria. *Ife Journal of Science* 17 (3), 565-577.
- Sandison, E. E. 1966. The effect of salinity fluctuations on the life cycle of *Balanuspallidus stutsburi* Darwin in Lagos Harbour, Nigeria. *Journal of Animal Ecology* 35, 363-378.
- Sandison, E. E., Hill, M. B. 1966. The distribution of *Balanuspallidus stutsburi* (Darwin), *Gryphar gasar* (Adanson), *Mercierella enigmatica* (Fauvel) and *Hydroides uncinata* (Philippi) in relation to salinity in Lagos Harbour and adjacent creeks. *Journal of Animal Ecology* 35, 235–250
- Saunders, J. B. 1958. Recent foraminifera of mangrove swamps and river estuaries and their fossil counterparts in Trinidad. *Micropaleontology* 4 (1), 79-92.

- Saunders, J. B. 1957. Trochamminidae and certain Lituolidae (foraminifera) from the recent brackish-water sediments of Trinidad, British West Indies. *Smithsonian miscellaneous contributions*, 134: 1-16.
- Saunders, J. B. 1961. *Helenina* Saunders, new name for the foraminifera genus *Helenia* Saunders 1957, non *Helenia* Walcott, 1880. *Contributions from the Cushman Foundation for Foraminiferal Research* 12:148.
- Savory, H. J. 1953. A note on the ecology of Rhizophora in Nigeria. *Kew Bulletin* 8 (1), 127-128.
- Schafer, C. T. 1970. Studies of benthonic foraminifera in the Restigouche Estuary: I .Faunal distribution pattern near pollution sources. *Maritime sediments* 6, 121-134.
- Schafer, C. T. 1973. Distribution of foraminifera near pollution sources in Chaleur Bay. *Water, Air, and Soil Pollution* 2, 219–233.
- Shennan, I., Horton, B. P. 2002. Holocene land and sea-level changes in Great Britain. *Journal of Quaternary Science*, v. 17, p. 5 11-526.
- Shennan, I., Horton, B. P., Peltier, W. R., Drummond, R. 2002. Global to local scale parameters determining relative sea-level changes and the post-glacial isostatic adjustment of Great Britain: *Quaternary Science Reviews*, v. 21, p. 397-408.
- Schlumberger, C. 1886. Note sur le genre *Adelosina*. *Bulletin de la Société Zoologique de France* 11:91-104.
- Schlumberger, C. 1891. Révision des Biloculines des grands fonds. *Mémoires de la Société Zoologique de France*, 4: 542-579.
- Schlumberger, C. 1893. Monographie des Miliolidées du golfe de Marseille. *Mémoires de la Société Zoologique de France*, 6: 57- 80.
- Schnitker, D. 1971. Distribution of foraminifera on the North Carolina continental Shelf. *Tulane Studies in Geology and Paleontology*, 8: 169-215.
- Schönfeld, J., Alve, E., Geslin, E., Jorissen, F., et al. 2012. The FOBIMO (FORaminiferal BIOMonitoring) initiative - towards a standardized protocol for soft-bottom benthic foraminiferal monitoring studies. *Marine Micropaleontology* 94, 1-13.
- Schott, W. 1955. Die Foraminiferen in den äquatorialen Teil des Atlantischen Ozeans. *Deutsche Südpolar Expedition* 6 (II), 411-616.
- Schmidt-Sinns, J. 2008. Rezente benthische Foraminiferen im Bereich des Benguelastroms, Südwestafrika – Verbreitungsmuster und ihre steuernden Faktoren. *Unpubl. PhD thesis, Mathematisch-Naturwissenschaftliche Fakultät - Universität Bonn*. ULB Bonn http://hss.ulb.unibonn.de/diss_online
- Schubert, R. J. 1904. Die Ergebnisse der mikroskopischen Untersuchung der bei der aerarischen Tiefbohrung zu Welsdurchteuften Schichten. *Jahrbuch Der Kaiserlich-Königlichen Geologischen Reichsanstalt, Wien*, 53: 385-422.

- Schultze, M. S. 1854. *Ueber den Organismus der Polythalamien (Foraminiferen), nebst Bemerkungen über die Rhizopoden im Allgemeinen*. Leipzig. Wilhelm Engelmann.
- Schwager, C. 1866. Fossile Foraminiferen von Kar Nikobar, Reise der Österreichischen Fregatte Novara um die Erde in den Jahren 1857, 1858, 1859 unter den Befehlen des Commodore B. Vo Wüllerstorff-Urbair. *Geologischer Theil 2 (1); Geologische Beobachtungen 2; Paläontologische Mittheilungen*: 187-268.
- Schwager, C. 1877. Quadro del proposto Sistema di classificazione dei foraminiferi con guscio. *Bolletino R. Comitato Geologico d'Italia 8*: 18-27.
- Scott, D. B., Medioli, F. S. 1978. Vertical zonations of marsh foraminifera as accurate indicators of former sea-levels. *Nature*, 272: 528–531.
- Scott, D. B., Medioli, F. S. 1980a. Quantitative studies of marsh foraminiferal distributions in Nova-Scotia Canada: Implications for sea level studies. – *Cushman Foundation for Foraminiferal Research Special Publication*, 17: 1–58.
- Scott, D. B., Medioli, F. S. 1980b. Living versus total foraminiferal populations: Their relative usefulness in paleoecology. *Journal of Foraminiferal Research*, 54: 814-831.
- Scott, D. B., Medioli, F. S. 1986. Foraminifera as sea-level indicators. In: van de Plassche O. (ed.), *Sea-Level Research: A Manual for the Collection and Evaluation of Data*. GEO Books, Norwich, England: 435–456.
- Scott, D. B., Medioli, F. S., Schafer, T. S. 2001. *Monitoring in Coastal Environments Using Foraminifera and Thecamoebian Indicators*. Cambridge University Press, 177pp.
- Scott, D. B., Schnack, E. S., Ferrero, L., Espinosa, M., Barbosa, C. F. 1990. Recent marsh foraminifera from the east coast of South America: comparison to the northern hemisphere. – In: Hemleben, C., Kaminski, M. A., Kuhnt, W., and Scott, D. B. (eds.), *Paleoecology, Biostratigraphy, Paleoceanography and Taxonomy of Agglutinated Foraminifera*, NATO ASI Series C, 327, Math and Physical Sciences: 717–38.
- Scott, D. B., Schafer, C. T., Medioli, F. S. 1980. Eastern Canadian estuarine foraminifera: a framework for comparison. *Journal of Foraminiferal Research 10*, 205–34.
- Scott, D. K., Leckie, R. M. 1990. Foraminiferal zonation of Great Sippewissett salt marsh. *Journal of Foraminiferal Research 20*, 248–66.
- Seiglie, G. A. 1965. Un genero nuevo y dos especies nuevas de foraminiferos de los Testigos, Venezuela. *Boletin del Instituto Oceanografico*, Universidad de Oriente, Cumana 4:51-59.
- Seiglie, G. A. 1968. Foraminifera assemblages as indicators of high organic carbon content in sediments and of polluted waters. *American Association of Petroleum geologists Bulletin*, v. 52, p. 2231-2241.
- Seiglie, G. A. 1969. Observaciones sobre el genero de foraminiferos *Buliminoides* Cushman. *Revista Espanola de Micropaleonologia I*, 327-333.
- Seiglie, G. A. 1970. Additional observations on the foraminiferal genus *Buliminoides* Cushman. *Contributions from the Cushman Foundation or Foraminiferal Research 21*:112-115.

