



# Taxonomy and Distribution of Benthic Foraminiferans in the Selected Group Islands of Gulf of Mannar Marine Biosphere Reserve

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## Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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## ABSTRACT

The present work deals with the taxonomy and distribution of benthic foraminifera from Gulf of Mannar Marine Biosphere Reserve (GoMBR), South east Coast of India during 2020 – 2023. Sediment samples were collected from Mandapam, Keezhakarai and Vembar group of Islands through standard methodology, A total of 36 species belonging to 20 genera, 16 families and 4 orders. A holistic approach regarding soil texture and physico-chemical properties of soil and water shed more light on the diversity and distribution of foraminifera in GoMBR.

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## 1. INTRODUCTION

Foraminifera are small hole bearing organisms found in tropical water to polar region. The faunal group is known as “forams”. Foraminiferans are single celled animals produced chambered shells made up of calcium carbonate. The faunal group evolved 900 to 650 million years ago. The Phylum Foraminifera is classified under Kingdom Chormista and Subkingdom Harosa. Benthic foraminifera are single-celled organisms with shells found in the sediments of marine and estuarine environments etc. from shallow marine to deep trenches. These micro-organisms are two types planktic which live in the upper few hundred meters of the sea water column and benthic which remain in the sea bottom. Worldwide, 8891 species of foraminiferans are recorded as accepted till date distributed under four classes. Of which, 595 species of foraminiferans are reported from the Indian waters (Padmanaban *et al.*, 2024) belonging to four classes, 11 orders and 99 genera. Foraminiferans are either planktonic or benthic in nature and found from marshes to deep oceans, from tropics to poles. A few are known from fresh and brackish water also. Benthic forms have a long record of existence since Cambrian [1] till recent while planktons are known to appear only since Jurassic [2] and hence the benthic variety are more diverse than the latter. They are extensively used to monitor the environmental changes today as well as in the past. This is because they are sensitive to even slight changes in salinity, temperature, nutrient flux, turbulence, current action, and bottom sediment - water interaction which in turn is reflected in their size of population. The distribution of foraminifera is controlled by various environmental factors such as sediment texture and physiochemical characteristics of sediments and water. They provide carbonates from its calcareous shell to Coral reefs during initial stages of development and they can be considered as one of the indicators. Apart from this, they release methane and proved as good indicator of marine environment and as a matter of fact importance of foraminifera in monitoring the coastal environment has been emphasized. [3,4]. Various studies have been carried out on the taxonomy and distribution of foraminifera, [5,6] however few are restricted to East Coast of India [7,8,9,10,11]. So far studies [12,13] have been carried out in the Islands of Tuticorin group only and no study was undertaken in remaining

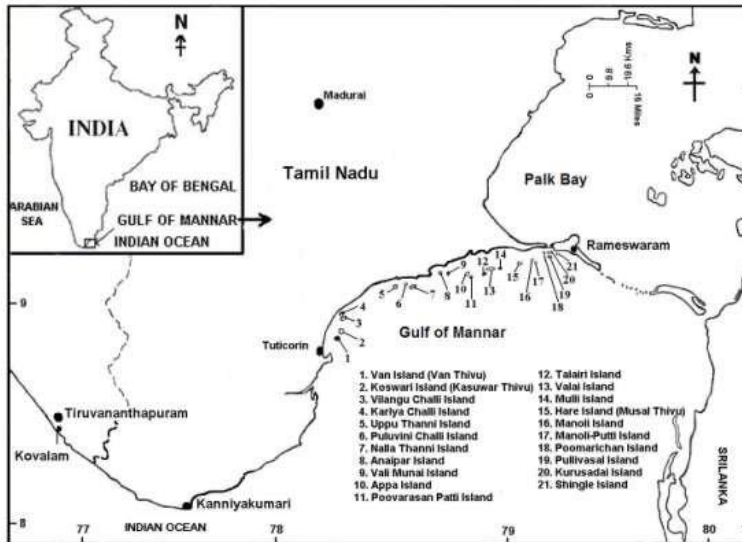
Islands such as Mandapam, Keezhkkarai and Vembar group of Islands, and hence the present study was carried out.

### 1.1 Study Area

**Gulf of mannar marine biosphere reserve:** Gulf of Mannar Biosphere Reserve extends from Rameswaram island to Tuticorin and lies between 8° 45'N - 9° 25'N and 78° 5' E - 79° 30'E, extends to a distance of 140 km. There are 21 islands running almost parallel to the coastline of Mannar. These islands lies between 8° 47' N - 9°15'N and 78° 12'E - 79° 14' E. These islands are situated at an average distance of about 8km from the coastline of Gulf of Mannar. It is bounded by Palk Bay, Rameshwaram island in the north side; by Ramanathapuram district in the northwest and west Tuticorin district in the south and by Bay of Bengal in the east (Fig. 1). It is endowed with three distinct ecosystems namely corals, sea grass and mangroves.

## 2. MATERIALS AND METHODS

The sediment samples were collected during December 2021 and 2022 in 12 Islands of Gulf of Mannar Biosphere Reserve. Each sampling sites were fixed at a distance of 500 metres to 1.5 km intervals from each other. In the case of larger areas, more sampling was plotted for collection. A total of 66 sediment samples were collected at water depth ranging from 1.0 – 2.0 m. Spatula and PVC corer was used for sediment collection and stored in clean bottles made from plastic secured with a screw topped lids. It was preserved immediately in 10% neutralized formaldehyde solutions and were labelled for further processing. Sorting and separating of foraminifera using Jayant make test sieves (120um) with ASTM 120, 230. Three grams of specimens were transferred in petty dish for identification of specimens using Magnus binocular microscope. Further, sorting species were done through handpicking using OO Windsor Newton sable hair brush and later transferred to single round one concavity micro slides with cover slips. Identification of specimens and photographs of different views of all the foraminifera species obtained through using *Leica DM 3000* compound microscope. The benthic foraminifera listed and described here are identified mainly based on the descriptions given by [14] for supra generic level. Other references are [15,16,17,18,19,20,21, 22,23,24,25,26].



