The Foraminifera of the Zanzibar Archipelago

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"*I do not know what I may appear to the world, but to myself I seem to have been only like a boy playing on the sea-shore, and diverting myself in now and then finding a smoother pebble or a prettier shell than ordinary, whilst the great ocean of truth lay all undiscovered before me.*"

Isaac Newton

Zusammenfassung

Der Sansibar-Archipel ist das größte Riffsystem im östlichen Afrika und stellt den Übergang von der Hochdiversitätsregion des asiatischen Indo-Pazifiks zu den Kaltwasserbereichen des südlichen Afrikas dar. Er gehört zu den produktivsten und biologisch reichsten Ökosystemen im östlichen Afrika und bietet den Küstenbewohnern wertvolle Vorteile. Der Sansibar-Archipel besteht aus den drei Hauptinseln Sansibar, Pemba und Mafia. Diese Inseln sind einer ganzen Reihe von sich zuspitzenden Bedrohungen ausgesetzt, wie dem Einfluss von wachsendem Tourismus, Küstenveränderungen, Überfischung, menschgemachter Erosion und Konsequenzen, die durch den globalen Klimawandel entstehen (Ozeanversauerung, Temperaturstress, Bleaching). Die Kombination aus globalen und lokalen Stressfaktoren macht Riffe immer anfälliger für Störungen und reduziert letztendlich ihre Fähigkeiten ihre physischen Strukturen zu erhalten. Trotz der weitverbreiteten Erkenntnis, dass die Riffe entlang des östlichen Afrikas ernsthaft bedroht sind, sind Information über Foraminiferen, einer bedeutenden Gruppe von Riffcarbonatproduzenten, begrenzt. In der vorliegenden Arbeit wurden die räumliche Verbreitung, Zusammensetzung, Diversität und ökologische Bedeutung von Foraminiferenvergesellschaftungen in Flachwasser-Riffökosystemen untersucht. Zum ersten Mal in diesem Gebiet wurde ein Katalog von 167 Arten, die zu 98 Gattungen gehören, erstellt und durch rasterelektronenmikroskopische Aufnahmen illustriert. Die Struktur der Foraminiferenfauna wurde in verschiedenen Habitaten analysiert, die mit Hilfe von statistischen Auswertungen unter Einbeziehung der Beobachtungen vor Ort bestimmt wurden.

Quantitative Faunenanalysen von Sedimentproben zeigen die Präsenz von sieben Makrohabitaten um die drei Inseln des Sansibar-Archipels an – jeweils charakterisiert durch bestimmte Indikatortaxa: 1.) Das küstennahe Habitat in unmittelbarer Nähe der Mangrovenwälder, dominiert von opportunistischen Arten, die in der Lage sind eutrophischen Bedingungen zu widerstehen, 2.) das flache Lagunenhabitat, charakterisiert durch kleinere porzellanschalige Foraminiferen, 3.) der flache und extrem warme Bereich des Riffdachs, dominiert von einer Art, die angepasst ist an extreme Bedingungen, 4.) die Hochenergie-Saumriffe östlich von Sansibar, die einen großen Anteil an symbiontentragenden Foraminiferen beheimaten, 5.) die kleineren Rampenriffe vor Mafia, die den größeren Saumriffen von Sansibar sehr ähnlich sind, 6.) die Fleckenriffe auf der geschützten Westseite Sansibars, charakterisiert durch eine sehr spezielle Fauna mit Arten, die fast ausschließlich in diesem Habitat vorhanden ist, und 7.) die hochdiversen Vorriffbereiche von Pemba. Die klar definierten Cluster zeigen, dass Habitate sogar in relativ kleinräumigen Milieus durch Foraminiferenvergesellschaftungen unterschie-den werden können.

Wegen ihrer großen Häufigkeit und ihres bedeutenden Beitrags zur Festigung von Riffgerüsten in diesen Habitaten sind einige der Indikatortaxa ergiebige Produzenten von Calciumcarbonat ($CaCO_3$) und tragen eine beträchtliche Menge zum Sedimenthaushalt von Riffstrukturen bei. Besonders symbiontentragende Großforaminiferen produzieren einen bedeutenden Anteil an Carbonat in verschiedenen Riffhabitaten. Der Vergleich zwischen prozentualer Häufigkeit und den Carbonatproduktionsfähigkeiten einzelner Taxa weist die wichtigsten Carbonatproduzenten in ihren bestimmten Habitaten aus. Sowohl die Habitate als auch die Foraminiferenarten, die eine herausragende und ökologisch wichtige Rolle in den Riffmilieus

rund um den Sansibar-Archipel spielen, wurden identifiziert. Diese Arten treten in enormen Mengen auf, beeinflussen die Verfügbarkeit von Ressourcen und verändern ihr physisches Habitat. Außerdem haben sie Auswirkungen auf die Zusammensetzung, die Diversität und den Artenreichtum von assoziierten Foraminiferengesellschaften und tragen zum Schutz von Riffstrukturen und Küstenbereichen bei. In ausgewählten Habitaten trägt der $CaCO_3$-Eintrag von Foraminiferen bedeutend zum Gleichgewicht, zur Akkretion und Stabilisierung von Riffgerüsten bei. Foraminiferen müssen daher als Ökosystemingenieure in Riffen um den Sansibar-Archipel betrachtet werden. Die Anerkennung ihrer Carbonatproduktionsfähigkeiten erfordert das Einbeziehen von Foraminiferen in zukünftige Riffmanagementstrategien und hilft bei der Identifizierung von ökologisch wichtigen Schlüsselhabitaten. In dieser Dissertation wurden die Umwelt- und Verbreitungscharakteristika von Schlüsselhabitat formenden Arten analysiert und deren Rolle als Ökosystemingenieure im Sansibar-Archipel ausgewertet. Der FoRAM-Index zeigt, dass die Riffe um die Inseln des Sansibar-Archipels weitgehend in einem guten Zustand sind, jedoch deuten mittlere FoRAM-Indizes auf erste Anzeichen für eine Verschlechterung in den Riffen vor den Westküsten der Inseln hin. In den östlichen Riffen könnte die große Anzahl an bestimmten, dominanten Großforaminiferenarten das Bild von gesunden, ungefährdeten Korallenriffen verfälschen.

Die höchste Produktivität und Ökosystemfunktionsweise wurde an den Orten erfasst, die von den am häufigsten vorkommenden Indikatorarten dominiert werden. An diesen Stellen ist die Diversität geringer und hängt generell mehr von Habitatcharakteristika in Bezug auf biotische und ökologische Beschränkungen ab als von der Wassertiefe, die gewöhnlich dem Trend zunehmender Foraminiferendiversität entspricht. Die höchsten Diversitätswerte wurden in feinkörnigen Sedimenten aus etwa 20 m Tiefe gemessen. Die Verteilung, Diversität und Zusammensetzung von Foraminiferenvergesellschaftungen zeigen demnach bestimmte Muster und morphologische Anpassungen, die relevante Informationen für Paläoumwelt- und paläoklimatische Interpretationen liefern.

Abstract

The Zanzibar Archipelago is the largest reef system in eastern Africa and represents the transition from the high-diversity region of the Asian Indo-Pacific to the cold-water areas of southern Africa. It is among the most productive and biologically rich ecosystems along eastern Africa and provides valuable benefits to coastal people. The Zanzibar Archipelago consists of the three major islands Zanzibar, Pemba and Mafia Island. These islands face an intensifying array of threats, including impacts from growing tourism, coastal development, overfishing, anthropogenic runoff, and consequences from global climate change (ocean acidification, temperature stress, bleaching). The combination of global and local stressors makes reefs increasingly susceptible to disturbance and ultimately reduces their capabilities to maintain their physical structure. Despite widespread recognition that the reefs along eastern Africa are seriously endangered, information on foraminifera, a prominent group of reefal carbonate producers, is limited. In this project the spatial distribution, composition, diversity and environmental significance of foraminiferal faunal assemblages in shallow-water reefal ecosystems were studied. For the first time in this area, a catalog of 167 species belonging to 98 genera, all illustrated by scanning electron microscopy, was established. The structure of the foraminiferal fauna was analyzed in different habitats that have been identified using statistical analyses, including observations made in the field.

Quantitative faunal analyses of sediment samples show the presence of seven macro-habitats around the three islands of the Zanzibar Archipelago, characterized by specific indicator taxa: 1.) the nearshore habitat in the vicinity of mangrove forests, dominated by opportunistic species able to withstand eutrophic conditions, 2.) the shallow lagoon habitat, characterized by smaller porcelaneous foraminifera, 3.) the shallow and extremely warm reef flats, dominated by a single species adapted to extreme conditions, 4.) the high-energy fringing reefs east of Zanzibar, harboring a large amount of symbiont-bearing foraminifera, 5.) the smaller apron reefs at Mafia Island, very similar to the larger fringing reefs of Zanzibar, 6.) the patch reefs on the sheltered western side of Zanzibar, characterized by a very particular fauna including species almost exclusively present in this habitat, and 7.) the highly diverse fore reefs at Pemba. The well-defined clusters show that even in relatively small-scale environments, habitats are excellently discriminable by foraminiferal assemblages.

Because of their high abundances and significant contribution to the stabilization of reefal frameworks in these habitats, some of the indicator taxa are prolific producers of calcium carbonate ($CaCO_3$) and contribute a substantial portion to the sedimentary budget of reefal structures. Especially larger symbiont-bearing foraminifera produce a significant amount of carbonate in different reefal habitats. Comparison between percent abundances and carbonate producing capabilities of single taxa reveals the most important carbonate producers among foraminifera in their specific habitats. Both habitats and foraminiferal species that play a prominent and economically important role in reefal environments around the Zanzibar Archipelago were identified. These species occur in enormous abundances, modulate the availability of resources and modify their physical habitat. They also impact the structure, diversity and species richness of associated foraminiferal communities and they contribute to the protection of reefal structures and shorelines. In selected habitats, the foraminiferal

$CaCO_3$-input contributes significantly to the balance, accretion and the stabilization of reefal frameworks. Therefore foraminifera must be considered ecosystem engineers in reefs around the Zanzibar Archipelago. Recognition of the carbonate producing capabilities requires foraminifera to be included in future reef management strategies and helps to identify ecologically important key-habitats. Here the environmental and distributional characteristics of key-habitat forming species were analyzed and their role as ecosystem engineers in the Zanzibar Archipelago was assessed. The FoRAM Index shows that the coral reefs around the islands of the Zanzibar Archipelago are generally in a good condition, though medium FoRAM Indexes in the reefs located at the western coasts of the islands indicate early signs of degradation. In the eastern reefs, high percentages of specific dominant larger foraminiferal species might skew the picture of healthy, less endangered coral reefs.

Highest productivity and ecosystem functioning was recorded at places dominated by the most abundant indicator taxa. The diversity at these places is lower and in general depends more on habitat characteristics related to biotic and environmental constraints than on water depth as the common trend of increasing foraminiferal diversity. Maximum diversity values were obtained from fine grained sediments at around 20 meters. The distribution, diversity and composition of foraminiferal assemblages thus show specific patterns and morphological adaptations that provide relevant information for paleoenvironmental and paleoclimatic interpretation.

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1 Introduction

Foraminifera are abundant in all marine habitats and a vital part of the marine food chain. Despite their size, these protists constitute about 90 % of the deep sea biomass (Armstrong & Brasier 2005). Foraminifera are biostratigraphical indicators for most of the Phanerozoic and have repeatedly formed large reef complexes since the Upper Carboniferous. There are more than 5,000 living species of foraminifera, which are important environmental indicators for all kinds of marine habitats (Armstrong & Brasier 2005). Especially larger benthic foraminifera (LBF) are important producers of calcium carbonate ($CaCO_3$) in the world's oceans and contribute significantly to the stabilization of reefal frameworks (Langer et al. 1997; Hallock 1999; Langer 2008). Over the last decades several studies have been conducted to assess the relevance and diversity of foraminifera in tropical ecosystems (i.a. Hallock 1981, 2002; Hohenegger 2006; Goldbeck & Langer 2006; Dawson et al. 2012).

The foraminifera of eastern Africa have been studied since the late 19th century. In the beginning most of the work had to be conducted seaborne. Even today large areas of the African coast are inaccessible by land due to dense vegetation, widespread river deltas (e.g. Rufiji or Zambezi) and insufficient infrastructure. This, together with limited prospects of success in finding hydrocarbons as well as safety issues due to occasional civil wars, has left East Africa a blank area on the map of many scientific projects. As of this writing an expedition to the Somali coast is practically inoperable due to political instability.

There are a few scientific papers and reports considering the foraminiferal assemblages of this biogeographically crucial area. The most significant studies of foraminifera from eastern Africa have been conducted by Heron-Allen & Earland (1914 & 1915), Braga (1961), Pereira (1979), Pignatti et al. (2012), and Langer et al. (2013a). But all of these studies consider exclusively regions either in Kenya or Mozambique. Thus, the foraminifera in reefal habitats from Tanzania have been barely studied so far, although Tanzania, located just a few degrees south of the Equator, possesses the largest reef area in East Africa (Spalding 2001). Only Neagu (1982) worked on foraminifera from Mbudya, a small uninhabited island off Dar es Salaam.

This thesis presents the first examination of foraminiferal assemblages from the islands of the Zanzibar Archipelago. The major goals of this project were:

1. to record, quantify and illustrate the diversity of foraminiferal species present around the Zanzibar Archipelago,

2. to compare distributional, occurrence and abundance data of benthic foraminifera from the Zanzibar Archipelago with other tropical sites previously studied along the coast of East Africa,

3. to contrast occurrence and diversity data recorded by Heron-Allen & Earland (1914 & 1915) with the data set compiled in this study,

4. to identify species endemic to the Zanzibar Archipelago and to determine the biogeographic extension of selected taxa,

5. to assess the validity of the term East African Faunal Province,

6. to determine the structure and composition of foraminiferal assemblages within individual reefal habitats,

7. to identify specific indicator taxa characterizing reefal, lagoonal and nearshore habitats,

8. to quantify and visualize the distribution and percent abundance of individual taxa and groups of benthic foraminifera,

9. to compare abundance data of larger symbiont-bearing and smaller benthic foraminifera,

10. to record bathymetric distribution patterns of foraminiferal species and assemblages,

11. to assess the situation of the coral reefs around the islands using the FoRAM Index,

12. to determine carbonate production rates of selected taxa to evaluate their significance as ecosystem engineers within marine habitats in shallow waters around Zanzibar, Pemba and Mafia,

13. to compare carbonate production rates of larger and smaller benthic foraminifera,

14. to correlate individual foraminiferal carbonate production rates with reefal habitats,

This study is part of the long-term research project: “Biogeographic key regions: faunal provinces of benthic foraminifera in southern Africa”, funded by the German Science Foundation (DFG).

2 Research area

2.1 Location

Fig. 1: Satellite image of Zanzibar Island (Google Earth 2013)

The Zanzibar Archipelago belongs to the Republic of Tanzania and consists of the three main islands Zanzibar (Unguja), Pemba and Mafia. The islands are located between 15 and 50 km off the coast of the Tanzanian mainland and extend between 4°51’ S and 8°04’ S and 39°05’ E and 39°55’ E. They have formed in the ancient Miocene Rufiji Delta and consist of marine limestones covered by clastic delta deposits (Nicholas et al. 2007). The islands have been separated from the mainland by tectonic movement and faulting, which created channels of up to 800 m depth (Nicholas et al. 2007). In the channels between the islands and the mainland, the continental shelf is wider than on the eastern side of the islands. Zanzibar is approximately 85 km long and about 30 km wide (Fig. 1). Covering a total area of 1,666 km^2, it is the largest of the three main islands. Pemba, situated about 50 km north of Zanzibar, covers an area of 984 km^2 and extends up to 67 km in North-South direction and about 22 km in West-East direction (Fig. 2). Mafia Island is located about 150 km south of Zanzibar and covers an area of about 435 km^2. The smallest of the three main islands is approximately 49 km long and up to 17 km wide (Fig. 3).

2.2 Climate

Fig. 2: Satellite image of Pemba Island (Google Earth 2013)

Located just a few degrees south of the Equator, Zanzibar is characterized by a tropical warm and humid climate with average temperatures of about 27°C and a generally high humidity. Zanzibar’s climate is mainly controlled by two monsoon seasons. The northeast monsoon (November-February) brings high temperatures and low wind speed, the southeast monsoon (April-September) is characterized by lower temperatures and stronger winds (Francis et al. 2001, Fig. 4). Due to the migration of the Intertropical Convergence Zone there are two rainy seasons: the major rainy season from March to May, often referred to as “long rains”, and a minor rainy season (“short rains”) in November and December (McSweeney et al. 2010). The long rains with their peak in April bring more than half of Zanzibar’s annual precipitation. The highest amount of rainfall is recorded from the island of Pemba (1916 mm/year; Francis et al. 2001).

2.3 Natural areas

Fig. 3: Satellite image of Mafia Island (Google Earth 2013)

The islands of the Zanzibar Archipelago are part of the East African Coral Coast, one of the ecoregions of the Western Indian Ocean province introduced by Spalding et al. (2007). All of the three islands are characterized by a distinct difference in the topography of the western and the eastern coasts. On the west of the islands, there are several smaller islets and patch reefs, sheltered bays and in some areas seagrass meadows, while the eastern coasts are more straight-lined and highly exposed to tidal influx and wave energy (Fig. 5). Due to the steeper shelf, the east coasts of Zanzibar and Pemba Island are covered by large fringing reefs facing the deep ocean (Arthurton 2003). On Zanzibar these reefs are only discontinuous at Chwaka Bay, a wide salt marsh connected to a rain forest and characterized by numerous mangroves (Figs. 1 & 5). Altogether, the mangrove forests on Zanzibar and Pemba cover an area of about 18,000 ha (Francis et al. 2001). Mangroves play an important role as a coastal ecosystem which hosts plenty of other species. Mangroves build land by sediment accumulation and also prevent coastal erosion and sediment run-off and thereby protect coral reefs from sediment cover. The coral cover around the islands highly varies from 1-80 % and due to coral bleaching and human pressure, up to 99 % of the coral reefs are endangered (Spalding 2001). At the south-eastern coast of Mafia Island there are no real fringing reefs, but several smaller apron reefs. The apron reefs are located between the smaller offshore islands Chole, Juani and Jibondo (Fig. 3). These islands, together with the southern part of the main island, form the Mafia Island Marine Park, the largest protected area of the Tanzanian coast (Spalding 2001). The coast of Pemba is characterized by several channels and widely ramified bays like Chake Chake Bay (Fig. 2). The so-called Mnemba Atoll, situated a few kilometers east of Zanzibar Island, constitutes a special area. This island is not actually an atoll but a small cay, protected by a crescent-shaped large reef to the east and characterized by a widespread reef flat (Figs. 1 & 5).

2.4 Oceanography

In the tropical western Indian Ocean around the Zanzibar Archipelago the mean sea surface temperature ranges between 25°C in September and 29°C in March (Bergman & Öhman 2001). Sea-surface temperatures are mainly monsoon-controlled. The southeast monsoon brings warm water from the central Indian Ocean, accompanied by strong winds of up to 9 m/s (Ngusaru 2011; Fig. 4). The tidal amplitude at the coasts of Zanzibar and Pemba during the monsoon season is up to 3.6 m (Ngusaru 2011). The Zanzibar Archipelago is situated in the northward flowing East African Coastal Current (EACC; Fig. 4). During the southeast monsoon the EACC flows at a speed of 3.5 m/s, bringing rough seas to the eastern shores (McClanahan 1988). The EACC is fed with warm water by the South Equatorial current, which flows westward through the central Indian Ocean at around 12° S (Fig. 4; Francis et al. 2001). The seawater at the coasts of the Zanzibar Archipelago can be subdivided into three main water masses: 1.) the surface water, characterized by temperatures of 22-30°C and a salinity of about 35.4 ‰, 2.) the high salinity water at depths of 150-250 m, and 3.) the Indian Ocean central water at depths of 250-500 m with temperatures of less than 18°C (Francis et al. 2001). The largest areas of the Indian Ocean are between 3,000 and 4,000 meters deep and characterized by nutrient-rich waters (Ngusaru 2011). These deep-sea waters are the main food supply for the phytoplankton, the base of the marine food chain, and brought up to the surface by seasonal up-welling at the Somalian and Arabian coast (Ngusaru 2011). The chlorophyll-a concentration ranges from 0.04 to 1.4 mg/m^3, which is very low in comparison to other tropical areas but increases slightly with the seasonal arise of the northeast monsoon (Francis et al. 2001).

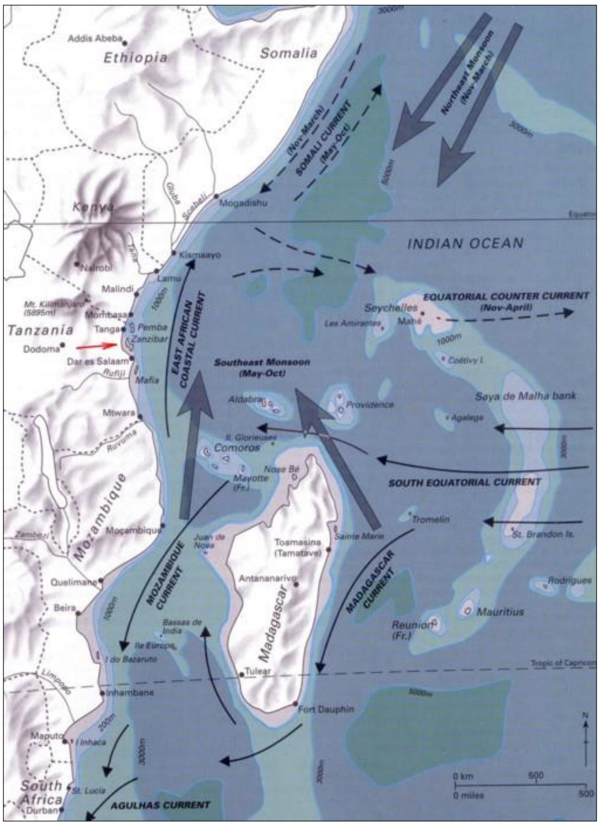

Fig. 4: Map of the Western Indian Ocean current system and monsoon phases. The red arrow indicates the location of Zanzibar (from Richmond 1997).

2.5 Marine biodiversity

Among the Indian Ocean macrofauna, polychaetes (33 %) are the dominant group, concerning the number of individuals; in terms of species, crustaceans (23 %) are the most diverse group (Wafar et al. 2011). The western Indian Ocean is home to more than 11,000 described species of major macrofloral and macrofaunal taxa (Griffiths 2005). However, this number does probably not even include half of the quantity of actually present taxa due to research limits especially in the deep sea. Highly diverse groups are molluscs, fish and macroalgae (Richmond 2000; Griffiths 2005). 528 species of coral fish are described from the western Indo-Pacific which constitutes the highest mean species density of reef fish in the world's oceans (Stuart-Smith et al. 2013). The reefs of Tanzania are characterized by at least 369 coral species (Obura 2012). Obura (2012) describes the area between the Northern Mozambique Channel and Mafia Island as the center of diversity or 'core' ecoregion of the western Indian Ocean in terms of reef-building corals. But also Pemba Island is known for its high species diversity. The small island of Misali, west of Pemba, is home to at least 40 coral genera and 350 species of fish (Spalding 2001). On land, the mangrove forests in Tanzania are characterized by ten different species.

2.6 Reef and mangrove areas of Tanzania

Fig. 5: Map of the reef (brown) and mangrove (green) areas of Tanzania (from Spalding 2001).

2.7 Typical coastal areas of the Zanzibar Archipelago

Fig. 6: Aerial view of the fringing reef at Ras Nungwi with Mnemba Island in the background (Photo by Martin Langer).

Fig. 7: Aerial view of Mnemba Island with Ras Nungwi in the background (Photo by Martin Langer).

Fig. 8: Mangroves at the beach at Menai Bay (Photo by Martin Langer).

Fig. 9: Tidal flats at Kizimkazi Beach (Photo by Martin Langer).

Fig. 10: Beach at Ocean Paradise with the shallow lagoon in the background (Photo by Martin Langer).

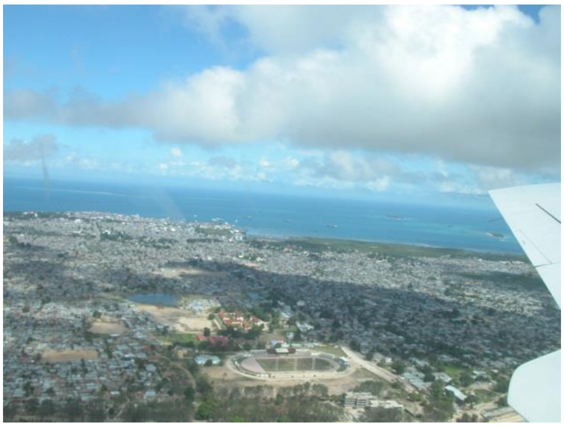

Fig. 11: Aerial view of Stone Town with Bawe Island and the Aquarium in the background (Photo by Martin Langer).

3 Material & Methods

3.1 Sampling

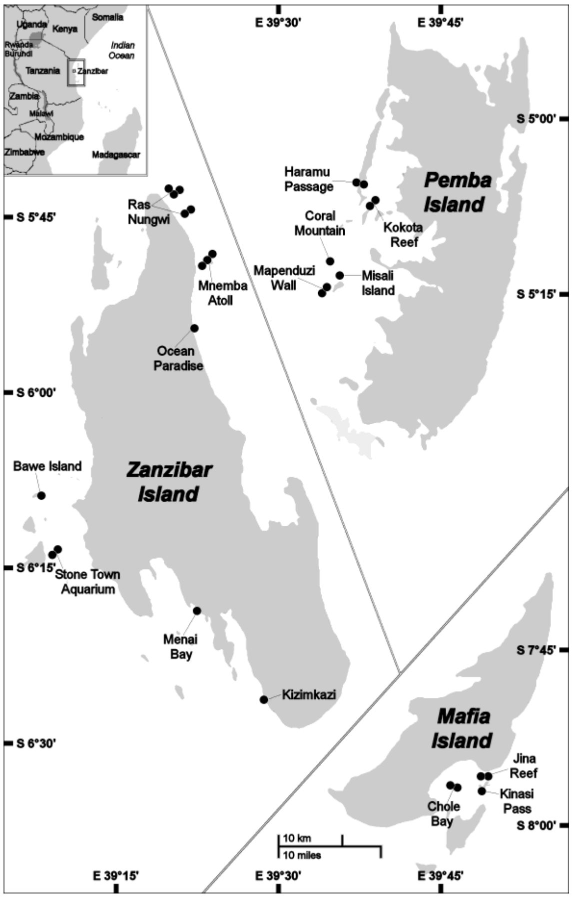

Fig. 12: Map of the sample stations.

The sampling material for this study was collected during two field trips in March 2005 at the islands of Zanzibar and Pemba, and in March 2012 at Mafia Island. This study is part of a major long-term project concerning the coastal habitats of southern Africa from Kenya to Angola. Its outcomes will be presented elsewhere. A total of 27 samples were collected by snorkeling and SCUBA diving in reefal and nearshore areas at depths of up to 42 m (Fig. 12, see also 9.1). Sampling locations were chosen to represent all different kinds of ecological habitats along the coasts of the islands. Sampling sites were selected by being preferably fine grained and mainly carbonaceous. The samples were dried and packed into labeled bags or boxes. In the lab, the sediment material was washed through a 63 µm sieve, and dried at 50°C in an oven over night (see also 9.1). Most of the sediment material was fine grained and consisting of about 90 % carbonate (see also Table 4). Quartz and feldspar were the lithogenic mineral components.

3.2 Data collection

At least 450 foraminiferal specimens were picked from each sample. Only total assemblages were recorded. Pictures of representative individuals of each species were made via Scanning Electron Microscopy (SEM) and arranged on plates using the graphic program Adobe Photoshop. The foraminifera were then identified at species level and counted. Heron-Allen & Earland (1915), Hottinger et al. (1993), and Loeblich & Tappan (1994) were used as main references to identify the species. Taxonomy and synonymy in this thesis follow the concepts introduced by Loeblich & Tappan (1988) and Hottinger et al. (1993). The Fisher α index was calculated to determine the foraminiferal diversity (Fisher et al. 1943; see also 4.1 and 9.1). Maps illustrating the location of the sample stations, the diversity at the stations and the distribution patterns of the foraminiferal species were established with Adobe Photoshop (see also 3.1, 4.1 and 4.2). Statistical analyses using the programs PAST and R were conducted to illustrate structures in the foraminiferal data set obtained (see also 3.3). Diagrams illustrating the distribution of major taxonomic groups, ecotypes and morphotypes were compiled with Microsoft Excel (see also 4.8, 4.9 and 4.10). Major taxonomic groups used in this study are larger Miliolina, larger Rotaliina and smaller foraminifera as well as families of larger benthic foraminifera present in this area (see also 4.8). Ecotypes used in thesis are based on terms primarily mentioned by Murray (1973, 2006), Lipps (1983), Kitazato (1986), and Langer (1993; see also 4.9). Morphotype analyses group the foraminiferal species into morphological groups on the basis of the shape of the test. These analyses were initially used by Chamney (1976), Severin (1983), and Corliss & Fois (1990) and the morphological terms used in this thesis follow those used in these studies (see also 4.10). The FoRAM Index was calculated after Hallock et al. (2003; see 4.11). The content of carbonate in the samples was determined chemically using a calcimeter (see also 4.12). The carbonate production by foraminifera was calculated using the method introduced by Langer et al. (1997). The different groups of foraminifera were weighed to assess their carbonate producing capabilities.

3.3 Statistical analyses

For the cluster analyses the counting data was imported into PAST and the analyses executed. For the Q-mode cluster the paired group algorithm and the Bray-Curtis dissimilarity were chosen, for the R-mode clusters Pearson's correlation was used with the paired group algorithm (see also 4.3). All of the 27 samples have been determined in a Q-mode cluster analysis for their similarity in terms of faunal composition, which is reflected in the corresponding assemblages of the R-mode cluster analysis. This was done twice, both on genus level and on species level, to illustrate that major faunal assemblages are still diagnostically conclusive even on a higher taxonomic level. For reasons of clarity and comprehensibility the 40 most abundant genera and the 45 most abundant species were chosen for these analyses. Later the clusters were colored and labeled in Photoshop for a better distinction. The principal component analysis (PCA) was conducted with PAST as well (see also 4.4). A PCA is used in multivariate statistics to structure and visualize larger data sets by reducing a large number of variables to only two linear combinations (principal components). This method is applied to help identifying structures in cluster analyses. Samples represent the items in this multivariate analysis and the most abundant taxa are the variables. The canonical correspondence analysis (CCA) was done with R. Samples, species and abiotic parameters were imported and the CCA executed (see also 4.5). The canonical correspondence analysis (CCA) is an extension of the correspondence analysis (CA) introduced by Ter Braak (1986). In this variety, the derived ordination axes are linear combinations of the environmental variables. Abiotic parameters used for the statistical analyses can be obtained from the Bio-ORACLE database (Tyberghein et al. 2011; www.oracle.ugent.be). Descriptive statistics were conducted using R again. By entering specified commands the different statistical values were calculated (see also 4.5). Dominance was calculated using PAST and later colored and labeled in Photoshop. Dominance is defined as the sum_i of the number of individuals of taxon *i* divided by the number of individuals of all taxa squared or simply 1-Simpson index. The values in the dominance analysis range from 0, where all taxa are even, to 1, which means that there is only one taxon present at all. For the resulting graph the number of species is plotted on the y-axis and dominance on the x-axis (see also 4.6). Ternary diagrams after Murray (1973), illustrating the percentage of each of the three major suborders (or test types) of foraminifera, are used to distinguish shallow water habitats. The ternary diagram was calculated using PAST and later colored and labeled in Photoshop (see also 4.7).

3.4 Previous studies

The first to explicitly study the foraminifera of the western Indian Ocean was Möbius (1880). He identified, drew and described foraminifera in shallow-water samples from Mauritius and the Seychelles. Though, there are some species described by d'Orbigny (1826) from type localities in the Indian Ocean at Madagascar and Mauritius. The world cruises conducted by Brady on H.M.S. Challenger (1873-1876) and Egger on S.M.S. Gazelle (1874-1876) included some samples from the southern Indian Ocean, especially from South Africa and Mauritius. The most relevant work about eastern African foraminifera was published by Heron-Allen & Earland (Part I 1914 & Part II 1915) who studied the foraminifera of the Kerimba Archipelago (today Quirimbas Islands). They found 477 species and varieties in 16 samples from depths of up to 85 fms (about 155 m; see also Table 1). In the first part Heron-Allen & Earland (1914) described two foraminiferal genera, *Iridia* and *Nouria*, and compared the individuals with similar material from the British Isles. In the second part Heron-Allen & Earland (1915) describe the rest of the 477 species and varieties and introduce a number of new species found in Kerimba. Braga (1961) and Moura (1965) collected and studied samples from the coast of southern Mozambique. Braga (1961) found a very diverse fauna in depths of up to 700 m off the coast of Mozambique; Moura's (1965) study involved shallow-water samples from a small island in the Maputo Bay. Detailed studies on the foraminifera from the Bazaruto Archipelago (Mozambique) have been conducted by Makled & Langer (2010) and Langer et al. (2013a). Makled & Langer (2010) report the capability of an agglutinating foraminiferal species to actively select specific grains for test construction; Langer et al. (2013a) provide biogeographical data and foraminiferal habitat preferences that might be useful in paleoecological studies. Pereira (1979), Chasens (1981), Levy et al. (1982), and Pignatti et al. (2012) studied foraminiferal assemblages from Kenya and southernmost Somalia. Pereira (1979) discussed occurrences and distribution of foraminifera in the fringing reefs off Mombasa in reference to habitat preferences. Chasens (1981) studied foraminifera in shallow lagoonal environments off Kenya. The littoral zone north of Mombasa was studied by Levy et al. (1982). Pignatti et al. (2012) described 256 foraminiferal species in shallow marine habitats and tidal channels from the Somali-Kenyan border. Thus, the foraminifera from Tanzania have been poorly studied so far. Only Neagu (1982) studied the foraminiferal assemblages from Mbudya, a small uninhabited island off Dar es Salaam. He studied the geographical distribution of foraminiferal species and compared the assemblages from Mbudya with other areas in tropical and subtropical seas.

A number of studies have been conducted off the continental coast of East Africa around Madagascar and adjacent islands: Le Calvez (1965) studied the foraminifera from lagoonal sediments around Mayotte, Monier (1974) collected foraminifera from a reef platform in Madagascar, Battistini (1976) worked on the foraminifera from the Glorioso Islands, Montaggioni (1981) studied the foraminiferal assemblages and their contribution to sediment production in reef sediments from the Mascarene Islands (Fig. 13).

Author (Year)	Title	Max. Depth	No. of species	Illustrations
Battistini, R. (1976)	Étude des sédiments et de la microfaune des îles Glorieuses (canal de Mozambique)	100 m	139	None
Braga, J.M. (1961)	Foraminíferos da Costa de Moçambique	700 m	270	21 plates
Chasens, S.A. (1981)	Foraminifera of the Kenya Coastline	20 m	100	2 plates
Heron-Allen, E. & Earland, A. (1914-1915)	The Foraminifera of the Kerimba Archipelago (Portuguese East Africa)	155 m	477	16 plates
Langer, M.R. et al. (2013a)	The Foraminifera from the Bazaruto Archipelago (Mozambique)	25 m	158	8 plates
Le Calvez, Y. (1965)	Les récifs coralliens et le lagon de l'île Mayotte (Archipel des Comores, Océan Indien) – Les Foraminiféres	75 m	241	4 plates
Levy, A. et al. (1982)	Contribution à la connaissance des foraminiferès du littoral Kenyan (Océan Indien)	n/s	83	5 plates
Möbius, K. (1880)	Beiträge zur Meeresfauna der Insel Mauritius und der Seychellen	n/s	40	14 plates
Monier, C. (1974)	Note préliminaire sur les foraminifères benthiques du platier interne du grand récif de Tuléar (Madagascar)	~ 2 m	23	None
Montaggioni, L.F. (1981)	Les associations de foraminifères dans les sédiments récifaux de l'archipel des Mascareignes (Océan Indien)	60 m	130	None
Moura, A.R. (1965)	Foraminíferos da Ilha da Inhaca	4 m	102	7 plates
Neagu, T. (1982)	Foraminifères récents de la zone du récif coralligène de l'île de Mbudya (côte orientale de la Tansanie)	25 m	86	13 plates
Pereira, C.P.G. (1979)	Foraminiferal distribution and ecology in the fringing reef complex of the coast, near Mombasa, Kenya	n/s	206	51 plates
Pignatti, J. et al. (2012)	Recent foraminiferal assemblages from mixed carbonate-siliciclastic sediments of southern Somalia and eastern Kenya	60 m	256	1 plate

Table 1: Studies about recent foraminifera from eastern Africa.

In addition, the foraminiferal fauna from the Zanzibar Archipelago was compared with other tropical areas from the Red Sea (Said 1949, 1950; Halicz & Reiss 1979; Reiss & Hottinger 1984; Hottinger et al. 1993; Haunold et al. 1998), the Persian Gulf (Cherif et al. 1997), India (Seibold 1975), the Maldives (Parker & Gischler 2011), the Chagos Archipelago (Murray 1994; Murray & Smart 1994), as well as New Caledonia (Debenay 2012).

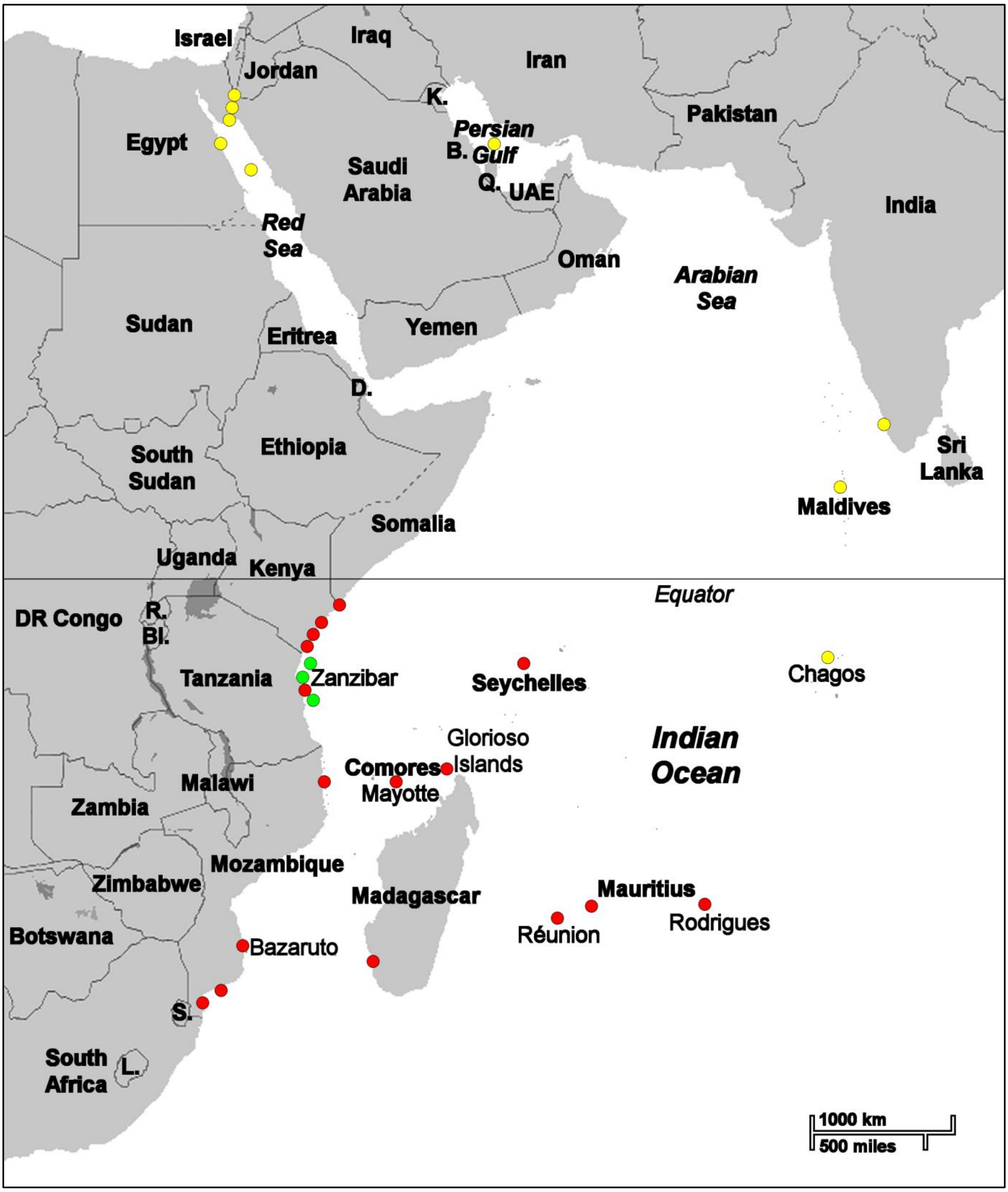

Fig. 13: Map showing the locations of studies about recent foraminifera in the western Indian Ocean. Green dots indicate the location of the Zanzibar Archipelago described in this work; red dots mark the positions of studies from eastern Africa (see Table 1); yellow dots mark the locations of comparative studies from the Red Sea, the Persian Gulf and the central Indian Ocean. Smaller countries are abbreviated (B = Bahrain, BI = Burundi, D = Djibouti, K = Kuwait, L = Lesotho, Q = Qatar, R = Ruanda, S = Swaziland, UAE = United Arab Emirates).

3.5 Typical sediments from the Zanzibar Archipelago

Bawe Island (Zanzibar):

The sediments from Bawe Island are generally medium grained and poorly sorted, and composed of about 88 % carbonate (see also Table 4). Main components are coral fragments, seashells, snail shells, foraminifera, echinoderm spines, other carbonate fragments as well as sponge spicules.

Fig. 14: Sediment material from Bawe Island (Zanzibar). Scale bar = 1 cm.

Chole Bay (Mafia):

Except for a few larger particles, the sediments from Chole Bay are well sorted, medium grained and consist of about 96 % carbonate (Table 4). Fragments of corals, foraminifera, seashells, echinoderm spines, bryozoans, coralline algae, and other carbonate fragments are the main components.

Fig. 15: Sediment material from Chole Bay (Mafia). Scale bar = 1 cm.

Coral Mountain (Pemba):

The sediments from Coral Mountain are poorly sorted and generally fine grained, and composed of about 95 % carbonate (Table 4). Main components are fragments of corals and coralline algae, seashells, foraminifera, snail shells, echinoderm spines, other carbonate fragments as well as sponge spicules.

Fig. 16: Sediment material from Coral Mountain (Pemba). Scale bar = 1 cm.

Haramu Passage (Pemba):

The sediment material from Haramu Passage is fine grained, mainly well sorted and consists of about 94 % carbonate (Table 4). Fragments of corals and coralline algae, seashells, foraminifera, snail shells, echinoderm spines, and other carbonate fragments are the main components.

Fig. 17: Sediment material from Haramu Passage (Pemba). Scale bar = 1 cm.

Jina Reef (Mafia):

The sediments from Jina Reef are fine grained, generally well sorted, and composed of about 98 % carbonate – the highest percentage along the islands (Table 4). Main components are coral fragments, seashells, foraminifera, echinoderm spines, other carbonate fragments as well as sponge spicules.

Fig. 18: Sediment material from Jina Reef (Mafia). Scale bar = 1 cm.

Kinasi Pass (Mafia):

The sediment material from Kinasi Pass is mainly well sorted, fine grained, and consists of about 95 % carbonate (Table 4). Fragments of corals, foraminifera, seashells, echinoderm spines, bryozoans, coralline algae, other carbonate fragments are the main components as well as sponge spicules.

Fig. 19: Sediment material from Kinasi Pass (Mafia). Scale bar = 1 cm.

Kizimkazi Beach (Zanzibar):

The sediments from Kizimkazi Beach are well sorted, very fine grained, and composed of about 92 % carbonate (Table 4). Main components are foraminifera, fragments of corals, seashells, other carbonate fragments as well as sponge spicules. Plant material indicates the vicinity of the coast.

Fig. 20: Sediment material from Kizimkazi Beach (Zanzibar). Scale bar = 1 cm.

Kokota Reef (Pemba):

Except for a few larger particles, the sediments from Kokota Reef are well sorted, fine grained and consist of about 95 % carbonate (see also Table 4). Fragments of corals and coralline algae, seashells, foraminifera, snail shells, echinoderm spines, and other carbonate fragments are the main components.

Fig. 21: Sediment material from Kokota Reef (Pemba). Scale bar = 1 cm.

Mapenduzi Wall (Pemba):

The sediments from Mapenduzi Wall are generally fine grained and poorly sorted, and composed of about 95 % carbonate (Table 4). Main components are coral fragments, seashells, foraminifera, echinoderm spines, snail shells, bryozoans, coralline algae, other carbonate fragments, as well as sponge spicules.

Fig. 22: Sediment material from Mapenduzi Wall (Pemba). Scale bar = 1 cm.

Menai Bay (Zanzibar):

The sediment material from Menai Bay is mainly well sorted, very fine grained, grey-colored, and consists of about 37 % carbonate (Table 4). Quartz grains, coral fragments, seashells, foraminifera, and other carbonate fragments are the main components. Organic material indicates the vicinity of a mangrove forest.

Fig. 23: Sediment material from Menai Bay (Zanzibar). Scale bar = 1 cm.

Misali Island (Pemba):

Except for a few larger particles, the sediments from Misali Island are well sorted, fine grained and consist of about 93 % carbonate (Table 4). The main components are coral fragments, seashells, foraminifera, snail shells, bryozoans, other carbonate fragments as well as sponge spicules.

Fig. 24: Sediment material from Misali Island (Pemba). Scale bar = 1 cm.

Mnemba Atoll (Pemba):

The sediments from the Mnemba Atoll are well sorted, very fine grained, and composed of about 90 % carbonate (Table 4). Main components are foraminifera, fragments of corals and coralline algae, seashells, snail shells, other carbonate fragments as well as sponge spicules.

Fig. 25: Sediment material from Mnemba Atoll (Zanzibar). Scale bar = 1 cm.

Ocean Paradise (Zanzibar):

The sediment material from Ocean Paradise is mainly well sorted, generally very fine grained, grey-colored, and consists of about 34 % carbonate (Table 4). Quartz grains, coral fragments, seashells, foraminifera, snail shells, and other carbonate fragments are the main components.

Fig. 26: Sediment material from Ocean Paradise (Zanzibar). Scale bar = 1 cm.

Ras Nungwi (Zanzibar):

The sediments from Ras Nungwi are coarse grained, poorly sorted, and composed of about 96 % carbonate (Table 4). Main components are fragments of corals and coralline algae, seashells, foraminifera, snail shells, echinoderm spines, other carbonate fragments as well as sponge spicules.

Fig. 27: Sediment material from Ras Nungwi (Zanzibar). Scale bar = 1 cm.

Ras Nungwi Peak (Zanzibar):

Except for a few larger particles, the sediments from Ras Nungwi Peak are well sorted, medium grained and consist of about 97 % carbonate (Table 4). Fragments of corals and coralline algae, foraminifera, seashells, snail shells, echinoderm spines, and other carbonate fragments are the main components.

Fig. 28: Sediment material from Ras Nungwi Peak (Zanzibar). Scale bar = 1 cm.

Stone Town Aquarium (Zanzibar):

The sediments from the Stone Town Aquarium are generally fine grained and poorly sorted, and composed of about 93 % carbonate (Table 4). Main components are coral fragments, seashells, snail shells, foraminifera, echinoderm spines, other carbonate fragments as well as sponge spicules.

Fig. 29: Sediment material from Stone Town Aquarium (Zanzibar). Scale bar = 1 cm.

4 Results

4.1 Diversity

167 species have been identified in 27 samples from around the three main islands of the Zanzibar Archipelago. The lowest diversity was recorded from the sample Ras Nungwi Lighthouse 12 m (31 species, Fisher α 7.41). The sample Kokota Reef 16 m contained 114 species (Fisher α 35.97) in contrast. In general the reefs at Pemba are the most diverse stations from around the islands of the Zanzibar Archipelago (Fig. 30). Figure 31 shows the diversity of the samples sorted by water depth. For samples with a depth range (e.g. Bawe Island 30-9 m) always the deepest information is given as reference. As an overall trend diversity increases with water depth but depends at a certain level on the local habitat. A list of all samples with number of species and Fisher α indices is attached in the appendix (see 9.1).

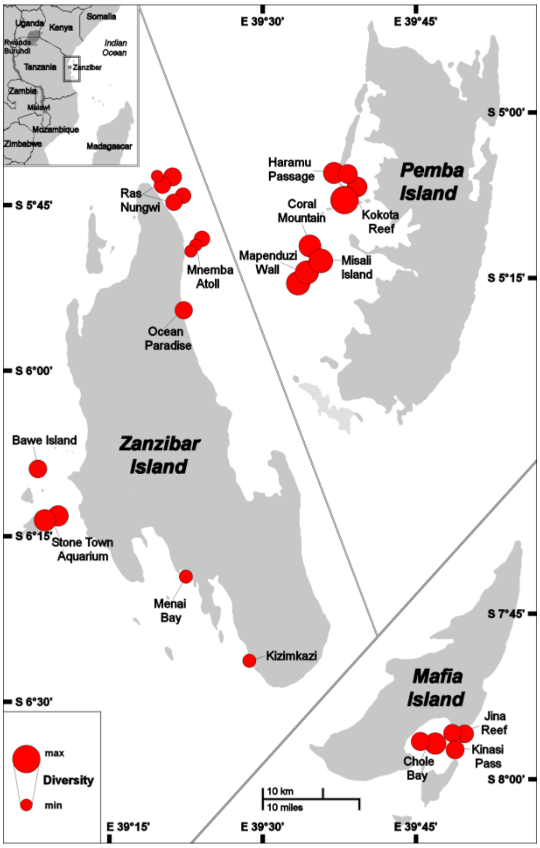

Fig. 30: Map showing the Fisher α diversity at the sample stations.

4.2 Distribution patterns

The following pages display a systematic list of all 167 species with synonymy, their distribution patterns, numerical abundances and depth ranges along the islands of the Zanzibar Archipelago. For samples with a depth range (e.g. Bawe Island 30-9 m) always the whole spectrum is given. 24 taxa have not been determined at species level and are recorded under open nomenclature.

Abundance categories (in % per sample):

- < 2 % = Rare
- 2-8 % = Common
- 8-30 % = Frequent
- > 30 % = Dominant

See also Tables 7-14 in the appendix (9.2).

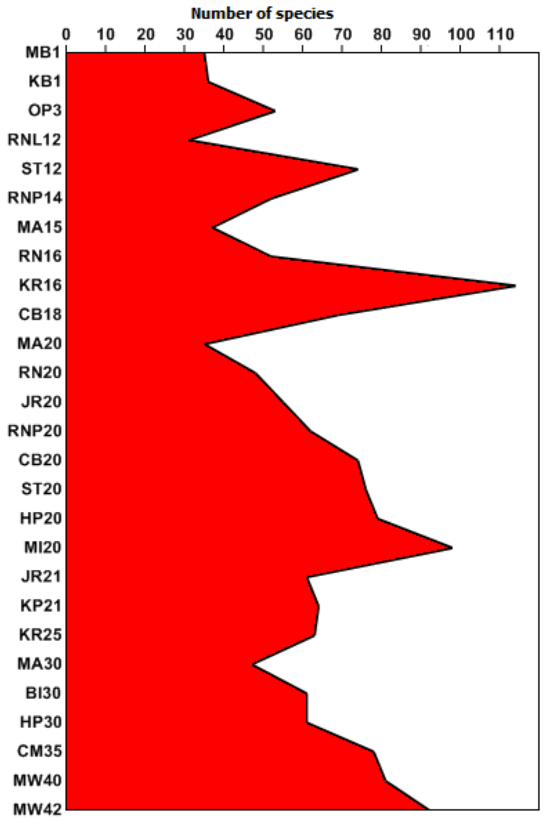

Fig. 31: Diversity sorted by water depth (in m).

Order Foraminiferida Eichwald, 1830

Suborder Textulariina Delage & Hérouard, 1896

Family Hormosinidae Haeckel, 1894

Genus *Hormosina* Brady, 1879

Hormosina globulifera **Brady**
Plate 1, Figs. 1-3

1879 *Hormosina globulifera* – Brady, p. 56
1915 *Hormosina globulifera* Brady – Heron-Allen & Earland, p. 617, pl. 46, fig. 25
1988 *Hormosina globulifera* Brady – Loeblich & Tappan, p. 61, pl. 45, figs. 18-20

Distribution: Mapenduzi Wall

Abundance: Rare

Depth: 42 m

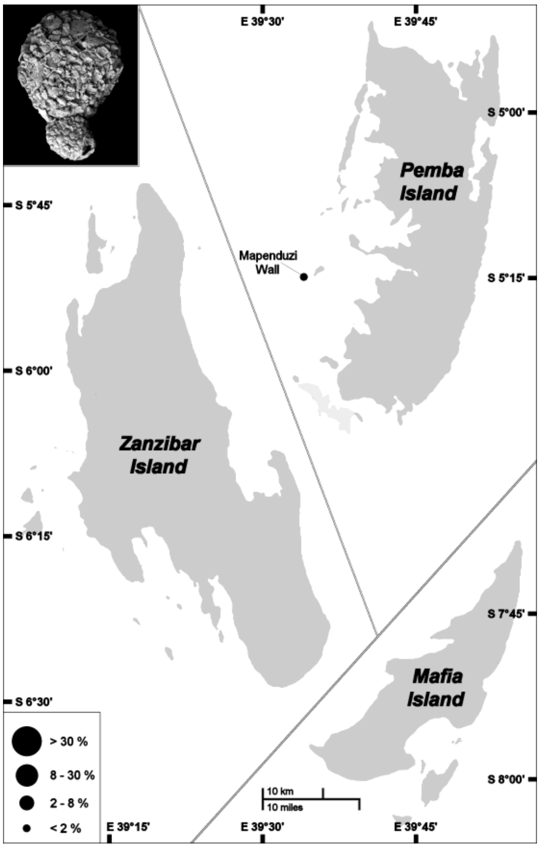

Fig. 32: Distribution of *Hormosina globulifera*.

Family Lituolidae de Blainville, 1827

Genus *Ammobaculites* Cushman, 1919

Ammobaculites exiguus **Cushman & Brönnimann**
Plate 1, Figs. 4-5

Distribution: Ocean Paradise

Abundance: Rare

Depth: 3 m

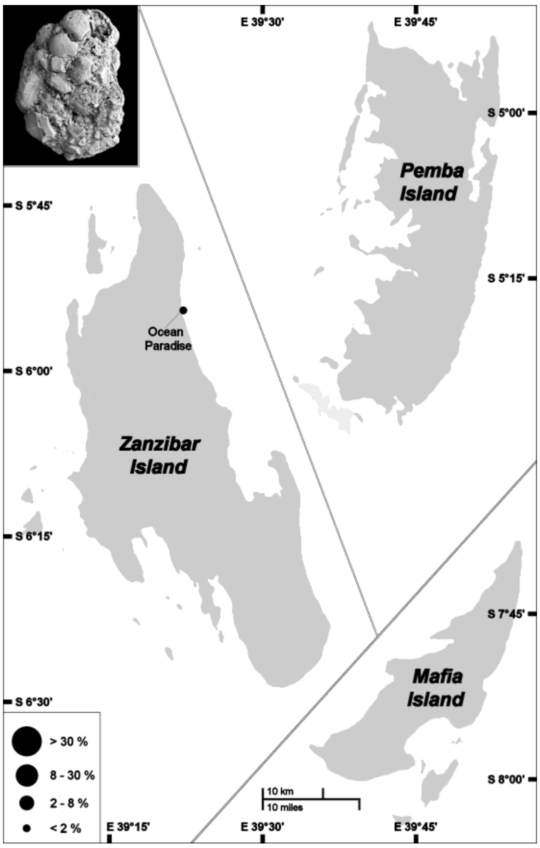

Fig. 33: Distribution of *Ammobaculites* sp. A.

Family Haddoniidae Saidova, 1981

Genus *Haddonia* Chapman, 1898

***Haddonia* ? sp. A**
Plate 1, Figs. 6-7

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

Distribution: Coral Mountain and Jina Reef

Abundance: Rare

Depth: 21-35 m

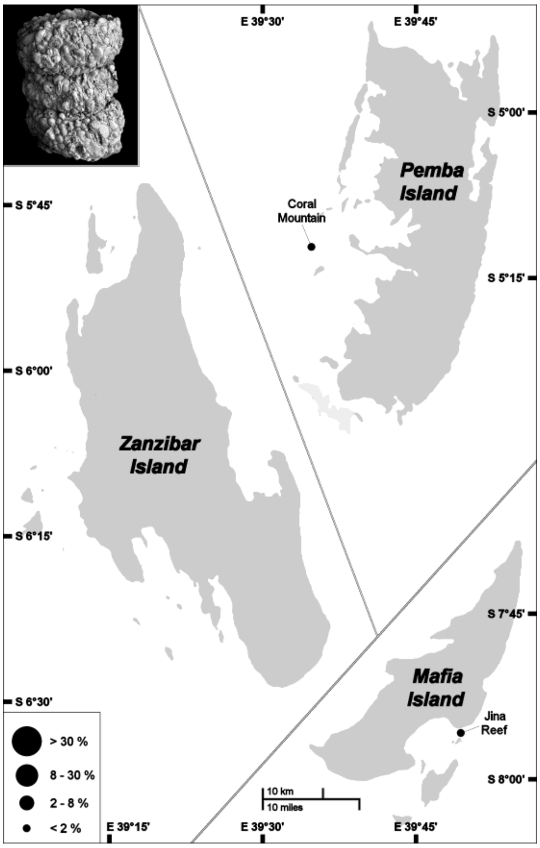

Fig. 34: Distribution of *Haddonia* ? sp. A.

***Haddonia* sp. B**
Plate 1, Figs. 8-9

1993 *Haddonia* sp. B – Hottinger et al., p. 30, pl. 4, figs. 1-4

Distribution: Coral Mountain and Misali Island

Abundance: Rare

Depth: 20-35 m

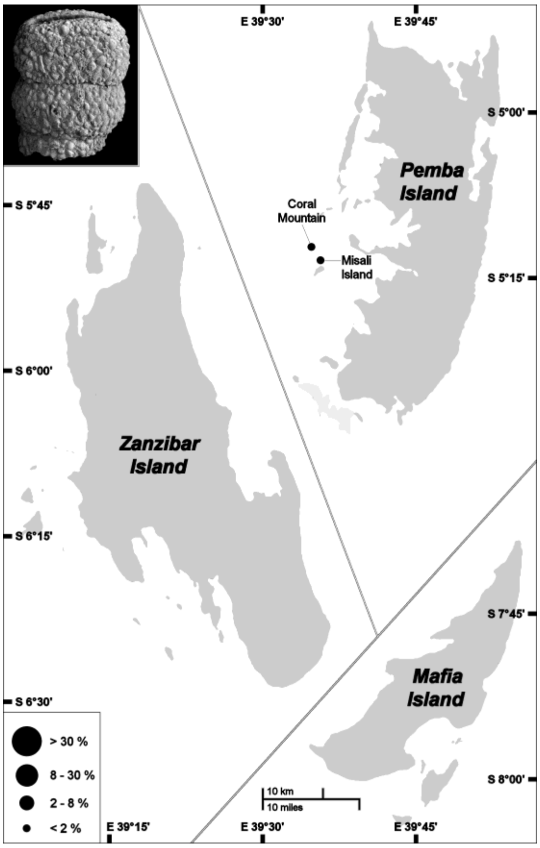

Fig. 35: Distribution of *Haddonia* sp. B.

***Haddonia* ? sp. C**
Plate 1, Figs. 10-11

1993 *Haddonia* sp. C – Hottinger et al., p. 31, pl. 4, figs. 5-9

Distribution: Misali Island and Ras Nungwi

Abundance: Rare

Depth: 16-20 m

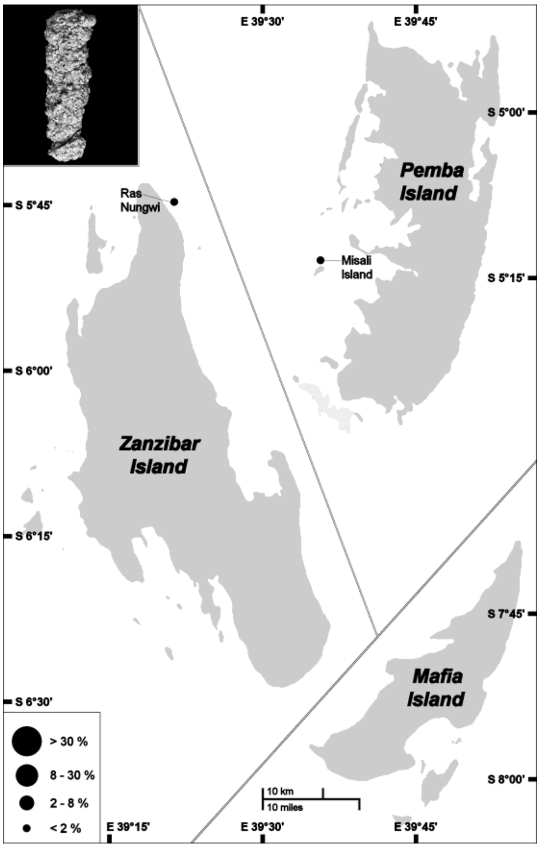

Fig. 36: Distribution of *Haddonia* ? sp. C.

***Haddonia* ? sp. D**
Plate 1, Figs. 12-13

1993 *Haddonia* sp. D – Hottinger et al., p. 31, pl. 5, figs. 1-11

Distribution: Misali Island

Abundance: Rare

Depth: 20 m

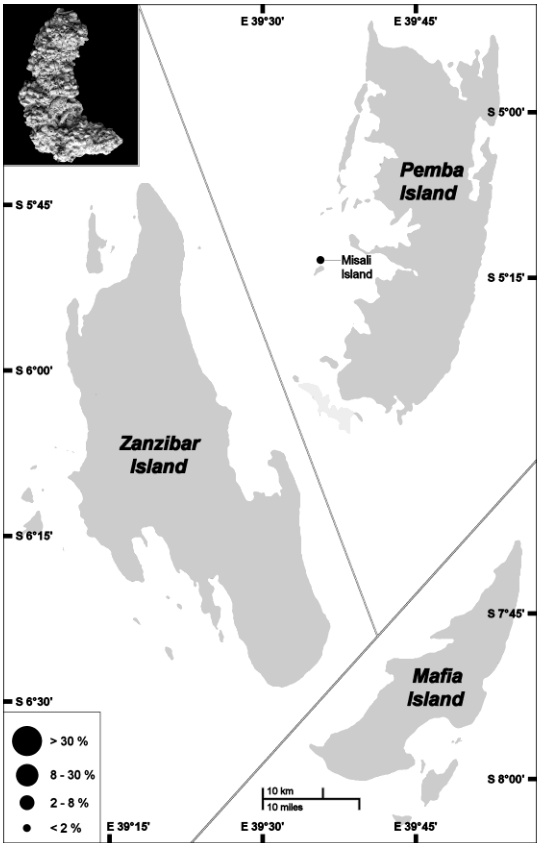

Fig. 37: Distribution of *Haddonia* ? sp. D.

Family Spiroplectamminidae Cushman, 1927

Genus *Spiroplectammina* Cushman, 1927

***Spiroplectammina* sp. A**
Plate 1, Figs. 14-15

<ins>Distribution</ins>: In reefs of Zanzibar and Pemba

<ins>Abundance</ins>: Rare to common

<ins>Depth</ins>: 9-42 m

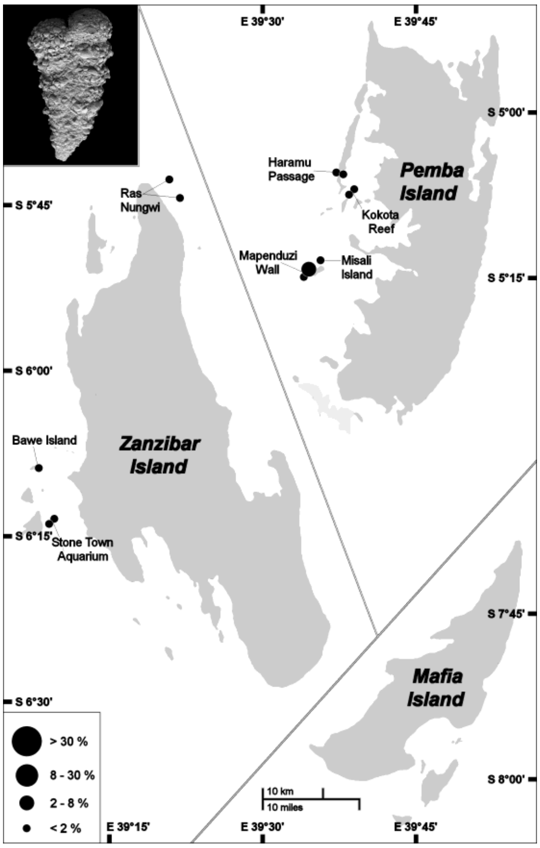

Fig. 38: Distribution of *Spiroplectammina* sp. A.

Family Textulariidae Ehrenberg, 1838

Genus *Sahulia* Loeblich & Tappan, 1985

***Sahulia* cf. *S. barkeri* (Hofker)**
Plate 1, Figs. 16-18

1884 cf. *Textularia trochus* d'Orbigny – Brady, pl. 43, figs. 15-16, 18-19
1915 *Textularia trochus* d'Orbigny – Heron-Allen & Earland, p. 630, pl. 47, fig. 28
1979 *Textularia barkeri* Hofker – Halicz & Reiss, p. 305, 318, pl. 3, figs. 3-4, 6-7, 10
1985 cf. *Sahulia patelliformis* – Loeblich & Tappan, p. 203, pl. 14, figs. 1-10
1987 *Textularia barkeri* Hofker – Baccaert, p. 17, pl. 5, figs. 3-6
1990 *Sahulia* cf. *S. barkeri* (Hofker) – Hottinger et al., p. 91, pl. 3, figs. 1-7
1993 *Sahulia* cf. *S. barkeri* (Hofker) – Hottinger et al., p. 33, pl. 8, figs. 7-11
2012 *Sahulia barkeri* (Hofker) – Debenay, p. 92, 263, pl. 2

<ins>Distribution</ins>: Most of the stations

<ins>Abundance</ins>: Rare to common

<ins>Depth</ins>: 3-42 m

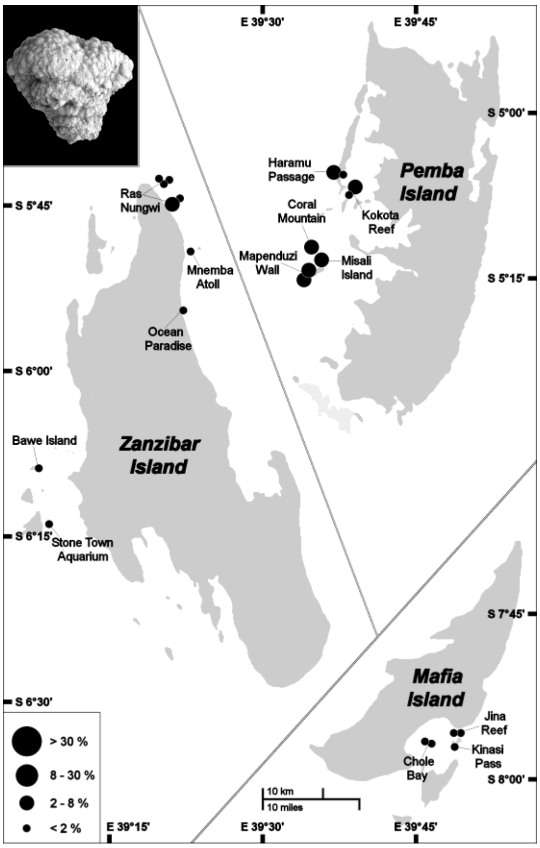

Fig. 39: Distribution of *Sahulia* cf. *S. barkeri*.

***Sahulia kerimbaensis* (Said)**
Plate 1, Figs. 19-22

1949 *Textularia kerimbaensis* – Said, p. 6, pl. 1, fig. 8
1979 *Spiroplectammina kerimbaensis* (Said) – Halicz & Reiss, p. 306, pl. 3, figs. 9, 13, 15-21
1984 *Spiroplectammina kerimbaensis* (Said) – Reiss & Hottinger, fig. G. 24a
1989 *Textularia kerimbaensis* Said – Bender, p. 303, pl. 17, fig. 19
1990 *Sahulia kerimbaensis* (Said) – Hottinger et al., p. 40, pl. 3, figs. 8-12, pl. 4, figs. 1-8
1993 *Sahulia kerimbaensis* (Said) – Hottinger et al., p. 34, pl. 9, figs. 8-12, pl. 10, figs. 1-10
1994 *Spiroplectinella kerimbaensis* (Said) – Loeblich & Tappan, p. 19, pl. 14, figs. 9-14
1998 *Sahulia kerimbaensis* (Said) – Haunold & Piller, p. 13, pl. 1, fig. 11
2012 *Textularia kerimbaensis* Said – Debenay, p. 97, 264, pl. 2
2013a *Sahulia* cf. *S. kerimbaensis* (Said) – Langer et al., fig. 4.7

<u>Distribution</u>: Most of the stations

<u>Abundance</u>: Rare (East) to common (West)

<u>Depth</u>: 9-42 m

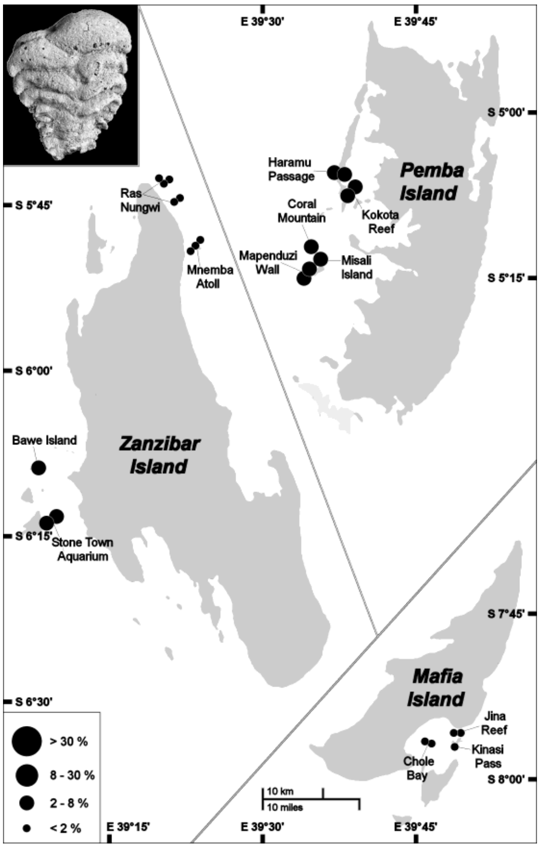

Fig. 40: Distribution of *Sahulia kerimbaensis*.

Genus *Siphotextularia* Finlay, 1939

***Siphotextularia* sp. A**
Plate 1, Figs. 23-24

<u>Distribution</u>: Mapenduzi Wall and Misali Island

<u>Abundance</u>: Rare

<u>Depth</u>: 20-42 m

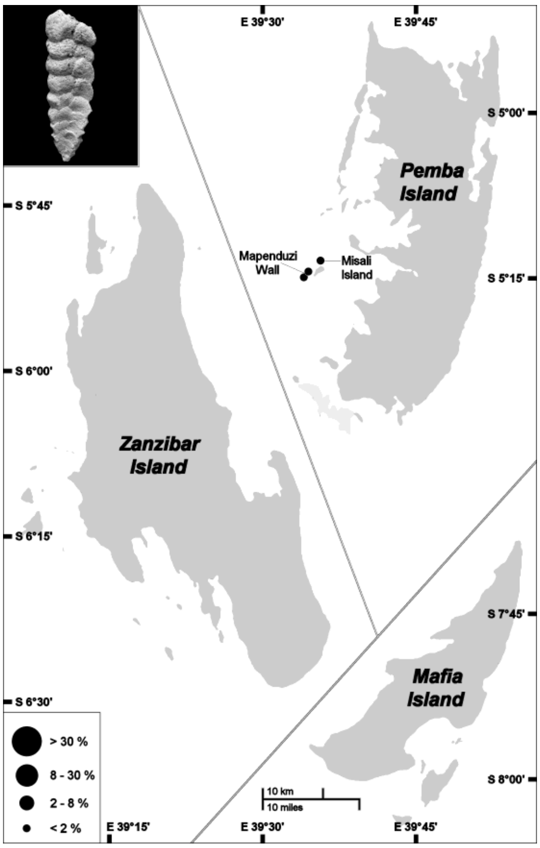

Fig. 41: Distribution of *Siphotextularia* sp. A.

Genus *Textularia* Defrance, 1824

***Textularia agglutinans* d'Orbigny**
Plate 2, Figs. 1-4

1880 *Textularia agglutinans* d'Orbigny – Möbius, pl. 9, figs. 1-8
1884 *Textularia agglutinans* d'Orbigny – Brady, pl. 363, fig. 1-2
1915 *Textularia agglutinans* d'Orbigny – Heron-Allen & Earland, p. 626
1949 *Textularia agglutinans* d'Orbigny – Said, p. 5, pl. 1, fig. 3
1961 *Textularia agglutinans* d'Orbigny – Braga, p. 34, pl. 3, fig. 1
1977a *Textularia agglutinans* d'Orbigny – Le Calvez, p. 13
1991 *Textularia agglutinans* d'Orbigny – Cimerman & Langer, p. 21, pl. 10, figs. 1-2
1992 *Textularia agglutinans* d'Orbigny – Hatta & Ujiie, p. 58, pl. 2, figs. 3a, b
1993 *Textularia agglutinans* d'Orbigny – Hottinger et al., p. 36, pl. 13, figs. 1-9
1994 *Textularia agglutinans* d'Orbigny – Loeblich & Tappan, p. 27, pl. 33, figs. 8-12
1998 *Textularia agglutinans* d'Orbigny – Haunold & Piller, p. 13, pl. 1, fig. 12
2012 *Textularia agglutinans* d'Orbigny – Debenay, p. 95, 263, pl. 2
2013a *Textularia agglutinans* d'Orbigny – Langer et al., fig. 4.8

Distribution: All of the stations

Abundance: Rare to frequent, most abundant in reef stations

Depth: 1-42 m

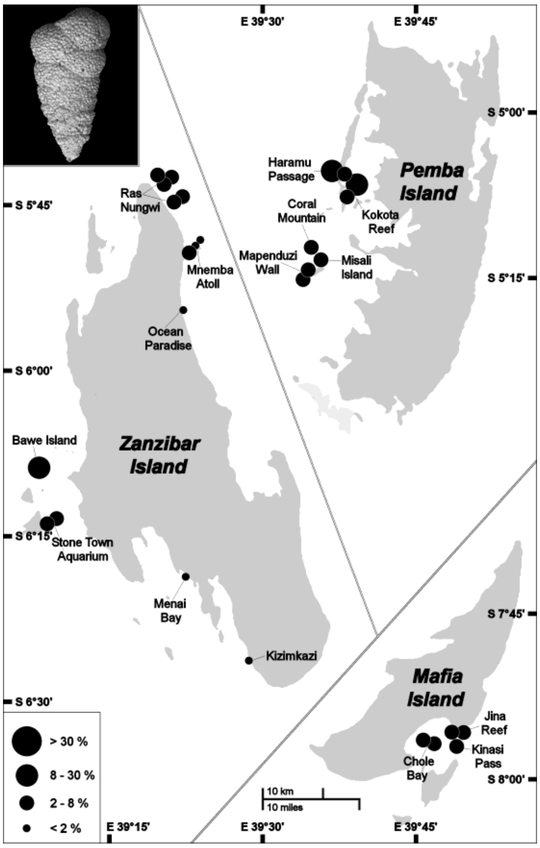

Fig. 42: Distribution of *Textularia agglutinans*.

***Textularia foliacea* Heron-Allen & Earland**
Plate 2, Figs. 5-8

1915 *Textularia foliacea* – Heron-Allen & Earland, p. 628, pl. 47, figs. 17-20
1949 *Textularia foliacea* Heron-Allen & Earland – Said, p. 6, pl. 1, fig. 9

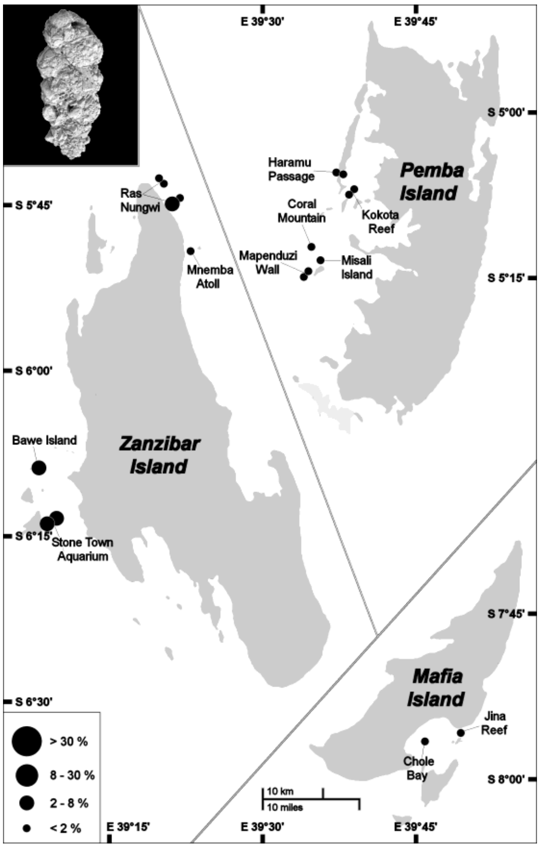

Fig. 43: Distribution of *Textularia foliacea*.

1979 *Textularia foliacea* Heron-Allen & Earland – Halicz & Reiss, p. 301, pl. 2, figs. 4-9, 12-13
1982 *Textularia foliacea* Heron-Allen & Earland – Neagu, p. 101, pl. 2, figs. 5-7
1992 *Textularia foliacea* Heron-Allen & Earland – Hatta & Ujiie, p. 59, pl. 2, figs. 7a-b
1993 *Textularia foliacea* Heron-Allen & Earland *foliacea* Heron-Allen & Earland – Hottinger et al., p. 37, pl. 13, figs. 15-18, pl. 14, figs. 1-5
1998 *Textularia foliacea* Heron-Allen & Earland *foliacea* Heron-Allen & Earland – Haunold & Piller, p. 13, pl. 1, fig. 14
2012 *Textularia foliacea* Heron-Allen & Earland – Debenay, p. 97, 264, pl. 2

Distribution: Most of the stations

Abundance: Rare to common

Depth: 9-42 m

Textularia occidentalis ? Cushman
Plate 2, Figs. 9-10

1922 *Textularia foliacea* Heron-Allen & Earland var. *occidentalis* – Cushman, p. 16, pl. 2, figs. 10-11, 15-16
1979 *Textularia foliacea* Heron-Allen & Earland var. *occidentalis* Cushman – Halicz & Reiss, p. 303, pl. 2, figs. 10-11, 15-16
1993 *Textularia foliacea* Heron-Allen & Earland *occidentalis* Cushman – Hottinger et al., p. 37, pl. 14, figs. 6-11
1998 *Textularia foliacea* Heron-Allen & Earland *occidentalis* Cushman – Haunold & Piller, p. 13, pl. 1, fig. 15
2012 *Textularia occidentalis* Heron-Allen & Earland – Debenay, p. 97, 264, pl. 2

Distribution: Western reefs

Abundance: Rare

Depth: 9-42 m

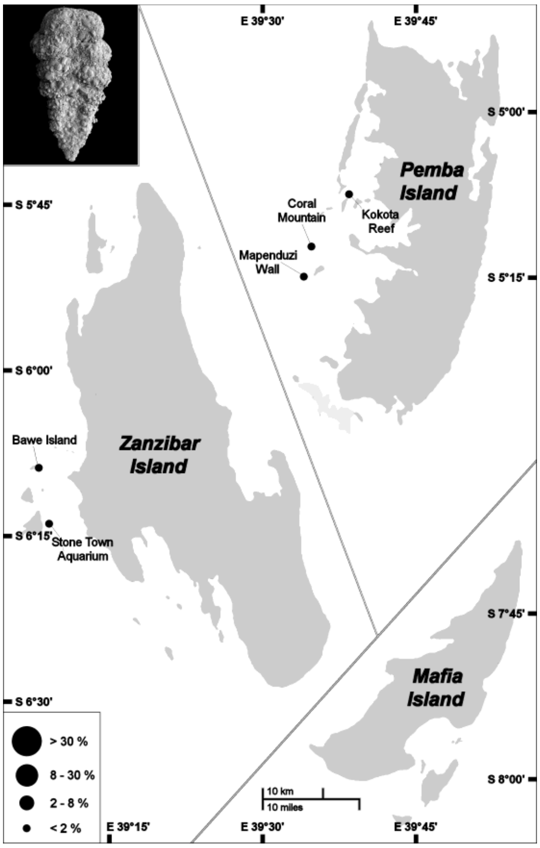

Fig. 44: Distribution of *Textularia occidentalis ?*.

Textularia cf. _T. porrecta_ Brady
Plate 2, Figs. 11-12

1884 *Textularia agglutinans* d'Orbigny var. *porrecta* – Brady, p. 364, pl. 43, fig. 4
1893 *Textularia porrecta* Brady – Egger, p. 269, pl. 6, figs. 17-18
1915 *Textularia porrecta* Brady – Heron-Allen & Earland, p. 627
1961 *Textularia porrecta* Brady – Braga, p. 39, pl. 3, fig. 9
1991 *Textularia porrecta* Brady – Cimerman & Langer, p. 22, pl. 11, figs. 1-4
2012 *Textularia porrecta* Brady – Debenay, p. 98, 264, pl. 2

Distribution: Several stations

Abundance: Rare

Depth: 9-35 m

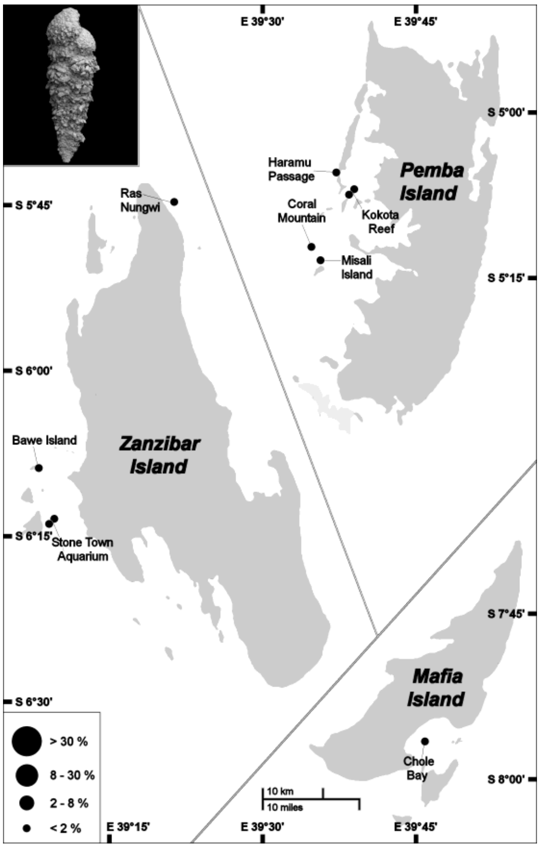

Fig. 45: Distribution of *Textularia* cf. *T. porrecta*.

Textularia sp. A
Plate 2, Figs. 13-14

Distribution: Several stations

Abundance: Rare

Depth: 9-42 m

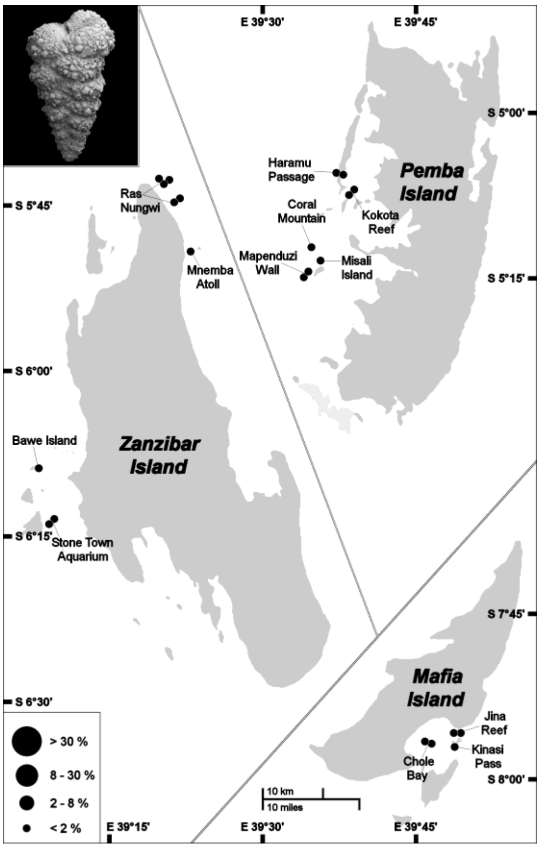

Fig. 46: Distribution of *Textularia* sp. A.

***Textularia* sp. B**
Plate 2, Figs. 15-19

1979 *Textularia* cf. *T. agglutinans* d'Orbigny – Halicz & Reiss, p. 299, pl. 1, figs. 3, 6-7, 9-10, 12-13, 16-17, 20
1993 *Textularia* sp. C – Hottinger et al., p. 39, pl. 16, figs. 1-6
1998 *Textularia* sp. C – Haunold & Piller, p. 13, pl. 2, fig. 1

Distribution: Few reef stations

Abundance: Rare

Depth: 9-35 m

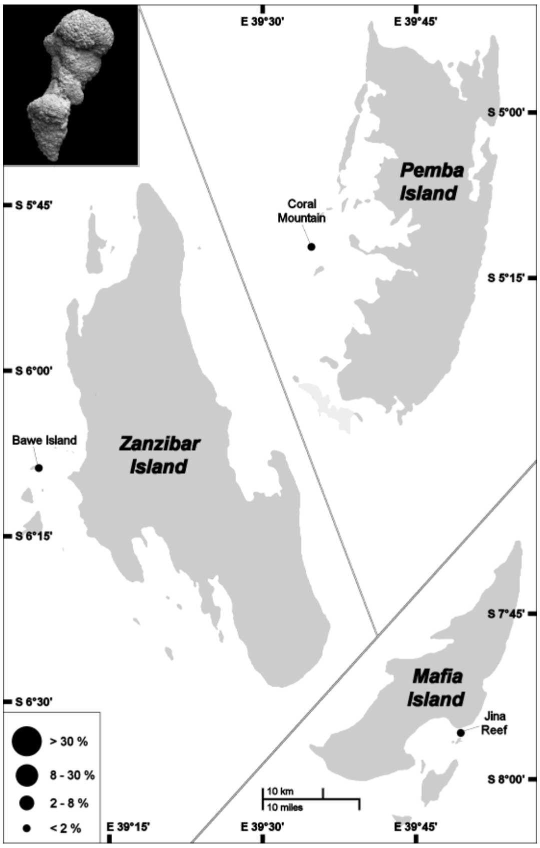

Fig. 47: Distribution of *Textularia* sp. B.

Family Pseudogaudryinidae Loeblich & Tappan, 1985

Genus *Siphoniferoides* Saidova, 1981

***Siphoniferoides* cf. *S. balearicus* (Colom)**
Plate 2, Figs. 20-22

1945 *Gaudryina* (*Siphogaudryina*) *balearica* – Colom, p. 20, pl. 7, figs. 79-81, 84-85
1990 *Siphoniferoides* cf. *S. balearicus* (Colom) – Hottinger et al., p. 38, pl. 2, figs. 1-6
1993 *Siphoniferoides* cf. *S. balearicus* (Colom) – Hottinger et al., p. 41, pl. 20, figs. 1-11
1998 *Siphoniferoides* cf. *S. balearicus* (Colom) – Haunold & Piller, p. 14, pl. 2, fig. 5
2013a *Siphoniferoides* cf. *S. balearicus* (Colom) – Langer et al., fig. 4.16

Distribution: Only present on Pemba

Abundance: Rare to common

Depth: 16-42 m

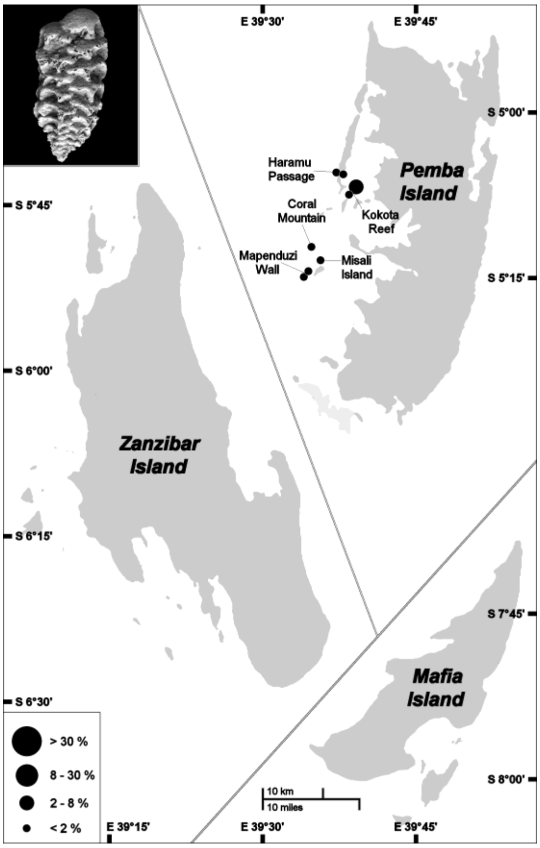

Fig. 48: Distribution of *Siphoniferoides* cf. *S. balearicus*.

Family Valvulinidae Berthelin, 1880

Genus *Clavulina* d'Orbigny, 1826

***Clavulina difformis* Brady**
Plate 2, Figs. 23-24

1884 *Clavulina angularis* var. *difformis* – Brady, p. 396, pl. 48, figs. 25-31
1915 *Clavulina angularis* var. *difformis* Brady – Heron-Allen & Earland, p. 637, pl. 48, figs. 20-22
1961 *Clavulina difformis* Brady – Braga, p. 48, pl. 4, fig. 14
1979 *Clavulina difformis* Brady – Pereira, pl. 6, fig. Q, pl. 7, figs. A-E, Q
1982 *Clavulina difformis* Brady – Levy et al., p. 136, pl. 1, fig. 3
2012 *Clavulina difformis* Brady – Debenay, p. 77, 262, pl. 1

<u>Distribution</u>: Few stations

<u>Abundance</u>: Rare

<u>Depth</u>: 3-21 m

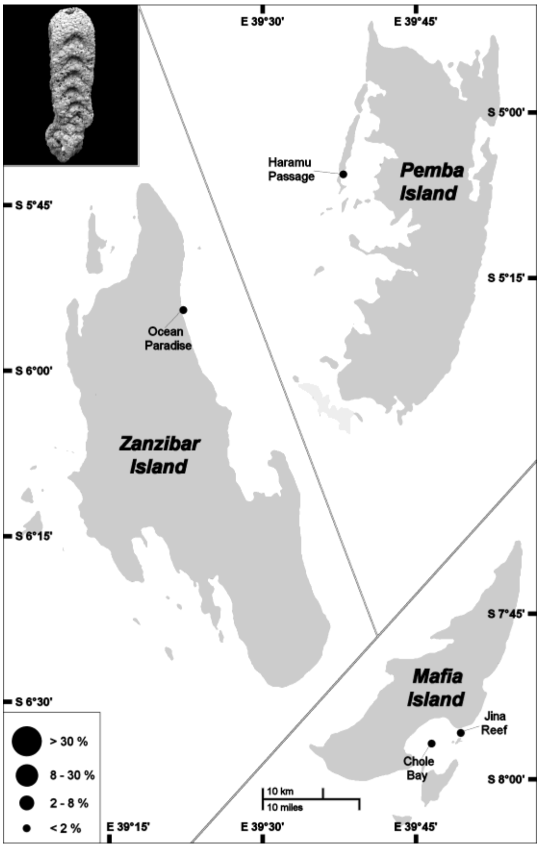

Fig. 49: Distribution of *Clavulina difformis*.

***Clavulina multicamerata* Chapman**
Plate 2, Figs. 25-26

1907 *Clavulina parisiensis* d'Orbigny var. *multicamerata* – Chapman, p. 127, pl. 9, fig. 5
1993 *Clavulina* cf. *C. multicamerata* Chapman – Hottinger et al., p. 42, pl. 22, figs. 1-6
1994 *Clavulina multicamerata* Chapman – Loeblich & Tappan, p. 33, pl. 47, figs. 11-15
2012 *Clavulina multicamerata* Cushman – Debenay, p. 78, 262, pl. 1

<u>Distribution</u>: Few stations

<u>Abundance</u>: Rare

<u>Depth</u>: 3-40 m

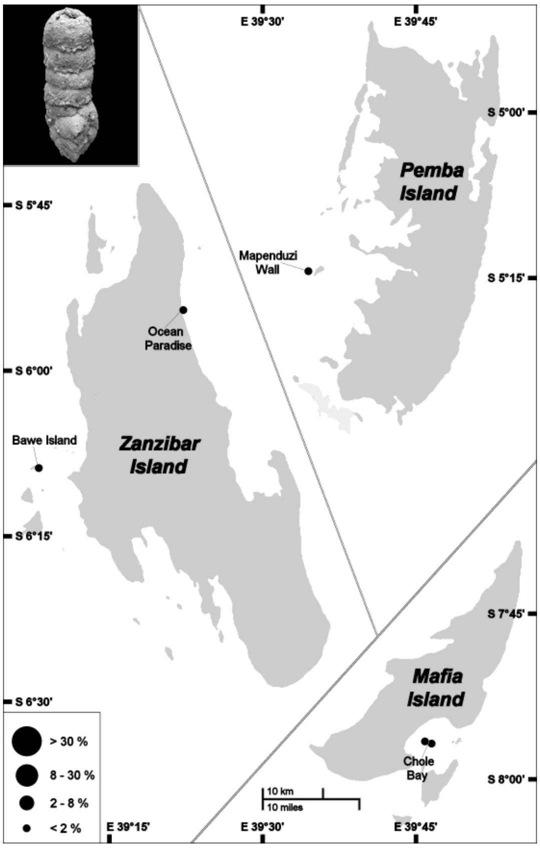

Fig. 50: Distribution of *Clavulina multicamerata*.