- Seiglie, G. A. 1975. Foraminifers of Guayanilla Bay and their use as Environmental Indicators: *Revista Española de Micropaleontología*, 7(3), 453-487.
- Seiglie, G. A., Grove, K., Rivera, J. A. 1977. Revision of some Caribbean *Archaiasinae*, new genera, species and subspecies. *Eclogae Geologicae Helvetiae* 70:855-883.
- Sellier de Civrieux, J. M. 1969. Cuatro generos nuevos de foraminiferos del Mar Caribe. *Boletin del Instituto Oceanografico, Universidad de Oriente, Cumana* 7: 149-193,
- Sellier de Civrieux, J. M. 1976. Estudio systematico y ecologico de las Bolivinitidae recientes de Venezuela. *Cuadernos Oceanograficos, Universidad de Oriente, Cumana* 5:3-101
- Sellier de Civrieux, J. M. 1977. Las Discorbidae del Mar Caribe, frente a Venezuela. *Cuadernos Oceanográficos, Universidad de Oriente, Cumana*, 6: 1-44.
- Sen Gupta, B. K. 1999. Modern Foraminifera. Kluwer Academic Publisher, Dordrecht.
- Sgarella, F., Moncharmont Zei M. 1993. Benthic foraminifera of the Gulf of Naples (Italy): systematics and autoecology. *Bollettino della Società paleontologica italiana*, 32: 145-264.
- Sharifi, A. R., Croudace, I. W., Austin R. L. 1991. Benthic foraminiferids as pollution indicators in Southampton Water, southern England, U.K. *Journal of micropaleontology*. 10(1), 109-113.
- Shaw, T. A., Kirby, J. R., Holgate, S., Tutman, P., Plater A. J. 2016. Contemporary salt-marsh foraminiferal distribution from the Adriatic coast of Croatia and its potential for sea-level studies. *Journal of Foraminiferal Research*, 46(3): 314-323.
- Sibuet, M., Vangriescim, A. 2009. Deep-sea environment and biodiversity of the West African Equatorial margin. *Deep Sea Research Part II: Topical Studies in Oceanography*, 56: 2156–2168. doi: 10.1016/j.dsr2.2009.04.015
- Sidebottom, H. 1904. Report on the recent foraminifera from the coast of of the island of Delos, (Grecian Archipelago). *Memoires and Proceedings of the Manchester Literary and Philosophical Society* 48(5):1-26
- Sidebottom, H. 1906. Report on the recent Foraminifera from the coast of the Island of Delos (Grecian Archipelago). Part. 3. *Manchester Literary and Philosophical Society Memoirs and Proceedings*, 50 (5): 1-18.
- Sidebottom, H. 1918. Report on the recent foraminifera dredged off the east coast of Australia, H. M.S. "Dart" Station 19 (May 14, 1895), lat. 29°22'S long. 153°51'E, 465 fathoms, Pteropod ooze. *Journal of the Royal Microscopical Society*, 1918: 121-152.
- Sigal, J. 1952. Aperçu stratigraphique sur la micropaléontologie du crétacé. In *XIX Congrès Géologique International Monographies regionals series I, Algerie* 26: 63.
- Silvestri, A. 1923. Lo stipite della Elissoforme e le sue affinità. *Memorie della Pontificia Accademia della Scienze, Nuovi Lincei*. ser. 2 6:231-270
- Sournia, A. 1976. Primary production of sands in the lagoon of an atoll and the role of foraminiferal symbionts. *Mar Biol.* 37: 29–32

- Stephenson, C. M., Hallock, P., Kelmo, F. 2015. Foraminiferal assemblage indices: A Comparison of Sediment and Reef rubble samples from Conch Reef, Florida, USA. *Ecological Indicators* 48: 1–7
- Szareck, R. 2001. Biodiversity and biogeography of recent benthic foraminiferal assemblages in the south-western South China Sea (Sunda Shelf). Unpublished Ph.D. thesis, Universitätsbibliothek der Christian-Albrechts-Universität Kiel, 273 p., 28 pls.
- Terquem, O. 1878. Les foraminifères et les Entomostracés-Ostracodes de Pliocène supérieur de l'île de Rhodes. *Mémoires de la Société Géologique de France*, série 3, 1 : 1-135.
- Teske, P. R., von der Heyden, S., Mcquaid, C. D., Barker, N. P. 2011. A review of marine phylogeography in southern Africa. *South African Journal Science* 107: 43–53. doi:10.4102/sajs.v107i5/6.514
- Thalman, H. E. 1950. New names and homonyms in foraminifera. *Contributions from the Cushman Foundation for Foraminiferal Research*, 1: 41-45.
- Thissen, J. M., Langer, M. R. 2016. Spatial Patterns and Structural Composition of Foraminiferal Assemblages from the Zanzibar Archipelago (Tanzania). *Paleontographica*, A, 1-67.
- Tinoco, I. de Medeiros 1955. Foraminiferos recentes de Cabo Frio, Estado do Rio de Janeiro. *Boletim Divisao de Geologia e Mineralogia. Rio de Janeiro* 159:7-43.
- Tobin, R., Scott, D. B., Collins, E. S., Medioli, F. S. 2005. Infaunal benthic foraminifera in some North American marshes and their influence on fossil assemblages. *Journal of Foraminiferal Research*, 35: 130–147.
- Todd, R. 1957. “Smaller foraminifers”. In: Geology of Saipan, Mariana Islands (Pt. 3) Paleontology, *Professional Papers U.S. Geological Survey*, 280-H: 265-320.
- Todd, R. 1965. The foraminifera of the tropical Pacific collections of the “Albatross”, 1899-1900, Part. 4. Rotaliform families and Planktonic families. *United States National Museum Bulletin*, 61: 1-127.
- Todd, R. 1966. Smaller Foraminifera from Guam. *Professional Papers U.S. Geological Survey*, 403-I: 1-41.
- Toefy, R., Gibbon, M. J., Mcmillan, I. K. 2005. The foraminifera associated with the alga *Gelidium pristoides*, South Africa. *African Invertebrates* 46: 1-26.
- Trapon, M. L., Pratchett, M. S., Penin, L. 2011. Comparative effects of different disturbances in coral reef habitats in Moorea, French Polynesia. *Mar Biol.* 1-11. doi:10.1155/2011/807625
- Ujiié, H., Rifardi, D. 1993. Some benthic foraminifera from the Oura River. Estuary and its Environs, Okinawa. *Bulletin of the College of Science University of the Ryukyus*, 5:121-243.
- United Nations 2004. World Urbanization Prospects: The Revision Highlights. Department of Economic and Social Affairs, Population Division (*United Nations publications ST/ESA/SER.A/336*).

- Vande Weghe, J. P. 2005. Akanda et Pongara. Plages Et mangroves. Les Parcs Nationaux Du Gabon. Libreville (Wildlife Conservation Society), 208 pp.
- Vella, P. 1957. Studies in New Zealand foraminifera; Part I – Foraminifera from Cook Strait. Part II – Upper Miocene to Recent species of the genus *Notorotalia*. *New Zealand Geological Survey Paleontological Bulletin*, 28: 1- 64.
- Véneç-Peyre, M. T. 1981. Apropos de quelques espèces de Foraminifères: *Cymbaloporeta milletti* (H.A. and E.), *Tretomphalus bulloides* (d'O.) et *Rosalina globularis* d'O. *Cah Micropal* 4:121-130.
- Véneç-Peyré, M. T. 1984. Foraminifera and the environment: study of three ecosystems. Benthos'83; 2nd Int. symp. Benthic Foraminifera (Pau) pp. 573-581
- Véneç-Peyré, M. T. 1985a. Foraminifera. *Proc Fifth Intl Coral Reef Congress*, Tahiti 1: 393–398.
- Véneç-Peyré, M. T. 1985b. The study of the living foraminiferan distribution in the lagoon of the high volcanic island of Moorea (French Polynesia). *Proc Fifth Int Coral Reef Congress*, Tahiti 5: 227–232
- Véneç-Peyré, M. T. 1987. Boring foraminifera in French Polynesian coral reefs. *Coral Reefs* 5: 205–212
- Véneç-Peyré, M. T. 1988. Two new species of bioeroding Trochamminidae (Foraminiferida) from French Polynesia. *Journal of Foraminiferal Research* 18: 1–5.
- Véneç-Peyré, M. T. 1991. Distribution of living benthic Foraminifera on the back-reef and outer slopes of a high island (Moorea, French Polynesia). *Coral Reefs* 9: 193–203
- Véneç-Peyré, M. T., Salvat, B. 1981. Les Foraminifères de l'atoll de Scilly (archipel de la Société): étude comparée de la biocénose et de la thanatocénose. *Ann. Inst. Océanogr. Paris*. 57: 79–110.
- Veron, J. E. N. 1995. Corals in space and time: the biogeography and evolution of the Scleractinia. Cornell University Press, Ithaca, New York 321 pp.
- Voituriez, B., Herbland, A. 1982. Comparaison des systèmes productifs de l'Atlantique tropical Est: dômes thermiques, upwelling côtier et upwelling équatorial. – Rapports et Procès-Verbaux des Réunions du Conseil International pour l'Exploration de la Mer, 180: 114–130.
- Voloshinova, N. A., 1958. O novoy sistematike Nonionid [On new systematics of the Nonionidae]. *Trudy Vsesoyuznogo Neftyanogo Nauchno-issledovatel'skogo Geologo-razvedochnogo Instituta (VNIGRI)* 115. *Mikrofauna SSSR* 9:117-191.
- Voloshinova, N. A., 1960. Uspekhi mikropaleontologii v dele izucheniya vnutrennego stroeniya foraminifer [Progress in micropaleontology in the work of studying the inner structure of Foraminifera], in *Trudy Pervogo Seminara po Mikrofaune*. Leningrad: Vsesoyuznyy Neftyanoy Nauchno-issledovatel'skii Geologo-razvedochnyy Institut (VNIGRI), p. 48-87.
- Walker, G., Boys, W. 1784. *Testacea minuta l'ariora, nuperrime detecta in arena litloris Sandvicensis a Gul. Boys. arm. S.A.S. Mu/ta addidi/. et omnium /iguras ope microscopii anpl/ia/Us accurate delineavit Geo. Walker*. London: J. March, p. 1-25.