**Map 1. The study area and surveyed localities**

1. Shingle 2. Krusadai 3. Manoli 4. Manolipputti 5. Pullivasal 6. Poomarichan 7. Hare 8. Appa 9. Anaippar 10. Thalayari 11. Vallimunai 12. Nallathanni

### 3. RESULTS

A total of 36 species belongs to 4 order, 13 family has been identified from twelve Islands of Gulf of Mannar during the study period. Highest number of species was identified in Manoliputti Island (29) followed by Anaippar (24), Manoli and Pullivasal (22) Island. Least number (07) of species was recorded in Thalayari Island followed by Shingle (06) Island (Table 1, Fig. 2). Three species namely *Ammonia beccarii*, *Elphidium crispum* and *Neorotalia calcar* were found almost all Island. Some species like *Operculina granulosa*, *Monalysidium confuse*, *Oolina laevigata*, and *Operculina ammonoides* were found particularly in Kurusadai, Manoliputti and Pullivasal Islands respectively. Few species like *Asterorotalia pulchella*, *Bolivina striatula*, *Cymbaloporeta bradyi*, and *Millettiana millettii* were found in two Islands Pullivasal Poomarichan, and Anaipar islands respectively. Detailed taxonomical descriptions all identified species are given below.

#### 3.1 Systematic Classification

**Phylum:** Foraminifera  
**Class:** Globobulimina  
**Order:** Rotaliida  
**Family:** Ammonitidae  
**Genus:** Ammonia

##### 1. *Ammonia beccarii* Linnaeus, 1758. (Plate 1, Fig. 1)

*Materials examined:* 1ex. Manoliputti, 11.xii.21, P. Padmanaban & party.

*Description:* Test calcareous, biconvex. Chambers on the dorsal sides are slightly higher than broad and gradually increase in size, surface smooth 11-13 chambers inflated, sub globular involuted on the umbilical side aperture extra umbilical, arch shaped opening present.

*Distribution:* East and West Coast, Andaman & Nicobar and Lakshadweep Islands.

##### 2. *Ammonia parkinsoniana* (d'Orbigny, 1839) (Plate 1, Fig. 2)

*Materials examined:* 3ex. Pullivasal, 10.xii.21, P. Padmanaban & party, 23 exs., Krusadai 9.xii.21, P. Padmanaban & party.

*Description:* Test small, circular, spiral side convex, triangular on the umbilical side,

periphery broadly rounded wall chambers calcareous, perforate, chambers sub globular inflated on the spiral side, triangular on the umbilical side, umbilical deeply sutured with a calcitic knob present.

*Distribution:* East and West Coast.

##### 3. *Ammonia tepida* (Cushman, 1926) (Plate 1, Fig. 3)

*Materials examined:* 14 exs., Krusadai 9.xii.21, P. Padmanaban & party.

*Description:* Test small, low trochospiral with 2-3 volutions spiral side convex, evolute umbilical side concave, involute, chambers inflated 67 in the last whorl, umbilical deep nearly filled with tubercles, slightly depressed on the spiral side, radial and more depressed on the umbilical side, umbilical plug missing, aperture terminal and arch like opening.

*Distribution:* India. GoMBR, Elsewhere: East and West Coast

#### Genus: Asterorotalia

##### 4. *Asterorotalia pulchella* (d'Orbigny, 1839) (Plate 1, Fig. 4)

*Materials examined :* 2 exs., Manoliputti, 11.xii.21., P. Padmanaban & party, 3 exs., 10.xii.21., Pullivasal, P. Padmanaban & party

*Description:* Test small, outline triangular, wall calcareous nearly triangular, wall calcareous, perforate with knobs, pustules and ridges; chambers many, gradually increasing in size as added; periphery with imperforate keel and long triradiate spines, sutures nearly straight, raised and limbate on the dorsal side, radial and slightly curved on the ventral side; aperture an equatorial, terminal, ovate opening on the apertural side.

*Distribution:* India. GoMBR, Elsewhere: East and West Coast

#### Family: Bolivinitidae Genus: Bolivina

##### 5. *Bolivina striatula* Cushman, 1922 (Plate 4, Fig. 19.)

*Materials examined :* 8 exs., Pullivasal, 10.xii.21., P. Padmanaban & party.

*Description:* Test elongate, wall calcareous, chambers numerous, biserially arranged, distinct, slightly inflated, sutures very slightly depressed, final chambers smooth, hardly punctate, aperture on elongated opening, narrow at the base and broad in the upper portion, long slit like opening, bordered by a thick rim, with a tooth.

*Distribution:* East and West Coast, Andaman & Nicobar and Lakshadweep Islands.

**Genus: Loxostomina**

*Materials examined :* 7exs. Manoliputti, 11.xii.21, P. Padmanaban & party.

**6. Loxostomina limbata (Brady,1881)**

*Description:* Test elongate, compressed, lobulate, initial end rounded and occasionally produced, sutures thickened and limbate, early biserial chambers ornamented by a few strong costae, aperture terminal, surrounded by a thickened lip, tooth plate at the top and base of the opening.

*Distribution :* East and West Coast, Andaman & Nicobar and Lakshadweep Islands.

**Family: Cymbaloporidae**

**Genus : Cymbaloporetta**

**7. Cymbaloporetta bradyi (Cushman,1915) (Plate 2, Fig.11)**

*Materials examined :* 1 ex., Krusadai 9.xii.21, P. Padmanaban & party.

*Description:* Low trochospiral test, slightly convex on the spiral side, peripheral margin rounded, chambers subglobular on the dorsal side, subtriangular on the ventral side and chambers appearing long and thin, sutures distinct, slightly depressed apertures three, two sutural and umbilical opening.

*Distribution:* East and West Coast, and Lakshadweep Islands.