Suborder Miliolina Delage and Hérouard, 1896

Family Cornuspiridae Schultze, 1854

Genus *Cornuspira* Schultze, 1854

***Cornuspira* ? sp. A**
Plate 3, Figs. 1-2

<u>Distribution</u>: Few reef stations

<u>Abundance</u>: Rare

<u>Depth</u>: 12-20 m

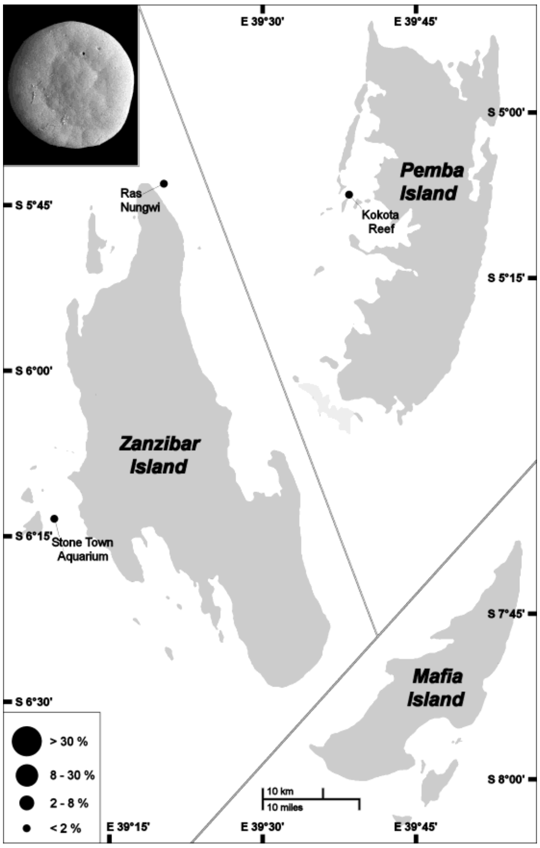

Fig. 51: Distribution of *Cornuspira* ? sp. A.

Family Fischerinidae Millett, 1898

***Fischerina* sp. A**
Plate 3, Figs. 3-4

<u>Distribution</u>: Few stations

<u>Abundance</u>: Rare

<u>Depth</u>: 15-40 m

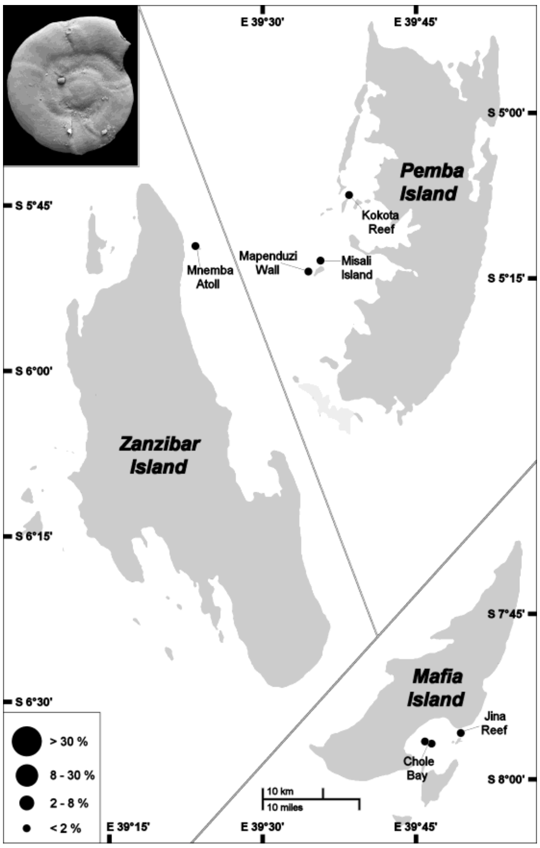

Fig. 52: Distribution of *Fischerina* sp. A.

Genus *Vertebralina* d'Orbigny, 1826

***Vertebralina striata* d'Orbigny**
Plate 3, Figs. 5-6

1826 *Vertebralina striata* – d'Orbigny, p. 283
1915 *Vertebralina striata* d'Orbigny – Heron-Allen & Earland, p. 587
1949 *Vertebralina striata* d'Orbigny – Said, p. 20, pl. 2, fig. 19
1965 *Vertebralina striata* d'Orbigny – Moura, p. 28, pl. 3, fig. 6
1982 *Vertebralina striata* d'Orbigny – Levy et al., p. 136, pl. 3, fig. 2
1982 *Vertebralina striata* d'Orbigny – Neagu, p. 103, pl. 3, fig. 13
1984 *Vertebralina striata* d'Orbigny – Reiss & Hottinger, fig. G 26 k
1991 *Vertebralina striata* d'Orbigny – Cimerman & Langer, p. 25, pl. 16, figs. 1-5
1992 *Vertebralina striata* d'Orbigny – Hatta & Ujiie, p. 62, pl. 4, figs. 6a-b
1993 *Vertebralina striata* d'Orbigny – Hottinger et al., p. 43, pl. 23, figs. 8-15
1994 *Vertebralina striata* d'Orbigny – Loeblich & Tappan, p. 39, pl. 60, figs. 1-7
1998 *Vertebralina striata* d'Orbigny – Haunold & Piller, p. 14, pl. 2, fig. 10
2012 *Vertebralina striata* d'Orbigny – Debenay, p. 139, 267, pl. 4
2013a *Vertebralina striata* d'Orbigny – Langer et al., fig. 4.21

Distribution: Kizimkazi and Ras Nungwi

Abundance: Rare

Depth: 1-20 m

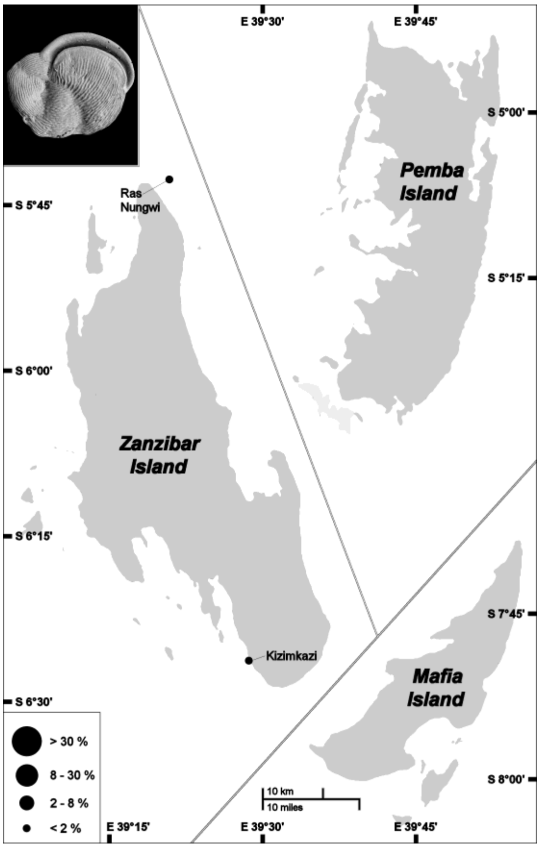

Fig. 53: Distribution of *Vertebralina striata*.

Family Spiroloculinidae Wiesner, 1920

Genus *Spiroloculina* d'Orbigny, 1826

***Spiroloculina antillarum* d'Orbigny**
Plate 3, Figs. 7-10

1944 *Spiroloculina antillarum* d'Orbigny – Cushman & Todd, p. 44, pl. 6, figs. 28-32
1977a *Spiroloculina antillarum* d'Orbigny – Le Calvez, p. 91

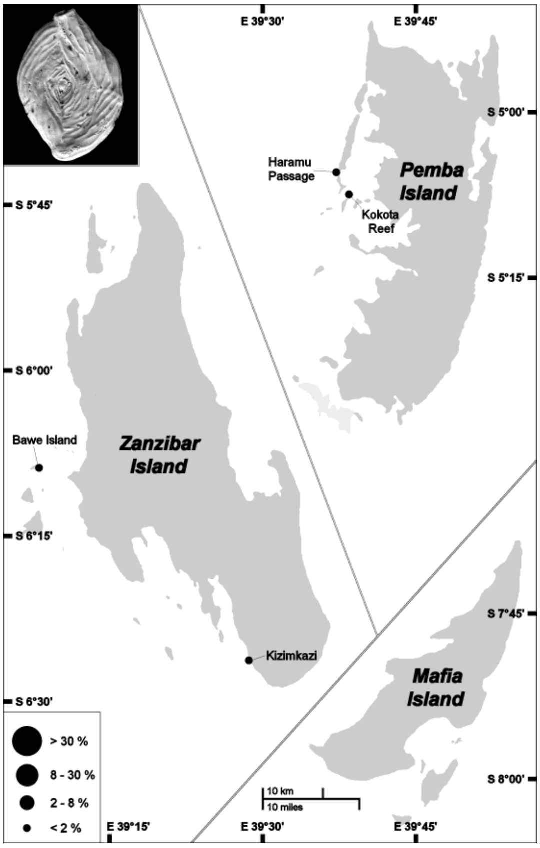

Fig. 54: Distribution of *Spiroloculina antillarum*.

1993 *Spiroloculina antillarum* d'Orbigny – Hottinger et al., p. 45, pl. 24, figs. 15-17, pl. 25, figs. 1-2
2011 *Spiroloculina antillarum* d'Orbigny – Parker & Gischler, p. 43, pl. 2, figs. 1-2
2012 *Spiroloculina antillarum* d'Orbigny – Debenay, p. 132, 269, pl. 5
2013a *Spiroloculina antillarum* d'Orbigny – Langer et al., fig. 4.23

Distribution: Few stations

Abundance: Rare

Depth: 1-20 m

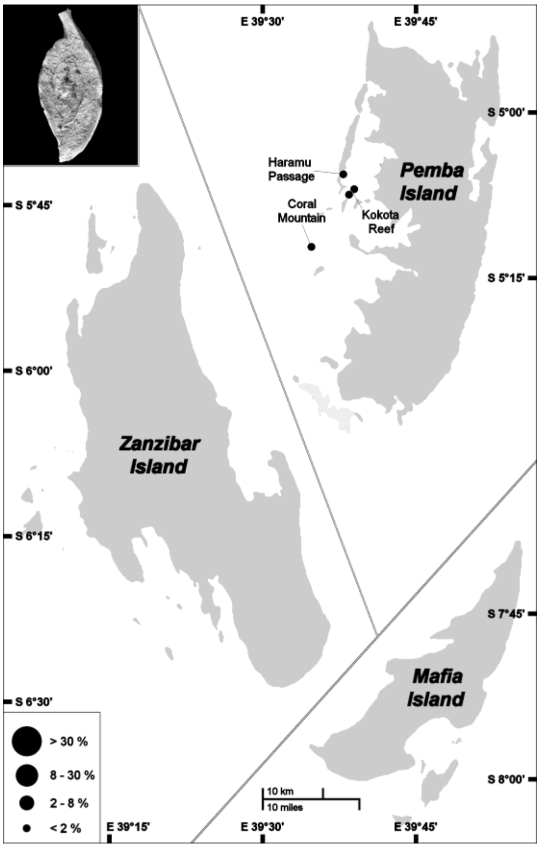

Fig. 55: Distribution of *Spiroloculina attenuata*.

Spiroloculina attenuata Cushman & Todd
Plate 3, Figs. 11-13

1944 *Spiroloculina attenuata* – Cushman & Todd, p. 67, pl. 9, figs. 23-25
1984 *Spiroloculina communis attenuata* Cushman & Todd – Reiss & Hottinger, fig. G 26 f
1993 *Spiroloculina attenuata* Cushman & Todd – Hottinger et al., p. 45, pl. 25, figs. 3-9
2011 *Spiroloculina* sp. 1 – Parker & Gischler, p. 43, pl. 2, figs. 7-9
2012 *Spiroloculina attenuata* Cushman & Todd – Debenay, p. 132, 269, pl. 5

Distribution: Few stations on Pemba

Abundance: Rare

Depth: 16-35 m

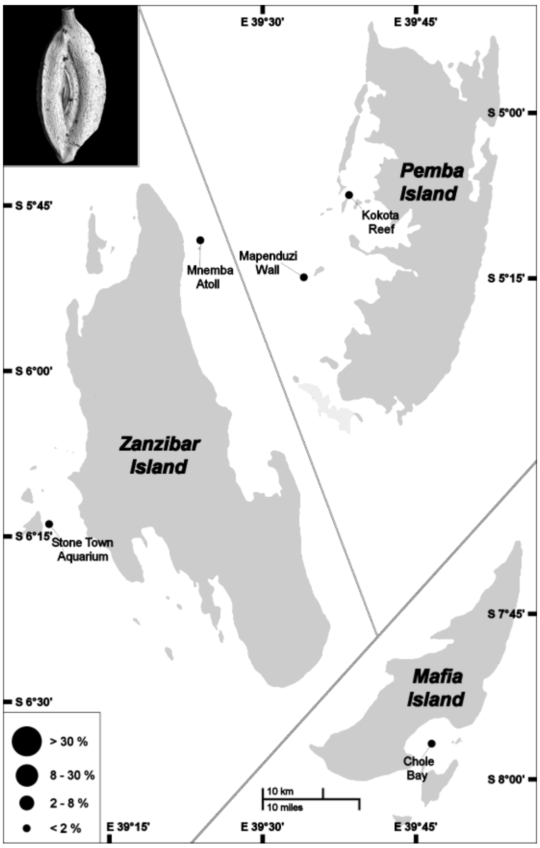

Fig. 56: Distribution of *Spiroloculina* aff. *S. communis*.

***Spiroloculina* aff. *S. communis* Cushman & Todd**
Plate 3, Figs. 14-16

1944 *Spiroloculina communis* – Cushman & Todd, p. 63, pl. 9, figs. 4-5, 7-8
1949 *Spiroloculina communis* Cushman & Todd – Said, p. 14, pl. 1, fig. 37
1961 *Spiroloculina communis* Cushman & Todd – Braga, p. 70, pl. 6, fig. 7

1992 *Spiroloculina communis* Cushman & Todd – Hatta & Ujiie, p. 63, pl. 5, figs. 4a-c
1993 *Spiroloculina* aff. *S. communis* Cushman & Todd – Hottinger et al., p. 45, pl. 25, figs. 10-15
1997 *Spiroloculina communis* Cushman & Todd – Cherif et al., p. 262, pl. 2, figs. 13-14
2012 *Spiroloculina communis* Cushman & Todd – Debenay, p. 133, 269, pl. 5

Distribution: Few stations

Abundance: Rare

Depth: 12-42 m

***Spiroloculina corrugata* Cushman & Todd**
Plate 3, Figs. 17-20

1921 *Spiroloculina antillarum* d'Orbigny – Cushman (part), p. 407, pl. 81, figs. 4a-b, not pl. 83, fig. 4.
1944 *Spiroloculina corrugata* – Cushman & Todd, p. 61, pl. 8, figs. 22-25
1949 *Spiroloculina corrugata* Cushman & Todd – Said, pl. 15, pl. 1, fig. 33
1984 *Spiroloculina corrugata* Cushman & Todd – Reiss & Hottinger, fig. G 26 e
1992 *Spiroloculina corrugata* Cushman & Todd – Hatta & Ujiie, p. 64, pl. 5, figs. 5a-b
1993 *Spiroloculina corrugata* Cushman & Todd – Hottinger et al., p. 46, pl. 26, figs. 5-9
1994 *Spiroloculina corrugata* Cushman & Todd – Loeblich & Tappan, p. 43, pl. 65, figs. 4-7
2012 *Spiroloculina corrugata* Cushman & Todd – Debenay, p. 133, 269, pl. 5
2013a *Spiroloculina corrugata* Cushman & Todd – Langer et al., figs. 4.25-26

Distribution: Several stations

Abundance: Rare

Depth: 1-42 m

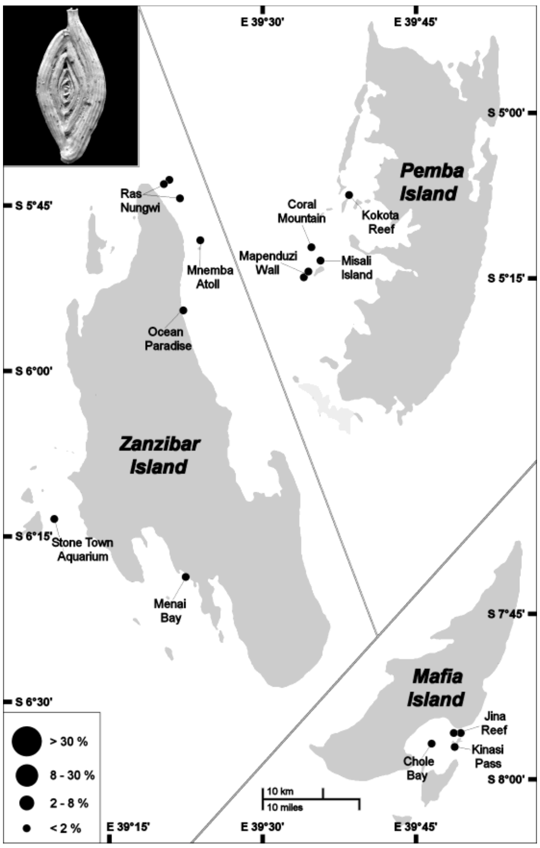

Fig. 57: Distribution of *Spiroloculina corrugata*.

***Spiroloculina foveolata* Egger**
Plate 3, Figs. 21-24

1893 *Spiroloculina foveolata* – Egger, p. 224, pl. 1, figs. 33-34
1915 *Spiroloculina foveolata* Egger – Heron-Allen & Earland, p. 553
1944 *Spiroloculina foveolata* Egger – Cushman & Todd, p. 48, pl. 7, figs. 7-12
1949 *Spiroloculina foveolata* Egger – Said, p. 15, pl. 1, fig. 40
1982 *Spiroloculina foveolata* Egger – Levy et al., p. 136, pl. 1, figs. 12-13
1994 *Spiroloculina foveolata* Egger – Loeblich & Tappan, p. 43, pl. 66, figs. 9-10

<u>Distribution</u>: Several stations

<u>Abundance</u>: Rare

<u>Depth</u>: 3-35 m

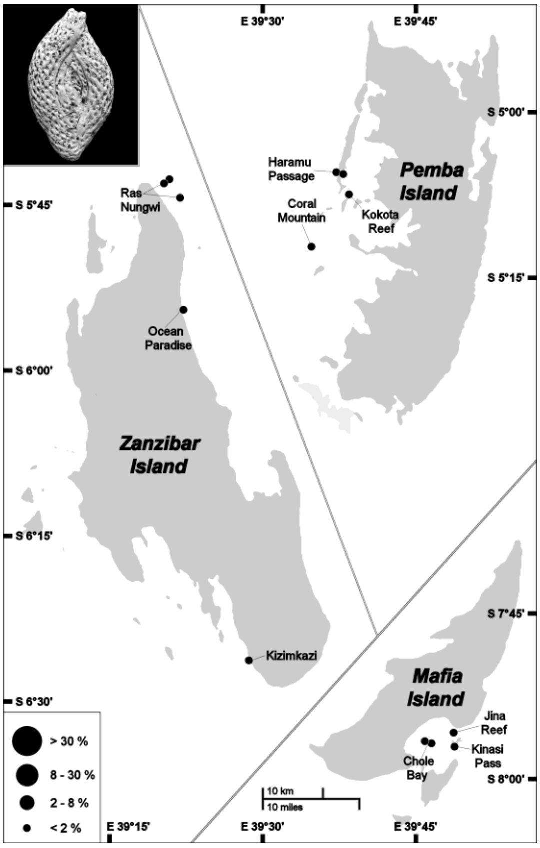

Fig. 58: Distribution of *Spiroloculina foveolata*.

***Spiroloculina* cf. *S. nitida* d'Orbigny**
Plate 3, Figs. 25-27

1826 *Spiroloculina* cf. *S. nitida* – d'Orbigny, p. 298, fig. 4

<u>Distribution</u>: Several stations

<u>Abundance</u>: Rare

<u>Depth</u>: 3-30 m

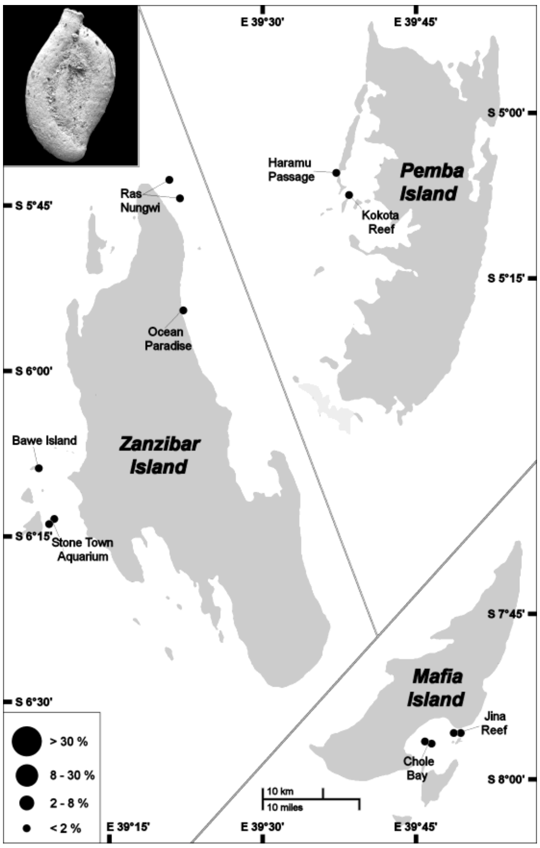

Fig. 59: Distribution of *Spiroloculina* cf. *S. nitida*.

***Spiroloculina* sp. A**
Plate 3, Figs. 28-30

1949 *Spiroloculina communis* Cushman & 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, pl. 5

<u>Distribution</u>: Few reef stations

<u>Abundance</u>: Rare

<u>Depth</u>: 16-42 m

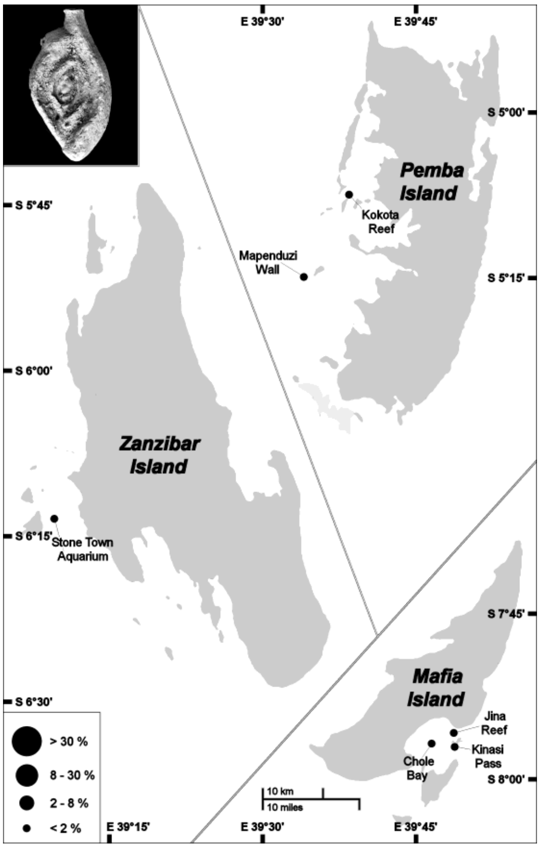

Fig. 60: Distribution of *Spiroloculina* sp. A.

Family Hauerinidae Schwager, 1876

Genus *Affinetrina* Luczkowska, 1972

***Affinetrina* cf. *A. quadrilateralis* d'Orbigny**
Plate 4, Figs. 1-4

1977a *Triloculina quadrilateralis* d'Orbigny – Le Calvez, p. 120
1979 *Triloculina quadrilateralis* d'Orbigny – Pereira, pl. 16, figs. E-J
1993 *Affinetrina* cf. *A. quadrilateralis* (d'Orbigny) – Hottinger et al., p. 47, pl. 28, figs. 9-15, pl. 29, figs. 1-4

<u>Distribution</u>: Several stations

<u>Abundance</u>: Rare

<u>Depth</u>: 1-42 m

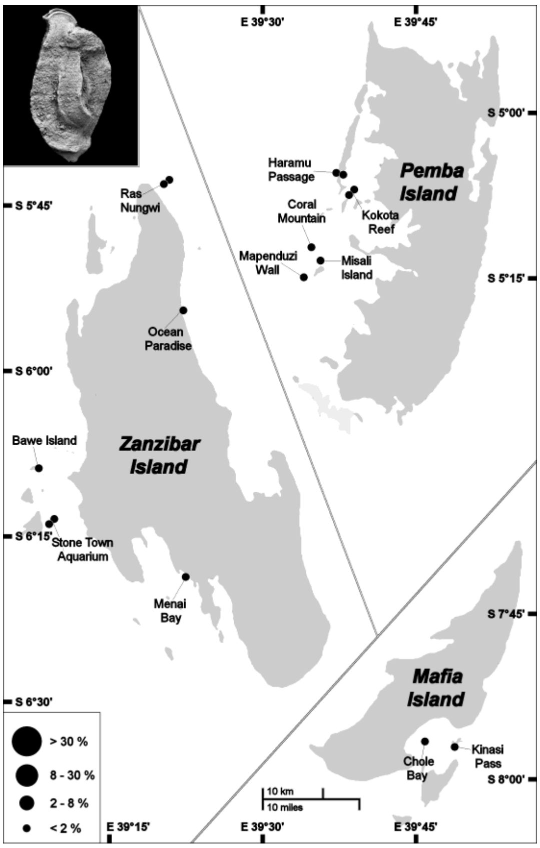

Fig. 61: Distribution of *Affinetrina cf. A. quadrilateralis*.

Genus *Agglutinella* El-Nakhal, 1983

***Agglutinella robusta* El-Nakhal**
Plate 4, Figs. 5-7

1983 *Agglutinella robusta* – El-Nakhal, p. 130, pl. 1, figs. 4-6, pl. 2, figs. 12-15
1993 *Agglutinella robusta* El-Nakhal – Hottinger et al., p. 48, pl. 29, figs. 11-14. pl. 30, figs. 1-6
1998 *Agglutinella robusta* El-Nakhal – Haunold & Piller, p. 15, pl. 3, fig. 3

Distribution: Few reef stations

Abundance: Rare

Depth: 15-42 m

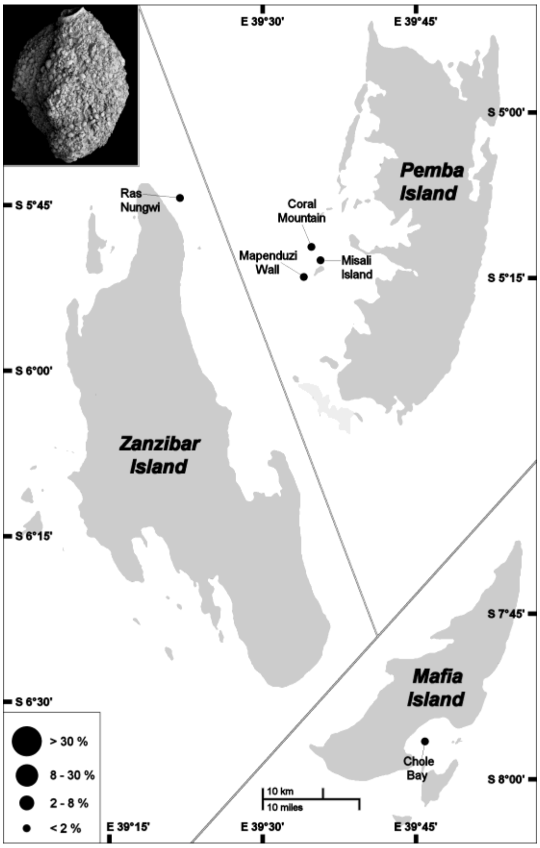

Fig. 62: Distribution of *Agglutinella robusta*.

Genus *Articulina* d'Orbigny, 1826

***Articulina scrobiculata* (Brady)**
Plate 4, Figs. 8-10

1884 *Miliolina scrobiculata* – Brady, p. 173, pl. 113, figs. 15
1915 *Miliolina scrobiculata* Brady – Heron-Allen & Earland, p. 581, pl. 44, figs. 18-21
2013a *Articularia scrobiculata* (Brady) – Langer et al., figs. 7.3-5

Distribution: Stone Town Aquarium

Abundance: Rare

Depth: 20 m

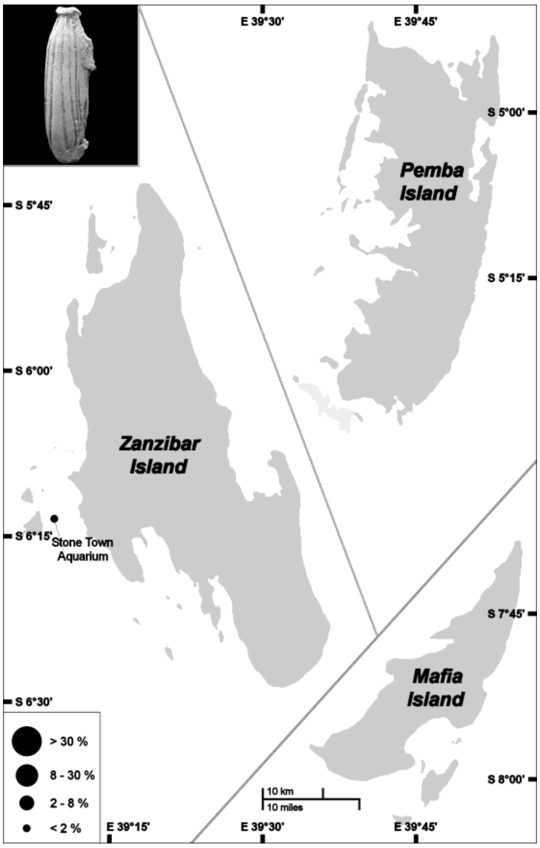

Fig. 63: Distribution of *Articulina scrobiculata*.

Genus *Cycloforina* Luczkowska, 1972

***Cycloforina exmouthensis* (Parker)**
Plate 4, Figs. 11-13

1993 *Cycloforina collumnosa* (Cushman) – Hottinger et al., p. 49, pl. 32, figs. 10-15
1998 *Cycloforina collumnosa* (Cushman) – Haunold & Piller, p. 16, pl. 3, fig. 13
2009 *Quinqueloculina exmouthensis* – Parker, p. 207, figs. 146 a-h
2011 *Quinqueloculina exmouthensis* Parker – Parker & Gischler, p. 43, pl. 2, figs. 10-12

Distribution: Few stations, mainly on Pemba

Abundance: Rare

Depth: 15-42 m

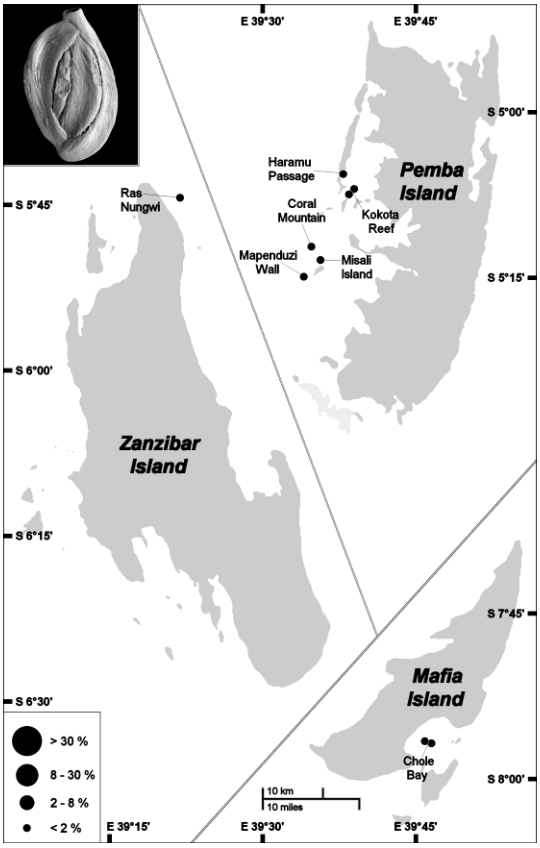

Fig. 64: Distribution of *Cycloforina exmouthensis.*

***Cycloforina* cf. *C. granulocostata* (Germeraad)**
Plate 4, Figs. 14-16

1884 *Miliolina linneana* (d'Orbigny) – Brady, p. 174, pl. 6, figs. 15, 17-20
1949 *Quinqueloculina sulcata* d'Orbigny – Said, p. 11, pl. 1, fig. 20
1977a *Triloculina linneiana* d'Orbigny – Le Calvez, p. 113
1982 *Quinqueloculina granulocostata* Germeraad – Levy et al., p. 136, pl. 2, fig. 6
1982 *Quinqueloculina granulocostata* Germeraad – Neagu, p. 104, pl. 4, figs. 15-20
1993 *Pseudotriloculina* (?) *granulocostata* (Germeraad) – Hottinger et al., p. 55, pl. 46, figs. 7-12
1994 *Massilina granulocostata* (Germeraad) – Loeblich & Tappan, p. 47, pl. 75, figs. 19-21, pl. 79, figs. 1-12

Distribution: Most of the stations

Abundance: Rare to common

Depth: 1-42 m

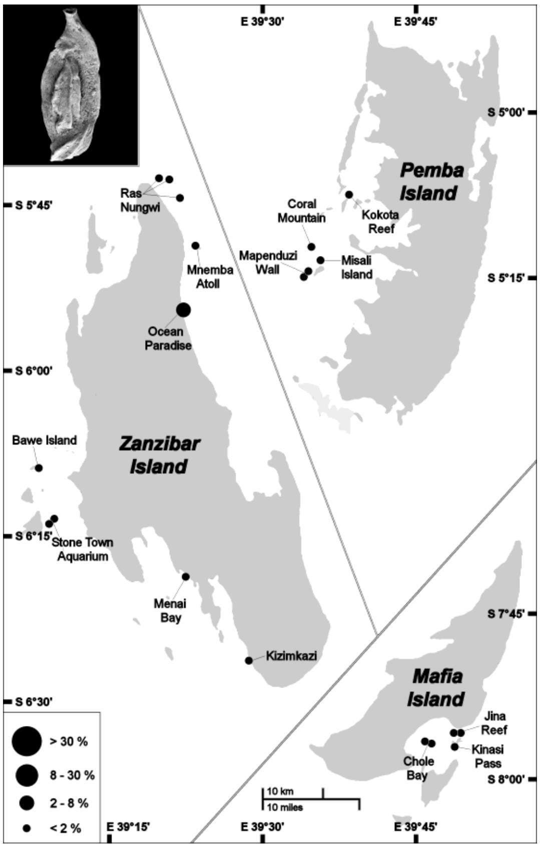

Fig. 65: Distribution of *Cycloforina* cf. *C. granulocostata*.

Cycloforina semiplicata (McCulloch)
Plate 4, Figs. 17-19

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 & Piller, p.. 16, pl. 3, fig. 16

Distribution: Three western reef stations

Abundance: Rare

Depth: 9-30 m

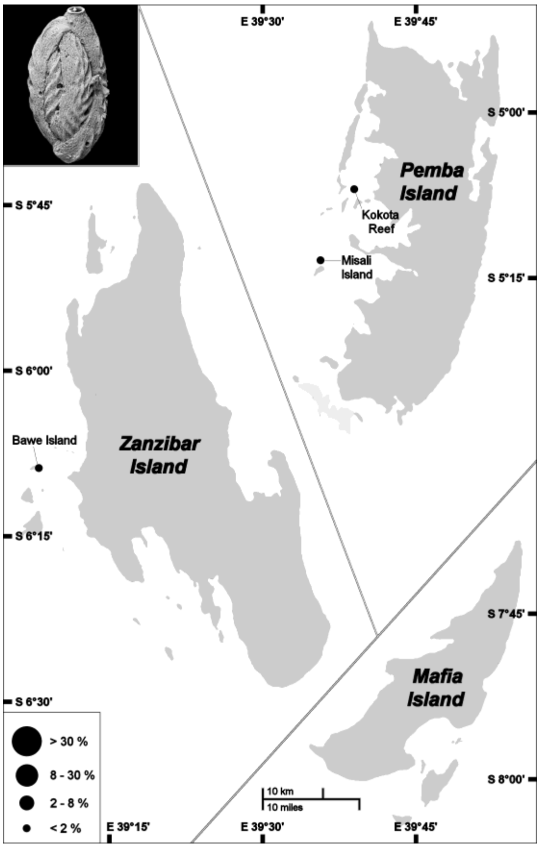

Fig. 66: Distribution of *Cycloforina semiplicata*.

Cycloforina cf. _C. semireticulosa_ (Cushman)
Plate 4, Figs. 20-23

1932 *Quinqueloculina semireticulosa* – Cushman, p. 27, pl. 7, fig. 2
1961 *Quinqueloculina semireticulosa* Cushman – Moura, p. 18, pl. 2, fig. 1
1979 *Quinqueloculina* cf. *Q. semireticulosa* Cushman – Pereira, pl. 14, figs. A-D
1982 *Quinqueloculina semireticulosa* Cushman – Levy et al., p. 136, pl. 2, fig. 11
1993 *Cycloforina* cf. *C. semireticulosa* (Cushman) – Hottinger et al., p. 50, pl. 34, figs. 9-12
2012 *Quinqueloculina semireticulosa* Cushman – Debenay, p. 126, 272, 273, pl. 7

Distribution: Several stations

Abundance: Rare

Depth: 3-42 m

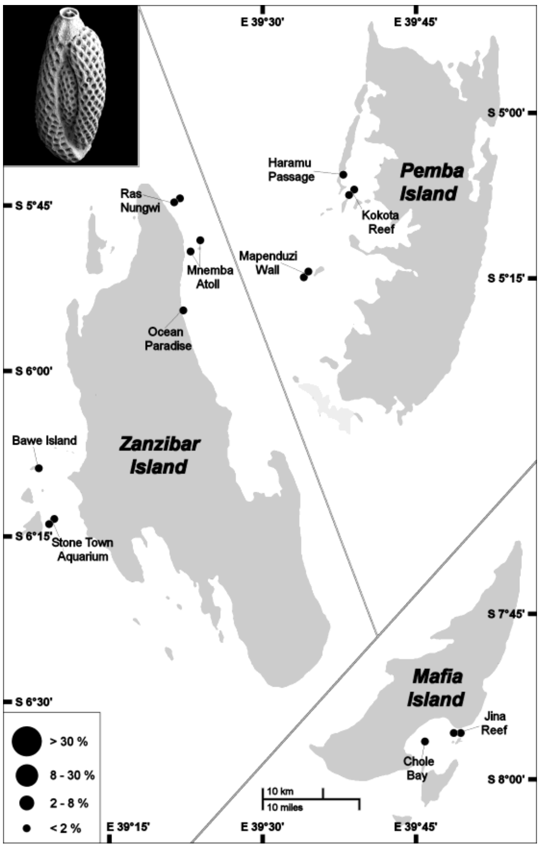

Fig. 67: Distribution of *Cycloforina cf. C. semireticulosa*.

***Cycloforina* sp. A**
Plate 4, Figs. 24-26

1979 *Quinqueloculina pseudoreticulata* Parr – Pereira, pl. 13, figs. H, J
1993 *Cycloforina* sp. C – Hottinger et al., p. 50, pl. 35, figs. 7-13
1998 *Cycloforina* sp. C – Haunold & Piller, p. 16, pl. 4, fig. 2

Distribution: Several stations

Abundance: Rare to common

Depth: 3-42 m

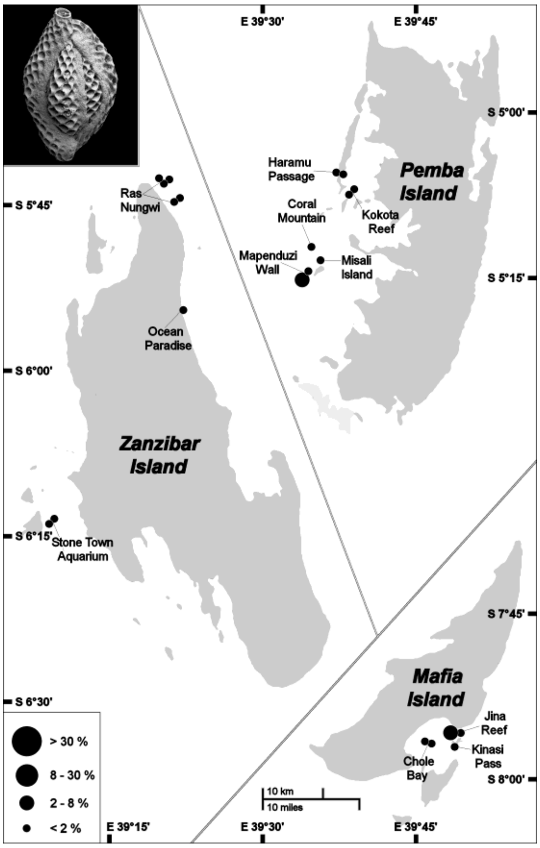

Fig. 68: Distribution of *Cycloforina* sp. A.

Genus *Miliolinella* Wiesner, 1931

***Miliolinella* cf. *M. hybrida* (Terquem)**
Plate 4, Figs. 27-28

1993 *Miliolinella* cf. *M. hybrida* (Terquem) – Hottinger et al., p. 52, pl. 39, figs. 1-6
1998 *Miliolinella* cf. *M. hybrida* (Terquem) – Haunold & Piller, p. 18, pl. 4, fig. 18
2013a *Miliolinella* cf. *M. hybrida* (Terquem) – Langer et al., figs. 5.43-44

Distribution: Few stations

Abundance: Rare

Depth: 12-25 m

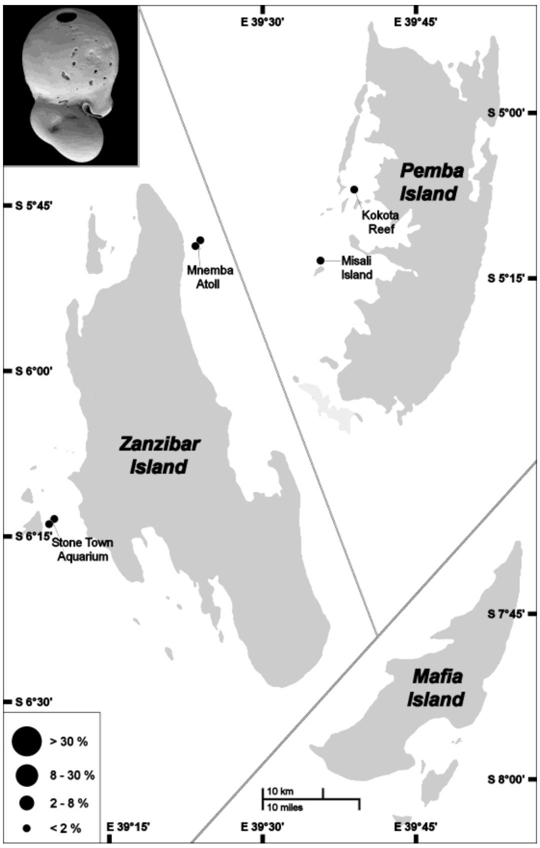

Fig. 69: Distribution of *Miliolinella* cf. *M. hybrida*.

***Miliolinella suborbicularis* (d'Orbigny)**
Plate 4, Figs. 29-30

1898 *Miliolina suborbicularis* (d'Orbigny) – Millett, p. 502, pl. 11, fig. 13
1915 *Miliolina suborbicularis* (d'Orbigny) – Heron-Allen & Earland, p. 560
1977a *Triloculina suborbicularis* d'Orbigny – Le Calvez, p. 12
1994 *Miliolinella suborbicularis* (d'Orbigny) – Loeblich & Tappan, p. 52, pl. 89, figs. 1-9, pl. 96, figs. 11-16

Distribution: Jina Reef

Abundance: Rare

Depth: 21 m

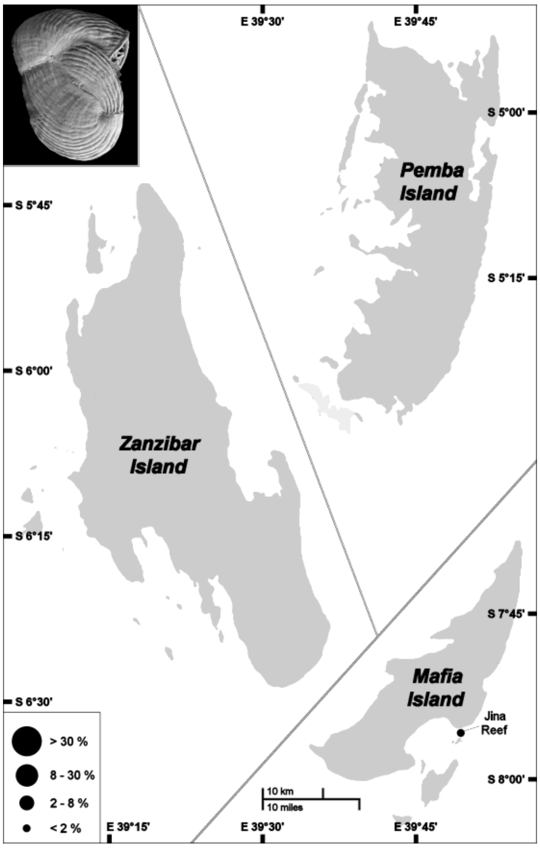

Fig. 70: Distribution of *Miliolinella suborbicularis*.

***Miliolinella* sp. A**
Plate 5, Figs. 1-3

1993 *Miliolinella* sp. A – Hottinger et al., p. 52, pl. 39, figs. 7-13

Distribution: Several stations

Abundance: Rare

Depth: 9-42 m

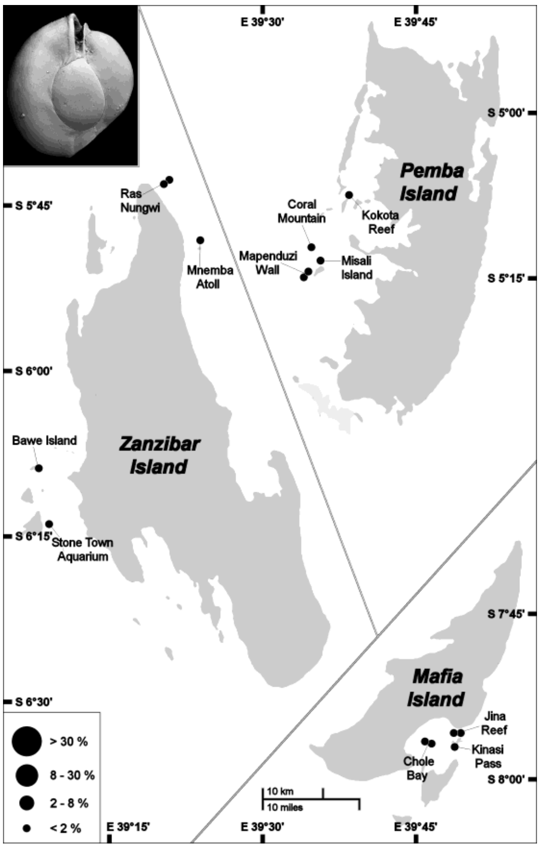

Fig. 71: Distribution of *Miliolinella* sp. A.

***Miliolinella* sp. B**
Plate 5, Figs. 4-5

1993 *Miliolinella* sp. B – Hottinger et al., p. 52, pl. 40, figs. 1-3

Distribution: Mapenduzi Wall and Mnemba Atoll

Abundance: Rare

Depth: 30-42 m

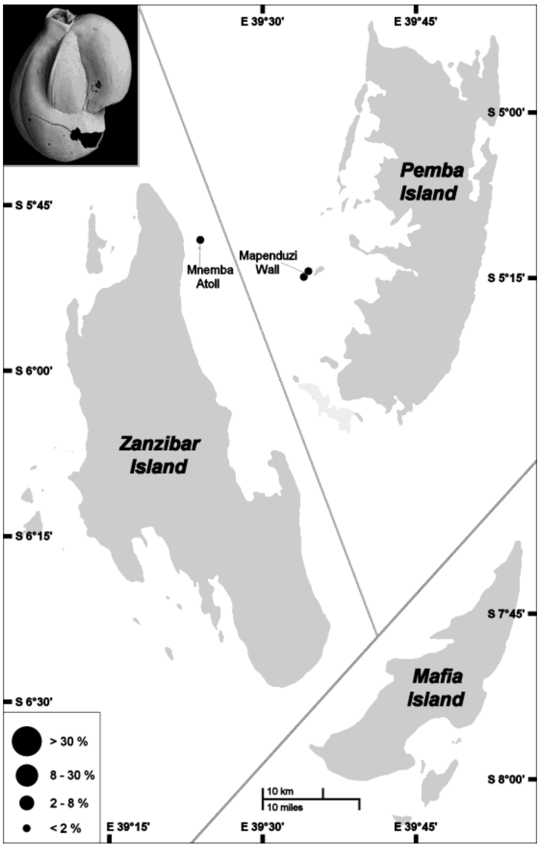

Fig. 72: Distribution of *Miliolinella* sp. B.

***Miliolinella* sp. C**
Plate 5, Figs. 6-7

1993 *Miliolinella* sp. E – Hottinger et al., p. 53, pl. 40, figs. 10-11, pl. 41, figs. 1-2

Distribution: Few reef stations

Abundance: Rare

Depth: 12-42 m

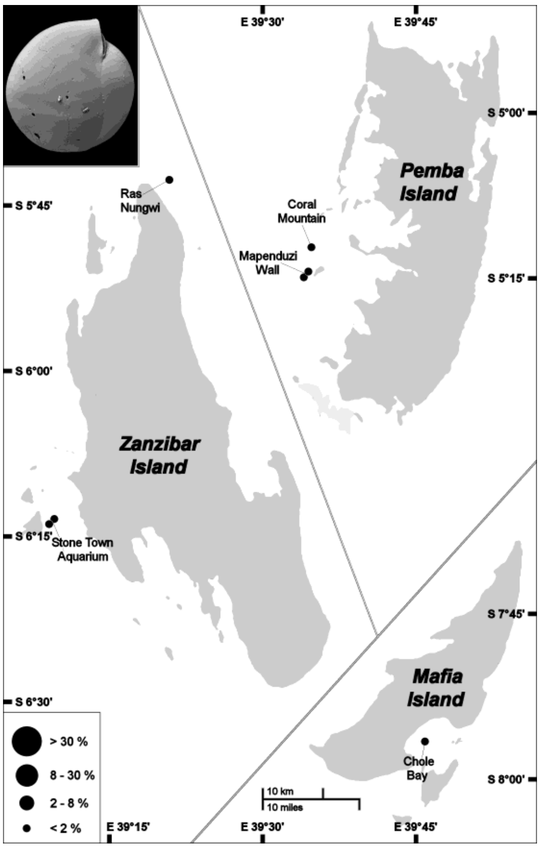

Fig. 73: Distribution of *Miliolinella* sp. C.

Genus *Nummoloculina* Steinmann, 1881

***Nummoloculina* ? sp. A**
Plate 5, Figs. 8-9

<u>Distribution</u>: Three reef stations

<u>Abundance</u>: Rare

<u>Depth</u>: 12-20 m

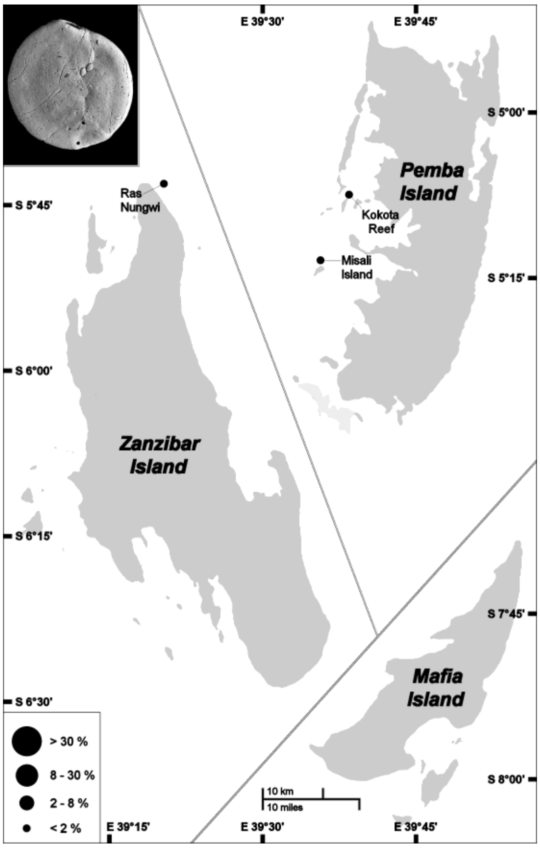

Fig. 74: Distribution of *Nummoloculina* ? sp. A.

***Pitella transversestriata* (Brady)**
Plate 5, Figs. 10-12

1881 *Miliolina transversestriata* – Brady, p. 45, pl. 4, fig. 6
1884 *Miliolina transversestriata* Brady – Brady, p. 177, pl. 4, figs. 6a-c
1915 *Miliolina transversestriata* Brady – Heron-Allen & Earland, p. 566, pl. 42, figs. 17-20
1957 *Triloculina transversestriata* (Brady) – Todd, p. 288, pl. 85, figs. 16 a-b
1958 *Quinqueloculina transversestriata* (Brady) – Collins, p. 370
1988 *Quinqueloculina transversestriata* (Brady) – Haig, p. 234, pl. 8, figs. 22-24
1994 *Triloculina transversestriata* (Brady) – Ujiié & Hatta, p. 12, pl. 1, figs. 6a-b
2012 *Quinqueloculina transversestriata* (Brady) – Debenay, p. 127

<u>Distribution</u>: Few stations on Zanzibar

<u>Abundance</u>: Rare

<u>Depth</u>: 3-30 m

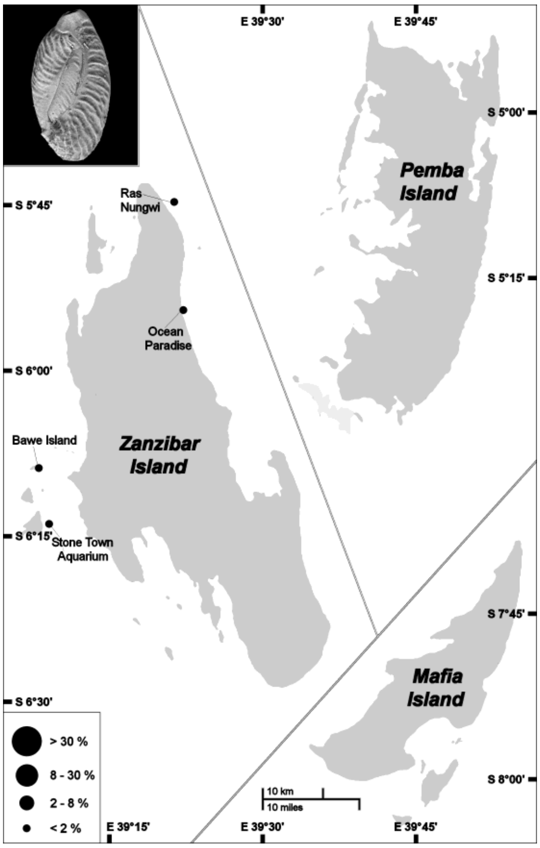

Fig. 75: Distribution of *Pitella transversestriata*.

Genus *Pseudohauerina* Ponder, 1972

***Pseudohauerina bradyi* (Cushman)**
Plate 5, Figs. 13-15

1884 *Hauerina compressa* d'Orbigny – Brady, p. 190, pl. 11, figs. 12-13
1915 *Hauerina compressa* d'Orbigny – Heron-Allen & Earland, p. 588
1917 *Hauerina bradyi* – Cushman, p. 62, pl. 23, fig. 2
1949 *Hauerina bradyi* Cushman – Said, p. 17, pl. 2, fig. 5
1982 *Hauerina brady* (Cushman) – Neagu, p. 107, pl. 6, figs. 1-3
1992 *Sigmoihauerina bradyi* (Cushman) – Hatta & Ujiie, p. 75, pl. 13, figs. 6a-bGenus *Pseudomassilina* Lacroix, 1938
1993 *Sigmoihauerina bradyi* (Cushman) – Hottinger et al., p. 62, pl. 60, figs. 1-12
1998 *Sigmoihauerina bradyi* (Cushman) – Haunold & Piller, p. 21, pl. 6, fig. 11
2013a *Sigmoihauerina bradyi* (Cushman) – Langer et al., fig. 7.2

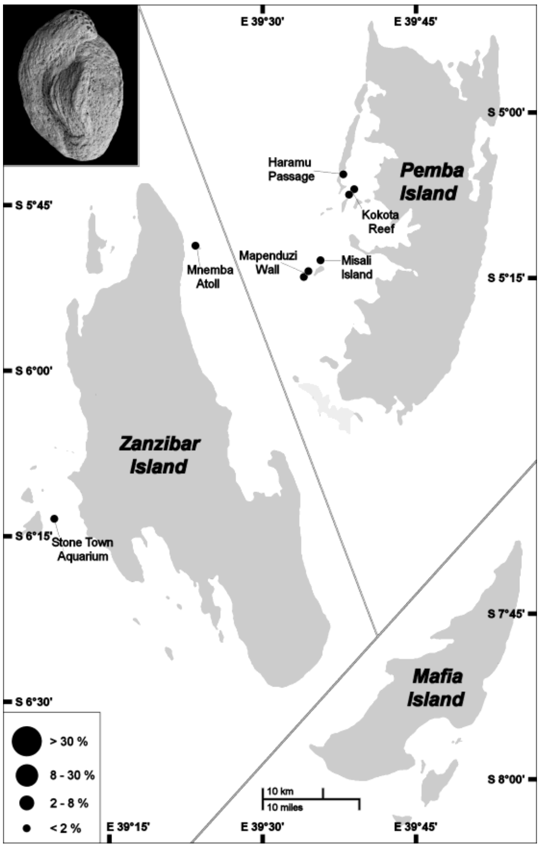

Fig. 76: Distribution of *Pseudohauerina bradyi*.

Distribution: Few stations

Abundance: Rare

Depth: 12-42 m

***Pseudohauerina fragilissima* (Brady)**
Plate 5, Figs. 16-18

1884 *Spiroloculina fragilissima* – Brady, p. 149, pl. 9, figs. 12-14
1915 *Hauerina fragilissima* (Brady) – Heron-Allen & Earland, p. 587, pl. 46, figs. 1-2
1949 *Hauerina fragilissima* (Brady) – Said, p. 17, pl. 2, fig. 9
1982 *Hauerina fragilissima* (Brady) – Neagu, p. 107, pl. 5, figs. 1-2
1992 *Sigmoihauerina fragilissima* (Brady) – Hatta & Ujiie, p. 75, pl. 13, figs. 7a-8b
1993 *Sigmoihauerina fragilissima* (Brady) – Hottinger et al., p. 62, pl. 61, figs. 1-3
1994 *Parahauerinoides fragilissimus* (Brady) – Loeblich & Tappan, p. 51, pl. 87, figs. 1-6
1997 *Hauerina* sp. – Cherif et al., p. 264, pl. 3, figs. 21,22

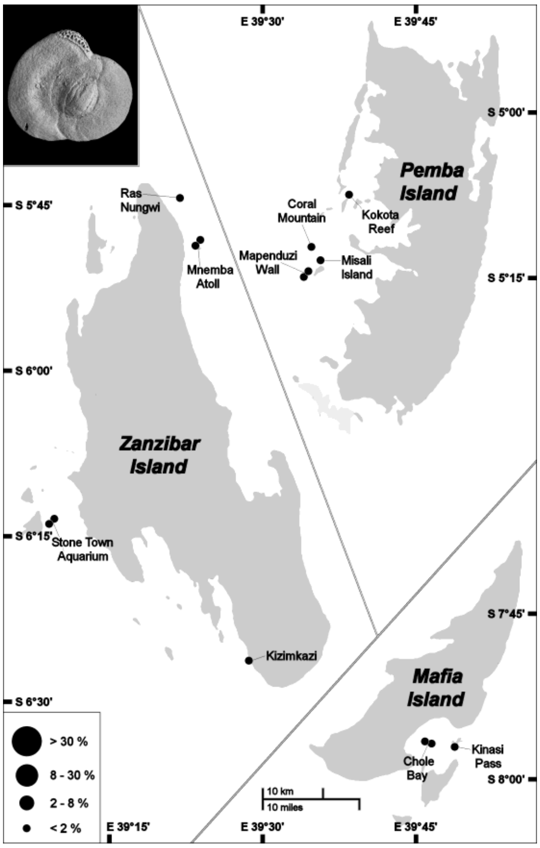

Fig. 77: Distribution of *Pseudohauerina fragilissima*.

Distribution: Several stations

Abundance: Rare

Depth: 1-42 m

***Pseudohauerina involuta* (Cushman)**
Plate 5, Figs. 19-21

1884 *Hauerina ornatissima* (Karrer) – Brady, p. 192, pl. 7, figs. 15-17
1915 *Hauerina ornatissima* (Karrer) – Heron-Allen & Earland, p. 590
1932 *Hauerina ornatissima* (Karrer) – Cushman, p. 43 (not pl. 10, figs. 16-17)
1994 *Sigmoihauerina involuta* (Cushman) – Loeblich & Tappan, p. 58, pl. 100, figs. 8-12

Distribution: Few stations

Abundance: Rare

Depth: 12-42 m

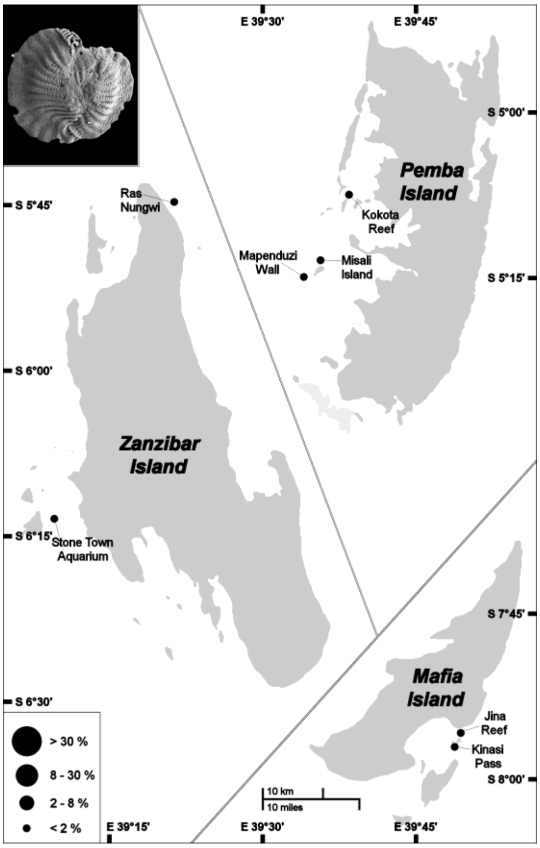

Fig. 78: Distribution of *Pseudohauerina involuta*.

***Pseudomassilina macilenta* (Brady)**
Plate 5, Figs. 22-24

1884 *Miliolina macilenta* – Brady, p. 167, pl. 7, figs. 5-6
1917 *Quinqueloculina macilenta* (Brady) – Cushman, p. 55
1924 *Massilina macilenta* (Brady) – Cushman, p. 64, pl. 24, figs. 3-4
1987 *Pseudomassilina australis* (Cushman) subsp. *macilenta* (Brady) – Baccaert, p. 112, pl. 51, figs. 3-4
1988 *Pseudomassilina macilenta* (Brady) – Haig, p. 228, pl. 3, figs. 21-24
1993 *Pseudomassilina* sp. A – Hottinger et al., p. 54, pl. 44, figs. 1-8
1998 *Pseudomassilina* sp. A – Haunold & Piller, p. 19, pl. 5, fig. 4
2009 *Pseudomassilina macilenta* (Brady) – Parker, p. 168, figs. 118 a-j
2011 *Pseudomassilina macilenta* (Brady) – Makled & Langer, p. 248, pl. 5, figs. 12-15

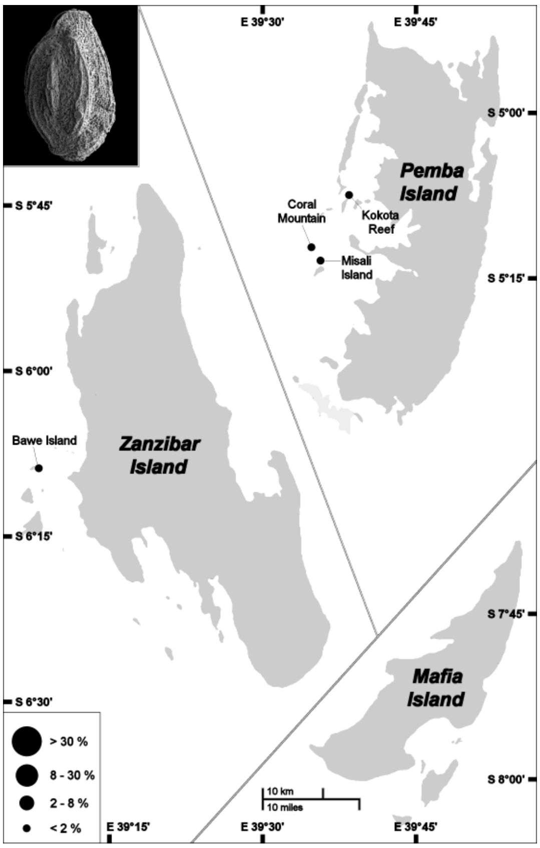

Fig. 79: Distribution of *Pseudomassilina macilenta*.

2012 *Pseudomassilina macilenta* (Brady) – Debenay, p. 115

Distribution: Four western reef stations

Abundance: Rare

Depth: 9-35 m

Pseudomassilina reticulata (Heron-Allen & Earland)

Plate 6, Figs. 1-3

1915 *Massilina secans* var. *reticulata* – Heron-Allen & Earland, p. 582, pl. 45, figs. 1-4
1949 *Massilina misrensis* – Said, p. 11, pl. 1, fig. 32
1992 *Pseudomassilina reticulata* (Heron-Allen & Earland) – Neagu, p. 105, pl. 6, fig. 10
1992 *Pseudomassilina reticulata* (Heron-Allen & Earland) – Hatta & Ujiie, p. 72, pl. 10, figs. 7a-b
1993 *Pseudomassilina reticulata* (Heron-Allen & Earland) – Hottinger et al., p. 54, pl. 42, figs. 5-8, pl. 43, figs. 1-8
1998 *Pseudomassilina reticulata* (Heron-Allen & Earland) – Haunold & Piller, p. 19, pl. 5, fig. 3
2013a *Pseudomassilina reticulata* (Heron-Allen & Earland) – Langer et al., figs. 6.12-13

Distribution: Mapenduzi Wall and Misali Island

Abundance: Rare

Depth: 20-42 m

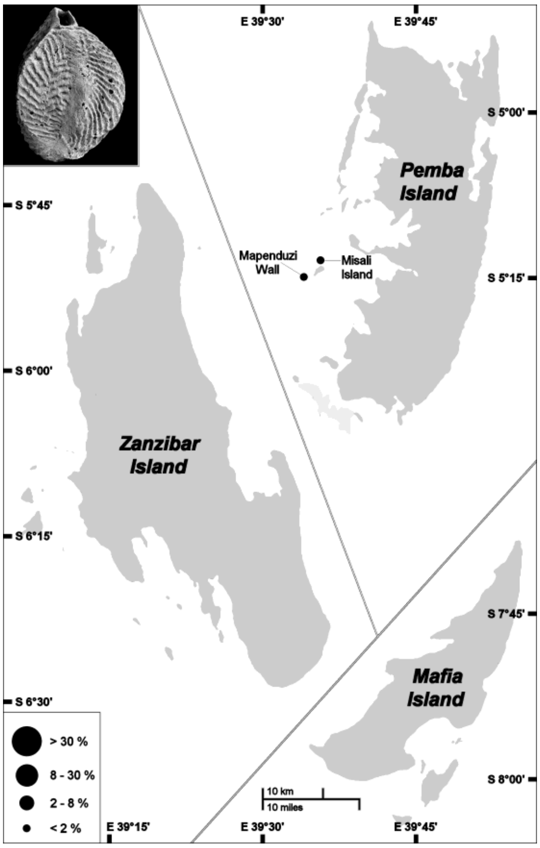

Fig. 80: Distribution of *Pseudomassilina reticulata*.

Pseudotriloculina cf. _P. kerimbatica_ (Heron-Allen & Earland)

Plate 6, Figs. 4-9

1915 *Miliolina kerimbatica* – Heron-Allen & Earland, p. 574, pl. 43, figs. 13-23
1982 *Quinqueloculina kerimbatica* (Heron-Allen & Earland) – Levy et al., p. 136, pl. 2, figs. 1-2
1982 *Quinqueloculina kerimbatica* (Heron-Allen & Earland) – Neagu, p. 103, pl. 4, figs. 4-6

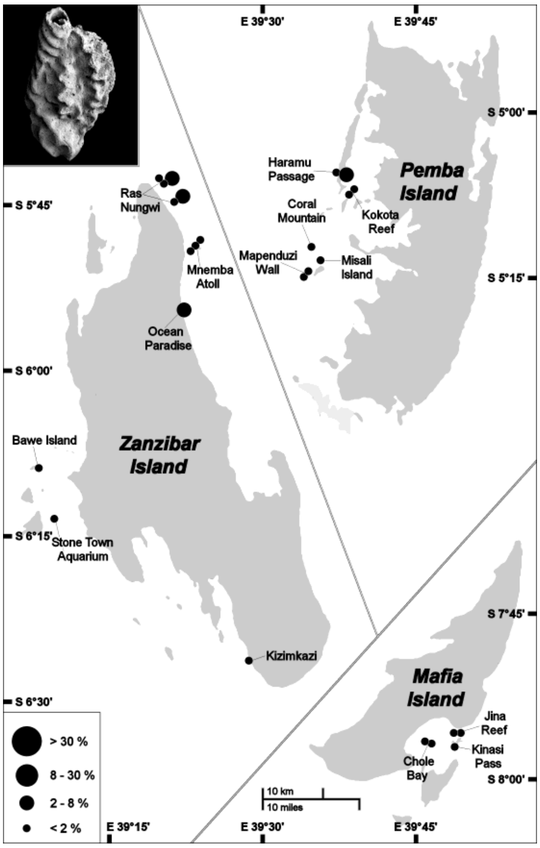

Fig. 81: Distribution of *Pseudotriloculina* cf. *P. kerimbatica*.

2013a *Pseudotriloculina kerimbatica* (Heron-Allen & Earland) – Langer et al., figs. 6.14-15

Distribution: Most of the stations

Abundance: Rare to common

Depth: 1-42 m

***Pseudotriloculina* cf. *P. limbata* (d'Orbigny)**
Plate 6, Figs. 10-12

1826 cf. *Quinqueloculina limbata* – d'Orbigny, p. 302, fig. 20
1915 cf. *Miliolina limbata* (d'Orbigny) – Heron-Allen & Earland, p. 577, pl. 44, figs. 5-8
1993 *Pseudotriloculina* sp. B – Hottinger et al., p. 56, pl. 49, figs. 1-7
1998 *Pseudotriloculina* sp. B – Haunold & Piller, p. 19, pl. 5, fig. 9
2013 *Pseudotriloculina* sp. B – Langer et al., p. 167, pl. 6, figs. 22, 23

Distribution: Few stations, mainly Ocean Paradise

Abundance: Rare to common

Depth: 3-30 m

Genus *Pyrgo* Defrance, 1824

***Pyrgo denticulata* (Brady)**
Plate 6, Figs. 13-16

1884 *Biloculina ringens* (Lamarck) var. *denticulata* – Brady, pl. 3, figs. 4-5
1915 *Biloculina ringens* (Lamarck) var. *denticulata* Brady – Heron-Allen & Earland, p. 551, pl. 40, fig. 11-13
1917 *Biloculina denticulata* Brady – Cushman, p. 80, pl. 33, fig. 1
1929 *Pyrgo denticulata* (Brady) – Cushman, p. 69, pl. 18, figs. 3-4
1950 *Pyrgo denticulata* (Brady) – Said, p. 7, pl. 1, fig. 15
1961 *Pyrgo denticulata* (Brady) – Braga, p. 87, pl. 8, figs. 5-6

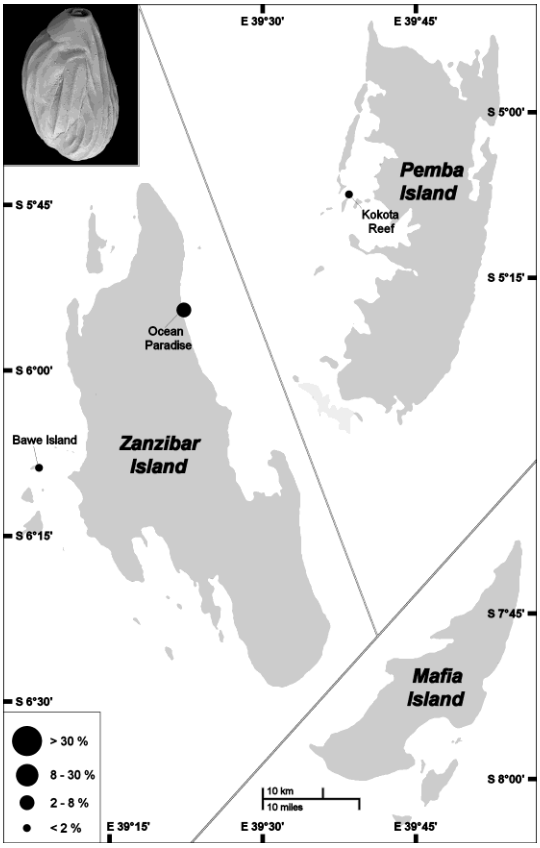

Fig. 82: Distribution of *Pseudotriloculina* sp. B.

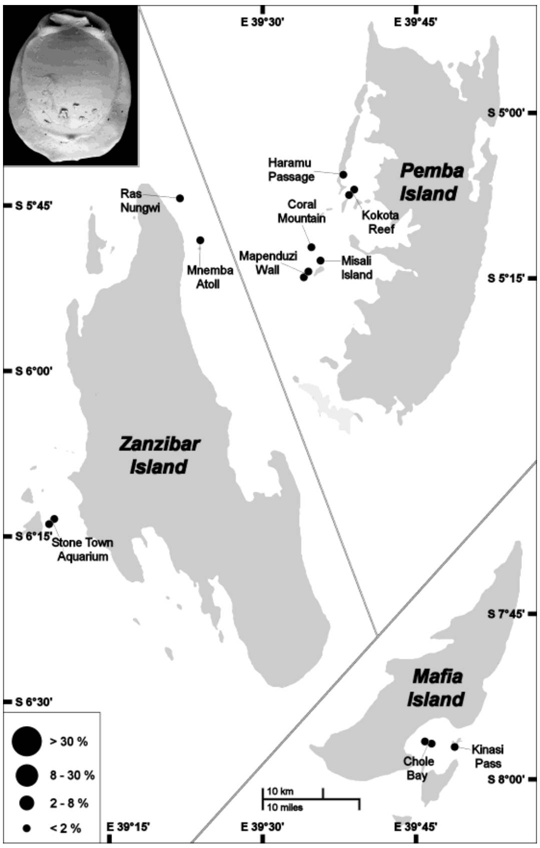

Fig. 83: Distribution of *Pyrgo denticulata*.

1965 *Pyrgo denticulata* (Brady) – Moura, p. 27, pl. 3, fig. 5
1992 *Pyrgo denticulata* (Brady) – Hatta & Ujiie, p. 72, pl. 11, figs. 1a-2b
1993 *Pyrgo denticulata* (Brady) – Hottinger et al., p. 56, pl. 49, figs. 8-12
1994 *Pyrgo denticulata* (Brady) – Loeblich & Tappan, p. 54, pl. 92, figs. 1-2
1998 *Pyrgo denticulata* (Brady) – Haunold & Piller, p. 19, pl. 5, fig. 10
2012 *Pyrgo denticulata* (Brady) – Debenay, p. 117, 276, pl. 5
2013a *Pyrgo denticulata* (Brady) – Langer et al., figs. 6.26-27

Distribution: Several stations
Abundance: Rare

Depth: 12-42 m

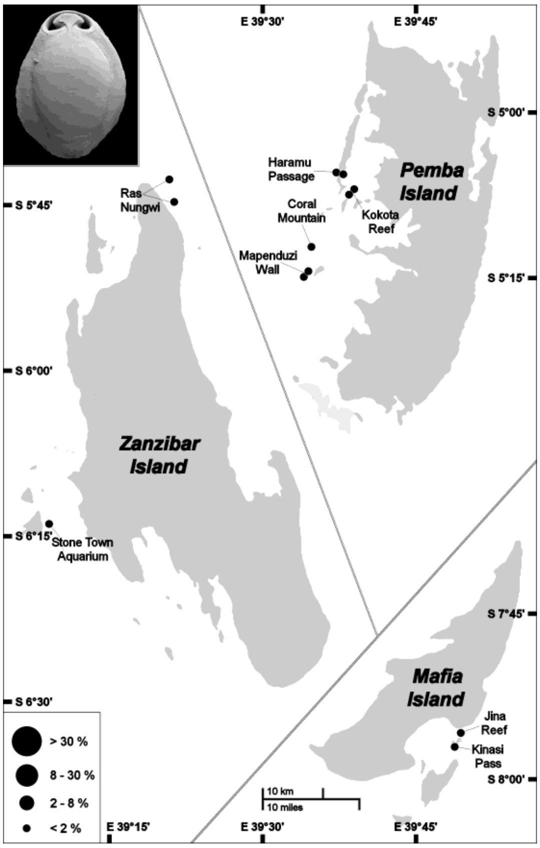

Fig. 84: Distribution of *Pyrgo oblonga*.

Pyrgo oblonga **(d'Orbigny)**
Plate 6, Figs. 17-19

1977a *Pyrgo oblonga* (d'Orbigny) – Le Calvez, p. 33
1993 *Pyrgo oblonga* (d'Orbigny) – Hottinger et al., p. 57, pl. 50, figs. 1-6
2012 *Pyrgo oblonga* (d'Orbigny) – Debenay, p. 117, 276, pl. 5

Distribution: Several stations

Abundance: Rare

Depth: 12-42 m

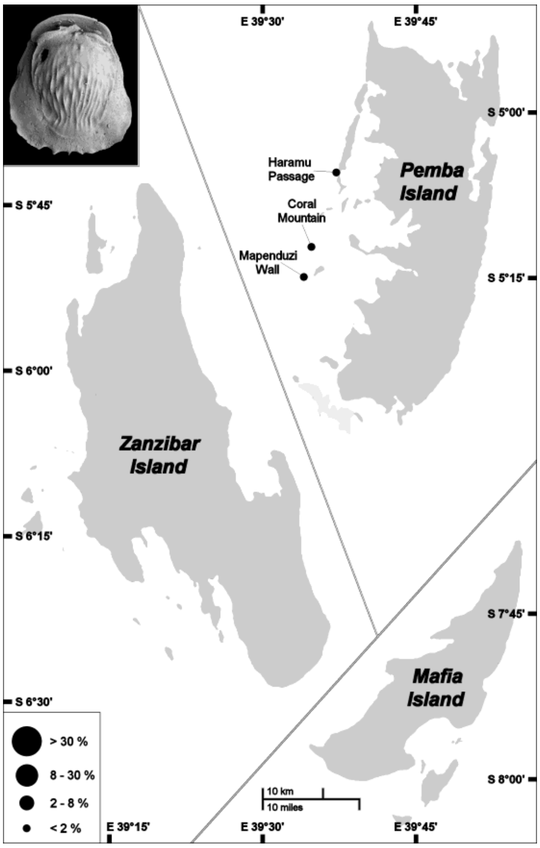

Fig. 85: Distribution of *Pyrgo striolata*.

Pyrgo striolata **(Brady)**
Plate 6, Figs. 20-22

1884 *Biloculina ringens* (Lamarck) var. *striolata* – Brady, p. 143, pl. 3, figs. 7-8
1915 *Biloculina ringens* (Lamarck) var. *striolata* Brady – Heron-Allen & 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

1994 *Pyrgo striolata* (Brady) – Loeblich & Tappan, p.. 54, pl. 92, figs. 9-15
1998 *Pyrgo striolata* (Brady) – Haunold & Piller, p. 19, pl. 5, fig. 13
2012 *Pyrgo striolata* (Brady) – Debenay, p. 118, 277, pl. 5

Distribution: Three stations on Pemba

Abundance: Rare

Depth: 30-42 m

Genus *Quinqueloculina* d'Orbigny, 1826

***Quinqueloculina* cf. *Q. cuvieriana* d'Orbigny**
Plate 6, Figs. 23-25

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

Distribution: Most of the stations

Abundance: Rare to common

Depth: 1-42 m

***Quinqueloculina eburnea* (d'Orbigny)**
Plate 7, Figs. 1-3

1977a *Triloculina eburnea* d'Orbigny – Le Calvez, p. 104
1993 "*Quinqueloculina*" *eburnea* d'Orbigny – Hottinger et al., p. 59, pl. 53, figs. 9-11, pl. 54, figs. 1-5
2013a *Quinqueloculina eburnea* d'Orbigny – Langer et al., figs. 5.3-4

Distribution: Few stations

Abundance: Rare

Depth: 3-35 m

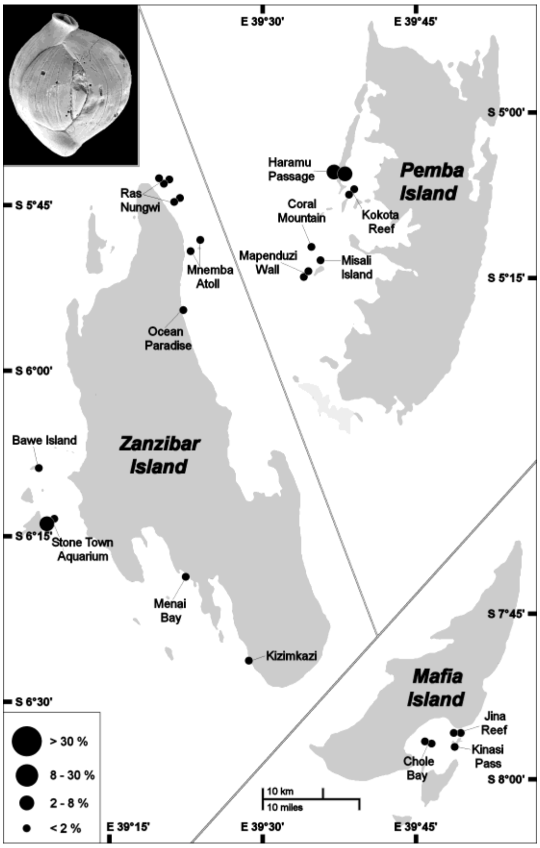

Fig. 86: Distribution of *Quinqueloculina* sp. A.

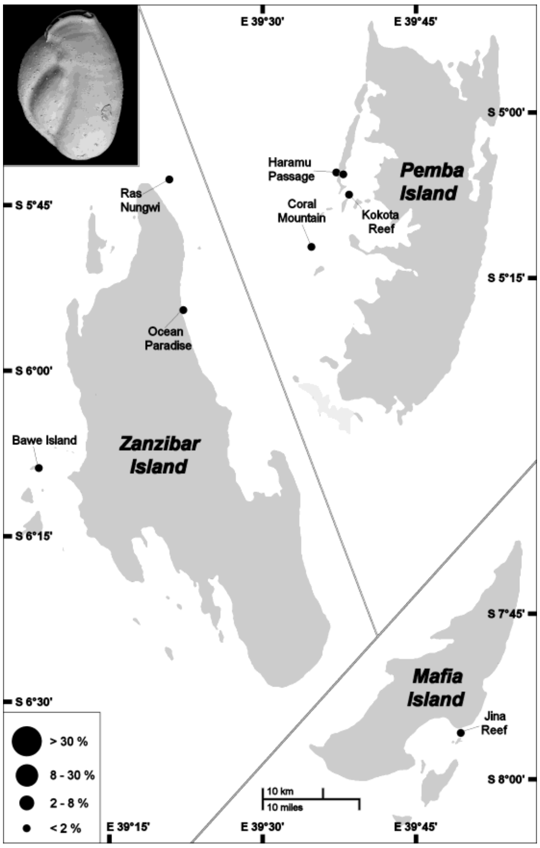

Fig. 87: Distribution of *Quinqueloculina* cf. *Q. eburnea*.

***Quinqueloculina* cf. *Q. multimarginata* Said**
Plate 7, Figs. 4-7

1949 *Quinqueloculina multimarginata* – Said, p. 10, pl. 1, fig. 34
1993 *Quinqueloculina* cf. *Q. multimarginata* Said – Hottinger et al., p. 59, pl. 55, figs. 7-10

Distribution: Most of the stations

Abundance: Rare to frequent

Depth: 1-42 m

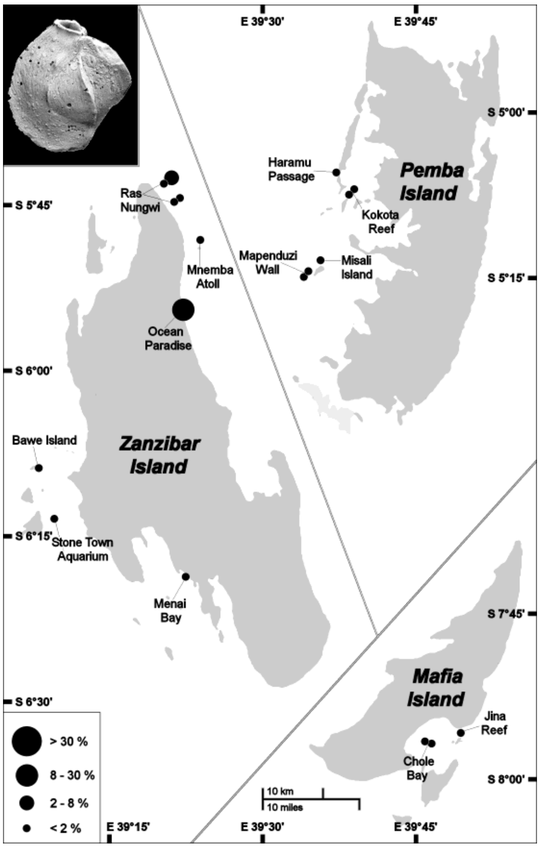

Fig. 88: Distribution of *Quinqueloculina* cf. *Q. multimarginata*.

***Quinqueloculina patagonica* d'Orbigny**
Plate 7, Figs. 8-11

1949 *Quinqueloculina laevigata* d'Orbigny – Said, p. 10, pl. 1, fig. 27
1993 *Quinqueloculina patagonica* d'Orbigny – Hottinger et al., p. 60, pl. 55, figs. 11-17
1994 *Pseudotriloculina patagonica* (d'Orbigny) – Loeblich & Tappan, p. 53, pl. 80, figs. 16-18, pl. 83, figs. 10-12

Distribution: Most of the stations

Abundance: Rare to frequent

Depth: 1-42 m

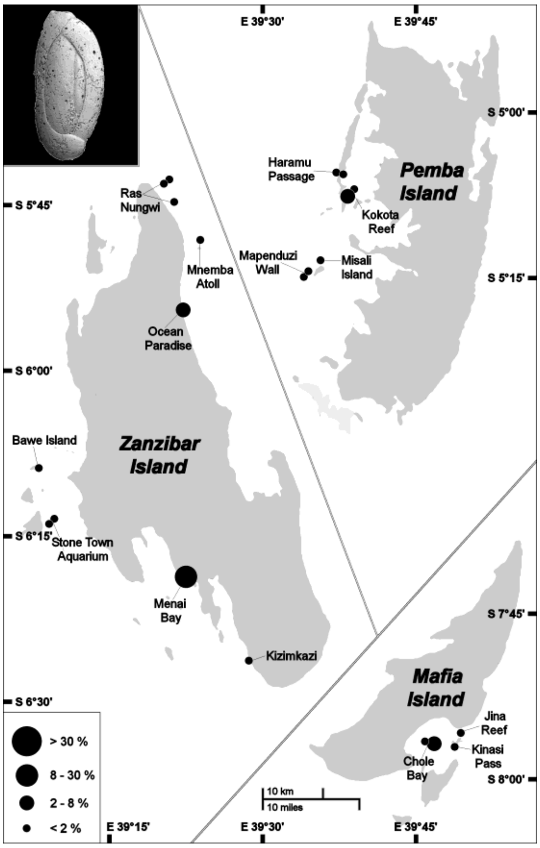

Fig. 89: Distribution of *Quinqueloculina patagonica*.

***Quinqueloculina* cf. *Q. rebeccae* Vella**
Plate 7, Figs. 12-14

1957 *Quinqueloculina* (*Lachlanella*) *rebeccae* – Vella, p. 25, pl. 5, figs. 84-85, 88
2009 *Quinqueloculina rebeccae* Vella – Parker, p. 248, figs. 178 a-c

Distribution: Several stations

Abundance: Rare

Depth: 1-40 m

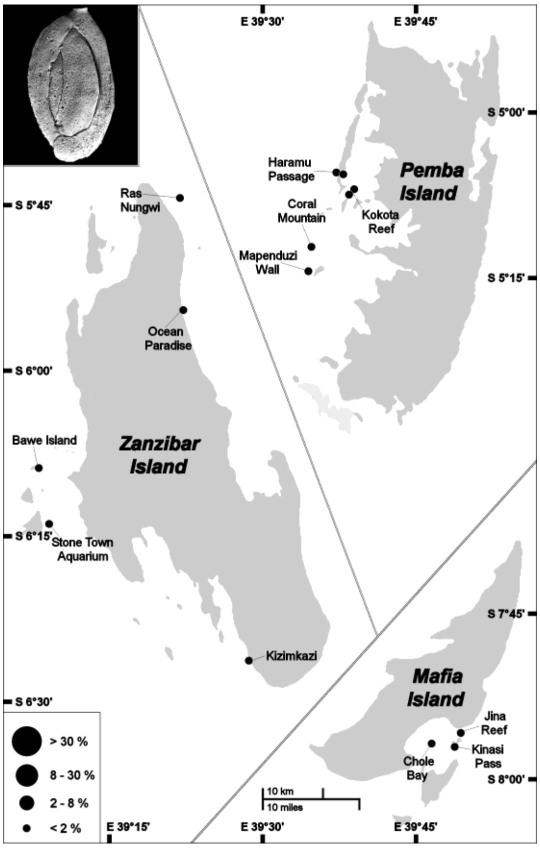

Fig. 90: Distribution of *Quinqueloculina* ? cf. *Q, rebeccae*.

***Quinqueloculina* cf. *Q. vulgaris* d'Orbigny**
Plate 7, Figs. 15-18

1915 *Miliolina vulgaris* d'Orbigny – Heron-Allen & Earland, p. 569
1929 *Quinqueloculina vulgaris* d'Orbigny – Cushman, p. 25, pl. 2, fig. 3
1949 *Quinqueloculina vulgaris* d'Orbigny – Said, p. 11, pl. 1, fig. 26
1993 *Quinqueloculina* sp. D – Hottinger et al., p. 61, pl. 58, figs. 1-4
1994 *Quinqueloculina incisa* Vella – Loeblich & Tappan, p. 49, pl. 80, figs. 13-15
1998 *Quinqueloculina* sp. D – Haunold & Piller, p. 18, pl. 4, fig. 14

Distribution: All of the stations

Abundance: Rare to frequent

Depth: 1-42 m

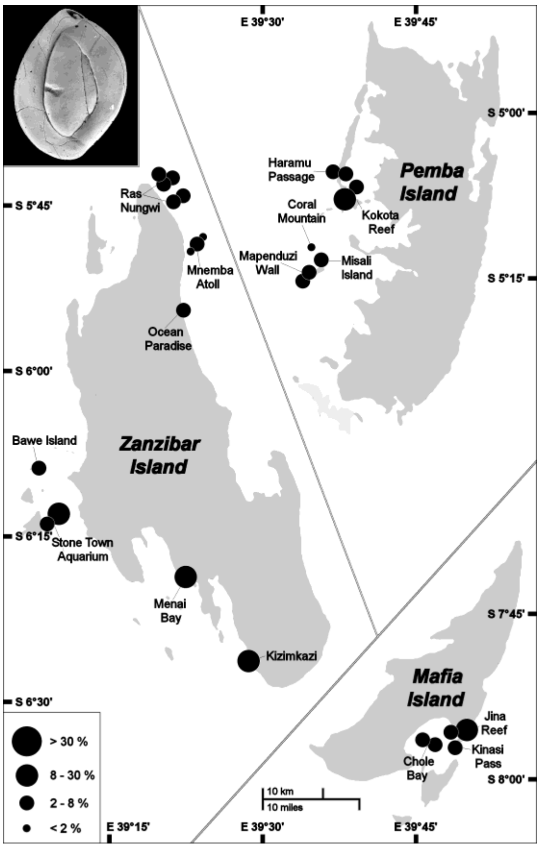

Fig. 91: Distribution of *Quinqueloculina* cf. *Q. vulgaris*.