- Walker, G., Jacob E. 1798. In Kanmacher F.: *Adam's Essays on the Microscope, Ed. 2.*
- Wang, P., Chappell, J. 2001. Foraminifera as Holocene environmental indicators in the South Alligator River, Northern Australia. *Quaternary International* 83, 47–62.
- Webb, J. E., Hill, M. B. 1958. The ecology of Lagos Lagoon. *Philosophical Transactions of the Royal Society of London*, 241, 307–419.
- WHO (World Health Organisation) 2008. Guidelines for Drinking Water Quality: Third Edition Incorporating the First and Second Addenda (Vol.1: Recommendations), pp. 515.
- Whittaker, J. E., Hodgkinson, R. L. 1979. Foraminifera of the Togopi Formation, eastern Sabah, Malaysia. *Bulletin of the British Museum (Natural History)*, 31: 1-120.
- Wiesner, H. 1920. Zur Systematik der Miliolideen. *Zoologisches Anzeiger* 51: 13-20.
- Wiesner, H. 1923. *Die Milioliden der östlichen Adria*. Prag-Bubenc. The author.
- Wiesner, H. 1931. Die foraminiferen der deutschen Sudpolar Expedition 1901-1903. *Deutsche Südpolar Expedition, v. 20, Zoologie*, 12: 53-165.
- Williamson, W. C. 1848. On the Recent British species of the genus *Lagena*. *Annals and Magazine of Natural History*, series 2, 1: 1-20.
- Williamson, W. C. 1858. *On the recent foraminifera of Great Britain*. London Ray Society, 107 p.
- Woodroffe, S. A., Horton, B. P., Larcombe, P., Whittaker, J. E. 2005. Intertidal mangrove foraminifera from the central Great Barrier Reef shelf, Australia: Implications for sea-level reconstruction. *Journal of Foraminiferal Research*, 35: 259–270.
- Wright, E. P. 1876. Notes on a small collection of Foraminifera from the Seychelles. *Proceedings of the Royal Irish Academy. Science* 2: 586–588.
- Wright, E. P. 1877. Notes on Foraminifera (from the Seychelles and from Cagliari). *Annals and Magazine of the Natural History Series* 4 19: 40–44.
- Wright, C. I., McMillan, I. K., Mason, T. R. 1990. Foraminifera and sedimentation patterns in St. Lucia Estuary mouth, Zululand, South Africa. *South African Journal of Geology* 93: 592–601.
- Yanko, V., Arnold, A. J., Parker, W. C. 1999. Effects of marine pollution on benthic foraminifera, In: Sen Gupta, B.K. (Ed.), *Modern Foraminifera*. Kluwer Academic Publisher, Dordrecht, pp. 217–235.
- Yassini, I., Jones B. G. 1995. *Foraminiferida and ostracoda from estuarine and shelf environments on the southeastern coast of Australia, Wollongong, NSW*. University of Wollongong, 484 p.
- Zaninetti, L., Brönnimann, P., Beurlen, G., Moura, J. A. 1977. La mangrove de Guaratiba et la Baie de Sepetiba, etat de Rio de Janeiro, Bresil: foraminiferes et ecologie. *Archives des Sciences (Geneve)*, 30: 161–78.

- Zaninetti, L., Dias-Britto, D., Arai, M., Casaletto, P., Koutsoukos, E., Silveira, S. 1979. Distribution ecologique des foraminifères dans la mangrove d'Acupe, Bahia, Brésil. *Notes du Laboratoire de Paleontologie de l'Université de Genève*, 4(1): 1–17.
- Zheng, S. Y. 1981. *Mesosigmoilina*, a new name for *Pseudosigmoilina* Zheng, 1979, preoccupied. *Journal of Paleontology* 55:483
- Zheng, S. Y. 1979. The recent foraminifera of the Xisha Islands, Guangdong Province, China, II. *Studia Marina Sinica*, 15: 101-232. [Chinese with summary and new genera and species in English]
- Zheng, S. Y. 1988. The agglutinated and porcelaneous foraminifera of the East China Sea. *China Ocean Press, Beijing*, 337 p. [Chinese with summary in English]
- Zmiri, A., Kahan, D., Hochstein, S., Reiss, Z. 1974. Phototaxis and thermotaxis in some species of *Amphistegina* (Foraminifera). *The Journal of Protozoology* 21: 133–138.

Appendix 1: Supporting Information (List S1) for Chapter 2.

List of foraminiferal species in alphabetical order (*denotes additional species recorded by Langer and Lipps, 2006; **denotes additional species recorded by Vénec-Peyré, 1985). Species identified to generic level only are summarized under their generic name (spp.).

Abditodentrix rhomboidalis (Millett 1899)
Acervulina mabahethi (Said 1949)
Acervulina inhaerens Schultze, 1854**
Acupeina triperforata (Millett 1899)
Adelosina laevigata d'Orbigny 1826
Adelosina sp.
Agglutinella agglutinans (d'Orbigny 1839)
Ammoastuta salsa Cushman & Brönnimann, 1948*
Ammobaculites agglutinans (d'Orbigny, 1846)**
Ammobaculites exiguus Cushman & Brönnimann, 1948
Ammomassilina alveoliniformis (Millett, 1898)**
Ammonia convexa Collins, 1958*
Ammonia tepida (Cushman, 1926)*
Ammonia cf. *A. tepida* (Cushman, 1926)*
Ammoscalaria compressa (Cushman & McCulloch, 1939)
Ammotium sp.*
Amphisorus hemprichii Ehrenberg, 1839
Amphistegina gibbosa d'Orbigny, 1839**
Amphistegina lessonii d'Orbigny, 1843
Amphistegina lobifera Larsen, 1976**
Amphistegina quoyi d'Orbigny, 1826**
Amphistegina radiata (Fichtel and Moll, 1798)**
Amphistegina sp.*
Anomalina globulosa Chapman and Parr, 1884**
Anomalina? maculosa Todd, 1957**
Anomalinella rostrata (Brady, 1881)*
Anomalinoides sp.*
Anomalinulla glabrata (Cushman, 1924)
Articulina alticostata Cushman, 1944*
Articulina pacifica Cushman, 1944
Articulina queenslandica Collins, 1958
Articulina sagra d'Orbigny, 1839
Assilina ammonoides (Gronovius, 1781)
Baggina phillipinensis (Cushman, 1921)
Bolivina compacta Sidebottom, 1905**
Bolivina currai Selier de Civrieux, 1976**
Bolivina doniezi Cushman & Wickenden, 1929
Bolivina earlandi Parr, 1950**
Bolivina lowmani Phleger and Parker, 1951**
Bolivina rhomboidalis Millett, 1895**
Bolivina seminuda Cushman, 1911**
Bolivina spathulata (Williamson, 1859)**
Bolivina spinata Cushman, 1937**
Bolivina striatula Cushman 1922*
Bolivina sublitoralis Cellier de Civrieux, 1976**
Bolivina cf. *B. suezensis* Said, 1949
Bolivina torquata Cushman & McCulloch, 1942**
Bolivina variabilis (Williamson, 1858)
Bolivinella elegans Parr 1932

Bolivinella folia (Parker and Jones, 1865)**
Brizalina cf. *B. subspathulata* (Boomgaard, 1949)*
Brizalina sp.*
Borelis schlumbergeri (Reichel, 1937)
Bulimina aculeata d'Orbigny, 1826**
Bulimina marginata d'Orbigny, 1826**
Bulimina spp.
Buliminella elegantissima (d'Orbigny, 1839)
Buliminella madagascariensis d'Orbigny, 1826**
Buliminella milletti Cushman, 1939**
Buliminoides williamsonia (Brady, 1984)**
Bronnimannia haliotis (Heron-Allen & Earland, 1924)
Calcarina calcar d'Orbigny, 1826**
Cancris auriculus (Fichtel & Moll, 1798)
Caronia exilis (Cushman & Brönnimann, 1948)
Carpenteria monticularis (Carter, 1877)**
Cerebrina lacunata (Burrows & Holland, 1895)
Cibicidella variabilis (d'Orbigny, 1826)**
Cibicides advenum (d'Orbigny, 1826)**
Cibicides mabahethi Said, 1949
Cibicides mayori (Cushman, 1924)
Cibicides pseudobulobatus Perelis and Reiss, 1975*
Cibicides pseudoungerianus (Cushman, 1922)**
Cibicides cf. *C. refulgens* de Montfort, 1808
Cibicides spp.
Cibrobaggina reniformis (Heron-Allen & Earland, 1915)
Clavulina difformis Brady, 1884
Clavulina cf. *C. multicamerata* Chapman, 1907
Clavulina pacifica Cushman, 1924
Clavulina sp.
Clavulina tricarinata d'Orbigny, 1839**
Clavulina angularis d'Orbigny, 1826**
Clavulinoides sp.*
Conicospirillinoidea sp. Cheng & Zheng, 1978
Cornuspira foliacea (Philippi, 1844),
Cornuspira planorbis Schultze, 1853.*
Cornuspira selseyensis Heron-Allen & Earland, 1909
Coscinospira hemprichi Ehrenberg, 1839
Criboelphidium poeyanum (d'Orbigny, 1839)**
Cyclammmina subtrullisata, (Parr, 1950)
Cycloclypeus carpenteri Brady, 1881**
Cyclogyra involvens (Reuss, 1849)**
Cycloforina cf. *C. carinata* (Albani 1974)*
Cycloforina cf. *C. granulocostata**