**Genus: Millettiana**

**8. Millettiana millettii Heron-Allen & Earland,1915 (Plate 2, Fig.12)**

*Materials examined :* 10 exs. Manoliputti, 11.xii.21., P. Padmanaban & party.

*Description:* Test trochospiral and planoconvex in the early stage chambers, it is broad in the

early stage and become crescent in later stage. Wall coarsely perforate on the spiral side, umbilical side imperforate with radial sutures. Later chambers added as cyclic arrangement, mushroom-shaped in umbilical side, vermicular ridges and irregularly positioned holes easily distinguish.

*Distribution:* East and West Coast, Andaman & Nicobar and Lakshadweep Islands.

**Family: Nummilitidae**

**Genus : Operculina**

**9. Operculina granulosa Leymerie, 1846**

*Materials examined :* 1 ex., Krusadai 9.xii.21, P. Padmanaban & party.

*Description:* Test large, compressed, wall calcareous, surface ornamented with more tubercles in the centre, final whorls sparsely covered by pustules, chambers narrow, coiling evolute, periphery with a distinct keel, sutures marked with pustules aperture terminal, at the base of the apertural face.

*Distribution:* East and West Coast.

**Family: Elphidiidae**

**Genus: Elphidium**

**10. Elphidium advena (Cushman,1922) (Plate 2, Fig.7)**

*Materials examined :* 2 exs., Manoliputti, 11.xii.21., P. Padmanaban & party.

*Description:* Test small, rounded, laterally slightly compressed test is planispiral involute and has a small umbo on either side. About 12-13 chambers of the last whorl are gradually increase in size. Distinct sutures are slightly raised, slightly curved back and have about 7-8 retral processes. Acute periphery is carinate and lobulate in the latter part of the test. Wall is finely perforate, calcareous, translucent and smooth excepting the tetral processes. Aperture consists of a few minute openings at the base of the sub triangular apertural face.

*Distribution:* East and West Coast, Andaman & Nicobar and Lakshadweep Islands.

**11. Elphidium crispum (Linnaeus, 1758) (Plate 2, Fig.8)**

*Materials examined :* 14 exs., Krusadai, 9.xii.21, P. Padmanaban & party.66 exs., Manoliputti,

11.xii.21., P. Padmanaban & party, 14 exs.  
Poomarichan, 10.12.21, P. Padmanaban & party

*Description:* Test is biconvex large, planispiral, involute, ornamented with small pustules in the apertural region 18 20 chambers final whorl is found to gradually increase in size, wall is calcareous perforate with smooth but the retral process, sutures strongly curved backwards, a series of openings at the base of the subtriangular apertural face.

*Distribution:* East and West Coast, Andaman & Nicobar and Lakshadweep Islands.

**Family: Globigerinidae**  
**Genus: Trilobatus**

**12. *Trilobatus sacculifer* (Brady,1877) (Plate 2, Fig.9)**

*Materials examined :* 3 exs., Manoliputti, 11.xii.21., P. Padmanaban & party.

*Description:* Test subglobular, wall perforate, surface smooth with spines, chambers spherical, gradually increasing in size as added, chamber arrangement trochospiral, periphery rounded, sutures distinct and depressed, aperture high arch, umbilical interio marginal.

*Distribution:* East and West Coast, Andaman & Nicobar and Lakshadweep Islands.

**Genus: Turborotalita**

**13. *Turborotalita quinqueloba* (Natland,1938) (Plate 2, Fig.10)**

*Materials examined :* 14 exs., Krusadai, 9.xii.21, P. Padmanaban & party.

*Description:* Test small, evolute, wall moderately agglunate, surface rough, chambers trochospirally arranged gradually increase in size as added, periphery rounded, sutures radial and depressed, aperture interio marginal.

*Distribution:* East and West Coast, Andaman & Nicobar and Lakshadweep Islands.

**Genus: Globorotalia**

**14. *Globorotalia cultrata* (d'Orbigny,1839) (Plate 3, Fig. 15)**

*Materials examined:* 5exs., Manoliputti, 11.xii.21., P. Padmanaban & party.

*Description:* Test broad, biconvex, wall calcareous, perforate, surface smooth, chambers nearly flat, subrounded on the spiral side, more inflated, subtriangular on the umbilical side, rapidly increasing in size as added, chamber arrangement trochospiral, periphery keeled, sutures arcuate on the spiral side, radial on the umbilical side, aperture interio marginal, umbilical, low arched, with a platelike tooth.

*Distribution:* East and West Coast.

**Family: Calcarinidae**  
**Genus: Neorotalia**

**15. *Neorotalia calcar* (d Orbigny in Deshayes,1830) (Plate 1, Fig.5)**

*Materials examined :* 3 exs., Krusadai, 9.xii.21, P. Padmanaban & party.05 exs., Manoliputti, 11.xii.21., P. Padmanaban & party, 03 exs. Poomarichan, 10.12.21, P. Padmanaban & party 13 exs. Anaipar, 24.12.22, P. Padmanaban & party.

*Description:* Test trochospiral, biconvex, spiral side evolute, umbilical side involute, 10 12 chambers in the last whorl periphery stellate, angular, star shaped spines, umbilicus filled with umbilicus fluid a low arch on the umbilical face with a lip a low arch and supplementary apertures at the periphery, also with a pustulate lip.

*Distribution:* East and West Coast, Andaman & Nicobar and Lakshadweep Islands.

**16. *Pararotalia calcariformata* Mc Culloch,1977 (Plate 1, Fig.6)**

*Materials examined :* 2 exs., Krusadai, 9.xii.21, P. Padmanaban & party. 12 exs., Manoliputti, 11.xii.21., P. Padmanaban & party.

*Description:* Test rounded biconvex, umbilicus with a plug, wall calcareous, perforate on both sides thin spines present at the chamber apexes; chambers slightly convex and involute on the ventral side, hyaline spine at the upper end of each side, broad and radiate on umbilical side.

*Distribution:* East and West Coast, Andaman & Nicobar and Lakshadweep Islands.