Genus *Schlumbergerina* Munier-Chalmas, 1882

***Schlumbergerina alveoliniformis* (Brady)**
Plate 7, Figs. 19-23

1884 *Miliolina alveoliniformis* – Brady, p. 181, pl. 8, figs. 15-20
1915 *Massilina alveoliniformis* (Millett) – Heron-Allen & Earland, p. 584, p. 45, fig. 1
1917 *Quinqueloculina alveoliniformis* (Brady) – Cushman, p. 43
1929 *Schlumbergerina alveoliniformis* (Brady) – Cushman, p. 36
1992 *Schlumbergerina alveoliniformis* (Brady) – Hatta & Ujiie, p. 65, pl. 6, figs. 2a-b
1993 *Schlumbergerina alveoliniformis* (Brady) – Hottinger et al., p. 61, pl. 58, figs. 11-14, pl. 59, figs. 1-9
1994 *Schlumbergerina alveoliniformis* (Brady) – Loeblich & Tappan, p. 46, pl. 72, figs. 9-11
1998 *Schlumbergerina alveoliniformis* (Brady) – Haunold & Piller, p. 15, pl. 3, fig. 5
2012 *Schlumbergerina alveoliniformis* (Brady) – Debenay, p. 130, 280, pl. 8

Distribution: Several stations

Abundance: Rare

Depth: 9-42 m

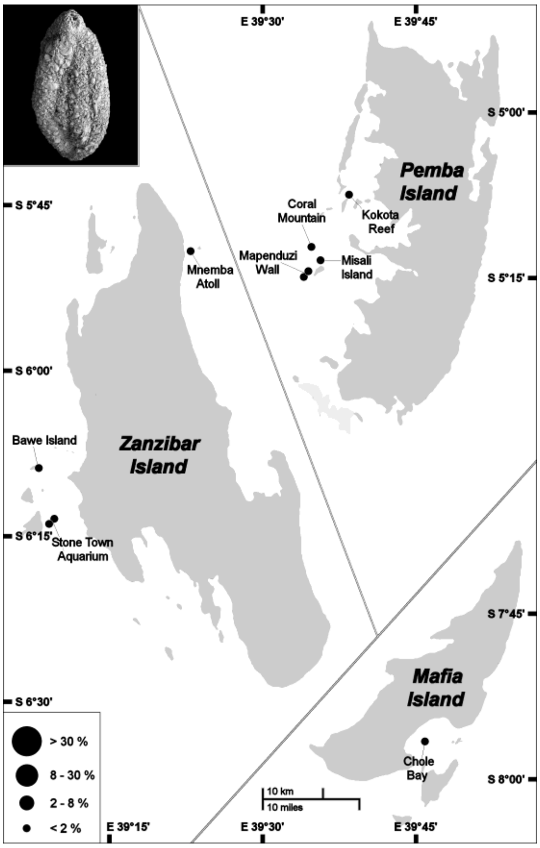

Fig. 92: Distribution of *Schlumbergerina alveoliniformis.*

Genus *Siphonaperta* Vella, 1957

***Siphonaperta* cf. *S. distorqueata* (Cushman)**
Plate 7, Figs. 24-26

1949 *Quinqueloculina bradyana* Cushman – Said, p. 9, pl. 1, fig. 22
1993 *Siphonaperta distorqueata* (Cushman) – Hottinger et al., p. 63, pl. 62, figs. 4-9, pl. 63, figs. 1-6
1998 *Siphonaperta distorqueata* (Cushman) – Haunold & Piller, p. 15, pl. 3, fig. 7
2013a *Siphonaperta distorqueata* (Cushman) – Langer et al., fig. 4.32

Distribution: Few reef stations

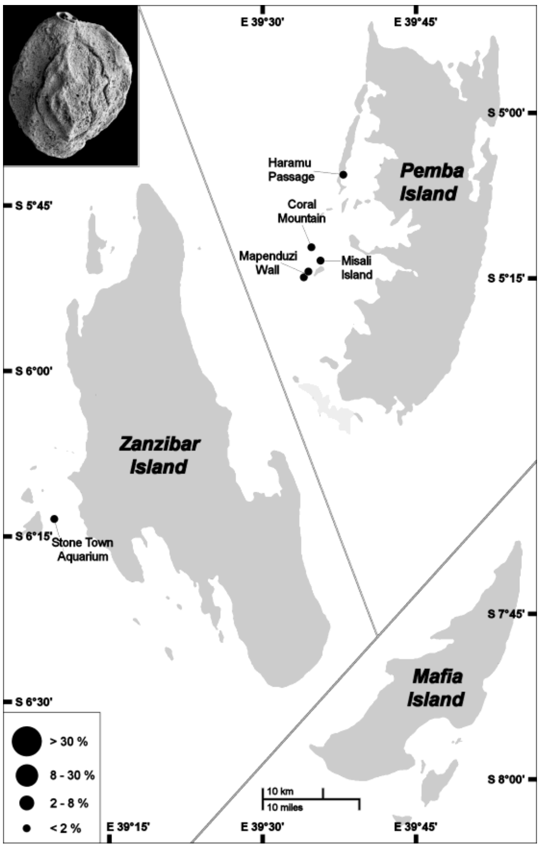

Fig. 93: Distribution of *Siphonaperta* cf. *S. distorqueata.*

Abundance: Rare

Depth: 12-42 m

***Siphonaperta pittensis* (Albani)**
Plate 8, Figs. 1-3

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
1998 *Siphonaperta pittensis* (Albani) – Haunold & Piller, p. 15, pl. 3, fig. 9
2013a *Siphonaperta pittensis* (Albani) – Langer et al., figs. 4.33-34

Distribution: Four reef stations

Abundance: Rare

Depth: 12-20 m

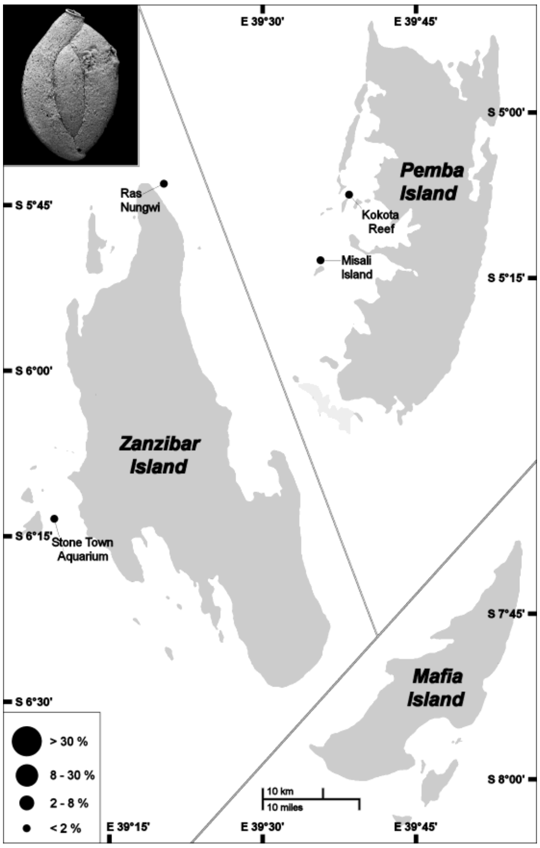

Fig. 94: Distribution of *Siphonaperta pittensis*.

***Triloculina asymmetrica* Said**
Plate 8, Figs. 4-6

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 & Piller, p. 20, pl. 6, fig. 2

Distribution: Most of the stations

Abundance: Rare to frequent

Depth: 1-42 m

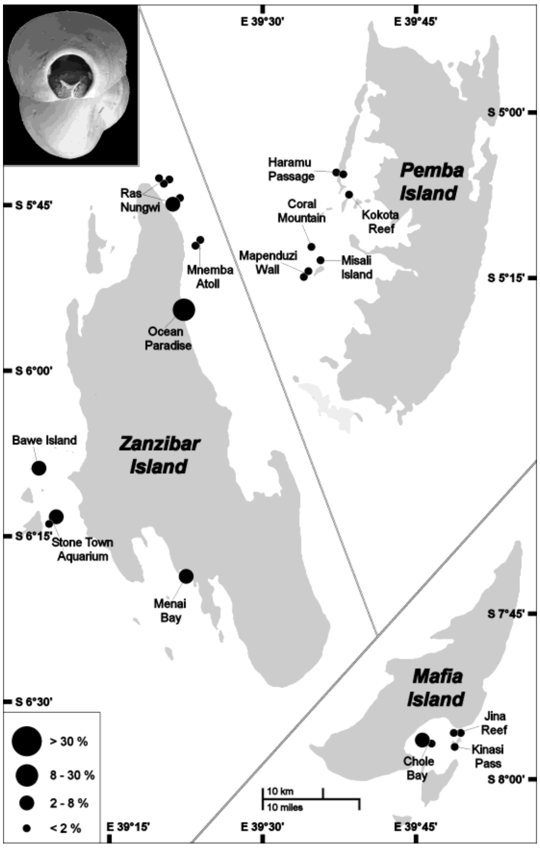

Fig. 95: Distribution of *Triloculina asymmetrica*.

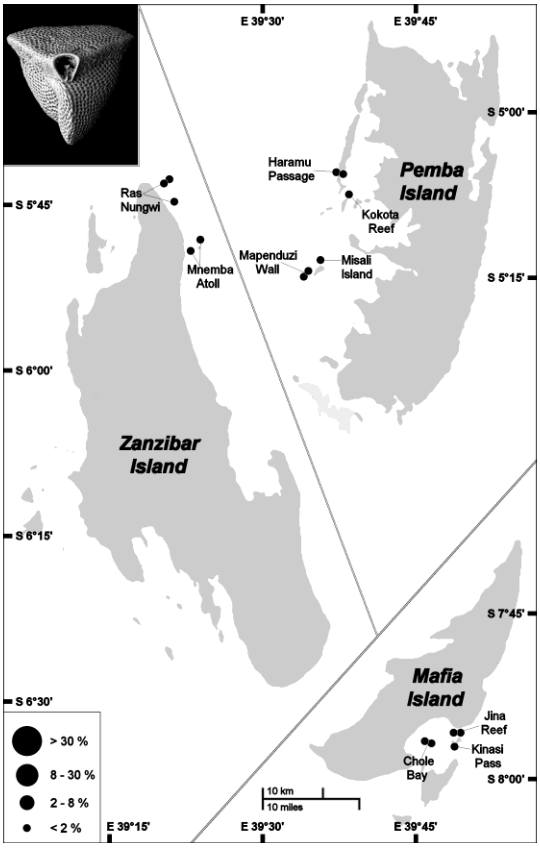

Fig. 96: Distribution of *Triloculina bertheliniana*.

***Triloculina bertheliniana* (Brady)**
Plate 8, Figs. 7-9

1884 *Miliolina bertheliniana* – Brady, p. 166, pl. 114, fig. 2
1915 *Miliolina bertheliniana* Brady – Heron-Allen & Earland, p. 563, pl. 41, figs. 32-35
1961 *Triloculina bertheliniana* (Brady) – Braga, p. 82, pl. 7, fig. 14
1965 *Triloculina bertheliniana* (Brady) – Moura, p. 24, pl. 2, fig. 14
1921 *Triloculina bertheliniana* (Brady) – Cushman, p. 457
1992 *Triloculina bertheliniana* (Brady) – Hatta & Ujiie, p. 73, pl. 11, figs. 7a-b
1994 *Triloculina bertheliniana* (Brady) – Loeblich & Tappan, p. 55, pl. 95, figs. 1-4
2012 *Triloculina bertheliniana* Brady – Debenay, p. 136, 277, pl. 6
2013a *Triloculina bertheliniana* (Brady) – Langer et al., figs. 6.28-29

Distribution: Several stations

Abundance: Rare

Depth: 12-42 m

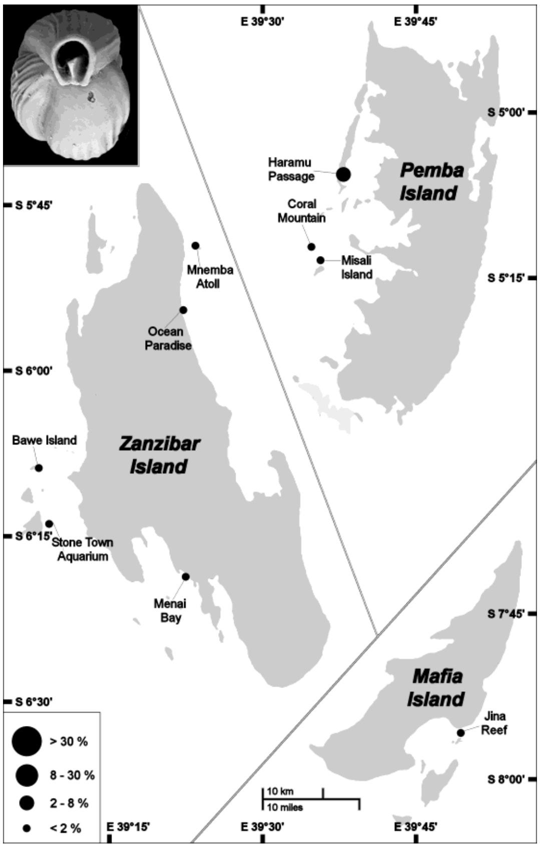

Fig. 97: Distribution of *Triloculina fichteliana*.

***Triloculina fichteliana* d'Orbigny**
Plate 8, Figs. 10-12

1915 *Miliolina fichteliana* (d'Orbigny) – Heron-Allen & Earland, p. 560
1977a *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 & Piller, p. 20, pl. 6, fig. 3
2012 *Triloculina fichteliana* d'Orbigny – Debenay, p. 137, 278, pl. 6
2013a *Triloculina fichteliana* d'Orbigny – Langer et al., figs. 6.30-31

Distribution: Several stations

Abundance: Rare to common

Depth: 1-35 m

Triloculina serrulata McCulloch
Plate 8, Figs. 13-15

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 & Piller, p. 20, pl. 6, fig. 4
2011 *Triloculina serrulata* McCulloch – Parker & Gischler, p. 43, pl. 3, figs. 13-15
2012 *Triloculina serrulata* McCulloch – Debenay, p. 137, 278, pl. 6
2013a *Triloculina serrulata* McCulloch – Langer et al., fig. 6.32

Distribution: Several stations

Abundance: Rare

Depth: 1-42 m

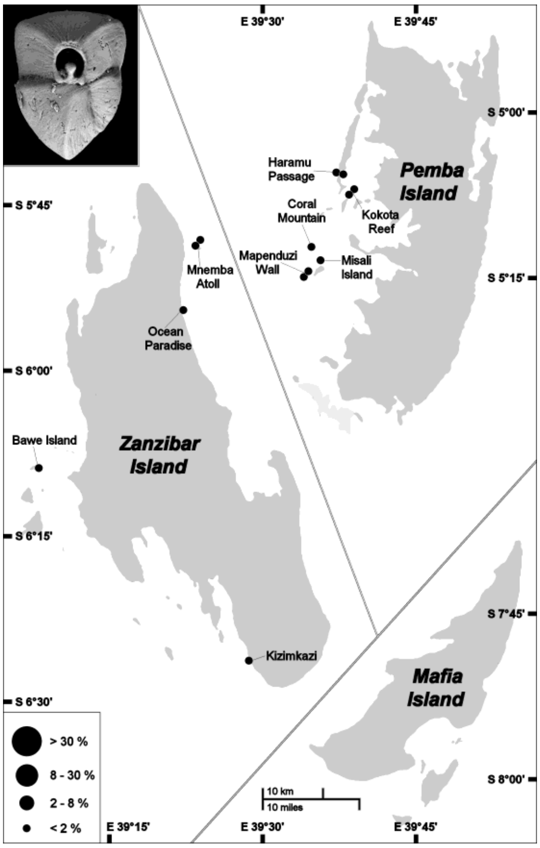

Fig. 98: Distribution of *Triloculina serrulata*.

Triloculina cf. _T. serrulata_ McCulloch
Plate 8, Figs. 16-18

1977 *Triloculina serrulata* McCulloch – 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 & Piller, p. 20, pl. 6, fig. 4
2011 *Triloculina serrulata* McCulloch – Parker & Gischler, p. 43, pl. 3, figs. 13-15
2012 *Triloculina serrulata* McCulloch – Debenay, p. 137, 278, pl. 6
2013a *Triloculina serrulata* McCulloch – Langer et al., fig. 6.32

Distribution: Ras Nungwi Lighthouse

Abundance: Rare

Depth: 12-14 m

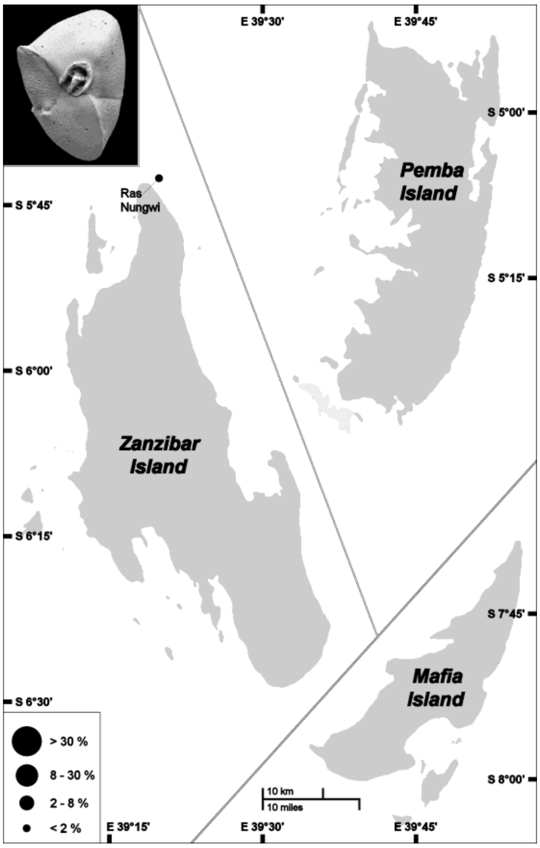

Fig. 99: Distribution of *Triloculina* cf. *T. serrulata*.

Triloculina terquemiana (Brady)
Plate 8, Figs. 19-21

1884 *Miliolina terquemiana* – Brady, p. 114, fig. 1
1915 *Miliolina terquemiana* Brady – Heron-Allen & Earland, p. 563, pl. 41, fig. 26-31
1917 *Triloculina terquemiana* (Brady) – Cushman, p. 72
1961 *Triloculina terquemiana* (Brady) – Braga, p. 78, pl. 7, figs. 6-8
1965 *Triloculina terquemiana* (Brady) – Moura, p. 25, pl. 2, fig. 15
1979 *Triloculina terquemiana* (Brady) – Pereira, pl. 16, fig. Q, pl. 17, fig. A
1993 *Triloculina terquemiana* (Brady) – Hottinger et al., p. 65, pl. 68, figs. 1-6
2012 *Triloculina terquemiana* (Brady) – Debenay, p. 138, 277, 278, pl. 6
2013a *Triloculina terquemiana* (Brady) – Langer et al., figs. 6.35-36

<u>Distribution</u>: Coral Mountain and Misali Island

<u>Abundance</u>: Rare

<u>Depth</u>: 20-35 m

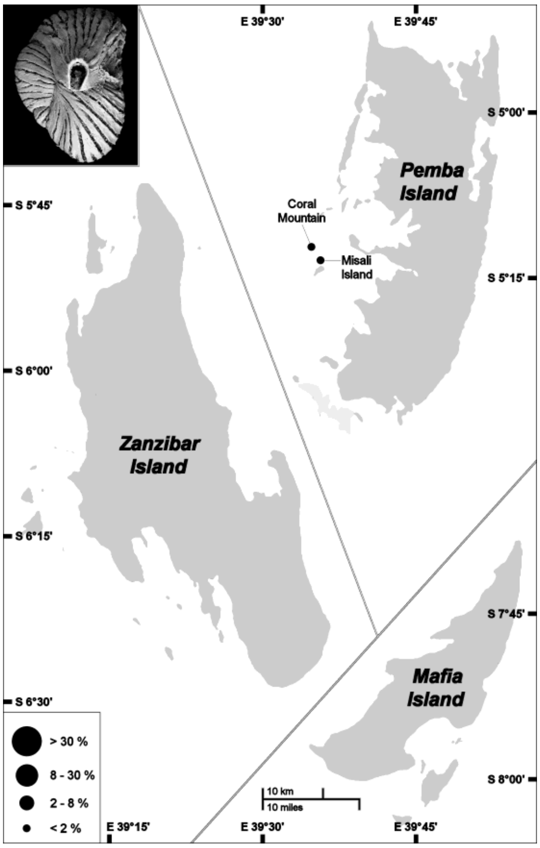

Fig. 100: Distribution of *Triloculina terquemiana*.

Triloculina trigonula (Lamarck)
Plate 8, Figs. 22-24

1804 *Miliolites trigonula* – Lamarck, p. 351
1884 *Miliolina trigonula* (Lamarck) – Brady, pl. 3, figs. 15-16
1915 *Miliolina trigonula* (Lamarck) – Heron-Allen & Earland, p. 561
1932 *Triloculina trigonula* (Lamarck) – Cushman, p. 56, pl. 13, fig. 1
1965 *Triloculina trigonula* (Lamarck) – Moura, p. 26, pl. 3, fig. 4
1982 *Triloculina trigonula* (Lamarck) – Neagu, p. 106, pl. 4, figs. 13-14
1993 *Triloculina trigonula* (Lamarck) – Hottinger et al., p. 66, pl. 69, figs. 1-10
1998 *Triloculina trigonula* (Lamarck) – Haunold & Piller, p. 20, pl. 6, fig. 6
2012 *Triloculina trigonula* (Lamarck) – Debenay, p. 138, 278, pl. 6
2013a *Triloculina trigonula* (Lamarck) – Langer et al., figs. 6.39-40

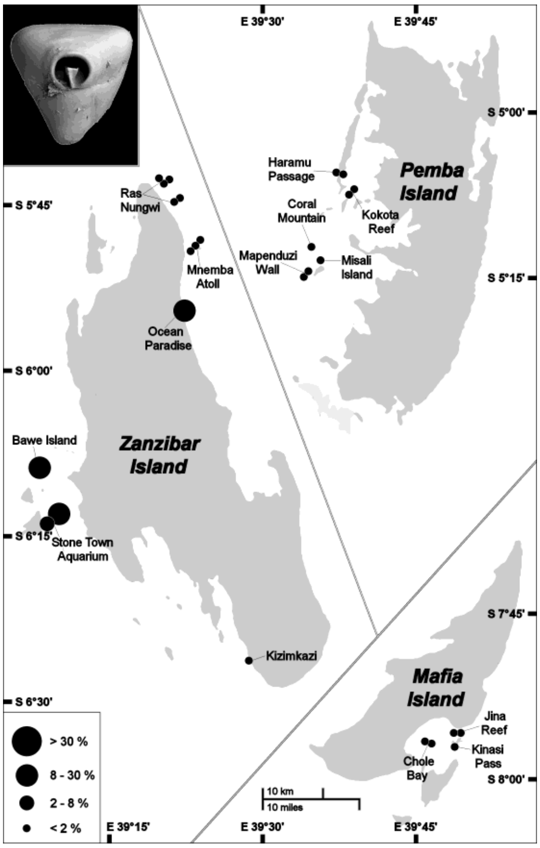

Fig. 101: Distribution of *Triloculina trigonula*.

Distribution: Most of the stations, mainly Ocean Paradise and west of Zanzibar

Abundance: Rare to frequent

Depth: 9-35 m

***Triloculina* sp. A**
Plate 9, Figs. 1-3

1993 *Pseudotriloculina subgranulata* (Cushman) – Hottinger et al., p. 56, pl. 47, figs. 8-13, pl. 48, figs. 1-8
1998 *Pseudotriloculina subgranulata* (Cushman) – Haunold & Piller, p. 19, pl. 5, fig. 8
2012 *Pseudotriloculina subgranulata* (Cushman) – Debenay, p. 116, 276, pl. 7
2013a *Pseudotriloculina subgranulata* (Cushman) – Langer et al., figs. 6.18-19

Distribution: Several stations

Abundance: Rare

Depth: 9-42 m

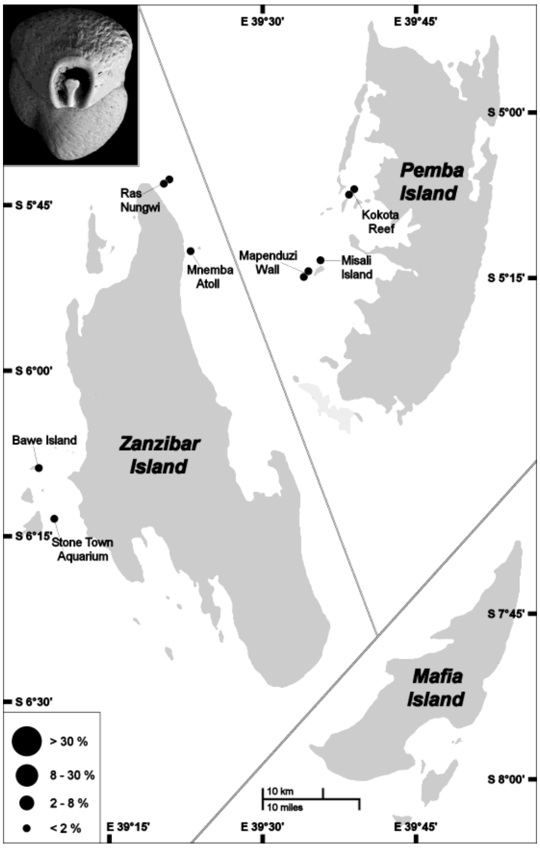

Fig. 102: Distribution of *Triloculina* sp. A.

***Triloculina* sp. B**
Plate 9, Figs. 4-5

1993 *Triloculina* sp. A – Hottinger et al., p. 66, pl. 70, figs. 1-4

Distribution: Only in western reefs

Abundance: Rare

Depth: 9-42 m

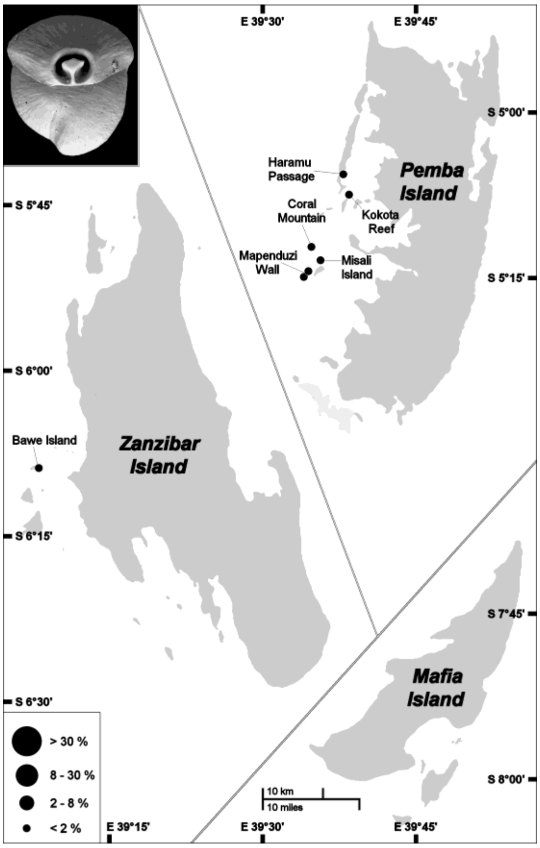

Fig. 103: Distribution of *Triloculina* sp. B.

***Triloculina* ? sp. C**
Plate 9, Figs. 6-8

Distribution: Several stations

Abundance: Rare

Depth: 1-40 m

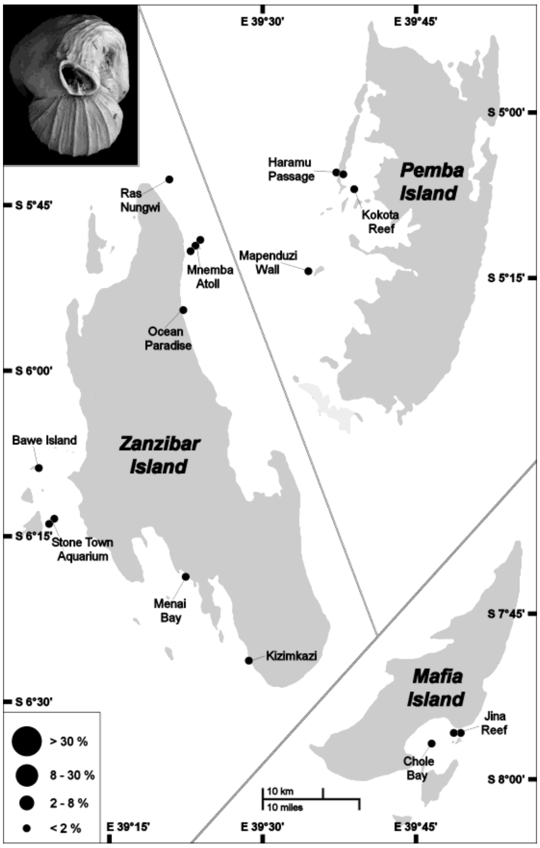

Fig. 104: Distribution of *Triloculina* ? sp. C.

***Triloculinella* cf. *T. pilasensis* (McCulloch)**
Plate 9, Figs. 9-10

1977 cf. *Miliolinella pilasensis* – McCulloch, p. 566, pl. 238, fig. 16
1993 *Miliolinella* sp. C – Hottinger et al., p. 53, pl. 40, figs. 4,5
2012 cf. *Miliolinella pilasensis* McCulloch – Debenay, p. 110
2013 *Triloculinella* sp. A – Langer et al., p. 167, pl. 6, figs. 44, 45

Distribution: Mnemba Atoll

Abundance: Rare

Depth: 30 m

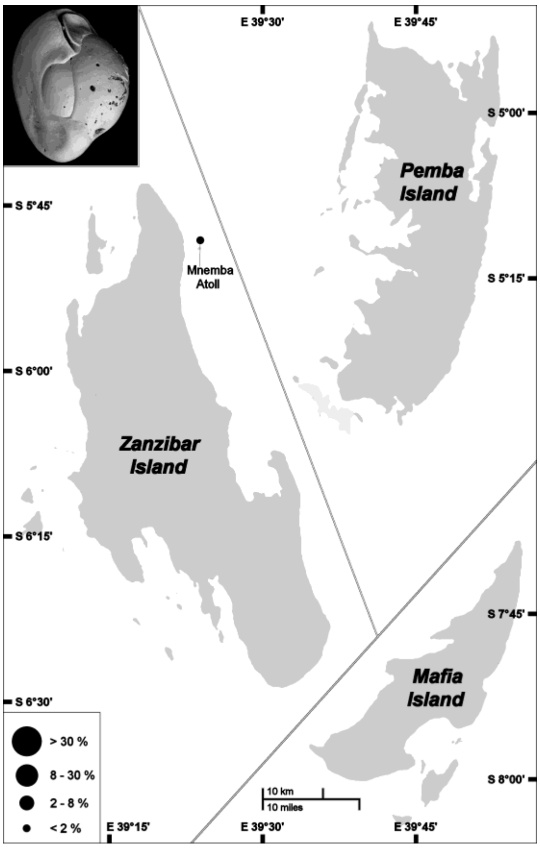

Fig. 105: Distribution of *Triloculinella* cf. *T. pilasensis.*

Family Miliolidae Ehrenberg, 1839

Genus *Rupertianella* Loeblich & Tappan, 1985

***Rupertianella rupertiana* (Brady)**
Plate 9, Figs. 11-14

1881 *Miliolina rupertiana* – Brady, p. 46
1884 *Miliolina rupertiana* – Brady, p. 178, pl. 7, figs. 7-12
1915 *Miliolina rupertiana* Brady – Heron-Allen & Earland, p. 565
1982 *Triloculina rupertiana* (Brady) – Neagu, p. 107, pl. 7, figs. 23-25
1984 *Edentostomina rupertiana* (Brady) – Reiss & Hottinger, fig. G 21 l
1985 *Rupertianella rupertiana* (Brady) – Loeblich & Tappan, p. 52
1993 *Rupertianella rupertiana* (Brady) – Hottinger et al., p. 67, pl. 73, figs. 1-10
1994 *Rupertianella rupertiana* (Brady) – Loeblich & Tappan, p. 60, pl. 106, figs. 1-14
1997 *Rupertianella rupertiana* (Brady) – Cherif et al., p.270, pl. 6, fig. 3

<u>Distribution</u>: Few reef stations

<u>Abundance</u>: Rare

<u>Depth</u>: 16-40 m

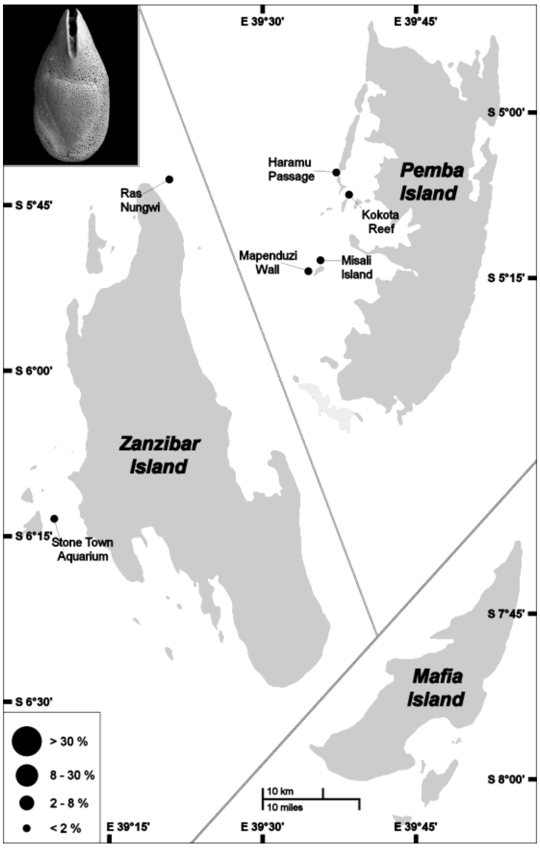

Fig. 106: Distribution of *Rupertianella rupertiana*.

Family Riveroinidae Saidova, 1981

Genus *Pseudohauerinella* McCulloch, 1981

***Pseudohauerinella dissidens* (McCulloch)**
Plate 9, Figs. 15-18

1915 *Spiroloculina crenata* Karrer – Heron-Allen & Earland, p. 557, pl. 41, fig. 6-8
1977 *Pseudohauerina dissidens* – McCulloch, p. 237, pl. 102, fig. 7
1993 *Pseudohauerinella dissidens* (McCulloch) – Hottinger et al., p. 67, pl. 74, figs. 1-8
1998 *Pseudohauerinella dissidens* (McCulloch) – Haunold & Piller, p. 21, pl. 6, fig. 15
2013a *Pseudohauerinella dissidens* (McCulloch) – Langer et al., figs. 7.11-12

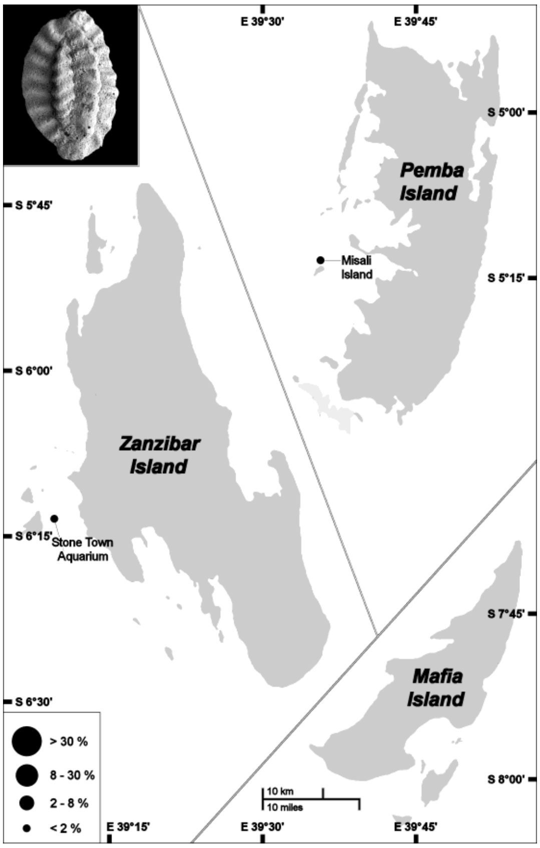

Fig. 107: Distribution of *Pseudohauerinella dissidens*.

Distribution: Misali Island and Stone Town Aquarium

Abundance: Rare

Depth: 20 m

Family Alveolinidae Ehrenberg, 1839

Genus *Borelis* De Montfort, 1808

***Borelis schlumbergeri* (Reichel)**
Plate 9, Figs. 19-26

1880 *Alveolina boscii* Defrance – Möbius, p. 79, pl. III, fig. 1
1915 *Alveolina boscii* (Defrance) – Heron-Allen & Earland, p. 606
1984 *Borelis schlumbergeri* (Reichel) – Reiss & Hottinger, p. 215, fig. G10
1993 *Borelis schlumbergeri* (Reichel) – Hottinger et al., p. 68, pl. 75, figs. 1-17
1997 *Borelis schlumbergeri* (Reichel) – Cherif et al., p. 270, pl. 6, fig. 4
1998 *Borelis schlumbergeri* (Reichel) – Haunold, Baal & Piller, p. 156, pl. 1, figs. 1-3
2012 *Borelis schlumbergeri* (Reichel) – Debenay, p. 104, 281, pl. 4
2013a *Borelis schlumbergeri* (Reichel) – Langer et al., fig. 7.14

Distribution: Most of the stations

Abundance: Rare to common

Depth: 9-42 m

Family Peneroplidae Schultze, 1854

Genus *Peneroplis* de Montfort, 1808

***Peneroplis pertusus* Forskål**
Plate 10, Figs. 1-5

1775 *Nautilus pertusus* – Forskål, p. 125
1884 *Peneroplis pertusus* (Forskål) – Brady, p. 204, pl. 13, figs. 16-17

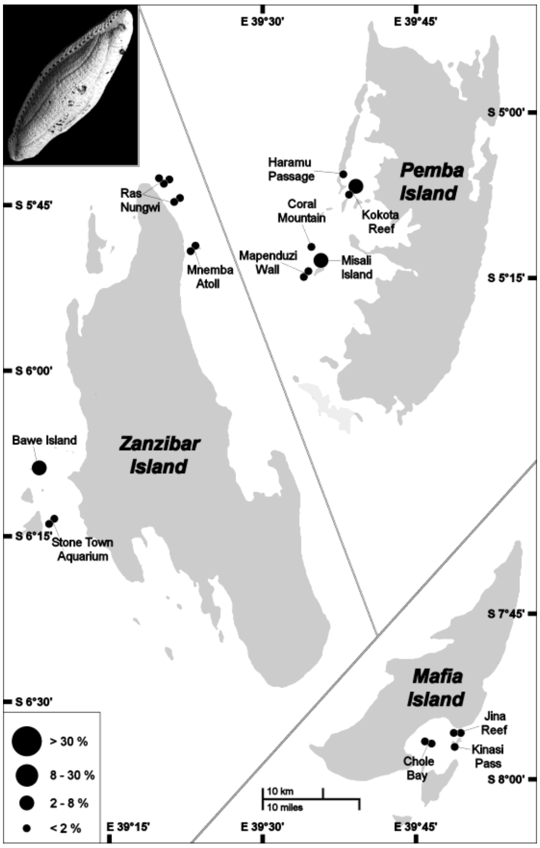

Fig. 108: Distribution of *Borelis schlumbergeri*.

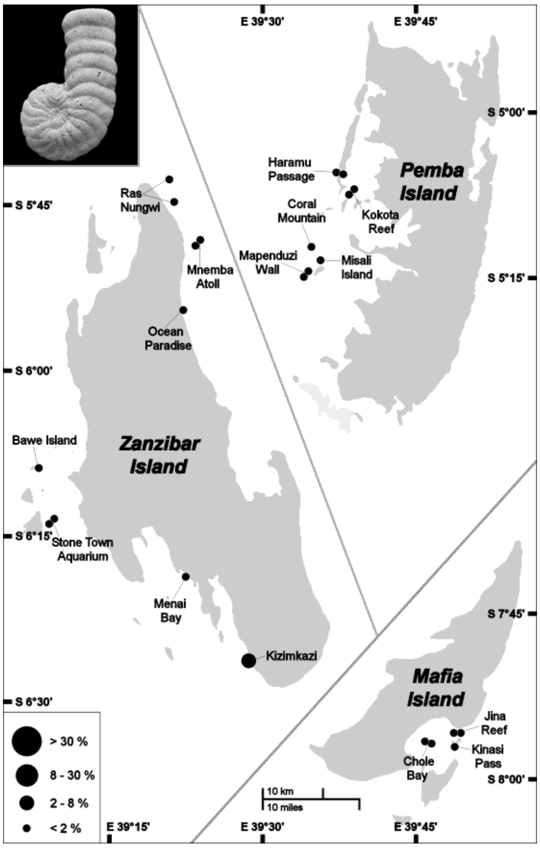

Fig. 109: Distribution of *Peneroplis pertusus*.

1994 *Peneroplis pertusus* (Forskål) – Loeblich & Tappan, p. 62, pl. 110, figs. 1-5

Distribution: Most of the stations

Abundance: Rare to common

Depth: 1-42 m

Peneroplis planatus **(Fichtel & Moll)**
Plate 10, Figs. 6-10

1798 *Nautilus planatus* – Fichtel & Moll, p. 91, pl. 16, figs. a-f, i
1915 *Peneroplis planatus* (Fichtel & Moll) – Heron-Allen & Earland, p. 601
1949 *Peneroplis planatus* (Fichtel & Moll) – Said, p. 24, pl. 2, fig. 38
1982 *Peneroplis planatus* (Fichtel & Moll) – Levy et al., p. 136, pl. 3, fig. 3
1982 *Peneroplis planatus* (Fichtel & Moll) – Neagu, p. 108, pl. 8, figs. 3-5
1984 *Peneroplis planatus* (Fichtel & Moll) – Reiss & Hottinger, pars, p. 242, figs. G25b, c, not fig. a
1992 *Peneroplis planatus* (Fichtel & Moll) – Hatta & Ujiie, p. 79, pl. 16, figs. 2a-b
1993 *Peneroplis planatus* (Fichtel & Moll) – Hottinger et al., p. 70, pl. 79, figs. 1-16, pl. 80, figs. 1-8
2012 *Peneroplis planatus* (Fichtel & Moll) – Debenay, p. 114, 281, pl. 4
2013a *Peneroplis planatus* (Fichtel & Moll) – Langer et al., figs. 7.16-18

Distribution: Most of the stations

Abundance: Rare

Depth: 1-42 m

Family Soritidae Ehrenberg, 1839

Genus *Amphisorus* Ehrenberg, 1839

Amphisorus hemprichii **Ehrenberg**
Plate 10, Figs. 11-14

1840 *Amphisorus hemprichii* – Ehrenberg, p. 130

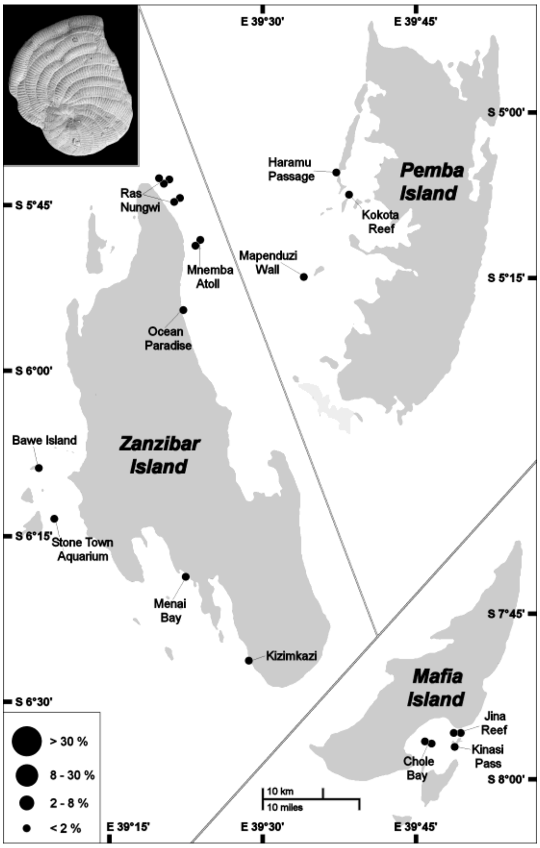

Fig. 110: Distribution of *Peneroplis planatus*.

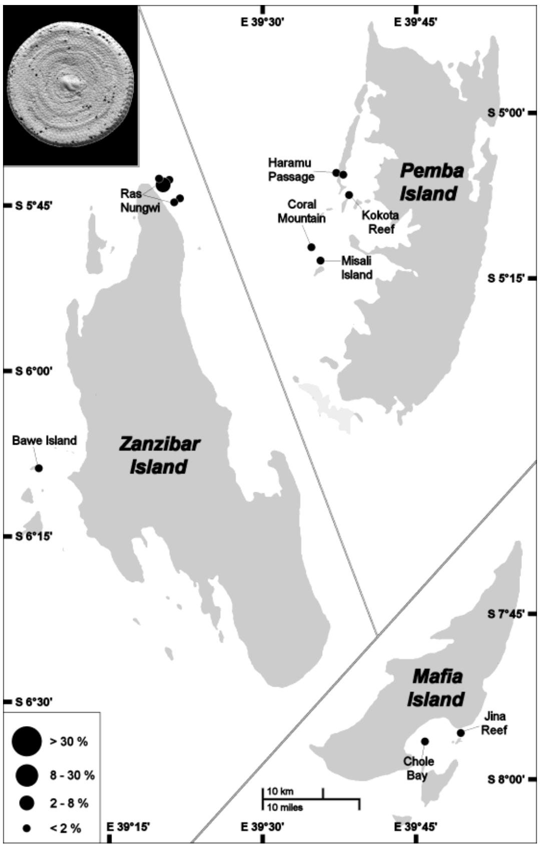

Fig. 111: Distribution of *Amphisorus hemprichii*.

1984 *Amphisorus hemprichii* Ehrenberg – Reiss & Hottinger, p. 205, figs. G3, G4
1992 *Amphisorus hemprichii* Ehrenberg – Hatta & Ujiie, p. 80, pl. 17, figs. 3a-4b, pl. 18, figs. 3-4
1993 *Amphisorus hemprichii* Ehrenberg – Hottinger et al., p. 71, pl. 81, figs. 1-8, pl. 82, figs. 1-11
1994 *Amphisorus hemprichii* Ehrenberg – Loeblich & Tappan, p. 62, pl. 109, figs. 7-13, pl. 110, figs. 6-7
1998 *Amphisorus hemprichii* Ehrenberg – Haunold, Baal & Piller, p. 156, pl. 1, figs. 8-10
2012 *Amphisorus hemprichii* Ehrenberg – Debenay, p. 103, 282, pl. 4
2013a *Amphisorus hemprichii* Ehrenberg – Langer et al., fig. 7.19

Distribution: Only in reefs

Abundance: Rare to common

Depth: 9-35 m

Genus *Sorites* Ehrenberg, 1839

***Sorites orbiculus* (Forskål)**
Plate 10, Figs. 15-21

1840 *Sorites orbiculus* (Forskål) – Ehrenberg, pl. 3, fig. 2
1984 *Sorites orbiculus* Ehrenberg – Reiss & Hottinger, p. 205, figs. 65a-d
1991 *Sorites orbiculus* Ehrenberg – Cimerman & Langer, p. 50, pl. 51, figs. 1-5
1992 *Sorites orbiculus* (Forskål) – Hatta & Ujiie, p. 80, pl. 17, figs. 5a-6b, pl. 18, figs. 5-6
1993 *Sorites orbiculus* (Forskål) – Hottinger et al., p. 72, pl. 83, figs. 1-13
1994 *Sorites orbiculus* (Forskål) – Loeblich & Tappan, p. 63, pl. 112, figs. 6-8
1998 *Sorites orbiculus* (Forskål) – Haunold, Baal & Piller, p. 156, pl. 2, figs. 1-3
2012 *Sorites orbiculus* (Forskål) – Debenay, p. 131, 282, pl. 4
2013a *Sorites orbiculus* Ehrenberg – Langer et al., fig. 7.20

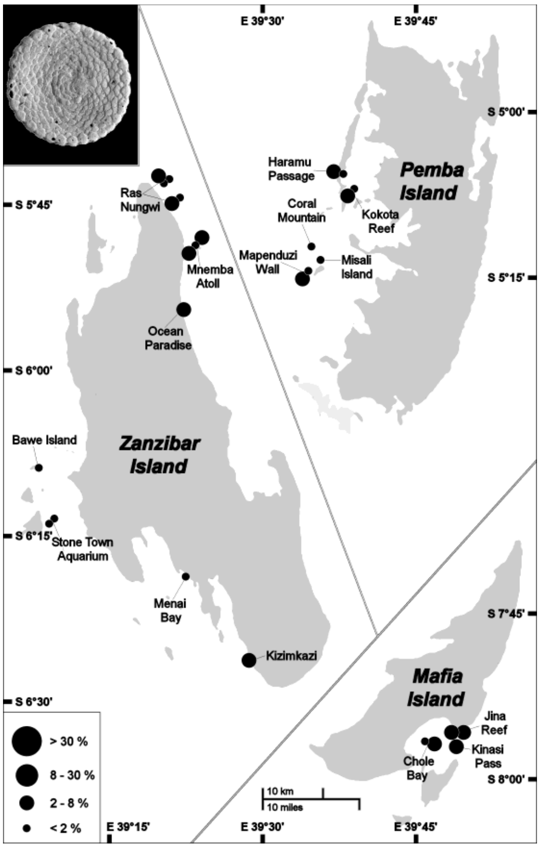

Fig. 112: Distribution of *Sorites orbiculus*.

2013a *Sorites orbiculus* Ehrenberg – Langer et al., fig. 7.20

Distribution: All of the stations

Abundance: Rare to common

Depth: 1-42 m

Suborder Spirillinina Hohenegger & Piller, 1975

Family Planispirillinidae Piller, 1978

Genus *Planispirillina* Bermudéz, 1952

***Planispirillina spinigera* (Chapman)**
Plate 11, Figs. 1-3

1900 *Spirillina spinigera* – Chapman, p. 133, pl. 1, fig. 7
1994 *Planispirillina spinigera* (Chapman) – Loeblich & Tappan, p. 35, pl. 51, figs. 7-12
2013a *Planispirillina spinigera* (Chapman) – Langer et al., figs. 4.17-18

Distribution: Several stations

Abundance: Rare

Depth: 1-42 m

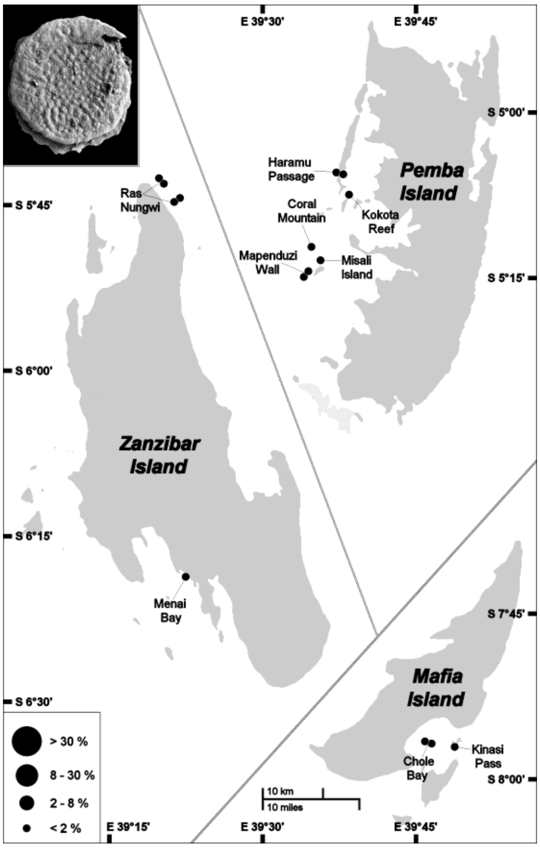

Fig. 113: Distribution of *Planispirillina spinigera*.

Family Spirillinidae Reuss & Fritsch, 1861

Genus *Spirillina* Ehrenberg, 1843

***Spirillina grosseperforata* Zheng**
Plate 11, Figs. 4-6

1994 *Spirillina grosseperforata* Zheng – Loeblich & Tappan, p. 36, pl. 53, figs. 1-8
2012 *Spirillina grosseperforata* Zheng – Debenay, p. 232, 282, pl. 19

Distribution: Few stations

Abundance: Rare

Depth: 12-20 m

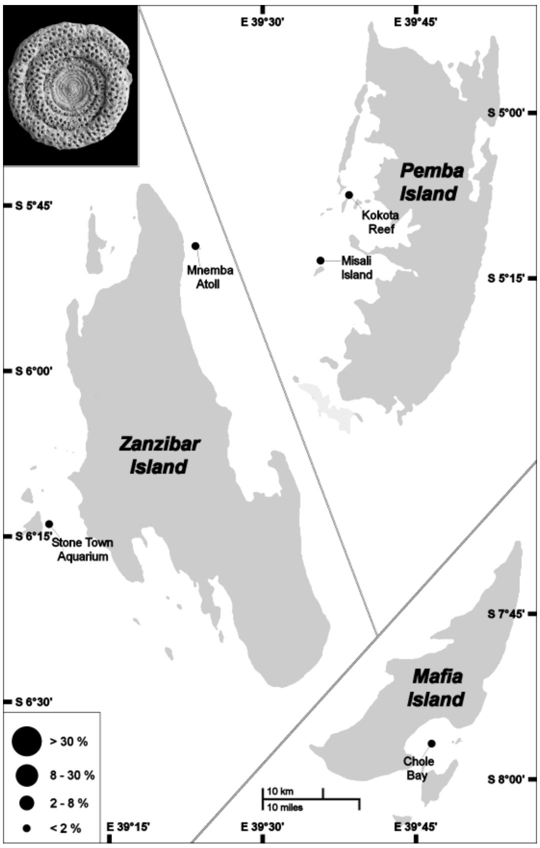

Fig. 114: Distribution of *Spirillina grosseperforata*.

Family Patellinidae Rhumbler, 1906

Genus *Patellina* Williamson, 1858

Patellina corrugata **Williamson**
Plate 11, Figs. 7-9

1858 *Patellina corrugata* – Williamson, p. 46, pl. 3, figs. 86-89
1884 *Patellina corrugata* Williamson – Brady, pl. 86, figs. 1-7
1915 *Patellina corrugata* Williamson – Heron-Allen & Earland, p. 686
1992 *Patellina corrugata* Williamson – Hatta & Ujiie, p. 164, pl. 20, figs. 5a-c
1993 *Patellina corrugata* Williamson – Hottinger et al., p. 76, pl. 87, figs. 7-11
1994 *Patellina corrugata* Williamson – Loeblich & Tappan, p. 36, pl. 55, figs. 1-9
2012 *Patellina corrugata* Williamson – Debenay, p. 206, 283, pl. 14

<u>Distribution</u>: Three stations

<u>Abundance</u>: Rare

<u>Depth</u>: 16-30 m

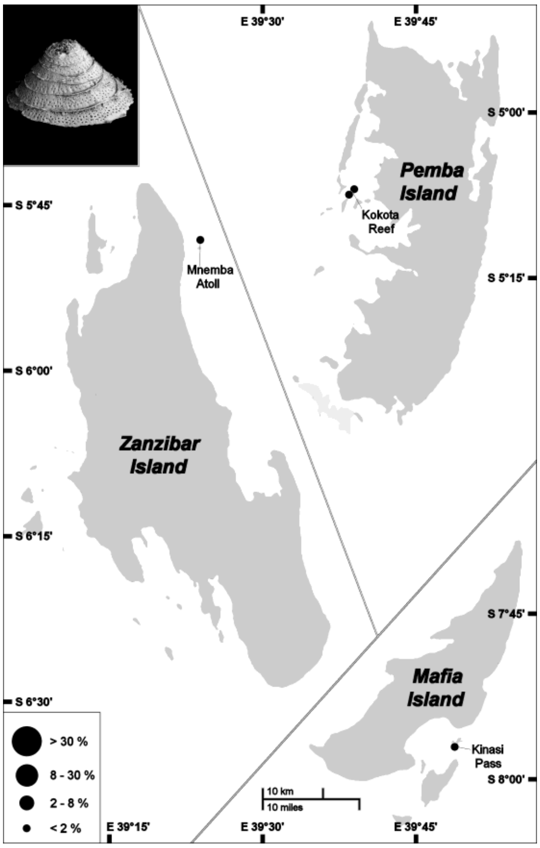

Fig. 115: Distribution of *Patellina corrugata*.

Suborder Lagenina Delage & Hérouard, 1896

Family Nodosariidae Ehrenberg, 1838

Genus *Pyramidulina* Fornasini, 1894

Pyramidulina catesbyi **(d'Orbigny)**
Plate 11, Figs. 10-11

1915 *Nodosaria proxima* Silvestri – Heron-Allen & Earland, p. 669
1949 *Nodosaria catesbyi* d'Orbigny – Said, p. 21, pl. 2, fig. 22
1977b *Lagenonodosaria catesbyi* d'Orbigny – Le Calvez, p. 47
1987 *Nodosaria catesbyi* d'Orbigny – Baccaert, p. 155, pl. 67, fig. 1
1993 *Pyramidulina catesbyi* (d'Orbigny) – Hottinger et al., p. 76, pl. 88, figs. 1-19
1994 *Pyramidulina catesbyi* (d'Orbigny) – Loeblich & Tappan, p. 66, pl. 116, figs. 10-12

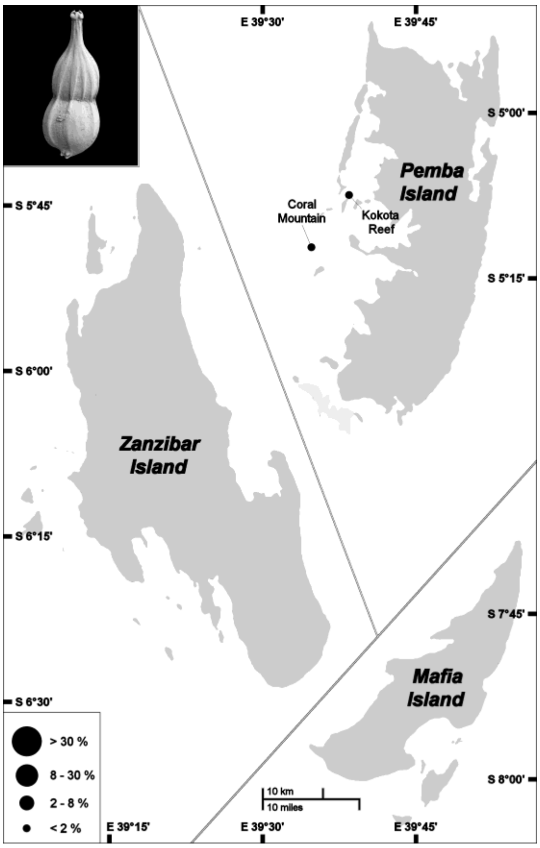

Fig. 116: Distribution of *Pyramidulina catesbyi*.

1998 *Pyramidulina catesbyi* (d'Orbigny) – Haunold & Piller, p. 21, pl. 7, fig. 2
2012 *Pyramidulina catesbyi* (d'Orbigny) – Debenay, p. 168, 285, pl. 11

Distribution: Coral Mountain and Kokota Reef

Abundance: Rare

Depth: 16-35 m

Family Vaginulinidae Reuss, 1860

Genus *Lenticulina* Lamarck, 1804

Lenticulina vortex **(Fichtel & Moll)**
Plate 11, Figs. 12-13

1798 *Nautilus vortex* – Fichtel & Moll, p. 33, pl. 2, figs. D-I
1884 *Cristellaria vortex* (Fichtel & Moll) – Brady, p. 548, pl. 69, figs. 14-16
1913 *Cristellaria vortex* (Fichtel & Moll) – Cushman, p. 68, pl. 32, fig. 3
1994 *Lenticulina vortex* (Fichtel & Moll) – Loeblich & Tappan, p. 68, pl. 121, figs. 9-14
2012 *Lenticulina vortex* (Fichtel & Moll) – Debenay, p. 225, 287, pl. 20

Distribution: Mapenduzi Wall and Kinasi Pass

Abundance: Rare

Depth: 18-40 m

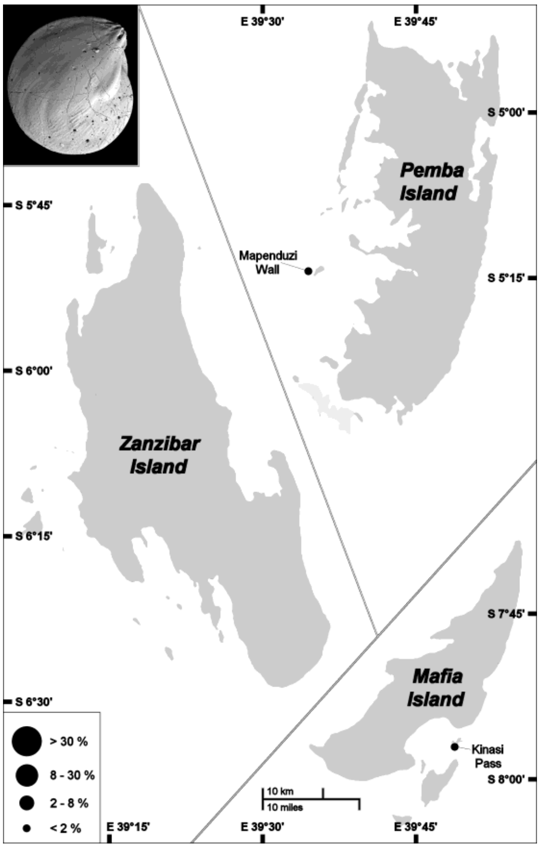

Fig. 117: Distribution of *Lenticulina vortex*.

Lenticulina **sp. A**
Plate 11, Figs. 14-15

1993 ? *Lenticulina* sp. D – Hottinger et al., p. 77, pl. 89, figs. 18-23

Distribution: Kokota Reef

Abundance: Rare

Depth: 16 m

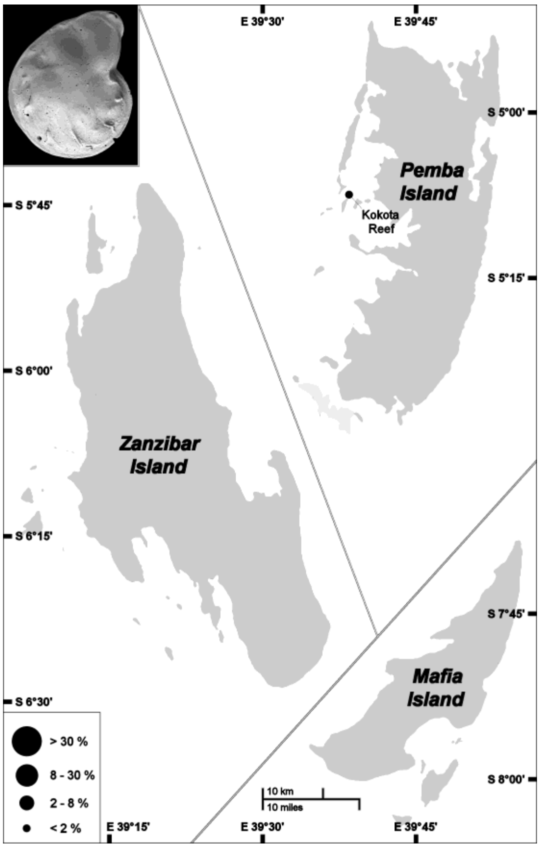

Fig. 118: Distribution of *Lenticulina* sp. A.

Suborder Robertinina Loeblich & Tappan, 1984

Family Robertinidae Reuss, 1950

Genus *Alliatinella* Carter, 1957

***Alliatinella panayensis* (McCulloch)**
Plate 11, Figs. 16-20

1977 *Fawcettia panayensis* – McCulloch, p. 377, pl. 161, fig. 3
1993 *Alliatinella panayensis* (McCulloch) – Hottinger et al., p. 84, pl. 98, figs. 3-13
1998 *Alliatinella panayensis* (McCulloch) – Haunold & Piller, p. 23, pl. 8, figs. 1-2

Distribution: Kinasi Pass and Stone Town Aquarium

Abundance: Rare

Depth: 18-21 m

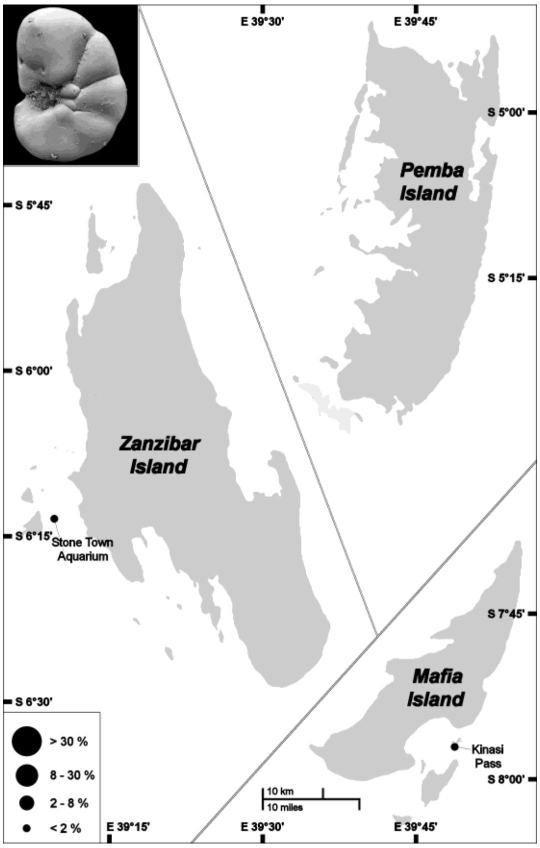

Fig. 119: Distribution of *Alliatinella panayensis*.

Suborder Globigerinina Delage & Hérouard, 1896

Family Globorotaliidae Cushman, 1927

Genus *Globorotalia* Cushman, 1927

***Globorotalia menardii* (Parker, Jones, & Brady)**
Plate 12, Figs. 1-3

1884 *Pulvinulina menardii* (Parker, Jones, & Brady) – Brady, p. 690, pl. 103, figs. 1-2
1915 *Pulvinulina menardii* (Parker, Jones & Brady) – Heron-Allen & Earland, p. 715
1961 *Globorotalia menardii* (d'Orbigny) – Braga, p. 175, pl. 19, figs. 1-2
1994 *Globorotalia menardii* (Parker, Jones, & Brady) – Loeblich & Tappan, p. 101, pl. 183, figs. 1-6

Distribution: Few reef stations

Abundance: Rare

Depth: 12-42 m

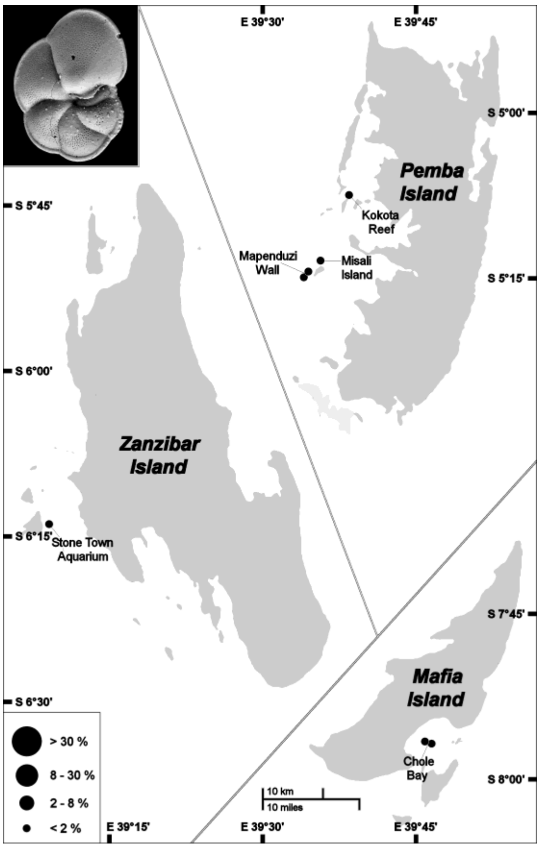

Fig. 120: Distribution of *Globorotalia menardii*.

Genus *Neogloboquadrina* Bandy, Frerichs, & Vincent, 1967

Neogloboquadrina humerosa **(Takayanagi & Saito)**
Plate 12, Figs. 4-6

1994 *Neogloboquadrina humerosa* (Takayanagi & Saito) – Loeblich & Tappan, p. 102, pl. 199, figs. 1-6

Distribution: Few reef stations on Mafia and Pemba

Abundance: Rare

Depth: 15-42 m

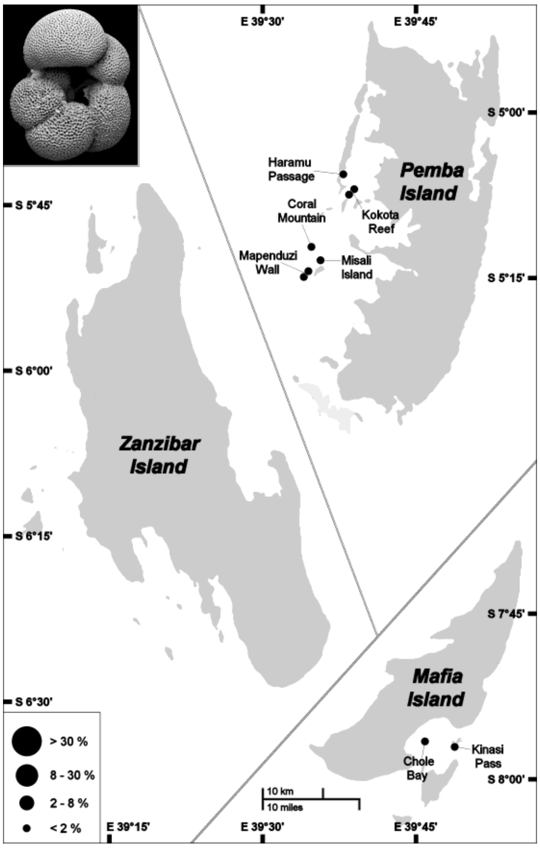

Fig. 121: Distribution of *Neogloboquadrina humerosa*.

Family Pulleniatinidae Cushman, 1927

Genus *Pulleniatina* Cushman, 1927

Pulleniatina obliquiloculata **(Parker & Jones)**
Plate 12, Figs. 7-8

1865 *Pullenia sphaeroides* (d'Orbigny) var. *obliquiloculata* Parker & Jones, p. 365, 368, pl. 19, fig. 4
1915 *Pullenia obliquiloculata* (Parker & Jones) – Heron-Allen & Earland, p. 681
1961 *Pulleniatina obliquiloculata* (Parker & Jones) – Braga, p. 173, pl. 18, fig. 16
1965 *Pulleniatina obliquiloculata* (Parker & Jones) – Todd, p. 67, pl. 27, figs. 2-4
1977 *Pulleniatina obliquiloculata* (Parker & Jones) – McCulloch, p. 435, pl. 174, fig. 4
1988 *Pulleniatina obliquiloculata* (Parker & Jones) – Loeblich & Tappan, p. 480, pl. 524, figs. 4-12
1994 *Pulleniatina obliquiloculata* (Parker & Jones) – Loeblich & Tappan, p. 103, pl. 187, figs. 8-13, pl. 188, figs. 1-6

Distribution: Few stations

Abundance: Rare

Depth: 12-42 m

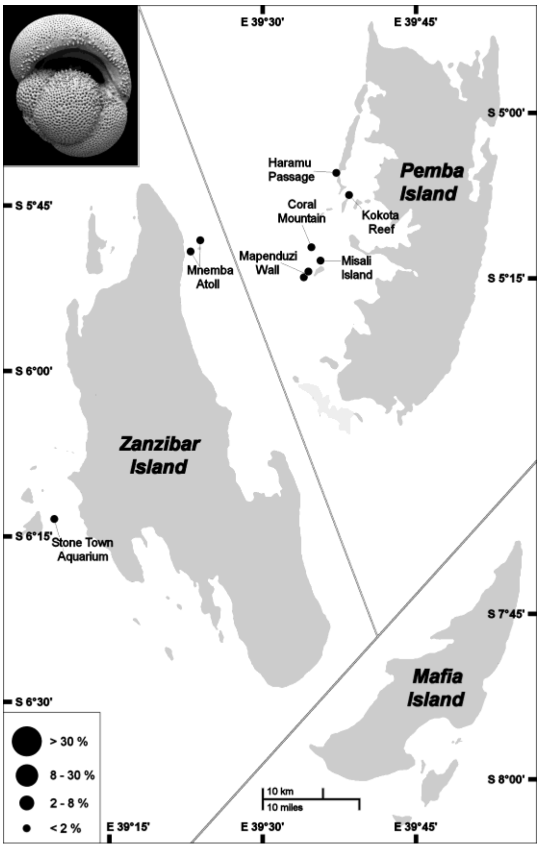

Fig. 122: Distribution of *Pulleniatina obliquiloculata*.

Family Globigerinidae Carpenter, Parker & Jones, 1862

Genus *Globigerina* d'Orbigny, 1826

Globigerina calida **Parker**
Plate 12, Figs. 9-10

1950 *Globigerina bulloides* d'Orbigny – Said, p. 8, pl. 1, fig. 27
1974 *Globigerina calida calida* Parker – Reiss et al., p. 73, pl. 1, figs. 5-8, pl. 2, figs. 1-4
1991 *Globigerina calida* Parker – Cimerman & Langer, p. 57, pl. 60, figs. 2-3
1993 *Globigerina calida* Parker – Hottinger et al., p. 86, pl. 101, figs. 9-12
1997 *Globigerina calida calida* Parker – Cherif et al., p. 270, pl. 6, figs. 10-11

<u>Distribution</u>: Several reef stations

<u>Abundance</u>: Rare to common

<u>Depth</u>: 12-42 m

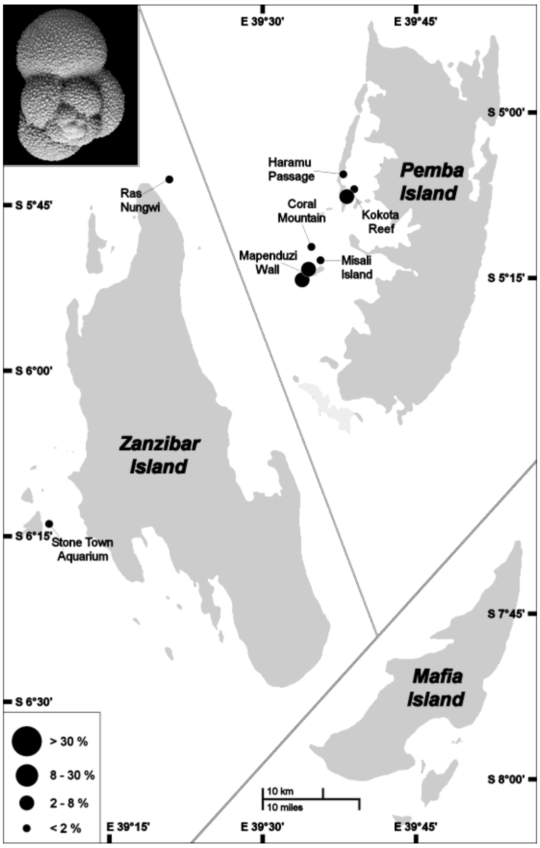

Fig. 123: Distribution of *Globigerina calida*.

Genus *Globigerinella* Cushman, 1927

Globigerinella siphonifera **(d'Orbigny)**
Plate 12, Figs. 11-13

1879 *Globigerina aequilateralis* – Brady, p. 285
1950 *Globigerinella aequilateralis* (Brady) – Said, p. 9, pl. 1, fig. 29
1974 *Globigerinella siphonifera* (d'Orbigny) – Reiss et al., p. 74-75, pl. 3, figs. 7-8, pl. 4, figs. 1-5
1977b *Hastigerina siphonifera* (d'Orbigny) – Le Calvez, p. 33
1993 *Globigerinella siphonifera* (d'Orbigny) – Hottinger et al., p. 86, pl. 102, figs. 1-10
1994 *Globigerinella siphonifera* (d'Orbigny) – Loeblich & Tappan, p. 106, pl. 200, figs. 7-10, pl. 201, figs. 1-3

<u>Distribution</u>: Only on Pemba

<u>Abundance</u>: Rare

<u>Depth</u>: 16-40 m

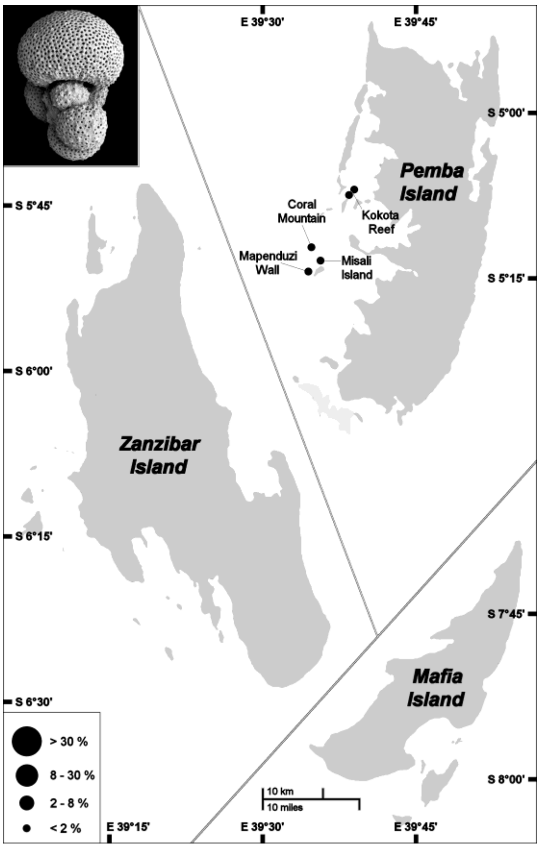

Fig. 124: Distribution of *Globigerinella siphonifera*.

Genus *Globigerinoides* Cushman, 1927

***Globigerinoides conglobatus* (Brady)**
Plate 12, Figs. 14-16

1879 *Globigerina conglobata* Brady, p. 286
1884 *Globigerina conglobata* Brady, p. 603, pl. 80, figs. 1-5, pl. 82, fig. 5
1915 *Globigerina conglobata* Brady – Heron-Allen & Earland, p. 680
1994 *Alloglobigerinoides conglobatus* (Brady) - Loeblich & Tappan, p. 105, pl. 193, figs. 5-10, pl. 194, figs. 1-3

Distribution: Few reef stations

Abundance: Rare

Depth: 16-42 m

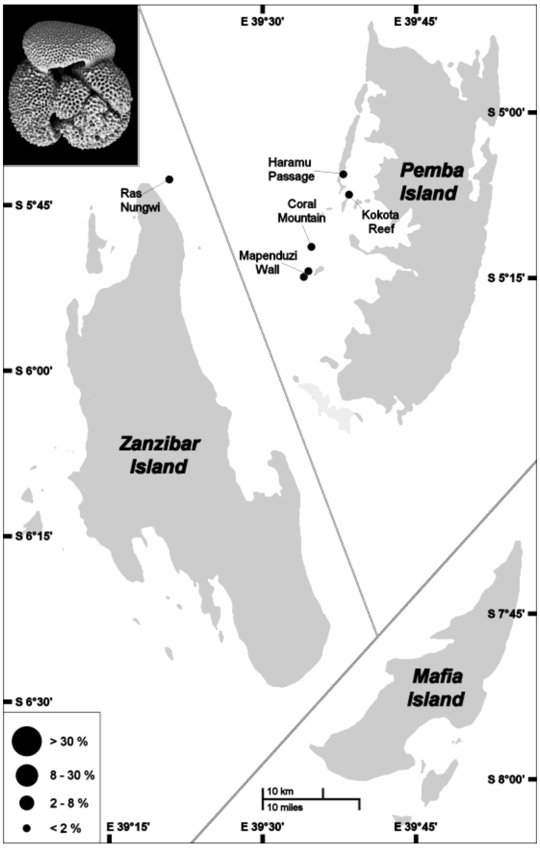

Fig. 125: Distribution of *Globigerinoides conglobatus*.

***Globigerinoides ruber* (d'Orbigny)**
Plate 12, Figs. 17-18

1915 *Globigerina rubra* d'Orbigny – Heron-Allen & Earland, p. 679
1974 *Globigerinoides ruber* (d'Orbigny) – Reiss et al., p. 76, pl. 6, figs. 1-9, pl. 7, figs. 1-3
1977b *Globigerinoides ruber* (d'Orbigny) – Le Calvez, p. 30
1982 *Globigerinoides ruber* (d'Orbigny) – Neagu, p. 128, pl. 13, figs. 4-5
1984 *Globigerinoides ruber* (d'Orbigny) – Reiss & Hottinger, pl. E.1., figs. 2-3
1993 *Globigerinoides ruber* (d'Orbigny) – Hottinger et al., p. 87, pl. 103, figs. 3-8, pl. 104, figs. 1-4
1994 *Globigerinoides ruber* (d'Orbigny) – Loeblich & Tappan, p. 107, pl. 203, figs. 1-9, pl. 206, figs. 10-12

Distribution: Most stations on Pemba

Abundance: Rare

Depth: 16-42 m

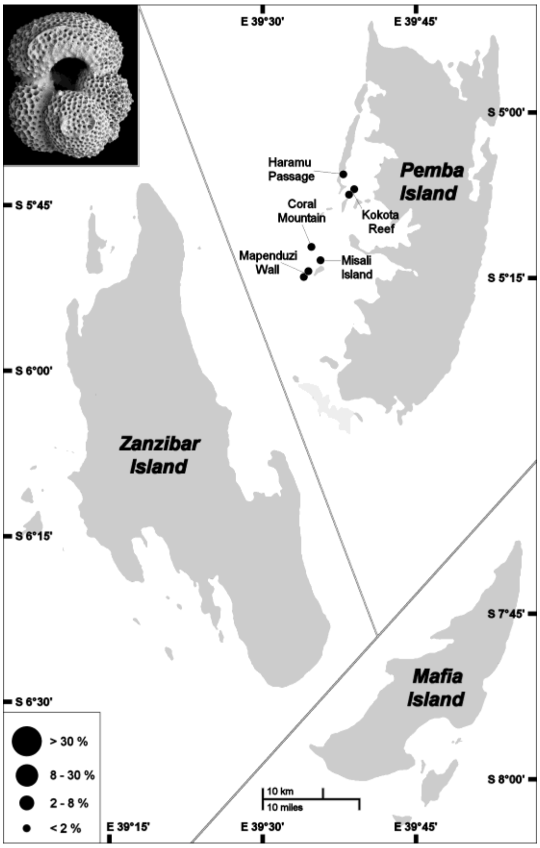

Fig. 126: Distribution of *Globigerinoides ruber*.

***Globigerinoides sacculifer* (Brady)**
Plate 12, Figs. 19-21

1884 *Globigerina sacculifera* – Brady, p. 604, pl. 80, figs. 11-17
1950 *Globigerinoides sacculifera* (Brady) – Said, p. 9, pl. 1, fig. 28
1974 *Globigerinoides quadrilobatus sacculifer* (Brady) – Reiss et al., p. 76, pl. 7, figs. 7-8, pl. 8, figs. 1-4
1984 *Globigerinoides sacculifer* (Brady) – Reiss & Hottinger, pl. E1, figs. 4-5
1993 *Globigerinoides sacculifer* (Brady) – Hottinger et al., p. 88, pl. 104, figs. 5-10, pl. 105, figs. 1-7
1994 *Globigerinoides sacculiferus* (Brady) – Loeblich & Tappan, p. 107, pl. 205, figs. 1-9

Distribution: Most of the reef stations

Abundance: Rare to common

Depth: 12-42 m

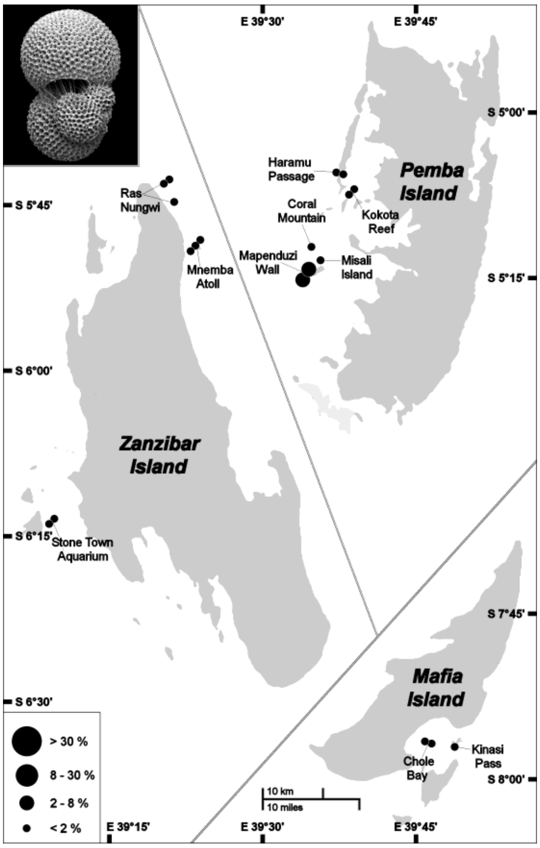

Fig. 127: Distribution of *Globigerinoides sacculifer*.

Genus *Globoturborotalita* Hofker, 1976

***Globoturborotalita rubescens* (Hofker)**
Plate 12, Figs. 22-24

1974 *Globigerina rubescens* Hofker – Reiss et al., p. 74-75, pl. 2, figs. 5-7
1993 *Globoturborotalita rubescens* (Hofker) – Hottinger et al., p. 88, pl. 105, figs. 8-13
1994 *Globoturborotalita rubescens* (Hofker) – Loeblich & Tappan, p. 108, pl. 208, figs. 1-12

Distribution: Several reef stations

Abundance: Rare

Depth: 12-35 m

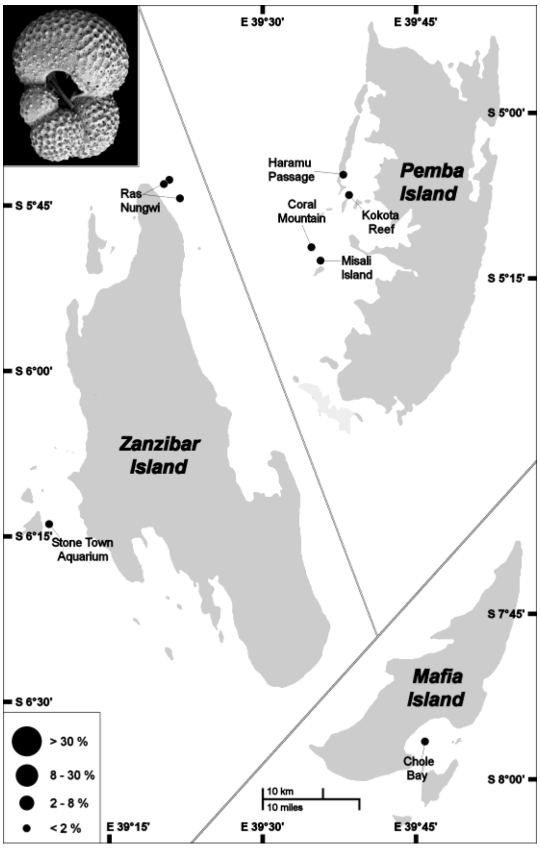

Fig. 128: Distribution of *Globoturborotalita rubescens*.

Genus *Orbulina* d'Orbigny, 1839

Orbulina universa **d'Orbigny**
Plate 12, Fig. 25

1914 *Orbulina universa* d'Orbigny – Cushman, p. 14, pl. 7, figs. 1-2
1915 *Orbulina universa* d'Orbigny – Heron-Allen & Earland, p. 681
1961 *Orbulina universa* d'Orbigny – Braga, p. 173, pl. 18, fig. 15
1974 *Orbulina universa* d'Orbigny – Reiss et al., p. 78, pl. 8, figs. 5-6
1977b *Orbulina universa* d'Orbigny – Le Calvez, p. 56
1991 *Orbulina universa* d'Orbigny – Cimerman & Langer, p. 58, pl. 60, fig. 8
1993 *Orbulina universa* d'Orbigny – Hottinger et al., p. 89, pl. 106, figs. 8-10
1994 *Orbulina universa* d'Orbigny – Loeblich & Tappan, p. 109, pl. 211, figs. 4-7
1997 *Orbulina universa* d'Orbigny – Cherif et al., p. 270, pl. 6, fig. 17

Distribution: Three reef stations

Abundance: Rare

Depth: 12-40 m

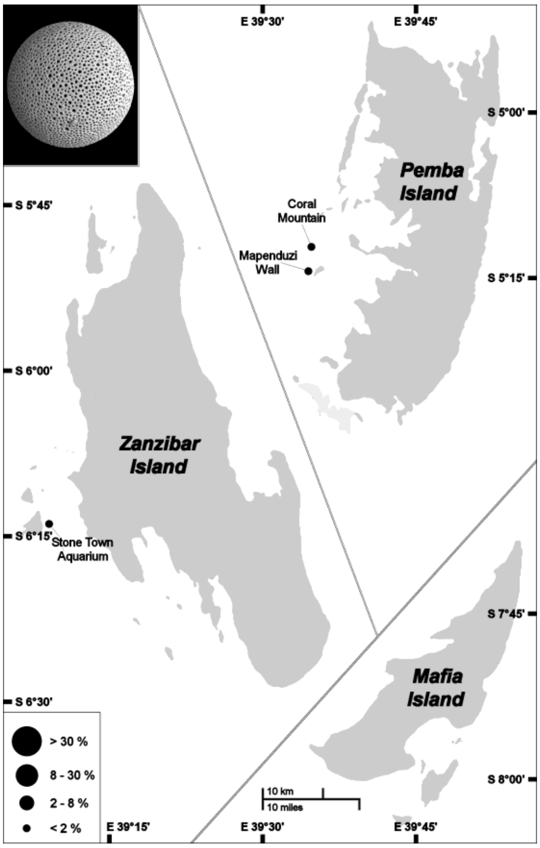

Fig. 129: Distribution of *Orbulina universa*.

Suborder Rotaliina Delage & Hérouard, 1896

Family Bolivinidae Glaessner, 1937

Genus *Brizalina* Costa, 1856

Brizalina ordinaria **(Phleger & Parker)**
Plate 13, Figs. 1-5

1975 *Brizalina* (*Brizalina*) sp. B. – Zweig-Strykowski & Reiss, p. 100, pl. 5, figs. 7-8
1993 *Brizalina ordinaria* (Phleger & Parker) – Hottinger et al., p. 92, pl. 111, figs. 4-7
1998 *Brizalina ordinaria* (Phleger & Parker) – Haunold & Piller, p. 24, pl. 8, fig. 11

Distribution: Few reef samples

Abundance: Rare to common

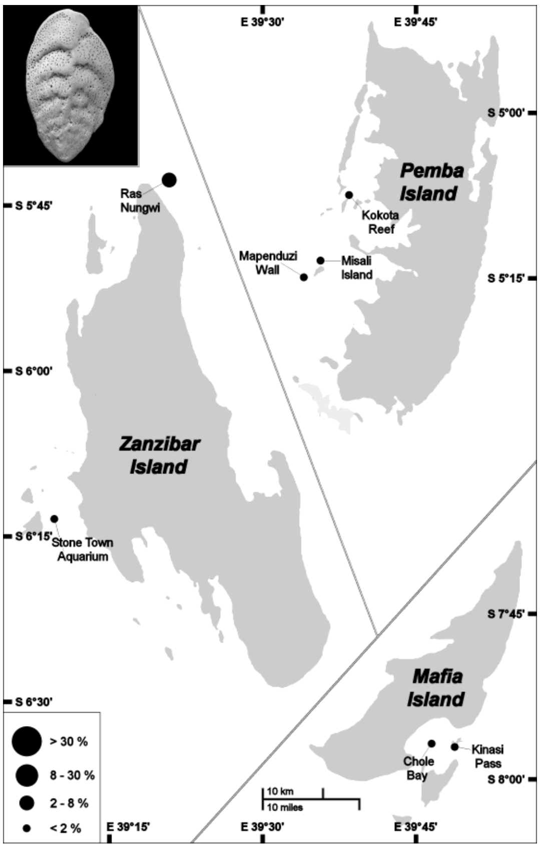

Fig. 130: Distribution of *Brizalina ordinaria*.

Depth: 16-42 m

Brizalina simpsoni **(Heron-Allen & Earland)**

Plate 13, Figs. 6-8

1915 *Bolivina simpsoni* – Heron-Allen & Earland, p. 648, pl. 17, pl. 49, figs. 18-35
1965 *Bolivina simpsoni* Heron-Allen & Earland – Moura, p. 43, pl. 5, fig. 9
1975 *Brizalina (Brizalina) simpsoni* (Heron-Allen & Earland) – Zweig-Strykowski & Reiss, p. 99, pl. 2, figs. 1-7
1984 *Brizalina (Brizalina) simpsoni* (Heron-Allen & Earland) – Reiss & Hottinger, fig. G 27m
1993 *Brizalina simpsoni* (Heron-Allen & Earland) – Hottinger et al., p. 92, pl. 111, figs. 8-13, pl. 112, figs. 1-2
1998 *Brizalina simpsoni* (Heron-Allen & Earland) – Haunold & Piller, p. 24, pl. 8, fig. 12
2013a *Brizalina simpsoni* (Heron-Allen & Earland) – Langer et al., figs. 7.25-26

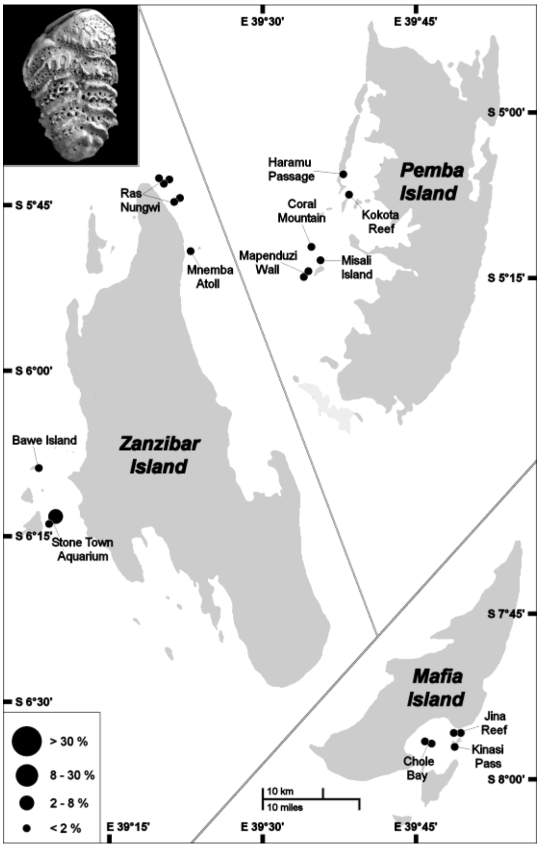

Fig. 131: Distribution of *Brizalina simpsoni*.