Cymbaloporella tabellaeformis (Brady, 1884)**
Cymbaloporeta bermudezi (Sellier & Civrieux, 1976)*
Cymbaloporeta bradyi (Cushman, 1924)
Cymbaloporeta sauammosa (d'Orbigny, 1839)**
Cymbaloporeta spp.
Chrysalidinella dimorpha (Brady, 1881)**
Discorbinella cf. *D. bertheloti* (d'Orbigny, 1839)
Discorbinella sp.*
Discorbis cf. *D. mira* Cushman, 1922*
Dyocibicides sp Cushman & Valentine, 1930
Eggerelloides sp.
Elongobula milletti (Cushman, 1933)
Elongobula spicata (Cushman & Parker, 1942)
Elongobula parallela (Cushman & Parker, 1931)
Edentostomina cultrata (Brady 1881)*
Edentostomina spp.
Elphidium advenum (Cushman, 1922)
Elphidium cf. *E. articulatum* (d'Orbigny, 1839)*
Elphidium botaniensis Albani, 1981
Elphidium clavatum Cushman, 1930
Elphidium craticulatum (Fichtel & Moll, 1798)*
Elphidium cf. *E. excavatum* Cushman, 1930
Elphidium oceanicum Cushman, 1933
Elphidium lene Cushman & McCulloch, 1940
Elphidium cf. *E. crispum* (Linnaeus, 1758)
Elphidium maorium Hayward, 1997
Elphidium milletti (Heron-Allen & Earland, 1915)
Elphidium simplex Cushman, 1933
Elphidium williamsoni Haynes, 1973*
Elphidium cf. *E. williamsoni* Haynes, 1973
Elphidium spp.
Epistominella tubulifera (Heron-Allen and Earland, 1915)**
Eponides repandus (Fichtel & Moll, 1798)*
Eponides sp.
Euthymonacha polita (Chapman, 1900)
Falsagglutinella angularis Loeblich & Tappan, 1994
Fischerinella diversa McCulloch, 1977
Fijiella simplex (Cushman, 1929)
Fissurina bispinata Ujjié, 1963
Fissurina lacubrata (Burrows and Holland, 1895)**
Fissurina cf. *F. tuberculata* Brady**
Fissurina squammoso-marginata Brady, 1884**
Fissurina spp.
Fursenkoina schreibersiana (Czjzek, 1848)
Fursenkoina sp.*
Gaudryina cf. *G. collinsi* Cushman, 1936**

- Gaudryina triangularis angulata* Cushman, 1924**
Gavelinopsis sp Hofker, 1951
Glabrata erecta (Sidebottom, 1908)**
Glabrata globosa (Sidebottom, 1909)**
Glabrata makinoi Uchio, 1952**
Glabrata patelliformis (Brady, 1884)**
Globocassidulina crassa (d'Orbigny, 1839)
Globocassidulina subglobosa (Brady, 1881)
Gypsina vesicularis (Parker & Jones, 1860) *
Haddonina sp. Chapman, 1898
Haynesina depressula (Walker & Jacob, 1798)
Hauerina bradyi Cushman, 1918**
Hauerina compressa d'Orbigny, 1846**
Hauerina diversa Cushman, 1946
Hauerina fragilissima (Brady, 1884)
Hauerina ornatissima (Karrer, 1868)
Hauerina pacifica Cushman, 1917*
Heterostegina depressa d'Orbigny, 1826
Heterostegina cf. *H. curva* Moebius, 1880
Heterostegina sp. *
Homotrema rubra (Lamarck, 1816)
Hopkinsina victoriensis Collins, 1974
Hopkinsinella glabra (Millett, 1903)
Lagena desmophora Jones, 1872**
Lagena filicusta Reuss, 1862**
Lagena spicata Cushman & McCulloch, 1950
Lagena spiralis Brady, 1884**
Lagena striata d'Orbigny, 1839**
Lagena strumosa Reuss, 1858
Lenticulina sp.
Lituotuba minuta Collins, 1958*
Lituotuba sp.*
Lobatula lobatula (Walker & Jacob, 1798)
Loxostomina cf. *L. africana* (Smither, 1955) *
Loxostomina limbata (Brady, 1881)
Loxostomina mayori (Cushman, 1922)
Loxostomum convalarium (Millett, 1900)**
Massilina crenata (Karrer, 1868)**
Massilina granulocostata (Germeraad, 1946)
Massilina inaequalis Cushman, 1921
Mesosigmoilina minuta (Zheng, 1979)
Miliola sublineata (Brady, 1884)
Miliolinella australis (Parr, 1932)
Miliolinella heligmateira Loeblich & Tappan, 1994
Miliolinella labiosa (d'Orbigny, 1839)
Miliolinella cf. *M. labiosa* (d'Orbigny, 1839)
Miliolinella oceanica (Cushman, 1932)
Miliolinella cf. *M. oceanica* (Cushman, 1932) *
Miliolinella pilasensis McCulloch, 1977
Miliolinella subrotunda (Montagu, 1803)
Miliolinella spp.
Millettia tessellata (Brady, 1884)**
Millettiana milletti (Heron-Allen & Earland, 1915) *
Mineacea mineacea (Pallas, 1766)**
Monalysidium acicularis (Batsch, 1791)
Monalysidium confusa (McCulloch, 1977)
Monalysidium sp.
Mimosina histrix Millett, 1900
Mimosina sp.
Murrayinella murayyi (Heron-Allen & Earland, 1915)
Neoconorbina albida McCulloch, 1977
Neoconorbina terquemii (Rhzechak, 1888)**
Neoconorbina tuberocapitula (Chapman, 1889)**
Neoconorbina spp.
Nodophthalmidium antillarum (Cushman, 1922)
Nonionoides grateloupi (d'Orbigny, 1826)
Nonion sloani (d'Orbigny, 1839)**
Nonion sp. 1
Nonion sp. 2
Nubeculina advena Cushman, 1924
Oolina striatopunctata (Parker and Jones, 1923)**
Oolina sp.
Palliolatella fasciata carinata (Sidebottom, 1906)
Parasorites orbitolitoideus (Hofker, 1930)
Parasorites cf. *P. orbitolitoideus*
Paratrochammina simplissima (Cushman & McCulloch, 1948)*
Paratrochammina cf. *P. simplissima* (Cushman & McCulloch, 1948)
Paratrochammina stoeni Brönnimann & Zaninetti, 1979 *
Paratrochammina sp.
Parrellina milletti (Heron-Allen & Earland, 1915) *
Parrina bradyi (Millett, 1898)**
Patellina corrugata Williamson, 1858**
Pitella haigi Langer, 1992*
Peneroplis pertusus (Forskål, 1775)
Pitella transversestrita (Brady 1881)*
Planogypsina squamiformis (Chapman, 1901)**
Planispirillina decorata Brady, 1884**
Planispirillina papillosa (Cushman, 1913)**
Planispirillina spinigera (Chapman, 1900)
Planispirillina cf. *P. tuberculatolimbata* (Chapman, 1900)
Planispirinella exigua (Brady, 1879)**
Planispirinella involuta Collins, 1958
Planogypsina acervalis (Brady, 1884)*
Planorbulinella larvata (Parker and Jones, 1865)**
Planorbulinoides reticanulatus (Parker and Jones, 1862)**
Poroeponoides lateralis (Terquem, 1878) *
Proroeponides cribrorependus Asano and Uchio, 1951**
Porosonion sp.
Procerolagena oceanica (Albani, 1974)
Pseudogaudryina sp.
Pseudohauerinella dissidens (McCulloch, 1977)
Pseudohauerina orientalis (Cushman, 1946)
Pseudomassilina cf. *P. australis* (Cushman, 1932)
Pseudononion granulombilicatum Zheng, 1979
Pseudononion sp.
Pseudoschlumbergerina ovata (Sidebottom, 1904)
Pseudotriloculina subgranulata (Cushman, 1918)
Pseudotriloculina sp.
Pyrgo canariensis (d'Orbigny, 1839)**
Pyrgo denticulata (Brady, 1884)**
Pyrgo elongata (d'Orbigny, 1826)**
Pyrgo oblonga (d'Orbigny, 1839)*
Pyrgo striolata (Brady, 1884)*
Pyrgo spp.
Quinqueloculina agglutinans d'Orbigny, 1839
Quinqueloculina angulariformis McCulloch, 1977
Quinqueloculina arenata Said, 1949
Quinqueloculina barnadi Rasheed 1971*
Quinqueloculina bicarinata d'Orbigny, 1826*
Quinqueloculina bosciiana d'Orbigny, 1839**
Quinqueloculina bradyana Cushman, 1917
Quinqueloculina collumosa Cushman, 1922
Quinqueloculina corrugata (Collins, 1958)*
Quinqueloculina crassicarinata Collins, 1958
Quinqueloculina cuvieriana d'Orbigny, 1839
Quinqueloculina debenayi, Langer 1992
Quinqueloculina cf. *Q. debenayi* Langer, 1992
Quinqueloculina deliculata Vella, 1957
Quinqueloculina disparilis d'Orbigny, 1826
Quinqueloculina distorquata Cushman, 1954
Quinqueloculina cf. *Q. distorquata* Cushman, 1954
Quinqueloculina eburnea (d'Orbigny, 1839)
Quinqueloculina exmouthensis Parker, 2009
Quinqueloculina exsculpta (Heron-Allen & Earland, 1915)
Quinqueloculina ferox (Rhumbler, 1907)**
Quinqueloculina funafutiensis (Chapman, 1900)
Quinqueloculina granulocostata Germeraad, 1946
Quinqueloculina cf. *Q. granulocostata* Germeraad, 1946
Quinqueloculina incisa Vella, 1957
Quinqueloculina cf. *Q. incisa* Vella, 1957*
Quinqueloculina cf. *Q. incisura* Todd 1957
Quinqueloculina jugosa Cushman, 1944
Quinqueloculina lamarckina d'Orbigny, 1839**
Quinqueloculina latidentella Loeblich & Tappan, 1994*
Quinqueloculina lizardi Baccaert, 1987
Quinqueloculina neostriatula Thalmann, 1950
Quinqueloculina cf. *Q. oblonga* (Montagu, 1803)
Quinqueloculina parkeri (Brady, 1881)
Quinqueloculina parvagliuta Vella, 1957
Quinqueloculina philippinensis Cushman, 1921
Quinqueloculina poeyana d'Orbigny, 1839