**Family: Nonionidae**  
**Genus: Nonion**

**17. *Nonion boueanum* (d'Orbigny, 1846)**

*Materials examined:* 2 exs., Krusadai, 9.xii.21, P. Padmanaban & party.05 exs., Manoliputti,

11.xii.21., P. Padmanaban & party, 3 exs. Anaipar, 24.12.22, P. Padmanaban & party

*Description:* Broadening towards the umbilici, periphery rounded, sutures slightly depressed, apertural face broadly rounded, depressed umbilical area often filled with secondary material, wall smooth, very finely perforate, aperture on equational slit at the base of the last-formed chamber.

*Distribution:* East and West Coast, Andaman & Nicobar and Lakshadweep Islands

### 18. *Nonion commune* (d'Orbigny, 1846)

*Materials examined:* 4 exs., Krusadai, 9.xii.21, P. Padmanaban & party. 9 exs., Manoliputti, 11.xii.21., P. Padmanaban & party, 01 exs. Poomarichan, 10.12.21, P. Padmanaban & party

*Description:* Test elongate -ovate, compressed, umbilical area depressed, wall calcareous, finely perforate, surface smooth, umbilicus, apertural side and to a very little extent along the sutures granulated, chambers distinct, slightly inflated, increasing in size as added, final chamber elongate, periphery subacutely rounded, sutures distinct, compressed, aperture opening at the base of the long apertural face.

*Distribution:* East and West Coast.

**Genus: Nonionellina**

### 19. *Nonionellina labradorica* (Dawson, 1860)

*Materials examined:* 3 exs., Krusadai, 9.xii.21, P. Padmanaban & party. 03 exs. Poomarichan, 10.12.21, P. Padmanaban & party, 6 exs. Anaipar, 24.12.22, P. Padmanaban & party

*Description:* Test small, symmetrical, wall calcareous, finely perforate, surface smooth, granular pustules along the sutures, apertural side and the umbilicus, chambers few, rapidly increasing in size, planispirally arranged, coiling involute, broadly triangular apertural face.

*Distribution:* India. GoMBR, Elsewhere: East and West Coast

### 20. *Operculina ammonoides* (Gronovius, 1781)

*Materials examined:* 3 exs., Krusadai, 9.xii.21, P. Padmanaban & party, 2 exs., Manoliputti, 11.xii.21., P. Padmanaban & party,

*Description:* Test large, compressed, planispiral, surface wall ornamented tubercles slightly raised in the umbilical area, chambers flat, curved, not divided, irregular in size, shape and number, sutures raised with pustules, apertural face concealed under a mask structure.

*Distribution:* India. GoMBR, Elsewhere: East and West Coast

**Class: Tubothalamea**

**Order: Miliolida**

**Family: Soritidae**

**Genus: Amphisorus**

### 21. *Amphisorus hemprichii* Ehrenberg, 1839

*Materials examined:* 1 ex., Krusadai, 9.xii.21, P. Padmanaban & party. 4 exs., Manoliputti, 11.xii.21., P. Padmanaban & party,

*Description:* Test discoidal biplane, chambers annular, palnispiral with about six undivided chambers and up to ten additional spiral chambers subdivided by septula before becoming annular, aperture of numerous slits on the peripheral margin, elongated across the margin, and aligned in two alternating rows.

*Distribution:* India. GoMBR, Elsewhere: East and West Coast

**Genus: Sorities**

### 22. *Sorites orbiculus* (Forsskål in Niebuhr, 1775) (Plate 4, Fig. 22)

*Materials examined :* 1 exs., Krusadai, 9.xii.21, P. Padmanaban & party. 11 exs., Manoliputti, 11.xii.21., P. Padmanaban & party, 02 exs. Poomarichan, 10.12.21, P. Padmanaban & party,

*Description:* Test discoidal biplane, thin, chamberlets adding in annular, concentric pattern adding in annular, giving the sutures a characteristic scalloped appearance, wall smooth, apertures ovate or 8-shape, bordered with a small rim, usually one on each side of the chamberlets positioned in a medial row on the peripheral margin.

*Distribution:* East and West Coast, Andaman & Nicobar and Lakshadweep Islands.

**Family: Milliamminidae**

**Genus: Miliammina**

### 23. *Miliammina fusca* (Brady, 1870)

*Materials examined:* 10 exs. Anaipar, 24.12.22, P. Padmanaban & party,



*Description:* Test with a quinqueloculine arrangement, elongate and ovate in section, with a rough surface, wall composed of well sorted agglutinated grains aperture terminal, ovate with a simple tooth.

*Distribution:* East and West Coast, Andaman & Nicobar and Lakshadweep Islands.

**Order: Soritida**  
**Family: Peneroplidae**  
**Genus: Peneroplis**

**24. *Peneroplis pertusus* (Forsskal in Niebhur,1775) (Plate 4, Fig. 23)**

*Materials examined* : 30 exs., Manoliputti, 11.xii.21., P. Padmanaban & party. 8 exs. Anaipar, 24.12.22, P. Padmanaban & party

*Description:* Highly variable, morphology characterized by a compressed, wall porcelaneous, biconvex, chambers many, initially planispiral coil, later uniserially arranged, fan-shaped, aperture multiple, terminal, irregular slits in juveniles, a row of rectangular openings in adults.

*Distribution:* East and West Coast, Andaman & Nicobar and Lakshadweep Islands.

**25. *Peneroplis planatus* (Fichtel & Moll, 1798) (Plate 4, Fig. 24 )**

*Materials examined* : 11 exs., Manoliputti, 11.xii.21., P. Padmanaban & party. 2 exs. Anaipar, 24.12.22, P. Padmanaban & party

*Description:* Test flat, early stage planispiral and involute last whorl fanning out, chambers radially increasing in width with nearly constant height, surface ornamented with numerous grooves placed at right angles to the sutures, umbilical region depressed, aperture a linear arrangement of irregularly oval openings.