Distribution: Most of the stations

Abundance: Rare to common

Depth: 9-42 m

Brizalina striatula **(Cushman)**

Plate 13, Figs. 9-10

1922 *Bolivina striatula* – Cushman, p. 27, pl. 3, fig. 10
1982 *Bolivina striatula* Cushman – Neagu, p. 115, pl. 7, figs. 11-13
1987 *Brizalina* (?) *striatula* (Cushman) – Baccaert, p. 183, pl. 74, figs. 3-5
1991 *Brizalina striatula* (Cushman) – Cimerman & 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 & Piller, p. 24, pl. 8, fig. 13

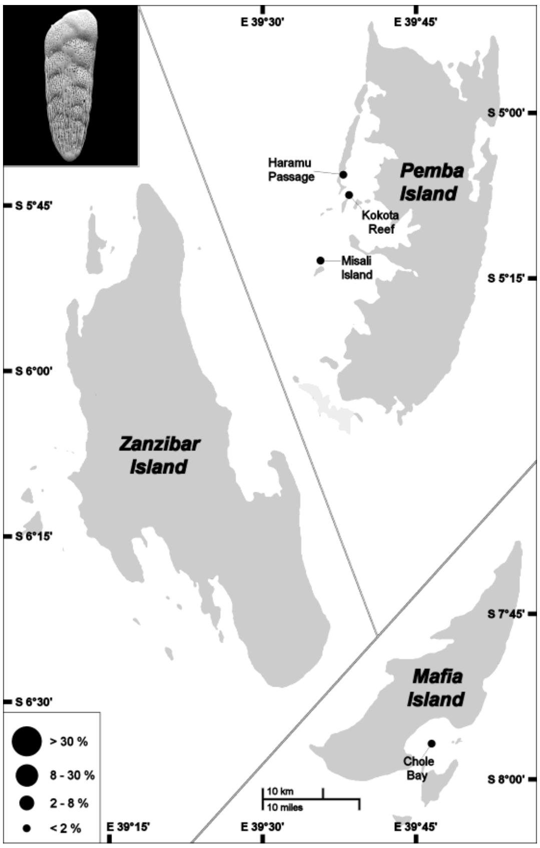

Fig. 132: Distribution of *Brizalina striatula*.

Distribution: Four reef samples

Abundance: Rare

Depth: 16-20 m

Family Turrilinidae Cushman, 1927

Genus *Floresina* Revets, 1990

***Floresina* cf. *F. durrandi* Revets**
Plate 13, Figs. 11-13

1990 *Floresina durrandi* – Revets, p. 157, pl. 1, figs. 1-6
1994 *Floresina durrandi* Revets – Loeblich & Tappan, p. 126, pl. 245, figs. 1-6
1998 *Floresina durrandi* Revets – Haunold & Piller, p. 25, pl. 9, fig. 7

Distribution: Kokota Reef

Abundance: Rare

Depth: 16 m

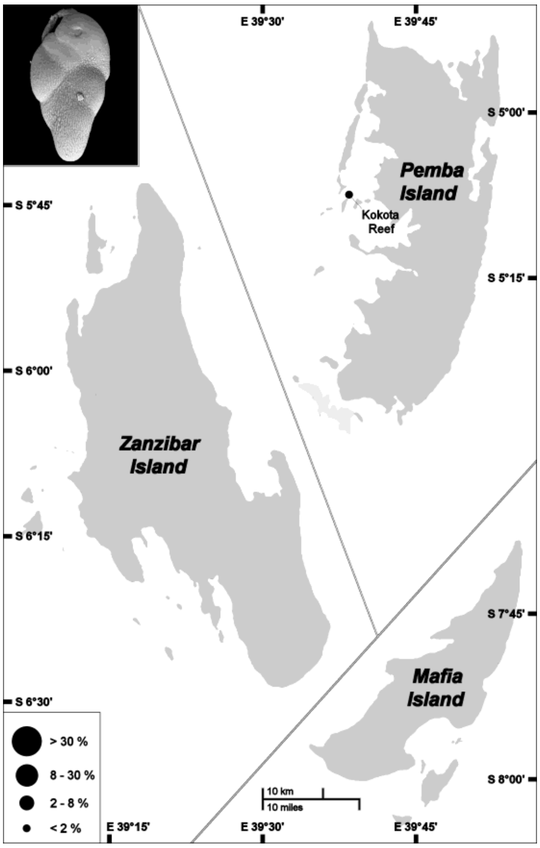

Fig. 133: Distribution of *Floresina* cf. *F. durrandi*.

***Floresina* cf. *F. madagascariensis* (d'Orbigny)**
Plate 13, Figs. 15-16

1942 *Buliminella madagascariensis* (d'Orbigny) var. *spicata* Cushman & Parker – Cushman, p. 8, pl. 3, figs. 5-6
1987 *Buliminoides madagascariensis* d'Orbigny – Baccaert, p. 176, pl. 72, figs. 2-3
1993 *Floresina madagascariensis* (d'Orbigny) *spicata* (Cushman & Parker) – Hottinger et al., p. 95, pl. 117, figs. 1-7
1994 *Floresina spicata* (Cushman & Parker) – Loeblich & Tappan, p. 126, pl. 245, figs. 13-19
1998 *Floresina spicata* (Cushman & Parker) – Haunold & Piller, p. 25, pl. 9, fig. 8

Distribution: Misali Island and Ras Nungwi

Abundance: Rare

Depth: 12-20 m

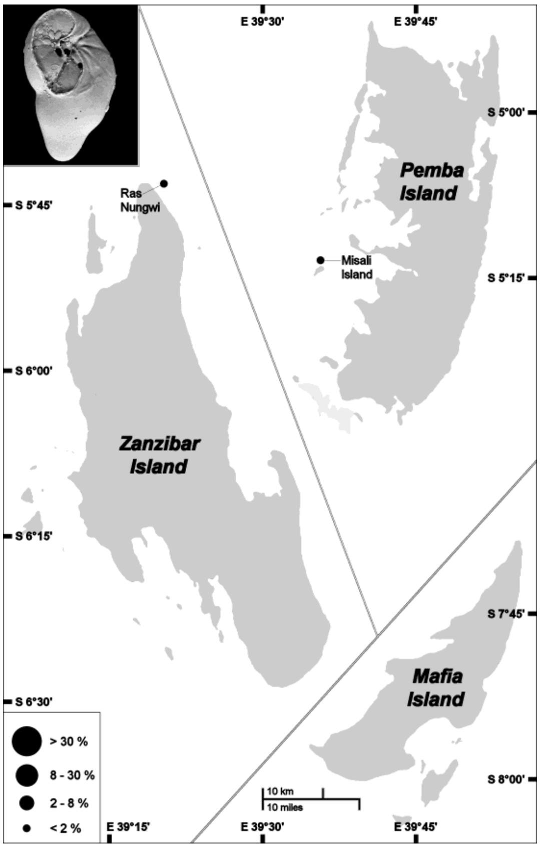

Fig. 134: Distribution of *Floresina* cf. *F. madagascariensis*.

Family Stainforthiidae Reiss, 1963

Genus *Cassidelina* Saidova, 1975

***Cassidelina* ? cf. *C.* ? *makiyamai* (Ishizaki)**
Plate 13, Figs. 17-18

1975 *Brizalina* (*Brizalina*) cf. *B.* (*B.*) *italica* (Cushman) – Zweig-Strykowski & Reiss, p. 99, pl. 4, figs. 6, 9
1987 *Brizalina pacifica* Cushman & McCulloch – Baccaert, p. 182, pl. 74, figs. 1-2
1993 *Cassidelina* ? cf. *C.*? *makiyamai* (Ishizaki) – Hottinger et al., p. 96, pl. 118, figs. 1-9

Distribution: Few samples

Abundance: Rare

Depth: 1-20 m

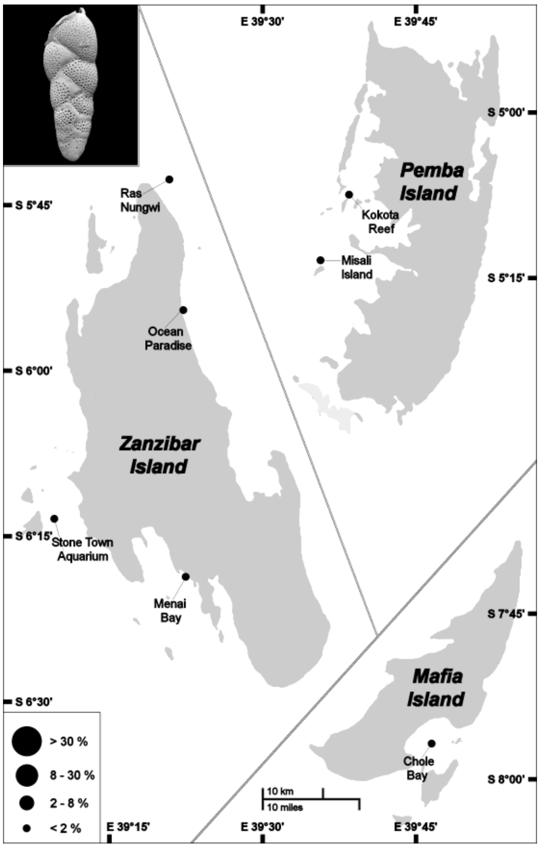

Fig. 135: Distribution of *Cassidelina* ? cf. *C.* ? *makiyamai*.

Family Siphogenerinoididae Saidova, 1981

Genus *Loxostomina* Sellier de Civrieux, 1964

***Loxostomina limbata* (Brady) *costulata* (Cushman)**
Plate 13, Figs. 19-21

1915 *Bolivina limbata* Brady – Heron-Allen & Earland, p. 646
1922 *Bolivina limbata* Brady var. *costulata* – Cushman, p. 26, pl. 3, fig. 8
1975 *Brizalina* (*Parabrizalina*) sp. A – Zweig-Strykowski & Reiss, p. 109, pl. 6, figs. 7-11
1984 *Brizalina* (*Parabrizalina*) sp. A – Reiss & Hottinger, fig. G 27 k, l
1992 *Loxostomina limbatum costulatum* (Cushman) – Hatta & Ujiie, p. 174, pl. 26, figs. 8-9
1993 *Loxostomina* ? *limbata* (Brady) *costulata* (Cushman) – Hottinger et al., p. 97, pl. 120, figs. 8-13
1994 *Loxostomina costulata* (Cushman) – Loeblich & Tappan, p. 119, pl. 232, figs. 12-16
2012 *Loxostomina limbata* (Brady) – Debenay, p. 175, 302, pl. 12

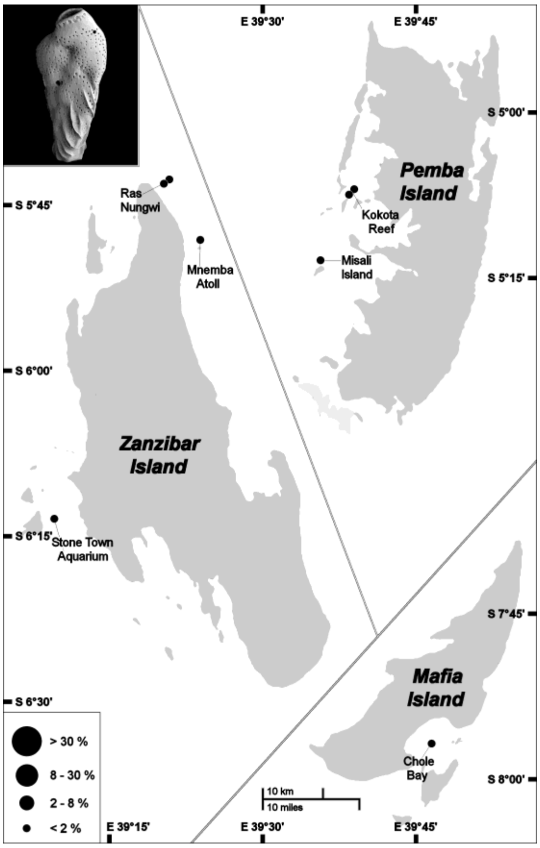

Fig. 136: Distribution of *Loxostomina limbata costulata*.

Distribution: Few samples

Abundance: Rare

Depth: 12-30 m

***Loxostomina* ? cf. *L.*? *sinuosa* (Cushman)**
Plate 13, Figs. 22-23

1936 *Loxostoma sinuosum* – Cushman, pl. 8, fig. 16
1993 *Loxostomina* ? cf. *L.*? *sinuosa* (Cushman) – Hottinger et al., p. 98, pl. 121, figs. 7-11

Distribution: Five stations

Abundance: Rare

Depth: 3-42 m

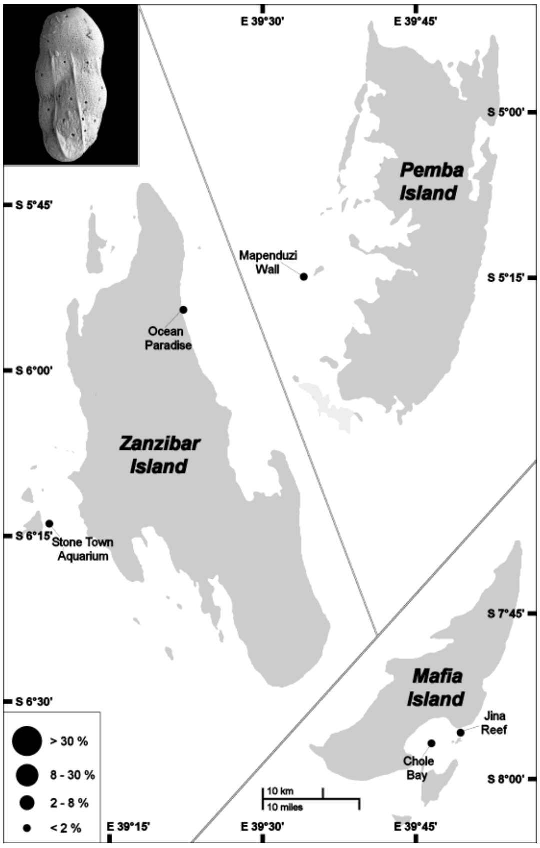

Fig. 137: Distribution of *Loxostomina* ? cf. *L.* ? *sinuosa*.

***Siphogenerina* cf. *S. raphana* (Parker & Jones)**
Plate 13, Figs. 24-26

1884 *Sagrina raphanus* (Parker & Jones) – Brady, p. 585, pl. 75, figs. 21-24
1915 *Sagrina raphanus* (Parker & Jones) – Heron-Allen & Earland, p. 677
1992 *Rectobolivina raphana* (Parker & Jones) – Hatta & Ujiie, p. 174, pl. 26, figs. 11-12
1994 *Siphogenerina raphana* (Parker & Jones) – Loeblich & Tappan, p. 123, pl. 240, figs. 1-11
2012 *Siphogenerina raphana* (Parker & Jones) – Debenay, p. 169, 302, pl. 11
2013a *Rectobolivina raphana* (Parker & Jones) – Langer et al., figs. 7.27-28

Distribution: Few stations

Abundance: Rare

Depth: 15-42 m

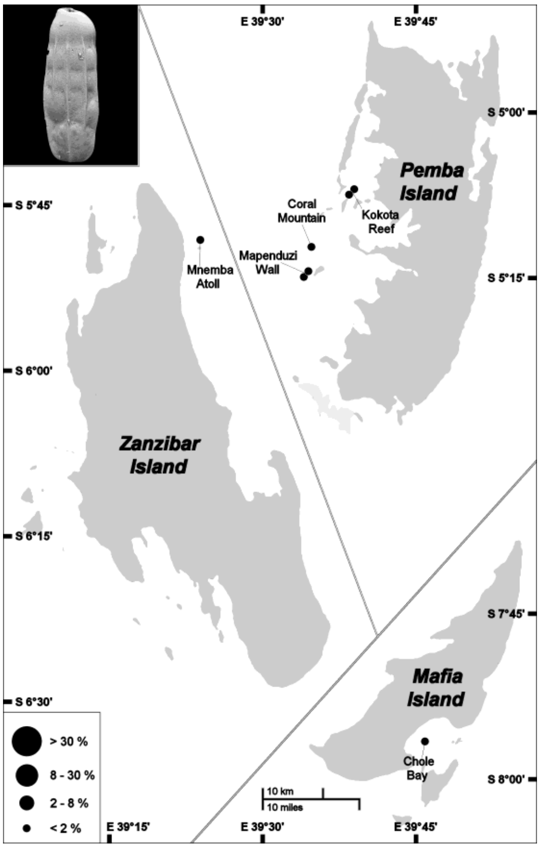

Fig. 138: Distribution of *Siphogenerina* cf. *raphana*.

Family Bagginidae Cushman, 1927

Genus *Baggina* Cushman, 1926

***Baggina* ? sp. A**
Plate 14, Figs. 1-3

Distribution: Kokota Reef

Abundance: Rare

Depth: 16 m

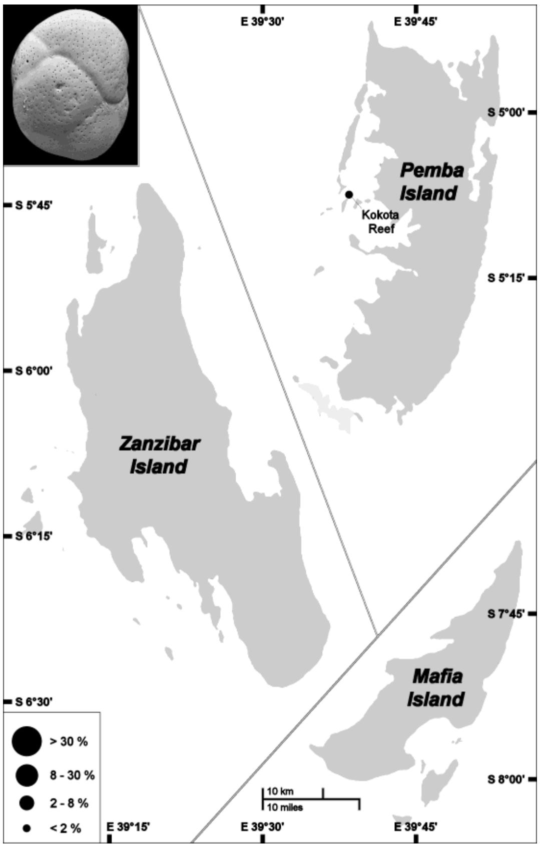

Fig. 139: Distribution of *Baggina* ? sp. A.

Genus *Cancris* Montfort, 1808

***Cancris bubnanensis* (McCulloch)**
Plate 14, Figs. 4-6

1977 *Baggina bubnanensis* – McCulloch, p. 342, pl. 137, fig. 5
1994 *Baggina bubnanensis* McCulloch – Loeblich & Tappan, p. 134, pl. 264, figs. 5-10
2009 *Cancris bubnanensis* (McCulloch) – Parker, p. 525, pl. 372, figs. a-d
2012 *Baggina bubnanensis* McCulloch – Debenay, p. 187, 306, pl. 16

Distribution: Three stations

Abundance: Rare

Depth: 15-42 m

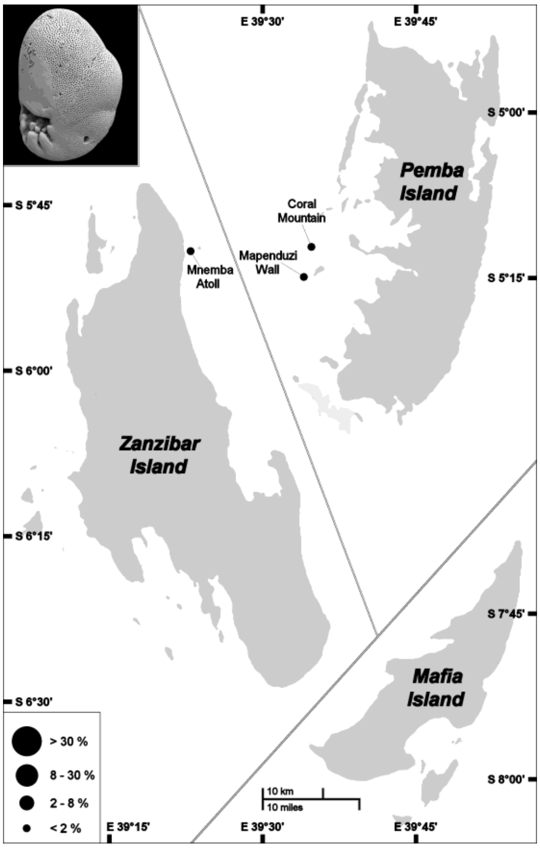

Fig. 140: Distribution of *Cancris bubnanensis*.

***Cancris* cf. *C. carinatus* (Millett)**
Plate 14, Figs. 7-9

1904 *Pulvinulina oblonga* Williamson var. *carinata* – Millett, p. 498, pl. 10, fig. 3
1915 *Pulvinulina oblonga* Williamson – Heron-Allen & Earland, p. 714
1977 *Cancris carinatus* (Millett) – McCulloch, p. 343, pl. 136, figs. 3, 5, 7
1994 *Cancris carinatus* (Millett) – Loeblich & Tappan, p. 134, pl. 266, figs. 1-13

Distribution: Only present on Pemba

Abundance: Rare

Depth: 16-42 m

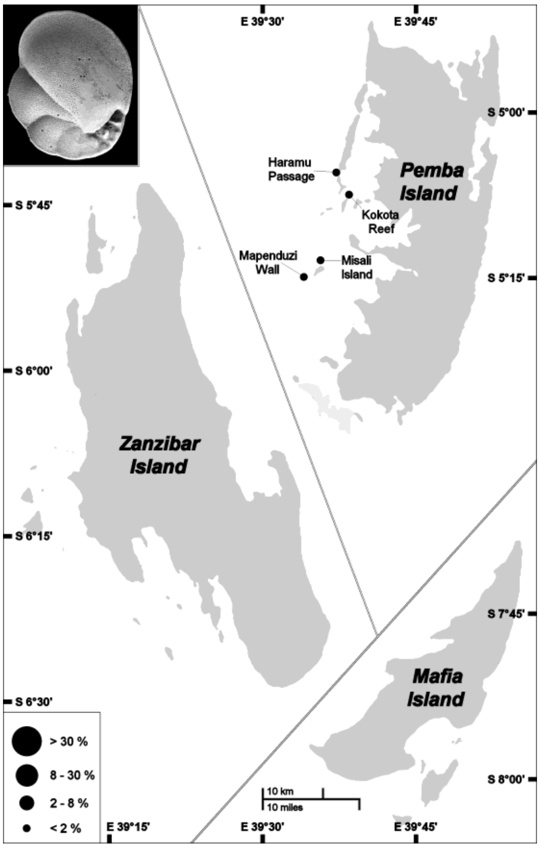

Fig. 141: Distribution of *Cancris carinatus*.

Family Reussellidae Cushman, 1933

Genus *Reussella* Galloway, 1933

***Reussella* cf. *R. insueta* Cushman**
Plate 14, Figs. 10-13

1915 *Verneuilina spinulosa* Reuss – Heron-Allen & Earland, p. 630
1993 *Reussella* cf. *R. insueta* Cushman – Hottinger et al., p. 103, pl. 131, figs. 1-5
1998 *Reussella* cf. *R. insueta* Cushman – Haunold & Piller, p. 26, pl. 9, fig. 15
2013a *Reussella* cf. *R. insueta* Cushman – Langer et al., figs. 7.33-34

Distribution: Few samples

Abundance: Rare

Depth: 12-42 m

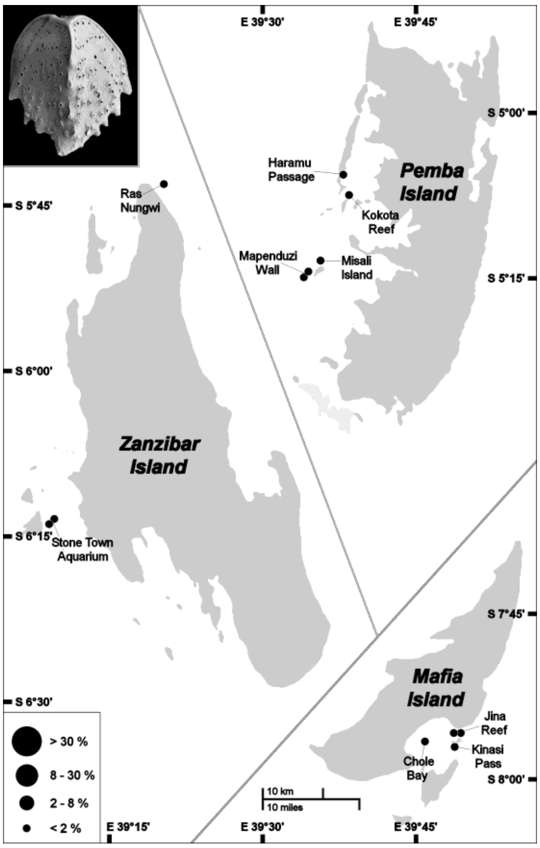

Fig. 142: Distribution of *Reussella* cf. *R. insueta*.

Genus *Valvobifarina* Hofker, 1951

***Valvobifarina mackinnonii* (Millett)**
Plate 14, Figs. 14-16

1900 *Bifarina mackinnonii* – Millett, p. 281, pl. 2, fig. 15
1915 *Bifarina mackinnonii* Millett – Heron-Allen & Earland, p. 643, pl. 48, figs. 36-37
1992 *Valvobifarina mackinnoni* (Millett) – Hatta & Ujiie, p. 177, pl. 28, figs. 2a-b
1993 *Valvobifarina mackinnonii* (Millett) – Hottinger et al., p. 104, pl. 133, figs. 4-8
1994 *Valvobifarina mackinnoni* (Millett) – Loeblich & Tappan, p. 130, pl. 254, figs. 9-12

Distribution: Misali Island

Abundance: Rare

Depth: 20 m

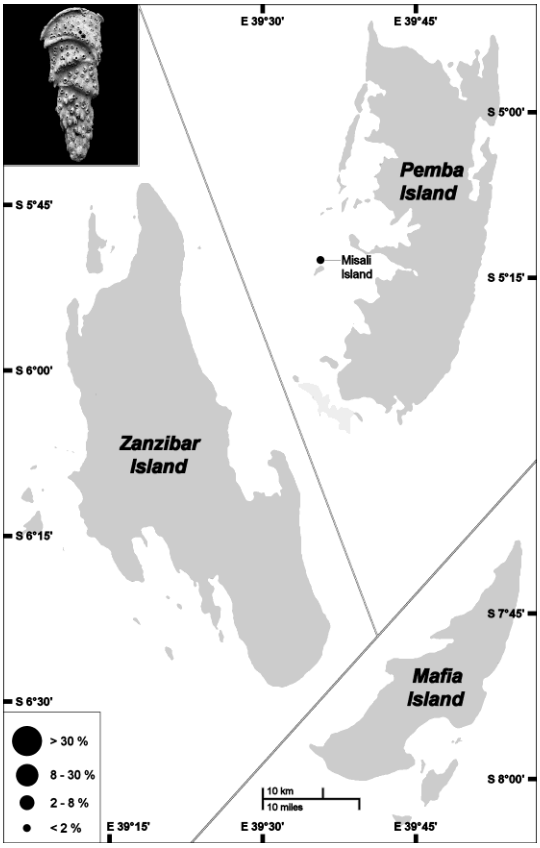

Fig. 143: Distribution of *Valvobifarina mackinnonii*.

Family Pavoninidae Eimer & Fickert, 1899

Genus *Pavonina* d'Orbigny, 1826

***Pavonina flabelliformis* d'Orbigny**
Plate 14, Figs. 17-18

1826 *Pavonina flabelliformis* – d'Orbigny, p. 260, pl. 10, figs. 10-11
1884 *Pavonina flabelliformis* d'Orbigny – Brady, p. 374, pl. 45, figs. 17-22
1915 *Pavonina flabelliformis* d'Orbigny – Heron-Allen & Earland, p. 632, pl. 48, figs. 1-6
1982 *Pavonina flabelliformis* d'Orbigny – Levy et al., p. 136, pl. 3, fig. 5
1982 *Pavonina flabelliformis* d'Orbigny – Neagu, p. 119, pl. 8, fig. 8
1988 *Pavonina flabelliformis* d'Orbigny – Loeblich & Tappan, p. 529, pl. 577, figs. 1-4
1994 *Pavonina flabelliformis* d'Orbigny – Loeblich & Tappan, p. 130, pl. 255, figs. 3-6

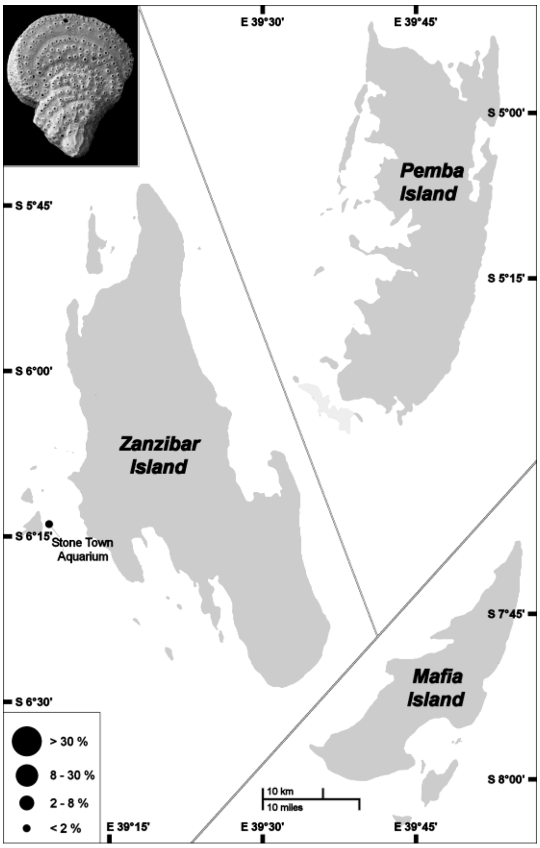

Fig. 144: Distribution of *Pavonina flabelliformis*.

2012 *Pavonina flabelliformis* d'Orbigny – Debenay, p. 168, 305, pl. 11
2013a *Pavonina flabelliformis* d'Orbigny – Langer et al., figs. 7.35-36

Distribution: Stone Town Aquarium

Abundance: Rare

Depth: 12 m

Family Eponididae Hofker, 1951

Genus *Eponides* De Montfort, 1808

***Eponides repandus* (Fichtel & Moll)**
Plate 14, Figs. 19-23

1798 *Nautilus repandus* – Fichtel & Moll, p. 35, pl. 3, figs. a-d
1915 *Pulvinulina repanda* (Fichtel & Moll) – Heron-Allen & Earland, p. 713
1965 *Eponides repandus* (Fichtel & Moll) – Moura, p. 50, pl. 6, fig. 8
1982 *Eponides repandus* (Fichtel & Moll) – Neagu, p. 128, pl. 9, figs. 4-6
1984 *Eponides repandus* (Fichtel & Moll) – Rögl & Hansen, p. 31, pl. 2, figs. 5-7, pl. 3, figs. 2-3, textfig. 9
1992 *Eponides repandus* (Fichtel & Moll) – Hatta & Ujiie, p. 179, pl. 30, figs. 1a-c, 2
1993 *Eponides repandus* (Fichtel & Moll) – Hottinger et al., p. 106, pl. 137, figs. 1-10
1994 *Eponides repandus* (Fichtel & Moll) – Loeblich & Tappan, p. 136, pl. 268, figs. 10-13
2012 *Eponides repandus* (Fichtel & Moll) – Debenay, p. 196, 307, pl. 15

Distribution: Most of the stations

Abundance: Rare to common, more abundant in western reefs

Depth:1-42 m

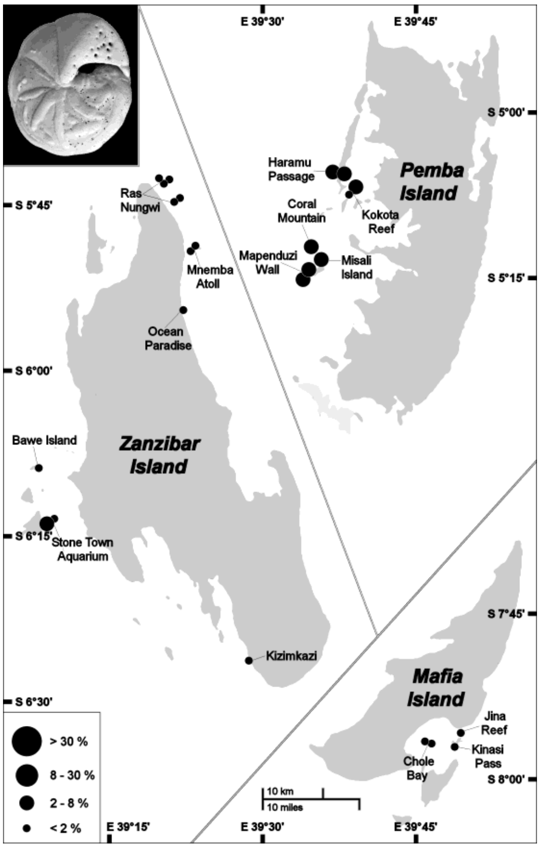

Fig. 145: Distribution of *Eponides repandus*.

Family Pegidiidae Heron-Allen & Earland, 1928

Genus *Pegidia* Heron-Allen & Earland, 1928

***Pegidia lacunata* McCulloch**
Plate 14, Figs. 24-26

1977 *Pegidia lacunata* – McCulloch, p. 347, pl. 154, fig. 2
1993 *Pegidia lacunata* McCulloch – Hottinger et al., p. 108, pl. 139, figs. 7-9, pl. 140, figs. 1-5
1994 *Pegidia lacunata* McCulloch – Loeblich & Tappan, p. 137, figs. 10-12
2012 *Pegidia lacunata* McCulloch – Debenay, p. 245, 308, pl. 21

Distribution: Mnemba Atoll and Ras Nungwi

Abundance: Rare

Depth: 12-20 m

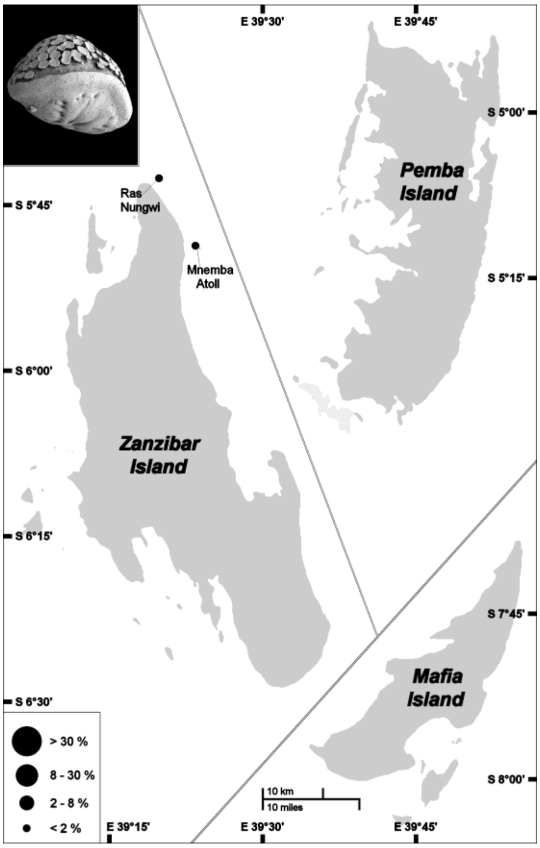

Fig. 146: Distribution of *Pegidia lacunata*.

Family Discorbidae Ehrenberg, 1838

***Orbitina* cf. *O. exquisita* (McCulloch)**
Plate 15, Figs. 1-3

1977 *Pararosalina dimorphiformis exquisita* – McCulloch, p. 336, pl. 121, fig. 7
1994 *Orbitina exquisita* (McCulloch) – Loeblich & Tappan, p. 137, pl. 276, figs. 1-13
2012 *Neoconorbina* sp. 1 – Debenay, p. 203, 310, pl. 15

Distribution: Several stations

Abundance: Rare

Depth: 12-42 m

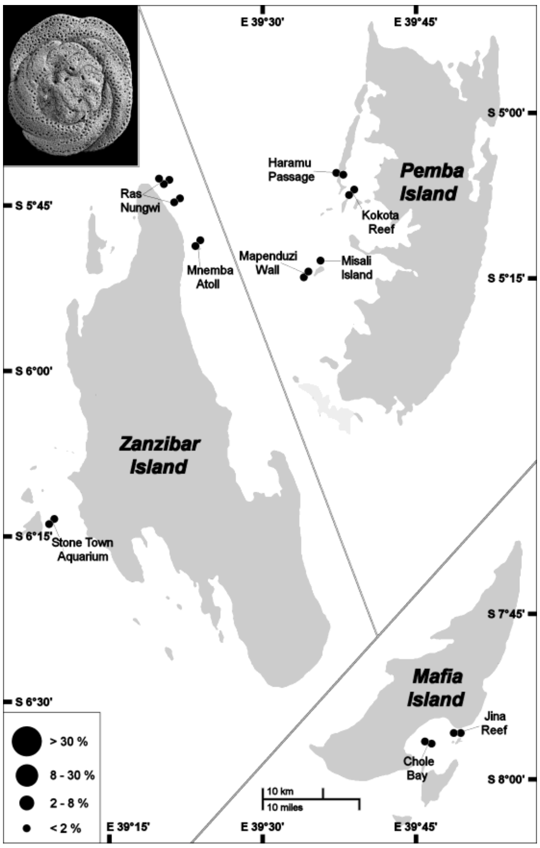

Fig. 147: Distribution of *Orbitina* cf. *O. exquisita.*

Orbitina sp. A
Plate 15, Figs. 4-5

Distribution: Misali Island

Abundance: Rare

Depth: 20 m

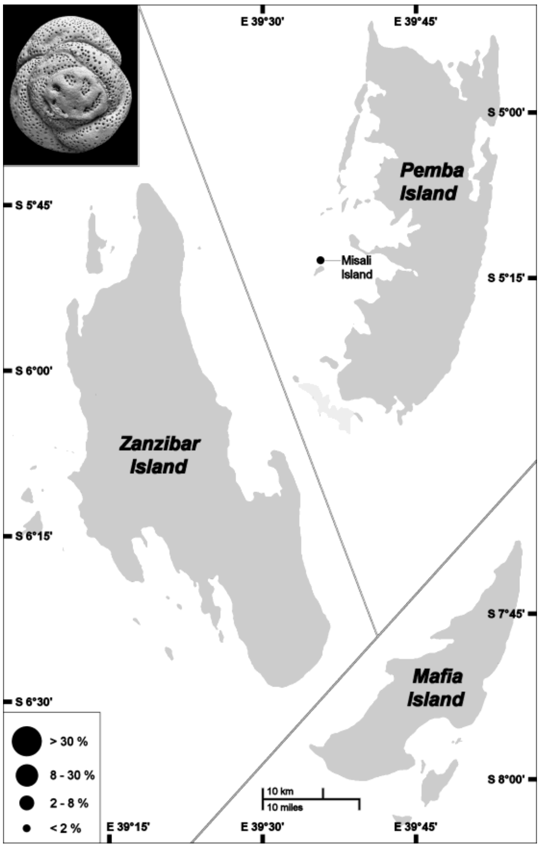

Fig. 148: Distribution of *Orbitina* sp. A.

Genus *Rotorbis* Sellier de Civrieux, 1977

Rotorbis auberii (d'Orbigny)
Plate 15, Figs. 6-8

1839 *Rosalina auberii* – d'Orbigny, p. 94, pl. 4, figs. 5-8
1922 *Discorbis mira* – Cushman, p. 39, pl. 6, figs. 10-11
1977b *Discorbis auberi* (d'Orbigny) – Le Calvez, p. 77
1988 *Neoeponides auberi* (d'Orbigny) – Loeblich & Tappan, p. 558, pl. 605, figs. 5-7
1994 *Rotorbis auberi* (d'Orbigny) – Loeblich & Tappan, p. 137, pl. 278, figs. 1-11
2012 *Rotorbis auberi* (d'Orbigny) – Debenay, p. 212, 309, pl. 15

Distribution: Most of the stations

Abundance: Rare to frequent, most abundant in the lagoon at Ocean Paradise

Depth: 1-42 m

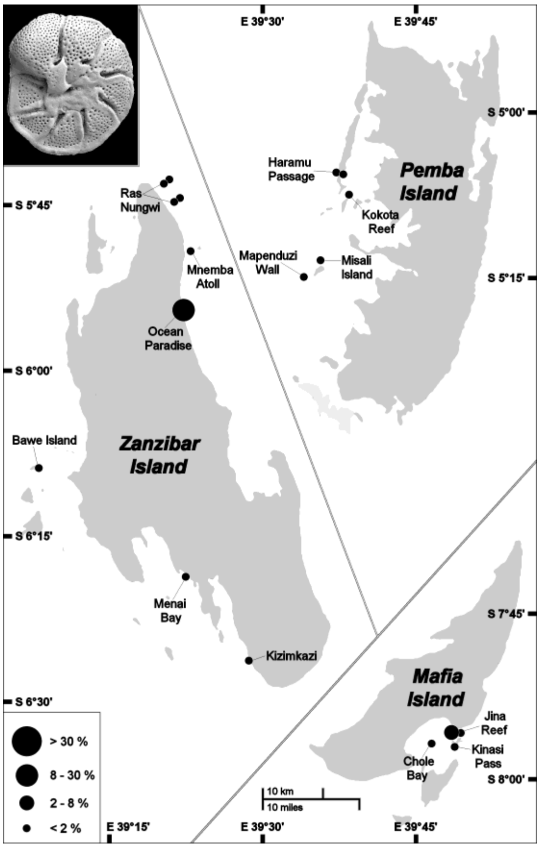

Fig. 149: Distribution of *Rotorbis auberii*.

Rotorbis rosacea **(d'Orbigny)**
Plate 15, Figs. 9-12

1826 *Rotalina rosacea* – d'Orbigny, p. 273, no. 15, modéle no. 39
1884 *Discorbina rosacea* (d'Orbigny) – Brady, p. 644, pl. 87, fig. 4
1893 *Discorbina rosacea* (d'Orbigny) – Egger, p. 385, pl. 15, figs. 39-41
1915 *Discorbina rosacea* (d'Orbigny) – Heron-Allen & Earland, p. 692

<u>Distribution</u>: Several stations

<u>Abundance</u>: Rare

<u>Depth</u>: 3-21 m

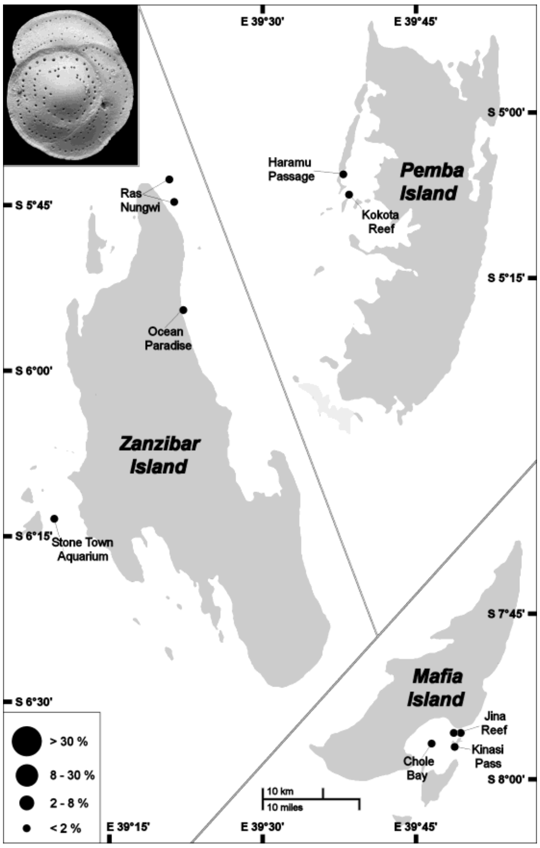

Fig. 150: Distribution of *Rotorbis rosacea*.

Family Rosalinidae Reiss, 1963

Genus *Rosalina* d'Orbigny, 1826

Rosalina bradyi **(Cushman)**
Plate 15, Figs. 13-15

1884 *Discorbina globularis* d'Orbigny – Brady, p. 643, pl. 86, fig. 8a-c
1915 *Discorbina globularis* d'Orbigny – Heron-Allen & Earland, p. 694, pl. 51, figs. 36-39
1991 *Rosalina bradyi* (Cushman) – Cimerman & 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 & Hatta, p. 14, pl. 3, fig. 4
2012 *Rosalina bradyi* (Cushman) – Debenay, p. 211, 310, pl. 15

<u>Distribution</u>: Most of the stations

<u>Abundance</u>: Rare to common

<u>Depth</u>: 1-42 m

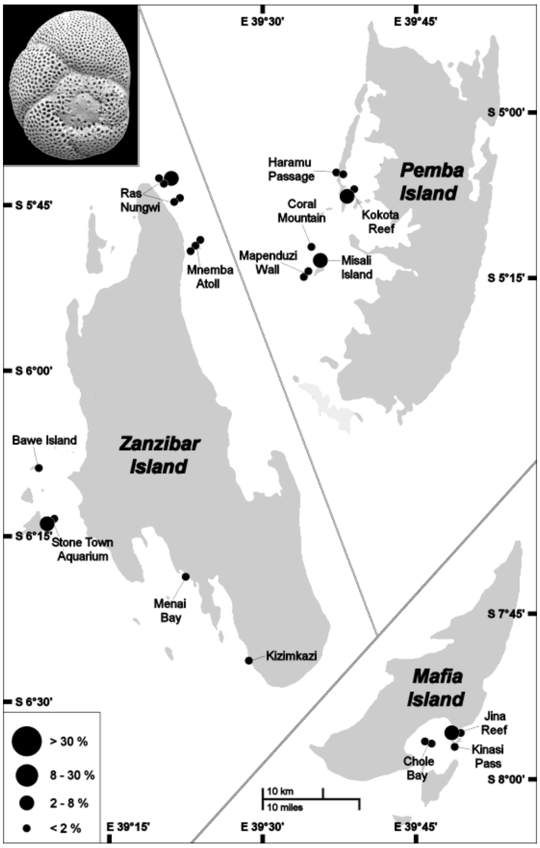

Fig. 151: Distribution of *Rosalina bradyi*.

Genus *Rotorboides* Sellier de Civrieux, 1977

***Rotorboides granulosus* (Heron-Allen & Earland)**
Plate 15, Figs. 16-19

1915 *Discorbina valvulata* var. *granulosa* – Heron-Allen & Earland, p. 695
1988 *Rotorboides granulosus* (Heron-Allen & Earland) – Loeblich & Tappan, p. 561, pl. 609, figs. 5-7

Distribution: Ras Nungwi

Abundance: Rare

Depth: 12-16 m

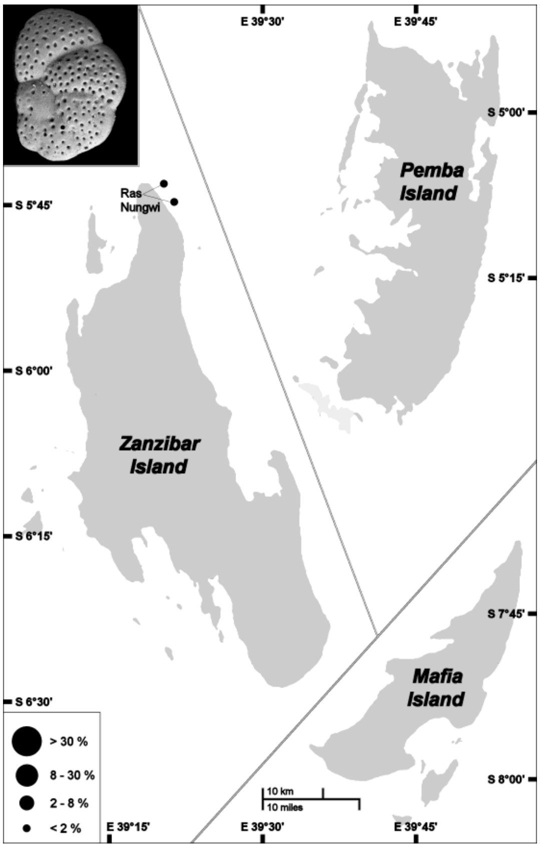

Fig. 152: Distribution of *Rotorboides granulosus*.

Family Glabratellidae Loeblich & Tappan, 1964

Genus *Glabratellina* Seiglie & Bermudéz, 1965

***Glabratellina australensis* Heron-Allen & Earland**
Plate 15, Figs. 20-22

1884 *Discorbina pileolus* d'Orbigny – Brady, p. 649, pl. 89, figs. 2-4
1932 *Discorbis australensis* – Heron-Allen & Earland, p. 416.

Distribution: Ras Nungwi and Mapenduzi Wall

Abundance: Rare

Depth: 12-42 m

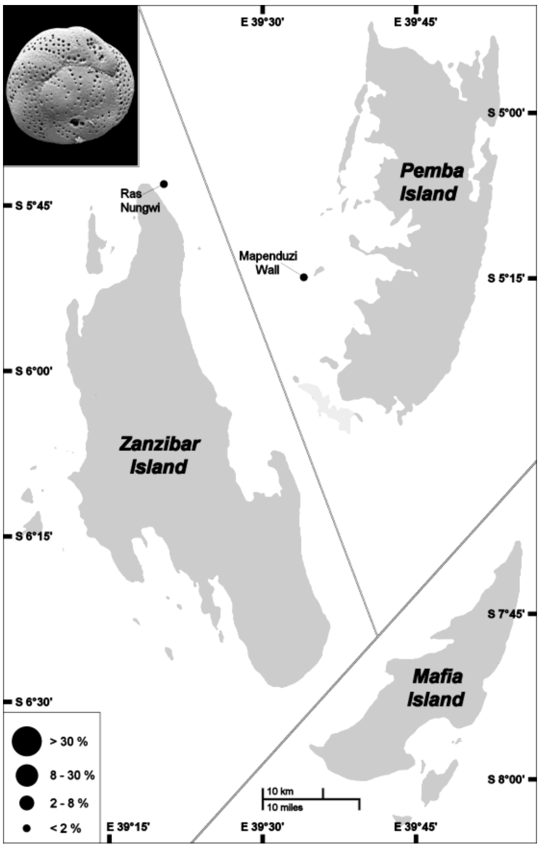

Fig. 153: Distribution of *Glabratellina australensis*.

Glabratellina cimermania Langer (in prep.)
Plate 15, Figs. 23-25

<u>Distribution</u>: Several stations

<u>Abundance</u>: Rare to common

<u>Depth</u>: 3-30 m

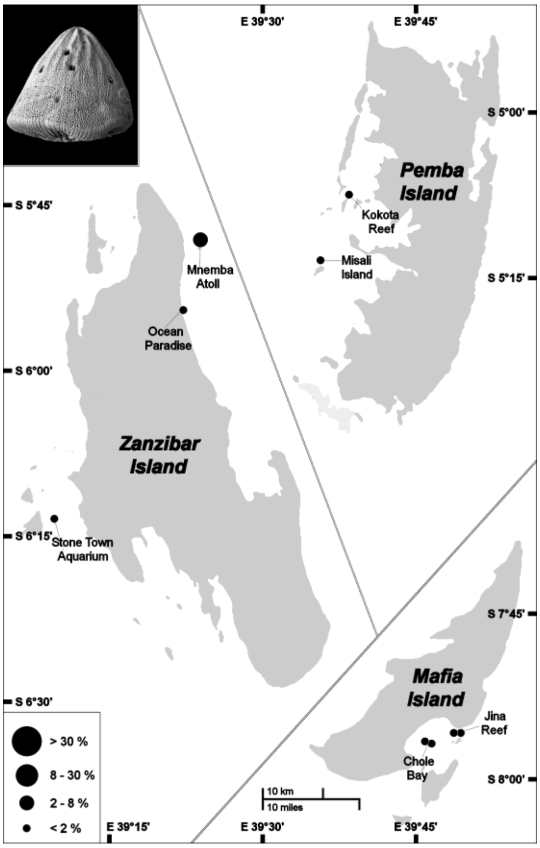

Fig. 154: Distribution of *Glabratellina cimermania*.

Genus *Pileolina* Bermúdez, 1952

***Pileolina* sp. A**
Plate 16, Figs. 1-3

1993 *Discorbinoides* sp. A – Hottinger et al., p. 113, pl. 148, figs. 1-6

<u>Distribution</u>: Chole Bay and Misali Island

<u>Abundance</u>: Rare

<u>Depth</u>: 20 m

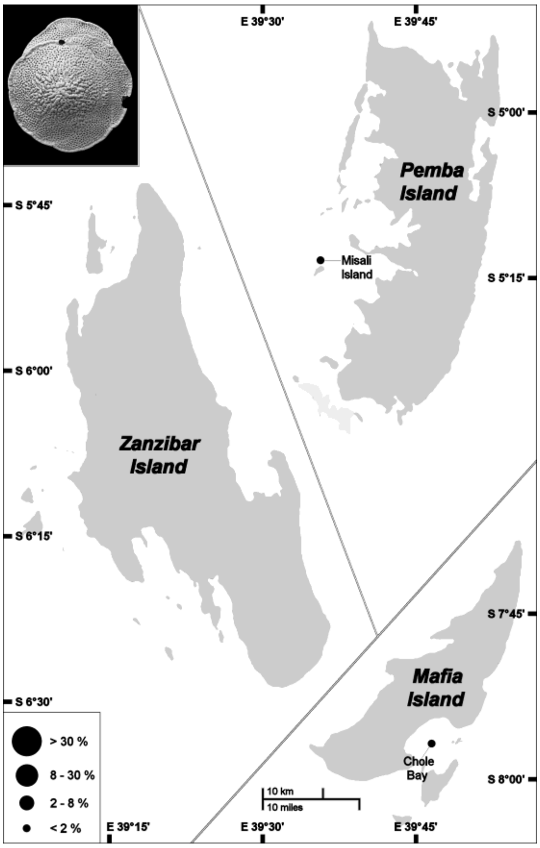

Fig. 155: Distribution of *Pileolina* sp. A.

Family Siphoninidae Cushman, 1927

Genus *Siphonina* Reuss, 1850

***Siphonina tubulosa* Cushman**
Plate 16, Figs. 4-6

1924 *Siphonina tubulosa* – Cushman, p. 40, pl. 13, figs. 1-2
1927 *Siphonina tubulosa* – Cushman, p. 10, pl. 1, figs. 3a-c, 5a-c
1992 *Siphonina tubulosa* Cushman – Hatta & Ujiie, p. 186, pl. 35, figs. 1a-2b
1993 *Siphonina tubulosa* Cushman – Hottinger et al., p. 114, pl. 149, figs. 1-4
1998 *Siphonina tubulosa* Cushman – Haunold & Piller, p. 28, pl. 10, fig. 11
2012 *Siphonina tubulosa* Cushman – Debenay, p. 213, 313, pl. 17

Distribution: Haramu Passage and Kokota Reef

Abundance: Rare

Depth: 16-30 m

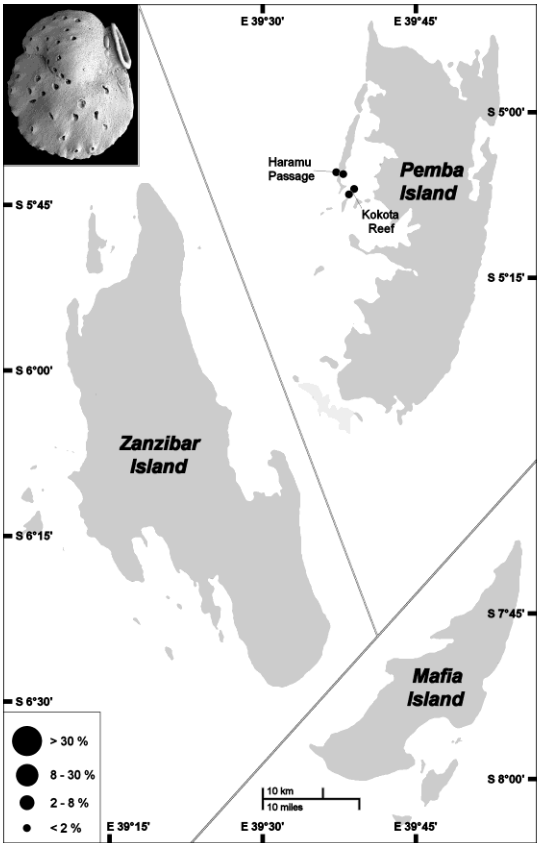

Fig. 156: Distribution of *Siphonina tubulosa*.

Genus *Siphoninoides* Cushman, 1927

***Siphoninoides echinatus* (Brady)**
Plate 16, Figs. 7-8

1879 *Planorbulina echinata* Brady – Brady, p. 283, pl. 8, fig. 31
1884 *Truncatulina echinata* (Brady) – Brady, p. 670, pl. 96, figs. 9-14
1915 *Truncatulina echinata* Brady – Heron-Allen & Earland, p. 711, pl. 53, fig. 1
1927 *Siphoninoides echinata* (Brady) – Cushman, p. 13, pl. 4, figs. 7a-b, 8a-b
1949 *Siphonoides echinatus* (Brady) – Said, p. 38, pl. 4, figs. 7-8
1982 *Siphoninoides echinatus* (Brady) – Neagu, p. 123, pl. 7, figs. 14-15
1992 *Siphoninoides echinatus* (Brady) – Hatta & Ujiie, p. 186, pl. 35, figs. 4a-b
1993 *Siphoninoides echinatus* (Brady) – Hottinger et al., p. 114, pl. 149, figs. 5-9
1994 *Siphoninoides echinatus* (Brady) – Loeblich & Tappan, p. 144, pl. 300, figs. 7-13

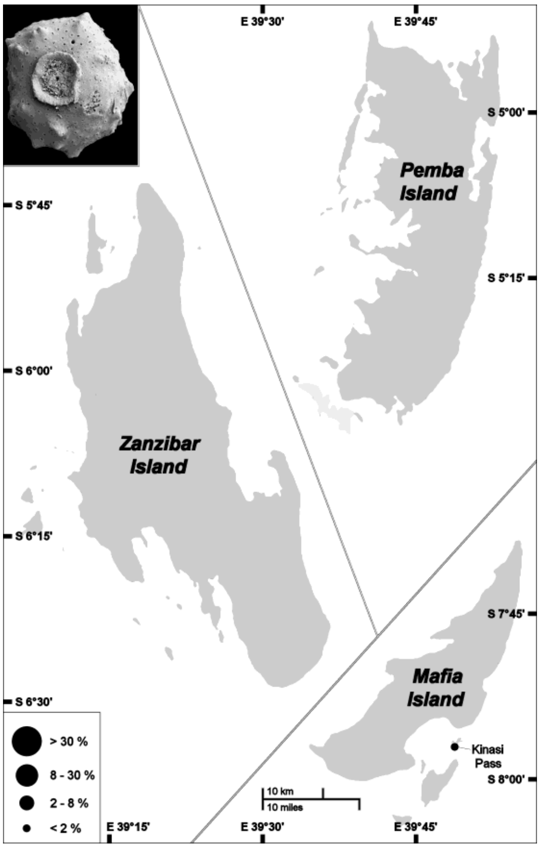

Fig. 157: Distribution of *Siphoninoides echinatus*.

2012 *Siphoninoides echinatus* (Brady) – Debenay, p. 248, 313, pl. 21

Distribution: Kinasi Pass

Abundance: Rare

Depth: 15-18 m

Family Discorbinellidae Sigal, 1952

Genus *Discorbinella* Cushman & Martin, 1935

Discorbinella minuta **Buzas, Smith & Beem**
Plate 16, Figs. 9-11

2009 *Discorbinella minuta* Buzas, Smith & Beem – Parker, p. 554, figs. 394a-e

Distribution: Four stations

Abundance: Rare

Depth: 15-30 m

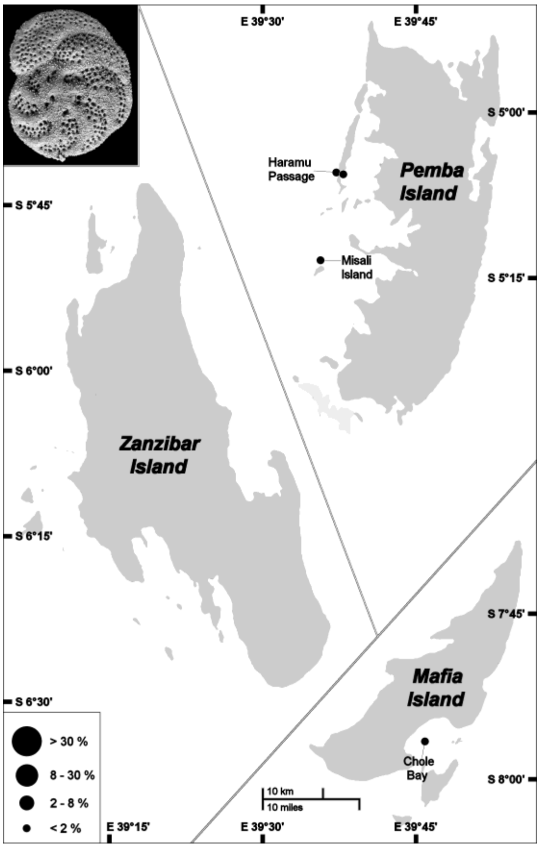

Fig. 158: Distribution of *Discorbinella minuta*.

Family Cibicididae Cushman, 1927

Genus *Cibicides* De Montfort, 1808

Cibicides pseudolobatulus **Perelis & Reiss**
Plate 16, Figs. 12-15

1975 *Cibicides pseudolobatulus* – Perelis & Reiss, p. 77, pl. 4, figs. 1-7
1993 *Cibicides pseudolobatulus* Perelis & Reiss – Hottinger et al., p. 116, pl. 152, figs. 7-11
2012 *Cibicides pseudolobatulus* Perelis & Reiss – Debenay, p. 190, 315, pl. 16

Distribution: All of the stations

Abundance: Rare to common

Depth: 1-42 m

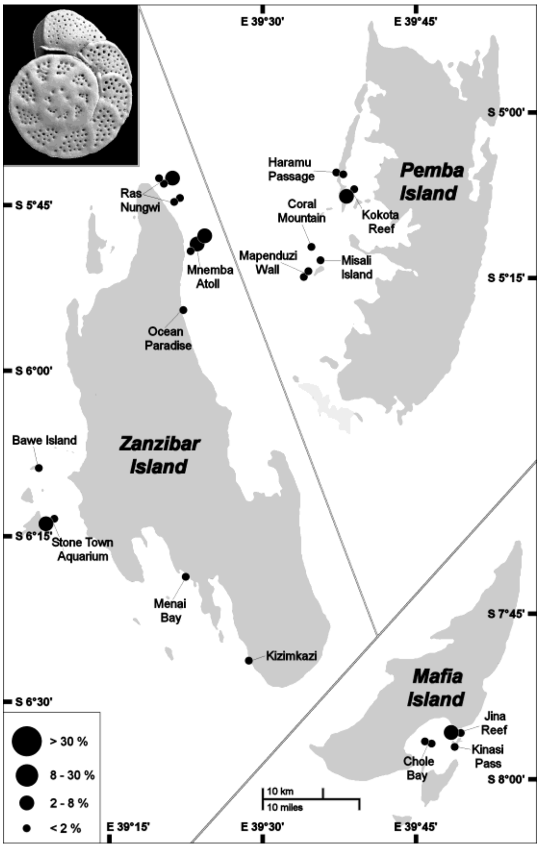

Fig. 159: Distribution of *Cibicides pseudolobatulus*.

Genus *Discorbia* Sellier de Civrieux, 1977

***Discorbia valvulinerioides* ? Sellier de Civrieux**
Plate 16, Figs. 16-18

1988 *Discorbia valvulinerioides* (Sellier de Civrieux) – Loeblich & Tappan, p. 582, pl. 635, figs. 4-6

Distribution: Three stations

Abundance: Rare

Depth: 16-42 m

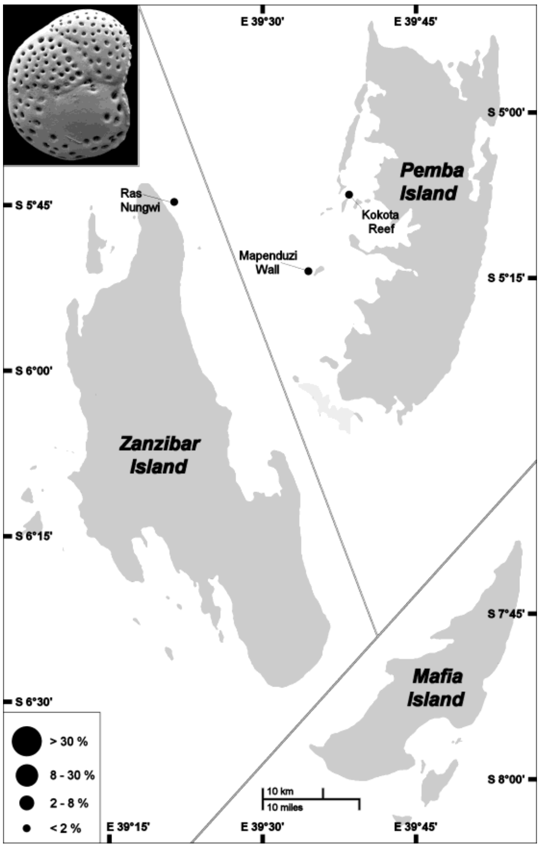

Fig. 160: Distribution of *Discorbia valvulinerioides*.

Genus *Dyocibicides* Cushman & Valentine, 1930

***Dyocibicides* sp. A**
Plate 16, Figs. 19-21

1993 *Dyocibicides* ? sp. A – Hottinger et al., p. 117, pl. 154, figs. 2-4

Distribution: Few stations

Abundance: Rare

Depth: 12-30 m

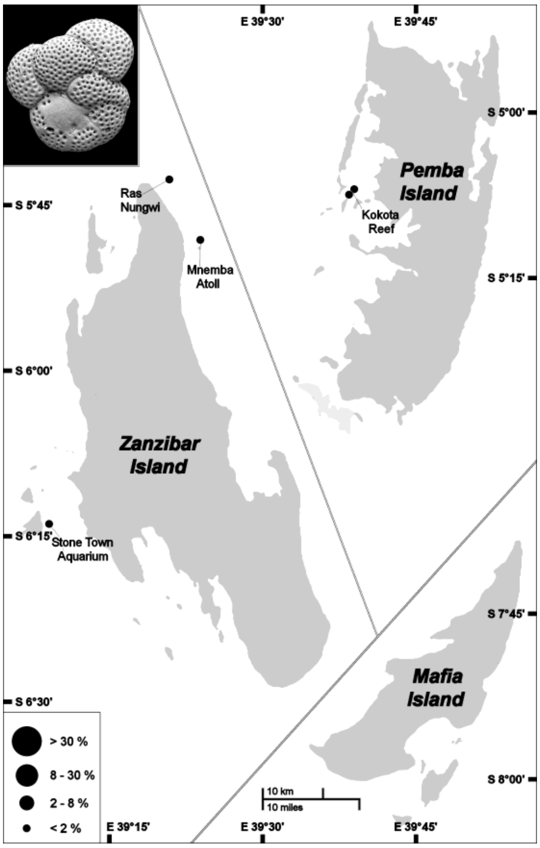

Fig. 161: Distribution of *Dyocibicides* cf. *D. biserialis*.

Genus *Fontbotia* González-Donoso & Linares, 1970

Fontbotia wuellerstorfi **(Schwager)**
Plate 16, Figs. 22-24

1884 *Truncatulina wuellerstorfi* (Schwager) – Brady, p. 662, pl. 93, figs. 8-9
1965 *Planulina wuellerstorfi* (Schwager) – Todd, p. 51, pl. 23, figs. 3-5
1988 *Fontbotia wuellerstorfi* (Schwager) – Loeblich & Tappan, p. 583, pl. 634, figs. 10-12, pl. 635, figs. 1-3
1994 *Fontbotia wuellerstorfi* (Schwager) – Loeblich & Tappan, p. 150, pl. 319, figs. 7-12
1994 *Fontbotia wuellerstorfi* (Schwager) – Debenay, p. 196, 315, pl. 16

Distribution: Few stations

Abundance: Rare

Depth: 12-42 m

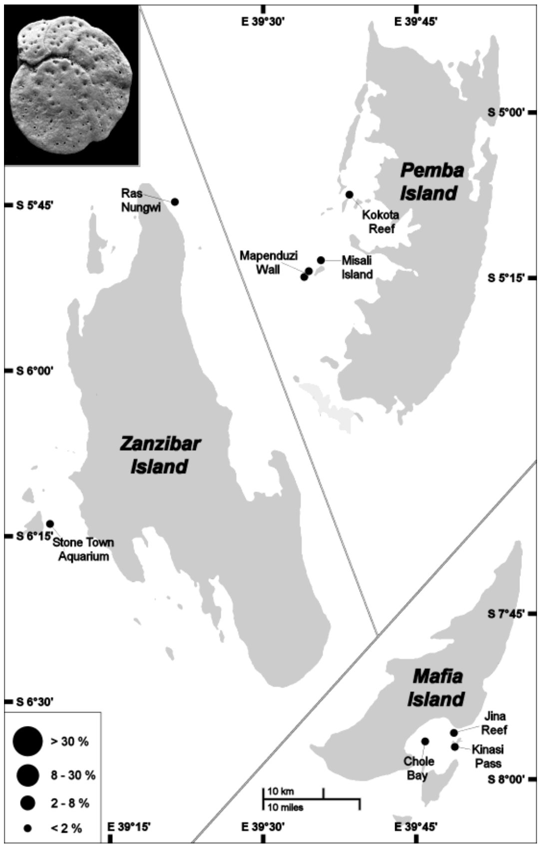

Fig. 162: Distribution of *Fontbotia wuellerstorfi*.

Family Planorbulinidae Schwager, 1877

Genus *Cibicidella* Cushman, 1927

Cibicidella variabilis **(d'Orbigny)**
Plate 17, Figs. 1-5

1839 *Truncatulina variabilis* – d'Orbigny, p. 135, pl. 2, fig. 29
1915 *Truncatulina variabilis* d'Orbigny – Heron-Allen & Earland, p. 706
1991 *Cibicidella variabilis* (d'Orbigny) – Cimerman & Langer, p. 72, pl. 77, figs. 1-10

Distribution: Three stations

Abundance: Rare

Depth: 12-20 m

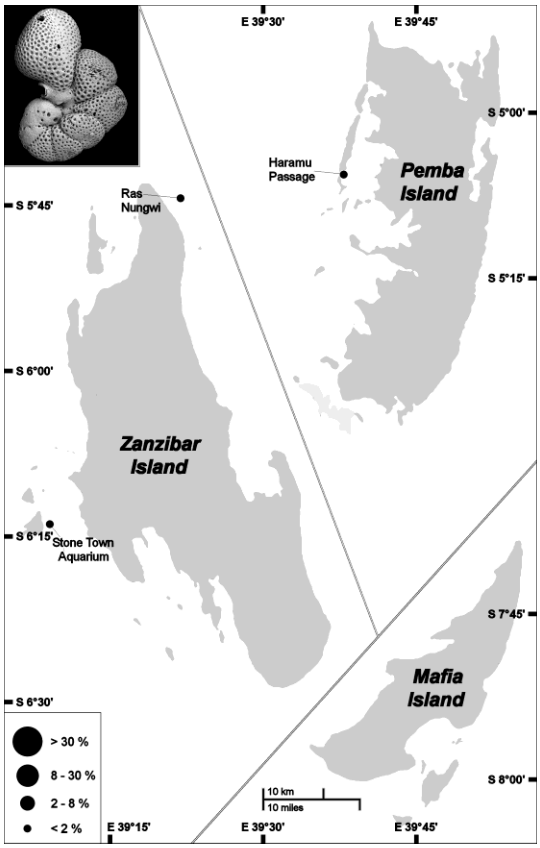

Fig. 163: Distribution of *Cibicidella variabilis*.

Genus *Planorbulina* d'Orbigny, 1826

***Planorbulina mediterranensis* d'Orbigny**
Plate 17, Figs. 6-8

1915 *Planorbulina mediterranensis* d'Orbigny – Heron-Allen & Earland, p. 705
1961 *Planorbulina mediterranensis* d'Orbigny – Braga, p. 189, pl. 21, fig. 7
1977b *Planorbulina mediterranensis* d'Orbigny – Le Calvez, p. 61
1988 *Planorbulina mediterranensis* d'Orbigny – Loeblich & Tappan, p. 588, pl. 645, figs. 1-4, pl. 646, figs. 1-2
1991 *Planorbulina mediterranensis* d'Orbigny – Cimerman & Langer, p. 71, pl. 78, figs. 1-8
1992 *Planorbulina mediterranensis* d'Orbigny – Hatta & Ujiie, p. 189, pl. 38, figs. 2a-c
1997 *Planorbulina mediterranensis* d'Orbigny – Cherif et al., p. 274, pl. 8, fig. 1

Distribution: Most of the stations

Abundance: Rare to common

Depth: 1-42 m

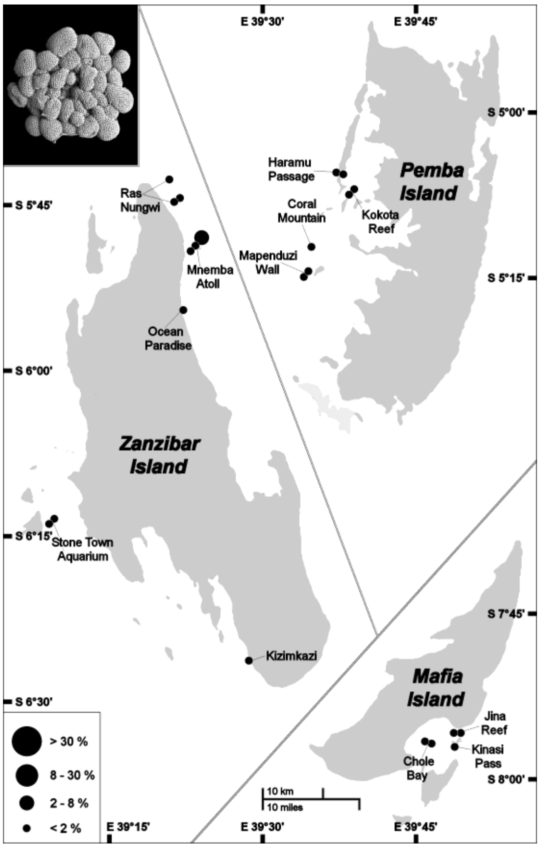

Fig. 164: Distribution of *Planorbulina mediterranensis*.

Genus *Planorbulinella* Cushman, 1927

***Planorbulinella larvata* (Parker & Jones)**
Plate 17, Figs. 9-11

1865 *Planorbulina vulgaris* d'Orbigny var. *larvata* – Parker & Jones, p. 68, pl. 19, fig. 3
1915 *Planorbulina larvata* Parker & Jones – Heron-Allen & Earland, p. 706
1949 *Planorbulinella larvata* (Parker & Jones) – Said, p. 44, pl. 4, fig. 27
1961 *Planorbulinella larvata* (Parker & Jones) – Braga, p. 190, pl. 21, fig. 8
1965 *Planorbulinella larvata* (Parker & Jones) – Moura, p. 59, pl. 7, fig. 13
1982 *Planorbulinella larvata* (Jones & Parker) – Neagu, p. 131, pl. 13, figs. 9-10
1984 *Planorbulinella larvata* (Parker & Jones) – Reiss & Hottinger, p. 249, figs. G 31 a, G 32 e-f

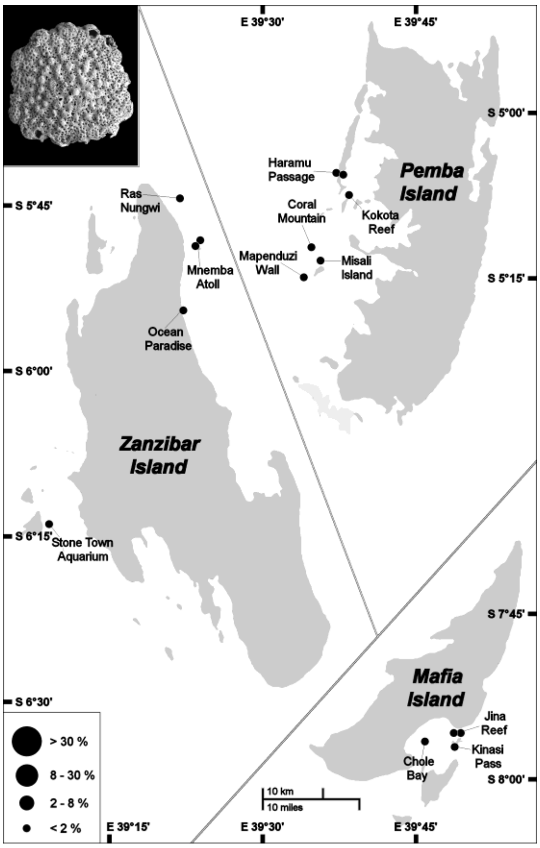

Fig. 165: Distribution of *Planorbulinella larvata*.

1992 *Planorbulinella larvata* (Parker & Jones) – Hatta & Ujiie, p. 189, pl. 38, figs. 3a-c
1993 *Planorbulinella larvata* (Parker & Jones) – Hottinger et al., p. 118, pl. 158, figs. 1-12
1994 *Planorbulinella larvata* (Parker & Jones) – Loeblich & Tappan, p. 152, pl. 327, figs. 1-7
1998 *Planorbulinella larvata* (Parker & Jones) – Haunold, Baal & Piller, p. 157, pl. 2, figs. 7-9
2012 *Planorbulinella larvata* (Parker & Jones) – Debenay, p. 246, 316, pl. 22
2013a *Planorbulinella larvata* (Parker & Jones) – Langer et al., figs. 8.5-6

Distribution: Several stations

Abundance: Rare

Depth: 3-42 m

Family Cymbaloporidae Cushman, 1927

Genus *Cymbaloporella* Cushman, 1927

***Cymbaloporella tabellaeformis* (Brady)**
Plate 17, Figs. 12-14

1884 *Cymbalopora tabellaeformis* – Brady, p. 637, pl. 102, figs. 15-18
1915 *Cymbalopora tabellaeformis* Brady – Heron-Allen & Earland, p. 688
1949 *Cymbaloporella tabellaeformis* (Brady) – Said, p. 41, pl. 4, fig. 15
1965 *Cymbaloporella tabellaeformis* (Brady) – Todd, p. 38, pl. 19, fig. 5
1992 *Cymbaloporella tabellaeformis* (Brady) – Hatta & Ujiie, p. 190, pl. 39, figs. 2a-3c
1993 *Cymbaloporella tabellaeformis* (Brady) – Hottinger et al., p. 119, pl. 159, figs. 1-6
2012 *Cymbaloporella tabellaeformis* (Brady) – Debenay, p. 235, 316, pl. 22

Distribution: Several stations

Abundance: Rare

Depth: 1-42 m

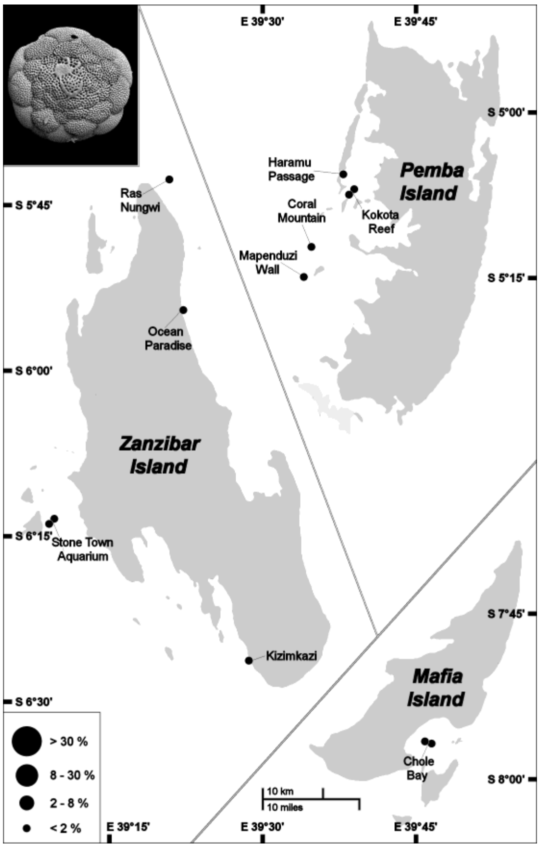

Fig. 166: Distribution of *Cymbaloporella tabellaeformis*.

Genus *Cymbaloporetta* Cushman, 1928

Cymbaloporetta bermudezi (Sellier de Civrieux)
Plate 17, Figs. 15-17

1949 *Cymbaloporetta squamosa* (d'Orbigny) – Said, p. 40, pl. 4, fig. 14
1993 *Cymbaloporetta bermudezi* (Sellier de Civrieux) – Hottinger et al., p. 119, pl. 159, figs. 7-10
1998 *Cymbaloporetta bermudezi* (Sellier de Civrieux) – Haunold & Piller, p. 29, pl. 11, fig. 1

<u>Distribution</u>: Several stations

<u>Abundance</u>: Rare

<u>Depth</u>: 1-42 m

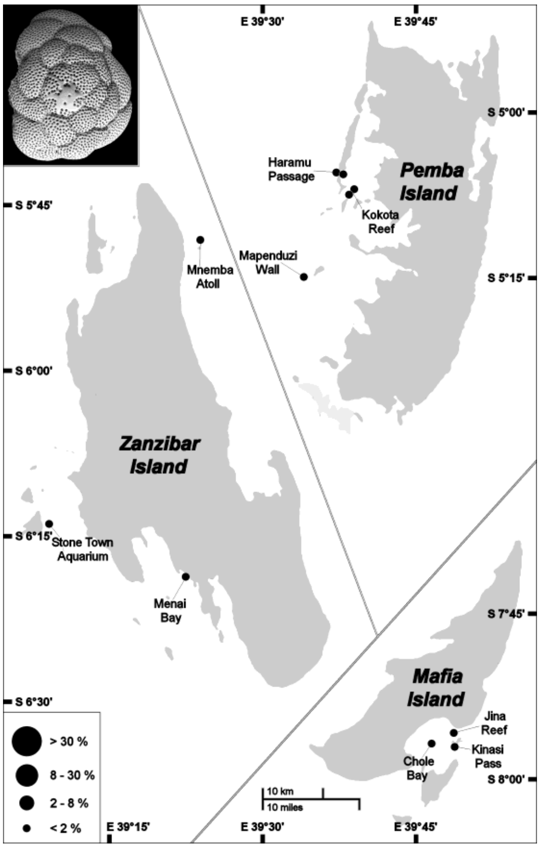

Fig. 167: Distribution of *Cymbaloporetta bermudezi*.

Cymbaloporetta bulloides (d'Orbigny)
Plate 18, Figs. 1-4

1884 *Cymbalopora* (*Tretomphalus*) *bulloides* (d'Orbigny) – Brady, p. 638, pl. 102, figs. 7-12
1915 *Cymbalopora bulloides* (d'Orbigny) – Heron-Allen & Earland, p. 688
1931 *Tretomphalus bulloides* (d'Orbigny) – Cushman, p. 86, pl. 16, fig. 5a-c
1977b *Tretomphalus bulloides* (d'Orbigny) – Le Calvez, p. 80
1983 *Cymbaloporetta bulloides* (d'Orbigny) – Rückert-Hilbig, p. 12, p. 28, pl. 2, pl. 5, pl. 7, figs. 2-3, 5, 7-10, pl. 8, figs. 3-5, 7-8
2013a *Cymbaloporetta bulloides* (d'Orbigny) – Langer et al., figs. 8.7-9

<u>Distribution</u>: Few stations

<u>Abundance</u>: Rare

<u>Depth</u>: 12-42 m

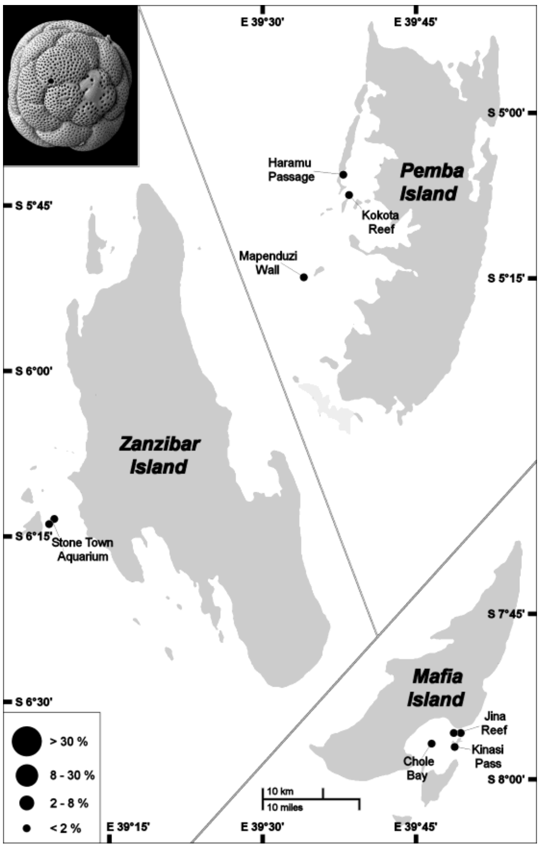

Fig. 168: Distribution of C*ymbaloporetta bulloides*.

Genus *Millettiana* Banner, Pereira, & Desai, 1985

Millettiana milletti **(Heron-Allen & Earland)**
Plate 18, Figs. 5-7

1915 *Cymbalopora milletti* – Heron-Allen & Earland, p. 698, pl. 51, figs. 32-35
1992 *Millettiana milletti* (Heron-Allen & Earland) – Hatta & Ujiie, p. 191, pl. 40, figs. 4a-b, 5, 6, 7a-c
1993 *Millettiana milletti* (Heron-Allen & Earland) – Hottinger et al., p. 120, pl. 160, figs. 9-13
1994 *Millettiana milletti* (Heron-Allen & Earland) – Loeblich & Tappan, p. 153, pl. 329, figs. 1-12
1998 *Millettiana milletti* (Heron-Allen & Earland) – Haunold & Piller, p. 29, pl. 11, fig. 2
2012 *Millettiana milletti* (Heron-Allen & Earland) – Debenay, p. 244, 316, pl. 22

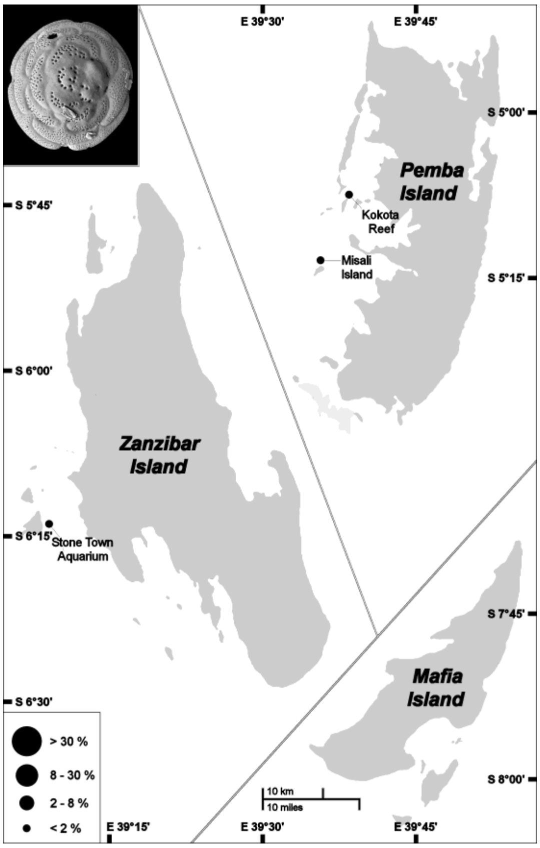

Fig. 169: Distribution of *Millettiana milletti*.

Distribution: Three stations

Abundance: Rare

Depth: 12-20 m

Family Acervulinidae Schultze, 1854

Genus *Acervulina* Schultze, 1854

Acervulina mabahethi **(Said)**
Plate 18, Figs. 8-13

1949 *Planorbulina mabahethi* – Said, p. 44, pl. 4, fig. 26
1979 *Planorbulina mabaheti* Said – Pereira, p. 288, pl. 41, figs. D-K
1993 *Acervulina mabaheti* (Said) – Hottinger et al., p. 122, pl. 165, figs. 1-7, pl. 166, figs. 1-8
1994 *Planorbulina mahabethi* Said – Loeblich & Tappan, p. 152, pl. 323, figs. 11-13
2012 *Acervulina mabahethi* Said – Debenay, p. 234, 317, pl. 22
2013a *Acervulina mabahethi* Said – Langer et al., figs. 8.10-11

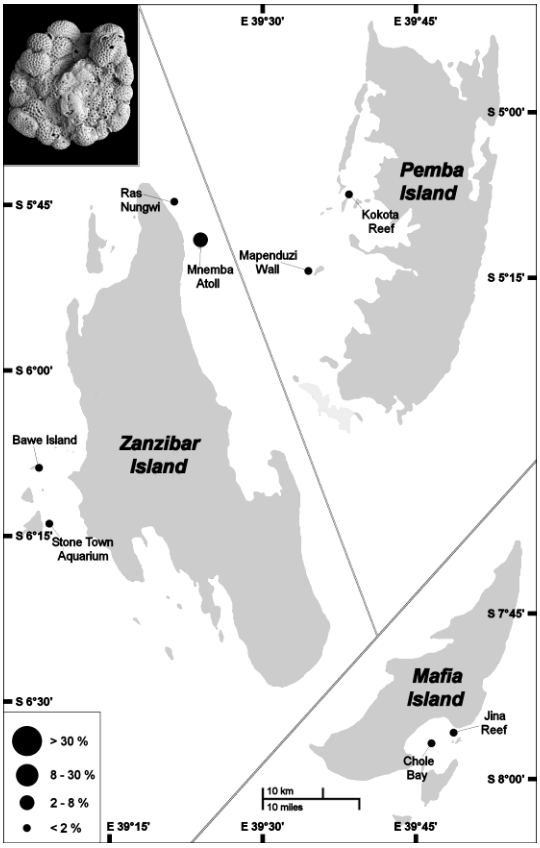

Fig. 170: Distribution of *Acervulina mabahethi*.

Distribution: Few stations

Abundance: Rare to common

Depth: 9-40 m

Genus *Sphaerogypsina* Galloway, 1933

***Sphaerogypsina globula* (Reuss)**
Plate 18, Figs. 14-16

1848 *Ceriopora globulus* – Reuss, p. 33, pl. 5, fig. 7
1915 *Gypsina globulus* (Reuss) – Heron-Allen & Earland, p. 727
1949 *Gypsina globula* (Reuss) – Said, p. 44, pl. 4, fig. 24
1984 *Sphaerogypsina globulus* (Reuss) – Reiss & Hottinger, p. 254, fig. G 34a
1991 *Sphaerogypsina globula* (Reuss) – Cimerman & Langer, p. 72, pl. 80, figs. 6-9
1992 *Sphaerogypsina globulus* (Reuss) – Hatta & Ujiie, p. 192, pl. 41, figs. 7-8
1993 *Sphaerogypsina globulus* (Reuss) – Hottinger et al., p. 128, pl. 173, figs. 1-10
1994 *Sphaerogypsina globula* (Reuss) – Loeblich & Tappan, p. 154, pl. 334, figs. 4-6
2012 *Sphaerogypsina globula* (Reuss) – Debenay, p. 249, 317, pl. 22

Distribution: Few reef stations

Abundance: Rare

Depth: 12-42 m

Family Epistomariidae Hofker, 1954

Genus *Asanonella* Huang, 1965

***Asanonella tubulifera* (Heron-Allen & Earland)**
Plate 18, Figs. 17-20

1915 *Truncatulina tubulifera* – Heron-Allen & Earland, p. 710, pl. 52, figs. 37-40

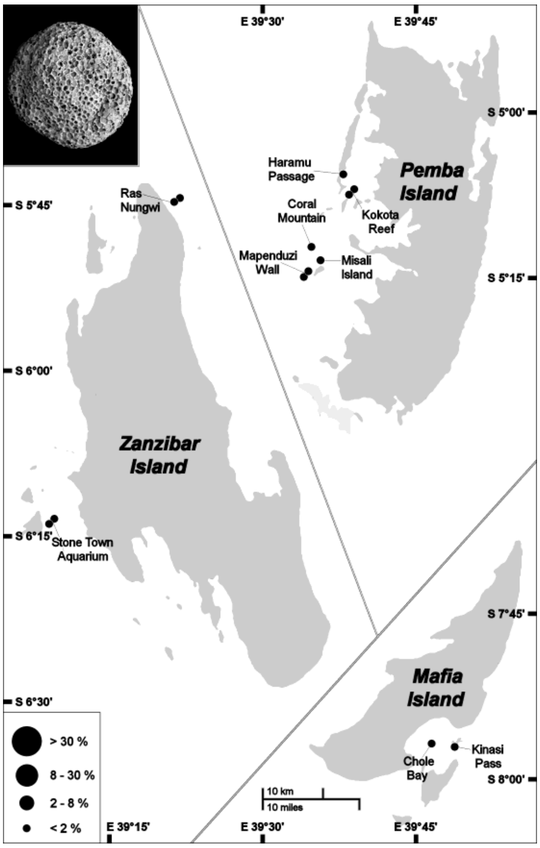

Fig. 171: Distribution of *Sphaerogypsina globula*.

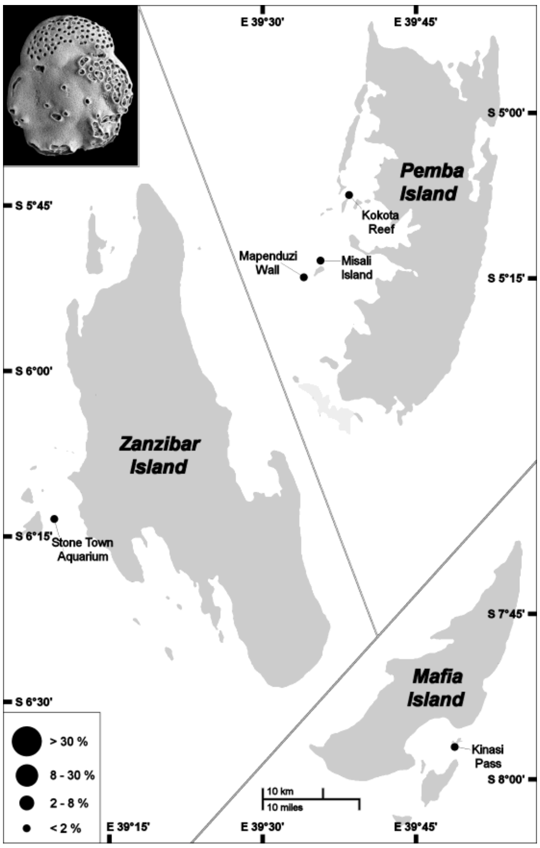

Fig. 172: Distribution of *Asanonella tubulifera*.