- Quinqueloculina polygona* d'Orbigny, 1839
Quinqueloculina pulchella d'Orbigny, 1826
Quinqueloculina quinquecarinata Collins, 1958
Quinqueloculina cf. *Q. rugosa* d'Orbigny, 1839
Quinqueloculina samoensis Cushman, 1924**
Quinqueloculina seminula (Linne 1767)
Quinqueloculina cf. *Q. semireticulosa* Cushman, 1932
Quinqueloculina sidebottomi (Rasheed, 1971)
Quinqueloculina cf. *Q. socorroensis* McCulloch, 1977
Quinqueloculina stelligera Schlumberger, 1893
Quinqueloculina subcuneata Cushman, 1921
Quinqueloculina subulosa Cushman, 1942**
Quinqueloculina subparkeri McCulloch, 1977
Quinqueloculina subpolygona Parr, 1945
Quinqueloculina sulcata d'Orbigny, 1826**
Quinqueloculina tantabiddiensis Parker, 2009
Quinqueloculina tricarinata d'Orbigny, 1839**
Quinqueloculina tropicalis Cushman, 1924
Quinqueloculina vandiemeniensis Loeblich & Tappan, 1994
Quinqueloculina viennensis Le Calvez, 1958**
Quinqueloculina zhengi Parker, 2009
Quinqueloculina spp.
Rectoglandulina sp.*
Reophax cf. *R. bacillaris* Brady, 1881*
Reophax communis Lacroix, 1930
Reophax irregularis Parker, 1954
Reophax scopiurus Montfort, 1808**
Reophax sp.
Reusella pacifica Cushman and McCulloch, 1948
Reusella simplex Cushman, 1929**
Reusella spinulosa (Reuss, 1850)**
Rhabdammina sp.
Rosalina advena (Cushman, 1931)**
Rosalina bradyi (Cushman, 1915)*
Rosalina concinna (Brady, 1884)**
Rosalina globularis d'Orbigny, 1826
Rosalina orbicularis Terquem, 1876**
Rosalina sp.
Rotorbis cf. *R. auberii* (d'Orbigny, 1839)
Rotorbis sp.
Rotorboides granulatus (Heron-Allen & Earland, 1915)
Sagrinella convallaria (Millett, 1900)
Sagrinopsis fimbriata (Millett, 1900)
Sahulia sp.
Saidovina cf. *S. carinata* (Millett, 1900)
Schlumbergerina alveoliniformis (Brady, 1879)
Septotextularia rugosa Cheng & Zheng, 1978
Sigmavirgulina tortuosa (Brady, 1881)
Sigmohauerina bradyi (Cushman, 1917)
Sigmohauerina involuta (Cushman, 1946)
Sigmoilina cf. *S. tortuosa* Zheng, 1979
Sigmoilinita costata (Schlumberger, 1893)
Sigmoilopsis elliptica (Galloway & Wissler, 1927)
Siphonaperta distorquata (Cushman, 1954)
Siphonaperta pittensis (Albani, 1974)
Siphonaperta cf. *S. pittensis* (Albani, 1974)*
Siphonaperta wiesneri (Parr, 1950)*
Siphonaperta subagglutinata (Asano, 1936)
Siphogenerina raphana (Parker & Jones, 1865)
Siphogenerina striata (Schwager, 1866)
Siphogenerina virgula (Brady, 1879)*
Siphogenerina sp.
Siphonina tubulosa Cushman, 1924
Siphonaperta pittensis (Albani, 1974)
Siphoninoides echinatus (Brady, 1879)**
Siphotextularia crispata (Brady, 1884)
Sorites marginalis Lamarck, 1816**
Sorites orbiculus (Forskål, 1775)
Sphaerogypsina globula (Reuss, 1848)
Spirillina grosseperforata Zheng, 1979
Spirillina cf. *S. sigillata* McCulloch, 1977*
Spirillina spp.
Spirolina arietina (Batsch, 1791)*
Spirolina pedum d'Orbigny, 1826**
Spiroloculina acescata Cushman, 1932
Spiroloculina angulata Cushman, 1917
Spiroloculina antillarum d'Orbigny, 1839*
Spiroloculina caduca Cushman, 1922
Spiroloculina communis Cushman & Todd, 1944
Spiroloculina cf. *S. communis**
Spiroloculina convexa Said, 1949
Spiroloculina corrugata Cushman & Todd, 1944
Spiroloculina exima Cushman, 1922**
Spiroloculina majori Cushman, 1924
Spiroloculina caduca Cushman, 1922
Spiroloculina ornata d'Orbigny, 1839**
Spiroloculina samoensis Cushman, 1924
Spiroloculina scrobiculata Cushman, 1921
Spiroloculina spp.
Spirophthalmidium cf. *S. elegantissimum* (Said, 1949)*
Spirophthalmidium prolixum Loeblich & Tappan, 1994
Spirophthalmidium scabrum Loeblich & Tappan, 1994
Spirophthalmidium sp.
Spirosigmoilina bradyi Collins, 1958
Spirosigmoilina parri Collins, 1958
Stictogonylus rugata (Heron-Allen & Earland, 1928)
Strebloides sp.
Svratkina australensis (Chapman, Parr and Collins, 1934)**
Textularia agglutinans d'Orbigny, 1839
Textularia candeiana d'Orbigny 1839
Textularia cushmani Said, 1949
Textularia earlandi Parker, 1952**
Textularia foliacea foliacea Heron-Allen and Earland, 1915
Textularia foliacea oceanica Heron-Allen & Earland, 1915
Textularia lateralis Lalicker, 1935**
Textularia pseudorugosa Lacroix, 1932**
Textularia stricta Cushman, 1911**
Textularia spp.
Tretomphalus bulloides (d'Orbigny, 1839)
Tretomphalus concinnus (Brady, 1884)
Trichohyalus aguayoi (Bermúdez, 1935)*
Triloculina asymetrica Said, 1949*
Triloculina barnadi Rasheed 1971
Triloculina bicarinata d'Orbigny, 1839
Triloculina earlandi Cushman, 1954
Triloculina elongotricarinata Debenay, 2013
Triloculina fichteliana d'Orbigny, 1839
Triloculina cf. *T. fichteliana* d'Orbigny, 1839
Triloculina inflata d'Orbigny, 1846**
Triloculina laevigata d'Orbigny, 1826**
Triloculina limbeana d'Orbigny, 1839**
Triloculina marioni Schlumberger, 1893**
Triloculina oblonga (Montagu, 1803)
Triloculina cf. *T. oblonga* (Montagu, 1803)
Triloculina planciana d'Orbigny, 1839**
Triloculina rotunda Schlumberger, 1893
Triloculina schreiberiana d'Orbigny, 1839**
Triloculina subgranulata Cushman, 1918*
Triloculina serrulata McCulloch, 1977
Triloculina cf. *T. striatotrigonula* Parr, 1941
Triloculina tricarinata d'Orbigny, 1826*
Triloculina cf. *T. tricarinata* d'Orbigny, 1826*
Triloculina trigonula (Lamarck, 1804)*
Triloculina triquetrella Loeblich & Tappan, 1994
Triloculina webbiana d'Orbigny, 1839**
Triloculina spp.
Triloculinella parisa Loeblich & Tappan, 1994
Triloculinella pseudooblonga (Zheng, 1980)
Trifarina bradyi Cushman, 1923
Trimosina orientalis Cushman, 1933
Trochammina inflata (Montagu, 1808)*
Ungulatella pacifica Cushman, 1931**
Uvigerina porrecta Brady, 1879**
Vagulina pauciloculata (Brady, 1884)**
Valvulinera candeiana (d'Orbigny, 1839)**
Vertebralina striata d'Orbigny, 1826*
Wiesnerella auriculata (Egger, 1893)*