*Distribution:* East and West Coast, Andaman & Nicobar and Lakshadweep Islands.

**Genus: Monalysidium**

**26. *Monalysidium confusa* (McCulloch,1977) (Plate 3, Fig. 17)**

*Materials examined* : 3 exs., Manoliputti, 11.xii.21., P. Padmanaban & party.

*Description:* Test robust, compressed, wall calcareous, planispirally enrolled and involute in the early stages, later uncoiled; surface ornamented with faint ribs, pitted in regular rows, aperture areal, centred, with a prominent lip, with teeth.

*Distribution:* East and West Coast.

**Family: Hauerinidae**  
**Genus: Quinqueloculina**

**27. *Quinqueloculina laevigata* d'Orbigny, 1839**

*Materials examined* : 2 exs., Krusadai, 9.xii.21, P. Padmanaban & party.03 exs., Manoliputti, 11.xii.21., P. Padmanaban & party, 04 exs. Poomarichan, 10.12.21, P. Padmanaban & party2 exs. Anaipar, 24.12.22, P. Padmanaban & party

*Description:* Uncommon, epifaunal, sometimes free or cling to plants or sediments, herbivore. Test elongate, convex on spiral side, wall calcareous, imperforate, surface with many visible striations, periphery carinate, sutures visible although often obscured by the arenaceous material, aperture terminal, long neck with bifid tooth.

*Distribution:* East and West Coast, Andaman & Nicobar and Lakshadweep Islands.

**28. *Quinqueloculina lamarckiana* d'Orbigny, 1839**

*Materials examined* : 2 exs., Krusadai, 9.xii.21, P. Padmanaban & party.03 exs., Manoliputti, 11.xii.21., P. Padmanaban & party,

*Description:* Test broadly oval, at the sides, apertural view triangular, wall calcareous, surface smooth, chambers visible, arrangement quinqueloculine sutures are arcuate, distinct and deressed, aperture terminal, subcircular at the end slightly produced neck, bordered by rim with a simple tooth which may protrude slightly above the periphery.

*Distribution:* East and West Coast and Lakshadweep Islands.

**29. *Quinqueloculina seminulum* (Linnaeus,1758) (Plate 4, Fig. 20)**

*Materials examined* : 2 exs., Krusadai, 9.xii.21, P. Padmanaban & party.03 exs., Manoliputti, 11.xii.21., P. Padmanaban & party.



*Description:* Test small, elongate suboval, 2 times as long as broad, rounded chambers visible, chamber arrangement quinaeloculine, ovate in lateral view, wall is smooth, broadly rounded periphery, sutures distinct, slightly depressed, aperture terminal, sub rounded, thickened rim but no lip.

*Distribution:* East and West Coast, Andaman & Nicobar and Lakshadweep Islands.

**Family: Spiroloculinidae**

**Genus: Spiroloculina**

**30. Spiroloculina angulata Cushman, 1917 (Plate 3, Fig. 18)**

*Materials examined :* 12 exs., Krusadai, 9.xii.21, P. Padmanaban & party. 03 exs., Manoliputti, 11.xii.21., P. Padmanaban & party.

*Description:* Test elongate, elliptical in lateral view, both ends of the chambers projecting, chambers angular in cross section, surface ornamented by longitudinal costae extending from the aboral end to the aperture, aperture terminal, produced on a cylindrical neck with a thin peristomal rim and small tooth, with bifid lip.

*Distribution:* East and West Coast and Lakshadweep Islands.

**31. Spiroloculina communis Cushman and Todd, 1944 (Plate 3, Fig. 14)**

*Materials examined :* 6 exs., Krusadai, 9.xii.21, P. Padmanaban & party. 5 exs., Manoliputti, 11.xii.21., P. Padmanaban & party.

*Description:* Test strongly built, ovate biconcave, wall porcelaneous, imperforate, surface smooth, carinated in earlier chambers, sutures thin, distinct and slightly depressed, aperture circular, produced on a cylindrical neck, bordered by a lip, with two teeth placed opposite to each other

*Distribution:* East and West Coast.

**32. Spiroloculina depressa d'Orbigny, 1826 (Plate 3, Fig. 16)**

*Materials examined :* 8 exs., Manoliputti, 11.xii.21., P. Padmanaban & party, 04 exs. Poomarichan, 10.12.21, P. Padmanaban & party

*Description:* Test robust, surface smooth, wall porcelaneous, chambers arcuate, the periphery

flattened or even slightly convex, sutures distinct and very much depressed. Chambers with the periphery and the inner margin raised, wall smooth and dull, aperture nearly circular, at the end of the short neck, with a simple tooth.

*Distribution:* East and West Coast, Andaman & Nicobar and Lakshadweep Islands.

**33. Spiroloculina inflata Terquem 1882**

*Materials examined :* 2 exs., Krusadai, 9.xii.21, P. Padmanaban & party. 03 exs., Manoliputti, 11.xii.21., P. Padmanaban & party,

*Description:* Test robust, oval, wall porcelaneous, imperforate, surface rough due to minute depressions, chambers inflated, final chambers broader, rapidly increasing in size as added, periphery broadly rounded, depressed surface, distinct, aperture circular, end of the neck distinct rim, with simple bifid tooth.

*Distribution:* East and West Coast, Andaman & Nicobar and Lakshadweep Islands.

**34. Spiroloculina ornata Le Calvez, 1958**

*Materials examined :* 03 exs., Manoliputti, 11.xii.21., P. Padmanaban & party.

*Description:* Test elongate, ovate, chambers with angular shoulders between the peripheral and lateral walls, sutural gas at the base of each chamber, aperture circular at the end of a cylindrical neck with a slight lip and a small Y-shaped tooth.

*Distribution:* East and West Coast.