1924 *Truncatulina tubulifera* Heron-Allen & Earland – Cushman, p. 38, pl. 11, fig. 8
1988 *Asanonella tubulifera* (Heron-Allen & Earland) – Loeblich & Tappan, p. 600, pl. 666, figs. 1-7
1992 *Asanonella tubulifera* (Heron-Allen & Earland) – Hatta & Ujiie, p. 193, pl. 42, figs. 1a-c
1994 *Asanonella tubulifera* (Heron-Allen & Earland) – Loeblich & Tappan, p. 155, pl. 337, figs. 1-10
2012 *Asanonella tubulifera* (Heron-Allen & Earland) – Debenay, p. 187, 318, pl. 15

<u>Distribution</u>: Few reef stations

<u>Abundance</u>: Rare

<u>Depth</u>: 16-42 m

Family Alfredinidae Singh & Kalia, 1972

Genus *Epistomaroides* Uchio, 1952

***Epistomaroides punctulatus* (d'Orbigny)**
Plate 19, Figs. 1-5

1826 *Anomalina punctulata* - d'Orbigny, p. 282
1915 *Discorbina polystomelloides* (Parker & Jones) – Heron-Allen & Earland, p. 698, pl. 52, figs. 19-23
1949 *Epistomaria punctata* – Said, p. 37, pl. 4, fig. 23
1984 *Epistomaroides punctata* (Said) – Reiss & Hottinger, fig. G29 a-b
1993 *Epistomaroides punctatus* (Said) – Hottinger et al., p. 131, pl. 180, figs. 1-6
1998 *Epistomaroides punctatus* (Said) – Haunold & Piller, p. 29, pl. 11, fig. 4
2013a *Epistomaroides punctatus* (Said) – Langer et al., figs. 8.16-17

<u>Distribution</u>: Several stations

<u>Abundance</u>: Rare

<u>Depth</u>: 1-42 m

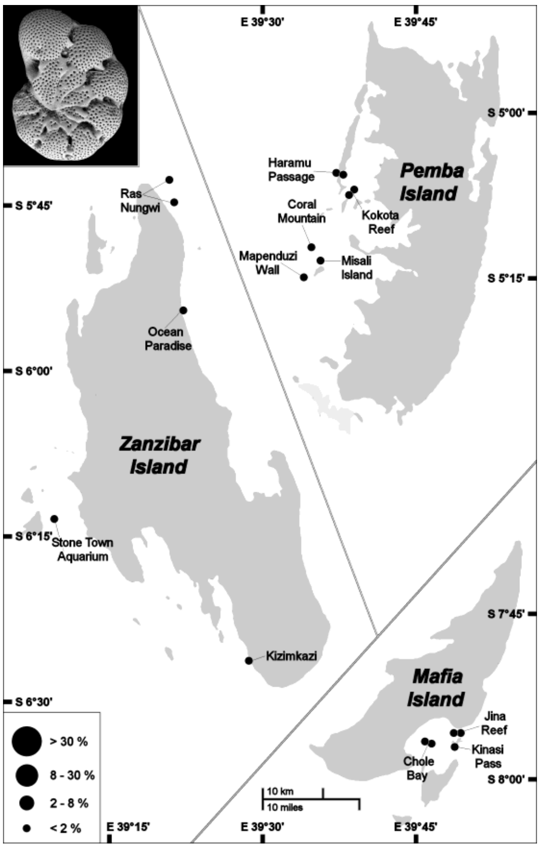

Fig. 173: Distribution of *Epistomaroides punctulatus.*

Family Amphisteginidae Cushman, 1927

Genus *Amphistegina* d'orbigny, 1826

***Amphistegina bicirculata* Larsen**
Plate 19, Figs. 6-8

1949 *Amphistegina radiata* (Fichtel & Moll) var. *venosa* (Fichtel & Moll) – Said, p. 39, pl. 4, fig. 11
1976 *Amphistegina bicirculata* – Larsen, p. 6, pl. 2, figs. 1-5, pl. 7, fig. 2, pl. 8, fig. 2
1984 *Amphistegina bicirculata* Larsen – Reiss & Hottinger, p. 217, figs. G11, G12 h-i
1993 *Amphistegina bicirculata* Larsen – Hottinger et al., p. 132, pl. 182, figs. 1-11, pl. 183, figs. 1-7
1998 *Amphistegina bicirculata* Larsen – Haunold, Baal & Piller, p. 157, pl. 3, figs. 1-4
2012 *Amphistegina bicirculata* Larsen – Debenay, p. 215, 318, pl. 20

<u>Distribution</u>: Most of the stations

<u>Abundance</u>: Rare to frequent

<u>Depth</u>: 1-42 m

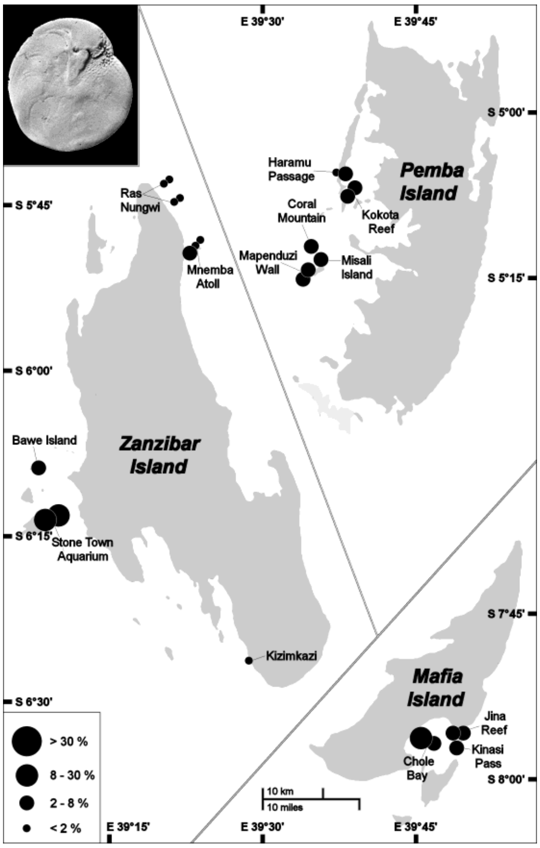

Fig. 174: Distribution of *Amphistegina bicirculata*.

***Amphistegina lessonii* d'Orbigny**
Plate 19, Figs. 9-11

1826 *Amphistegina lessonii* – d'Orbigny, p. 304
1915 *Amphistegina lessonii* d'Orbigny – Heron-Allen & Earland, p. 736
1976 *Amphistegina lessonii* d'Orbigny – Larsen, p. 2, pl. 1, figs. 1-5, pl. 7, fig. 1, pl. 8, fig. 1
1982 *Amphistegina madagascariensis* d'Orbigny – Neagu, p. 132, pl. 11, figs. 11-13
1984 *Amphistegina lessonii* d'Orbigny – Reiss & Hottinger, p. 217, fig. G11, G12 d, e
1992 *Amphistegina lessonii* d'Orbigny – Hatta & Ujiie, p. 195, pl. 42, figs. 4a, b, text-figs. 1-1a-b
1993 *Amphistegina lessonii* d'Orbigny – Hottinger et al., p. 132, pl. 184, figs. 1-11, pl. 185, figs. 1-7

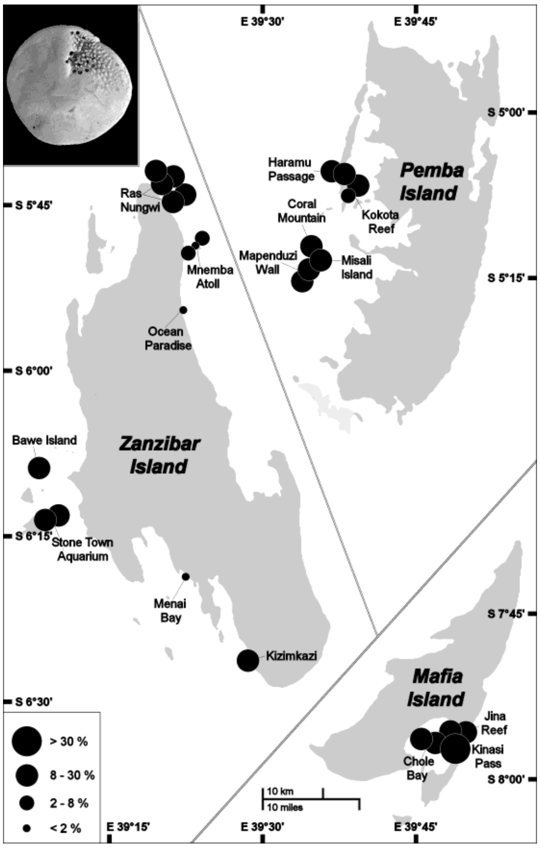

Fig. 175: Distribution of *Amphistegina lessonii*.

1994 *Amphistegina lessonii* d'Orbigny – Loeblich & Tappan, p. 156, pl. 340, figs. 1-9
1997 *Amphistegina lessonii* d'Orbigny – Cherif et al., p. 274, pl. 8, figs. 5-6
1998 *Amphistegina lessonii* d'Orbigny – Haunold, Baal & Piller, p. 157, pl. 3, figs. 5-8
2012 *Amphistegina lessonii* d'Orbigny – Debenay, p. 215, 318, pl. 20

Distribution: All of the stations

Abundance: Rare to dominant

Depth: 1-42 m

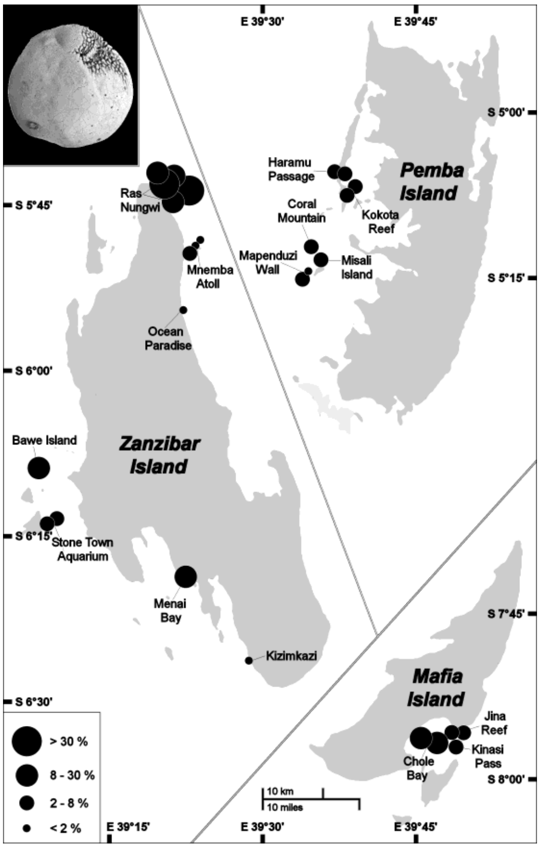

Fig. 176: Distribution of *Amphistegina lobifera*.

Amphistegina lobifera **Larsen**
Plate 19, Figs. 12-14

1880 *Amphistegina lessonii* d'Orbigny – Möbius, p. 99, pl. 10, figs. 11-14, pl. 11, figs. 1-3
1976 *Amphistegina lobifera* – Larsen, p. 4, pl. 3, figs. 1-5, pl. 7, fig. 3, pl. 8, fig. 3
1984 *Amphistegina lobifera* Larsen – Reiss & Hottinger, p. 217, fig. G11, G12a-c
1993 *Amphistegina lobifera* Larsen – Hottinger et al., p. 133, pl. 186, figs. 1-11, pl. 187, figs. 1-7, pl. 188, figs. 1-6
1998 *Amphistegina lobifera* Larsen – Haunold, Baal & Piller, p. 157, pl. 4, figs. 1-3
2011 *Amphistegina lobifera* Larsen – Parker & Gischler, p. 47, pl. 5, figs. 7-9
2012 *Amphistegina lobifera* Larsen – Debenay, p. 216, 319, pl. 20

Distribution: All of the stations

Abundance: Rare to dominant

Depth: 1-42 m

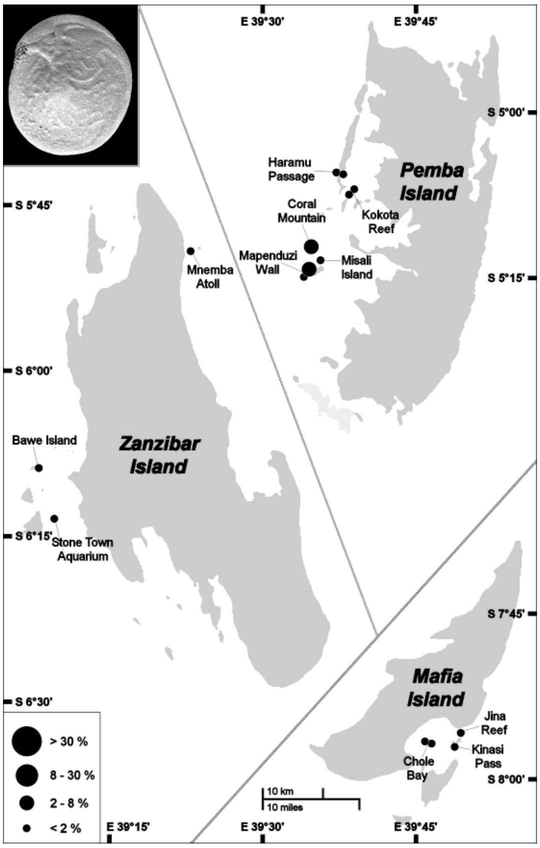

Fig. 177: Distribution of *Amphistegina papillosa*.

Amphistegina papillosa **Said**
Plate 19, Figs. 15-17

1949 *Amphistegina radiata* var. *papillosa* Terquem – 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
1984 *Amphistegina papillosa* Said – Reiss & Hottinger, p. 217, figs. G11, G12 f-g
1992 *Amphistegina papillosa* Said – Hatta & Ujiie, p. 196, pl. 42, figs. 3a-b
1993 *Amphistegina papillosa* Said – Hottinger et al., p. 134, pl. 189, figs. 1-10., pl. 190, figs. 1-7
1994 *Amphistegina papillosa* Said – Loeblich & Tappan, p. 157, pl. 339, figs. 4-7, pl. 341, figs. 1-7
1998 *Amphistegina papillosa* Said – Haunold, Baal & Piller, p. 157, pl. 4, figs. 4-7
2012 *Amphistegina papillosa* Said – Debenay, p. 216, 319, pl. 20

Distribution: Several stations

Abundance: Rare to common

Depth: 9-42 m

***Amphistegina radiata* (Fichtel & Moll)**
Plate 19, Figs. 18-20

1915 *Amphistegina lessonii* d'Orbigny var. *radiata* (Fichtel & Moll) – Heron-Allen & Earland, p. 736
1949 *Amphistegina* aff. *A. radiata* Fichtel & Moll – Said, p. 38, pl. 4, fig. 10
1976 *Amphistegina radiata* (Fichtel & Moll) – Larsen, p. 7, pl. 5, figs. 1-5, pl. 6, figs. 1-2, pl. 7, fig. 5, pl. 8, fig. 5
1982 *Amphistegina radiata* (Fichtel & Moll) – Neagu, p. 132, pl. 12, figs. 6-8
1992 *Amphistegina radiata* (Fichtel & Moll) – Hatta & Ujiie, p. 196, pl. 42, figs. 5a, b, text-figs. 1, 2a-b
1993 *Amphistegina* aff. *A. radiata* Fichtel & Moll – Hottinger et al., p. 135, pl. 191, figs. 1-7, pl. 192, figs. 1-2, 4-7
1994 *Amphistegina radiata* (Fichtel & Moll) – Loeblich & Tappan, p. 157, pl. 339, figs. 8-11, pl. 341, figs. 8-10
2011 *Amphistegina radiata (*Fichtel & Moll) – Parker & Gischler, p. 47, pl. 5, figs. 10-12
2012 *Amphistegina radiata (*Fichtel & Moll) – Debenay, p. 216, 319, pl. 20

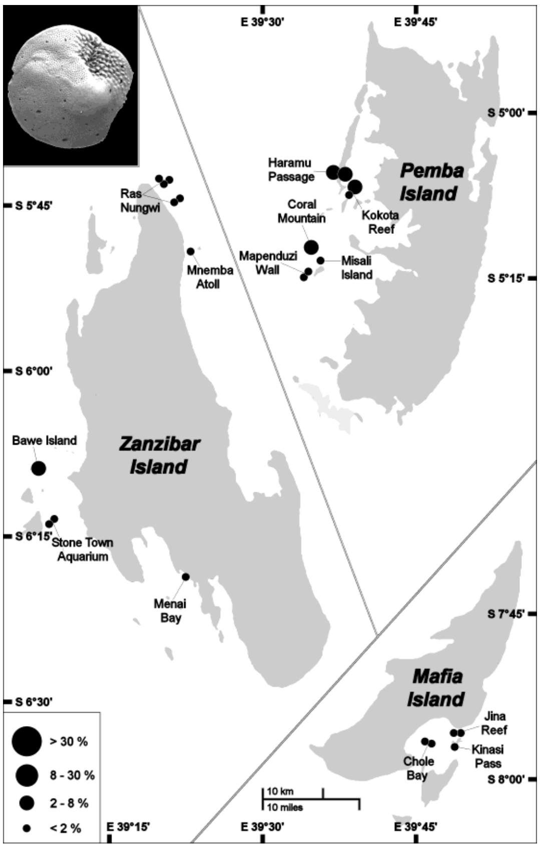

Fig. 178: Distribution of *Amphistegina radiata*.

Distribution: Most of the stations

Abundance: Rare to common

Depth: 1-42 m

Family Nonionidae Schultze, 1854

Genus *Nonionoides* Saidova, 1975

***Nonionoides grateloupi* (d'Orbigny)**
Plate 19, Figs. 21-23

1977b *Nonion grateloupi* (d'Orbigny) – Le Calvez, p. 53
1992 *Nonionoides grateloupi* (d'Orbigny) – Hatta and Ujiie, p. 196, pl. 43, figs. 1a-c
1993 *Nonionoides grateloupi* (d'Orbigny) – Hottinger et al., p. 138, pl. 195, figs. 4-13
1994 *Nonionoides grateloupi* (d'Orbigny) – Loeblich & Tappan, p. 158, pl. 342, figs. 1-5
1998 *Nonionoides grateloupi* (d'Orbigny) – Haunold & Piller, p. 30, pl. 11, fig. 11
2012 *Nonionoides grateloupi* (d'Orbigny) – Debenay, p. 227, 320, pl. 19

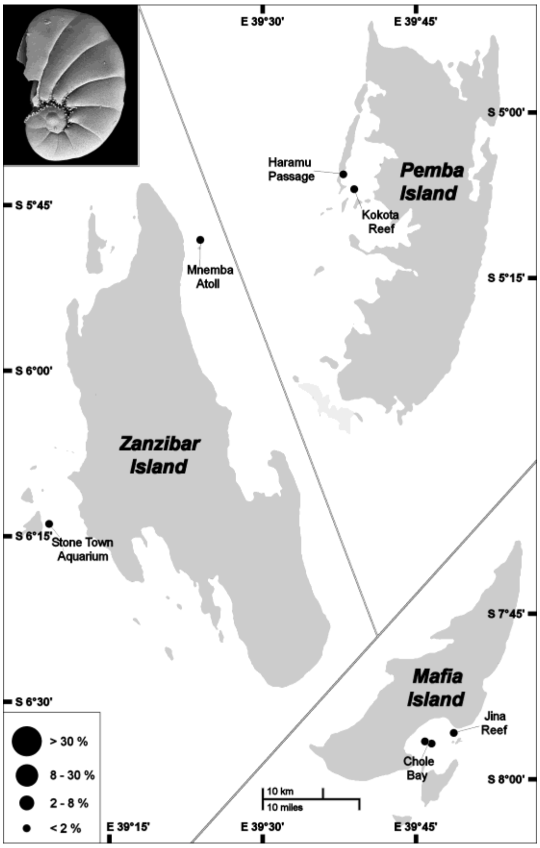

Fig. 179: Distribution of *Nonionoides grateloupi*.

Distribution: Few stations

Abundance: Rare

Depth: 12-30 m

Family Almaenidae Myatlyuk *in* Rauzer-Chernousova & Fursenko, 1959

Genus *Anomalinella* Cushman, 1927

***Anomalinella rostrata* (Brady)**
Plate 19, Figs. 24-26

1884 *Truncatulina rostrata* – Brady, p. 668, pl. 94, fig. 6
1915 *Truncatulina rostrata* Brady – Heron-Allen & Earland, p. 709, pl. 52, figs. 33-36
1961 *Anomalinella rostrata* (Brady) – Braga, p. 182, pl. 19, fig. 15
1965 *Anomalinella rostrata* (Brady) – Moura, p. 57, pl. 7, fig. 9

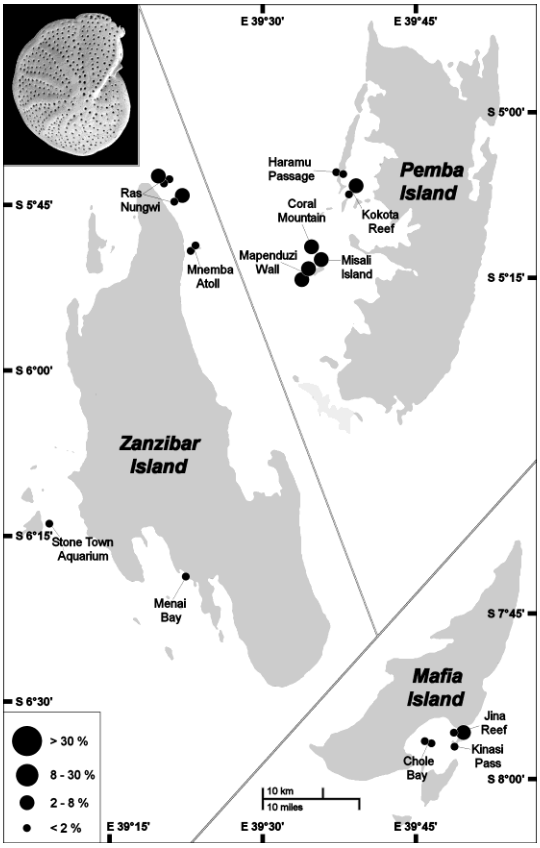

Fig. 180: Distribution of *Anomalinella rostrata*.

1965 *Anomalinella rostrata* (Brady) – Todd, p. 50, pl. 21, figs. 7-10
1988 *Anomalinella rostrata* (Brady) – Loeblich & Tappan, p. 623, pl. 700, figs. 8-12
1992 *Anomalinella rostrata* (Brady) – Hatta & Ujiie, p. 197, pl. 43, figs. 3a-b
1994 *Anomalinella rostrata* (Brady) – Loeblich & Tappan, p. 160, pl. 349, figs. 1-8
2011 *Anomalinella rostrata* (Brady) – Parker & Gischler, p. 45, pl. 4, figs. 16-17
2012 *Anomalinella rostrata* (Brady) – Debenay, p. 217, 320, pl. 19

Distribution: Most of the stations

Abundance: Rare to common

Depth: 1-42 m

Family Gavelinellidae Hofker, 1956

Genus *Anomalinulla* Saidova, 1975

***Anomalinulla glabrata* (Cushman)**
Plate 20, Figs. 1-3

1924 *Anomalina glabrata* – Cushman, p. 39, pl. 12, figs. 5-7
1993 *Anomalinulla glabrata* (Cushman) – Hottinger et al., p. 139, pl. 197, figs. 5-11
1998 *Anomalinulla glabrata* (Cushman) – Haunold & Piller, p. 31, pl. 11, fig. 15

Distribution: Mapenduzi Wall

Abundance: Rare

Depth: 40-42 m

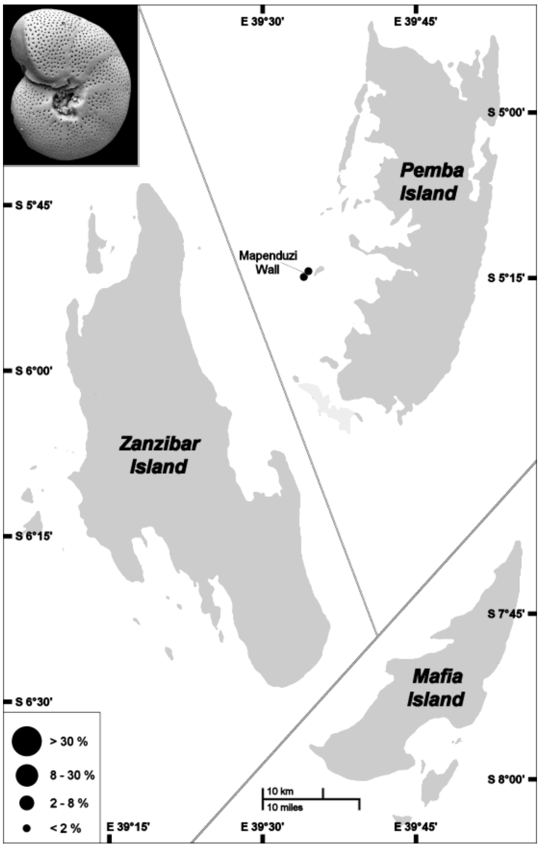

Fig. 181: Distribution of *Anomalinulla glabrata*.

Genus *Gyroidina* d'orbigny, 1826

***Gyroidina neosoldanii* Brotzen**
Plate 20, Figs. 4-6

1884 *Rotalia soldanii* d'Orbigny – Brady, p. 706, pl. 107, figs. 6-7
1915 *Rotalia soldanii* d'Orbigny – Heron-Allen & Earland, p. 719

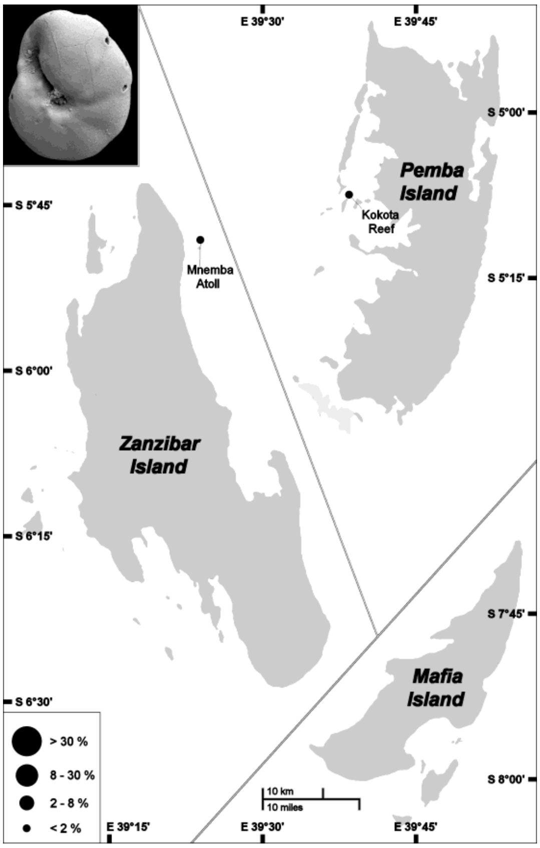

Fig. 182: Distribution of *Gyroidina neosoldanii*.

1977 *Gyroidina* cf. *neosoldanii* Brotzen – McCulloch, p. 371, pl. 139, figs. 5-8
1994 *Gyroidina neosoldanii* Brotzen – Loeblich & Tappan, p. 163, pl. 361, figs. 13-15, pl. 362, figs. 1-7

Distribution: Kokota Reef and Mnemba Atoll

Abundance: Rare

Depth: 16-30 m

Family Pararotaliidae Reiss, 1963

Genus *Neorotalia* Bermudéz, 1952

***Neorotalia calcar* (d'Orbigny)**
Plate 20, Figs. 7-12

1880 *Rotalia defrancei* (d'Orbigny) – Möbius, p. 104-105, pl. 14, figs. 1-7
1884 *Rotalia calcar* (d'Orbigny) – Brady, p. 709, pl. 108, figs. 3-4
1915 *Rotalia calcar* (d'Orbigny) – Heron-Allen & Earland, p. 720
1950 *Calcarina defrancii* d'Orbigny – Said, p. 8, pl. 1, fig. 26
1977b *Calcarina calcar* d'Orbigny – Le Calvez, p. 15
1982 *Calcarina calcar* d'Orbigny – Levy et al., p. 136, pl. 4, fig. 1
1984 *Calcarina calcar* d'Orbigny – Reiss & Hottinger, p. 246-247, figs. G28k-m
1991 *Neorotalia calcar* (d'Orbigny) – Hottinger et al., p. 23, figs. 4.1-4.6, 5.1-5.4, 6.1-6.6, 7.1-7.2
1992 *Calcarina calcar* d'Orbigny – Hatta & Ujiie, p. 200, pl. 45, figs. 1a-4c, 5
1993 *Neorotalia calcar* (d'Orbigny) – Hottinger et al., p. 140, pl. 199, figs. 1-10
1998 *Neorotalia calcar* (d'Orbigny) – Haunold & Piller, p. 31, pl. 12, fig. 1
2011 *Neorotalia calcar* (d'Orbigny) – Parker & Gischler, p. 48, pl. 6, figs. 1-4
2012 *Neorotalia calcar* (d'Orbigny) – Debenay, p. 204, 205, 323, pl. 18
2013a *Neorotalia calcar* (d'Orbigny) – Langer et al., fig. 8.27

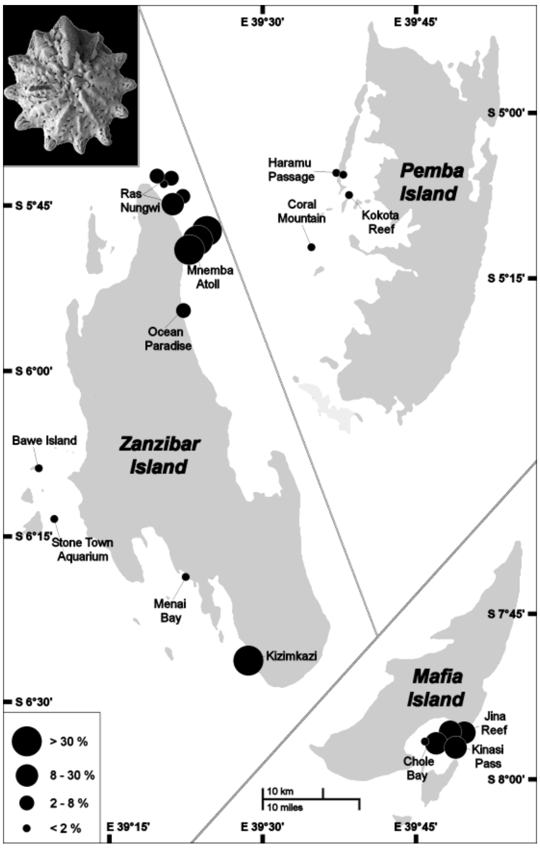

Fig. 183: Distribution of *Neorotalia calcar*.

Distribution: Most of the stations

Abundance: Rare to dominant

Depth: 1-35 m

Family Ammoniidae Saidova, 1981

Genus *Ammonia* Brünnich, 1772

***Ammonia convexa* (Collins)**
Plate 20, Figs. 13-16

1884 *Rotalia beccarii* (Linné) – Brady, p. 704, pl. 107, figs. 1-2
1915 *Rotalia beccarii* (Linné) – Heron-Allen & Earland, p. 717
1958 *Streblus convexus* – Collins, p. 414, pl. 5, fig. 10a-c
1979 *Ammonia* cf. *beccarii* (Linné) – Pereira, p. 261, pl. 35, figs. K-M
1984 *Ammonia convexa* (Collins) – Reiss & Hottinger, p. 244, fig. G28 e-j
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, pl. 205, fig. 1
1994 *Ammonia convexa* (Collins) – Loeblich & Tappan, p. 165, pl. 369, figs. 1-10
1998 *Ammonia convexa* (Collins) – Haunold & Piller, p. 31, pl. 12, fig. 2
2012 *Ammonia convexa* (Collins) – Debenay, p. 185, 322, pl. 14
2013a *Ammonia convexa* (Collins) – Langer et al., figs. 8.23-24

Distribution: Most of the stations

Abundance: Rare to dominant

Depth: 1-42 m

***Ammonia faceta* He, Hu & Wang**
Plate 20, Figs. 17-19

1987 *Monspeliensina japonica* (Uchio) – Baccaert, p. 235, pl. 95, figs. 6-7, pl. 96, figs. 1a-c
2009 *Ammonia faceta* He, Hu & Wang – Parker, p. 481, figs. 346a-m

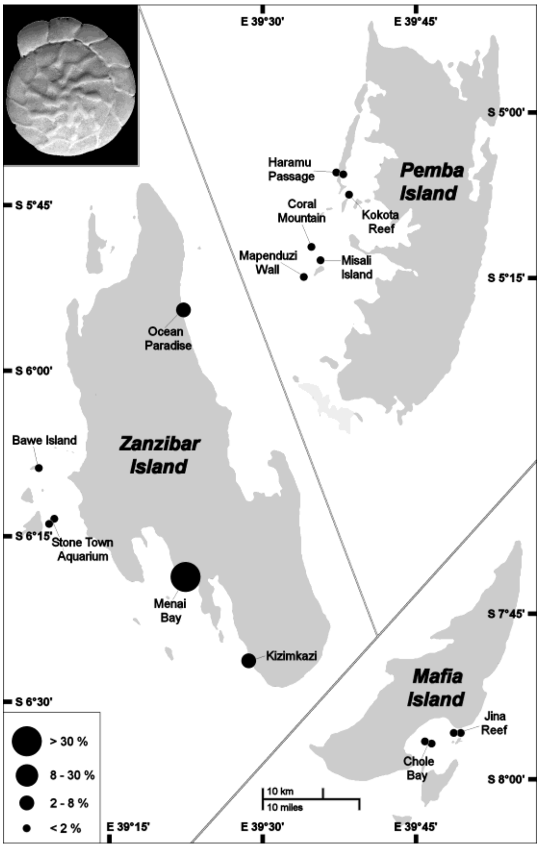

Fig. 184: Distribution of *Ammonia convexa*.

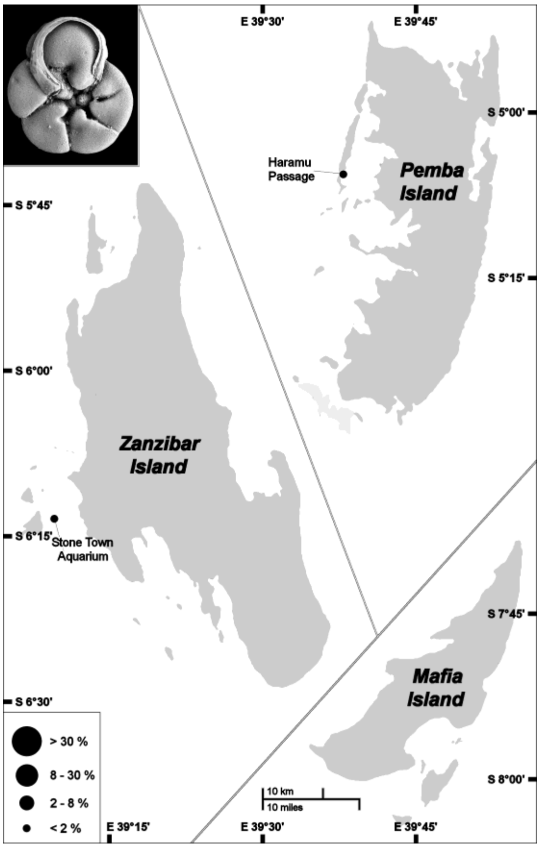

Fig. 185: Distribution of *Ammonia faceta*.

Distribution: Haramu Passage and Stone Town Aquarium

Abundance: Rare

Depth: 20 m

Genus *Challengerella* Billman, Hottinger, & Oesterle, 1980

Challengerella bradyi **Billman, Hottinger, & Oesterle**
Plate 20, Figs. 20-22

1949 *Rotalia beccarii* (Linné) – Said, p. 37, pl. 4, fig. 5
1980 *Challengerella bradyi* – Billman, Hottinger, & Oesterle, p. 91, text fig. 17, pl. 12, figs. 1-6, 8-10, 13-14, pl. 13, not pl. 12, figs. 7, 12
1984 *Challengerella bradyi* Billman, Hottinger, & Oesterle – Reiss & Hottinger, p. 244, fig. G28 a-d
1993 *Challengerella bradyi* Billman, Hottinger, & Oesterle – Hottinger et al., p. 144, pl. 204, figs. 1-13, pl. 205, figs. 2-7
1998 *Challengerella bradyi* Billman, Hottinger, & Oesterle – Haunold & Piller, p. 31, pl. 12, fig. 4

Distribution: Few stations

Abundance: Rare to common

Depth: 1-30 m

Genus *Pseudoeponides* Uchio, 1950

Pseudoeponides falsobeccarii **Rouvillois**
Plate 20, Figs. 23-25

1974 *Pseudoeponides falsobeccarii* – Rouvillois, p. 4, pl. 1, figs. 1-12
1993 *Pseudoeponides falsobeccarii* Rouvillois – Hottinger et al., p. 145, pl. 206, figs. 1-10

Distribution: Three stations

Abundance: Rare

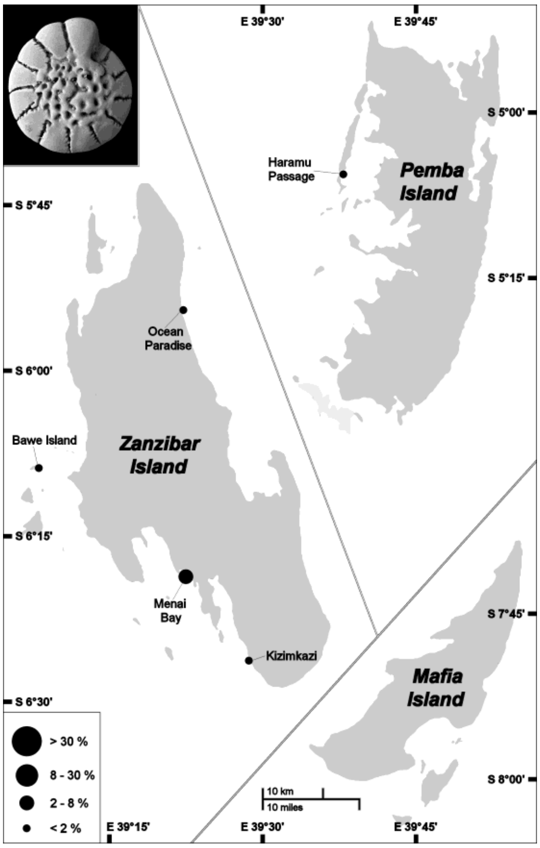

Fig. 186: Distribution of *Challengerella bradyi*.

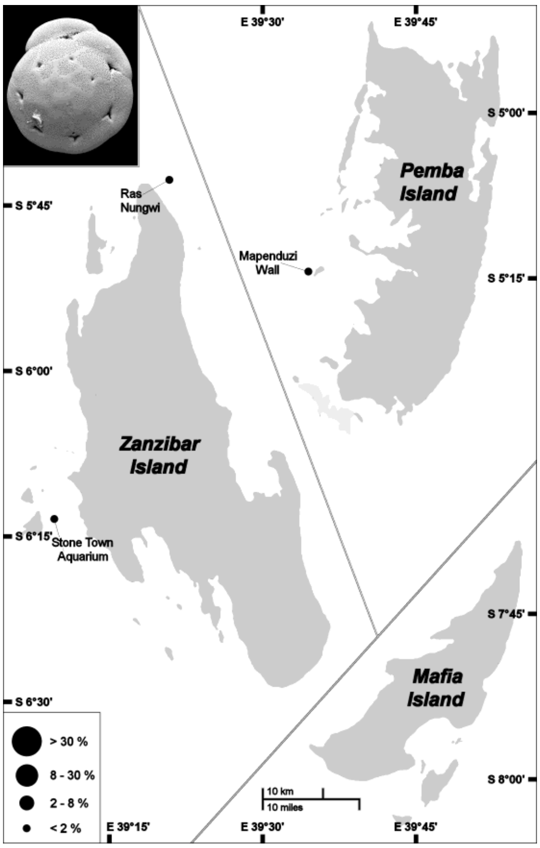

Fig. 187: Distribution of *Pseudoeponides falsobeccarii*.

Depth: 20-40 m

Family Elphidiidae Galloway, 1933

Genus *Elphidium* De Montfort, 1808

***Elphidium jenseni* Cushman**
Plate 21, Figs. 1-3

1975 *Elphidium jenseni* Cushman – Seibold, p. 195, pl. 3, fig. 3
1991 *Elphidium jenseni* Cushman – Cimerman & Langer, p. 78, pl. 92, figs. 1-3
1992 *Elphidium jenseni* Cushman – Hatta & Ujiie, p. 203, pl. 49, figs. 6a-b
1993 *Elphidium jenseni* Cushman – Hottinger et al., p. 148, pl. 211, figs. 8-14
1994 *Elphidium jenseni* Cushman – Loeblich & Tappan, p. 169, pl. 381, figs. 1-5
1998 *Elphidium jenseni* Cushman – Haunold & Piller, p. 31, pl. 12, fig. 7
2013a *Elphidium jenseni* Cushman – Langer et al., figs. 8.28-29

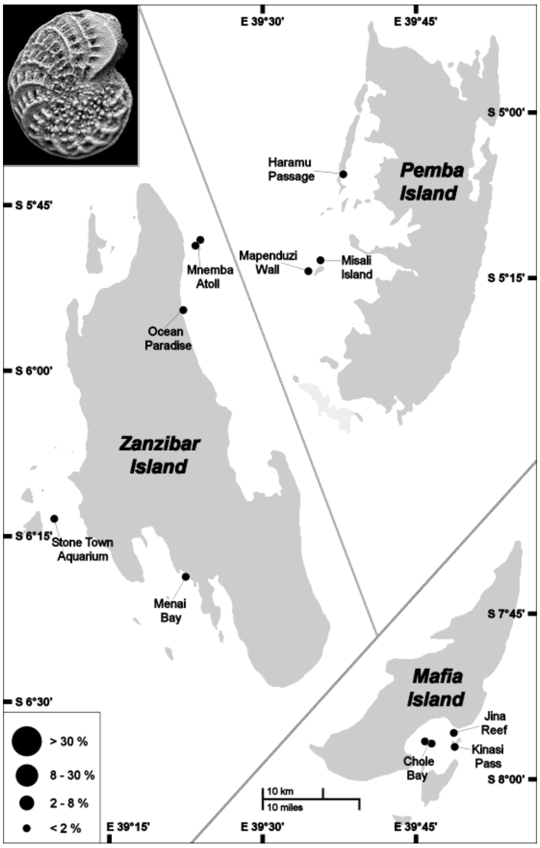

Fig. 188: Distribution of *Elphidium jenseni*.

Distribution: Several stations

Abundance: Rare

Depth: 1-40 m

***Elphidium limbatum* sp. 1 (Chapman)**
Plate 21, Figs. 4-6

1979 *Elphidium macellum* (Fichtel & Moll) – Pereira, pl. 37, fig. J
1982 *Elphidium macellum limbatum* (Chapman) – Neagu, p. 127, pl. 9, figs. 9-10
1993 *Elphidium* cf. *E. limbatum* (Chapman) – Hottinger et al., p. 149, pl. 212, figs. 1-9
1998 *Elphidium* cf. *E. limbatum* (Chapman) – Haunold & Piller, p. 31, pl. 12, fig. 8
2012 *Elphidium limbatum* (Chapman) – Debenay, p. 220, 324, pl. 19

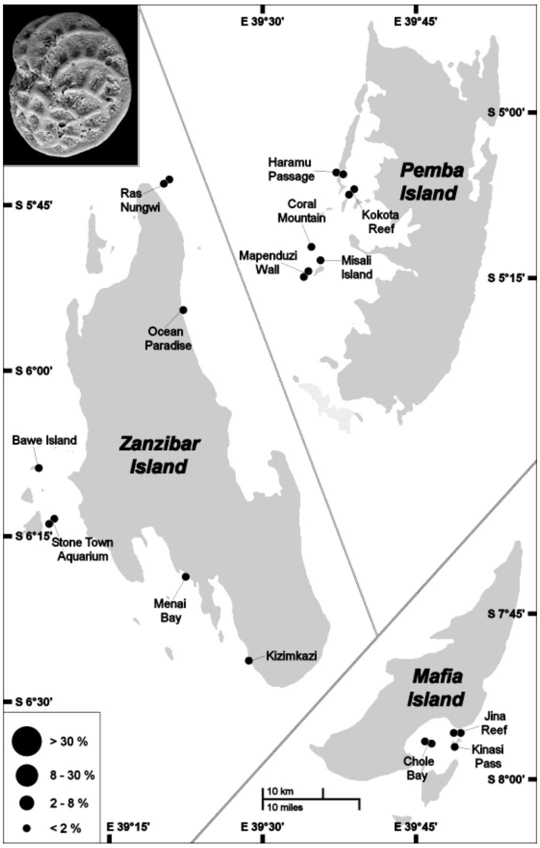

Fig. 189: Distribution of *Elphidium limbatum* sp. 1.

Distribution: Most of the stations

Abundance: Rare

Depth: 1-42 m

Elphidium limbatum sp. 2 (Chapman)
Plate 21, Figs. 7-9

1979 *Elphidium macellum* (Fichtel & Moll) – Pereira, pl. 37, fig. J
1982 *Elphidium macellum limbatum* (Chapman) – Neagu, p. 127, pl. 9, figs. 9-10
1993 *Elphidium* cf. *E. limbatum* (Chapman) – Hottinger et al., p. 149, pl. 212, figs. 1-9
1998 *Elphidium* cf. *E. limbatum* (Chapman) – Haunold & Piller, p. 31, pl. 12, fig. 8
2012 *Elphidium limbatum* (Chapman) – Debenay, p. 220, 324, pl. 19

Distribution: Most of the stations

Abundance: Rare to frequent

Depth: 1-42 m

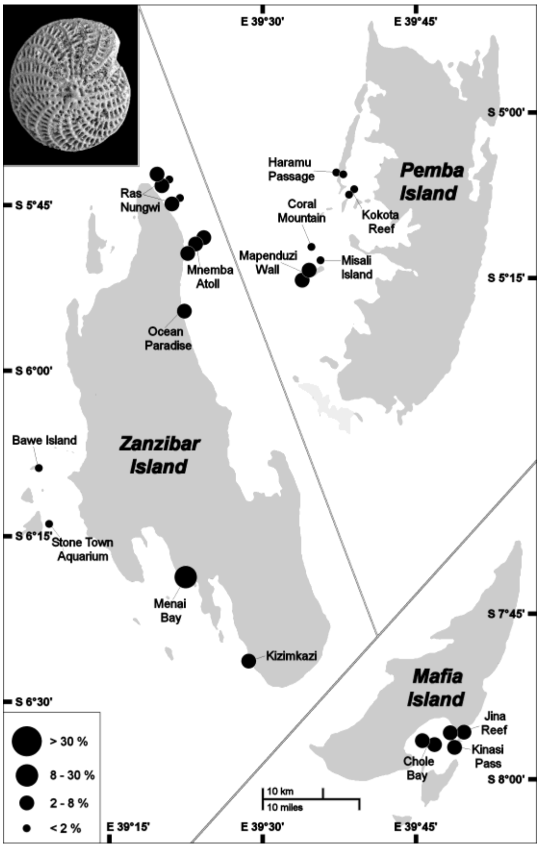

Fig. 190: Distribution of *Elphidium limbatum* sp. 2.

Elphidium lunatum Langer (in prep.)
Plate 21, Figs. 10-12

Distribution: Several stations, mainly on Pemba

Abundance: Rare to common

Depth: 1-42 m

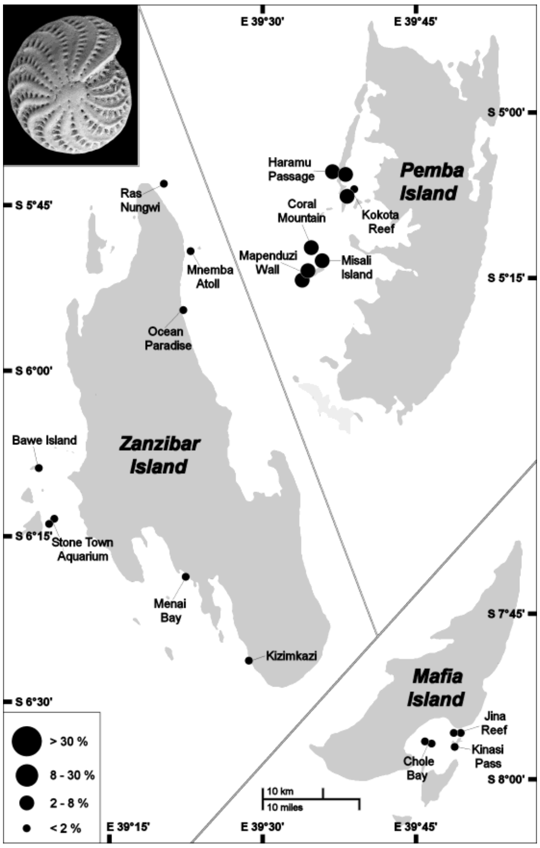

Fig. 191: Distribution of *Elphidium lunatum*.

Elphidium milletti (Heron-Allen & Earland)
Plate 21, Figs. 13-16

1915 *Polystomella milletti* – Heron-Allen & Earland, p. 735, pl. 53, figs. 38-42
1979 *Elphidium milletti* (Heron-Allen & Earland) – Pereira, pl. 37, figs. K-M
1987 *Parrellina milletti* (Heron-Allen & Earland) – Baccaert, p. 262, pl. 100, figs. 4-5, pl. 101, figs. 1-2
1993 *Parrellina* ? cf. *P.*? *milletti* (Heron-Allen & Earland) – Hottinger et al., pl. 218, figs. 5-9, pl. 219, figs. 1-4
1994 *Cristatavultus milletti* (Heron-Allen & Earland) – Loeblich & Tappan, p. 168, pl. 377, figs. 1-6
1998 *Parrellina* ? cf. *P.*? *milletti* (Heron-Allen & Earland) – Haunold & Piller, p. 32, pl. 12, fig. 14
2009 *Elphidium milletti* (Heron-Allen & Earland) – Parker, p. 582, figs. 411a-i, 412a-f
2012 *Elphidium milletti* (Heron-Allen & Earland) – Debenay, p. 221, p. 324

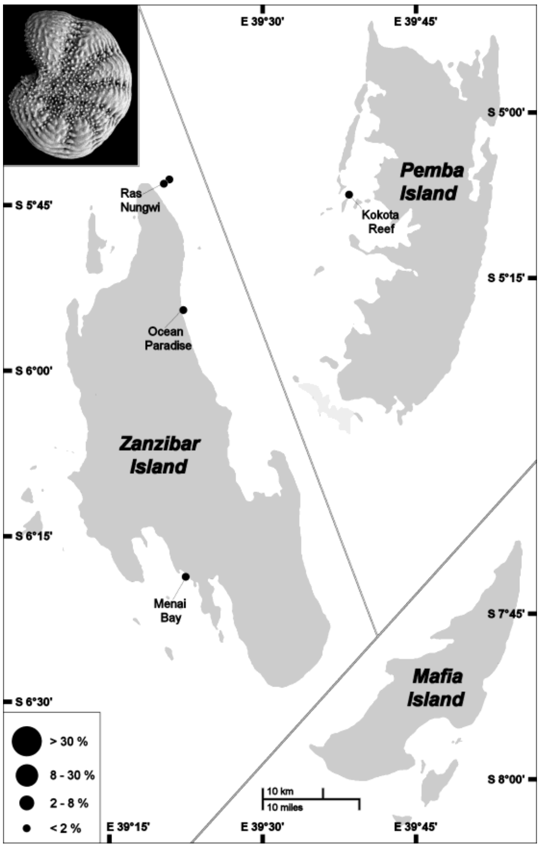

Fig. 192: Distribution of *Elphidium milletti*.

Distribution: Few stations

Abundance: Rare

Depth: 1-20 m

Elphidium striatopunctatum Fichtel & Moll
Plate 21, Figs. 17-19

1798 *Nautilus striato-punctatus* – Fichtel & Moll, p. 61, pl. 9, figs. a-c
1915 *Polystomella striato-punctata* (Fichtel & Moll) – HeronAllen & Earland, p. 732
1976 *Elphidium striatopunctatum* (Fichtel & Moll) – Hansen & Lykke-Andersen, p. 8, pl. 3, figs. 11-12, pl. 4, figs. 1-7
1984 *Elphidium striatopunctatum* (Fichtel and Moll) – Rögl and Hansen, p. 45, pl. 12, figs. 3-4
1993 *Elphidium striatopunctatum* (Fichtel and Moll) – Hottinger et al., p. 149, pl. 213, figs. 1-8, pl. 214, figs. 1-6

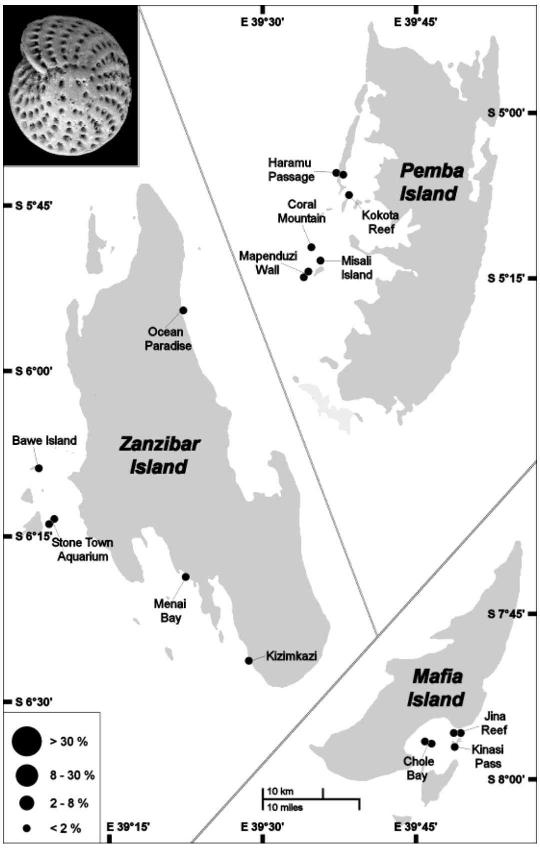

Fig. 193: Distribution of *Elphidium striatopunctatum*.

Distribution: Several stations

Abundance: Rare

Depth: 1-42 m

Elphidium tongaense Cushman

Plate 21, Figs. 20-22

1931 *Ozawaia tongaensis* – Cushman, p. 80, pl. 10, figs. 7-10
1939 *Ozawaia tongaensis* Cushman – Cushman, p. 67, pl. 19, figs. 5-8
2012 *Elphidium tongaense* (Cushman) – Debenay, p. 221, p. 325

Distribution: Few stations

Abundance: Rare to common

Depth: 1-42 m

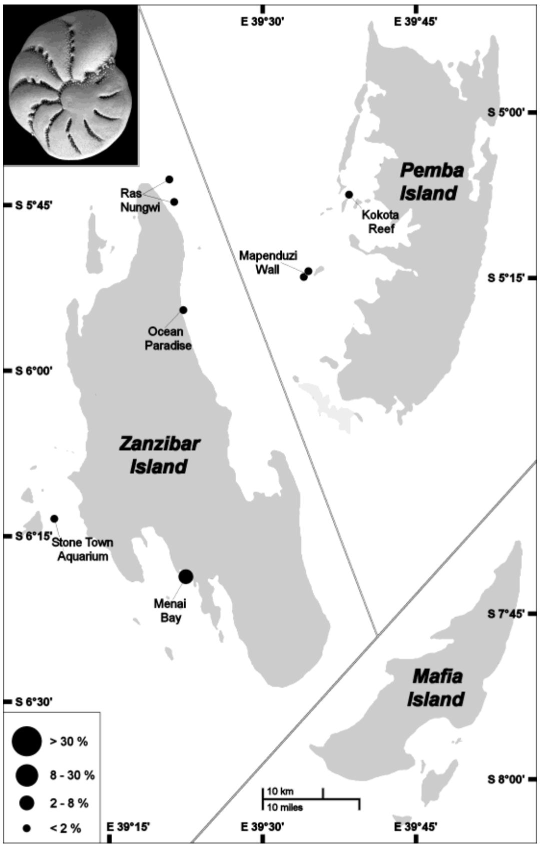

Fig. 194: Distribution of *Elphidium tongaense*.

Elphidium voorthuyseni Haake

Plate 21, Figs. 23-25

1962 *Elphidium voorthuyseni* – Haake, p. 50, pl. 5, figs. 6-7
1976 *Elphidium voorthuyseni* – Hansen & Lykke-Andersen, p. 9, pl. 4, figs. 8-12
1993 Elphidiid genus 2 sp. E – Hottinger et al., p. 152, pl. 217, figs. 7-10, pl. 218, figs. 1-4

Distribution: Two stations

Abundance: Rare

Depth: 3-20 m

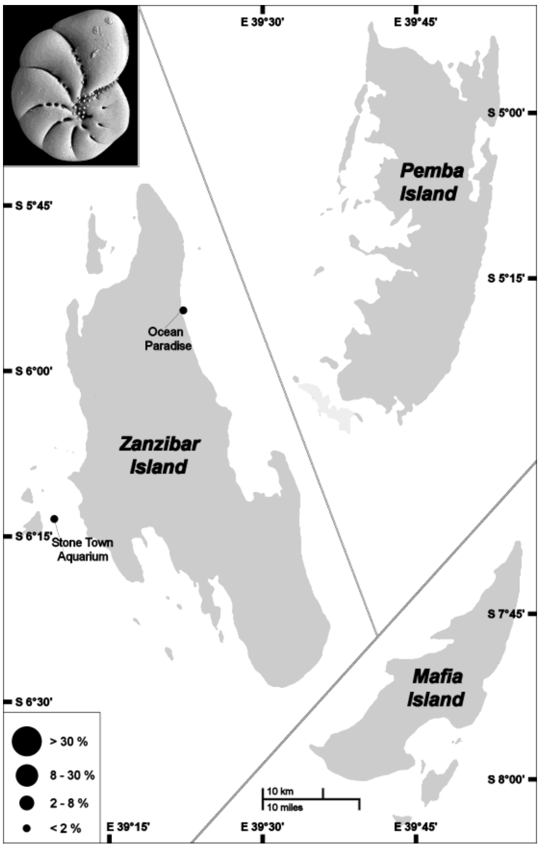

Fig. 195: Distribution of *Elphidium voorthuyseni*.

Family Nummulitidae de Blainville, 1827

Genus *Assilina* d'Orbigny, 1839

Assilina ammonoides **(Gronovius)**
Plate 22, Figs. 1-5

1884 *Operculina complanata* (Defrance) – Brady, p. 749, pl. 112, figs. 3-9
1915 *Operculina ammonoides* (Gronovius) – Heron-Allen & Earland, p. 737
1949 *Operculina gaimardi* d'Orbigny – Said, p. 24, pl. 2, fig. 37
1961 *Operculina complanata* (Defrance) – Braga, p. 130, pl. 13, fig. 13
1982 *Operculina ammonoides* (Gronovius) – Neagu, p. 127, pl. 12, figs. 1-3
1992 *Operculina ammonoides* (Gronovius) – Hatta & Ujiie, p. 205, pl. 50, figs. 7a-b
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
1994 *Assilina ammonoides* (Gronovius) – Loeblich & Tappan, p. 170, pl. 387, figs. 7-9, pl. 388, figs. 1-4
1998 *Operculina ammonoides* (Gronovius) – Haunold, Baal & Piller, p. 158, pl. 5, figs. 5-8
2011 *Operculina ammonoides* (Gronovius) – Parker & Gischler, p. 47, pl. 5, figs. 23-24
2012 *Operculina ammonoides* (Gronovius) – Debenay, p. 228, 326, pl. 20

Distribution: Most of the stations

Abundance: Rare

Depth: 1-42 m

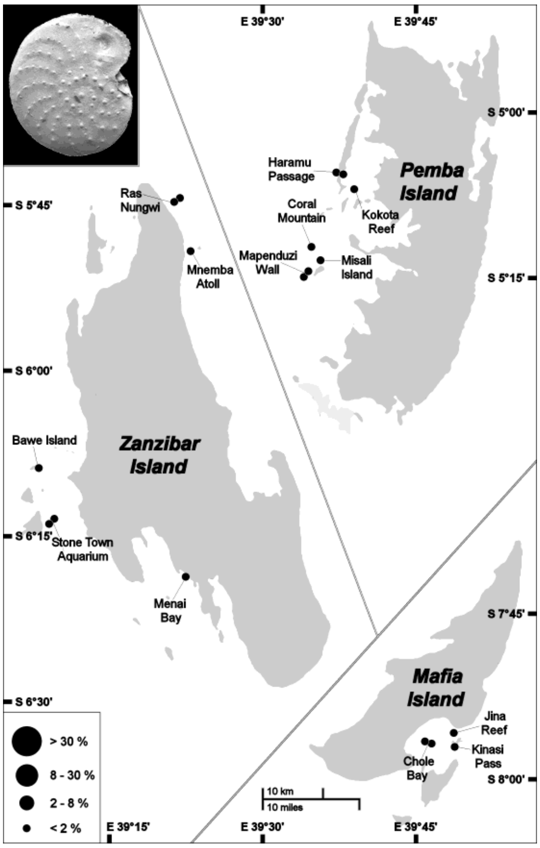

Fig. 196: Distribution of *Assilina ammonoides.*

Assilina discoidalis **(d'Orbigny)**
Plate 22, Figs. 6-8

1826 *Nummulina (Assiline) discoidalis* – d'Orbigny, p. 296
1865 *Nummulina (Assiline) discoidalis* d'Orbigny – Parker, Jones & Brady, p. 33, pl. 3, fig. 94
2009 *Assilina discoidalis* (d'Orbigny) – Parker, p. 519, figs. 368a-e

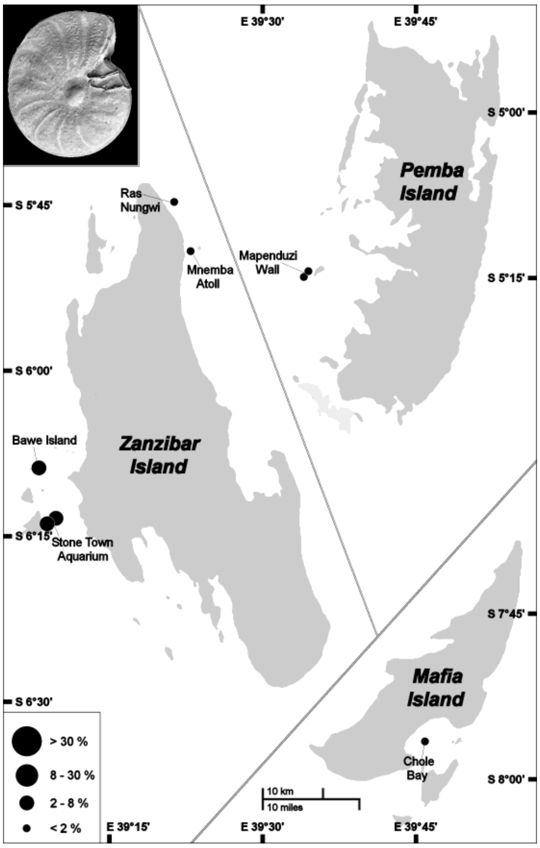

Fig. 197: Distribution of *Assilina discoidalis.*

2012 *Operculina discoidalis* (d'Orbigny) – Debenay, p. 228, p. 326

Distribution: Several stations

Abundance: Rare to common

Depth: 9-42 m

Genus *Heterostegina* d'Orbigny, 1826

***Heterostegina depressa* d'Orbigny**
Plate 22, Figs. 9-15

1826 *Heterostegina depressa* – d'Orbigny, p. 305, pl. 17, figs. 5-7
1880 *Heterostegina curva* – Möbius, p. 105, pl. 13, figs. 1-6
1884 *Heterostegina depressa* d'Orbigny – Brady, p. 746, pl. 112, figs. 14-18
1915 *Heterostegina depressa* d'Orbigny – Heron-Allen & Earland, p. 738
1949 *Heterostegina suborbicularis* d'Orbigny – Said, p. 24, pl. 2, fig. 40
1984 *Heterostegina depressa* d'Orbigny – Reiss & Hottinger, p. 230, figs. G19b, G22, G23
1992 *Heterostegina depressa* d'Orbigny – Hatta & Ujiie, p. 204, pl. 50, figs. 4a-b
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 & Tappan, p. 171, pl. 389, figs. 1-6, pl. 390, figs. 1-3
1998 *Heterostegina depressa* d'Orbigny – Haunold, Baal & Piller, p. 158, pl. 5, figs. 1-4
2011 *Heterostegina depressa* d'Orbigny – Parker & Gischler, p. 47, pl. 5, figs. 27-28
2012 *Heterostegina depressa* d'Orbigny – Debenay, p. 222, 325, pl. 20
2013a *Heterostegina depressa* d'Orbigny – Langer et al., fig. 8.39

Distribution: Most of the stations

Abundance: Rare to frequent

Depth: 1-42 m

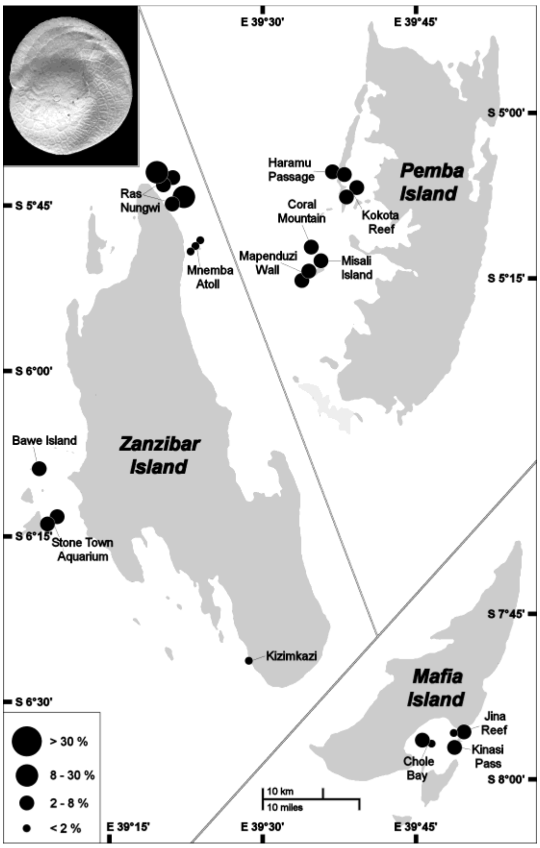

Fig. 198: Distribution of *Heterostegina depressa.*

4.3 Cluster analyses

All of the 27 samples have been determined in a Q-mode cluster analysis for their similarity in terms of faunal composition (Fig. 199), which is reflected in the corresponding assemblages of the R-mode cluster analyses on genus level as well as on species level (Figs. 209 & 210). The map reveals the locations of the clusters (Fig. 200).

4.3.1 Q-mode cluster analysis

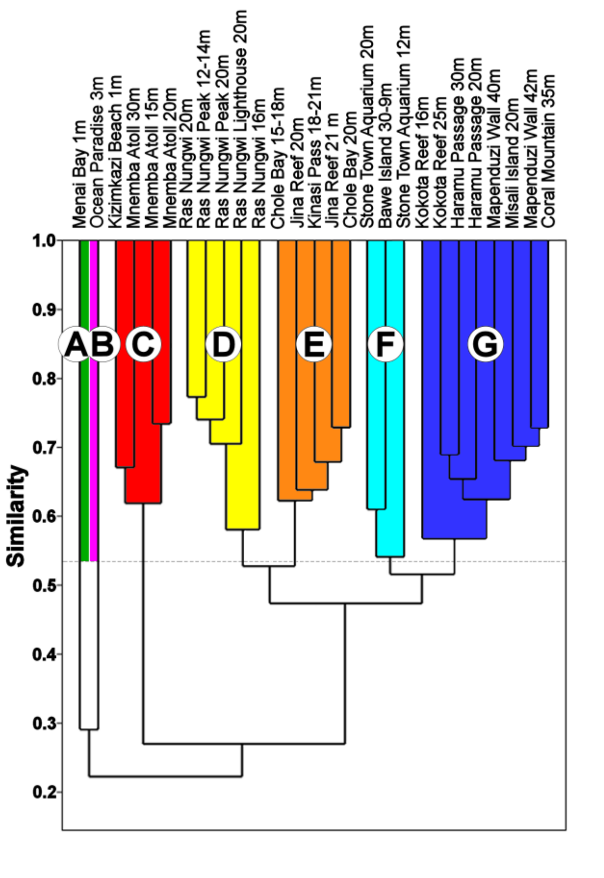

Fig. 199: Q-mode cluster analysis.

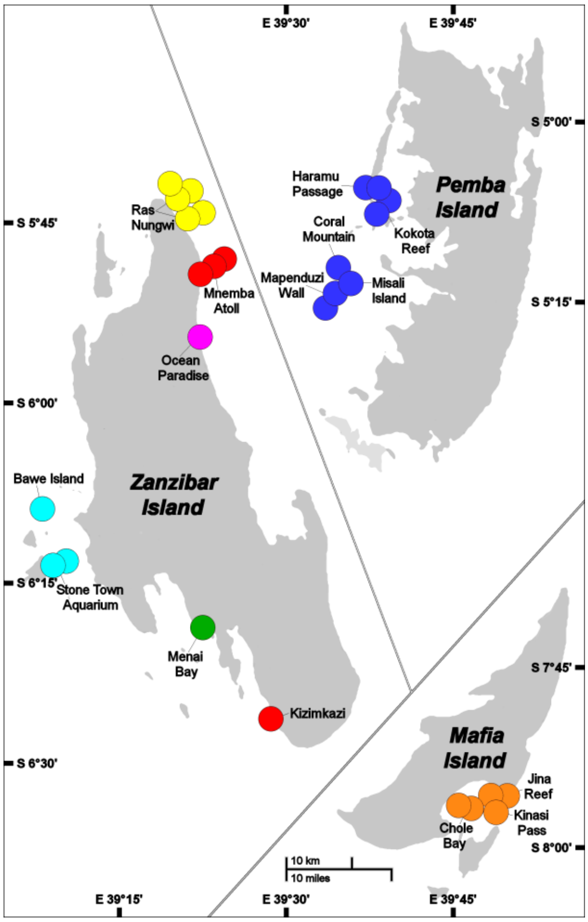

Fig. 200: Map of the locations of the seven clusters.

Cluster A (green) – Mangroves at Menai Bay:

The sample from Menai Bay is the only mangrove habitat. The station is located at the southwestern coast of Zanzibar Island (Fig. 200). It is characterized by opportunistic species, which are able to withstand eutrophic conditions to a certain level, like *Ammonia convexa*, *Quinqueloculina patagonica* or *Elphidium limbatum* sp. 2. This habitat at a depth of 1 m is with 35 species the least diverse. The most abundant species are *A. convexa* (31.5 %), *Q. patagonica* (15.9 %), *E. limbatum* sp. 2 (11.1 %), *Quinqueloculina* cf. *Q. vulgaris* (9.3 %), *Amphistegina lobifera* (8.7 %), and *Triloculina asymmetrica* (4.4 %) (Fig. 201).

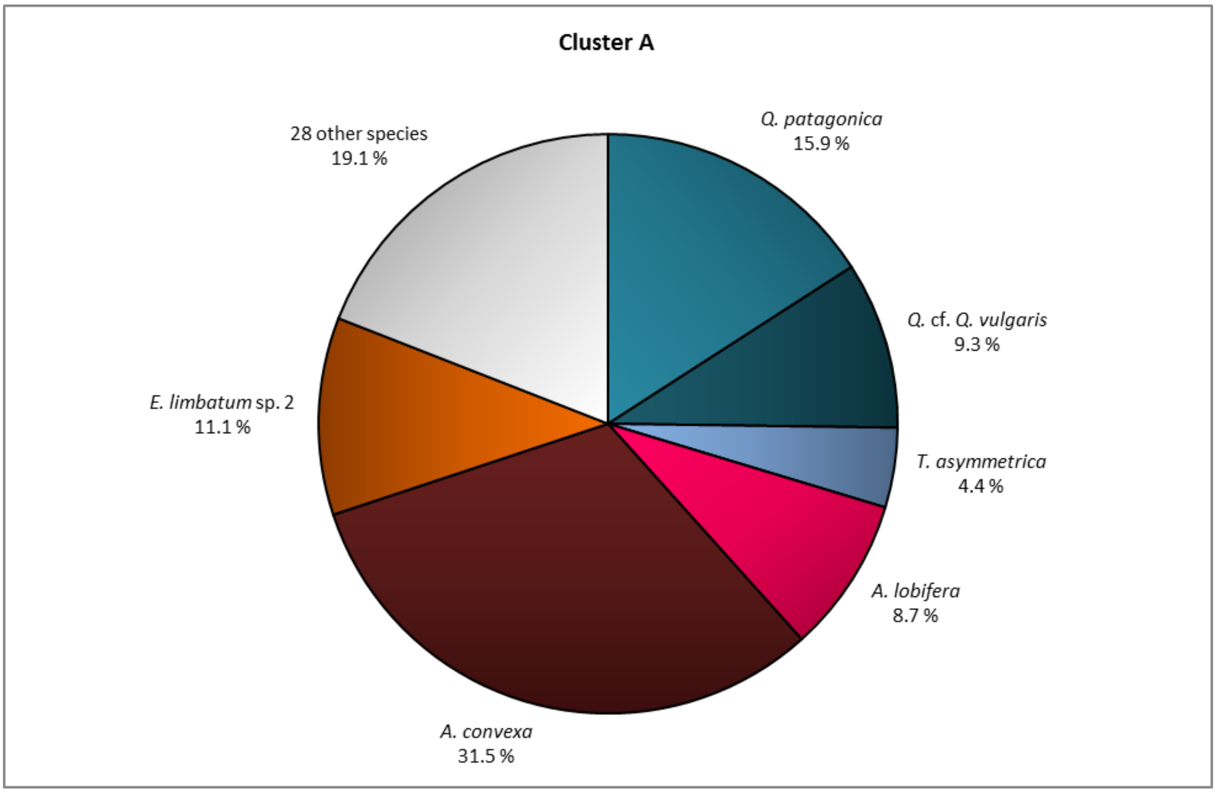

Fig. 201: Pie chart showing the percentages of the most abundant species at Menai Bay (Cluster A).

Cluster B (pink) – Lagoon at Ocean Paradise:

The shallow lagoon at Ocean Paradise on the eastern coast of Zanzibar Island is mainly characterized by smaller miliolids like *Triloculina asymmetrica* or *Quinqueloculina* cf. *Q. multimarginata*. Another relevant species in this sample is *Rotorbis auberii*. 53 species were found in the lagoon at a depth of 3 m. The most abundant species at Ocean Paradise are *T. asymmetrica* (13.9 %), *R. auberii* (12.7 %), *T. trigonula* (11.5 %), *Q.* cf. *Q. multimarginata* (10.1 %), *Ammonia convexa* (4.9 %), *Quinqueloculina* cf. *Q. vulgaris* (4.4 %), *Neorotalia calcar* (4.2 %), and *Quinqueloculina patagonica* (4.2 %) (Fig. 202).

Cluster C (red) – Reef flats at Kizimkazi and Mnemba Atoll:

The sample from Kizimkazi Beach and the three samples from Mnemba Atoll constitute Cluster C. These stations are located at the southern coast of Zanzibar Island and at the small island of Mnemba, east of Zanzibar (Fig. 200). The reef flats are characterized by *Neorotalia calcar* and accompanying *Peneroplis pertusus* and *Sorites orbiculus*. Altogether 80 species were obtained from four samples at depths of 1-30 m. This habitat is dominated by *N. calcar* (62.4 %); other abundant species are *Amphistegina lessonii* (4.9 %), *Elphidium limbatum* sp. 2 (4.2 %), *Quinqueloculina* cf. *Q. vulgaris* (3.8 %), *S. orbiculus* (3.2 %), *Textularia agglutinans* (1.8 %), and *Peneroplis pertusus* (1.5 %) (Fig. 203).

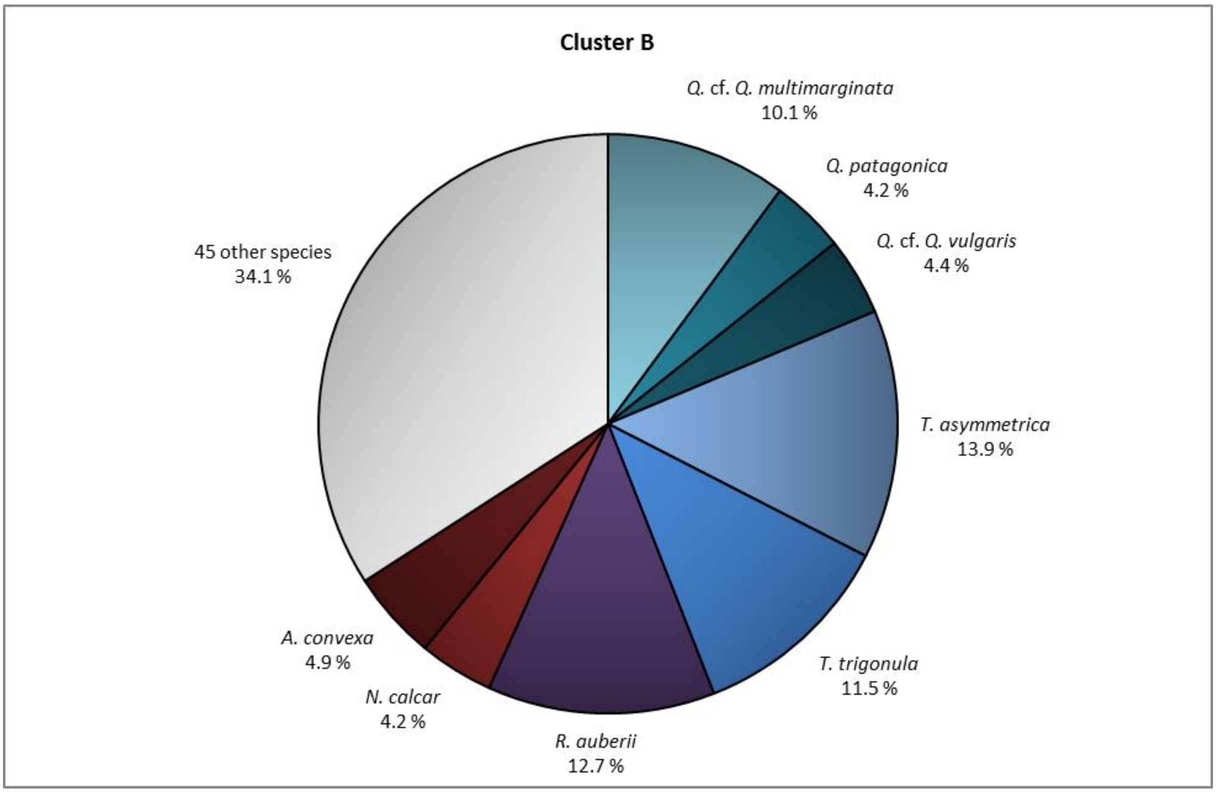

Fig. 202: Pie chart showing the percentages of the most abundant species at Ocean Paradise (Cluster B).

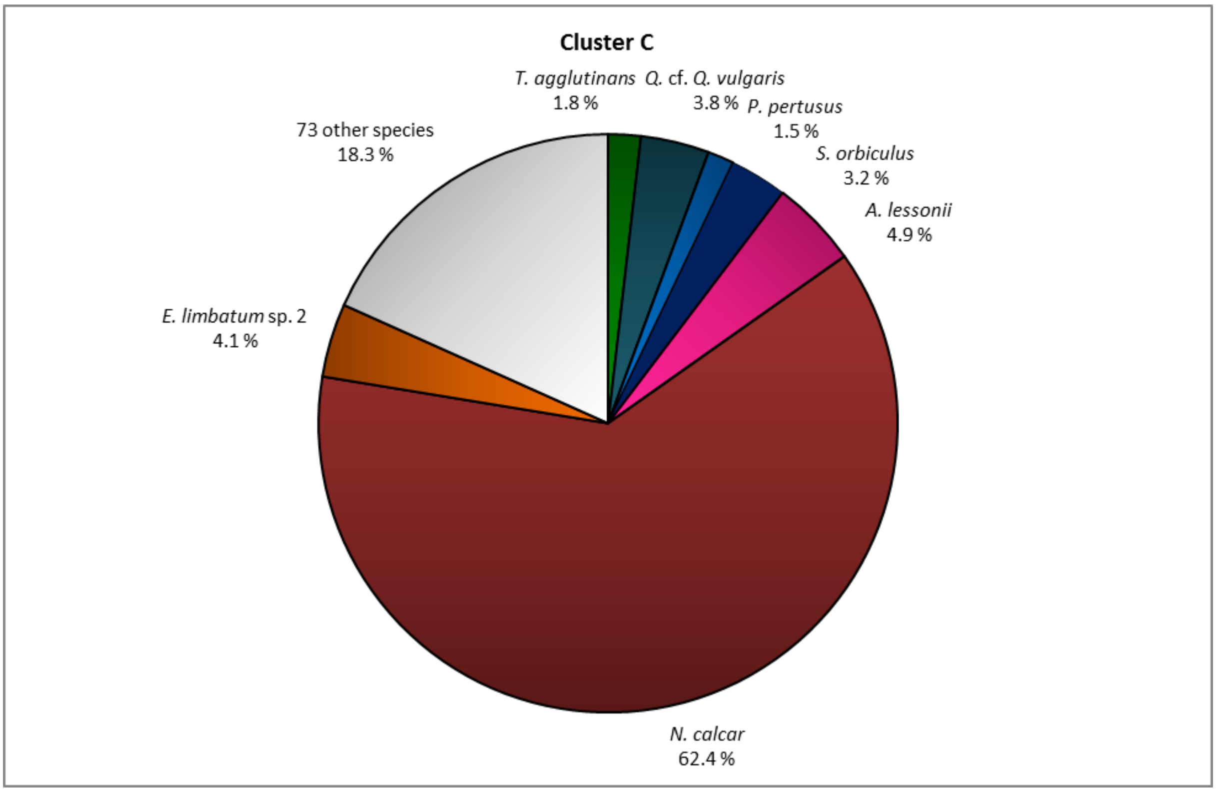

Fig. 203: Pie chart showing the percentages of the most abundant species in the samples of Cluster C.

Cluster D (yellow) – Fringing reef at Ras Nungwi:

The fringing reef cluster consists of the five samples from Ras Nungwi at the northwestern tip of Zanzibar Island (Fig. 200). *Amphistegina lobifera*, *Heterostegina depressa* and *Amphisorus hemprichii* are the characteristic taxa for this habitat. 94 species were obtained from the samples at Ras Nungwi from depths of 12-20 m. The similarity to the apron reefs at Mafia (both eastern reefs) is quite distinct and resembles the faunal content. The most abundant species in the samples from Ras Nungwi are *A. lobifera* (28.7 %), *Amphistegina lessonii* (14.9 %), *H. depressa* (6.9 %), *Quinqueloculina* cf. *Q. vulgaris* (5.5 %), *Neorotalia calcar* (5.4 %), *Textularia agglutinans* (5.1 %), and *Amphisorus hemprichii* (1.6 %) (Fig. 204).

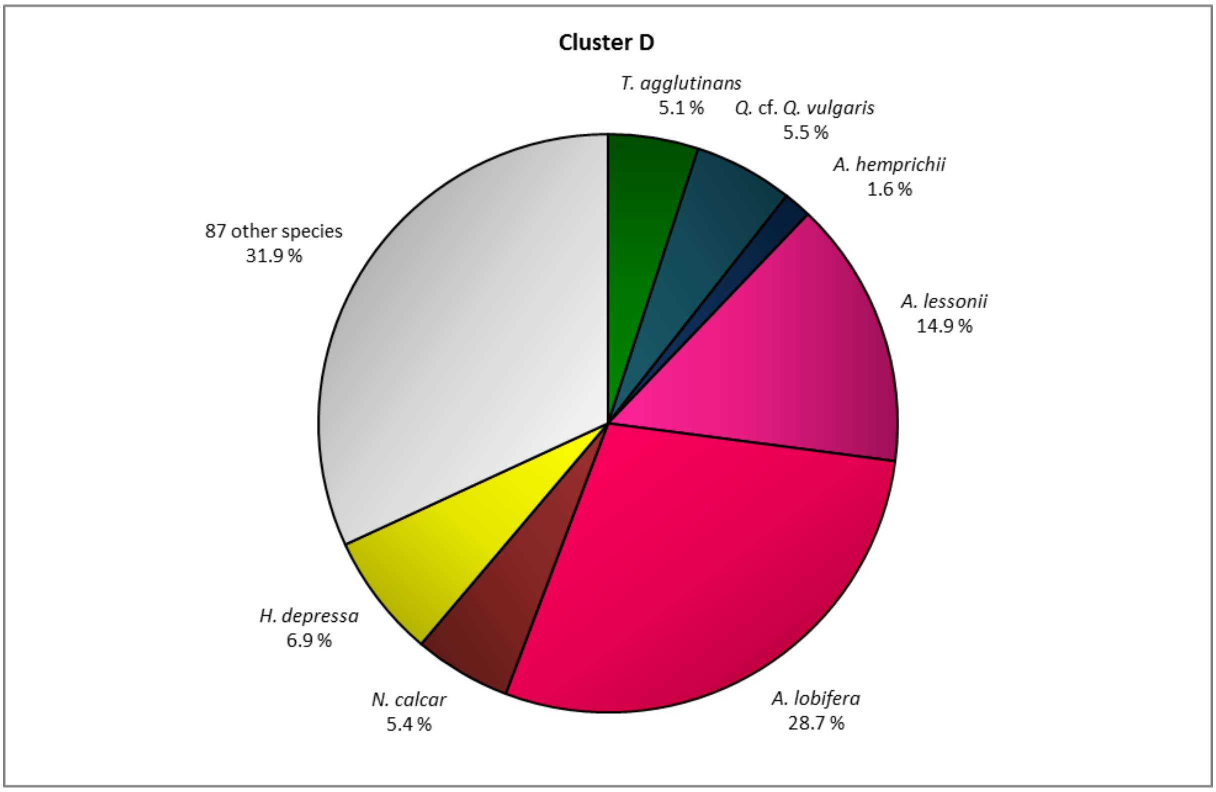

Fig. 204: Pie chart showing the percentages of the most abundant species in the samples of Cluster D.

Cluster E (orange) – Apron reefs at Mafia Island:

The five samples from Mafia Island form the apron reef cluster (Fig. 199 & 200). Characteristic species for this cluster are *Amphistegina lessonii* and *A. bicirculata*. The apron reef samples at Mafia from depths of 15-21 m contained 102 species. *A. lessonii* (21.1 %), *Neorotalia calcar* (11.6 %), *Amphistegina lobifera* (9.6 %), *A. bicirculata* (7.1 %), *Quinqueloculina* cf. *Q. vulgaris* (6.3 %), *Sorites orbiculus* (3.9 %), and *Textularia agglutinans* (3.8 %) are the most abundant species in the samples of Cluster E (Fig. 205).

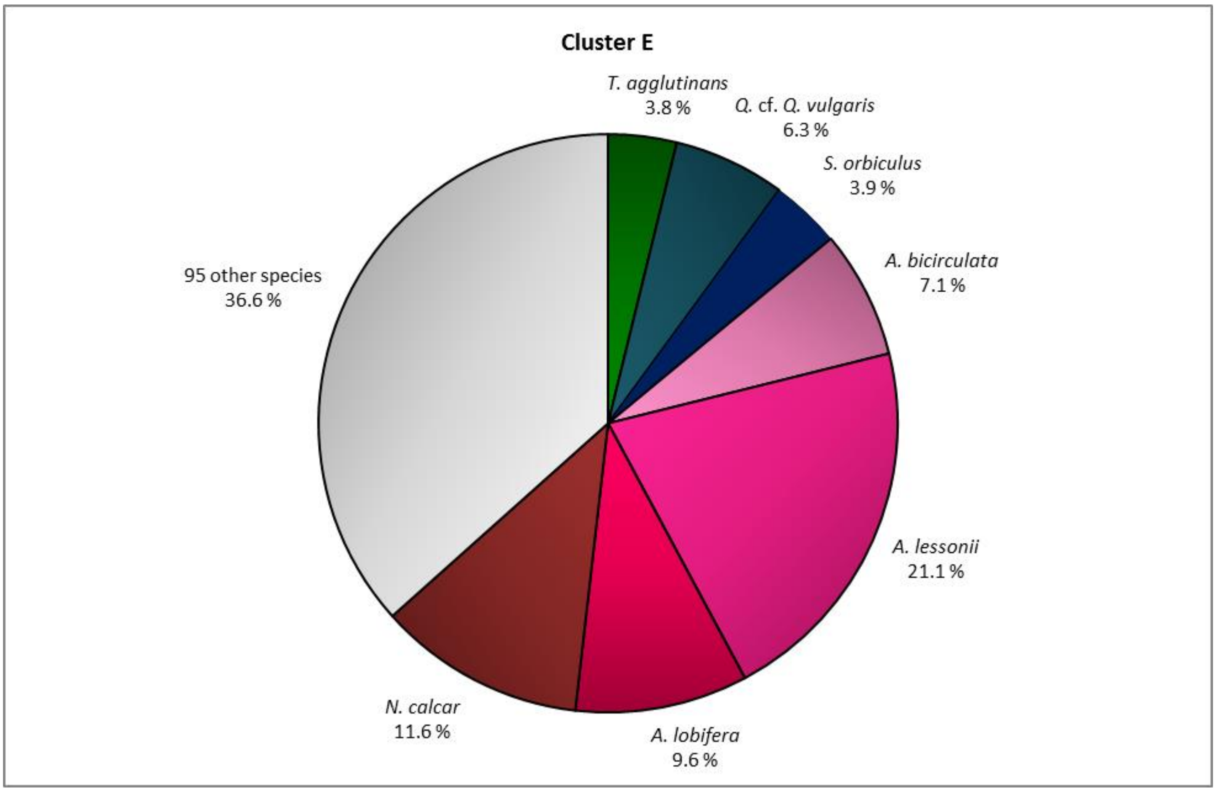

Fig. 205: Pie chart showing the percentages of the most abundant species in the samples of Cluster E.

Cluster F (cyan) – Patch reefs west of Zanzibar:

The patch reefs at Bawe Island and in the Stone Town Aquarium are characterized by three species which almost exclusively occur at these three stations: *Textularia foliacea*, *Triloculina trigonula* and *Assilina discoidalis*. 120 species were found in depths of 9-30 m in these stations from west of Zanzibar Island (Fig. 200). The most abundant species are *Amphistegina lessonii* (11.1 %), *T. trigonula* (8.8 %), *A. bicirculata* (8.2 %), *Textularia agglutinans* (7.6 %), *Quinqueloculina* cf. *Q. vulgaris* (5.7 %), *A. lobifera* (5.3 %), *A. discoidalis* (3.5 %), and *T. foliacea* (3.3 %) (Fig. 206).

Cluster G (blue) – Fore reefs at Pemba Island:

The fore reefs at Pemba (Fig. 200) host a very diverse fauna (154 species). Characteristic species for these stations are *Sahulia kerimbaensis*, *Eponides repandus*, *Amphistegina radiata*, and *Elphidium lunatum*. Eight samples from Pemba were collected in depths of 16-42 m in the fore reef. There is a similarity to the patch reefs at Zanzibar (both western reefs) but the diversity in the reefs at Pemba is considerably higher. *Amphistegina lessonii* (14.3 %), *Heterostegina depressa* (5.6 %), *Textularia agglutinans* (5.4 %), *Quinqueloculina* cf. *Q. vulgaris* (5.3 %), *Amphistegina bicirculata* (4.2 %), *S. kerimbaensis* (4.1 %), *E. repandus* (4.1 %), *Amphistegina lobifera* (3.8 %), *Elphidium lunatum* (3.2 %), *A. radiata* (2.4 %), and *Sorites orbiculus* (2.4 %) are the most abundant species in the fore reefs of Pemba (Fig. 207).

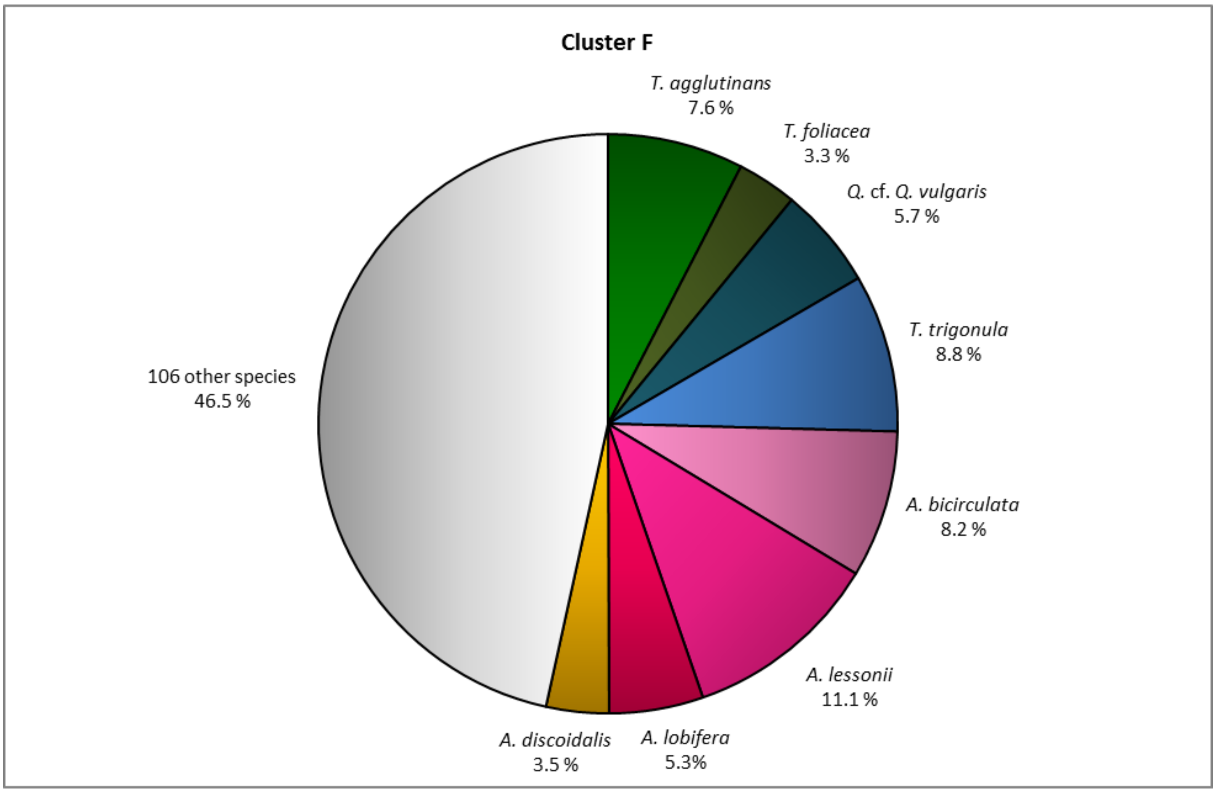

Fig. 206: Pie chart showing the percentages of the most abundant species in the samples of Cluster F.