Appendix II: Moorea Species List (M1-M51)

	M1	M3	M4	M7	M8	M9b	M10	M11	M13	M15	M16	M31	M32	M35	M40	M41	M43	M45	M47	M48	M49	M50	M51
<i>Sorites orbiculus</i>	13	5	5	1	0	7	2	2	2	0	7	7	11	10	0	0	0	7	0	2	8	0	0
<i>Sphaerogypsina globula</i>	0	2	0	0	0	0	0	0	0	0	2	0	0	1	0	0	0	0	0	0	0	0	0
<i>Spirillina grosseperforata</i>	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Spirillina sp. 1</i>	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	2	0	0	0
<i>Spirillina sp. 2</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
<i>Spiroloculina cf. S. caduca</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Spiroloculina angulata</i>	0	0	0	1	0	0	0	0	0	0	1	12	2	6	0	0	0	0	0	3	0	0	0
<i>Spiroloculina antillarum</i>	0	0	0	0	0	0	1	3	0	0	0	0	1	2	0	0	0	4	0	0	0	0	0
<i>Spiroloculina communis</i>	1	1	1	1	1	0	0	2	0	1	0	3	0	1	0	5	0	2	5	7	4	5	0
<i>S. cf. S. communis</i>	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
<i>Spiroloculina cf. S. convexa</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Spiroloculina corrugata</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Spiroloculina mayori</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
<i>Spiroloculina samoensis</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Spiroloculina scrobiculata</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Spiroloculina sp. 1</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Spiroloculina sp. 2</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Spiroloculina sp. 3</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Spiroloculina sp. 4</i>	0	0	0	0	0	0	0	2	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0
<i>Spiroloculina sp. 5</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0
<i>Spirophthalmidium aff. S. prolixum</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
<i>Spirophthalmidium scabrum</i>	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	3	0	0	0
<i>Spitoplectinella sp. 1</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Spirosigmoilina bradyi</i>	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	1	0	0
<i>Spirosigmoilina parri</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0
<i>Stictogongylus rugata</i>	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Textularia agglutinans</i>	2	0	0	0	0	0	0	0	0	0	0	0	0	0	18	6	0	0	0	0	0	0	0
<i>Textularia candeiana</i>	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	22	17	0	0	0	22	0
<i>Textularia foliacea</i>	0	1	0	0	0	0	0	1	0	1	0	1	0	0	0	0	27	0	1	3	2	0	0
<i>Textularia oceanica</i>	1	0	0	0	0	0	0	4	2	2	0	2	5	0	0	0	18	0	2	8	0	0	0
<i>Textularia sp. 1</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Textularia sp. 2</i>	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Textularia sp. 3</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	14	13	0	0	0
<i>Textularia sp. 4</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Textularia sp. 5</i>	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0
<i>Textularia sp. 6</i>	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Tretomphalus bulloides</i>	0	0	0	0	0	1	0	0	0	0	0	2	1	1	0	0	0	0	1	1	0	3	0
<i>Triloculina cf. T. assymetrica</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Triloculina barnadi</i>	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Triloculina cf. T. barnadi</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Triloculina bicarinata</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Triloculina earlandi</i>	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>T. elongotricarinata</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	1	0
<i>Triloculina fichteliana</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>T. cf. T. fichteliana sp. 1</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>T. cf. T. fichteliana sp. 2</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Triloculina kawea</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>T. cf. T. lalibertadensis</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Triloculina littoralis</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	1
<i>Triloculina rotunda</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Triloculina serrulata</i>	0	0	0	2	0	0	0	0	2	1	0	0	3	0	0	0	0	0	0	0	0	0	0
<i>T. cf. T. striatotrigonula</i>	0	0	0	0	0	0	0	0	4	0	0	0	6	0	0	0	3	0	1	1	0	0	0
<i>T. cf. T. tricarinata</i>	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Triloculina trigonula</i>	2	0	0	0	0	0	0	0	5	2	1	1	7	8	0	3	0	8	1	5	3	5	0
<i>Triloculina cf. T. trigonula</i>	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
<i>Triloculina triquetrella</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Triloculina cf. T. triquetrella</i>	0	0	0	0	0	0	0	0	3	0	7	19	0	0	0	0	0	0	3	13	0	0	0
<i>Triloculina sp. 1</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Triloculina sp. 2</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Triloculina sp. 3</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Trifarina bradyi</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	2	0
	499	380	282	526	320	245	325	358	331	522	402	357	443	314	503	305	273	349	362	291	366	321	380

Appendix II: Moorea Species List (M52-M96)

	M52	M53	M54	M56	M57	M58	M61	M62	M69	M71	M72	M75	M77	M78	M79	M83	M86	M87	M88	M93	M95	M96
<i>Abditodentrix rhomboidalis</i>	0	0	0	1	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0
<i>Acervulina mabahethi</i>	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Acupeina triperforata</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Adelosina laevigata</i>	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0
<i>Adelosina sp. 1</i>	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
<i>Agglutinella sp. 1</i>	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	6	0	0	0	0	0	0
<i>Affinetrina sp. 1</i>	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Allasoida virgula</i>	0	0	1	0	0	0	0	0	0	0	0	0	3	1	0	0	0	0	0	0	0	0
<i>Ammobaculites exiguus</i>	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
<i>Ammobaculites sp. 1</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Ammobaculites sp. 2</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0
<i>Ammomarginulina ensis</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Ammonia convexa</i>	0	0	0	0	1	0	2	0	1	2	0	0	0	0	0	1	0	0	0	0	0	0
<i>Ammonia tepida</i>	3	0	2	2	0	0	0	5	0	0	178	9	12	2	6	2	1	1	1	0	0	0
<i>Amphistegina lessonii</i>	5	8	21	0	1	43	247	134	0	173	132	0	3	0	0	22	51	6	60	127	251	101
<i>A. cf. A. papillosa</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	9	3	2	2	2
<i>Anomalinella rostrata</i>	1	2	5	0	1	4	2	13	0	8	1	0	0	0	0	0	1	2	13	13	22	27
<i>Anomalinoides sp. 1</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Anomalinoides sp. 2</i>	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Anomalinulla glabrata</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Anomalinulla sp. 1</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Articulina pacifica</i>	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
<i>Articulina queenslandica</i>	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
<i>Articulina sagra</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
<i>Baggina philipinensis</i>	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0
<i>Bolivinella elegans</i>	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Bolivina striatula</i>	0	0	1	15	0	1	0	1	0	0	9	9	73	56	16	1	3	3	0	0	0	0
<i>Bolivina cf. B. striatula</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Bolivina variabilis</i>	0	0	1	7	1	0	0	1	0	0	0	1	6	14	4	0	15	2	0	0	0	0
<i>Borelis schlumbergeri</i>	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	3	0	0	0	0
<i>Bulimina sp. 1</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Buliminella elegantissima</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Bronnimannia haliotis</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
<i>Buchnerina aff. B. lacunata</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Buchnerina sp. 1</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
<i>Buchnerina sp. 2</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
<i>Cancris auriculus</i>	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	2	0	0	0	0	0
<i>Caronia exilis</i>	0	0	0	1	0	0	0	1	0	0	39	0	0	0	1	2	0	0	0	0	0	1
<i>Cassidulina? sp. 1</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Cibicides mabahethi</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Cibicides philipinensis</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	0	0	0	0
<i>C. pseudulobatus</i>	0	0	2	0	0	0	1	2	0	0	0	2	0	0	0	0	3	0	4	1	2	2
<i>Cibrobagina reniformis</i>	0	0	0	0	1	0	0	0	0	3	0	0	0	0	0	1	0	0	1	0	0	0
<i>Clavulina pacifica</i>	3	1	0	0	1	0	1	0	0	1	0	0	1	0	0	2	7	3	2	8	8	8
<i>Conicospirillinoides sp. 1</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Conicospirillinoides sp. 2</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
<i>Cornuspira planorbis</i>	0	0	0	5	1	3	0	2	0	1	0	0	0	0	3	0	5	0	0	0	0	0
<i>Cornuspira sp. 1</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Coscinospira hemprichi</i>	0	0	1	0	0	0	0	1	0	0	5	0	0	0	0	0	0	0	0	0	0	0
<i>Cymbaloporella tabellaeformis</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
<i>Cymbaloporetta sp. 1</i>	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
<i>Cymbaloporetta sp. 2</i>	0	1	1	0	0	0	0	2	4	0	2	0	2	1	0	0	0	1	0	0	0	0
<i>Cymbaloporetta sp. 3</i>	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
<i>Discorbinella bertheloti</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Discorinopsis aguayoi</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Eggerelloides scabrus</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Elongobula milletti</i>	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0
<i>Elongobula parallela</i>	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
<i>Endostomina cultrata</i>	2	0	0	3	0	0	0	2	0	0	6	13	0	3	4	1	1	0	0	0	0	0
<i>Endostomina sp. 1</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Elphidium botaniensis</i>	0	0	0	8	0	0	0	0	0	0	18	25	3	17	0	0	0	0	0	0	0	0
<i>Elphidium clavatum</i>	0	0	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
<i>Elphidium lene</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0