**Class: Nodosariata**

**Order: Polymorphinoidea**

**Family: Ellipsolagenidae**

**Genus: Oolina**

**35. Oolina baukalionilla Loeblich & Tappan, 1994.**

*Materials examined :* 01 exs., Manoliputti, 11.xii.21., P. Padmanaban & party, 04 exs. Poomarichan, 10.12.21, P. Padmanaban & party. 2 exs. Anaipar, 24.12.22, P. Padmanaban & party

*Description:* Test subcylindrical, surface ornamented with several costae, thin at the base of the test, thickening towards the apertural end and joining to form a smooth hyaline blunt flat apertural end, aperture very small, round in the center of a slightly depressed area.

*Distribution:* East and West Coast.

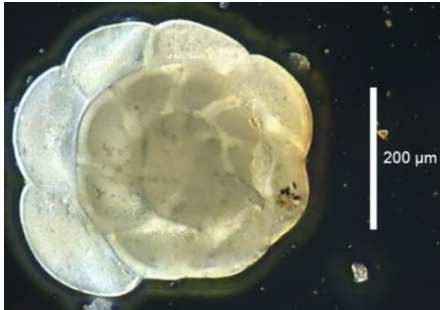
**36. *Oolina laevigata* (d'Orbigny, 1839) (Plate 3, Fig. 13)**

*Materials examined* : 1 exs., Manoliputti, 11.xii.21., P. Padmanaban & party, 2 exs. Anaipar, 24.12.22, P. Padmanaban & party

*Description:* Test globular, wall calcareous, hyaline, unilocular, surface ornamented with many long striae and an apical pseudospine, aperture crescent-like with polygonal corrugations at the base of a neck.

*Distribution:* East and West Coast.

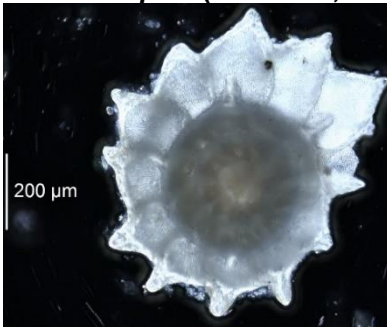
**Plate-1**



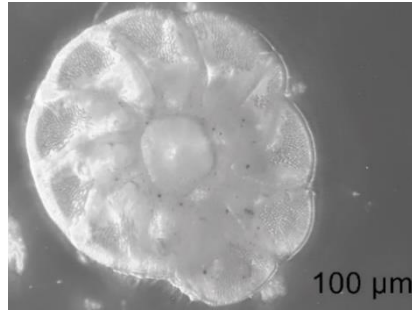
***Ammonia tepida* (Cushman, 1926)**



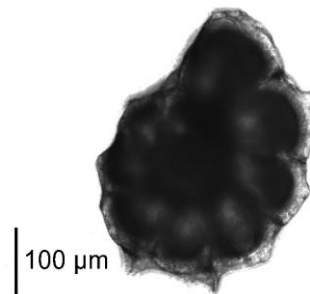
***Ammonia tepida* (Cushman, 1926)**



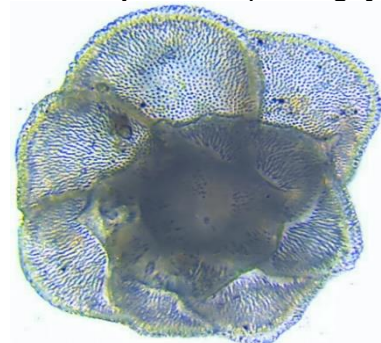
***Neorotalia calcar* (d'Orbigny in Deshayes)**



***Ammonia parkinsoniana* (d'Orbigny, 1839b)**

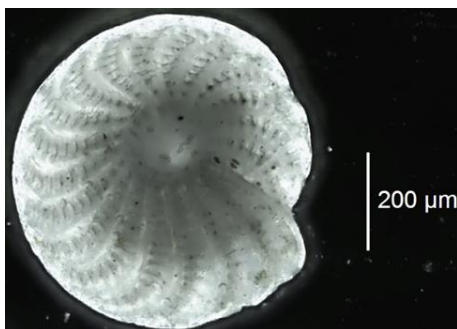


***Asterorotalia pulchella* (d'Orbigny, 1839)**

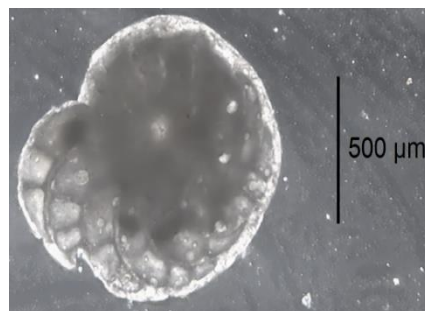


***Pararotalia calcariformata* McCulloch**

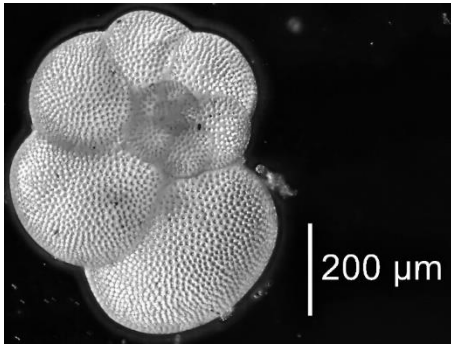
**Plate-2**



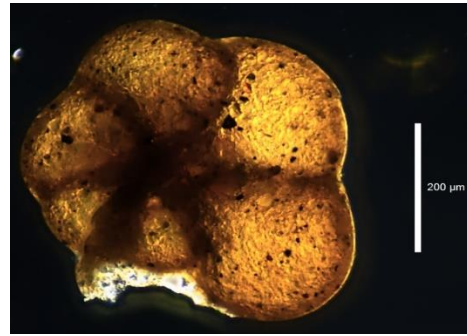
***Elphidium crispum* (Linnaeus, 1758)**