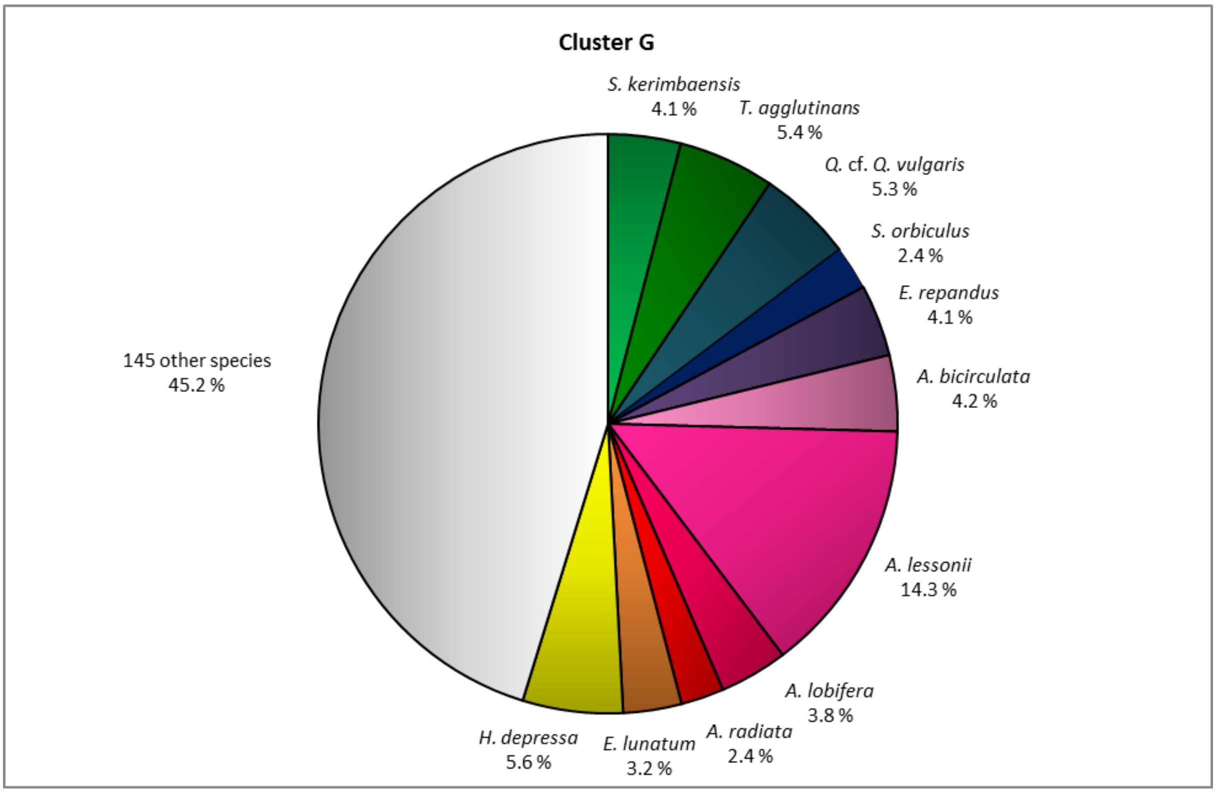

Fig. 207: Pie chart showing the percentages of the most abundant species in the samples of Cluster G.

4.3.2 Indicator taxa

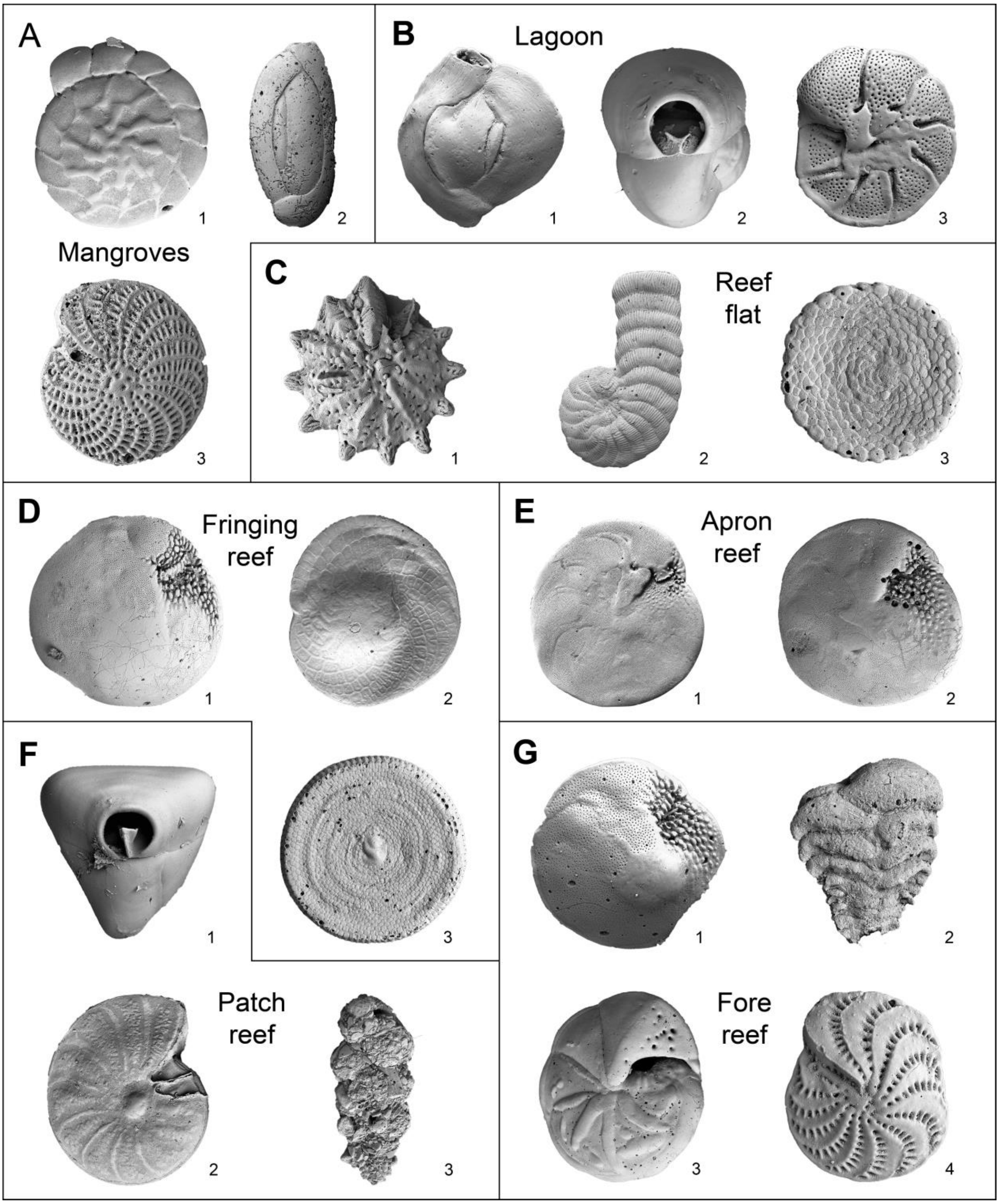

Fig. 208: Selected species characterizing the reefal habitats. **A** Mangroves. 1 *Ammonia convexa*; 2 *Quin-queloculina patagonica*; 3 *Elphidium limbatum* sp. 2. **B** Lagoon. 1 *Quinqueloculina* cf. *Q. multimarginata*; 2 *Triloculina asymmetrica*; 3 *Rotorbis auberii*. **C** Reef flat. 1 *Neorotalia calcar*; 2 *Peneroplis pertusus*; 3 *Sorites orbiculus*. **D** Fringing reef. 1 *Amphistegina lobifera*; 2 *Heterostegina depressa*; 3 *Amphisorus hemprichii*. **E** Apron reef. 1 *Amphistegina bicirculata*; 2 *Amphistegina lessonii*. **F** Patch reef. 1 *Triloculina trigonula*; 2 *Assilina discoidalis*; 3 *Textularia foliacea*. **G** Fore reef. 1 *Amphistegina radiata*; 2 *Sahulia kerimbaensis*; 3 *Eponides repandus*; 4 *Elphidium lunatum*.

4.3.3 R-mode cluster analyses

The R-mode cluster analysis was done twice, both on species level (Fig. 209) and on genus level (Fig. 210), to illustrate that major faunal assemblages are still diagnostically conclusive even on a higher taxonomic level. For reasons of clarity and comprehensibility the 45 most abundant species (90 % of the total fauna) and the 40 most abundant genera (96 %) were chosen for these analyses.

4.3.3.1 Species level

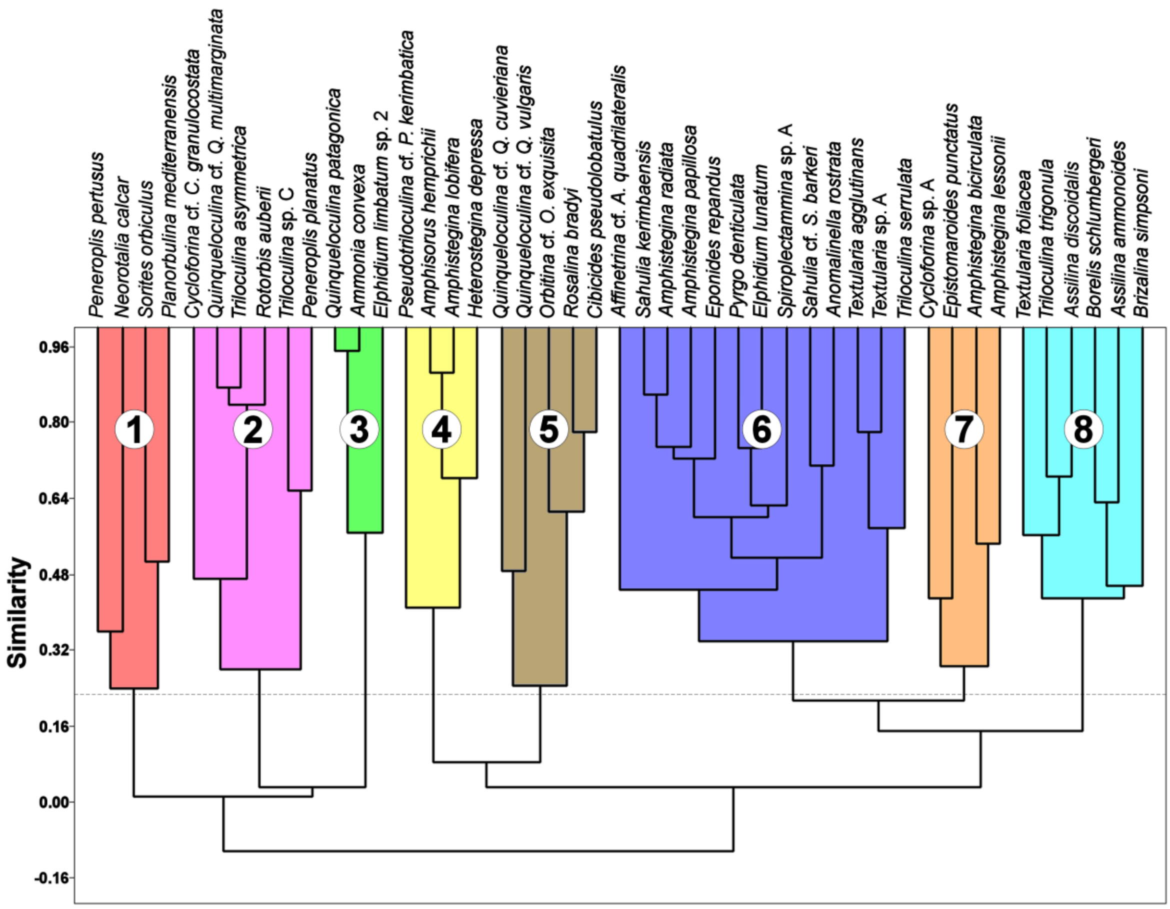

Fig. 209: R-mode cluster (species level)

Cluster 1 (red) – Reef flat assemblage

The reef flats are mainly characterized by the dominant species *Neorotalia calcar* as well as associated *Peneroplis pertusus, Sorites orbiculus* and *Planorbulina mediterranensis.*

Cluster 2 (pink) – Lagoon assemblage

The lagoon assemblage of Cluster 2 comprises *Cycloforina* cf. *C. granulocostata*, *Quinqueloculina* cf. *Q. multimarginata*, *Triloculina asymmetrica*, *Rotorbis auberii*, *Triloculina* sp. C, and *Peneroplis planatus*.

Cluster 3 (green) – Mangrove assemblage

The mangrove assemblage consists of the for this habitat characteristic species *Quinqueloculina patagonica*, *Ammonia convexa*, *Elphidium limbatum* sp. 2.

Cluster 4 (yellow) – Fringing reef assemblage

Pseudotriloculina cf. *P. kerimbatica*, *Amphisorus hemprichii*, *Amphistegina lobifera*, and *Heterostegina depressa* are typical taxa for the assemblage of Cluster 4 which characterize the fringing reefs at Ras Nungwi.

Cluster 5 (brown) – Temporarily attached taxa

Cluster 5 consists of the temporarily attached and ubiquitous species *Quinqueloculina* cf. *Q. cuvieriana*, *Quinqueloculina* cf. *Q. vulgaris*, *Orbitina* cf. *O. exquisita*, *Rosalina bradyi*, and *Cibicides pseudolobatulus*. These taxa have no preferred reefal habitat but depend on the presence of seagrasses or algae.

Cluster 6 (blue) – Fore reef assemblage

The fore reefs at Pemba are characterized by a number of species: *Affinetrina* cf. *A. quadrilateralis*, *Sahulia kerimbaensis*, *Amphistegina radiata*, *Amphistegina papillosa*, *Eponides repandus*, *Pyrgo denticulata*, *Elphidium lunatum*, *Spiroplectammina* sp. A, *Sahulia* cf. *S. barkeri*, *Anomalinella rostrata*, *Textularia agglutinans*, *Textularia* sp. A, and *Triloculina serrulata*.

Cluster 7 (orange) – Apron reef assemblage

Cluster 7 is made up by *Cycloforina* sp. A, *Epistomaroides punctulatus*, *Amphistegina bicirculata*, and *Amphistegina lessonii*. These taxa are characteristic for the apron reefs at Mafia Island.

Cluster 8 (cyan) – Patch reef assemblage

Textularia foliacea, *Triloculina trigonula*, *Assilina discoidalis*, *Borelis schlumbergeri*, *Assilina ammonoides* and *Brizalina simpsoni* form Cluster 8. This assemblage is typical for the patch reefs west of Zanzibar.

4.3.3.2 Genus level

On genus level the seven reef habitats are still well represented but there are two clusters of epiphytic species. The permanently attached genera are distinctly segregated from the temporarily attached, so two separate clusters were established.

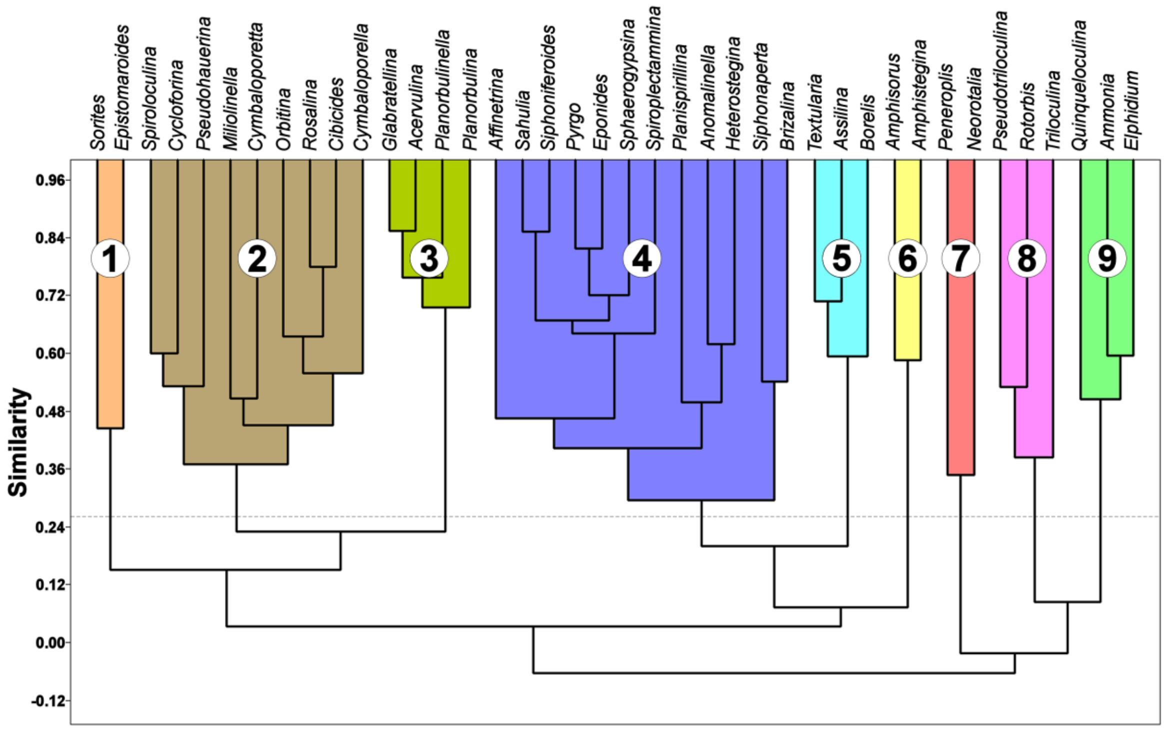

Fig. 210: R-mode cluster (generic level)

Cluster 1 (orange) – Apron reef assemblage

Sorites and *Epistomaroides* form Cluster 1. These three genera are most abundant in the apron reef at Kinasi Pass off Mafia.

Cluster 2 (brown) – Temporarily attached taxa

The temporarily attached genera *Spiroloculina*, *Cycloforina*, *Pseudohauerina*, *Miliolinella*, *Cymbaloporetta*, *Orbitina*, *Rosalina*, *Cibicides*, and *Cymbaloporella* form Cluster 2. Their abundances are not related to the reefal habitats but depend on the presence of phorophytes.

Cluster 3 (olive) – Permanently attached taxa

Cluster 6 consists of the three permanently attached taxa *Planorbulina*, *Acervulina* and *Planorbulinella*. Their highest abundances are at Kokota Reef and Mnemba Atoll.

Cluster 4 (blue) – Fore reef assemblage

This reef assemblage comprises the genera *Affinetrina*, *Sahulia*, *Siphoniferoides*, *Pyrgo*, *Eponides*, *Sphaerogypsina*, *Spiroplectammina*, *Planispirillina*, *Anomalinella*, *Heterostegina*, *Siphonaperta*, and *Brizalina*. These taxa have their highest abundances in the fore reefs at Pemba.

Cluster 5 (cyan) – Patch reef assemblage

Textularia, *Borelis* and *Assilina* form Cluster 5. Their common feature is their high abundances in the patch reef west of Zanzibar.

Cluster 6 (yellow) – Fringing reef assemblage

Cluster 6 consists of the larger symbiont-bearing genera *Amphisorus* and *Amphistegina*. These taxa share their high abundances in reefal habitats, especially in the fringing reef at Ras Nungwi.

Cluster 7 (red) – *Neorotalia*

Cluster 7 comprises *Neorotalia* and *Peneroplis*, which are most abundant on the reef flats at Kizimkazi Beach and Mnemba Island.

Cluster 8 (pink) – Lagoon assemblage

Cluster 8 comprises the shallow water genera *Pseudotriloculina*, *Rotorbis* and *Triloculina*. Their common feature is their highest abundances in the lagoon at Ocean Paradise.

Cluster 9 (green) – Mangrove assemblage

Similar to its equivalent on species level, Cluster 9 is made up by the opportunistic taxa *Quinqueloculina*, *Ammonia* and *Elphidium*. These genera share their high abundances in shallow waters, especially close to the mangroves at Menai Bay.

4.4 Principal component analysis

A principal component analysis (PCA) is used in multivariate statistics to structure and visualize larger data sets by reducing a large number of variables to only two linear combinations (principal components). This method is applied to help identifying structures in cluster analyses.

The PCA reveals distinct differences between the major clusters (reefal habitats) but also illustrates similarities within these clusters (Fig. 211). The dependency of the samples on the main factors (in this case the four most abundant taxa) becomes obvious. *Amphistegina*, *Neorotalia*, *Quinqueloculina* and *Textularia* are the most abundant genera in the samples. The taxa are outlined as vectors and the lengths of these vectors represent their eigenvalue or the 'importance' of these factors. The *Neorotalia*-vector points clearly towards the reef flat stations (red) and indeed it is the most important taxon in these samples. The second of the longer vectors, *Amphistegina* is closely related to the eastern reefs (yellow and orange). *Textularia* is most abundant in the patch reefs of western Zanzibar (cyan) and points clearly towards these samples. *Quinqueloculina* is most abundant in the lagoon at Ocean Paradise (pink) but also ubiquitous in the fore reefs at Pemba (blue). The Mangrove sample from Menai Bay (green) is the outlier on this graph because only one of the less strong factors, *Quinqueloculina,* is of higher abundance at this station.

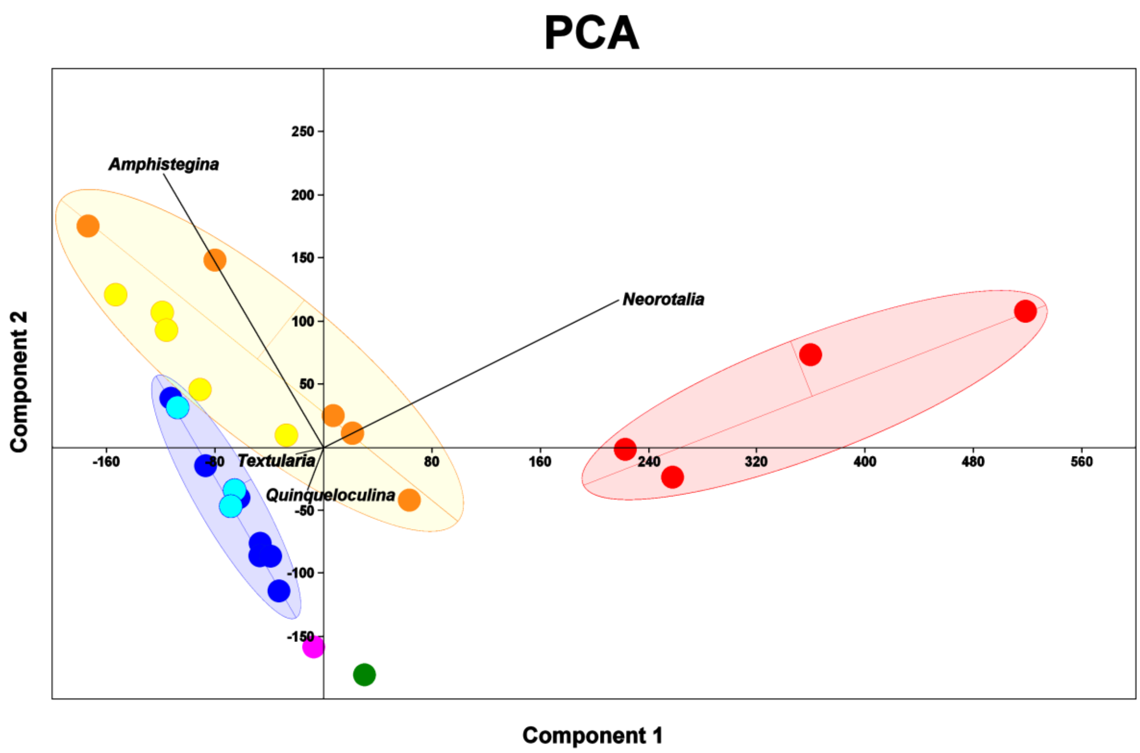

Fig. 211: Principal component analysis showing the dependency of the samples on the main factors, the four most abundant genera.

4.5 Canonical correspondence analysis

The correspondence analysis (CA) is a method used in multivariate statistics, similar to the PCA but applies to categorical instead of continuous data. The canonical correspondence analysis (CCA) is an extension of the correspondence analysis (CA) introduced by Ter Braak (1986). In this variety, the derived ordination axes are linear combinations of the environmental variables, which were obtained from Bio-ORACLE (Tyberghein et al. 2011; Table 2). Table 3 shows a cross tabulation of the environmental parameters.

Variable	Mean	Median	Skewness	Kurtosis	Min	Max	Range	Variance	SE	SD	CV
calcite	0,011	0,002	1,469	3,710	0,0001	0,051	0,051	0,00027	0,000	0,02	1,860144
chlorophyll	0,484	0,391	1,184	3,861	0,101	1,181	0,960	0,06402	0,05	0,18	0,372175
cloud	0,657	0,657	-1,001	4,261	0,435	0,804	0,369	0,00159	0,01	0,04	0,060896
da	0,076	0,066	0,884	3,069	0,031	0,135	0,104	0,00061	0,01	0,02	0,262911
dissox	4,748	4,749	-0,180	1,481	4,722	4,768	0,046	0,0003	0	0,02	0,004212
nitrate	0,428	0,437	-0,712	2,234	0,342	0,485	0,143	0,00255	0,01	0,05	0,116803
parmean	45,288	45,464	-0,529	2,882	42,976	46,864	3,888	1,06727	0,27	1,03	0,022743
ph	8,213	8,214	-0,543	2,186	8,208	8,217	0,009	0,00001	0	0	0
phosphate	0,200	0,201	-1,050	2,572	0,192	0,204	0,012	0,00002	0	0	0
salinity	35,122	35,118	0,756	2,148	35,110	35,143	0,033	0,00015	0	0,01	0,000285
silicate	3,911	3,907	0,506	2,016	3,882	3,947	0,065	0,00052	0,01	0,02	0,005114
sst	27,966	27,882	0,747	2,392	25,495	32,135	6,640	0,15635	0,23	0,4	0,014303

Table 2: Environmental parameters with main statistical values (SE = standard error, SD = standard deviation, CV = coefficient of variation). Data obtained from www.oracle.ugent.be.

The environmental parameters used in this analysis are calcite, mean chlorophyll content (chlomean), mean diffuse attenuation (damean), dissolved oxygen (dissox), mean photosynthetically active radiation (parmean), pH, salinity, mean sea-surface temperature (sstmean), and sea-surface temperature range (sstrange) (see also 4.6). Due to the spatial resolution of the satellite data (5 arcmin/9.2 km), the samples are conflated to sample stations. For reasons of clarity and comprehensibility the 18 most important indicator species were chosen for this analysis.

Variable	calcite	chlorophyll	cloud	da	dissox	nitrate	par	ph	phosphate	salinity	silicate
chlorophyll	0,048										
cloud	-0,049	-0,375									
da	0,057	0,988	-0,443								
dissox	0,234	-0,211	-0,337	-0,114							
nitrate	0,289	0,657	-0,505	0,757	0,365						
par	-0,16	-0,562	0,223	-0,638	-0,109	-0,749					
ph	0,317	0,093	-0,569	0,201	0,9	0,609	-0,28				
phosphate	0,304	0,573	-0,509	0,682	0,495	0,989	-0,718	0,698			
salinity	-0,369	-0,564	0,563	-0,672	-0,42	-0,972	0,639	-0,69	-0,968		
silicate	-0,294	-0,688	0,511	-0,784	-0,288	-0,995	0,741	-0,562	-0,971	0,974	
sst	-0,307	-0,198	0,338	-0,259	0,069	-0,417	0,218	-0,082	-0,382	0,47	0,449

Table 3: Environmental parameters in relation to each other.

On the species-conditional triplot based on the CCA, the eigenvalues of axis 1 (horizontal) and axis 2 (vertical) are 0.48 and 0.45 respectively, displaying 59 % of the inertia (Fig. 212). The first axis is positively correlated with pH (0.39) and dissox (0.78); the second axis is positively correlated with the temperature (sstrange (0.36) and sstmean (0.17)) and negatively correlated with salinity (0.21) and parmean (0.57). The vectors chlomean and damean are close together and appear to be correlated with the occurrence of *Triloculina trigonula*, *Sahulia kerimbaensis*, *Heterostegina depressa*, *Textularia agglutinans*, *Amphistegina bicirculata*, *A. lessonii*, *A. lobifera*, and *Elphidium lunatum*. These species are indicator taxa for the sample stations Bawe Island (BI), Stone Town Aquarium (ST), Coral Mountain (CM), Haramu Passage (HP), Kokota Reef (KR), Misali Island (MI), Mapenduzi Wall (MW), Ras Nungwi (RN), Chole Bay (CB) and to some extent Kinasi Pass (KP) (see also 4.3.2). *Elphidium lunatum* appears to be correlated with temperature. The species *T. asymmetrica*, *Quinqueloculina* cf. *Q. multimarginata* and *Rotorbis auberii* are indicator taxa for the lagoon at Ocean Paradise (OP) (see also 4.3.2). The mangrove station at Menai Bay (MB) is characterized by *Quinqueloculina patagonica*, *Ammonia convexa* and *Elphidium limbatum* sp. 2 and appears to be correlated to pH and dissox. *Neorotalia calcar* is the dominant species at Kizimkazi Beach (KB) and Mnemba Atoll (MA). These stations seem to be correlated with salinity. *Q.* cf. *Q. vulgaris* and *Sorites orbiculus* are positioned in the center of the diagram and without recognizable correlation with any of the variables.

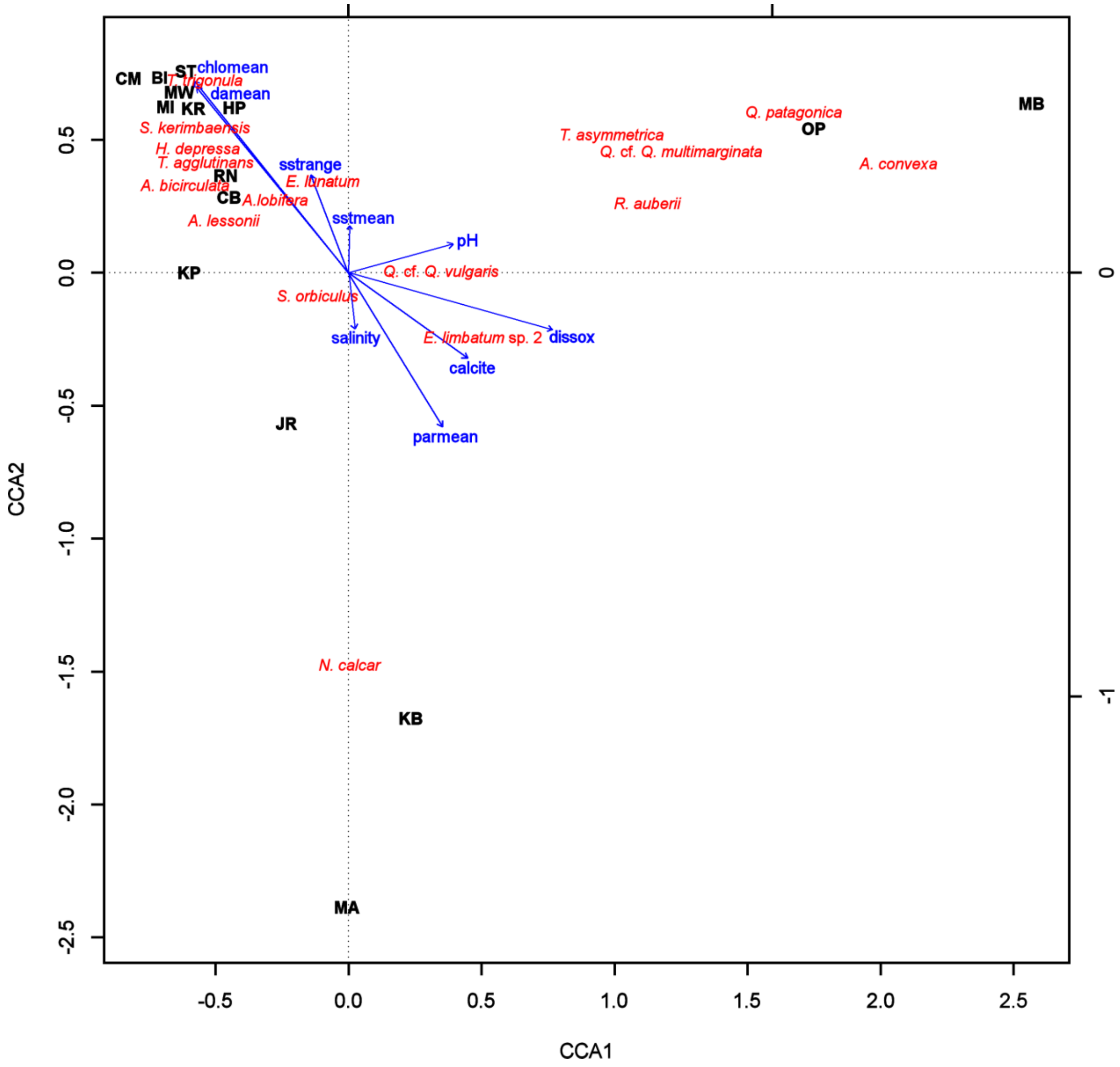

Fig. 212: Species-conditional triplot based on the CCA, carried out on the 18 most important indicator taxa, displaying the nine most relevant environmental variables.

4.6 Dominance

Dominance is defined as the sum$_i$ of the number of individuals of taxon *i* divided by the number of individuals of all taxa squared or simply 1-Simpson index. Dominance values range from 0, where all taxa are even, to 1, which means that there is only one taxon present at all. For the resulting graph the number of species is plotted on the y-axis and dominance on the x-axis.

The graph (Fig. 213) shows the correlation between dominance and the number of species. Highly diverse samples exhibit low dominance values, highly dominated assemblages are low diverse. Dominance values were separated into four groups, ranging from very low to high. Thus a habitat dependency on diversity and dominance becomes clear. The highly diverse assemblages from the western reefs (in blue and cyan) show very low dominance values of less than 0.08 (minimum value at Kokota Reef 16 m with 0.02). In the lagoon at Ocean Paradise (pink) the assemblage is not very diverse but the taxa coexist more evenly than in the other shallow water samples (see also Fig. 202). The eastern reefs at Mafia Island and Ras Nungwi (yellow and orange) as well as the mangrove sample from Menai Bay (green) are characterized by low to medium dominance values. Highest dominance values were obtained from the reef flats at Kizimkazi Beach and Mnemba Atoll (red), with a maximum of 0.63 at Mnemba Atoll 20 m. These stations are characterized by high percentages of *Neorotalia calcar* as the dominant species (see also Fig. 203). The overall trend is a decreasing curve from the most diverse sample to the most dominated one (see also Fig. 226).

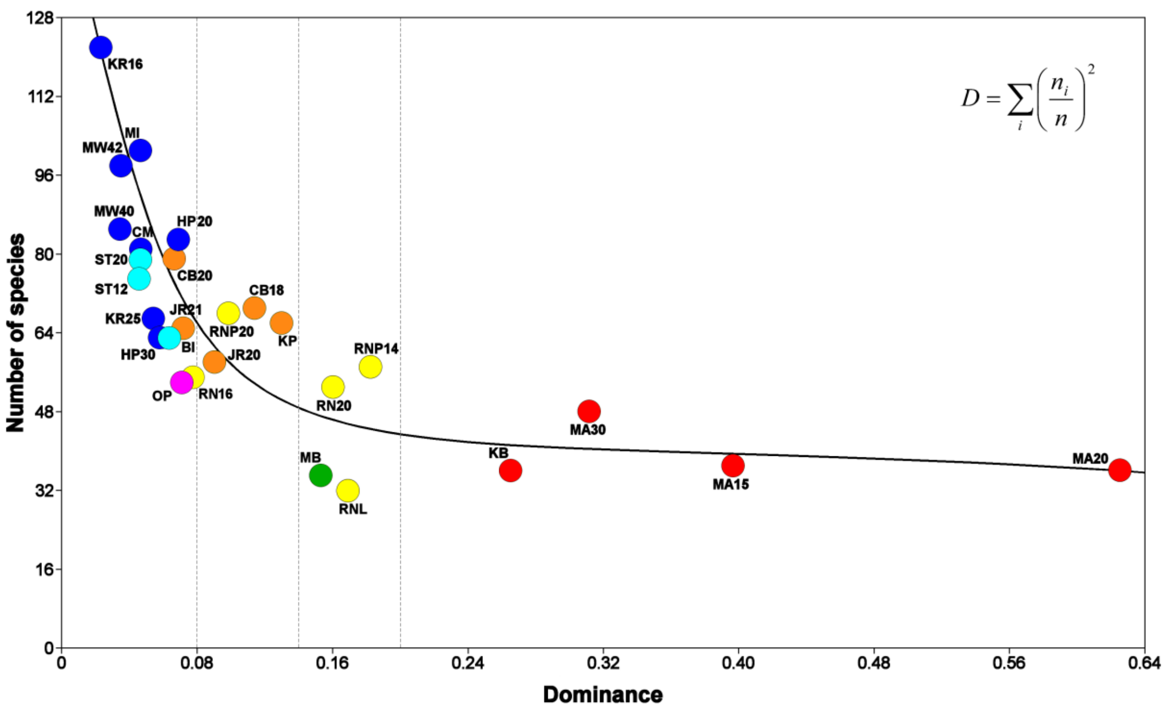

Fig. 213: Diagram showing the correlation between dominance and the number of species.

4.7 Ternary diagram

Ternary diagrams after Murray (1973), illustrating the percentage of each of the three major suborders (or test types) of foraminifera, are used to distinguish shallow water habitats. Each corner of the triangle stands for 100 % of the specific suborder, numbers decreasing in 10 % steps towards the opposite side. Grey areas indicate the partially overlapping large-scale habitats (Fig. 214). Colored dots, interconnected by brighter colored polygons for a better distinction of similar reefal habitats, represent the sample stations. All samples are situated between 1-29 % Textulariina, 9-63 % Miliolina, and 33-89 % Rotaliina. Thus, perforated taxa are the dominant group in this region. Because of its high percentage of miliolid taxa, the most conspicuous outlier among the sample stations is Ocean Paradise (pink), which truly fits into the concept of a normal marine to hypersaline lagoon. Samples dominated by *Neorotalia* (red) show the highest amount of rotaliid taxa. Both the western (blue and cyan) and the eastern (yellow and orange) reef habitats are closely related and their areas partially overlap. One noticeable fact is the low percentage of Textulariina in the shallowest samples (green).

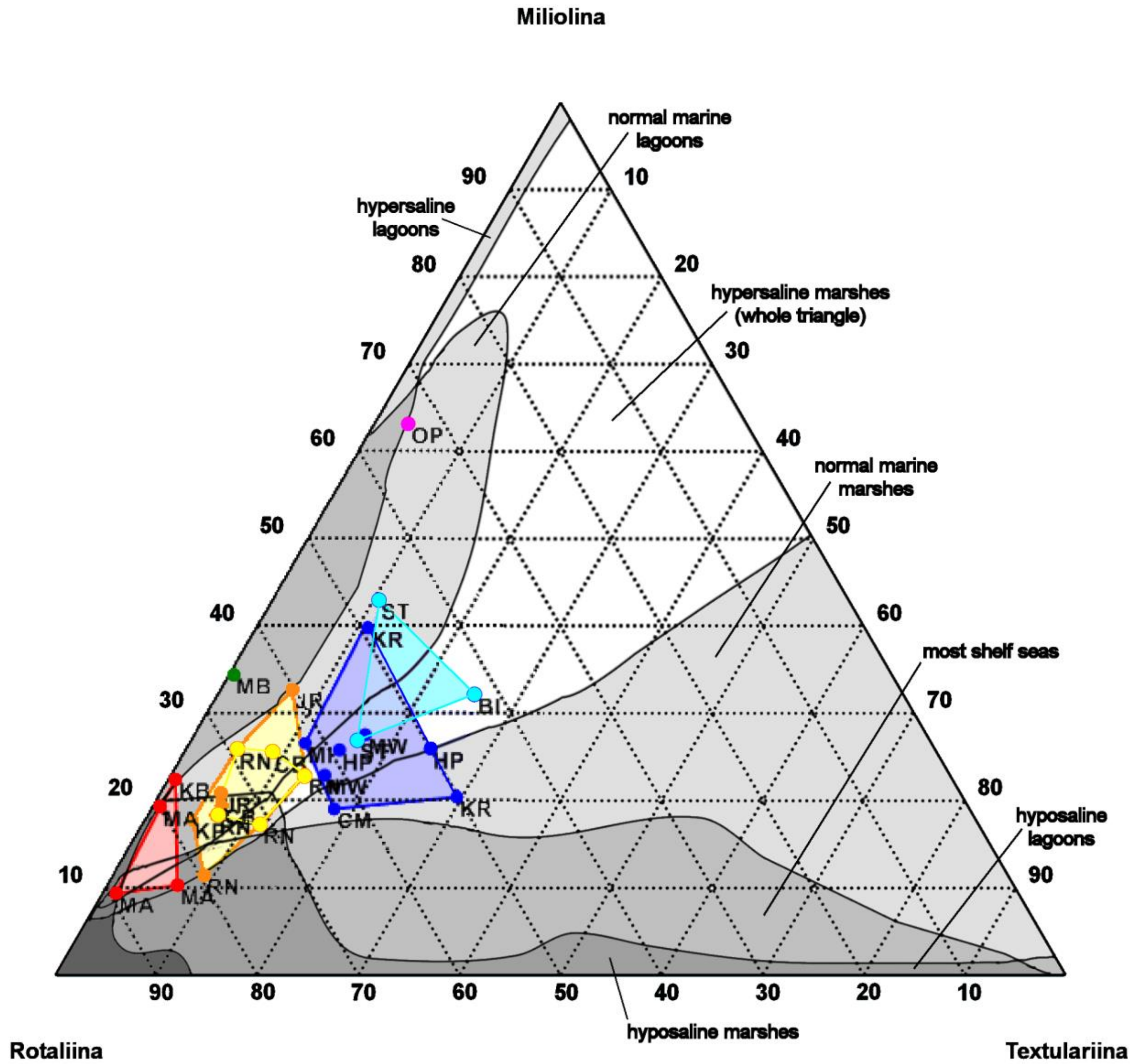

Fig. 214: Ternary diagram illustrating the proportional distribution of the three major suborders of foraminifera in the samples to distinguish shallow water habitats (after Murray 1973).

4.8 Comparison of major taxonomic groups

Figures 215 show the proportion of larger miliolids and larger rotaliids in comparison to the amount of smaller foraminifera in the samples. Remarkable about this chart is the fact that all samples, dominated by *Neorotalia* and *Amphistegina* (in parts), consist of more than 50 % larger foraminifera (MA20-CB20). This applies to samples of the eastern reef clusters C, D and E (see 4.3.1). The highest percentage of larger foraminifera was found at Mnemba Atoll 20 m (MA20, 85.5 %). The less dominated samples from the western reefs (HP20-KR16) show lower amounts of larger benthic foraminifera (see also 4.7). The mangrove and lagoon habitats (MB1 and OP3) are dominated by smaller foraminifera (more than 85 %). On average larger foraminifera constitute 51.01 % of the total fauna, smaller foraminifera 48.99 %. Figure 217 shows these proportions projected on a map of the Zanzibar Archipelago.

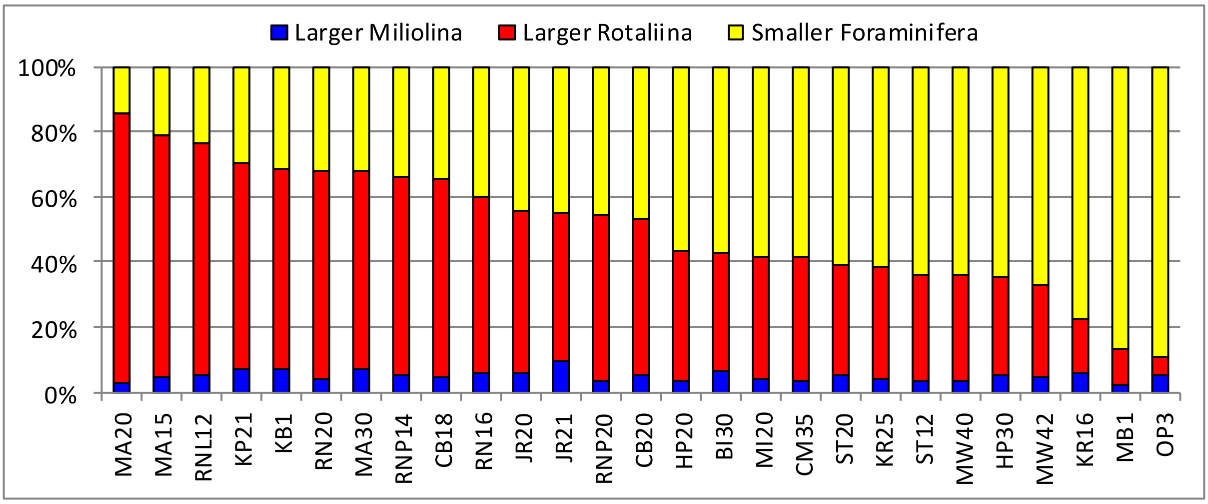

Fig. 215: Chart showing the proportion of larger and smaller foraminifera in the samples.

The percentage of larger miliolid foraminifera in relation to the amount of larger rotaliids is shown in Figure 216. In most of the samples the Rotaliina are the dominant group among the larger benthic foraminifera (73.1-96.4 %). Ocean Paradise is the only station at which the larger miliolids constitute the majority (50.9 %). Although (as seen in Fig. 215) the total amount of larger foraminifera at this place is quite low anyway.

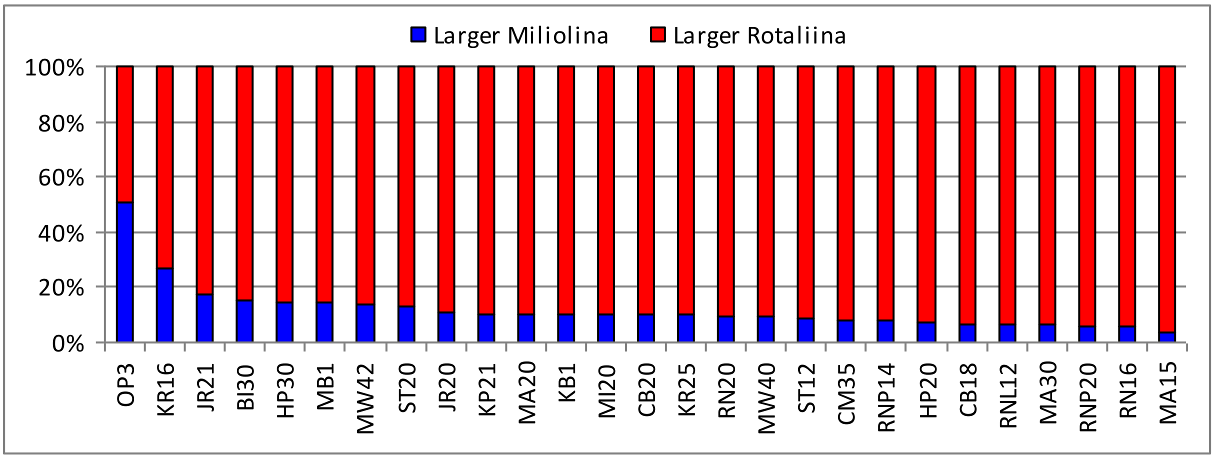

Fig. 216: Chart showing the proportion of larger imperforate and perforated foraminifera in the samples.

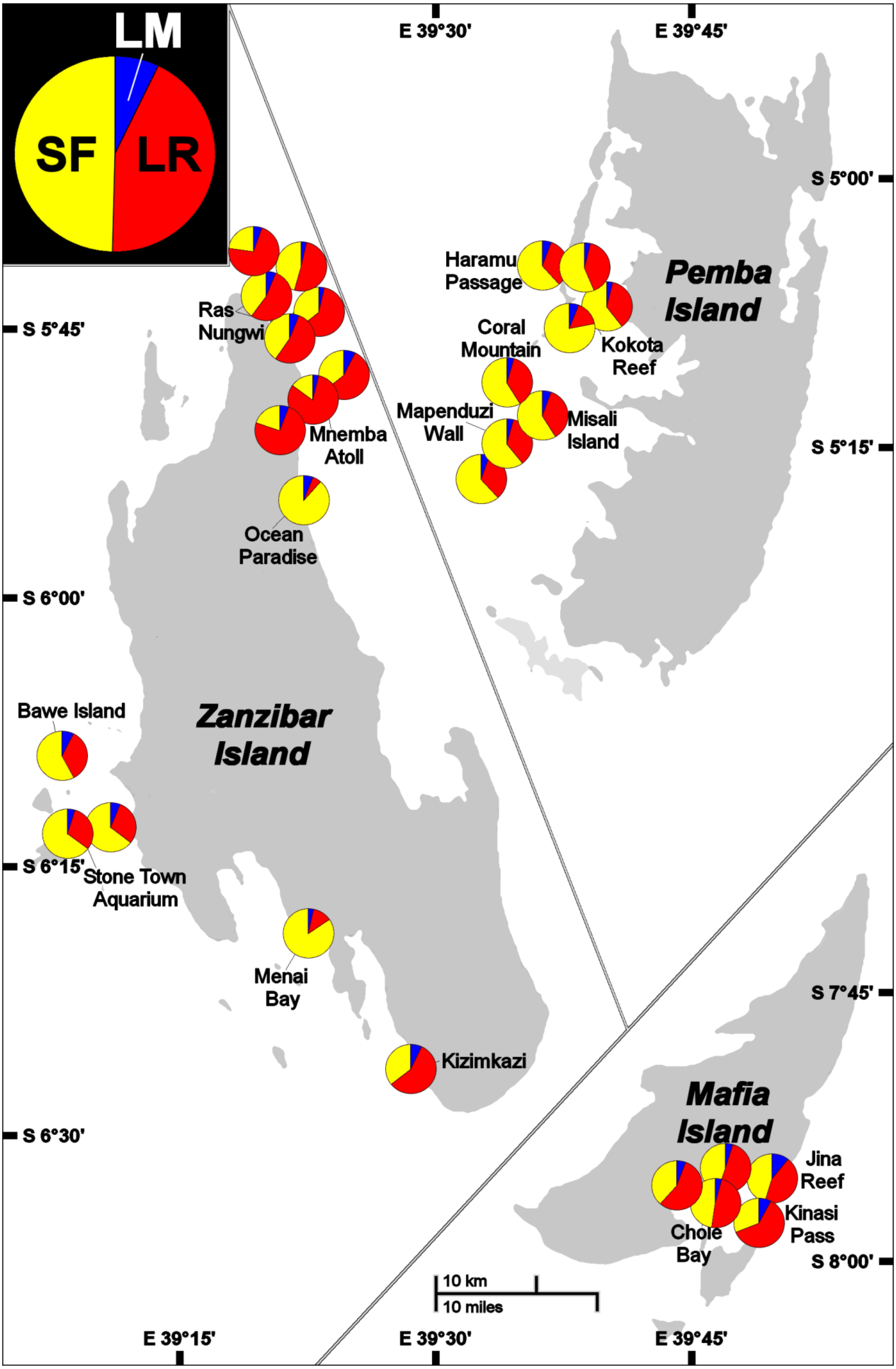

Fig. 217: Amounts of larger Miliolina (LM), larger Rotaliina (LR) and smaller foraminifera (SF) in the samples.

Figure 218 shows the percentage composition of the six groups of larger benthic foraminifera found in the samples. These are from bottom to top: Alveolinidae (yellow), represented in the samples by *Borelis schlumbergeri*, Peneroplidae (purple), represented by *Peneroplis pertusus* and *P. planatus*, Soritidae (blue), represented by *Amphisorus hemprichii* and *Sorites orbiculus*, the Amphisteginidae (green) *Amphistegina bicirculata*, *A. lessonii*, *A. lobifera*, *A. papillosa*, and *A. radiata*, Pararotaliidae (brown), represented by *Neorotalia calcar*, and the Nummulitidae (orange) *Assilina ammonoides*, *Assilina discoidalis*, and *Heterostegina depressa*. The samples are sorted by habitats to illustrate the distribution of specific taxa in different environments. The left four bars represent the reef-flat samples of Cluster C (MA20-KB1), followed by the apron reefs from Mafia Island of Cluster E (JR20-CB18), the mangrove habitat at Menai Bay of Cluster A (MB1), the fore reefs from Pemba of Cluster G (HP20-MW40), the patch-reef samples of Cluster F (BI30-ST20), the fringing-reef samples from Ras Nungwi of Cluster D (RNP14-RN16), and finally to the far right the lagoon sample from Ocean Paradise of Cluster B (OP3).

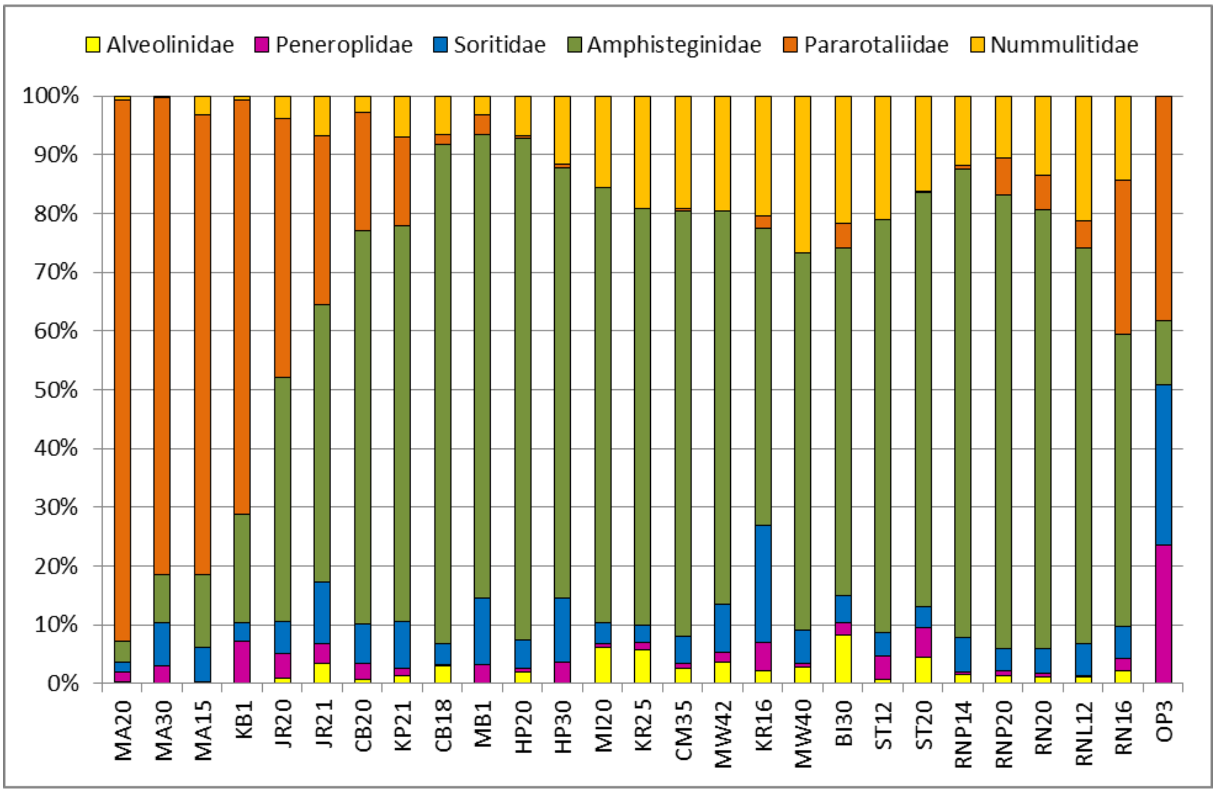

Fig. 218: Chart showing the proportion of larger symbiont-bearing foraminifera in the samples sorted by habitats (MA20-KB1 = reef flats, JR20-CB18 = apron reefs, MB1 = mangroves, HP20-MW40 = fore reefs, BI30-ST20 = patch reefs, RNP14-RN16 = fringing reefs, OP3 = lagoon).

Eye-catching is the high amount of amphisteginids (green) among the larger benthics in most of the samples. The second most abundant group of symbiont-bearing foraminifera is the Pararotaliidae (brown) represented by *Neorotalia calcar*. This taxon dominates the reef flats and only coexists evenly with *Amphistegina* to a certain degree in the apron reefs at Mafia Island (JR20-CB18). The nummulitids (orange) are mainly present at Pemba and Ras Nungwi (HP20-RN16). The low amount of larger miliolids (Alveolinidae, Peneroplidae and Soritidae) is again clearly recognizable (see also Fig. 216). The generally low amount of larger foraminifera at Ocean Paradise (OP3) leads to inordinately high percentages of certain groups (e.g. Peneroplidae (purple)).

4.9 Bathymetrical distribution of specific ecotypes

For this analysis the taxa were subdivided into 11 groups according to their ecological characteristics. A list of taxa with their ecological information is attached in the appendix (see 9.3). Fig. 219 shows the percentages of each ecological group sorted by water depth.

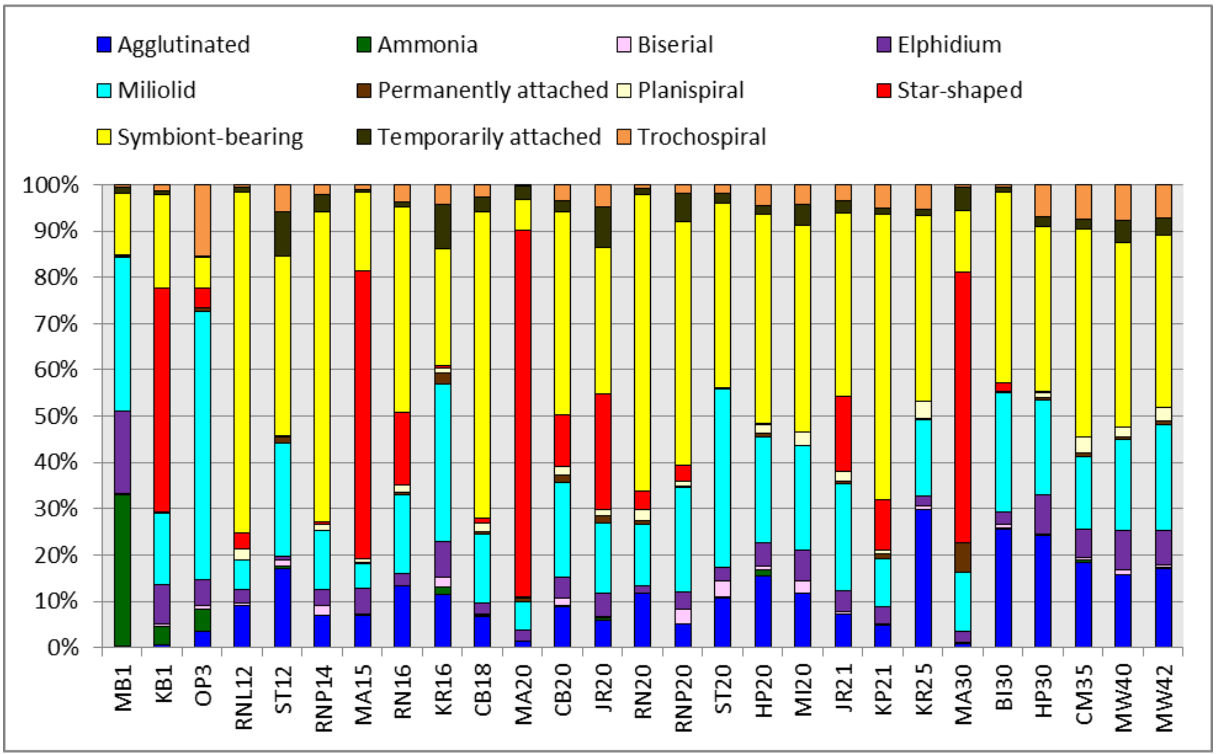

Fig. 219: Percentage of the ecological groups in the samples sorted by water depth from shallow (left) to deep (right). Sample abbreviations include depths in meters.

Group 1 (blue) – Agglutinated

Group 1 consists of all agglutinated taxa, main genera are *Sahulia* and *Textularia*. The percentages of this group range from 0.4 to 28.6 %. Eye-catching is their very low amount in shallow waters but high percentages in deeper waters >25 m. They are most abundant at Kokota Reef 25 m (KR25).

Group 2 (green) – *Ammonia*

Ammonia convexa is the only species of group 2. Its percentages range from 0-31.6 %. This taxon is mainly present in shallow waters, especially at Menai Bay (MB1).

Group 3 (rose) – Biserial

The biserial group consists of the genera *Brizalina*, *Cassidelina* and *Loxostomina*. The percentages of this group are quite low throughout the whole depth range (0-3.5 %). These taxa are most abundant at Stone Town Aquarium 20 m (ST20).

Group 4 (purple) – *Elphidium*

The Elphidiids make up group 4. These taxa are present in all samples with percentages of 0.6-17.2 %. Elphidiids are most abundant at Menai Bay (MB1).

Group 5 (cyan) – Miliolid

Group 5 comprises the miliolids, most important genera are *Cycloforina*, *Quinqueloculina* and *Triloculina*. With percentages ranging from 5.3-57.5 % the miliolids are one of the most abundant groups in the samples but show no clear depth gradient. Highest abundances were obtained from the shallow lagoon at Ocean Paradise (OP3).

Group 6 (brown) – Permanently attached

The permanently attached Planorbulinids and Acervulinids are arranged in group 6. Their percentages range from 0-5.9 %. This rare group is most abundant at Mnemba Atoll 30 m (MA30).

Group 7 (pale yellow) – Planispiral

Anomalinella rostrata is the only species of group 7. The percentages of this planispiral species range from 0-3.5 %. It is most abundant at Kokota Reef 25 m (KR25).

Group 8 (red) – Star-shaped

Group 8 consists of only one taxon, *Neorotalia calcar*. Percentages of this star-shaped species range from 0-78.9 %. *Neorotalia* is most abundant at Mnemba Atoll 20 m (MA20). It is not present in depth >30 m but depends much more on habitat characteristics than on depth.

Group 9 (yellow) – Symbiont-bearing

The symbiont-bearing genera *Borelis*, *Peneroplis*, *Amphisorus*, *Sorites*, *Amphistegina*, *Assilina*, and *Heterostegina* constitute group 9. With percentages ranging from 6.6-73.1 %, this is the most prominent group in the samples. Highest abundances were obtained from Ras Nungwi Lighthouse (RNL12), lowest in shallow waters.

Group 10 (black) – Temporarily attached

The temporarily attached Rosalinidae and Cicibididae are arranged in group 10. Their percentages range from 0.2-9 %, most abundant at Stone Town Aquarium 12 m (ST12).

Group 11 (orange) – Trochospiral

Group 11 comprises the trochospiral taxa with prominent genera like *Eponides* and *Rotorbis*. The percentages for this group range from 0.1-15.3 %. Highest abundances were recorded from the lagoon at Ocean Paradise (OP3).

4.10 Bathymetrical distribution of specific morphotypes

For this analysis the taxa were subdivided into 9 specific groups according to their morphological characteristics. A list of taxa with their morphological classification is attached in the appendix (see 9.3). Fig. 220 shows the percentages of each group sorted by water depth.

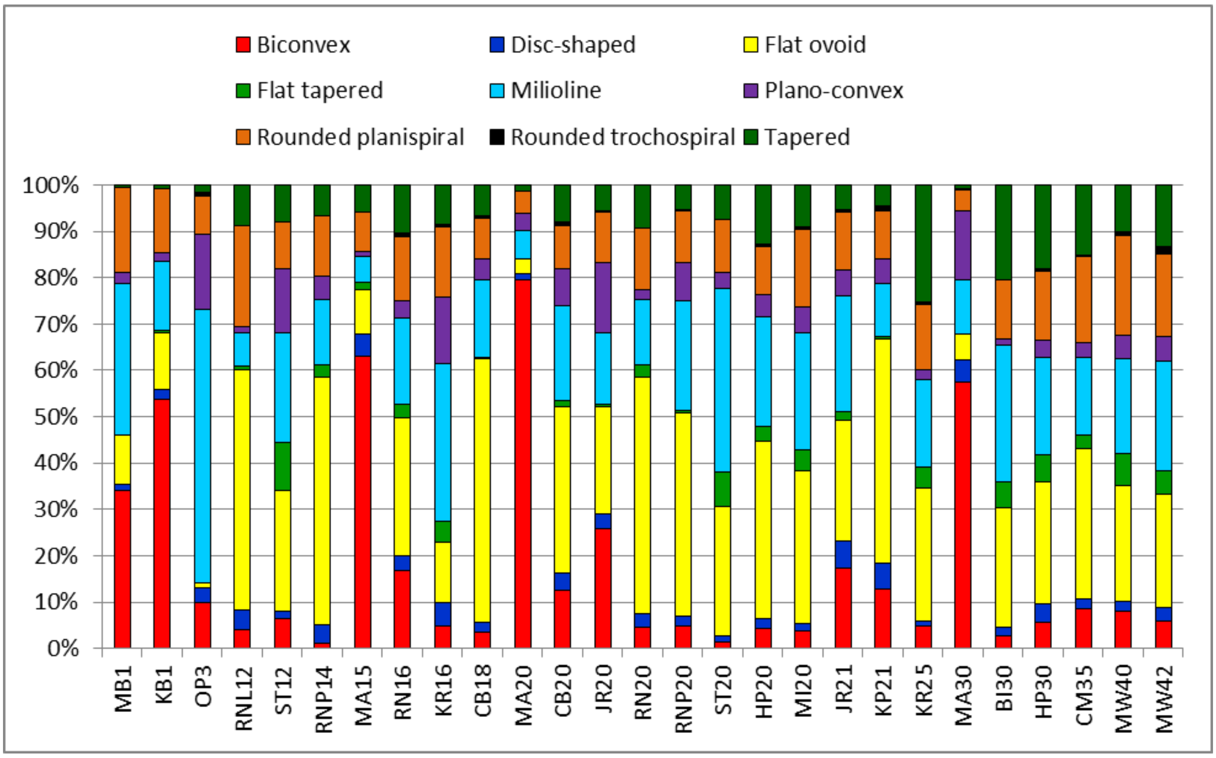

Fig. 220: Percentage of the morphological groups in the samples sorted by water depth from shallow (left) to deep (right). Sample abbreviations include depths in meters.

Group 1 (red) – Biconvex

Group 1 contains the biconvex taxa *Eponides repandus*, *Neorotalia calcar* and *Ammonia convexa*. With percentages of 1.1-79.1 % the amount varies strongly. This group is most abundant at Mnemba Atoll 20 m (MA20).

Group 2 (blue) – Disc-shaped

Group 2 comprises the disc-shaped soritids. The percentages of this group range from 1.1-5.8 %. The soritids are most abundant at Jina Reef 21 m (JR21).

Group 3 (yellow) – Flat ovoid

The flat ovoid group is made up by the species of *Amphistegina*. Their percentages range from 1.2-55.7 %. This group is most prominent at water depth of at least 12 m in habitats not dominated by the biconvex taxa of group 1. Highest abundances for the amphisteginids were obtained from Chole Bay 15-18 m (CB18).

Group 4 (green) – Flat tapered

Group 4 consists of the flat tapered taxa *Spiroplectammina*, *Textularia* and *Brizalina*. The percentages of this group range from 0-10.1 %. They are almost absent at shallow waters and reach highest abundances at Stone Town Aquarium 12 m (ST12).

Group 5 (cyan) – Milioline

Group 5 comprises the milioline taxa, most important genera are *Cycloforina*, *Quinqueloculina* and *Triloculina*. With percentages ranging from 5.3-57.5 % the miliolines are one of the most abundant groups in the samples. Highest abundances were obtained from the shallow lagoon at Ocean Paradise (OP3).

Group 6 (purple) – Plano-convex

All of the epiphytes and taxa like *Orbitina*, *Rotorbis*, *Rosalina*, and *Cibicides* are components of group 6. The percentages of the plano-convex taxa range from 1-15.9 %. They are most abundant at Ocean Paradise (OP3).

Group 7 (orange) – Rounded planispiral

Group 7 consists of *Peneroplis*, *Anomalinella rostrata*, the elphidiids and nummulitids. The rounded planispiral taxa are present in all samples with percentages of 4.6-21.9 %. This group is most abundant at Ras Nungwi Lighthouse (RNL12).

Group 8 (black) – Rounded trochospiral

The rounded trochospiral taxon *Epistomaroides punctatus* and the species of the family Gavelinellidae form group 8. The percentages of these rare taxa range from 0-1.3 %. Highest abundances for this group were recorded from the deepest sample Mapenduzi Wall 42 m (MW42).

Group 9 (dark green) – Tapered

Group 9 comprises the tapered textulariids. Their percentages range from 0.4-24.2 % and slightly increase with water depth. This group is most abundant at Kokota Reef 25 m (KR25).

4.11 FoRAM Index

The Foraminifera in Reef Assessment and Monitoring (FoRAM) Index was proposed by Hallock et al. (2003) to assess the water quality of coral reefs, using foraminifera as bioindicators. Three functional groups of foraminifera are distinguished for the FoRAM Index: larger symbiont-bearing taxa, opportunistic taxa, and heterotrophic foraminiferal taxa. Each group is given a different weighting. The FoRAM Index (FI) is calculated as follows:

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

Where $P_s = N_s/T$, $P_o = N_o/T$, $P_h = N_h/T$, and T = total number of foraminiferal specimens, N_s = number of specimens of larger foraminifera, N_o = number of specimens of opportunistic taxa, N_h = number of specimens of heterotrophic foraminifera (Hallock et al. 2003). FI > 4 (high) indicates reefs in good health, not immediately endangered, FI ~ 3-5/6 (medium) indicates early stages of environmental decline or that reefs are endangered but capable of recovering, FI ~ 1-3 (low) indicates local environment marginal for reef growth, FI < 2 (very low) indicates conditions unsuitable for reef growth (Hallock et al. 2003).

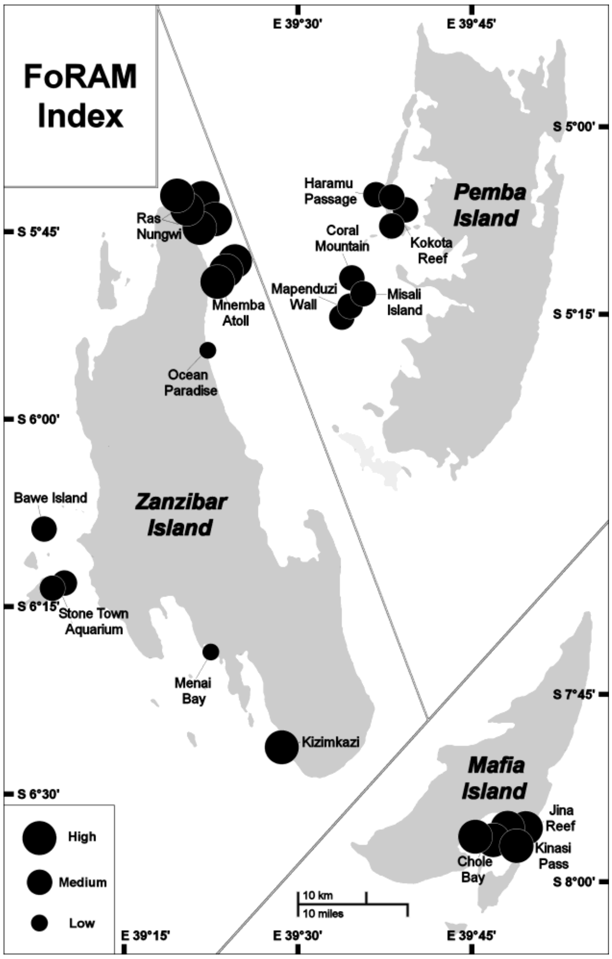

Fig. 221: Map showing the FoRAM Index for each sample.

The reefs around the Zanzibar Archipelago show medium to high FoRAM Indexes (Fig. 221, for details see 9.1). The two shallow-water stations Menai Bay and Ocean Paradise naturally restrict the growth of coral reefs and therefore show low values. Menai Bay is the station with the highest amount of opportunistic taxa (see also Fig. 201). Medium FoRAM Indexes are given for the western reefs of Zanzibar and Pemba (Fig. 221). These stations are characterized by a majority of smaller heterotrophic foraminiferal species (see also Figs. 206, 207, 215, 217). Highest FoRAM Indexes were calculated for the eastern reefs of Zanzibar and Mafia as well as the reef flats at Mnemba and Kizimkazi (Fig. 221). These habitats are characterized by high percentages of larger foraminiferal taxa (see also Figs. 203-205, 215, 217).

4.12 Carbonate production

Foraminifera are prolific producers of calcium carbonate ($CaCO_3$) in modern oceans. Table 4 shows the percentage of $CaCO_3$ in the samples and the share of foraminifera in the carbonate production, as well as the grain size. The majority of samples were made of very fine to fine grained, well sorted carbonate sediments, containing coral fragments, seashells, coralline algae, echinoderm spines, bryozoans, snail shells, sponge spicules, along with foraminiferal tests (see also 3.5). Most of the samples consist of 88-98 % $CaCO_3$, while the percentages of carbonate at the stations Menai Bay and Ocean Paradise are at only 37 and 34 %, respectively. In these shallow water samples clastic sediments prevail. The percentages of foraminifera range from 0.6 % at Menai Bay to 20.2 % at Kizimkazi Beach. Similar habitats show similar foraminiferal percentages (see also Figs. 201-207, 223, 224).

Sample station	**Grain size**	**$CaCO_3$ in %**	**Foraminifera in %**	**$CaCO_3$ $g/m^2/a$**
Bawe Island 30-9 m	Coarse	88	6.9	276
Chole Bay 15-18 m	Medium	96	5.5	220
Chole Bay 20 m	Medium	96	5.9	236
Coral Mountain 35 m	Fine	95	4.2	168
Haramu Passage 20 m	Fine	93	2	80
Haramu Passage 30 m	Fine	94	3.2	128
Jina Reef 20 m	Fine	98	4.4	176
Jina Reef 21 m	Fine	97	4.6	184
Kinasi Pass 18-21 m	Fine	95	3.9	156
Kizimkazi Beach 1 m	Very fine	92	20.2	161.6*
Kokota Reef 16 m	Fine	96	5.1	204
Kokota Reef 25 m	Fine	94	3	120
Mapenduzi Wall 40 m	Fine	95	3.6	144
Mapenduzi Wall 42 m	Fine	95	2.1	84
Menai Bay 1 m	Very fine	37	0.6	4.8*
Misali Island 20 m	Fine	93	8	320
Mnemba Atoll 15 m	Very fine	91	8.8	352
Mnemba Atoll 20 m	Very fine	90	8.9	356
Mnemba Atoll 30 m	Very fine	89	7	280
Ocean Paradise 3 m	Very fine	34	2.9	23.2*
Ras Nungwi 16 m	Coarse	95	6.6	264
Ras Nungwi 20 m	Coarse	96	6.7	268
Ras Nungwi Lighthouse 12 m	Coarse	90	6.8	272
Ras Nungwi Peak 12-14 m	Medium	98	6.3	252
Ras Nungwi Peak 20 m	Medium	95	6.1	244
Stone Town Aquarium 12 m	Fine	92	3.4	136
Stone Town Aquarium 20 m	Fine	93	4	160

Table 4: Grain size, percentages of $CaCO_3$ in the samples, percentages of foraminifera in the samples and their annual carbonate production (* = treated as lagoons (see Langer et al. 1997)).

The annual carbonate production by foraminifera was calculated after the method introduced by Langer et al. (1997) using the number of foraminiferal specimens in the samples and the average weight of each group of larger and smaller foraminifera. Numbers are given in grams per square meter per year ($g/m^2/a$). The shallowest samples, collected close to the shore, were treated as lagoons (see Langer et al. 1997). Production in these areas ranges from 4.8 g/m^2/a at Menai Bay to 161.6 g/m^2/a at Kizimkazi Beach. The reefal carbonate production ranges between 80 and 356 g/m^2/a. Due to their generally low weight, smaller foraminifera were summed up to one group (Figs. 222, 223, 224).

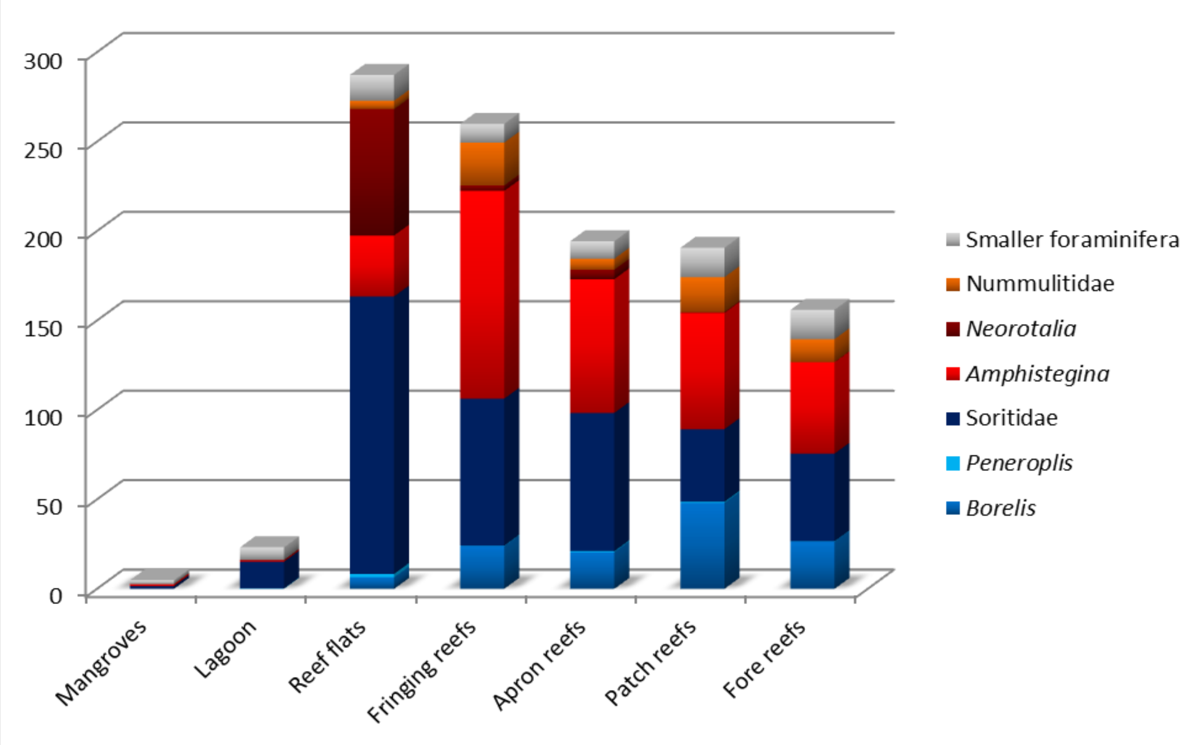

Fig. 222: Mean carbonate production by foraminifera (in g/m^2/a) at the seven major habitats arranged by distance from the shore.

As seen in Fig. 222 the most important producers of $CaCO_3$ among foraminifera around the islands of the Zanzibar Archipelago are the Soritidae (dark blue) and *Amphistegina* (red). Together these taxa produce about two thirds of the annual carbonate at the sample stations, but their productivity (like their abundances) depends on habitat characteristics. The third most productive taxon of larger foraminifera is *Borelis* (blue), which contributes its highest amount of carbonate to the patch reefs. The Nummulitidae (orange) are most productive in the fringing and patch reefs, *Peneroplis* (light blue) is less important due to its generally low weight and abundance. The annual carbonate production by foraminifera in the mangrove and lagoonal stations are apparently low due to the small amount of foraminifera in the samples and the generally lower productivity in shallow nearshore habitats. On a percentage basis smaller foraminifera (grey) are quite important producers of carbonate in these habitats due to the low amount of larger benthics in the sediment. The Soritidae are the only considerable group of larger foraminifera in the lagoon and produce about 64 % of the carbonate at this station. The highest carbonate production along the coasts of the Zanzibar Archipelago was recorded from the reef flats at Mnemba Island and Kizimkazi. Despite its high abundances (up to 79 %) but due its comparatively low weight, *Neorotalia* (brown) produces about 25 % of the carbonate at these stations. This is the only habitat at which this taxon contributes a considerable portion to the carbonate production. From the reef flats the mean annual carbonate production decreases with increasing distance from the shore.

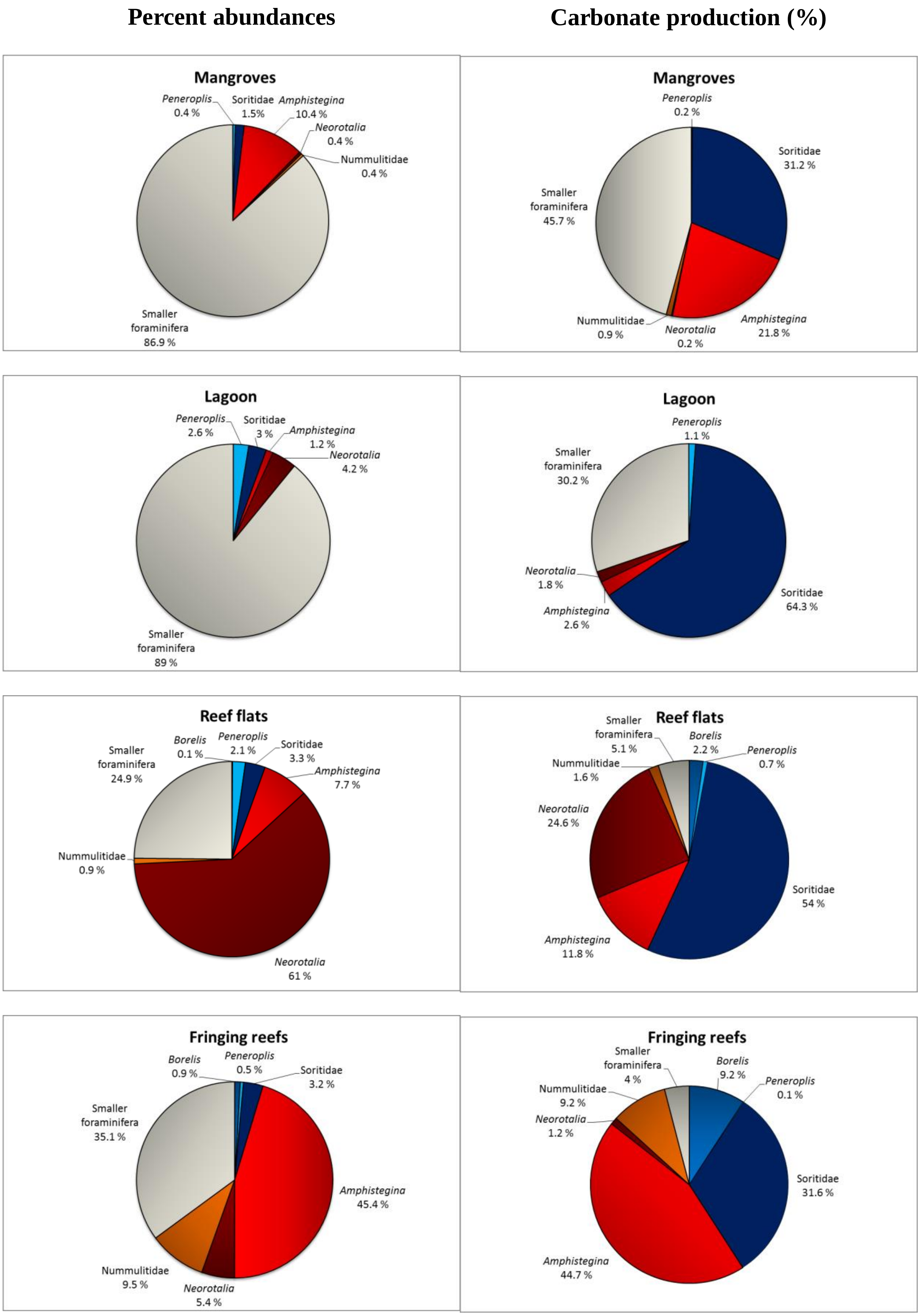

Fig. 223: Comparison of percent abundances of groups of larger and smaller foraminifera with the carbonate production (%) of individual groups in mangroves, lagoon, reef flats and fringing reefs.

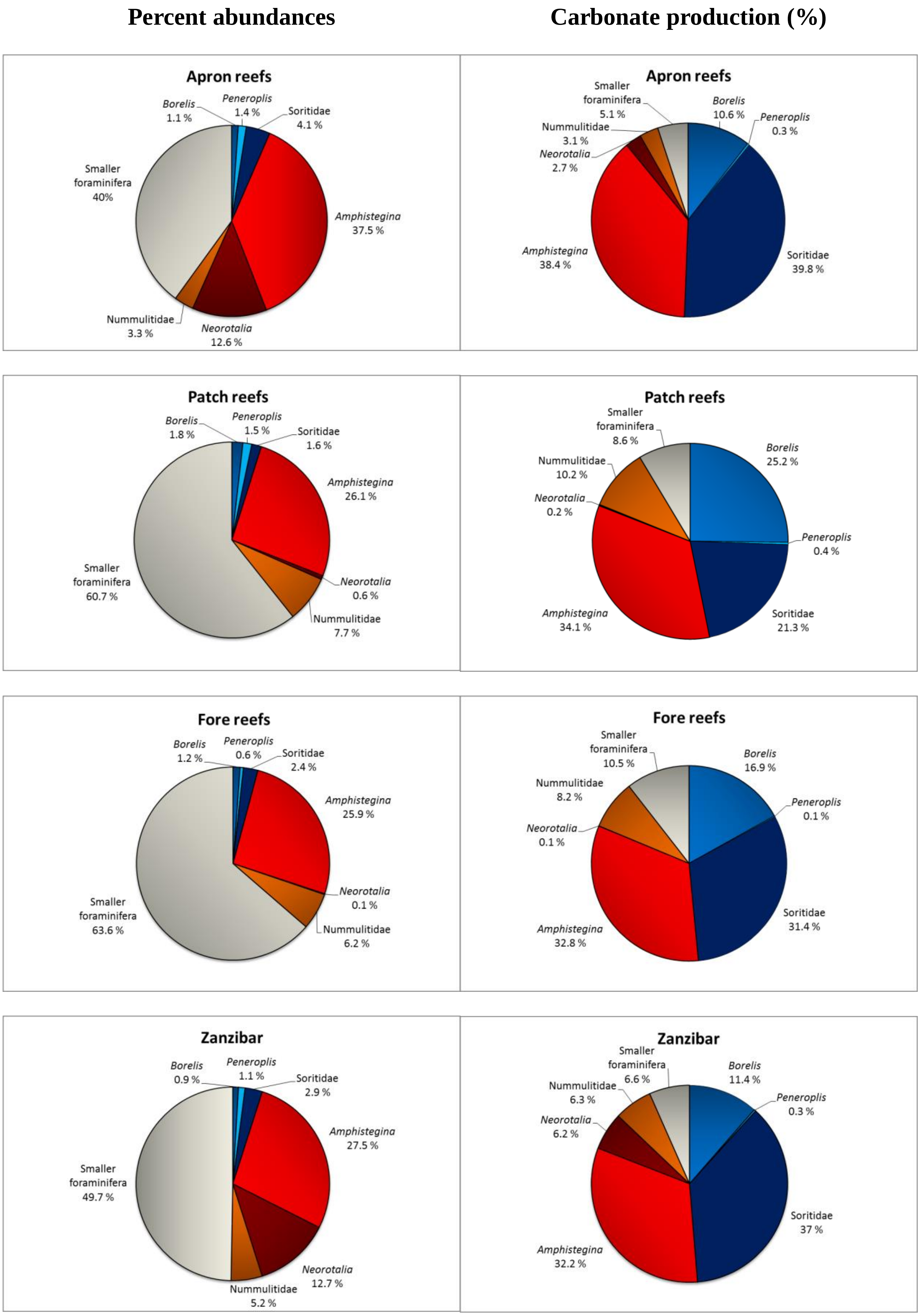

Fig. 224: Comparison of percent abundances of groups of larger and smaller foraminifera with the carbonate production (%) of individual groups in apron reefs, patch reefs, fore reefs and all over Zanzibar.

5 Discussion

5.1 Diversity

In the course of this study about the foraminifera of the Zanzibar Archipelago, 167 species belonging to 98 genera were identified in samples from reefal and nearshore habitats. The most diverse sample collected along the islands of the Zanzibar Archipelago is Kokota Reef 16 m (115 species). Among the three islands, the assemblages from Pemba are by far the most diverse (altogether 156 species). As seen in Fig. 31, there is a general trend of increasing diversity with depth, but the dependency on habitat characteristics is more obvious. Also more obvious than the depth trend of diversity is its correlation to the distance from the shore (as seen in 4.3). Besides this, the most likely factors influencing diversity are wave energy (see 2.3), nutrient levels, and competition with other organisms like algae as well as predation pressure. Temperature, salinity, light intensity, pH-value, and other factors seem to play less important roles due to the tropical and mostly consistent conditions (see also 4.5). Another important factor is the anthropogenic influence on the sensitive ecosystem of a coral reef. The fact that the reefs of Pemba looked much healthier during sampling than those around the other islands substantiates the outstanding species richness outlined above (Langer, pers. com.). The trend of diversity increasing offshore from the beach towards the outer reefs resembles the outcome of other studies (e.g. Langer & Lipps 2003; Renema 2008). In contrast to shallow waters directly off the beach, the deeper fore reef is characterized by lower wave energy and less transport of terrestrial sediments. The most diverse (and abundant) groups among the foraminifera from Zanzibar are the hyaline-perforated Rotaliina (69 species) and the porcelaneous Miliolina (62 species). The resulting ternary diagram (see 4.8) is a typical picture of the distribution of foraminifera in a tropical carbonate shelf (Murray 2006). A similar situation is present in Kerimba where Heron-Allen & Earland (1914 & 1915) described 194 perforated and 122 porcelaneous species. The most diverse genus in Zanzibar is *Triloculina* with 10 different species. Agglutinated foraminifera are represented by only 19 species and mainly present in depths of at least 10 m. In Kerimba, Heron-Allen & Earland (1914 & 1915) described 74 species of agglutinated foraminifera. Together with the discovery of 60 species of lagenid foraminifera (3 species in Zanzibar), these findings are results of stations sampled deeper than the extension of the coral reefs. The suborder Spirillinina only comprises three species in samples from the Zanzibar Archipelago (14 species in Kerimba). The Robertinina are only represented by few specimens of *Alliatinella panayensis*. These smaller groups of foraminifera are statistically and ecologically less important in nearshore habitats from the Zanzibar Archipelago. Planktonic foraminifera have been mostly disregarded in this study due to their minor relevance in shallow-water carbonate sediments. Together, the ten planktonic species (12 species in Kerimba) constitute about 2 % of the total assemblages in the samples. Their abundance and higher species richness in samples from Pemba are a consequence of the greater distance of this island from the mainland.

In comparison with other studies from the western Indian Ocean (see also Table 1), the foraminiferal diversity from the Zanzibar Archipelago displays a medium value: Monier (1974; 23 species) gives a preliminary note from the subtidal zone of a reef platform in southwestern Madagascar. In such a small-scale area diversity is naturally restricted. Similar applies to Levy et al. (1982; 83 species) who studied the littoral zone in Kenya. Neagu (1982;

86 species) confined his study to the small island of Mbudya without distinct habitat differences. Chasens (1981; 100 species) collected 22 samples from the Kenyan coastline, restricted to a shallow lagoonal environment of up to 20 m depth. Moura's (1965; 102 species) study of the foraminifera from the island of Inhaca in southern Mozambique reveals a fauna, which is surprisingly diverse due to the fact that the deepest sample has been collected only 4 m below sea level. Montaggioni (1981; 130 species) studied the foraminiferal composition in sediments from the oceanic islands Réunion, Mauritius and Rodriguez of the Mascarene Archipelago. The diversity in this study might be negatively influenced by dominant *Amphistegina* and *Triloculina* or the proximity of some of the samples to mangroves. These two genera are among the most common taxa in Zanzibar as well and especially *Amphistegina* is the most abundant and dominant genus in both areas. The foraminiferal assemblages from the Bazaruto Archipelago (Langer et al. 2013; 158 species) are in composition and ecology comparative to those of the Zanzibar Archipelago. Both areas are characterized by reefal habitats dominated by *Amphistegina* and lagoonal habitats dominated by smaller miliolids. Bazaruto differs from Zanzibar in the existence of a channel habitat between the islands and a higher number of miliolid species. In addition, the reefs of the Bazaruto Archipelago are all located off the less protected eastern coasts of the islands, whereas Zanzibar and Pemba harbor a highly diverse fauna in the reefs of the sheltered western coasts. In comparison to those from Kerimba, the assemblages from Bazaruto are apparently less diverse due to lower water depths (25 m in comparison to up to 155 m) and fewer different habitats. Pereira (1979; 206 species) conducted an extensive study in the fringing reef complex near Mombasa which is comparative in location and implementation to the present one. But he took more samples during a two-year investigation from a relatively small-scale environment and picked way more specimens (Pereira, pers. com.). Diversity values reported by Le Calvez (1965; 241 species) are probably higher due to far more stations (at least 92). Pignatti et al. (2012; 256 species) additionally studied brackish-water habitats and Braga (1961; 270 species) took way deeper samples (up to 700 m in comparison to 42 m in Zanzibar). However, it is conspicuous that none of the recent studies nearly reaches the diversity discovered by Heron-Allen & Earland (1914 & 1915; 477 taxa). Of course, due to different investigated habitats and research intentions, the studies are hard to compare, but the discrepancy in species richness remains remarkable.