Appendix II: Moorea Species List (M52-M96)

	M52	M53	M54	M56	M57	M58	M61	M62	M69	M71	M72	M75	M77	M78	M79	M83	M86	M87	M88	M93	M95	M96
<i>Neoconorbina sp. 1</i>	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Neoconorbina sp. 2</i>	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Nodophthalmidium antillarum</i>	3	0	0	0	0	0	0	0	1	0	0	0	0	0	0	3	5	1	2	0	0	0
<i>Nonion suburgidum</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Nonion sp. 1</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Nonion sp. 2</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Nonionoides grateloupi</i>	0	0	0	11	0	0	0	0	1	0	0	6	8	8	9	7	1	1	0	0	0	0
<i>Nubeculina advena</i>	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	7	0	5	4	
<i>Oolina aff. O. stellula</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
<i>Operculina ammonoides</i>	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	14	0	15	0	0	0
<i>Palliolatella fasciata carinata</i>	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Parasorites orbitolitoideis</i>	4	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	1	1	5	0	2	0
<i>P. cf. P. orbitolitoideis</i>	1	4	1	4	3	3	0	4	5	2	0	0	2	0	0	1	9	5	4	3	0	0
<i>Paratrochammina cf. P. simplissima</i>	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
<i>Paratrochammina sp. 1</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
<i>Peneroplis arietina</i>	3	10	7	5	7	4	4	6	5	0	12	0	2	0	0	2	9	6	13	3	4	5
<i>Planispirillina cf. P. tuberculalimbata</i>	0	3	1	0	0	3	0	1	0	0	0	0	0	0	0	0	1	0	0	2	3	0
<i>Planispirillina sp. 1</i>	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	2
<i>Planispirillina sp. 2</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
<i>Planispirinella exigua</i>	3	0	0	0	0	0	0	0	0	0	0	1	0	0	2	2	0	1	0	0	0	0
<i>Planispirinella sp. 1</i>	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Planorbulina sp. 1</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Planorbulina sp. 2</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Planogypsina acervalis</i>	0	1	1	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Paroepionides lateralis</i>	0	0	0	0	0	1	0	0	1	0	3	0	0	0	0	0	0	15	11	7	10	6
<i>Parosonionion sp. 1</i>	0	0	0	1	0	0	0	0	0	0	3	4	0	0	0	0	0	0	0	0	0	0
<i>Procerolagena oceanica</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Pseudogaudryina sp. 1</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
<i>Pseudohauerinella dissidens</i>	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
<i>Pseudohauerina orientalis</i>	0	2	0	0	1	0	0	0	1	0	1	0	0	0	0	0	0	0	4	1	1	1
<i>Pseudohauerina sp. 1</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
<i>Pseudolachlanella angusteoralis</i>	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Pseudolachlanella eburnea</i>	1	5	0	15	0	7	0	6	3	0	5	0	17	2	1	17	4	14	5	4	0	1
<i>Pseudolachlanella slitella</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Pseudolachlanella sp. 1</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Pseudomassilina cf. P. australis</i>	0	0	0	0	0	0	0	0	0	0	4	5	0	0	0	0	0	0	0	0	0	0
<i>Pseudononion granulounbilocatum</i>	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0
<i>Pseudoschlumbergerina ovata</i>	0	0	0	0	2	0	0	0	0	0	2	0	0	0	1	0	1	7	4	1	2	0
<i>Pseudotriloculina cf. P. limbata</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Pseudotriloculina cf. P. oblonga</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Pseudotriloculina subgranulata</i>	2	8	21	1	35	14	0	12	9	1	3	0	0	2	0	0	2	8	2	1	0	1
<i>P. cf. P. sommeri</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Pseudotriloculina sp. 1</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
<i>Pseudotriloculina sp. 2</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
<i>Pseudotriloculina sp. 3</i>	0	1	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	2	4	0	0
<i>Pseudotriloculina sp. 4</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
<i>Pseudotriloculina sp. 5</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Pseudotriloculina sp. 6</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Pseudotriloculina sp. 7</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Pseudotriloculina sp. 8</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Pyrgo denticulata</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	2	0	0	3	1	1	1
<i>Pyrgo phlegeri</i>	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Pyrgo sarsi</i>	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
<i>Pyrgo striolata</i>	1	2	0	0	4	5	2	3	0	0	0	0	0	0	5	3	1	3	4	1	3	3
<i>Pyrgo cf. P. striolata</i>	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Pyrgo sp. 1</i>	0	0	2	0	0	0	0	0	0	0	0	1	0	2	0	1	0	0	0	1	3	3
<i>Quinqueloculina agglutinans</i>	4	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	1	3	0	0	0	0

Appendix II: Moorea Species List (M52-M96)

	M52	M53	M54	M56	M57	M58	M61	M62	M69	M71	M72	M75	M77	M78	M79	M83	M86	M87	M88	M93	M95	M96
<i>Quinqueloculina sp. 7</i>	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Quinqueloculina sp. 8</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Quinqueloculina sp. 9</i>	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Quinqueloculina sp. 10</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Quinqueloculina sp. 11</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Quinqueloculina sp. 12</i>	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Quinqueloculina sp. 13</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Quinqueloculina sp. 14</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
<i>Quinqueloculina sp. 15</i>	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
<i>Quinqueloculina sp. 16</i>	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
<i>Quinqueloculina sp. 17</i>	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Quinqueloculina sp. 18</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Quinqueloculina sp. 19</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	1
<i>Quinqueloculina sp. 20</i>	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Quinqueloculina sp. 21</i>	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
<i>Quinqueloculina sp. 22</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
<i>Quinqueloculina sp. 23</i>	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Reophax communis</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Reophax sp. 1</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Rectobolivina? sp. 1</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Reusella pacifica</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Rhaptohelenina sp. 1</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
<i>Rosalina bradyi</i>	1	0	1	0	5	5	0	0	2	0	0	0	5	0	0	3	3	2	0	0	0	1
<i>Rosalina floridana</i>	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0
<i>Rosalina globularis</i>	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Rosalina sp. 1</i>	0	0	2	0	0	0	0	0	1	0	0	0	26	0	0	0	0	0	0	3	0	2
<i>Rosalina sp. 2</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Rotorbis auberii</i>	0	0	1	0	1	0	0	2	3	0	0	0	2	0	0	4	3	2	0	0	0	0
<i>Rotorboides granulatus</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
<i>Saidovina carinata</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
<i>Saidovina karrerianum</i>	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0
<i>Saidovina sp. 1</i>	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
<i>Sagrinella convallaria</i>	0	0	0	0	0	0	0	0	1	0	0	1	2	6	12	0	0	0	1	0	0	0
<i>Sagrinopsis fimbriata</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Sahulia cf. S. barkeri</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
<i>Sahulia sp. 1</i>	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Sahulia sp. 2</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Schlumbergerina alveoliniformis</i>	29	48	0	0	8	3	0	2	24	24	7	0	0	0	0	1	22	3	38	7	18	10
<i>Septotextularia rugosa</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Sigmavirgulina turtosa</i>	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	1	0	3	0	0	0	0
<i>Sigmella sp</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Sigmoihauerina involuta</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Sigmoilinella tortuosa</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	1	0	0
<i>Sigmoilinella sp. 1</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
<i>Sigmoilinita costata</i>	1	0	0	2	0	0	0	0	0	0	0	5	0	7	0	1	1	1	0	0	0	0
<i>Sigmoilopsis elliptica</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Siphonaperta hallocki</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
<i>Siphonaperta cf. S. hallocki</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
<i>Siphonaperta pittensis</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
<i>siphonaperta cf. S. pittensis</i>	0	0	0	0	0	0	0	0	0	0	0	1	0	2	0	0	1	1	0	0	0	0
<i>Siphonaperta sp. 1</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
<i>Siphogenerina raphana</i>	0	0	2	0	0	1	0	0	2	0	0	0	2	0	1	5	0	2	4	2	0	0
<i>Siphogenerina striata</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
<i>Siphogenerina sp. 1</i>	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
<i>Siphonina tubulosa</i>	0	2	4	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
<i>Siphotrochammina lobata</i>	0	0	0	0	0	0	0	0	0	0	2	1	0	1	0	0	0	0	0	0	0	0
<i>Sorites orbiculus</i>	6	18	13	0	6	35	18	27	6	23	41	0	2	0	0	0	15	5	22	7	1	4
<i>Sphaerogypsina globula</i>	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1
<i>Spirillina grosseperforata</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
<i>Spirillina sp. 1</i>	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	3	2	0	0
<i>Spirillina sp. 2</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
<i>Spiroloculina cf. S. caduca</i>	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0