***Elphidium advena* (Cushman, 1922)**



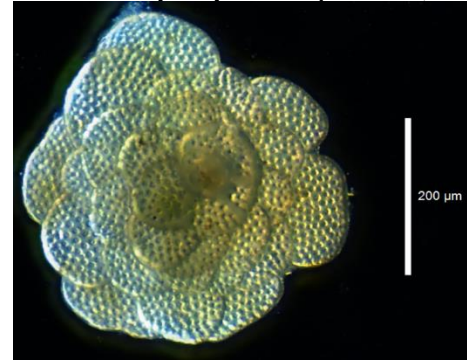
*Globigerinoides sacculifer* (Brady, 1877)



*Turbotalita quinqueloba* (Natland, 1938)

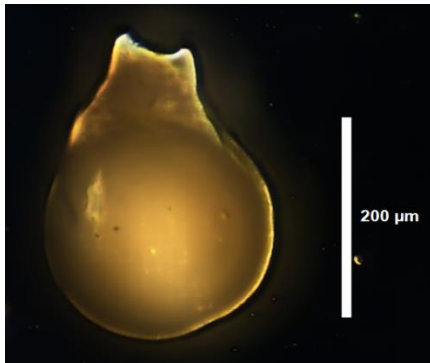


*Cymbaloporetta bradyi* (Cushman, 1915)



*Millettiana millettii* Heron-Allen &

Plate-3



*Oolina laevigata* d'Orbigny, 1839



*Spiroloculina communis* Cushman and Todd, 1944



*Globorotalia cultrata* (d'Orbigny, 1839)



*Spiroloculina depressa* d'Orbigny



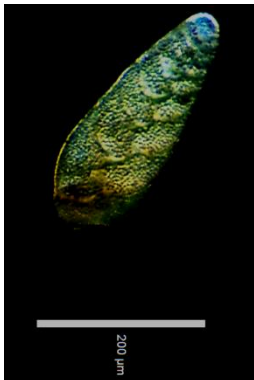


*Monalysidium confusa* (McCulloch, 1977)



*Spiroloculina antillarum* d'Orbigny, 1839

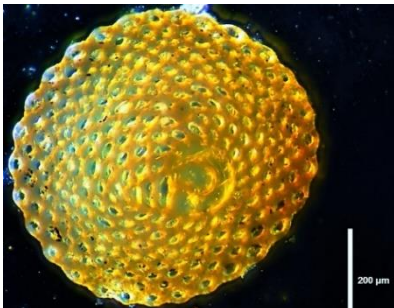
Plate-4



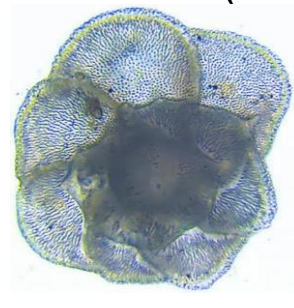
*Bolivina striatula* Cushman



*Quinqueloculina seminula* (Linnaeus, 1758)



*Sorties orbiculus* Forsskal in Niebuhr, 1775)



*Pararotalia calcariformata* McCulloch, 1977



*Peneroplis pertusus* (Forsskal in Niebuhr, 1775)



*Peneroplis planatus* (Fichtel & Moll, 1798)

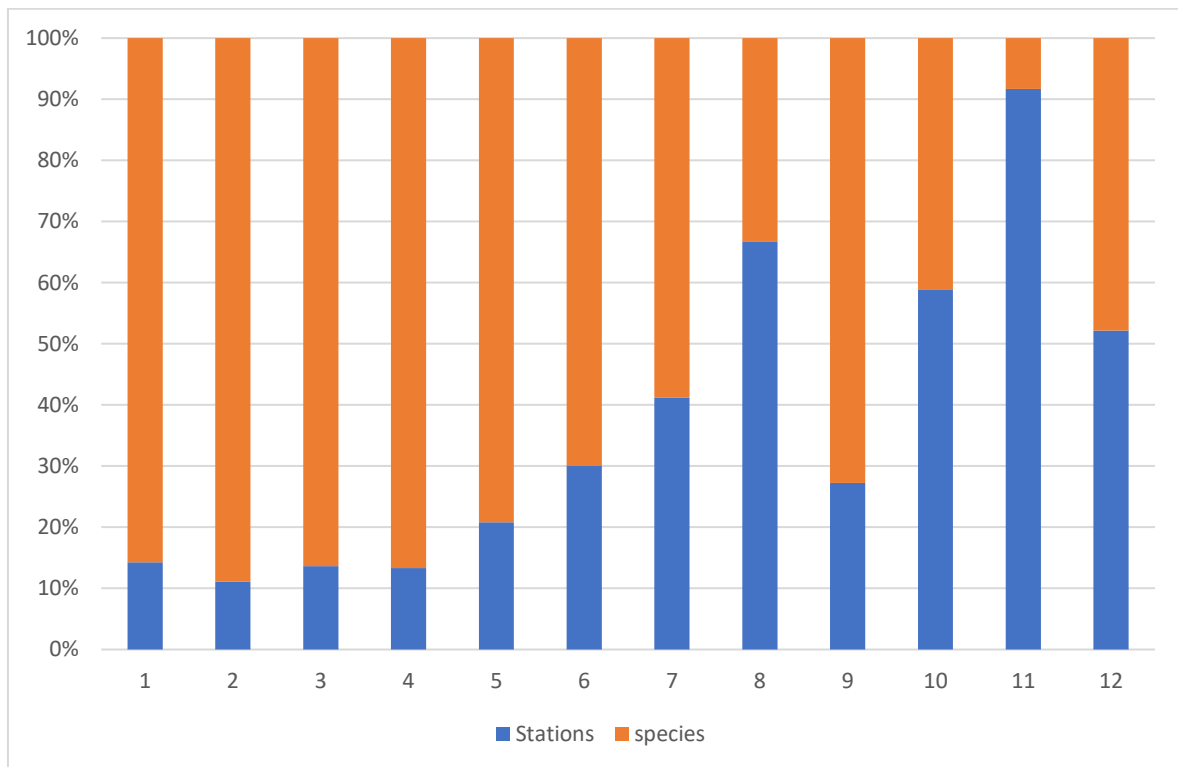
Plate 1-4. Benthic foraminifera of gulf of mannar