In comparison with the most relevant study of eastern African foraminifera by Heron-Allen & Earland (1914 & 1915) from Kerimba, located in northern Mozambique just about 600 km south of Zanzibar, the diversity appears somewhat low. The reasons for this discrepancy of about 300 species are complex. Sampling and taxonomical classification methods by Heron-Allen & Earland (1914 & 1915) were not sufficiently reported but obviously differ from modern standard procedures. The exact positions of the stations are not provided and sample material originates from mixed habitats. Moreover, only 67 foraminiferal species were found to concur in samples from both Kerimba and Zanzibar (see Table 5). This leads to the assumption that these two regions may be more different than expected at a first glance, which is especially surprising because the northward flowing East African Coastal Current (EACC) should easily transport species from the high-diversity region of the Quirimbas (as the archipelago is called today) to the islands of the Zanzibar Archipelago (see Fig. 4). Thus, population dynamics and migration paths of benthic foraminiferal species along the eastern

Zanzibar		**Kerimba (Heron-Allen & Earland 1914-15)**
Hormosina globulifera		*Hormosina globulifera*
Sahulia cf. *S. barkeri*	?	*Textularia trochus*
Textularia agglutinans		*Textularia agglutinans*
Textularia foliacea		*Textularia foliacea*
Textularia cf. *T. porrecta*		*Textularia porrecta*
Clavulina difformis		*Clavulina angularis* var. *difformis*
Vertebralina striata		*Vertebralina striata*
Spiroloculina foveolata		*Spiroloculina foveolata*
Spiroloculina cf. *S. nitida*		*Spiroloculina nitida*
Articulina scrobiculata		*Miliolina scrobiculata*
Miliolinella suborbicularis		*Miliolina suborbicularis*
Pseudomassilina reticulata		*Massilina secans* var. *reticulata*
Pseudohauerina bradyi	!	*Hauerina compressa*
Pseudohauerina fragilissima		*Hauerina fragilissima*
Pseudohauerina involuta	?	*Hauerina ornatissima*
Pseudotriloculina cf. *P. kerimbatica*		*Miliolina kerimbatica*
Pyrgo denticulata		*Biloculina ringens* var. *denticulata*
Pyrgo striolata		*Biloculina ringens* var. *striolata*
Quinqueloculina cf. *Q. vulgaris*		*Miliolina vulgaris*
Schlumbergerina alveoliniformis		*Massilina alveoliniformis*
Triloculina bertheliniana		*Miliolina bertheliniana*
Triloculina fichteliana		*Miliolina fichteliana*
Triloculina terquemiana		*Miliolina terquemiana*
Triloculina trigonula		*Miliolina trigonula*
Rupertianella rupertiana		*Miliolina rupertiana*
Pseudohauerinella dissidens	?	*Spiroloculina crenata*
Borelis schlumbergeri	?	*Alveolina boscii*
Peneroplis pertusus		*Peneroplis pertusus*
Peneroplis planatus		*Peneroplis planatus*
Patellina corrugata		*Patellina corrugata*
Pyramidulina catesbyi	?	*Nodosaria proxima*
Globorotalia menardii		*Pulvinulina menardii*
Pulleniatina obliquiloculata		*Pullenia obliquiloculata*
Globigerinoides conglobatus		*Globigerina conglobata*
Globigerinoides ruber		*Globigerina rubra*
Orbulina universa		*Orbulina universa*
Brizalina simpsoni		*Bolivina simpsoni*
Loxostomina limbata costulata		*Bolivina limbata*
Siphogenerina cf. *S. raphana*		*Sagrina raphanus*
Cancris carinatus	?	*Pulvinulina oblonga*
Reussella insueta	?	*Verneuilina spinuosa*
Valvobifarina mackinnonii		*Bifarina mackinnonii*
Pavonina flabelliformis		*Pavonina flabelliformis*
Eponides repandus		*Pulvinulina repanda*
Rotorbis rosacea		*Discorbina rosacea*
Rosalina bradyi	?	*Discorbina globularis*
Siphoninoides echinatus		*Truncatulina echinata*
Cibicides pseudolobatulus	?	*Truncatulina refulgens*
Cibicidella variabilis		*Truncatulina variabilis*
Planorbulina mediterranensis		*Planorbulina mediterranensis*
Planorbulinella larvata		*Planorbulina larvata*
Cymbaloporella tabellaeformis		*Cymbalopora tabellaeformis*
Cymbaloporetta bulloides		*Cymbalopora bulloides*
Millettiana milletti		*Cymbalopora milletti*
Sphaerogypsina globula		*Gypsina globulus*
Asanonella tubulifera		*Truncatulina tubulifera*
Epistomaroides punctulatus	!	*Discorbina polystomelloides*
Amphistegina lessonii		*Amphistegina lessonii*
Amphistegina radiata		*Amphistegina lessonii* var. *radiata*
Anomalinella rostrata		*Truncatulina rostrata*
Gyroidina neosoldanii		*Rotalia soldanii*
Neorotalia calcar		*Rotalia calcar*
Challengerella bradyi	!	*Rotalia beccarii*
Elphidium milletti		*Polystomella milletti*
Elphidium striatopunctatum		*Polystomella striato-punctata*
Assilina ammonoides		*Operculina ammonoides*
Heterostegina depressa		*Heterostegina depressa*

Table 5: Co-occurring taxa at Zanzibar and Kerimba (? = uncertain synonymy, ! = accepted synonymy).

African coasts require further investigations. Inspection of the original Heron-Allen & Earland type-slides at the Natural History Museum in London revealed that they definitely discovered more species than found today at Zanzibar, but sampling locations and maximum depths were not precisely described. Although no absolute numbers are given by Heron-Allen & Earland (1914 & 1915), it seems that the fauna in Kerimba is more even and less dominated by single taxa. There are a number of deep-water species present, but this alone cannot explain the strikingly higher diversity. Climatic changes, anthropogenic environmental pollution and overfishing have certainly affected the biodiversity in this area. Still, it remains unknown if such a large number of species have disappeared from this region within a time span of just 100 years. To solve this problem would require a taxonomic revision of the material collected by Heron-Allen & Earland (1914 & 1915) and definitely more comparative sampling material from this area.

5.2 Biogeography

In general, faunal provinces and distributions of foraminifera seem to be confined by geological factors: longitudinally mainly by temperature but also by landmasses (in case of the Indian Ocean) and latitudinally mainly by continents separating the oceans as well as deep-sea basins separating shelf areas (Adams 1989). The number of species in faunal provinces additionally depends on the size of the certain area. That is why the highest diversity (not only of foraminifera) is found in the central Indo-Pacific around Indonesia and adjacent islands (see Fig. 225). Over geological periods of time, plate tectonics and sea-level changes have several times parted and (re)combined faunal provinces (e.g. Middle Eastern Tethys Ocean or the Isthmus of Panama). *Borelis* for example was during Miocene times distributed all over the Tethyan Ocean but absent in America, today, after the occlusion of the Tethys, this taxon is distributed circumtropical but absent from the Mediterranean (Adams 1989). From the Asiatic core region, the number of genera of larger symbiont-bearing foraminifera decreases outwards (Langer 1997, Fig. 225). *Borelis schlumbergeri* is the only alveolinid species in the East African Faunal Province (Reiss & Hottinger 1984). The soritids of eastern Africa are represented by *Amphisorus* and *Sorites*. *Amphisorus hemprichii* and *Sorites orbiculus* are known from the tropical areas of all oceans (Langer & Hottinger 2000). All species of *Amphistegina* found in this study are widespread in the Indo-Pacific and even beyond. Measured by temperature and latitude, *Amphistegina* is the most widespread genus of larger benthic foraminifera (Adams et al. 1990; Langer & Hottinger 2000). *Neorotalia calcar* is the most common calcarinid species and present in tropical areas all around the globe (Langer & Hottinger 2000). Of the nummulitids *Assilina* (≈ *Operculina*) and *Heterostegina* are present in the western Indian Ocean. *Heterostegina depressa* is a widespread cosmopolitan genus, *Assilina* restricted to the Indo-Pacific (Langer & Hottinger 2000).

The larger benthics are common in most of the Indo-Pacific region or in some cases even cosmopolitan (Langer & Hottinger 2000). For most of the smaller foraminiferal species there are no references considering their biogeographic distributions. The 24 species not identified on a generic level in this project require further detailed morphological studies to determine species characteristics and biogeographic distributions. No adequate synonyms were found and so these taxa have not been determined at species level and are recorded under open nomenclature. Thus, there is so far no evidence that there are any species endemic to the Zanzibar Archipelago among the taxa discovered around the islands. Though, some of them may at least be endemic to the Eastern African Faunal Province due to geographic and climatic barriers. As of today, the biogeographic distributions of most foraminiferal species are unknown. Only larger foraminiferal distributions have been studied in detail so far (e.g. Langer & Hottinger 2000).

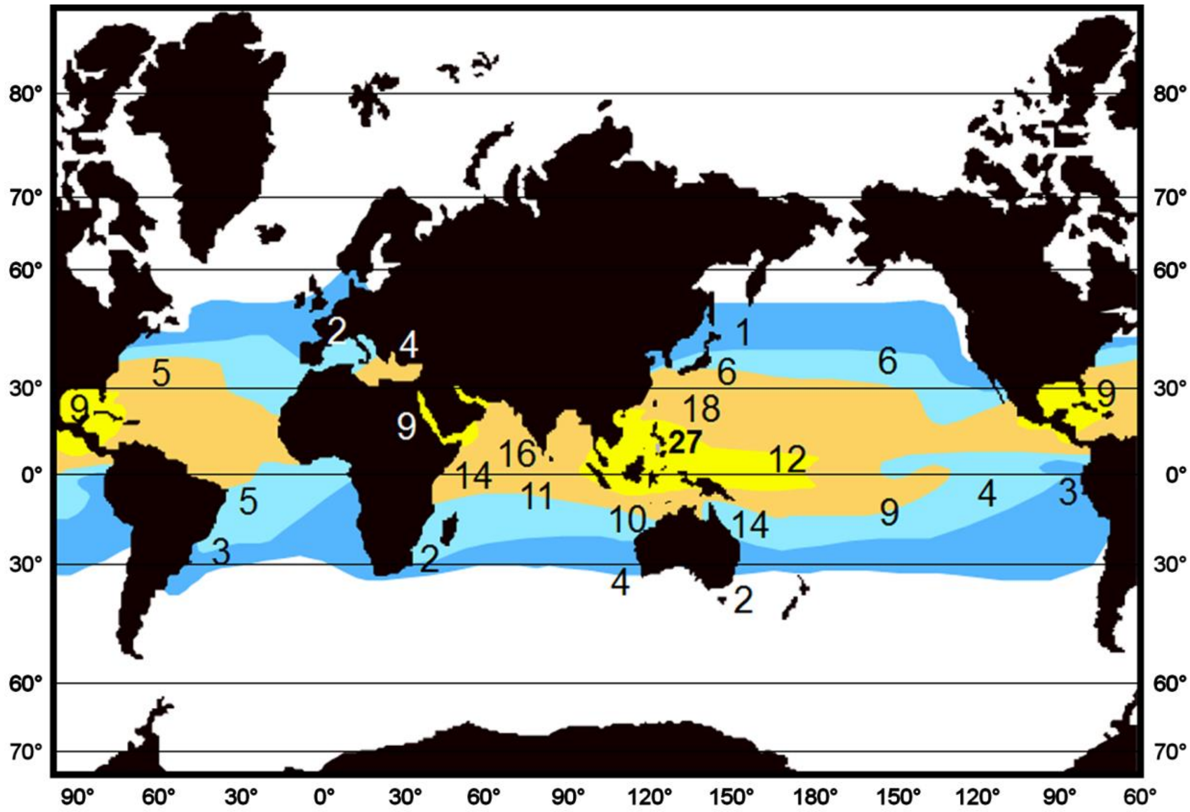

Fig. 225: Generic diversity of recent larger symbiont-bearing foraminifera (after Langer 1997).

As seen in Table 5, there are 67 species occurring in both Zanzibar and Kerimba. If there were a verifiable Eastern African Faunal Province, more co-occurring taxa would be expected from these two areas. The main problems are different maximum sampling depths and possibly varying classification methods. As discussed above, a hundred years of human impact and climate change might also have affected biogeographical distribution patterns and species richness. On the other hand, besides the deeper cold-water taxa described by Heron-Allen & Earland (1914 & 1915) from Kerimba, the characteristic species and the typical reefal and lagoonal fauna are similar in both regions. Local endemic species and varieties due to the geographical distance are further explanations of the differing faunal composition. Additionally, the Quirimbas Islands are a UNESCO world heritage site, sparsely inhabited, and economically and touristic unexploited. The reefs around these islands are unspoiled and have not been harmed by fishery or diving tourism. The greater part of the coral reefs has yet not even been mapped. In contrast, Zanzibar has been one of the most important harbors and transshipment points in East Africa for centuries and fishery has ever since been the main economic sector to feed the large population.

5.3 Reef habitats and indicator taxa

The results of the Q-mode cluster analysis (Fig. 199) and the location of the determined clusters (Fig. 200) reflect the observations made by the divers during the collection of the samples. All major habitats of a tropical environment are represented in the samples, from the shallow-water mangroves to the deeper fore reef. The clusters are well correlatable with the different habitats and precisely conform to the physio-geomorphological environment, which means that foraminifera are excellent indicators for the determination of reefal habitats and thus a useful tool in paleoecological studies. The geographical distribution of the major clusters reflects the distribution of the reefal habitats. Classification of the samples in the ternary diagram introduced by Murray (1973) shows expected normal marine to lagoonal conditions for the Zanzibar Archipelago (see also 4.7). The indicator taxa (see 4.3.2) have been chosen to represent the different habitats in the reefs of the Zanzibar Archipelago. Best indicators are those species which are almost endemic to one of the habitats. *Triloculina trigonula* and *Assilina discoidalis* in the patch reefs west of Zanzibar Island are the best examples of such kind of species (see Figs. 206 & 208). About 80 % of the individuals of these two species were found in this specific habitat. In a fossil reef, taxa similar to these could ideally be used as indicators for such an environment. Further good indicators are the dominant species of specific habitats like *Neorotalia calcar* (reef flats), *Ammonia convexa* (mangroves) or *Amphistegina lobifera* (fringing reefs). High numbers of individuals of these taxa are a significant hint to their respective habitats.

A highly diverse fauna was found in the fore reef samples. *Amphistegina* is the most abundant taxon but it is less dominant than at the eastern reef stations (see Figs. 204, 205, 207). Experience shows that *Amphistegina* is very abundant in high-energy habitats right beneath the reef crest, a place which is more difficult to inhabit for fragile species (Hallock & Glenn 1986; Langer & Lipps 2003). Especially robust and spheroid tests, like that of *A. lobifera*, are well adapted to high-energy conditions, whereas flat, fragile forms, like that of *A. bicirculata* are found in deeper and more quiet environments (Larsen 1976; Hallock & Glenn 1986). Calmer places around patch reefs or in the deeper fore reef, which are characterized by highly diverse assemblages, usually contain lower amounts of this taxon. It seems that high reproduction rates of *Amphistegina* in extremer habitats lead to the dominance of this genus, whereas foraminiferal assemblages in protected environments are more diverse and less dominated by *Amphistegina* probably due to less competition between species. Less dominated habitats like the lagoon at Ocean Paradise or the fore reefs at Pemba can be determined by their characteristic assemblages. The lagoon is characterized by a high amount of miliolids like *Quinqueloculina*, *Triloculina*, *Miliolinella*, or *Pyrgo* and generally high percentages of smaller foraminifera (Fig. 206). In comparative studies Montaggioni (1981) discovered 60-90 % miliolids in the back-reef areas of Mauritius, whereas Murray & Smart (1994) identified less than 30 % miliolids in lagoons of the Chagos Archipelago. This leads to the conclusion that several factors impact the composition of foraminifera in the sediment, like water depth, wave energy, or regional natural features. The absence of larger benthics in the lagoon is mainly a result of the very low water depth (see also 4.8). Langer & Lipps (2003) describe a highly diverse lagoon at Madang/Papua New Guinea, additionally characterized by larger benthics like *Assilina* due to numerous patch reefs inside the lagoon.

The mangroves station is probably the most extreme habitat along the coasts of the Zanzibar Archipelago. Due to its eutrophic conditions it is characterized by opportunistic species, which are able to withstand to a certain level, like *Ammonia convexa*, *Quinqueloculina patagonica* or *Elphidium limbatum* sp. 2. This fauna is very similar to the mangrove-covered bay inlets at Madang, characterized by *A. convexa* together with *Elphidium striatopunctatum* and smaller miliolids (Langer & Lipps 2003). Especially *A. convexa* is highly specialized and mainly found in shallow-water, eutrophic or semi-brackish environments, which are inhabitable for most other foraminiferal taxa. The same applies to *Neorotalia calcar* in high-energy but unpolluted shallow-waters like Kizimkazi Beach or the reef flats at Mnemba Island. These two species rarely share the same habitat and only co-exist in the shallow lagoon at Ocean Paradise which seems to display conditions suitable to a certain degree for both of them. Especially the low water depth in this lagoon and the relatively high wave energy are the main common ground for *A. convexa* and *N. calcar*.

The results of the CCA elucidate how environmental parameters control the distribution of different species and their adaptations to specific habitats (see also 4.5). The distribution of different eco- and morphotypes emphasizes the dependency of taxa on specific environmental conditions (4.9 & 4.10). Renema (2008) established three clusters, of which each was characterized by different reef geomorphology (reef flat/crest, reef base, reef slope) and substrate type (algae, sand, rubble). Due to that, he was not able to discriminate which of the two factors was more important. In this study, accept for the fine-grained, sand-dominated shallow-water clusters, the substrate was mostly very similar, so the reef habitat itself was found to be the decisive factor. Especially the different composition of the assemblages in the eastern and the western reefs are prominent examples for the dependency of the fauna on habitat characteristics. The results of this environmental analysis confirm the standard facies model for reefal and lagoonal environments conceptualized by Hallock & Glenn (1986) and reflect observations previously made by Murray (1973): In a standardized Indo-Pacific reef environment, the fore reef is mainly characterized by larger benthic foraminifera like *Amphistegina* or *Heterostegina* and smaller foraminifera including *Eponides*; the reef crest is dominated by robust larger foraminifera like *Neorotalia* or *Amphistegina* (see also Langer & Lipps 2003); the reef flat is dominated by calcarinids and associated soritids and peneroplids; and the lagoon is characterized by high percentages of smaller miliolids. These standard models are confirmed by the results made in this study from the Zanzibar Archipelago.

Calculation of the FoRAM Index shows that the coral reefs around the islands of the Zanzibar Archipelago are generally in a good condition, though medium FoRAM Indexes indicate early signs of degradation in the highly diverse reefs located at the western coasts of Zanzibar and Pemba (Fig. 221). Especially the patch reefs at Bawe Island and the Stone Town Aquarium showed evidence of anthropogenic disturbance. High species richness and medium FoRAM Indexes are good indicators for mesotrophic conditions favoring algal overgrowth (Hallock 2012). In the eastern reefs, high percentages of dominant *Amphistegina* might skew the picture of healthy, less endangered coral reefs purported by high FoRAM Indexes (Figs. 203-205, 221). High abundances of *Amphistegina* have to be interpreted more critically because the genus tolerates a wider environmental spectrum, including greater tolerance of turbidity and pollution than other taxa of symbiont-bearing foraminifera (Langer et al. 2012).

5.4 Ecosystem engineers

Jones et al. (1994) define ecosystem engineers as “organisms that directly or indirectly modulate the availability of resources (other than themselves) to other species, by causing physical state changes in biotic or abiotic materials. In so doing they modify, maintain and/or create habitats.” There is probably no ecosystem on earth that has not been engineered to a certain degree and there are many examples of more or less effective ecosystem engineers (Jones et al. 1994).

Foraminifera most considerably modify their habitats by producing large amounts of tests (or in other words sediment grains) which effect ecosystems and can persist for millions of years in a fossilized state. In some cases large foraminifera even act as hard substrates for smaller attached foraminiferal species (Martin 2008). By transforming the sediment’s composition and chemistry (e.g. from predominantly siliceous sands to carbonate sediments), foraminifera inflict changes to the conditions and resources for burrowing organisms, sediment feeders and organisms depending on silicate or carbonate respectively. By taking $CaCO_3$ from the environment, foraminifera inflict its availability for other organisms and influence the carbon cycle. On the other hand, by producing sediment, foraminifera (like corals) prevent coastal erosion and support coastal areas (especially atolls) in keeping up with a rising sea level. Recently, experiments are made to test the abilities of intentionally cultivated foraminiferal populations in preventing densely populated coastal areas from sediment run-off and flooding (Hosono et al. 2014).

The most abundant taxon among the foraminifera of the Zanzibar Archipelago is *Amphistegina*. This genus is present in all of the habitats and dominant in most of the eastern reef assemblages (see Figs. 174-178, 204, 205). Zanzibar is an excellent example of how successful the genus *Amphistegina* actually is in modern days’ warm waters. With its high reproduction rate and adaptability, this taxon is one of the major producers of foraminiferal carbonate and widespread in many different environments. The environmental significance of *Amphistegina* is reflected in its abundance and carbonate productivity (each up to 50 % in reef samples). Figure 226 shows that there is a clearly visible correlation between the numerical abundance of *Amphistegina* and diversity. With an increasing percentage of *Amphistegina* at the reef stations, the species richness decreases. Even the non-reefal stations, which are less affected by *Amphistegina*, show the same trend (Fig. 226). Thus, mass abundances of dominant *Amphistegina* in these environments inflict assemblages and the species richness of foraminiferal communities. In reef samples from the Bazaruto Archipelago, Langer et al. (2013a) even discovered *Amphistegina* as a monoculture at one place. This might have been a consequence of sediment sorting but still emphasizes the impact of this genus on foraminiferal assemblages. Surprisingly, in the Kerimba Archipelago of the early 20th century, *Amphistegina* seems to play a minor role as its abundance is mainly declared as ‘common’ but never as highly abundant or dominant (Heron-Allen & Earland, 1914 & 1915). In this case, a less dominant *Amphistegina* could facilitate the high diversity of an untouched environment (see Figs. 213 & 226). Recent studies (e.g. Langer et al. 2012, Weinmann et al. 2013) describe the severe effects of *Amphistegina* as an invasive taxon in the Mediterranean Sea after the opening of the Suez Canal. In some of the areas invaded by *Amphistegina* it constitutes up to 90 % of the foraminiferal individuals, supersedes local species and decreases diversity (see

Fig. 226). An expansion throughout the whole Mediterranean is only prevented by low winter temperatures in the western part, but *Amphistegina* will profit from climate change and further expand in the next decades (Weinmann et al. 2013). The same trend was observed in South Africa, where *Amphistegina* expands with up to 8 km/year southwestward following the Agulhas current (Langer et al. 2013b). These studies elucidate the biogeographic range expansion of *Amphistegina*, its benefit from global climate change, and predict an even stronger impact of this genus on foraminiferal communities in the future.

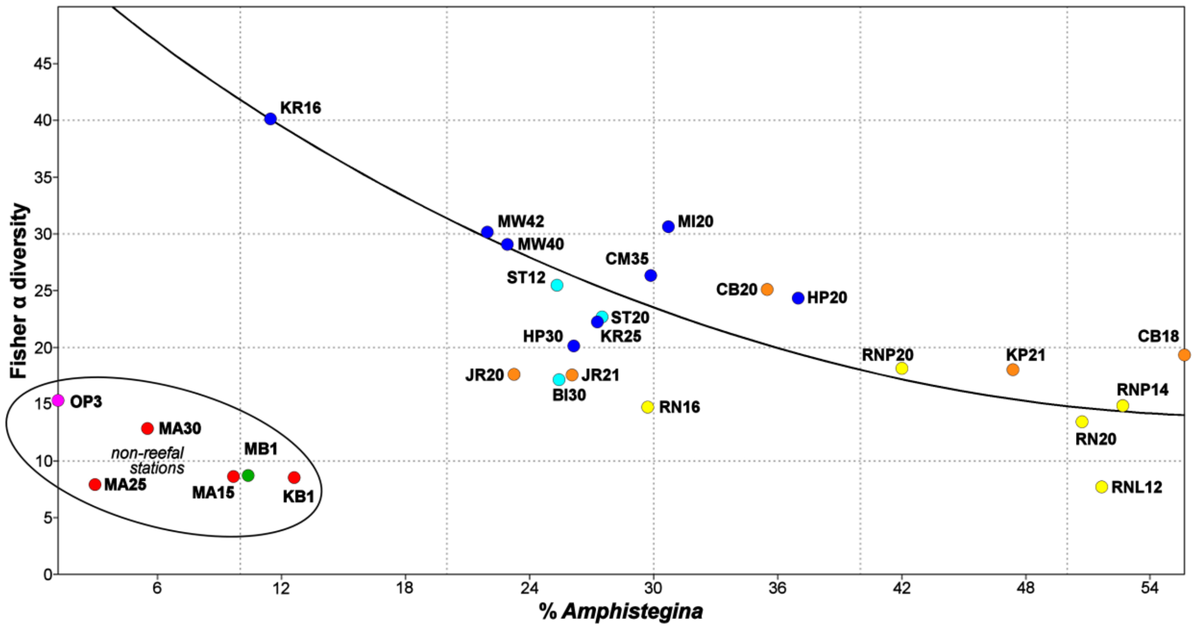

Fig. 226: Graph showing the correlation between the abundance of *Amphistegina* and diversity.

The second most abundant taxon along the coasts of Zanzibar is *Neorotalia calcar*. This species is specialized to high-energy and extremely warm surface water conditions. It is absolutely dominant in the reef flats at Kizimkazi and Mnemba Island and furthermore significant in the wave-exposed eastern reefs. Pereira (1979) reports that *Pararotalia*, which is in this case probably synonymous with *Neorotalia*, dominates the outer reef zone with about 60 % of the total assemblage. In some shallow-water areas of the Indo-Pacific calcarinid foraminiferal tests almost entirely constitute the beach sediments (Hallock 2002, Hohenegger 2006, Dawson et al. 2012). That is why they are commonly known as 'living sands' or 'star sands'. As seen in Figure 213, the number of species in places highly dominated by *Neorotalia* is lower than in the less dominated reef. Because of its mass abundances in specific areas *Neorotalia* seems to have an even stronger effect on the diversity of foraminiferal assemblages than *Amphistegina*. Though, the extreme conditions in places inhabited by *Neorotalia* or other calcarinids might bias this impact. Again, in the Kerimba Archipelago of the early 20th century, *Neorotalia* (like *Amphistegina*) seems to play a minor role as it is present in few of the stations and only 'very common' in one of the samples but never dominant or obviously affecting diversity (Heron-Allen & Earland, 1914 & 1915). The outstanding positions and definition as the major principal components in the PCA due to their high eigenvalues emphasize the importance of these two taxa, their significant influence on habitats, and substantiate their role as ecosystem engineers (see also 4.4).

One of the most prominent groups of foraminifera, although not among the most abundant taxa in samples from the Zanzibar Archipelago, is the soritids. *Amphisorus* and *Sorites* are the largest foraminiferal species in the samples according to test size. They are not very abundant but due to their large tests, together with *Amphistegina*, the most important producers of calcium carbonate in this area (see Figs. 222-224). By producing such large tests, the soritids consume great quantities of available calcium carbonate from the environment and occupy large areas that might have been available for other species. In the western Pacific extremely large specimens of the soritid species *Marginopora kudakajimensis*, visible to naked eye, cover large areas and produce more carbonate than reported for any other foraminiferal species (Fujita et al. 2000). Therefore, soritids, amphisteginids, and calcarinids are the major ecosystem engineers among larger foraminifera.

5.5 Carbonate production

After Smith & Kinsey (1976) the annual production of calcium carbonate per square meter is about 4 kg in reefs and 0.8 kg in lagoons. Langer et al. (1997) used these values to establish a formula to calculate the carbonate production of foraminifera by their percentages in carbonate sediments. In the central Indo-Pacific region benthic foraminifera (amphisteginids and calcarinids above all) produce up to 2 kg of $CaCO_3$ per square meter per year (Hallock 1981). In the Asiatic core region, larger benthic foraminifera produce up to 12.8 million tons of calcium carbonate per year (Langer 2008, Fig. 227). Larger symbiont-bearing foraminifera in the Indian Ocean produce up to 10.2 million tons of carbonate per year (Langer 2008, Fig. 227). Altogether, present-day coral reefs globally produce about 900 million tons of carbonate each year (Milliman 1993). Benthic foraminifera contribute about 5 % of the annual carbonate production in modern reefs (Langer 2008, Doo et al. 2014). The average production rate by foraminifera in Zanzibar confirms this percentage (see Table 6).

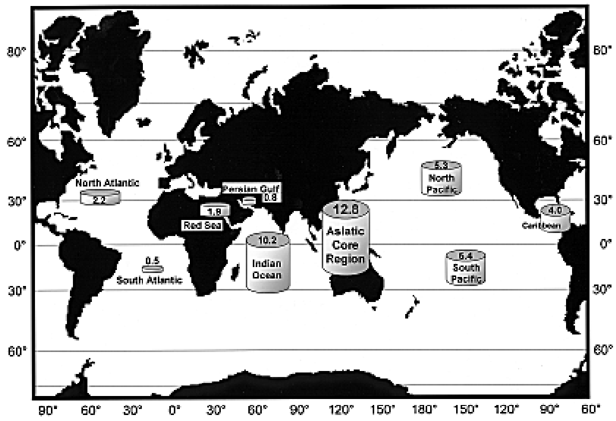

Fig. 227: Annual carbonate production of larger symbiont-bearing reef foraminifera in individual oceanic provinces between 0 and 30 m water depth, given in millions of tons of $CaCO_3$ (Langer 2008).

The highest foraminiferal carbonate production rate around the islands of the Zanzibar Archipelago was obtained from the reef flats (up to 356 g/m^2/a). This finding is explained by the high percentage of foraminifera in the sediment (up to 20.2 % of the total grains) as well as the greater portion of larger foraminifera in this habitat (up to 85.5 % of the total assemblages). Because of the great differences in size and weight, the largest portion of carbonate in these samples is not produced by dominant *Neorotalia calcar* but by large soritids (Figs. 222 & 223). As discussed in the previous chapter, large soritids like *Marginopora kudakajimensis* are able to produce up to 5 kg of calcium carbonate per square meter per year, which is more than the average carbonate production in coral reefs at all (Fujita et al. 2000, Smith & Kinsey 1976).

Amphistegina spp. is the most important producer of calcium carbonate in the reefal ecosystems around the Zanzibar Archipelago (Figs. 222 & 224). Especially in reefs, dominant *Amphistegina* spp. is the most productive taxon of carbonate. A considerable portion of the reefal carbonate is produced by less abundant but larger *Borelis schlumbergeri*, and the soritids *Amphisorus hemprichii* and *Sorites orbiculus* (Fig. 221). *B. schlumbergeri* is not very abundant but the second most productive taxon in the patch reefs (Fig. 223). Due to its high abundance in the reef flats *Neorotalia calcar* contributes 24.6 % to the carbonate production in this habitat (Fig. 223). In deeper waters, the percentage of carbonate produced by *N. calcar* is almost negligible (Figs. 222-224). Despite their size, the nummulitids *Heterostegina depressa, Assilina ammonoides*, and *Assilina discoidalis* never exceed more than 10 % of the carbonate production in one of the habitats (Figs. 222-224). Due to their higher abundances in the fringing reefs and patch reefs, they are most productive in these habitats. Because their medium size is not much larger than that of smaller foraminifera, the peneroplids *Peneroplis pertusus* and *P. planatus* constitute the lowest amount of the carbonate production among larger benthic foraminifera (Figs. 222-224). Smaller foraminifera represent almost 50 % of the total assemblages but due to their small size, these taxa contribute a minor portion to the carbonate production. In the shallow-water stations the carbonate production is very low (2.3 $g/m^2/a$ in Menai Bay) due to comparatively fewer larger foraminifera (13.1 % of the total assemblage) and the generally lower production rate in lagoonal habitats (Fig. 215; Smith & Kinsey 1976, Langer et al. 1997). As an inversely proportional trend to that of the diversity, the carbonate productivity of foraminifera decreases with the distance from the shore. From the reef flats to the fore reef diversity rises from 79 to 156 species (Figs. 203-207), while the carbonate production by foraminifera declines from about 280 to 150 $g/m^2/a$ (Fig. 222). This is a consequence of the higher numbers of smaller foraminifera in the highly diverse fore reefs and the less dominance of larger foraminifera.

Shagude & Wannäs (2000) have studied the mineralogical and biogenic composition of sediments from the Zanzibar Channel which separates the island from the mainland of Tanzania. The sample stations analyzed in the present study from within the Zanzibar Channel are Bawe Island and Stone Town Aquarium (the patch reef cluster, Fig. 206). The percentage of carbonate fragments and the percent amount of foraminiferal tests in the sediments was analyzed in both studies, with remarkably different results. While the percentage of calcium carbonate at the two comparable sample stations is about 90-95 % in both studies, the amount of foraminifera varies tenfold. In this thesis, the percentage of foraminifera in the sediment at these stations is 3-7 %, whereas Shagude & Wannäs (2000) give an average amount of 65-70 % foraminifera. Such a discrepancy can only be explained by considerably different sampling procedures and interpretation methods, primarily caused by different research approaches. One noticeable difference is the low amount of corals. Coral fragments in the sediments used in this thesis constitute the main amount of carbonate grains. In the samples described by Shagude & Wannäs (2000), coral fragments never exceed 7 % of the biogenic components in the sediments, even in the reef platforms/patch reef zone. This leads to the assumption that Shagude & Wannäs (2000) have collected their samples in greater distances from the actual coral reefs and principally focused on the open platforms between the patch reefs.

5.6 Conclusion

This thesis presents the first examination of the spatial distribution, composition, diversity and environmental significance of foraminiferal faunal assemblages in shallow-water reefal ecosystems from the islands of the Zanzibar Archipelago. The main results of this study were:

1. 167 species belonging to 98 genera were identified in samples from reefal and nearshore habitats.

2. Maximum diversity values were obtained from fine grained reef sediments at a depth of around 20 m.

3. Quantitative analyses of sediment samples indicate the presence of seven major habitats around the three islands of the Zanzibar Archipelago, characterized by specific indicator taxa.

4. The well-defined clusters show that even in relatively small-scale environments, habitats are excellently discriminable by foraminiferal assemblages.

5. Extreme habitats like the eutrophic mangroves stations or the high-energy eastern reefs are inhabited by low diverse biotas and highly specialized taxa like *Ammonia* or *Neorotalia*.

6. In tropical reef systems, foraminiferal diversity depends more on habitat characteristics than on water depth or any other abiotic factor.

7. The distribution patterns of foraminiferal taxa reflect the ecological adaptations and display useful information for the reconstruction of fossil environments.

8. In comparison to other studies from eastern Africa, the foraminiferal diversity from the Zanzibar Archipelago displays a medium value but appears somewhat low compared to the most relevant study from this area by Heron-Allen & Earland (1914-15).

9. Foraminiferal taxa like *Amphistegina* or *Neorotalia* locally occur in enormous abundances, modulate the availability of resources, modify their physical habitat, and impact the structure, diversity and species richness of associated foraminiferal communities.

10. Because of their high abundances and significant contribution to the stabilization of reefal frameworks in these habitats, benthic foraminifera are prolific producers of calcium carbonate and contribute a substantial portion to the sedimentary budget of reefal structures.

11. Foraminifera are to be considered ecosystem engineers in modern day's shallow-water tropical reef habitats.

12. The FoRAM Index indicates that the reefs around the three islands are generally in a good condition, but early signs of degradation require reefal monitoring and the implementation of coral reef conservation programs.

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7 Alphabetical index of taxa at species level

8 Plates

Plates 1-22

Plate 1

Figure		Scale	Sample	Page
1-3	***Hormosina globulifera***			18
	1 Lateral view	200 µm	Mapenduzi Wall 42 m	
	2 Aboral view	200 µm	Mapenduzi Wall 42 m	
	3 Lateral view	200 µm	Mapenduzi Wall 42 m	
4-5	***Ammobaculites exiguus***			18
	4 Lateral view	100 µm	Ocean Paradise 3 m	
	5 Apertural view	50 µm	Ocean Paradise 3 m	
6-7	***Haddonia* ? sp. A**			19
	6 Lateral view	500 µm	Coral Mountain 35 m	
	7 Apertural view	500 µm	Coral Mountain 35 m	
8-9	***Haddonia* sp. B**			19
	8 Lateral view	500 µm	Misali Island 20 m	
	9 Apertural view	500 µm	Misali Island 20 m	
10-11	***Haddonia* ? sp. C**			20
	10 Lateral view	500 µm	Misali Island 20 m	
	11 Apertural view	200 µm	Misali Island 20 m	
12-13	***Haddonia* ? sp. D**			20
	12 Lateral view	500 µm	Kokota Reef 16 m	
	13 Peripheral view	200 µm	Kokota Reef 16 m	
14-15	***Spiroplectammina* sp. A**			21
	14 Lateral view	200 µm	Mapenduzi Wall 42 m	
	15 Apertural view	100 µm	Mapenduzi Wall 42 m	
16-18	***Sahulia* cf. *S. barkeri***			21
	16 Lateral view	200 µm	Kokota Reef 25 m	
	17 Oblique apertural view	500 µm	Kokota Reef 25 m	
	18 Aboral view	500 µm	Ras Nungwi 16 m	
19-22	***Sahulia kerimbaensis***			22
	19 Lateral view	200 µm	Mapenduzi Wall 42 m	
	20 Lateral view	200 µm	Ras Nungwi Lighthouse 12 m	
	21 Apertural view	200 µm	Ras Nungwi Lighthouse 12 m	
	22 Peripheral view	200 µm	Ras Nungwi 20 m	
23-24	***Siphotextularia* sp. A**			22
	23 Lateral view	200 µm	Mapenduzi Wall 42 m	
	24 Oblique apertural view	200 µm	Mapenduzi Wall 42 m	

Plate 1

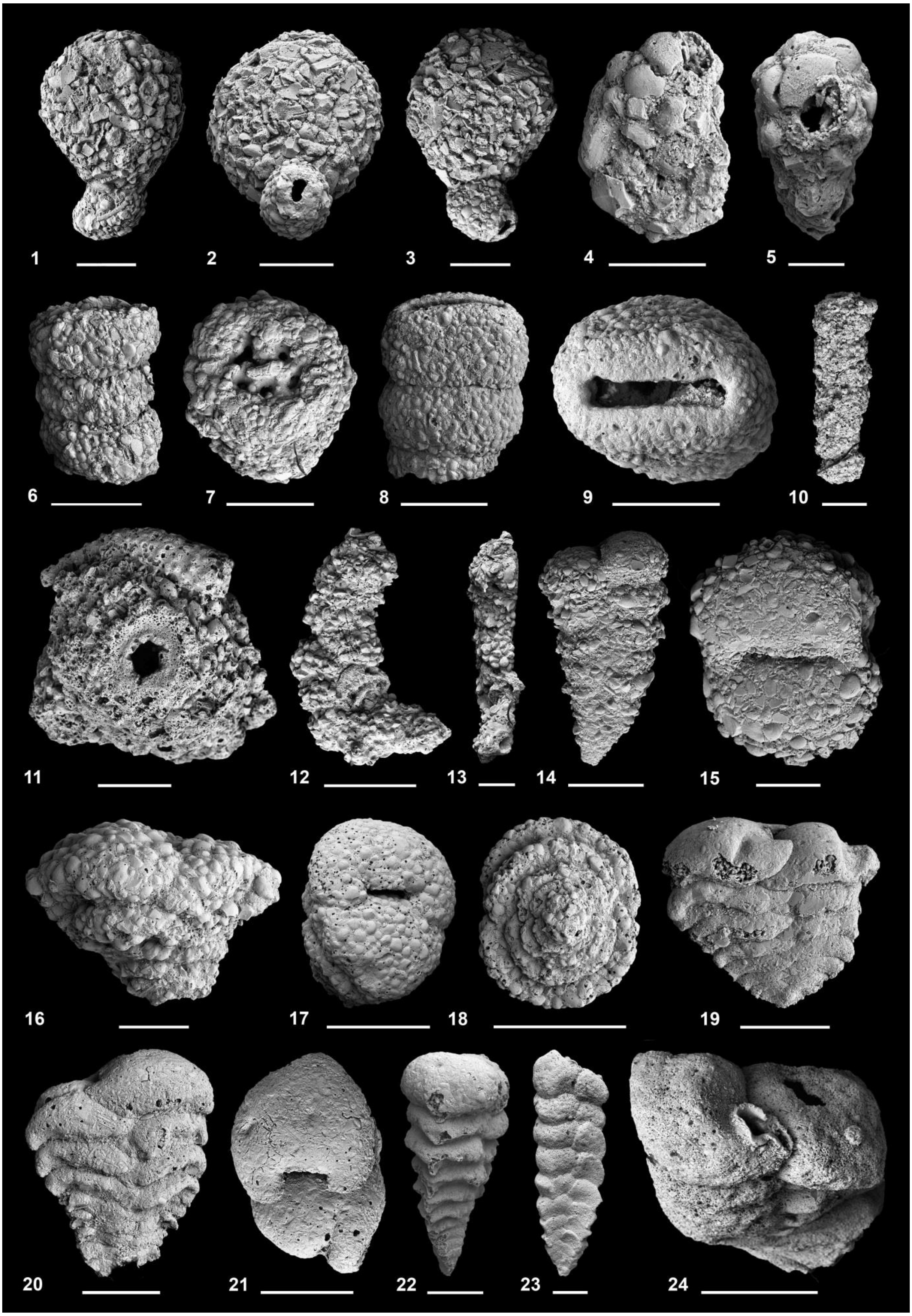

Plate 2

Figure		Scale	Sample	Page
1-4	***Textularia agglutinans***			23
	1 Lateral view	500 µm	Ras Nungwi Lighthouse 12 m	
	2 Apertural view	500 µm	Ras Nungwi Lighthouse 12 m	
	3 Lateral view	500 µm	Ras Nungwi Lighthouse 12 m	
	4 Apertural view	500 µm	Ras Nungwi Lighthouse 12 m	
5-8	***Textularia foliacea***			23
	5 Lateral view	200 µm	Kokota Reef 16 m	
	6 Lateral view	200 µm	Stone Town Aquarium 12 m	
	7 Apertural view	200 µm	Stone Town Aquarium 12 m	
	8 Peripheral view	200 µm	Stone Town Aquarium 12 m	
9-10	***Textularia occidentalis*** **?**			24
	9 Lateral view	200 µm	Mapenduzi Wall 42 m	
	10 Apertural view	200 µm	Mapenduzi Wall 42 m	
11-12	***Textularia*** **cf.** ***T. porrecta***			25
	11 Lateral view	200 µm	Stone Town Aquarium 20 m	
	12 Apertural view	200 µm	Stone Town Aquarium 20 m	
13-14	***Textularia*** **sp. A**			25
	13 Lateral view	200 µm	Bawe Island 30-9 m	
	14 Apertural view	200 µm	Bawe Island 30-9 m	
15-19	***Textularia*** **sp. B**			26
	15 Peripheral view	500 µm	Bawe Island 30-9 m	
	16 Peripheral view	500 µm	Bawe Island 30-9 m	
	17 Lateral view	500 µm	Bawe Island 30-9 m	
	18 Apertural view	500 µm	Bawe Island 30-9 m	
	19 Aboral view	500 µm	Bawe Island 30-9 m	
20-22	***Siphoniferoides*** **cf.** ***S. balearicus***			26
	20 Lateral view	200 µm	Kokota Reef 25 m	
	21 Oblique apertural view	200 µm	Kokota Reef 25 m	
	22 Lateral view	500 µm	Kokota Reef 25 m	
23-24	***Clavulina difformis***			27
	23 Lateral view	200 µm	Ocean Paradise 3 m	
	24 Apertural view	200 µm	Ocean Paradise 3 m	
25-26	***Clavulina multicamerata***			27
	25 Lateral view	200 µm	Ocean Paradise 3 m	
	26 Apertural view	100 µm	Ocean Paradise 3 m	

Plate 2

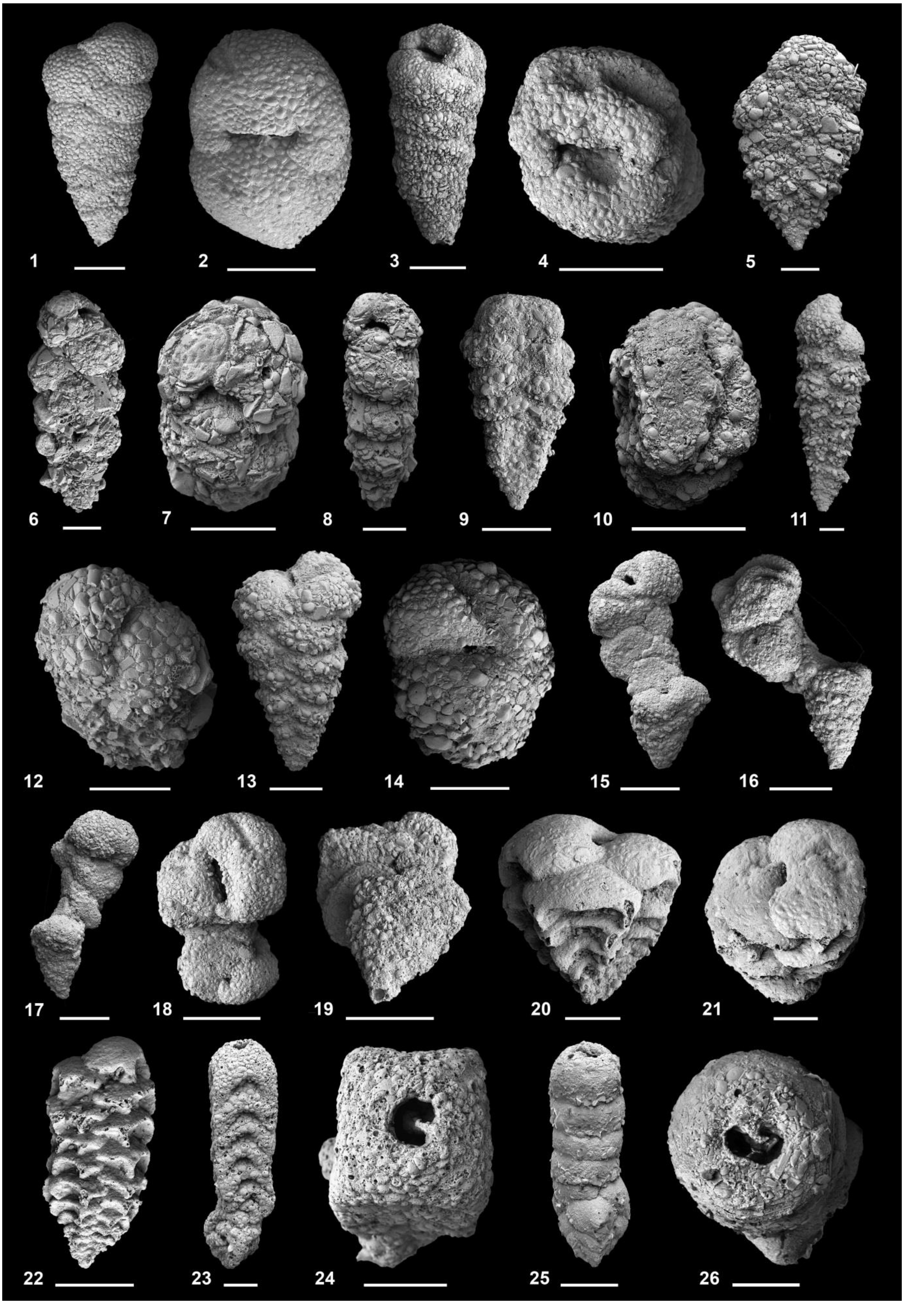

Plate 3

Figure		Scale	Sample	Page
1-2	***Cornuspira* ? sp. A**			28
	1 Lateral view	100 µm	Kokota Reef 16 m	
	2 Peripheral view	50 µm	Kokota Reef 16 m	
3-4	***Fischerina* sp. A**			28
	3 Spiral view	100 µm	Mapenduzi Wall 40 m	
	4 Peripheral view	50 µm	Mapenduzi Wall 40 m	
5-6	***Vertebralina striata***			29
	5 Lateral view	200 µm	Kizimkazi Beach 1 m	
	6 Apertural view	200 µm	Kizimkazi Beach 1 m	
7-10	***Spiroloculina antillarum***			29
	7 Lateral view	200 µm	Bawe Island 30-9 m	
	8 Apertural view	100 µm	Bawe Island 30-9 m	
	9 Oblique apertural view	200 µm	Bawe Island 30-9 m	
	10 Oblique peripheral view	200 µm	Bawe Island 30-9 m	
11-13	***Spiroloculina attenuata***			30
	11 Lateral view	200 µm	Kokota Reef 16 m	
	12 Peripheral view	200 µm	Kokota Reef 16 m	
	13 Apertural view	200 µm	Kokota Reef 16 m	
14-16	***Spiroloculina* aff. *S. communis***			30
	14 Lateral view	200 µm	Kokota Reef 16 m	
	15 Apertural view	100 µm	Kokota Reef 16 m	
	16 Peripheral view	200 µm	Kokota Reef 16 m	
17-20	***Spiroloculina corrugata***			31
	17 Lateral view	500 µm	Mapenduzi Wall 42 m	
	18 Oblique apertural view	200 µm	Mapenduzi Wall 42 m	
	19 Apertural view	200 µm	Mapenduzi Wall 42 m	
	20 Oblique peripheral view	200 µm	Mapenduzi Wall 42 m	
21-24	***Spiroloculina foveolata***			32
	21 Lateral view	500 µm	Haramu Passage 20 m	
	22 Apertural view	200 µm	Haramu Passage 20 m	
	23 Oblique apertural view	200 µm	Haramu Passage 20 m	
	24 Oblique peripheral view	200 µm	Haramu Passage 20 m	
25-27	***Spiroloculina* cf. *S. nitida***			32
	25 Lateral view	200 µm	Stone Town Aquarium 20 m	
	26 Apertural view	200 µm	Stone Town Aquarium 20 m	
	27 Oblique peripheral view	200 µm	Stone Town Aquarium 20 m	
28-30	***Spiroloculina* sp. A**			33
	28 Lateral view	200 µm	Mapenduzi Wall 42 m	
	29 Apertural view	200 µm	Mapenduzi Wall 42 m	
	30 Peripheral view	200 µm	Mapenduzi Wall 42 m	

Plate 3


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Plate 4

Figure		Scale	Sample	Page
1-4	***Affinetrina* cf. *A. quadrilateralis***			33
	1 Lateral view	200 µm	Coral Mountain 35 m	
	2 Peripheral view	200 µm	Coral Mountain 35 m	
	3 Apertural view	200 µm	Coral Mountain 35 m	
	4 Lateral view	200 µm	Coral Mountain 35 m	
5-7	***Agglutinella robusta***			34
	5 Lateral view	200 µm	Coral Mountain 35 m	
	6 Apertural view	200 µm	Coral Mountain 35 m	
	7 Lateral view	500 µm	Coral Mountain 35 m	
8-10	***Articulina scrobiculata***			34
	8 Lateral view	100 µm	Stone Town Aquarium 20 m	
	9 Oblique apertural view	100 µm	Stone Town Aquarium 20 m	
	10 Peripheral view	100 µm	Stone Town Aquarium 20 m	
11-13	***Cycloforina exmouthensis***			35
	11 Lateral view	100 µm	Mapenduzi Wall 42 m	
	12 Apertural view	50 µm	Mapenduzi Wall 42 m	
	13 Lateral view	100 µm	Coral Mountain 35 m	
14-16	***Cycloforina* cf. *C. granulocostata***			35
	14 Lateral view	200 µm	Mapenduzi Wall 42 m	
	15 Oblique apertural view	100 µm	Mapenduzi Wall 42 m	
	16 Lateral view	200 µm	Mapenduzi Wall 42 m	
17-19	***Cycloforina semiplicata***			36
	17 Lateral view	200 µm	Misali Island 20 m	
	18 Apertural view	200 µm	Misali Island 20 m	
	19 Lateral view	200 µm	Misali Island 20 m	
20-23	***Cycloforina* cf. *C. semireticulosa***			36
	20 Lateral view	200 µm	Ras Nungwi 20 m	
	21 Apertural view	200 µm	Ras Nungwi 20 m	
	22 Peripheral view	200 µm	Ras Nungwi 20 m	
	23 Lateral view	200 µm	Ras Nungwi 20 m	
24-26	***Cycloforina* sp. A**			37
	24 Lateral view	200 µm	Stone Town Aquarium 12 m	
	25 Apertural view	200 µm	Stone Town Aquarium 12 m	
	26 Lateral view	100 µm	Misali Island 20 m	
27-28	***Miliolinella* cf. *M. hybrida***			37
	27 Lateral view	100 µm	Misali Island 20 m	
	28 Peripheral view	100 µm	Misali Island 20 m	
29-30	***Miliolinella suborbicularis***			38
	29 Lateral view	100 µm	Jina Reef 21 m	
	30 Apertural view	100 µm	Jina Reef 21 m	

Plate 4

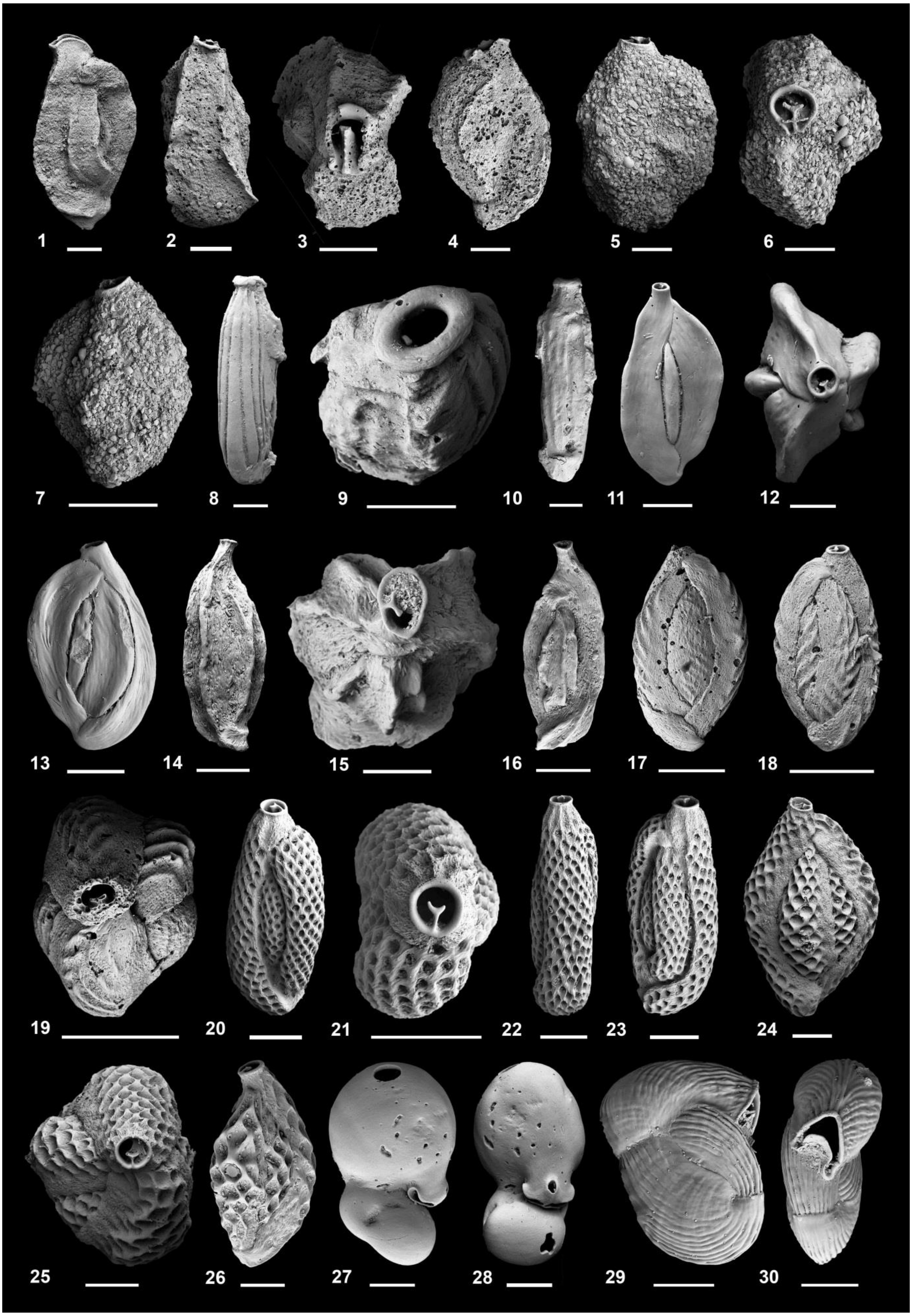
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Plate 5

Figure		Scale	Sample	Page
1-3	***Miliolinella* sp. A**			38
	1 Lateral view	200 µm	Misali Island 20 m	
	2 Apertural view	200 µm	Misali Island 20 m	
	3 Lateral view	200 µm	Misali Island 20 m	
4-5	***Miliolinella* sp. B**			39
	4 Lateral view	200 µm	Mnemba Atoll 30 m	
	5 Apertural view	200 µm	Mnemba Atoll 30 m	
6-7	***Miliolinella* sp. C**			39
	6 Lateral view	200 µm	Coral Mountain 35 m	
	7 Apertural view	200 µm	Coral Mountain 35 m	
8-9	***Nummoloculina* ? sp. A**			40
	8 Apertural view	50 µm	Misali Island 20 m	
	9 Lateral view	100 µm	Misali Island 20 m	
10-12	***Pitella transversestriata***			40
	10 Lateral view	100 µm	Bawe Island 30-9 m	
	11 Apertural view	100 µm	Bawe Island 30-9 m	
	12 Lateral view	100 µm	Bawe Island 30-9 m	
13-15	***Pseudohauerina bradyi***			41
	13 Lateral view	100 µm	Mnemba Atoll 20 m	
	14 Apertural view	100 µm	Mnemba Atoll 20 m	
	15 Lateral view	200 µm	Mnemba Atoll 20 m	
16-18	***Pseudohauerina fragilissima***			41
	16 Lateral view	200 µm	Stone Town Aquarium 12 m	
	17 Apertural view	100 µm	Stone Town Aquarium 12 m	
	18 Lateral view	200 µm	Mnemba Atoll 20 m	
19-21	***Pseudohauerina involuta***			42
	19 Lateral view	200 µm	Misali Island 20 m	
	20 Apertural view	100 µm	Misali Island 20 m	
	21 Lateral view	200 µm	Misali Island 20 m	
22-24	***Pseudomassilina macilenta***			42
	22 Lateral view	200 µm	Misali Island 20 m	
	23 Apertural view	100 µm	Misali Island 20 m	
	24 Lateral view	200 µm	Misali Island 20 m	

Plate 5

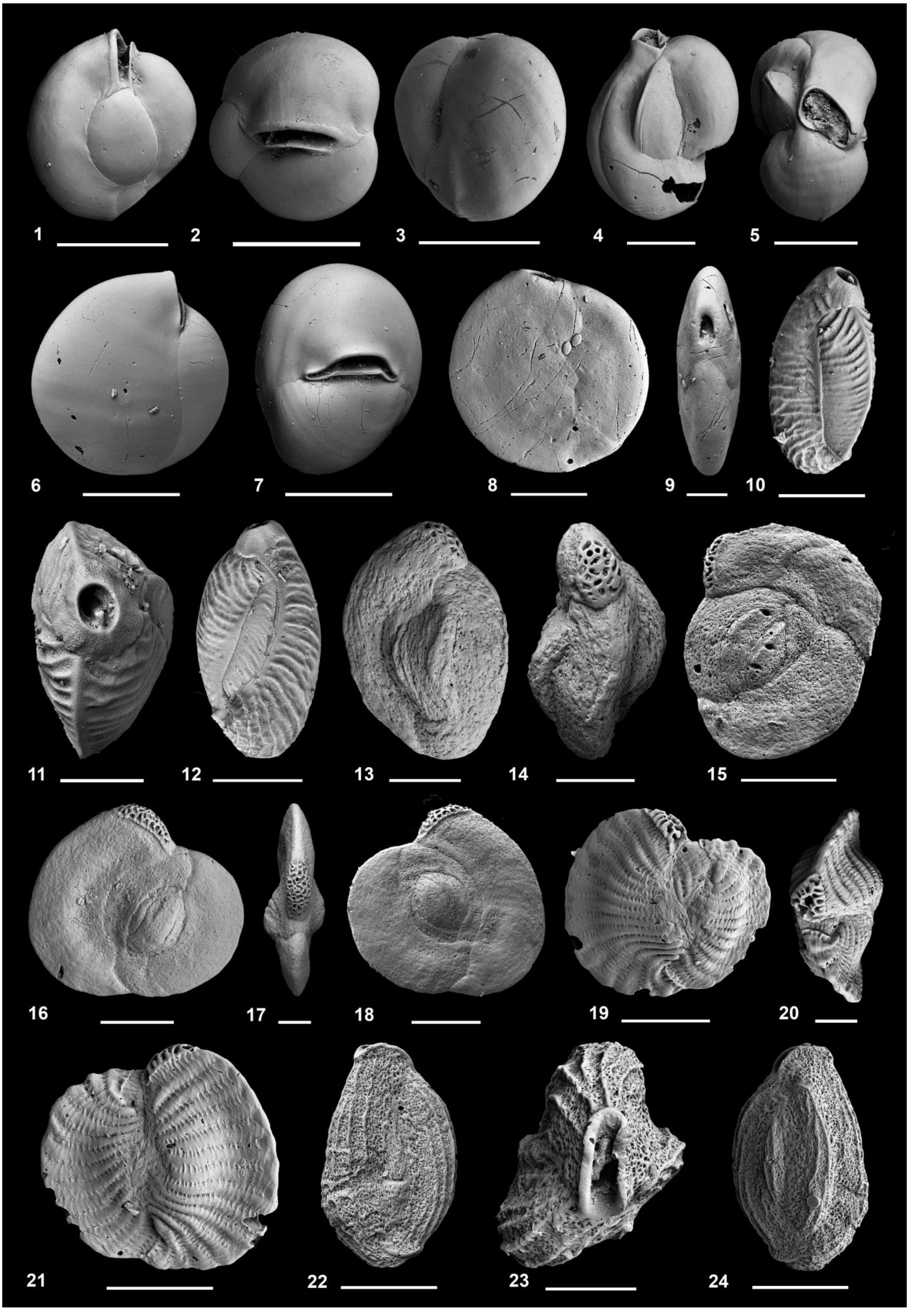


Plate 6

Figure		Scale	Sample	Page
1-3	***Pseudomassilina reticulata***			43
	1 Lateral view	200 µm	Misali Island 20 m	
	2 Apertural view	200 µm	Misali Island 20 m	
	3 Lateral view	200 µm	Misali Island 20 m	
4-9	***Pseudotriloculina* cf. *P. kerimbatica***			43
	4 Lateral view	500 µm	Ras Nungwi Lighthouse 12 m	
	5 Apertural view	200 µm	Ras Nungwi Lighthouse 12 m	
	6 Peripheral view	200 µm	Ras Nungwi Lighthouse 12 m	
	7 Lateral view	200 µm	Misali Island 20 m	
	8 Apertural view	200 µm	Misali Island 20 m	
	9 Lateral view	200 µm	Misali Island 20 m	
10-12	***Pseudotriloculina* cf. *P. limbata***			44
	10 Lateral view	100 µm	Ocean Paradise 3 m	
	11 Apertural view	100 µm	Ocean Paradise 3 m	
	12 Lateral view	200 µm	Ocean Paradise 3 m	
13-16	***Pyrgo denticulata***			44
	13 Lateral view	200 µm	Coral Mountain 35 m	
	14 Apertural view	200 µm	Coral Mountain 35 m	
	15 Broken specimen, lateral view	200 µm	Coral Mountain 35 m	
	16 Lateral view	200 µm	Coral Mountain 35 m	
17-19	***Pyrgo oblonga***			45
	17 Peripheral view	200 µm	Kokota Reef 16 m	
	18 Apertural view	100 µm	Kokota Reef 16 m	
	19 Lateral view	200 µm	Kokota Reef 16 m	
20-22	***Pyrgo striolata***			45
	20 Apertural view	200 µm	Haramu Passage 30 m	
	21 Lateral view	200 µm	Haramu Passage 30 m	
	22 Lateral view	200 µm	Haramu Passage 30 m	
23-25	***Quinqueloculina* cf. *Q. cuvieriana***			46
	23 Apertural view	200 µm	Mapenduzi Wall 42 m	
	24 Lateral view	200 µm	Mapenduzi Wall 42 m	
	25 Lateral view	200 µm	Mapenduzi Wall 42 m	

Plate 6

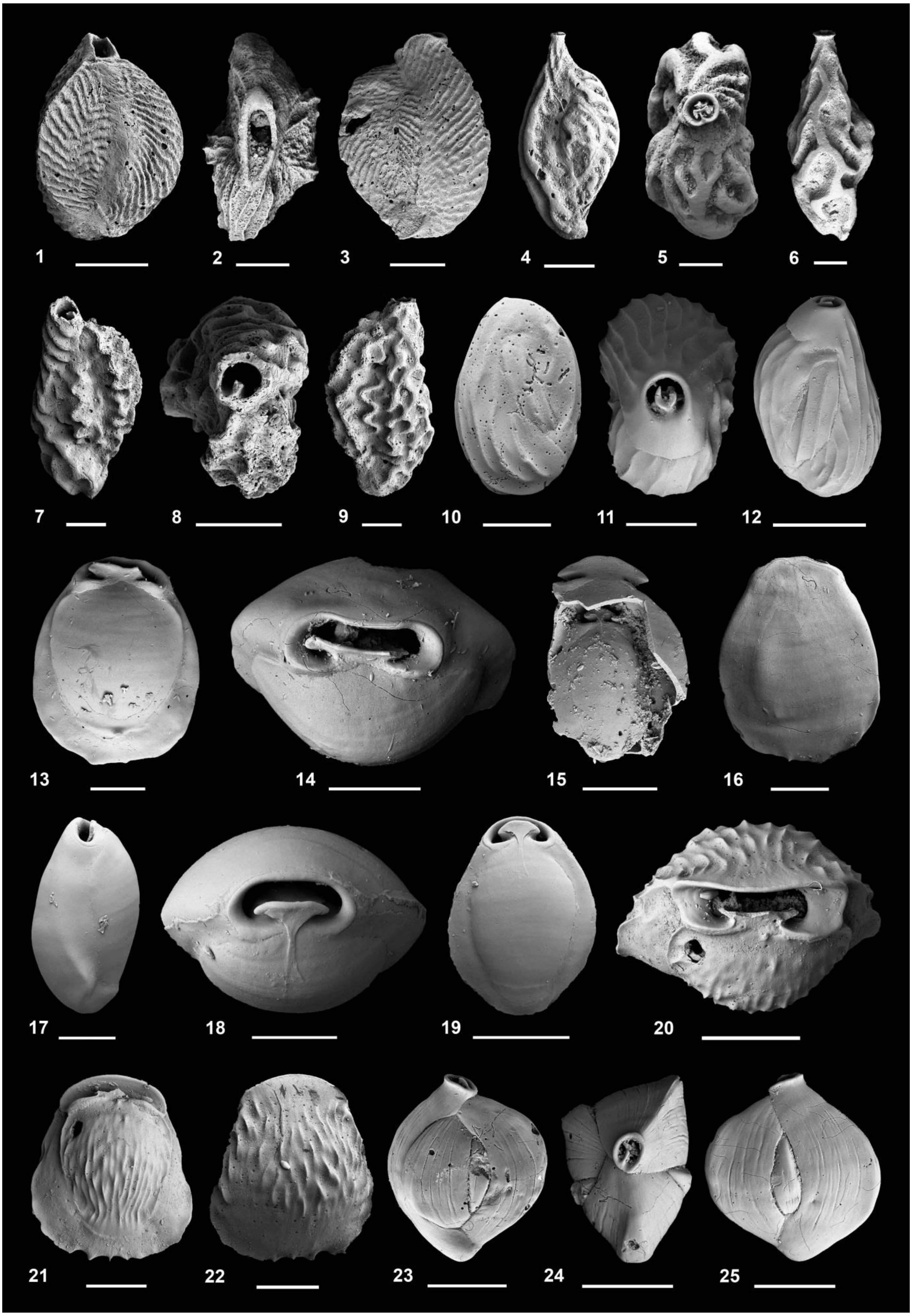


Plate 7

Figure		Scale	Sample	Page
1-3	***Quinqueloculina eburnea***			46
	1 Peripheral view	50 µm	Ocean Paradise 3 m	
	2 Apertural view	100 µm	Haramu Passage 30 m	
	3 Lateral view	100 µm	Haramu Passage 30 m	
4-7	***Quinqueloculina* cf. *Q. multimarginata***			47
	4 Lateral view	200 µm	Ocean Paradise 3 m	
	5 Apertural view	200 µm	Ocean Paradise 3 m	
	6 Lateral view	200 µm	Misali Island 20 m	
	7 Apertural view	200 µm	Misali Island 20 m	
8-11	***Quinqueloculina patagonica***			47
	8 Lateral view	200 µm	Ocean Paradise 3 m	
	9 Apertural view	100 µm	Ocean Paradise 3 m	
	10 Peripheral view	200 µm	Ocean Paradise 3 m	
	11 Lateral view	200 µm	Ocean Paradise 3 m	
12-14	***Quinqueloculina* cf. *Q. rebeccae***			48
	12 Lateral view	200 µm	Coral Mountain 35 m	
	13 Apertural view	200 µm	Coral Mountain 35 m	
	14 Lateral view	200 µm	Coral Mountain 35 m	
15-18	***Quinqueloculina* cf. *Q. vulgaris***			48
	15 Lateral view	100 µm	Coral Mountain 35 m	
	16 Apertural view	200 µm	Coral Mountain 35 m	
	17 Oblique apertural view	100 µm	Misali Island 20 m	
	18 Lateral view	100 µm	Misali Island 20 m	
19-23	***Schlumbergerina alveoliniformis***			49
	19 Lateral view	200 µm	Misali Island 20 m	
	20 Apertural view	200 µm	Misali Island 20 m	
	21 Lateral view	200 µm	Misali Island 20 m	
	22 Lateral view	200 µm	Misali Island 20 m	
	23 Lateral view	200 µm	Misali Island 20 m	
24-26	***Siphonaperta distorqueata***			49
	24 Lateral view	200 µm	Misali Island 20 m	
	25 Apertural view	200 µm	Misali Island 20 m	
	26 Lateral view	200 µm	Misali Island 20 m	

Plate 7

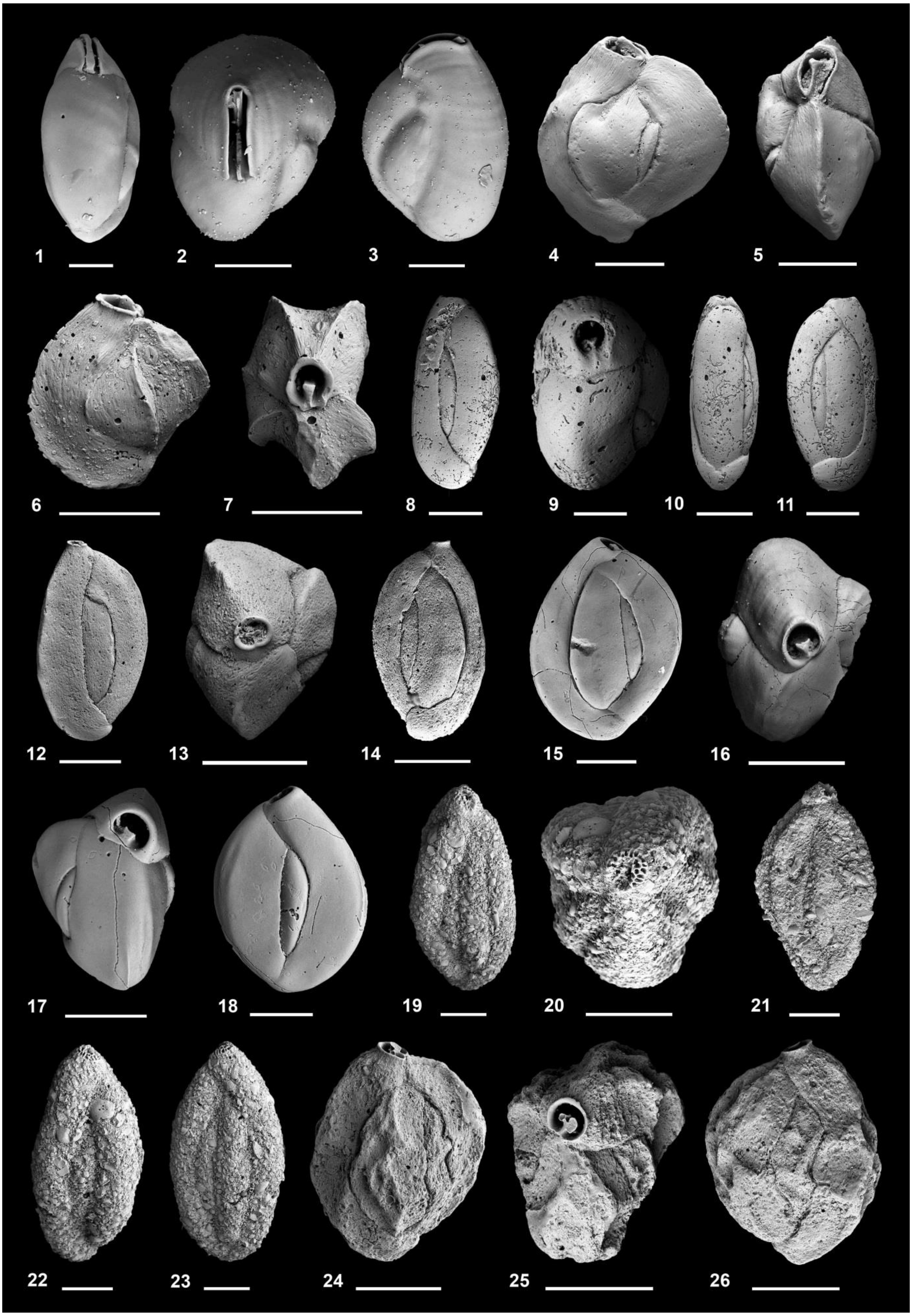


Plate 8

Figure		Scale	Sample	Page
1-3	***Siphonaperta pittensis***			50
	1 Lateral view	200 µm	Misali Island 20 m	
	2 Apertural view	100 µm	Misali Island 20 m	
	3 Lateral view	100 µm	Misali Island 20 m	
4-6	***Triloculina asymmetrica***			50
	4 Lateral view	200 µm	Ocean Paradise 3 m	
	5 Apertural view	200 µm	Ocean Paradise 3 m	
	6 Lateral view	100 µm	Misali Island 20 m	
7-9	***Triloculina bertheliniana***			51
	7 Lateral view	500 µm	Haramu Passage 20 m	
	8 Apertural view	200 µm	Haramu Passage 20 m	
	9 Aboral view	200 µm	Misali Island 20 m	
10-12	***Triloculina fichteliana***			51
	10 Lateral view	200 µm	Ocean Paradise 3 m	
	11 Apertural view	100 µm	Ocean Paradise 3 m	
	12 Lateral view	100 µm	Ocean Paradise 3 m	
13-15	***Triloculina serrulata***			52
	13 Lateral view	200 µm	Misali Island 20 m	
	14 Apertural view	100 µm	Ocean Paradise 3 m	
	15 Lateral view	200 µm	Ocean Paradise 3 m	
16-18	***Triloculina* cf. *T. serrulata***			52
	16 Lateral view	200 µm	Ras Nungwi Lighthouse 12 m	
	17 Apertural view	200 µm	Ras Nungwi Lighthouse 12 m	
	18 Lateral view	200 µm	Ras Nungwi Lighthouse 12 m	
19-21	***Triloculina terquemiana***			53
	19 Lateral view	200 µm	Coral Mountain 35 m	
	20 Apertural view	200 µm	Coral Mountain 35 m	
	21 Lateral view	200 µm	Coral Mountain 35 m	
22-24	***Triloculina trigonula***			53
	22 Lateral view	200 µm	Ras Nungwi 20 m	
	23 Apertural view	200 µm	Misali Island 20 m	
	24 Lateral view	200 µm	Ras Nungwi 20 m	

Plate 8

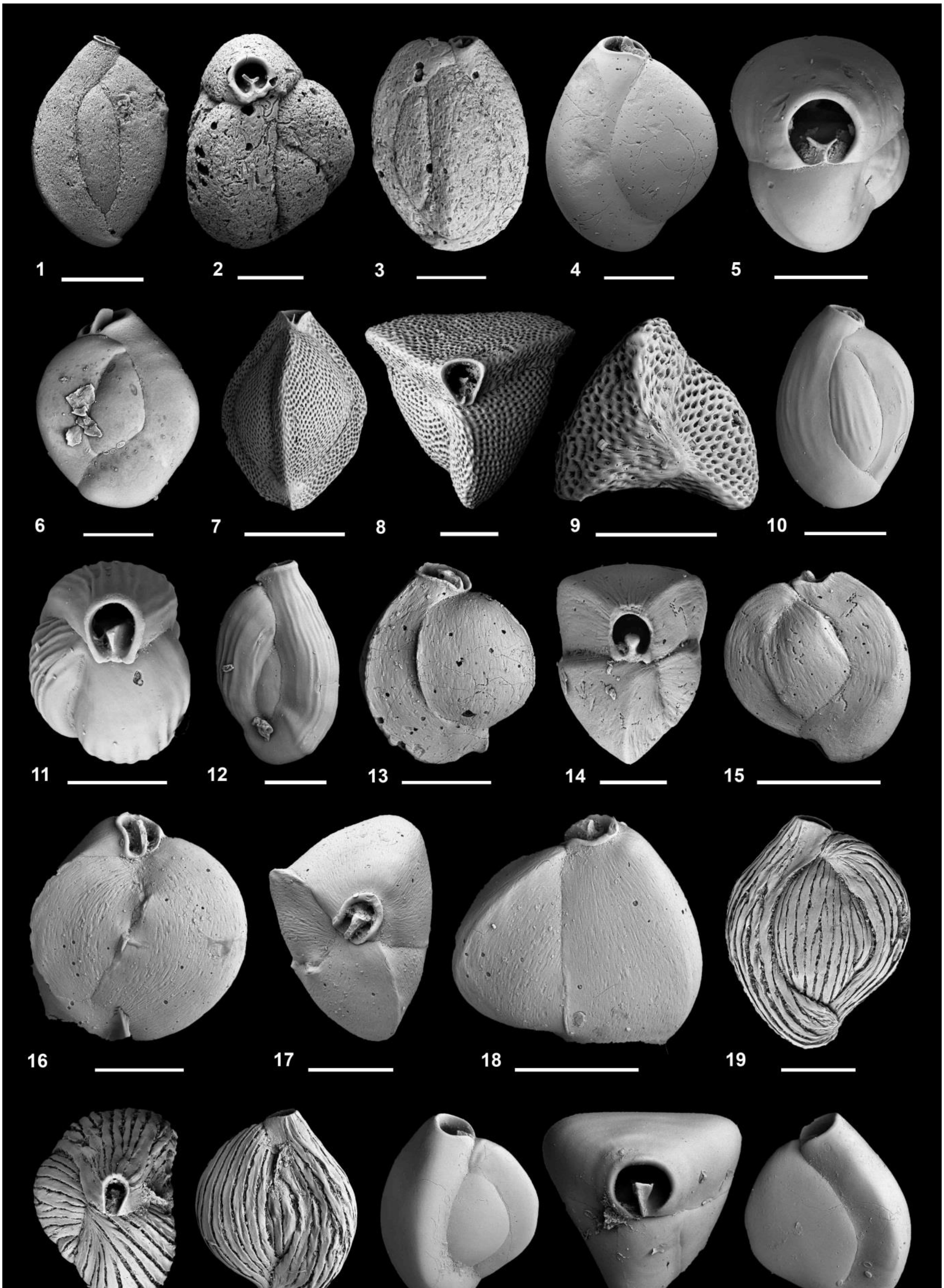


Plate 9

Figure		Scale	Sample	Page
1-3	***Triloculina* sp. A**			54
	1 Lateral view	200 µm	Misali Island 20 m	
	2 Apertural view	100 µm	Mapenduzi Wall 42 m	
	3 Lateral view	200 µm	Mapenduzi Wall 42 m	
4-5	***Triloculina* sp. B**			54
	4 Apertural view	200 µm	Mapenduzi Wall 42 m	
	5 Lateral view	200 µm	Mapenduzi Wall 42 m	
6-8	***Triloculina* ? sp. C**			55
	6 Oblique lateral view	200 µm	Ocean Paradise 3 m	
	7 Apertural view	200 µm	Ocean Paradise 3 m	
	8 Lateral view	200 µm	Ocean Paradise 3 m	
9-10	***Triloculinella* cf. *T. pilasensis***			55
	9 Lateral view	200 µm	Mnemba Atoll 30 m	
	10 Peripheral view	200 µm	Mnemba Atoll 30 m	
11-14	***Rupertianella rupertiana***			56
	11 Lateral view	500 µm	Misali Island 20 m	
	12 Peripheral view	500 µm	Misali Island 20 m	
	13 Apertural view	200 µm	Misali Island 20 m	
	14 Oblique apertural view	200 µm	Haramu Passage 30 m	
15-18	***Pseudohauerinella dissidens***			56
	15 Apertural view	100 µm	Misali Island 20 m	
	16 Lateral view	200 µm	Misali Island 20 m	
	17 Apertural view	100 µm	Misali Island 20 m	
	18 Peripheral view	100 µm	Misali Island 20 m	
19-26	***Borelis schlumbergeri***			57
	19 Peripheral view	200 µm	Ras Nungwi 20 m	
	20 Lateral view	500 µm	Ras Nungwi 20 m	
	21 Lateral view	500 µm	Ras Nungwi 20 m	
	22 Peripheral view	200 µm	Coral Mountain 35 m	
	23 Lateral view	200 µm	Coral Mountain 35 m	
	24 Abraded shell, peripheral view	100 µm	Misali Island 20 m	
	25 Abraded shell, lateral view	200 µm	Misali Island 20 m	
	26 Abraded shell, lateral view	200 µm	Misali Island 20 m	

Plate 9

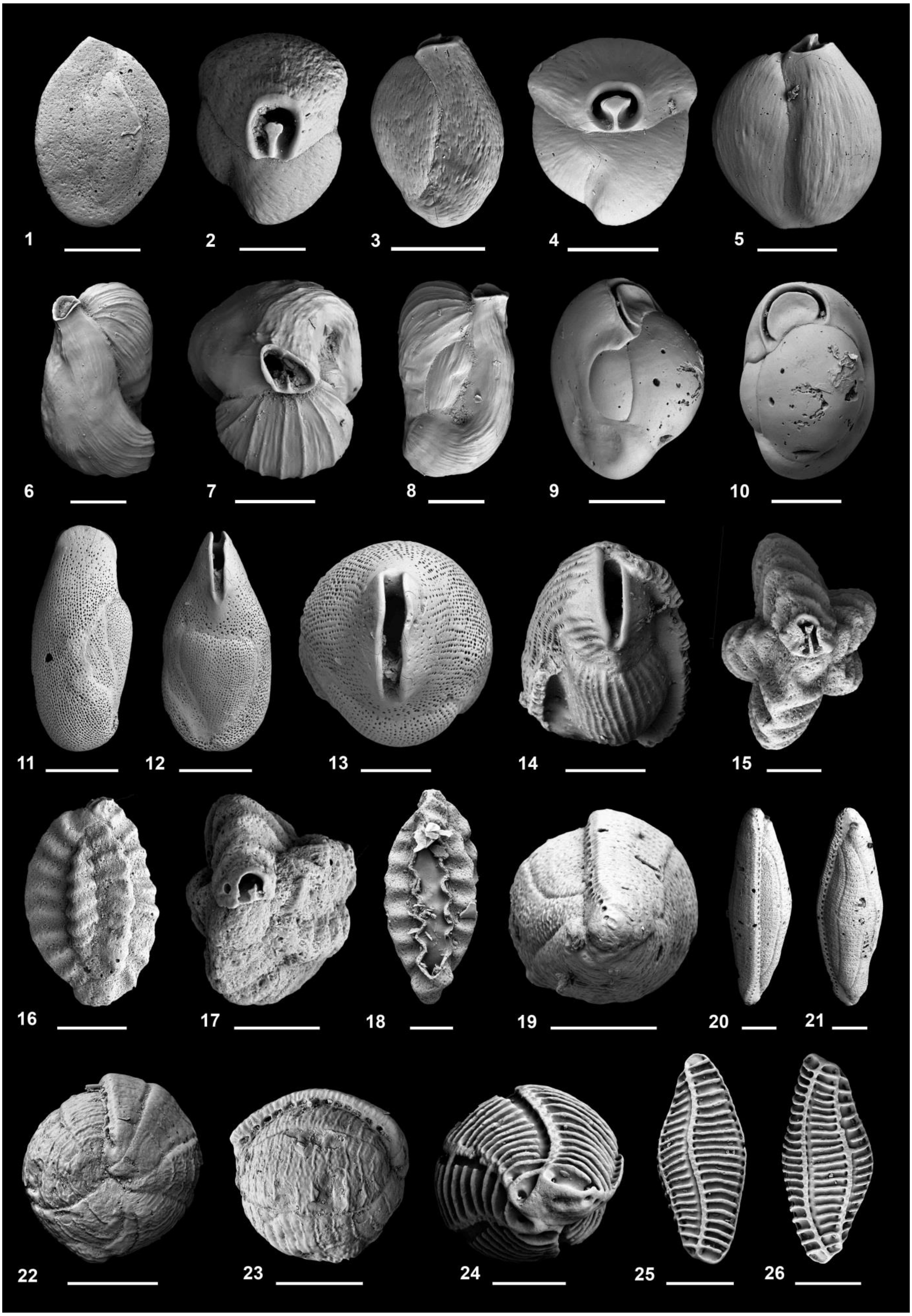


Plate 10

Figure		Scale	Sample	Page
1-5	***Peneroplis pertusus***			57
	1 Lateral view	100 µm	Stone Town Aquarium 20 m	
	2 Apertural view	50 µm	Stone Town Aquarium 20 m	
	3 Lateral view	200 µm	Coral Mountain 35 m	
	4 Apertural view	100 µm	Coral Mountain 35 m	
	5 Lateral view	500 µm	Jina Reef 20 m	
6-10	***Peneroplis planatus***			58
	6 Lateral view	200 µm	Ocean Paradise 3 m	
	7 Apertural view	100 µm	Ocean Paradise 3 m	
	8 Lateral view	200 µm	Ras Nungwi 20 m	
	9 Apertural view	100 µm	Ras Nungwi 20 m	
	10 Lateral view	500 µm	Jina Reef 21 m	
11-14	***Amphisorus hemprichii***			58
	11 Lateral view	1 mm	Haramu Passage 20 m	
	12 Peripheral view	1 mm	Haramu Passage 20 m	
	13 Peripheral view	1 mm	Misali Island 20 m	
	14 Lateral view	500 µm	Misali Island 20 m	
15-21	***Sorites orbiculus***			59
	15 Lateral view	500 µm	Ras Nungwi 20 m	
	16 Peripheral view	500 µm	Ras Nungwi 20 m	
	17 Peripheral view	200 µm	Bawe Island 30-9 m	
	18 Lateral view	500 µm	Bawe Island 30-9 m	
	19 Juvenile, lateral view	100 µm	Mapenduzi Wall 40 m	
	20 Juvenile, lateral view	200 µm	Kokota Reef 16 m	
	21 Juvenile, oblique peripheral view	100 µm	Mapenduzi Wall 40 m	

Plate 10

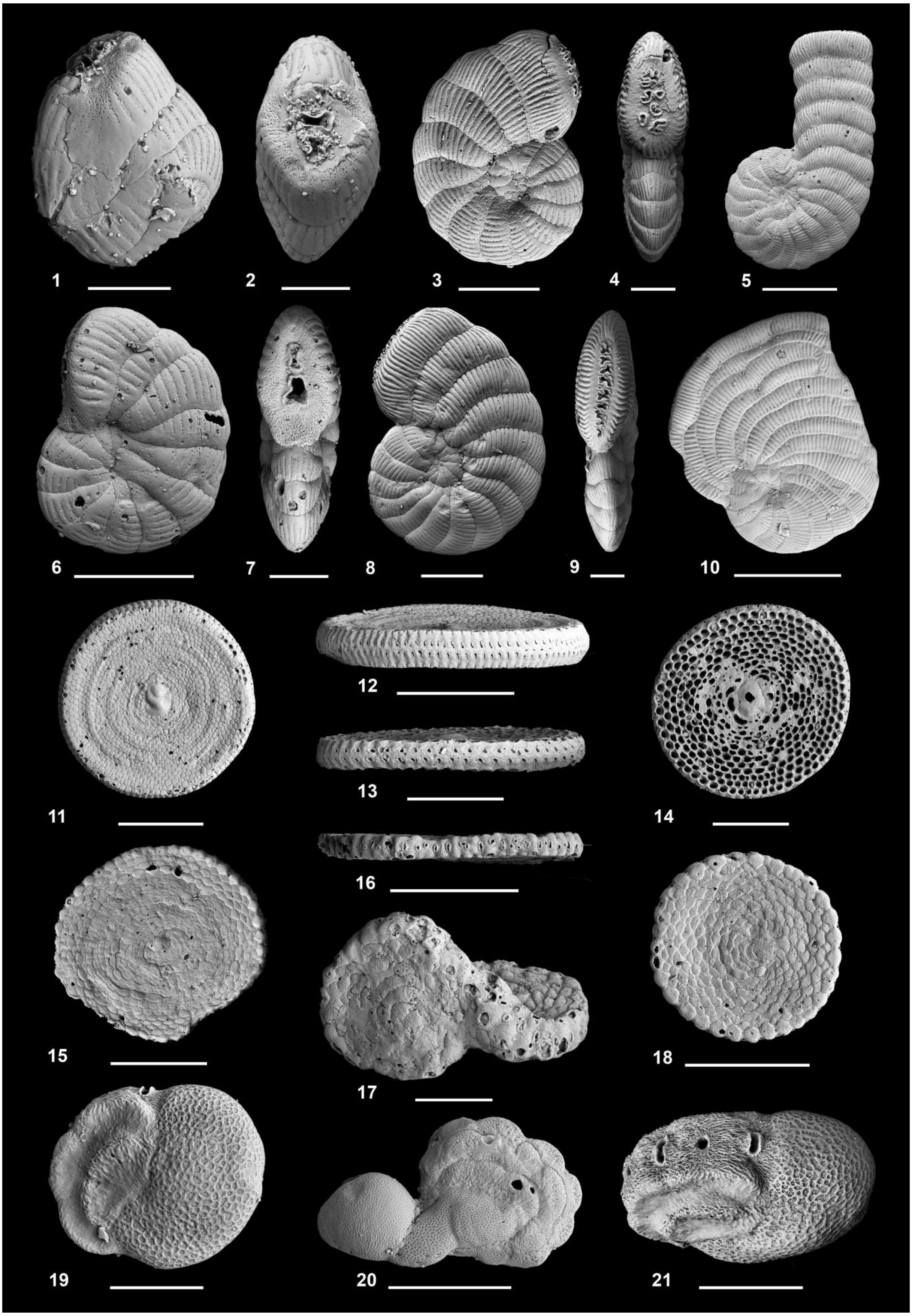


Plate 11

Figure		Scale	Sample	Page
1-3	***Planispirillina spinigera***			60
	1 Umbilical view	200 µm	Mapenduzi Wall 42 m	
	2 Peripheral view	200 µm	Mapenduzi Wall 42 m	
	3 Spiral view	200 µm	Coral Mountain 35 m	
4-6	***Spirillina grosseperforata***			60
	4 Spiral view	100 µm	Misali Island 20 m	
	5 Oblique peripheral view	100 µm	Misali Island 20 m	
	6 Spiral view	100 µm	Misali Island 20 m	
7-9	***Pattellina corrugata***			61
	7 Spiral view	100 µm	Kokota Reef 25 m	
	8 Umbilical view	100 µm	Kokota Reef 25 m	
	9 Lateral view	100 µm	Kokota Reef 25 m	
10-11	***Pyramidulina catesbyi***			61
	10 Lateral view	200 µm	Coral Mountain 35 m	
	11 Apertural view	100 µm	Coral Mountain 35 m	
12-13	***Lenticulina vortex***			62
	12 Lateral view	200 µm	Mapenduzi Wall 40 m	
	13 Apertural view	200 µm	Mapenduzi Wall 40 m	
14-15	***Lenticulina* sp. A**			62
	14 Lateral view	200 µm	Kokota Reef 16 m	
	15 Peripheral view	200 µm	Kokota Reef 16 m	
16-20	***Alliatinella panayensis***			63
	16 Spiral view	100 µm	Stone Town Aquarium 20 m	
	17 Apertural view	100 µm	Stone Town Aquarium 20 m	
	18 Umbilical view	100 µm	Stone Town Aquarium 20 m	
	19 Umbilical view	100 µm	Kinasi Pass 18-21 m	
	20 Apertural view	100 µm	Kinasi Pass 18-21 m	