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	M52	M53	M54	M56	M57	M58	M61	M62	M69	M71	M72	M75	M77	M78	M79	M83	M86	M87	M88	M93	M95	M96
<i>Spiroloculina angulata</i>	2	1	5	0	4	5	0	3	2	1	0	0	1	0	0	0	3	5	1	6	1	7
<i>Spiroloculina antillarum</i>	0	3	1	1	0	3	0	0	0	0	1	0	0	0	0	0	1	1	2	0	0	2
<i>Spiroloculina communis</i>	1	0	0	0	0	0	0	0	1	0	0	0	0	14	0	3	0	2	0	0	0	0
<i>Spiroloculina cf. S. communis</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Spiroloculina cf. S. convexa</i>	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	7	0
<i>Spiroloculina corrugata</i>	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Spiroloculina mayori</i>	0	0	1	0	1	0	0	1	3	0	0	0	0	1	0	0	0	1	2	3	3	7
<i>S. samoensis</i>	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>S. scrobiculata</i>	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
<i>Spiroloculina sp. 1</i>	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
<i>Spiroloculina sp. 2</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	2	5	0	0	0	0	0	0	0
<i>Spiroloculina sp. 3</i>	0	0	0	8	0	0	0	0	0	0	0	0	0	2	23	0	0	0	0	0	0	0
<i>Spiroloculina sp. 4</i>	0	0	0	0	0	0	0	1	0	0	0	0	2	0	0	0	0	0	0	0	0	0
<i>Spiroloculina sp. 5</i>	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Spirophthalmidium aff. S. prolixum</i>	0	0	0	1	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0
<i>Spirophthalmidium scabrum</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
<i>Spitoplectinella sp. 1</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
<i>Spirosigmoilina bradyi</i>	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	2	1	0	0	0	1	0
<i>Spirosigmoilina parri</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0
<i>Stictogonylus rugata</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Textularia agglutinans</i>	0	0	1	1	0	0	0	0	0	1	0	2	2	2	0	1	0	24	5	0	4	1
<i>Textularia candeiana</i>	0	0	0	3	0	0	0	0	2	0	0	0	1	3	0	0	1	11	12	0	0	0
<i>Textularia foliacea</i>	7	0	0	0	0	0	0	0	21	0	0	0	1	3	0	0	0	0	5	0	0	0
<i>Textularia oceanica</i>	21	0	0	0	0	0	0	0	19	0	0	0	2	0	0	1	26	5	3	0	0	0
<i>Textularia sp. 1</i>	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Textularia sp. 2</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Textularia sp. 3</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Textularia sp. 4</i>	0	0	0	0	0	0	0	0	0	0	0	0	8	28	0	0	0	0	0	0	0	0
<i>Textularia sp. 5</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Textularia sp. 6</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Tretomphalus bulloides</i>	0	1	1	0	1	0	0	1	2	1	0	0	0	0	1	1	0	1	0	1	0	0
<i>Triluculina cf. T. asymmetrica</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
<i>Triluculina barnadi</i>	0	0	0	1	0	0	0	0	2	0	0	0	0	0	0	1	1	0	0	0	0	0
<i>Triluculina cf. T. barnadi</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
<i>Triluculina bicarinata</i>	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Triluculina earlandi</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
<i>Triluculina elongatricarinata</i>	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Triluculina fichteliana</i>	0	0	0	0	0	0	0	0	2	0	1	1	0	0	0	0	0	0	0	0	0	0
<i>T. cf. T. fichteliana sp. 1</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0
<i>T. cf. T. fichteliana sp. 2</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
<i>Triluculina kawea</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0
<i>T. cf. T. lalibertadensis</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
<i>Triluculina littoralis</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Triluculina rotunda</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
<i>Triluculina serrulata</i>	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>T. cf. T. striatotrigonula</i>	0	0	0	0	0	0	0	0	6	0	0	0	0	0	1	6	8	0	0	0	0	0
<i>Triluculina cf. T. tricarinata</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Triluculina trigonula</i>	3	0	1	13	0	0	0	0	11	0	3	11	4	5	4	7	9	1	1	3	0	0
<i>Triluculina cf. T. trigonula</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Triluculina triquetrella</i>	0	0	0	1	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Triluculina cf. T. triquetrella</i>	3	0	0	0	0	0	0	0	13	0	0	2	7	15	11	0	8	0	0	0	0	0
<i>Triluculina sp. 1</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
<i>Triluculina sp. 2</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
<i>Triluculina sp. 3</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
<i>Trifarina bradyi</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Trochammina inflata</i>	1	0	0	1	0	0	0	0	0	0	0	0	0	4	0	17	0	0	2	0	0	0
<i>Valvulineria aff. V. minuta</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
<i>Vertebralina striata</i>	1	5	3	18	13	2	0	0	2	0	1	0	0	0	0	1	3	0	0	3	0	1
<i>Wiesrenella auriculata</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	1	1	0	0	0
	234	318	338	352	297	368	382	349	302	374	415	315	341	302	320	312	379	379	495	431	508	371

CURRICULUM VITAE

Academic records with Dates/Issuing Authority

Ph.D. Applied Geology (Micropaleontology), University of Bonn, Germany, 2014 to date.

M.Sc. Applied Geology, Obafemi Awolowo University, Nigeria, 2011.

B.Sc. Geology, Obafemi Awolowo University, Nigeria, 2004.

Articles

2017

- **Fajemila O.T.**, Langer M. R. 2017: Shallow-water benthic Foraminifera from the Island of Moorea (Society Islands, French Polynesia) - *In prep*

2016

- **Fajemila, O.T.**, Langer, M.R., 2016c. Ecosystem indicators: Foraminifera, Thecamoebians and Diatoms from the Ologe Lagoon, Nigeria. *Revue de micropaléontologie*, <http://dx.doi.org/10.1016/j.revmic.2016.09.002>
- Langer, M.R., **Fajemila, O.T.**, Saskia M. (2016b): Assemblages of recent intertidal mangrove foraminifera from the Akanda National Park, Gabon: sea level proxies preserved in faunal assemblages. *Neues Jahrbuch für Geologie und Paläontologie Abhandlungen*, 281/3, 327-338, Stuttgart.

- Langer, M.R., Mouanga, G.H., **Fajemila, O. T.** (2016a): Shallow-water nearshore benthic foraminifera assemblages from Gabon. *Micropaleontology* 62 (1): 69-80

2015

- **Fajemila, O.T.**, Langer, M.R., Lipps, J.H. (2015): Spatial Patterns in the Distribution, Diversity and Abundance of Benthic Foraminifera around Moorea (Society Archipelago, French Polynesia). *PLoS ONE* 10(12): e0145752. doi: 10.1371/journal.pone.0145752

2014

- Fadiya S.L., Jaiyeola-Ganiyu F., **Fajemila O.T.** (2014): Foraminifera Biostratigraphy and Paleoenvironment of Sediments from Well Am-2, Niger Delta. *Ife Journal of Science*, Vol. 16, No. 1. pp 61-72
- Adekola S.A., Akinlua A., Fadiya S.L., **Fajemila O.T.**, Ugwu G.C. (2014): Palynological and Paleoenvironmental analyses of selected shale samples from the Orange Basin, South Africa. *Ife Journal of Science*, Vol. 16, No. 1. pp 45-60.
- **Fajemila, O.T.**, Salami, M.B. (2014): Calcareous Nannofossils Biostratigraphy of two Wells from the Tongo Field, Offshore Niger Delta. *Journal of Mining and Geology* Vol. 50(1) pp. 11-18

2012

- **Fajemila, O.T. (2012)**: Foraminifera Biostratigraphy and paleoenvironmental Studies of Two Wells from Offshore Western Niger Delta; *Ife Journal of Science* Vol. 14, No. 2. pp 369-384.