**Table 1. Distribution of benthic foraminifera species in different islands**

Sl.No	Name of the species	Localities											
		1	2	3	4	5	6	7	8	9	10	11	12
1.	<i>Ammonia beccarii</i>	*	*	*	*	*	-	*	*	*	*	-	*
2.	<i>Ammonia parkinsoniana</i>	*	*	*	*	*	*	-	-	*	-	-	*
3.	<i>Ammonia tepida</i>	-	*	*	*	*	-	*	*	-	*	*	-
4.	<i>Amphisorus hemprichii</i>	-	-	*	*	-	-	-	-	*	-	-	*
5.	<i>Sorites orbiculus</i>	-	*	*	*	*	-	*	*	-	-	-	-
6.	<i>Asterorotalia pulchella</i>	-	-	-	-	-	*	-	-	*	-	-	-
7.	<i>Bolivina striatula</i>	-	-	-	-	*	*	-	-	-	-	-	-
8.	<i>Cymbaloporeta bradyi</i>	-	*	-	-	-	-	-	-	*	-	-	-
9.	<i>Elphidium advenum</i>	-	*	*	-	*	*	*	-	*	*	-	*
10.	<i>Elphidium crispum</i>	*	*	*	*	*	*	*	-	*	*	-	*
11.	<i>Oerculina granulosa</i>	-	*	-	-	-	-	-	-	-	-	-	-
12.	<i>Trilobatus sacculifer</i>	-	-	*	*	-	-	-	-	*	-	-	-
13.	<i>Globorotalia cultrata</i>	-	-	*	*	*	-	-	-	*	*	-	-
14.	<i>Loxostomina limbata</i>	-	-	*	*	-	*	-	-	*	-	-	-
15.	<i>Miliammina fusca</i>	*	-	-	*	-	-	*	-	*	-	-	-
16.	<i>Millettiana millettii</i>	-	-	-	*	-	-	-	-	*	-	-	-
17.	<i>Monalysidium confusa</i>	-	-	-	*	-	-	-	-	-	-	-	-
18.	<i>Neorotalia calcar</i>	*	*	*	*	*	*	*	*	*	*	-	*
19.	<i>Nonion boueanum</i>	-	-	*	*	*	-	-	-	*	-	-	-
20.	<i>Nonion commune</i>	-	-	*	*	*	-	-	-	-	-	-	*
21.	<i>Nonionellina labradorica</i>	-	*	-	-	*	*	-	-	-	-	-	-
22.	<i>Oolina baukalionilla</i>	-	*	*	*	*	-	-	-	-	-	-	-
23.	<i>Oolina laevigata</i>	-	-	-	*	-	-	-	-	-	-	-	-
24.	<i>Operculina ammonoides</i>	-	-	-	-	*	-	-	-	-	-	-	-
25.	<i>Peneroplis pertusus</i>	-	-	*	*	-	-	*	-	*	-	-	*
26.	<i>Peneroplis planatus</i>	*	-	*	*	-	*	-	-	*	-	-	*
27.	<i>Quinqueloculina laevigata</i>	-	*	*	*	-	-	*	*	*	-	-	-
28.	<i>Quinqueloculina lamarckiana</i>	-	*	*	*	*	*	-	-	*	-	-	*
29.	<i>Quinqueloculina seminula</i>	-	*	*	*	*	*	-	-	*	*	-	-
30.	<i>Spiroloculina inflata</i>	-	*	*	*	*	-	-	-	-	-	-	-
31.	<i>Spiroloculina angulata</i>	-	*	-	*	*	*	-	-	*	-	-	-

SI.No	Name of the species	Localities											
		1	2	3	4	5	6	7	8	9	10	11	12
32.	<i>Spiroloculina communis</i>	-	*	-	*	-	*	-	-	-	*	-	-
33.	<i>Spiroloculina depressa</i>	-	-	-	*	*	-	-	-	*	-	-	*
34.	<i>Spiroloculina ornata var. tricarinata</i>	-	*	*	*	*	*	*	-	*	-	-	-
35.	<i>Turborotalita quinqueloba</i>	-	-	*	*	*	-	-	-	*	-	-	-
36.	<i>Pararotalia calcariformata</i>	-	*	-	*	*	-	*	-	*	-	-	-
<b>Total</b>		<b>6</b>	<b>19</b>	<b>22</b>	<b>29</b>	<b>22</b>	<b>14</b>	<b>11</b>	<b>5</b>	<b>24</b>	<b>07</b>	<b>01</b>	<b>11</b>

1.Shingle 2.Krusdai 3.Manoli 4. Manolipputti 5 Pullivasal 6. Poomarichan 7.Hare 8.Appa 9.Anaippar 10.Thalayari 11.Vaalimunai 12.Nallathanni



**Graph 1. Diversity of foraminifera species in different Islands.**

#### 4. DISCUSSION

Highest number (29) of species found in Manoliputti Island is due high diversity of corals and sea grass and single species is identified due to small size of the island and less biodiversity of organisms. A total of 169 species of foraminifera was recorded from Tuticorin group of Islands by Sheeba and Mohanraj[13]. But Babu et al. [12] reported 24 species of foraminifera from Vaan Island of Tuticorin. Lower no of species recorded during the present study might be due to lesser sample size, restricted locality and the winnowing action of the waves.

#### 5. CONCLUSION

It is clear from the present study that Manoli, Manoliputti, Kurusadai, Anaipar and Pullivasal Islands are the vital habitat in terms of diversity, richness and similarity. The benthic foraminiferal species around each of the twelve coral Islands in the Gulf of Mannar Biosphere Reserve are much more evenly distributed than in other islands probably an indicator of better ecological condition in the study area. A holistic approach is needed regarding soil texture and physico-chemical properties of soil and water shed more light on the diversity and distribution of foraminifera in GoMBR.

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Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.



## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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