Plate 11

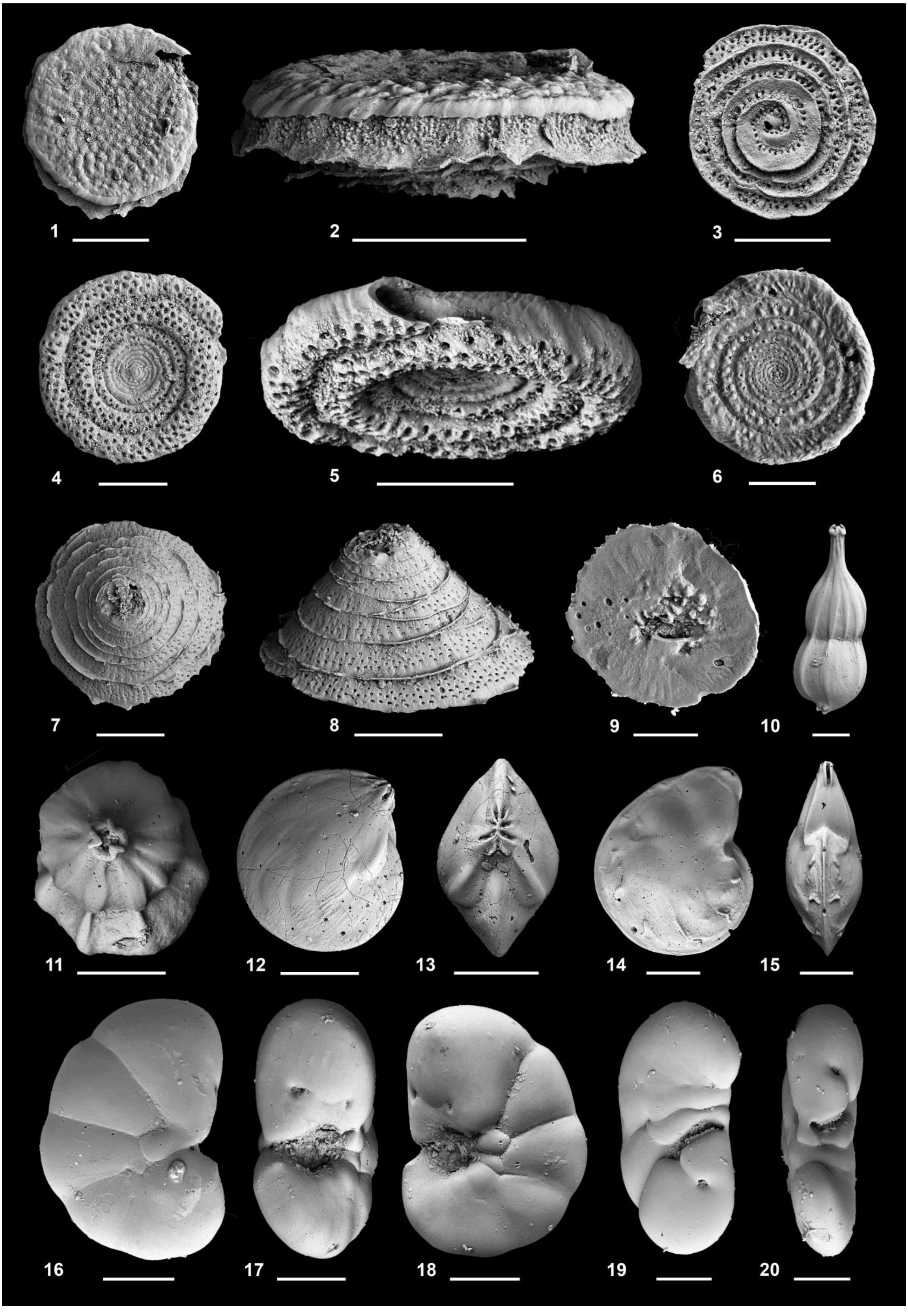


Plate 12

Figure		Scale	Sample	Page
1-3	***Globorotalia menardii***			63
	1 Umbilical view	100 µm	Mapenduzi Wall 40 m	
	2 Apertural view	100 µm	Mapenduzi Wall 40 m	
	3 Spiral view	100 µm	Mapenduzi Wall 40 m	
4-6	***Neogloboquadrina humerosa***			64
	4 Peripheral view	200 µm	Kokota Reef 25 m	
	5 Spiral view	200 µm	Kokota Reef 25 m	
	6 Umbilical view	200 µm	Kokota Reef 25 m	
7-8	***Pulleniatina obliquiloculata***			64
	7 Spiral view	200 µm	Mapenduzi Wall 42 m	
	8 Apertural view	200 µm	Mapenduzi Wall 42 m	
9-10	***Globigerina calida***			65
	9 Peripheral view	100 µm	Kokota Reef 16 m	
	10 Spiral view	100 µm	Kokota Reef 16 m	
11-13	***Globigerinella siphonifera***			65
	11 Spiral view	100 µm	Kokota Reef 16 m	
	12 Peripheral view	100 µm	Kokota Reef 16 m	
	13 Umbilical view	100 µm	Kokota Reef 16 m	
14-16	***Globigerinoides conglobatus***			66
	14 Spiral view	200 µm	Coral Mountain 35 m	
	15 Peripheral view	200 µm	Coral Mountain 35 m	
	16 Lateral view	200 µm	Coral Mountain 35 m	
17-18	***Globigerinoides ruber***			66
	17 Umbilical view	100 µm	Mapenduzi Wall 42 m	
	18 Spiral view	100 µm	Haramu Passage 20 m	
19-21	***Globigerinoides sacculifer***			67
	19 Apertural view	100 µm	Mapenduzi Wall 42 m	
	20 Spiral view	100 µm	Mapenduzi Wall 42 m	
	21 Spiral view	100 µm	Misali Island 20 m	
22-24	***Globoturborotalita rubescens***			67
	22 Spiral view	100 µm	Haramu Passage 20 m	
	23 Apertural view	100 µm	Haramu Passage 20 m	
	24 Umbilical view	100 µm	Haramu Passage 20 m	
25	***Orbulina universa***			68
	25 Lateral view	200 µm	Coral Mountain 35 m	

Plate 12

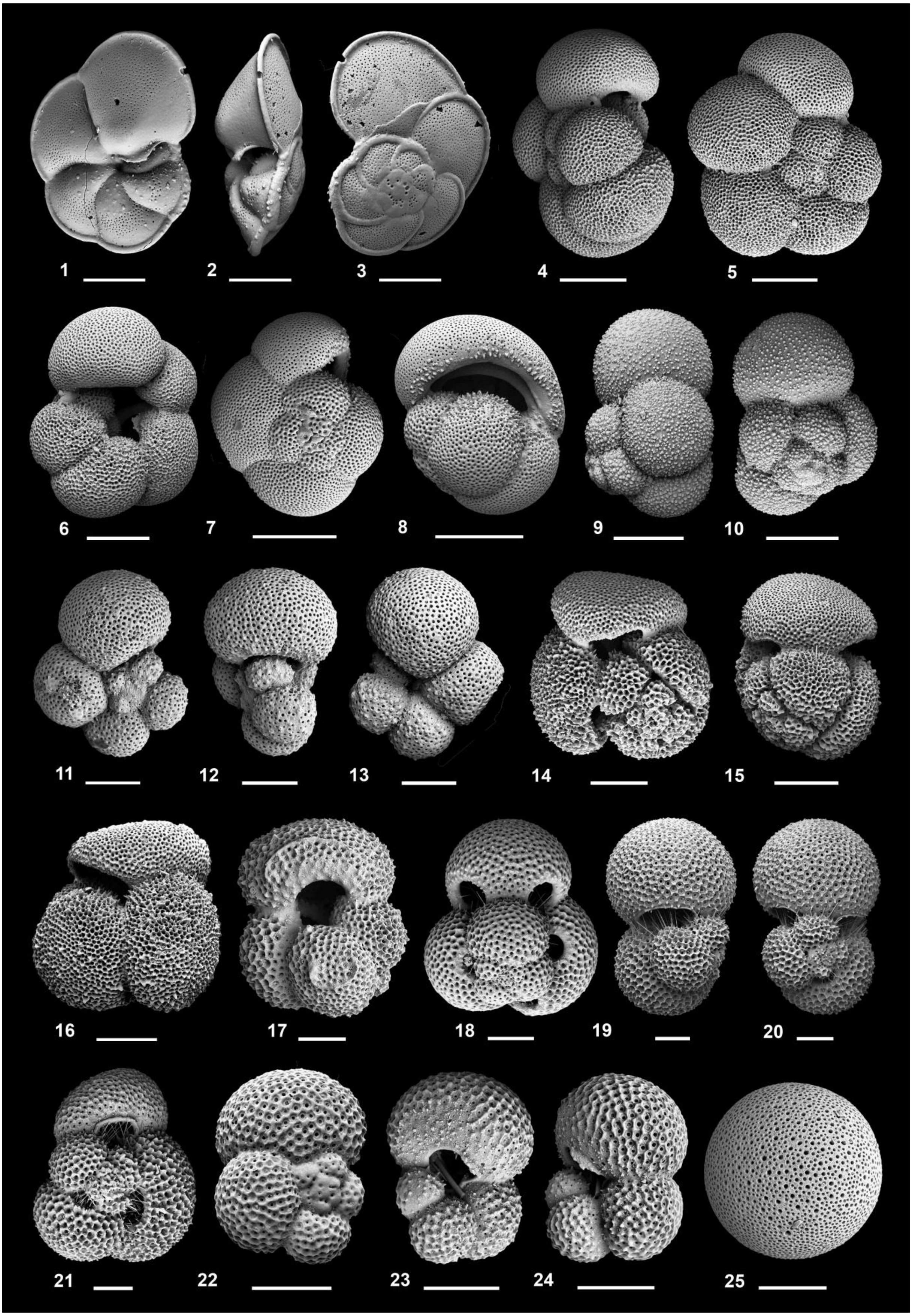


Plate 13

Figure		Scale	Sample	Page
1-5	***Brizalina ordinaria***			68
	1 Lateral view	100 µm	Kokota Reef 16 m	
	2 Apertural view	50 µm	Misali Island 20 m	
	3 Peripheral view	100 µm	Stone Town Aquarium 20 m	
	4 Lateral view	100 µm	Ras Nungwi Peak 12-14 m	
	5 Apertural view	100 µm	Ras Nungwi Peak 12-14 m	
6-8	***Brizalina simpsoni***			69
	6 Lateral view	100 µm	Stone Town Aquarium 20 m	
	7 Apertural view	100 µm	Stone Town Aquarium 20 m	
	8 Peripheral view	100 µm	Stone Town Aquarium 20 m	
9-10	***Brizalina striatula***			69
	9 Lateral view	100 µm	Haramu Passage 20 m	
	10 Oblique apertural view	50 µm	Haramu Passage 20 m	
11-13	***Floresina* cf. *F. durrandi***			70
	11 Umbilical view	50 µm	Kokota Reef 16 m	
	12 Peripheral view	50 µm	Kokota Reef 16 m	
	13 Spiral view	50 µm	Kokota Reef 16 m	
14-16	***Floresina* cf. *F. madagascariensis***			70
	14 Umbilical view	50 µm	Misali Island 20 m	
	15 Peripheral view	50 µm	Misali Island 20 m	
	16 Spiral view	50 µm	Misali Island 20 m	
17-18	***Cassidelina* cf. *C. makiyamai***			71
	17 Lateral view	100 µm	Misali Island 20 m	
	18 Oblique apertural view	50 µm	Misali Island 20 m	
19-21	***Loxostomina limbata costulata***			71
	19 Lateral view	100 µm	Kokota Reef 16 m	
	20 Lateral view	100 µm	Kokota Reef 16 m	
	21 Apertural view	50 µm	Kokota Reef 16 m	
22-23	***Loxostomina* ? cf. *L. sinuosa***			72
	22 Lateral view	100 µm	Ocean Paradise 3 m	
	23 Apertural view	50 µm	Ocean Paradise 3 m	
24-26	***Siphogenerina* cf. *S. raphana***			72
	24 Lateral view	200 µm	Mapenduzi Wall 42 m	
	25 Apertural view	50 µm	Mapenduzi Wall 42 m	
	26 Lateral view	100 µm	Kokota Reef 16 m	

Plate 13

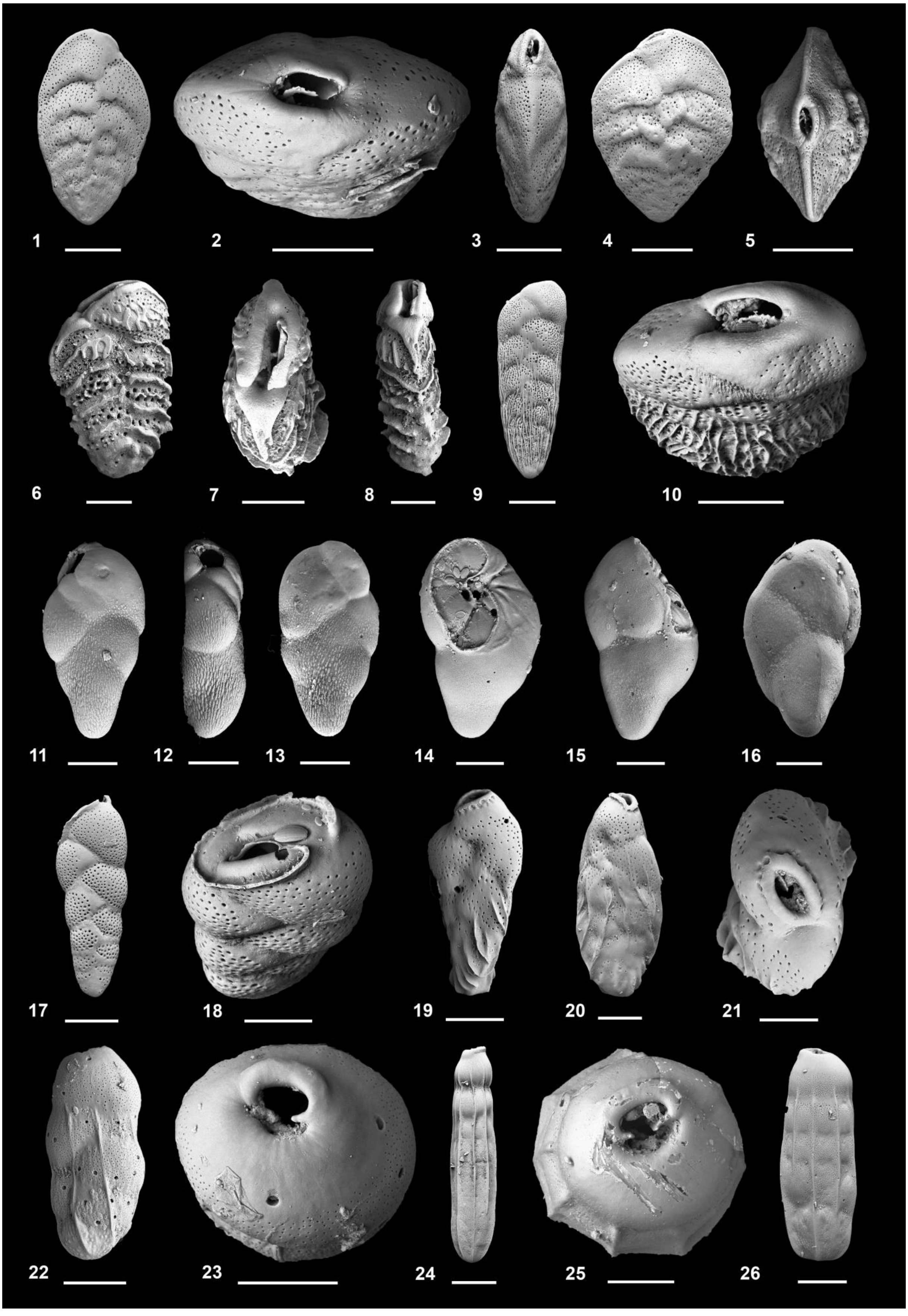


Plate 14

Figure		Scale	Sample	Page
1-3	***Baggina* ? sp. A**			73
	1 Spiral view	50 µm	Kokota Reef 16 m	
	2 Peripheral view	50 µm	Kokota Reef 16 m	
	3 Umbilical view	50 µm	Kokota Reef 16 m	
4-6	***Cancris bubnanensis***			73
	4 Spiral view	200 µm	Coral Mountain 35 m	
	5 Apertural view	200 µm	Coral Mountain 35 m	
	6 Umbilical view	200 µm	Coral Mountain 35 m	
7-9	***Cancris* cf. *C. carinatus***			74
	7 Umbilical view	200 µm	Mapenduzi Wall 42 m	
	8 Peripheral view	200 µm	Mapenduzi Wall 42 m	
	9 Spiral view	200 µm	Mapenduzi Wall 42 m	
10-13	***Reussella* cf. *R. insueta***			74
	10 Lateral view	100 µm	Misali Island 20 m	
	11 Oblique apertural view	100 µm	Misali Island 20 m	
	12 Aboral view	100 µm	Misali Island 20 m	
	13 Lateral view	100 µm	Misali Island 20 m	
14-16	***Valvobifarina mackinnonii***			75
	14 Lateral view	200 µm	Misali Island 20 m	
	15 Lateral view	100 µm	Misali Island 20 m	
	16 Apertural view	100 µm	Misali Island 20 m	
17-18	***Pavonina flabelliformis***			75
	17 Lateral view	200 µm	Stone Town Aquarium 12 m	
	18 Peripheral view	100 µm	Stone Town Aquarium 12 m	
19-23	***Eponides repandus***			76
	19 Umbilical view	500 µm	Haramu Passage 20 m	
	20 Apertural view	500 µm	Haramu Passage 20 m	
	21 Spiral view	200 µm	Coral Mountain 35 m	
	22 Apertural view	200 µm	Ras Nungwi 20 m	
	23 Spiral view	200 µm	Ras Nungwi 20 m	
24-26	***Pegidia lacunata***			77
	24 Spiral view	200 µm	Ras Nungwi Lighthouse 12 m	
	25 Umbilical view	200 µm	Ras Nungwi Lighthouse 12 m	
	26 Peripheral view	200 µm	Ras Nungwi Lighthouse 12 m	

Plate 14

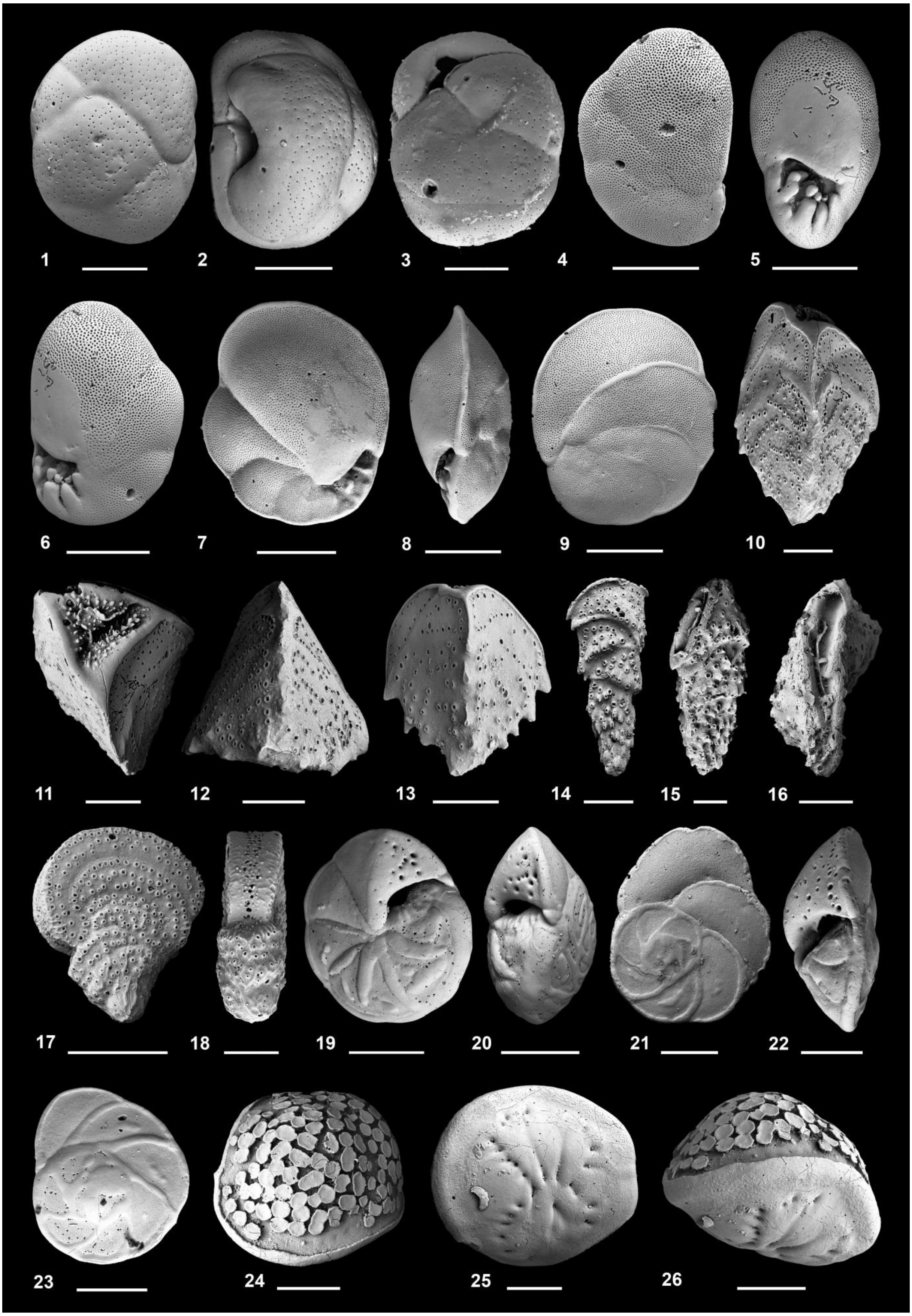


Plate 15

Figure		Scale	Sample	Page
1-3	***Orbitina* cf. *O. exquisita***			77
	1 Spiral view	100 µm	Kokota Reef 25 m	
	2 Peripheral view	100 µm	Kokota Reef 25 m	
	3 Umbilical view	100 µm	Misali Island 20 m	
4-5	***Orbitina* sp. A**			78
	4 Peripheral view	100 µm	Misali Island 20 m	
	5 Spiral view	200 µm	Misali Island 20 m	
6-8	***Rotorbis auberii***			78
	6 Peripheral view	200 µm	Ocean Paradise 3 m	
	7 Spiral view	200 µm	Ocean Paradise 3 m	
	8 Umbilical view	200 µm	Kizimkazi Beach 1 m	
9-12	***Rotorbis rosacea***			79
	9 Spiral view	200 µm	Stone Town Aquarium 20 m	
	10 Peripheral view	100 µm	Stone Town Aquarium 20 m	
	11 Umbilical view	200 µm	Ras Nungwi 20 m	
	12 Peripheral view	100 µm	Ras Nungwi 20 m	
13-15	***Rosalina bradyi***			79
	13 Spiral view	200 µm	Stone Town Aquarium 20 m	
	14 Peripheral view	100 µm	Stone Town Aquarium 20 m	
	15 Umbilical view	200 µm	Misali Island 20 m	
16-19	***Rotorboides granulosus***			80
	16 Umbilical view	100 µm	Ras Nungwi 16 m	
	17 Spiral view	100 µm	Ras Nungwi 16 m	
	18 Peripheral view	50 µm	Ras Nungwi Peak 12-14 m	
	19 Spiral view	50 µm	Ras Nungwi Peak 12-14 m	
20-22	***Glabratellina australensis***			80
	20 Spiral view	100 µm	Mapenduzi Wall 42 m	
	21 Peripheral view	20 µm	Mapenduzi Wall 42 m	
	22 Umbilical view	100 µm	Mapenduzi Wall 42 m	
23-25	***Glabratellina cimermania***			81
	23 Spiral view	100 µm	Ocean Paradise 3 m	
	24 Lateral view	100 µm	Ocean Paradise 3 m	
	25 Umbilical view	100 µm	Ocean Paradise 3 m	

Plate 15

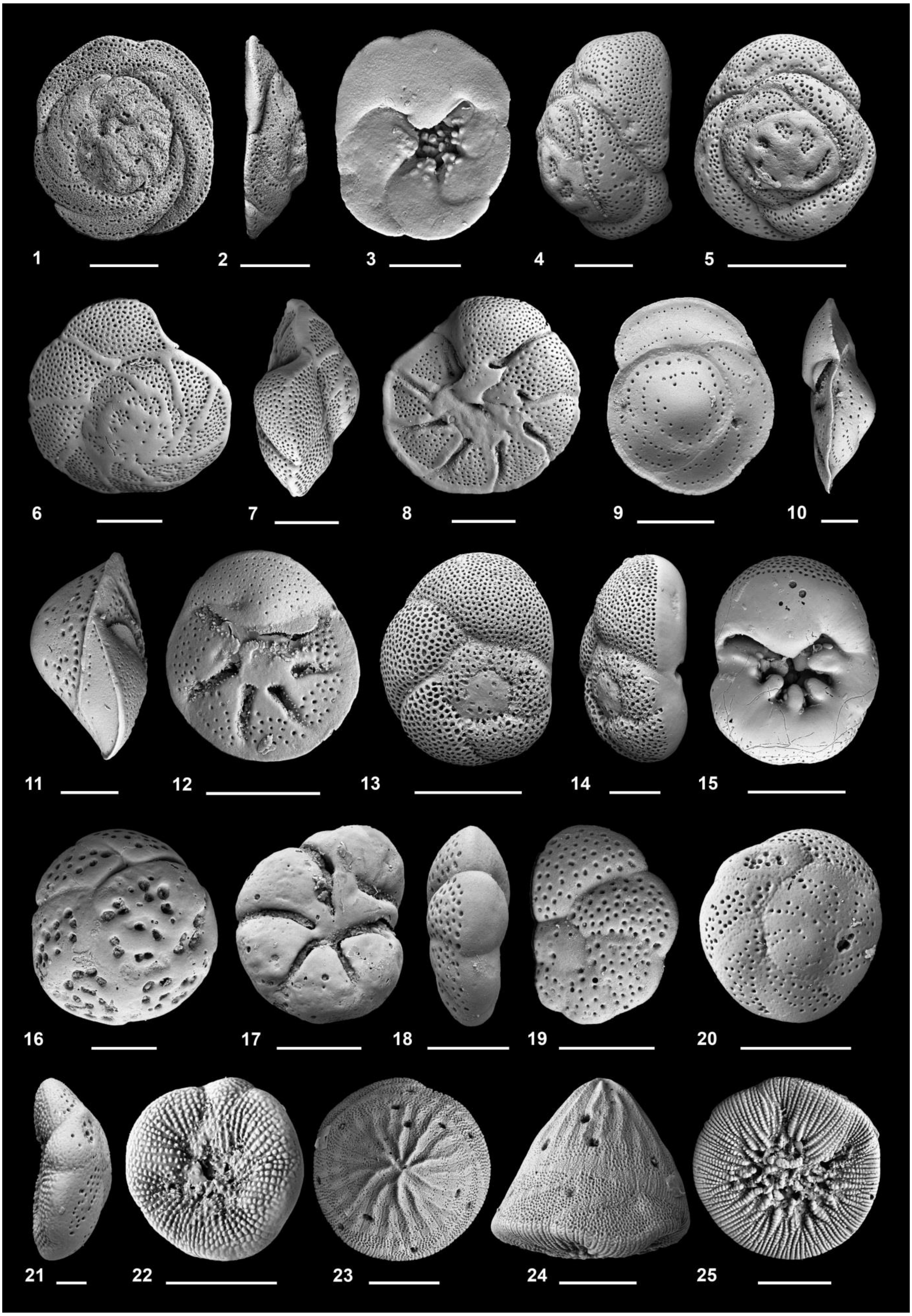


Plate 16

Figure		Scale	Sample	Page
1-3	***Pileolina* sp. A**			81
	1 Spiral view	100 µm	Misali Island 20 m	
	2 Umbilical view	50 µm	Misali Island 20 m	
	3 Peripheral view	100 µm	Misali Island 20 m	
4-6	***Siphonina tubulosa***			82
	4 Lateral view	100 µm	Haramu Passage 20 m	
	5 Apertural view	100 µm	Haramu Passage 20 m	
	6 Lateral view	100 µm	Kokota Reef 16 m	
7-8	***Siphoninoides echinatus***			82
	7 Lateral view	100 µm	Kinasi Pass 18-21 m	
	8 Apertural view	100 µm	Kinasi Pass 18-21 m	
9-11	***Discorbinella minuta***			83
	9 Umbilical view	50 µm	Misali Island 20 m	
	10 Peripheral view	50 µm	Misali Island 20 m	
	11 Spiral view	50 µm	Misali Island 20 m	
12-15	***Cibicides pseudolobatulus***			83
	12 Umbilical view	100 µm	Kokota Reef 16 m	
	13 Apertural view	100 µm	Ras Nungwi 20 m	
	14 Spiral view	100 µm	Bawe Island 30-9 m	
	15 Peripheral view	100 µm	Misali Island 20 m	
16-18	***Discorbia valvulinerioides* ?**			84
	16 Spiral view	100 µm	Kokota Reef 16 m	
	17 Apertural view	50 µm	Kokota Reef 16 m	
	18 Umbilical view	100 µm	Kokota Reef 16 m	
19-21	***Dyocibicides* sp. A**			84
	19 Dorsal view	100 µm	Kokota Reef 16 m	
	20 Peripheral view	50 µm	Kokota Reef 16 m	
	21 Ventral view	50 µm	Kokota Reef 16 m	
22-24	***Fontbotia wuellerstorfi***			85
	22 Dorsal view	100 µm	Kokota Reef 16 m	
	23 Qblique peripheral view	100 µm	Kokota Reef 16 m	
	24 Ventral view	100 µm	Kokota Reef 16 m	

Plate 16

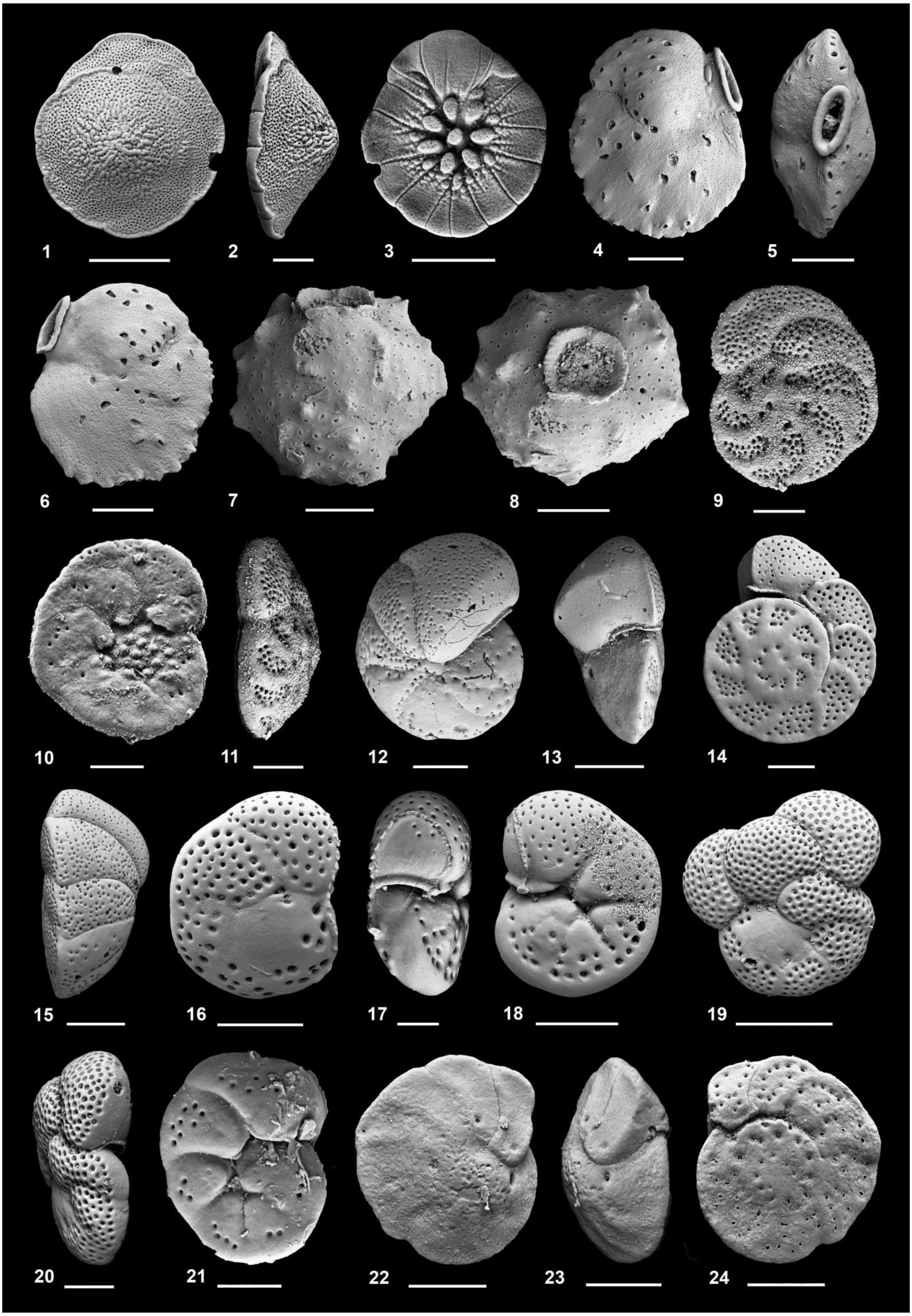


Plate 17

Figure		Scale	Sample	Page
1-5	***Cibicidella variabilis***			85
	1 Lateral view	200 µm	Haramu Passage 20 m	
	2 Apertural view	200 µm	Haramu Passage 20 m	
	3 Peripheral view	200 µm	Ras Nungwi 20 m	
	4 Umbilical view	200 µm	Ras Nungwi 20 m	
	5 Spiral view	200 µm	Ras Nungwi 20 m	
6-8	***Planorbulina mediterranensis***			86
	6 Dorsal view	500 µm	Mapenduzi Wall 42 m	
	7 Oblique peripheral view	200 µm	Mapenduzi Wall 42 m	
	8 Ventral view	500 µm	Mapenduzi Wall 42 m	
9-11	***Planorbulinella larvata***			86
	9 Ventral view	500 µm	Mnemba Atoll 30 m	
	10 Peripheral view	500 µm	Ras Nungwi 20 m	
	11 Ventral view	200 µm	Coral Mountain 35 m	
12-14	***Cymbaloporella tabellaeformis***			87
	12 Spiral view	200 µm	Mapenduzi Wall 42 m	
	13 Peripheral view	200 µm	Ocean Paradise 3 m	
	14 Umbilical view	100 µm	Haramu Passage 20 m	
15-17	***Cymbaloporetta bermudezi***			88
	15 Spiral view	200 µm	Haramu Passage 30 m	
	16 Peripheral view	200 µm	Kokota Reef 16 m	
	17 Umbilical view	200 µm	Haramu Passage 30 m	

Plate 17

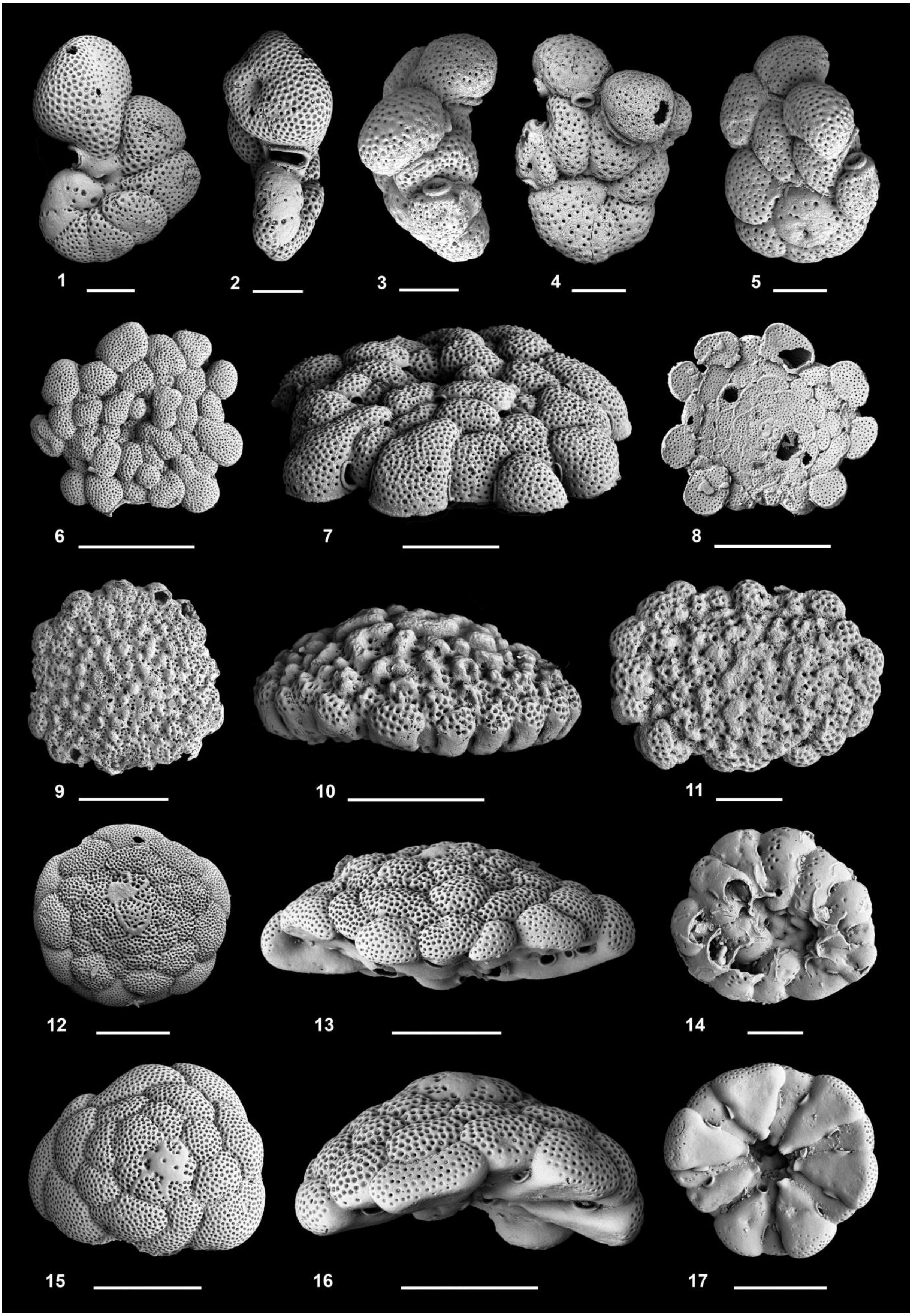


Plate 18

Figure		Scale	Sample	Page
1-4	***Cymbaloporetta bulloides***			88
	1 Spiral view	100 µm	Mapenduzi Wall 42 m	
	2 Peripheral view	100 µm	Mapenduzi Wall 42 m	
	3 Umbilical view	100 µm	Kokota Reef 16 m	
	4 Float chamber, lateral view	100 µm	Kokota Reef 16 m	
5-7	***Millettiana milletti***			89
	5 Spiral view	100 µm	Misali Island 20 m	
	6 Peripheral view	100 µm	Misali Island 20 m	
	7 Umbilical view	100 µm	Kokota Reef 16 m	
8-13	***Acervulina mabahethi***			89
	8 Apertural view	100 µm	Ocean Paradise 3 m	
	9 Umbilical view	100 µm	Ocean Paradise 3 m	
	10 Spiral view	100 µm	Ocean Paradise 3 m	
	11 Dorsal view	200 µm	Kokota Reef 16 m	
	12 Peripheral view	200 µm	Kokota Reef 16 m	
	13 Ventral view	200 µm	Kokota Reef 16 m	
14-16	***Sphaerogypsina globula***			90
	14 Lateral view	1 mm	Misali Island 20 m	
	15 Wall close-up	100 µm	Misali Island 20 m	
	16 Broken specimen, interior view	200 µm	Kokota Reef 25 m	
17-20	***Asanonella tubulifera***			90
	17 Spiral view	100 µm	Kokota Reef 16 m	
	18 Peripheral view	100 µm	Kokota Reef 16 m	
	19 Spiral view	100 µm	Misali Island 20 m	
	20 Umbilical view	100 µm	Misali Island 20 m	

Plate 18

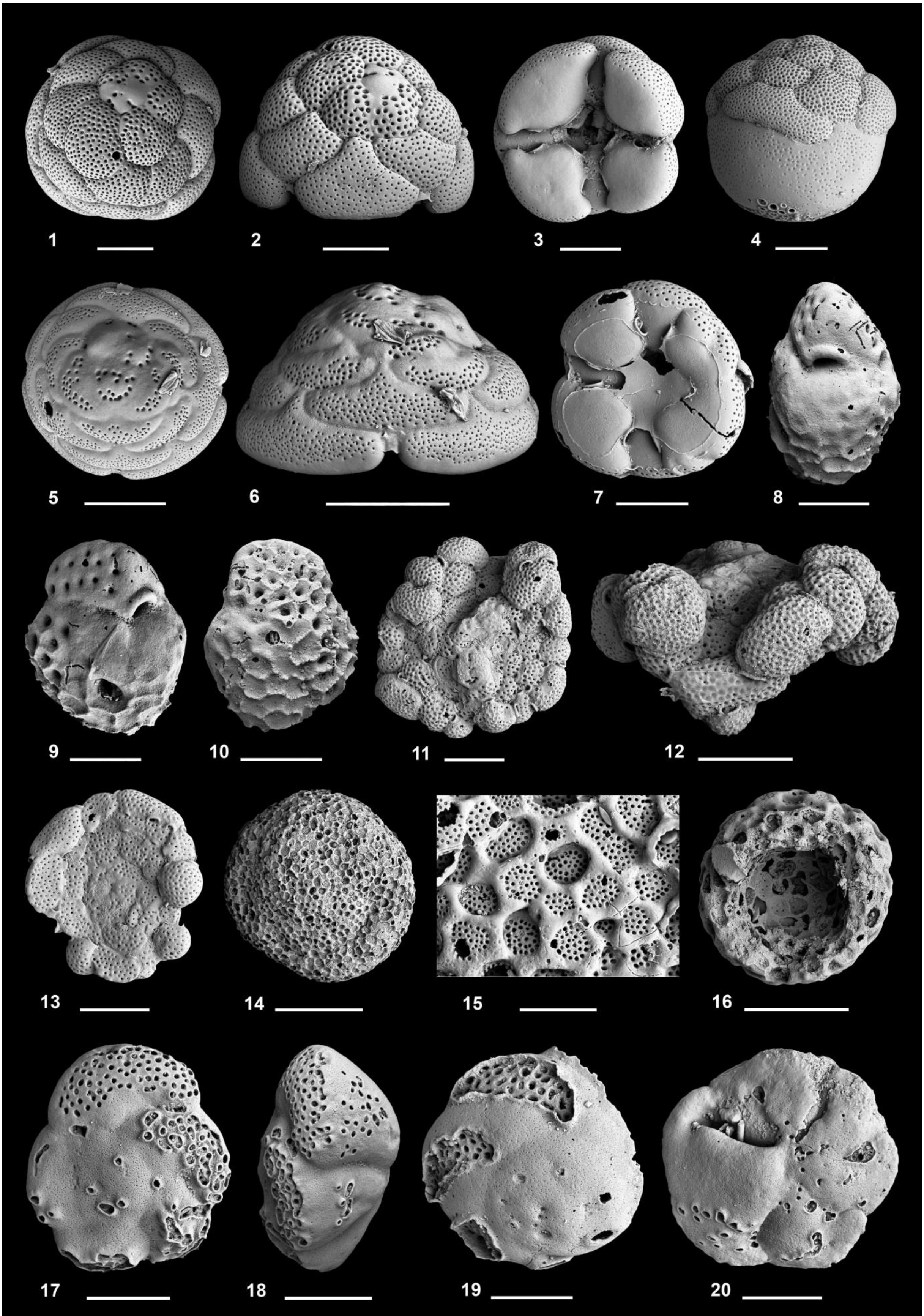


Plate 19

Figure		Scale	Sample	Page
1-5	***Epistomaroides punctulatus***			91
	1 Umbilical view	200 µm	Mapenduzi Wall 42 m	
	2 Peripheral view	200 µm	Mapenduzi Wall 42 m	
	3 Spiral view	500 µm	Haramu Passage 30 m	
	4 Apertural view	100 µm	Misali Island 20 m	
	5 Umbilical view	100 µm	Misali Island 20 m	
6-8	***Amphistegina bicirculata***			92
	6 Umbilical view	200 µm	Mapenduzi Wall 42 m	
	7 Peripheral view	200 µm	Mapenduzi Wall 42 m	
	8 Spiral view	200 µm	Mapenduzi Wall 42 m	
9-11	***Amphistegina lessonii***			92
	9 Umbilical view	200 µm	Haramu Passage 20 m	
	10 Peripheral view	200 µm	Haramu Passage 20 m	
	11 Spiral view	200 µm	Haramu Passage 20 m	
12-14	***Amphistegina lobifera***			93
	12 Umbilical view	200 µm	Ras Nungwi 20 m	
	13 Peripheral view	200 µm	Ras Nungwi Lighthouse 12 m	
	14 Spiral view	500 µm	Ras Nungwi 20 m	
15-17	***Amphistegina papillosa***			93
	15 Spiral view	500 µm	Haramu Passage 30 m	
	16 Peripheral view	500 µm	Haramu Passage 30 m	
	17 Umbilical view	200 µm	Haramu Passage 30 m	
18-20	***Amphistegina radiata***			94
	18 Umbilical view	500 µm	Ras Nungwi Lighthouse 12 m	
	19 Peripheral view	200 µm	Ras Nungwi Lighthouse 12 m	
	20 Spiral view	500 µm	Ras Nungwi Lighthouse 12 m	
21-23	***Nonionides grateloupi***			95
	21 Umbilical view	100 µm	Haramu Passage 20 m	
	22 Peripheral view	50 µm	Haramu Passage 20 m	
	23 Spiral view	100 µm	Haramu Passage 20 m	
24-26	***Anomalinella rostrata***			95
	24 Lateral view	200 µm	Coral Mountain 35 m	
	25 Peripheral view	200 µm	Coral Mountain 35 m	
	26 Apertural view	200 µm	Coral Mountain 35 m	

Plate 19

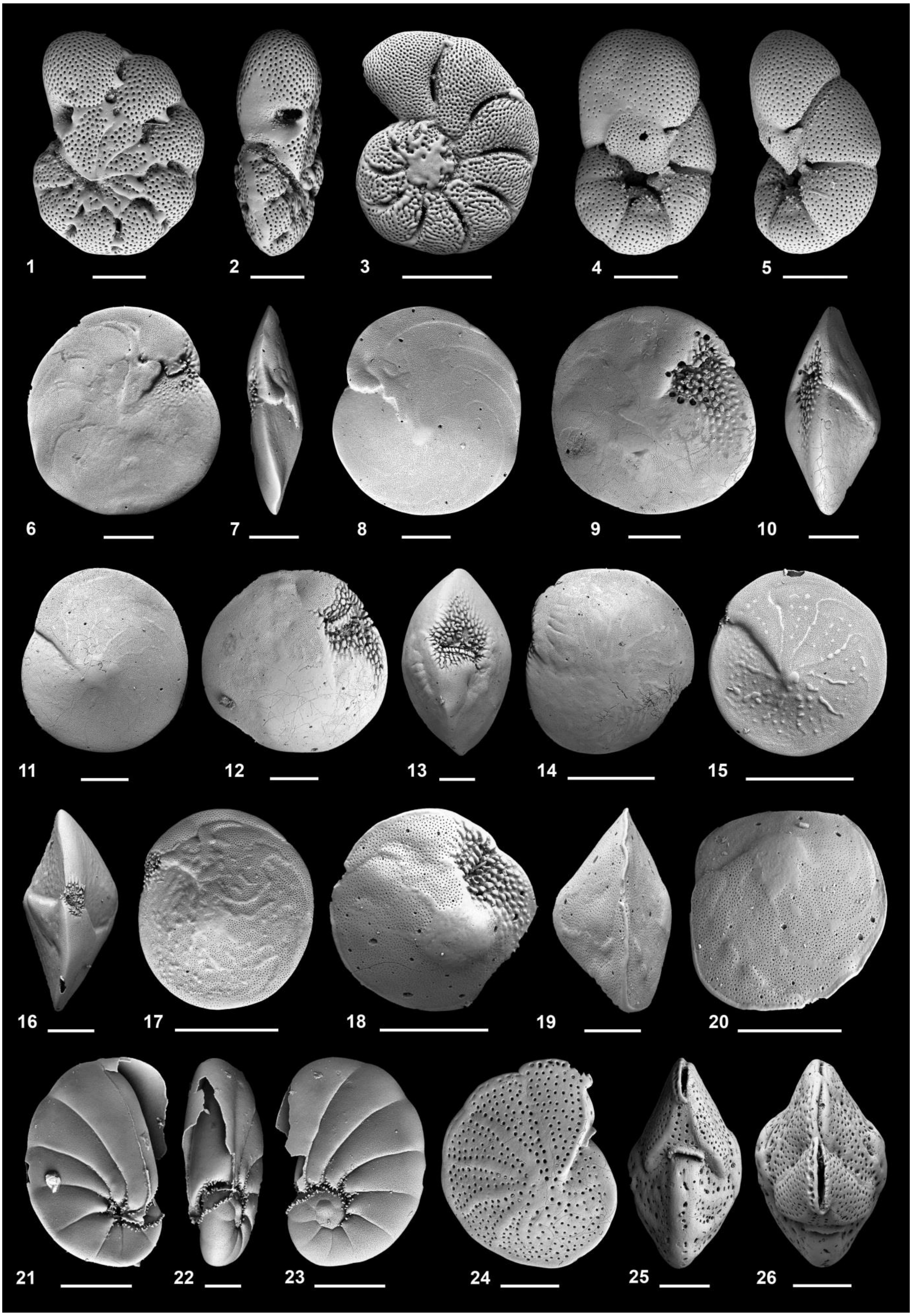


Plate 20

Figure		Scale	Sample	Page
1-3	***Anomalinulla glabrata***			96
	1 Spiral view	100 µm	Mapenduzi Wall 42 m	
	2 Peripheral view	100 µm	Mapenduzi Wall 42 m	
	3 Umbilical view	100 µm	Mapenduzi Wall 42 m	
4-6	***Gyroidina neosoldanii***			96
	4 Umbilical view	50 µm	Kokota Reef 16 m	
	5 Apertural view	50 µm	Kokota Reef 16 m	
	6 Spiral view	50 µm	Kokota Reef 16 m	
7-12	***Neorotalia calcar***			97
	7 Umbilical view	200 µm	Mnemba Atoll 20 m	
	8 Apertural view	200 µm	Mnemba Atoll 20 m	
	9 Spiral view	200 µm	Mnemba Atoll 20 m	
	10 Umbilical view	200 µm	Ras Nungwi 20 m	
	11 Apertural view	200 µm	Ras Nungwi 20 m	
	12 Peripheral view	200 µm	Ras Nungwi 20 m	
13-16	***Ammonia convexa***			98
	13 Spiral view	100 µm	Ocean Paradise 3 m	
	14 Peripheral view	100 µm	Menai Bay 1 m	
	15 Umbilical view	100 µm	Ocean Paradise 3 m	
	16 Spiral view	500 µm	Bawe Island 30-9 m	
17-19	***Ammonia faceta***			98
	17 Umbilical view	200 µm	Stone Town Aquarium 20 m	
	18 Apertural view	100 µm	Stone Town Aquarium 20 m	
	19 Peripheral view	200 µm	Stone Town Aquarium 20 m	
20-22	***Challengerella bradyi***			99
	20 Umbilical view	500 µm	Bawe Island 30-9 m	
	21 Peripheral view	500 µm	Bawe Island 30-9 m	
	22 Spiral view	200 µm	Bawe Island 30-9 m	
23-25	***Pseudoeponides falsobeccarii***			99
	23 Umbilical view	100 µm	Stone Town Aquarium 20 m	
	24 Peripheral view	50 µm	Stone Town Aquarium 20 m	
	25 Spiral view	100 µm	Stone Town Aquarium 20 m	

Plate 20

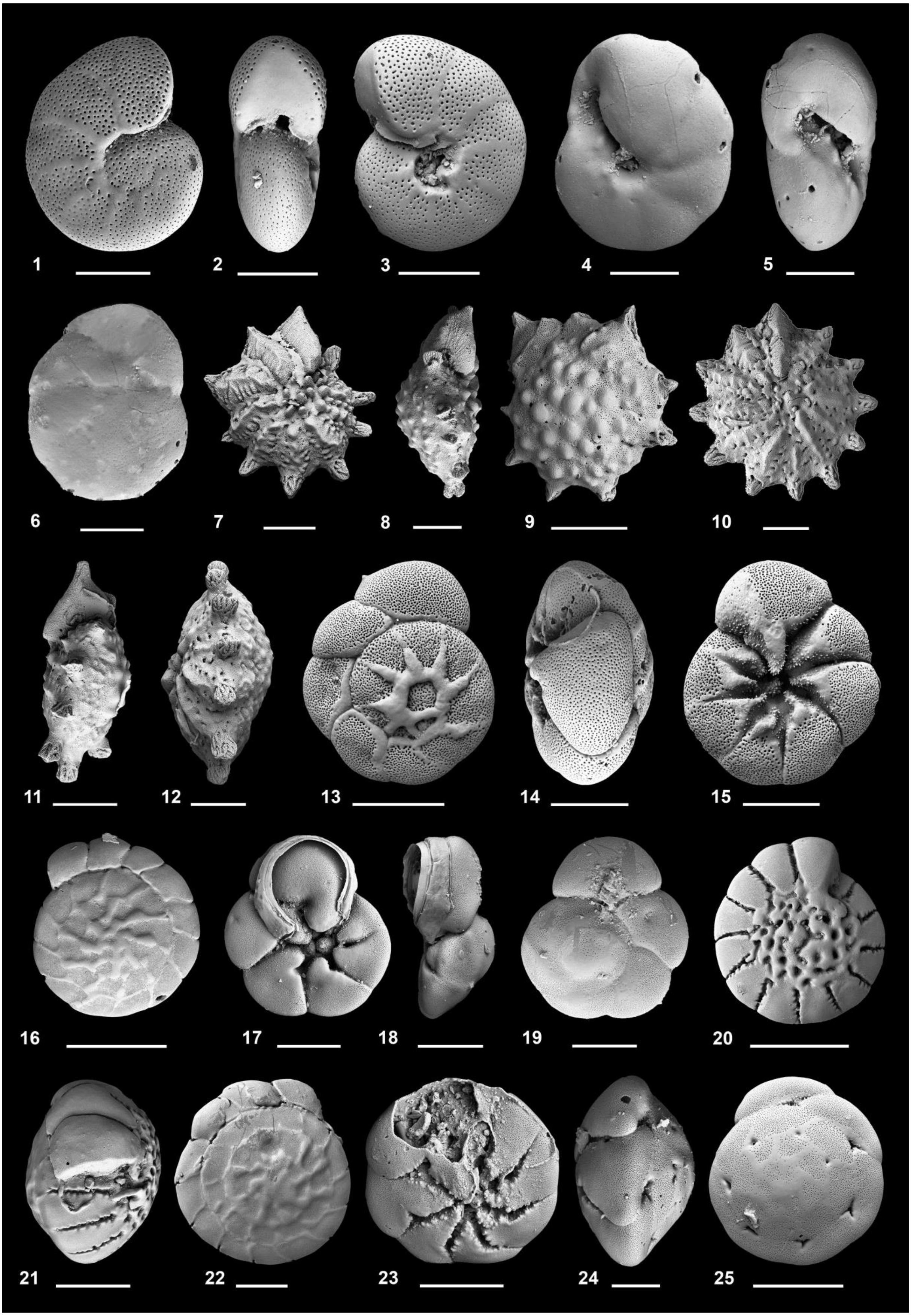


Plate 21

Figure		Scale	Sample	Page
1-3	***Elphidium jenseni***			100
	1 Lateral view	100 µm	Haramu Passage 20 m	
	2 Peripheral view	100 µm	Ocean Paradise 3 m	
	3 Lateral view	200 µm	Haramu Passage 20 m	
4-6	***Elphidium limbatum* sp. 1**			100
	4 Lateral view	100 µm	Misali Island 20 m	
	5 Peripheral view	50 µm	Misali Island 20 m	
	6 Lateral view	100 µm	Misali Island 20 m	
7-9	***Elphidium limbatum* sp. 2**			101
	7 Lateral view	200 µm	Ras Nungwi 20 m	
	8 Peripheral view	200 µm	Ras Nungwi 20 m	
	9 Lateral view	200 µm	Ras Nungwi 20 m	
10-12	***Elphidium lunatum***			101
	10 Lateral view	200 µm	Haramu Passage 20 m	
	11 Peripheral view	200 µm	Kokota Reef 16 m	
	12 Lateral view	200 µm	Mapenduzi Wall 42 m	
13-16	***Elphidium milletti***			102
	13 Lateral view	100 µm	Ocean Paradise 3 m	
	14 Peripheral view	100 µm	Ocean Paradise 3 m	
	15 Lateral view	100 µm	Ocean Paradise 3 m	
	16 Juvenile, peripheral view	50 µm	Kokota Reef 16 m	
17-19	***Elphidium striatopunctatum***			102
	17 Lateral view	200 µm	Misali Island 20 m	
	18 Peripheral view	100 µm	Misali Island 20 m	
	19 Lateral view	200 µm	Misali Island 20 m	
20-22	***Elphidium tongaense***			103
	20 Lateral view	100 µm	Mapenduzi Wall 42 m	
	21 Peripheral view	50 µm	Mapenduzi Wall 42 m	
	22 Lateral view	100 µm	Mapenduzi Wall 42 m	
23-25	***Elphidium voorthuyseni***			103
	23 Lateral view	100 µm	Stone Town Aquarium 20 m	
	24 Peripheral view	100 µm	Stone Town Aquarium 20 m	
	25 Lateral view	100 µm	Stone Town Aquarium 20 m	

Plate 21

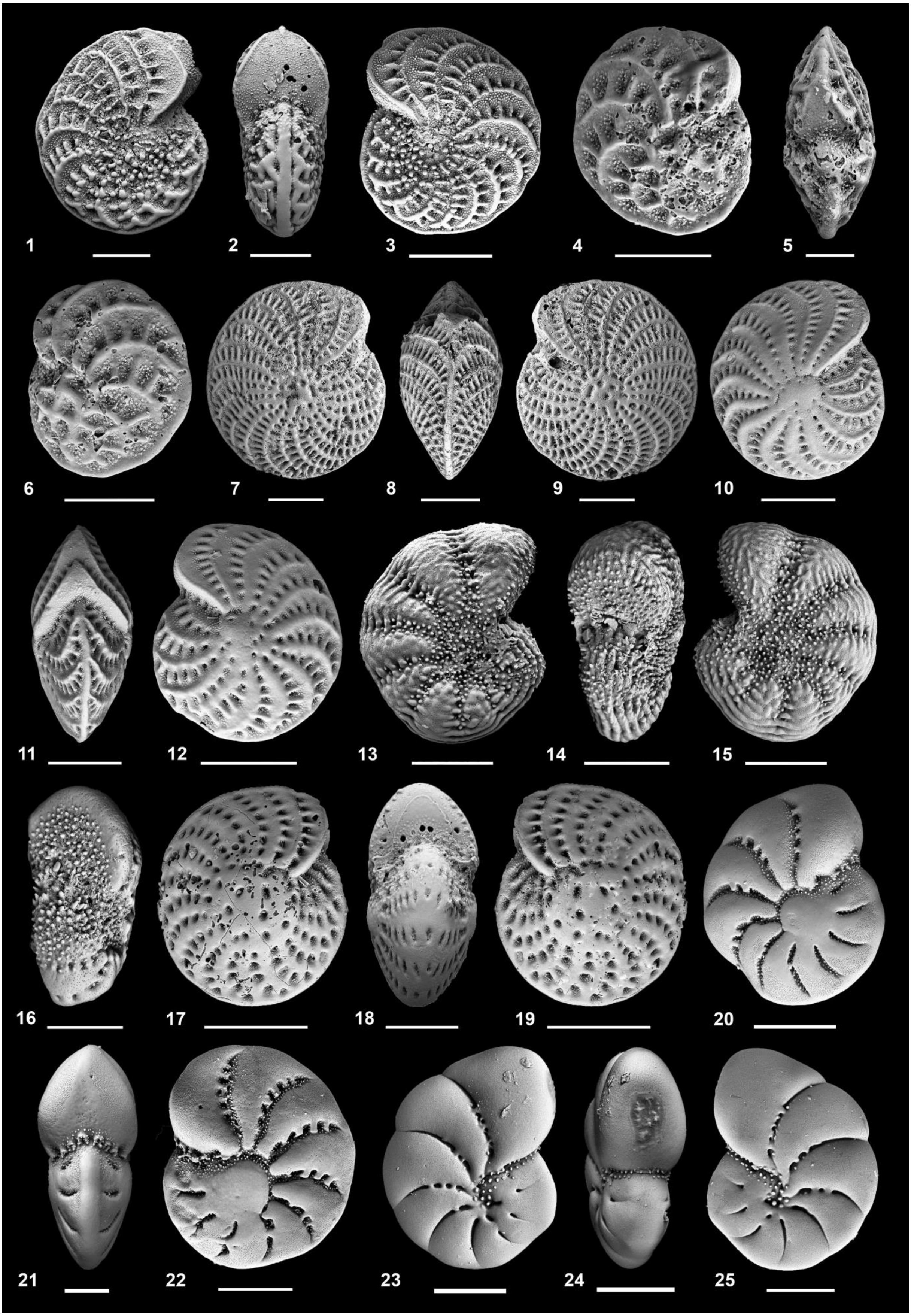
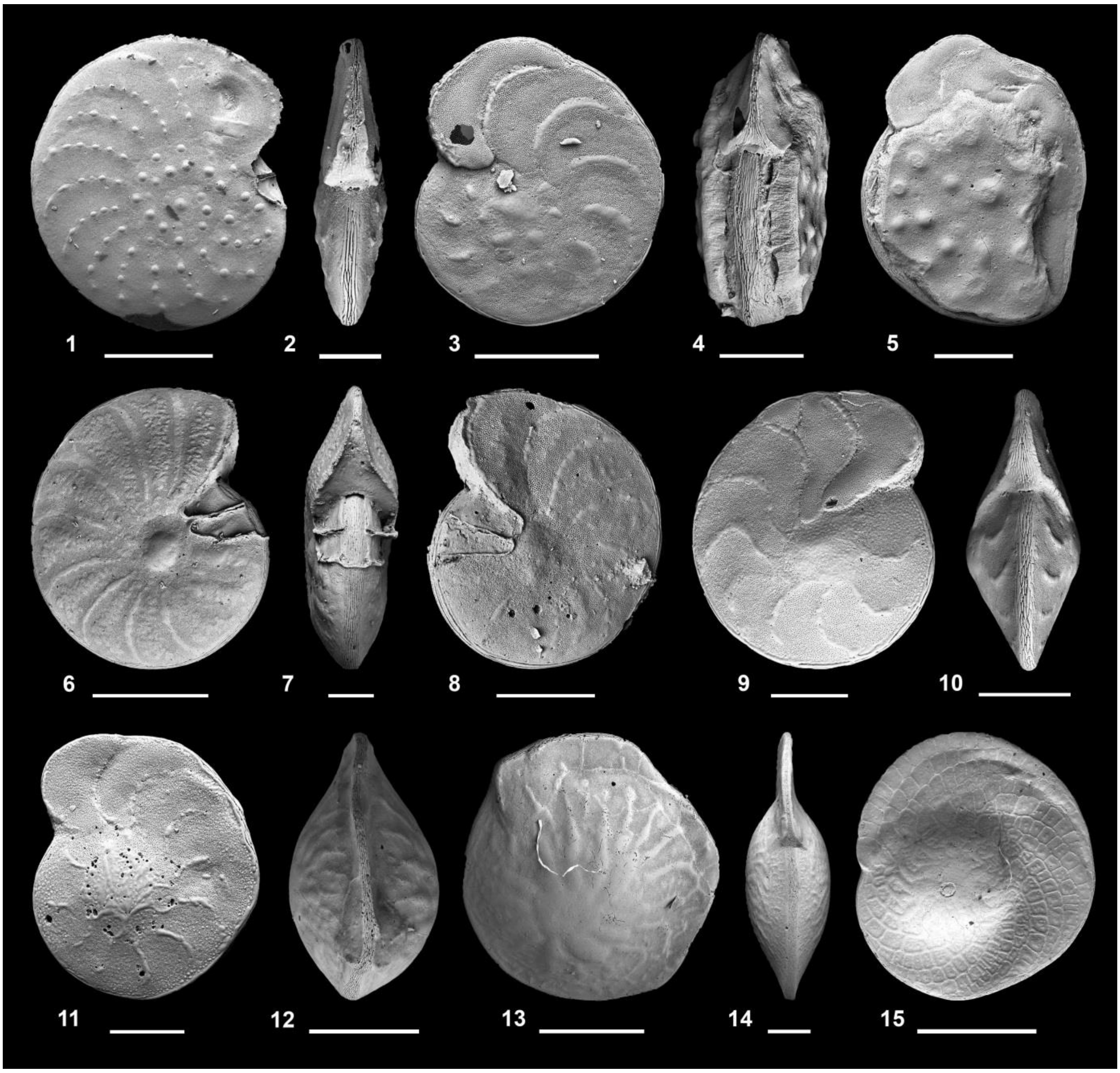


Plate 22

Figure		Scale	Sample	Page
1-5	***Assilina ammonoides***			104
	1 Lateral view	500 µm	Ras Nungwi 20 m	
	2 Peripheral view	100 µm	Haramu Passage 20 m	
	3 Lateral view	200 µm	Haramu Passage 20 m	
	4 Peripheral view	200 µm	Haramu Passage 30 m	
	5 Lateral view	200 µm	Haramu Passage 30 m	
6-8	***Assilina discoidalis***			104
	6 Lateral view	500 µm	Bawe Island 30-9 m	
	7 Apertural view	200 µm	Bawe Island 30-9 m	
	8 Lateral view	200 µm	Bawe Island 30-9 m	
9-15	***Heterostegina depressa***			105
	9 Lateral view	100 µm	Mapenduzi Wall 42 m	
	10 Peripheral view	100 µm	Ras Nungwi 20 m	
	11 Lateral view	100 µm	Mapenduzi Wall 42 m	
	12 Peripheral view	500 µm	Ras Nungwi 12 m	
	13 Lateral view	500 µm	Ras Nungwi 12 m	
	14 Peripheral view	500 µm	Ras Nungwi 20 m	
	15 Lateral view	1 mm	Ras Nungwi 20 m	

Plate 22



9 Appendix

9.1 Sample information

Sample station	Geographical position		Depth (m)	No. of species	Fisher α diversity	FoRAM Index	Habitat type
	Longitude	Latitude					
Bawe Island	39°08'27.00"E	6°08'06.00"S	9-30	61	16.43	5.4	Patch reef
Chole Bay	39°47'11.56"E	7°56'55.08"S	15-18	69	18.61	7.2	Apron reef
Chole Bay	39°47'11.56"E	7°56'55.08"S	20	74	22.88	6.2	Apron reef
Coral Mountain	39°35'33.51"E	5°13'03.86"S	35	78	24.52	5.3	Fore reef
Haramu Passage	39°37'40.96"E	5°05'40.57"S	20	79	22.74	5.4	Fore reef
Haramu Passage	39°37'40.96"E	5°05'40.57"S	30	61	18.81	4.8	Fore reef
Jina Reef	39°49'31.10"E	7°55'11.07"S	20	55	16.35	6.3	Apron reef
Jina Reef	39°49'31.10"E	7°55'11.07"S	21	61	16.14	6.3	Apron reef
Kinasi Pass	39°49'02.29"E	7°56'29.23"S	18-21	64	16.96	7.5	Apron reef
Kizimkazi Beach	39°27'36.00"E	6°26'17.00"S	1	36	8.54	7.3	Reef flat
Kokota Reef	39°38'49.74"E	5°07'51.79"S	16	114	35.97	3.8	Fore reef
Kokota Reef	39°38'49.74"E	5°07'51.79"S	25	63	19.92	5.1	Fore reef
Mapenduzi Wall	39°36'09.48"E	5°14'00.20"S	40	81	27.57	4.8	Fore reef
Mapenduzi Wall	39°36'09.48"E	5°14'00.20"S	42	92	27.59	4.6	Fore reef
Menai Bay	39°22'19.00"E	6°19'25.00"S	1	35	8.73	2.5	Mangroves
Misali Island	39°35'30.64"E	5°14'44.28"S	20	98	28.97	5.3	Fore reef
Mnemba Atoll	39°23'38.00"E	5°50'56.00"S	15	37	8.35	8.3	Reef flat
Mnemba Atoll	39°23'38.00"E	5°50'56.00"S	25	35	7.64	8.8	Reef flat
Mnemba Atoll	39°23'38.00"E	5°50'56.00"S	30	47	12.49	7.4	Reef flat
Ocean Paradise	39°21'51.00"E	5°55'06.00"S	3	53	14.94	2.6	Lagoon
Ras Nungwi	39°20'33.00"E	5°44'53.00"S	16	52	13.35	6.7	Fringing reef
Ras Nungwi	39°20'33.00"E	5°44'53.00"S	20	48	12.09	7.4	Fringing reef
Ras Nungwi Lighthouse	39°19'09.00"E	5°43'21.00"S	12	31	7.41	8.1	Fringing reef
Ras Nungwi Peak	39°19'09.00"E	5°43'21.00"S	12-14	52	13.17	7.2	Fringing reef
Ras Nungwi Peak	39°19'09.00"E	5°43'21.00"S	20	62	16.04	6.3	Fringing reef
Stone Town Aquarium	39°08'50.60"E	6°12'49.24"S	12	74	24.49	4.9	Patch reef
Stone Town Aquarium	39°08'50.60"E	6°12'49.24"S	20	76	21.14	5.1	Patch reef

Table 6: Sample site information (see also Fig. 30) with geographical position, depth, number of species, Fisher α diversity, FoRAM Index, and habitat type.

9.2 Counting data

	Bawe Island 30-9 m	Chole Bay 15-18 m	Chole Bay 20 m	Coral Mountain 35 m	Haramu Passage 20 m	Haramu Passage 30 m	Jina Reef 20 m	Jina Reef 21 m	Kinasi Pass 18-21 m	Kizimkazi Beach 1 m	Kokota Reef 16 m	Kokota Reef 25 m	Mapenduzi Wall 40 m	Mapenduzi Wall 42 m
Hormosina globulifera														1
Ammobaculites exiguus														
Hormosina sp. A				1				1						
Hormosina sp. B				2										
Hormosina sp. C														
Hormosina sp. D														
Spiroplectammina sp. A	2				3	3					3	7	10	7
Sahulia cf. *S. barkeri*	7	6	3	16	13	10	1	7	5		6	23	13	18
Sahulia kerimbaensis	25	7	8	30	27	24	2	9	7		22	34	18	24
Siphotextularia sp. A													1	1
Textularia agglutinans	90	29	32	21	45	51	20	21	19	4	24	47	16	43
Textularia foliacea	23	1		8	3	9		6			15	2	5	7
Textularia occidentalis ?	2			2							2			2
Textularia cf. *T. porrecta*	5	1		2		3					2	1		
Textularia sp. A	11	4	3	6	10	6	2	4	2		5	5	1	6
Textularia sp. B	1			1			2							
Siphoniferoides cf. *S. balearicus*				6	4	5					4	10	4	4
Clavulina difformis			1		1			1						
Clavulina multicamerata	1	1	1										1	
Cornuspira ? sp. A											1			
Vertebralina striata										1				
Fischerina sp. A		1	1					1			2		1	
Spiroloculina antillarum	2				1					1	1			
Spiroloculina attenuata				1		1					2	1		
Spiroloculina aff. *S. communis*			2								5			1
Spiroloculina corrugata			3	2			3	5	2		5		1	7
Spiroloculina foveolata		3	2	1	4	3	2		6	1	2			
Spiroloculina cf. *S. nitida*	2	2	1			1	1	2			2			
Spiroloculina sp. A			2				5		1		1			2
Affinetrina cf. *A. quadrilateralis*	5	1		4	2	4			1		9	4		3
Agglutinella robusta		1		2										2
Cycloforina exmouthensis		1	1	3	1						1	1		1
Cycloforina semiplicata	2											1		
Cycloforina semireticulosa	2	3			3		1	3			2	1	3	2
Cycloforina cf. *C. granulocostata*	3	2	2	4			1	1	1	2	16		3	9
Cycloforina sp. A		1	11	1	3	4	14	6	1		7	3	2	16
Miliolinella cf. *M. hybrida*												2		
Miliolinella suborbicularis								1						
Miliolinella sp. A	2	4	2	1			2	2	1		6		4	3
Miliolinella sp. B													3	2
Miliolinella sp. C		2		1									1	2
Nummoloculina ? sp. A											1			
Pitella transversestriata	1													
Pseudohauerina bradyi					1						9	1	1	1
Pseudohauerina fragilissima		2	1	1					1	1	3		1	1
Pseudohauerina involuta							3		1		1			1
Pseudomassilina reticulata														2
Pseudomassilina macilenta	3			1							1			
Pseudotriloculina cf. *P. kerimbatica*	1	3	8	6	15	7	3	6	11	3	9	5	3	11
Pseudotriloculina cf. *P. limbata*	4										3			
Pyrgo denticulata		1	2	9	2				2		7	3	8	8
Pyrgo oblonga				4	4	3		2	1		5	1	2	5
Pyrgo striolata				1		1								1
Quinqueloculina cf. *Q. cuvieriana*	10	2	6	2	15	18	2	12	2	8	12	1	5	3
Quinqueloculina eburnea	1			1	3	1		1			1			
Quinqueloculina cf. *Q. multimarginata*	3	2	2			2		1			8	2	4	2

Table 7: Counting data (*Hormosina globulifera* – *Quinqueloculina* cf. *Q. multimarginata*; Bawe Island 30-9 m – Mapenduzi Wall 42 m).

	Menai Bay 1m	Misali Island 20m	Mnemba Atoll 15m	Mnemba Atoll 20m	Mnemba Atoll 30m	Ocean Paradise 3m	Ras Nungwi 16m	Ras Nungwi 20m	Ras Nungwi Lighthouse 12m	Ras Nungwi Peak 12-14m	Ras Nungwi Peak 20m	Stone Town Aquarium 12m	Stone Town Aquarium 20m	Total number of specimens
Hormosina globulifera														**1**
Ammobaculites exiguus						1								**1**
Hormosina ? sp. A														**2**
Hormosina sp. B		2												**4**
Hormosina ? sp. C		1					1							**2**
Hormosina ? sp. D		1												**1**
Spiroplectammina sp. A		8						1			1	5	6	**56**
Sahulia cf. *S. barkeri*		18	3			1	23	2	4	1	3	1		**184**
Sahulia kerimbaensis		21	3	3	1		10	8	3	7	4	15	15	**327**
Siphotextularia sp. A		1												**3**
Textularia agglutinans	2	19	32	7	3	6	27	44	29	34	26	21	32	**744**
Textularia foliacea		4	8				14	11	1	1		24	16	**158**
Textularia occidentalis ?												2		**10**
Textularia cf. *T. porrecta*		2					1					4	7	**28**
Textularia sp. A		5	2				9	7	6	2	3	4	2	**105**
Textularia sp. B														**4**
Siphoniferoides cf. *S. balearicus*		7												**44**
Clavulina difformis						4								**7**
Clavulina multicamerata						5								**9**
Cornuspira ? sp. A										1			1	**3**
Vertebralina striata											1			**2**
Fischerina sp. A		1		1										**8**
Spiroloculina antillarum														**5**
Spiroloculina attenuata														**5**
Spiroloculina aff. *S. communis*					4							1		**13**
Spiroloculina corrugata	2	2			1	4		1		2	3		1	**44**
Spiroloculina foveolata						1		2		1	1			**29**
Spiroloculina cf. *S. nitida*						1		1			1	1	8	**23**
Spiroloculina sp. A													1	**12**
Affinetrina cf. *A. quadrilateralis*	2	9				1				2	1	7	1	**56**
Agglutinella robusta		3						1						**9**
Cycloforina exmouthensis		14						1						**24**
Cycloforina semiplicata		1												**4**
Cycloforina semireticulosa			3		1	2	3	2				5	1	**37**
Cycloforina cf. *C. granulocostata*	1	9		1		13		2	1		11	2	9	**93**
Cycloforina sp. A		6				1	2	2	1	3	3	1	8	**96**
Miliolinella cf. *M. hybrida*		1		1	1							1	1	**7**
Miliolinella suborbicularis														**1**
Miliolinella sp. A		1			8					1	4	7		**48**
Miliolinella sp. B					1									**6**
Miliolinella sp. C											1	3	1	**11**
Nummoloculina ? sp. A		1								1				**3**
Pitella transversestriata						1	1					2		**5**
Pseudohauerina bradyi		1		2									1	**17**
Pseudohauerina fragilissima		1		1	1			1				5	14	**34**
Pseudohauerina involuta		1					1						2	**10**
Pseudomassilina reticulata		3												**5**
Pseudomassilina macilenta		2												**7**
Pseudotriloculina cf. *P. kerimbatica*		3	2	1	1	11	8	24	9	3	20		1	**174**
Pseudotriloculina cf. *P. limbata*						15								**22**
Pyrgo denticulata		5			1			2				1	8	**59**
Pyrgo oblonga							2				1	2		**32**
Pyrgo striolata														**3**
Quinqueloculina cf. *Q. cuvieriana*	2	10	5		5	4	5	7	3	12	9	10	10	**180**
Quinqueloculina eburnea						1					1			**10**
Quinqueloculina cf. *Q. multimarginata*	2	4			5	51	10	2		5	18		3	**126**

Table 8: Counting data (*Hormosina globulifera* – *Quinqueloculina* cf. *Q. multimarginata*; Menai Bay 1 m – Stone Town Aquarium 20 m).

	Bawe Island 30-9 m	Chole Bay 15-18 m	Chole Bay 20 m	Coral Mountain 35 m	Haramu Passage 20 m	Haramu Passage 30 m	Jina Reef 20 m	Jina Reef 21 m	Kinasi Pass 18-21 m	Kizimkazi Beach 1 m	Kokota Reef 16 m	Kokota Reef 25 m	Mapenduzi Wall 40 m	Mapenduzi Wall 42 m
Quinqueloculina patagonica	1	5	12		4	4		6	3	1	20	3	3	3
Quinqueloculina cf. *Q. rebeccae*	2		1	1	2	3		1	1	1	5	4	1	
Quinqueloculina cf. *Q. vulgaris*	29	33	31	8	36	35	23	81	30	61	69	22	21	35
Schlumbergerina alveoliniformis	1	4		1							1		1	1
Siphonaperta distorqueata				4	4								2	2
Siphonaperta pittensis											1			
Triloculina asymmetrica	15	15	8	7	5	1	1	5	2		11		1	3
Triloculina bertheliniana		7	3		4	1	3	5	3		2		2	1
Triloculina fichteliana	10			1	17			1						
Triloculina serrulata	13			6	14	1				1	1	2	2	7
Triloculina cf. *T. serrulata*														
Triloculina terquemiana				2										
Triloculina trigonula	53	13	4	4	14	2	3	5	3	6	11	6	9	11
Triloculina sp. A	1										3	8	1	1
Triloculina sp. B	2			2	1						1		1	2
Triloculina sp. C	1		6		1	2	1	13		1		1	1	
Triloculinella cf. *T. pilasensis*														
Articulina scrobiculata														
Rupertianella rupertiana						1					1		1	
Pseudohauerinella dissidens														
Borelis schlumbergeri	23	14	2	6	6		2	13	7		4	10	5	9
Peneroplis pertusus	4	1	5	2	2	2	8	6	4	27	7	2	1	3
Peneroplis planatus	2	1	3			4	3	7	2	1	2			1
Amphisorus hemprichii	1	4		1	1	3		3			1			
Sorites orbiculus	12	13	20	10	14	15	14	37	40	12	36	5	10	20
Planispirillina spinigera		4	1	3	1	1			2		4		4	3
Spirillina grosseperforata			1								1			
Patellina corrugata									2		4	1		
Pyramidulina catesbyi				1							1			
Lenticulina vortex									1				1	
Lenticulina sp. A											1			
Alliatinella panayensis									1					
Globorotalia menardii		2	1								1		1	1
Neogloboquadrina humerosa		1		1	1				1		2	1	1	7
Pulleniatina obliquiloculata				1		1					2		1	6
Globigerina calida				7	3						25	1	10	26
Globigerinella siphonifera				2							1	2	1	
Alloglobigerinoides conglobatus				2	1						3		1	3
Globigerinoides ruber				5	5						8	2	2	12
Globigerinoides sacculifer		1	1	8	2	1			6		13	6	13	18
Globoturborotalita rubescens		2		8	2						2			
Orbulina universa				1									3	
Brizalina ordinaria			1						1		7	1		1
Brizalina simpsoni	6	1	2	2	5		1	2	2	3	1		5	2
Brizalina striatula			2		1						2			
Floresina cf. *F. durrandi*											4			
Floresina cf. *F. madagascariensis*														
Cassidelina cf. *C. makiyamai*			1								2			
Loxostomina limbata costulata			1								4	2		
Loxostomina ? cf. *L.*? *sinuosa*			1					1						1
Siphogenerina cf. *S. raphana*		3		1							2	1	1	2
Baggina ? sp. A											1			
Cancris bubnanensis				1										1
Cancris cf. *C. carinatus*						1					2			4
Reussella cf. *R. insueta*			1		1		1	1	2		3		1	2
Valvobifarina mackinnonii														
Pavonina flabelliformis														

Table 9: Counting data (*Quinqueloculina patagonica* – *Pavonina flabelliformis*; Bawe Island 30-9 m – Mapenduzi Wall 42 m).

	Menai Bay 1m	Misali Island 20m	Mnemba Atoll 15m	Mnemba Atoll 20m	Mnemba Atoll 30m	Ocean Paradise 3m	Ras Nungwi 16m	Ras Nungwi 20m	Ras Nungwi Lighthouse 12m	Ras Nungwi Peak 12-14m	Ras Nungwi Peak 20m	Stone Town Aquarium 12m	Stone Town Aquarium 20m	Total number of specimens
Quinqueloculina patagonica	75	4			1	21	1			3	7	3	4	**184**
Quinqueloculina cf. *Q. rebeccae*						3		1				5		**31**
Quinqueloculina cf. *Q. vulgaris*	44	36	10	16	10	22	51	17	7	42	59	18	60	**906**
Schlumbergerina alveoliniformis		8	1									2	4	**24**
Siphonaperta distorqueata		4										1		**17**
Siphonaperta pittensis		5								1			5	**12**
Triloculina asymmetrica	21	8		4	6	70	14	12	5	2	8	8	18	**250**
Triloculina bertheliniana		1	1		3		1			2	2			**41**
Triloculina fichteliana	1	1		3		5						1		**40**
Triloculina serrulata		4		1	3	1								**56**
Triloculina cf. *T. serrulata*									1					**1**
Triloculina terquemiana		1												**3**
Triloculina trigonula		8	8	11	7	58	11	5	3	4	8	21	92	**380**
Triloculina sp. A		4	2							1	3		8	**32**
Triloculina sp. B		1												**10**
Triloculina sp. C	3		5	4	3	4					3	2	14	**65**
Triloculinella cf. *T. pilasensis*					1									**1**
Articulina scrobiculata													1	**1**
Rupertianella rupertiana		1									1		1	**6**
Pseudohauerinella dissidens		8											4	**12**
Borelis schlumbergeri		21	2	1			8	5	4	7	5	1	13	**168**
Peneroplis pertusus	1	2		6	4	4	5				1	7	7	**111**
Peneroplis planatus	1			5	7	9	3	2	1	2	3		8	**67**
Amphisorus hemprichii		1					8	9	6	19	7			**64**
Sorites orbiculus	7	11	32	11	26	15	13	9	14	7	8	7	10	**428**
Planispirillina spinigera	1	3					1	2	1	1				**32**
Spirillina grosseperforata		1		1								1		**5**
Patellina corrugata					1									**8**
Pyramidulina catesbyi														**2**
Lenticulina vortex														**2**
Lenticulina sp. A														**1**
Alliatinella panayensis													1	**2**
Globorotalia menardii		3										2		**11**
Neogloboquadrina humerosa														**15**
Pulleniatina obliquiloculata		2	1		2							1		**17**
Globigerina calida		5									4	4		**85**
Globigerinella siphonifera		1												**7**
Globigerinoides conglobatus											1			**11**
Globigerinoides ruber		7												**41**
Globigerinoides sacculifer		15	1	1	3		1			2	1	2	3	**98**
Globoturborotalita rubescens		7						1		5	8	5		**40**
Orbulina universa												1		**5**
Brizalina ordinaria		2								1	19	1	1	**35**
Brizalina simpsoni		12	2				1	1	3	13	3	2	23	**92**
Brizalina striatula		3												**8**
Floresina cf. *F. durrandi*														**4**
Floresina cf. *F. madagascariensis*		1								3				**4**
Cassidelina cf. *C. makiyamai*	2	1				2					1		1	**10**
Loxostomina limbata costulata		2			1					1	1		1	**13**
Loxostomina ? cf. *L.*? *sinuosa*						1						3		**7**
Siphogenerina cf. *S. raphana*					1									**11**
Baggina ? sp. A														**1**
Cancris bubnanensis			1											**3**
Cancris cf. *C. carinatus*		1												**8**
Reussella cf. *R. insueta*		2								1		1	2	**18**
Valvobifarina mackinnonii		1												**1**
Pavonina flabelliformis												1		**1**

Table 10: Counting data (*Quinqueloculina patagonica* – *Pavonina flabelliformis*; Menai Bay 1 m – Stone Town Aquarium 20 m).

	Bawe Island 30-9 m	**Chole Bay 15-18 m**	**Chole Bay 20 m**	**Coral Mountain 35 m**	**Haramu Passage 20 m**	**Haramu Passage 30 m**	**Jina Reef 20 m**	**Jina Reef 21 m**	**Kinasi Pass 18-21 m**	**Kizimkazi Beach 1 m**	**Kokota Reef 16 m**	**Kokota Reef 25 m**	**Mapenduzi Wall 40 m**	**Mapenduzi Wall 42 m**
Eponides repandus	3	14	4	35	19	23		6	10	1	15	19	31	33
Pegidia lacunata														
Orbitina cf. *O. exquisita*		2	1		5	1	5	1			4	1	4	1
Orbitina sp. A														
Rotorbis auberii	1		5		3	5	15	12	7	5	1			2
Rotorbis rosacea			6		1		3	2	10		2			
Rosalina bradyi	2	5	4	2	6	5	16	5	3	4	26	1	6	13
Rotorboides granulosus														
Glabratellina australensis														1
Glabratellina cimermania		2	2				1	1			1			
Pileolina sp. A			6											
Siphonina tubulosa					1	1					2	1		
Siphoninoides echinatus									1					
Discorbinella minuta		1			1	1								
Cibicides pseudolobatulus	4	14	7	10	2	2	15	13	5	1	30	3	8	9
Discorbia valvulinerioides ?											3		1	
Dyocibicides sp. A											4	1		
Fontbotia wuellerstorfi		1					3		1		1		2	1
Cibicidella variabilis					2								1	
Planorbulina mediterranensis		3	6	2	2	1	3	1	3	1	10	1	1	3
Planorbulinella larvata		1		2	1	1	2	1	4		2			2
Cymbaloporella tabellaeformis		3	1		5					1	7	1		1
Cymbaloporetta bermudezi			2		4	1	1		1		5	1		1
Cymbaloporetta bulloides			3		1		2	2	4		3			1
Millettiana milletti											1			
Acervulina mabahethi	1		2				3	1			5		1	
Sphaerogypsina globula			1	6	3				3		2	3	9	2
Asanonella tubulifera									1		4			1
Epistomaroides punctulatus		3	3	2	2	2	2	3	8	1	3	2		6
Amphistegina bicirculata	19	81	36	34	20	7	25	28	56	6	17	17	26	32
Amphistegina lessonii	73	195	94	86	154	74	48	103	226	61	44	63	56	89
Amphistegina lobifera	53	116	60	20	50	19	32	47	51	5	20	20	8	24
Amphistegina papillosa	8	11	7	12	12	5		1	4		6	7	14	8
Amphistegina radiata	14	9	1	17	27	16	1	1	4		7	16	9	11
Nonionoides grateloupi		2	1		1		2					1		
Anomalinella rostrata		14	10	18	14	5	6	16	5		9	16	10	20
Anomalinulla glabrata													2	2
Gyroidina neosoldanii											1			
Neorotalia calcar	12	8	60	1	1	1	112	110	77	275	4			
Ammonia convexa	2	2	1	4	8	1	2	1		22	11			1
Ammonia faceta					2									
Challengerella bradyi	3				2					1				
Pseudoeponides falsobeccarii													1	
Elphidium jenseni		1	3		1		4		2				1	
Elphidium limbatum sp. 1	1	1	3	2	1	4	1	3	2	3	2	1	2	3
Elphidium limbatum sp. 2	3	13	14	6	14	14	15	19	16	43	13	3	10	17
Elphidium lunatum	12	1	3	22	16	17	2	6	3	2	31	5	21	24
Elphidium milletti											2			
Elphidium striatopunctatum	1	1	2	2	2	4	1	3	3	1	3		2	3
Elphidium tongaense											4		2	2
Elphidium voorthuyseni														
Assilina ammonoides	8	6	1	5	2	1	1		1			2	7	2
Assilina discoidalis	37	7											2	1
Heterostegina depressa	16	19	7	40	19	18	9	26	34	3	38	31	38	45
All species	**657**	**740**	**558**	**566**	**711**	**463**	**456**	**691**	**722**	**571**	**820**	**451**	**493**	**747**

Table 11: Counting data (*Eponides repandus* – *Heterostegina depressa*; Bawe Island 30-9 m – Mapenduzi Wall 42 m).

	Menai Bay 1m	**Misali Island 20m**	**Mnemba Atoll 15m**	**Mnemba Atoll 20m**	**Mnemba Atoll 30m**	**Ocean Paradise 3m**	**Ras Nungwi 16m**	**Ras Nungwi 20m**	**Ras Nungwi Lighthouse 12m**	**Ras Nungwi Peak 12-14m**	**Ras Nungwi Peak 20m**	**Stone Town Aquarium 12m**	**Stone Town Aquarium 20m**	**Total number of specimens**
Eponides repandus		23	5	1		1	5	4	2	4	6	25	8	**297**
Pegidia lacunata				1					1					**2**
Orbitina cf. *O. exquisita*		2		1	3		1	2	1	3	9	6	3	**56**
Orbitina sp. A		2												**2**
Rotorbis auberii	2	2	1			64	1	1		6	3			**136**
Rotorbis rosacea						8	2				2		4	**40**
Rosalina bradyi	5	17	2	6	8		3	2	2	9	20	13	3	**188**
Rotorboides granulosus							11			1				**12**
Glabratellina australensis										2				**9**
Glabratellina cimermania		3			19	1							1	**31**
Pileolina sp. A		3												**3**
Siphonina tubulosa														**5**
Siphoninoides echinatus														**1**
Discorbinella minuta		1												**4**
Cibicides pseudolobatulus	2	10	2	15	13	1	2	4	3	13	15	18	9	**230**
Discorbia valvulinerioides ?		2					1					4		**16**
Dyocibicides sp. A							1							**5**
Fontbotia wuellerstorfi					1						1	2		**9**
Cibicidella variabilis								1				2		**6**
Planorbulina mediterranensis			2	5	11	1	1	1			2	1	1	**62**
Planorbulinella larvata		1		1	8	1		3				1		**31**
Cymbaloporella tabellaeformis						3					7	4	2	**35**
Cymbaloporetta bermudezi	2				5							5		**28**
Cymbaloporetta bulloides												5	2	**23**
Millettiana milletti		1										1		**3**
Acervulina mabahethi					12	1	1					2		**29**
Sphaerogypsina globula		5					1	1				1	2	**39**
Asanonella tubulifera		3											2	**11**
Epistomaroides punctulatus		5				4	4				2		1	**53**
Amphistegina bicirculata		57	18	4	3		12	4		1	8	45	91	**647**
Amphistegina lessonii	7	140	29	11	23	3	77	94	105	89	109	64	71	**2188**
Amphistegina lobifera	41	27	18	7	3	3	97	219	142	261	191	10	36	**1580**
Amphistegina papillosa		13	1										2	**111**
Amphistegina radiata	1	16	1				5	2	1	2	7	2	6	**176**
Nonionoides grateloupi					1							1		**9**
Anomalinella rostrata	1	21	5	1			11	14	12	9	7	1		**225**
Anomalinulla glabrata														**4**
Gyroidina neosoldanii					1									**2**
Neorotalia calcar	2		430	584	289	21	101	25	17	3	26		1	**2160**
Ammonia convexa	149	1				25						2	1	**233**
Ammonia faceta													1	**3**
Challengerella bradyi	10					1								**17**
Pseudoeponides falsobeccarii											1		3	**5**
Elphidium jenseni	1	6		2	2	7							5	**35**
Elphidium limbatum sp. 1	1	3				2				1	1	1	1	**39**
Elphidium limbatum sp. 2	52	13	36	16	11	13	15	10	14	15	13		4	**412**
Elphidium lunatum	6	25	2							1		1	9	**209**
Elphidium milletti	9					1				5	8			**25**
Elphidium striatopunctatum	1	4				2	1				4		1	**37**
Elphidium tongaense	11					2	1				4		1	**27**
Elphidium voorthuyseni						1							1	**2**
Assilina ammonoides	2	5	4				1	1				1	6	**56**
Assilina discoidalis			3				3					10	19	**82**
Heterostegina depressa		48	10	4	1		51	56	78	52	43	25	22	**733**
All species	**472**	**824**	**693**	**740**	**526**	**504**	**643**	**629**	**480**	**670**	**750**	**478**	**749**	**16804**

Table 12: Counting data (*Eponides repandus* – *Heterostegina depressa*; Menai Bay 1 m – Stone Town Aquarium 20 m).

9.3 Ecological classification of chosen taxa

Genus	Fauna	Ecotype	Morphotype
Affinetrina	Epifauna mobile	Miliolid	Milioline
Ammonia	Epifauna	Ammonia	Biconvex trochospiral
Amphisorus	Epiphyte	Symbiont-bearing	Disc-shaped
Amphistegina	Epiphyte	Symbiont-bearing	Flattened ovoid
Anomalinella	Epifauna	Planispiral	Rounded planispiral
Assilina	Epiphyte	Symbiont-bearing	Rounded planispiral
Borelis	Epifauna	Symbiont-bearing	Milioline
Brizalina	Infauna	Biserial	Flattened tapered
Cibicides	Epiphyte	Temporarily attached	Plano-convex trochospiral
Cycloforina	Epifauna mobile	Miliolid	Milioline
Elphidium	Universal	Elphidium	Rounded planispiral
Epistomaroides	Epifauna	Trochospiral	Rounded trochospiral
Eponides	Epifauna	Trochospiral	Biconvex trochospiral
Heterostegina	Epiphyte	Symbiont-bearing	Rounded planispiral
Neorotalia	Epifauna	Star-shaped	Biconvex trochospiral
Peneroplis	Epifauna	Symbiont-bearing	Rounded planispiral
Planorbulina	Epiphyte	Permanently attached	Plano-convex trochospiral
Pseudotriloculina	Epifauna mobile	Miliolid	Milioline
Pyrgo	Epifauna mobile	Miliolid	Milioline
Quinqueloculina	Epifauna mobile	Miliolid	Milioline
Rosalina	Epiphyte	Temporarily attached	Plano-convex trochospiral
Sahulia	Infauna	Agglutinated	Tapered and cylindrical
Sorites	Epiphyte	Symbiont-bearing	Disc-shaped
Spiroplectammina	Infauna	Biserial	Flattened tapered
Trochulina	Epifauna	Trochospiral	Plano-convex trochospiral
Triloculina	Epifauna mobile	Miliolid	Milioline
Textularia	Infauna	Agglutinated	Flattened tapered

Table 13: Ecological classification of chosen taxa concerning fauna, ecotypes and morphotypes.