PALEOCLIMATIC RECONSTRUCTION THROUGH THE STUDY OF FORAMINIFERA IN MARINE SEDIMENTS OFF CENTRAL WEST COAST OF INDIA

Thesis submitted

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DOCTOR OF PHILOSOPHY

in

Marine Sciences

by

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June 2005

To

The Almighty

STATEMENT

I, hereby state that the present thesis entitled ***"Paleoclimatic Reconstruction through the Study of Foraminifera in Marine Sediments off Central West Coast of India"*** is my original contribution and the same has not been submitted on any previous occasion. To the best of my knowledge, the present study is the first comprehensive work of its kind from the area mentioned.

The literature related to the problem investigated has been cited. Due acknowledgements have been made wherever facilities and suggestions have been availed of.

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CERTIFICATE

As required under the university ordinance O.19.8 (vi), I certify that the thesis entitled ***"Paleoclimatic Reconstruction through the Study of Foraminifera in Marine Sediments off Central West Coast of India"***, submitted by **Shri Abhijit Mazumder** for the award of the degree of Doctor of Philosophy in Marine Sciences is based on his original studies carried out by him under my supervision. The thesis or any part thereof has not been previously submitted for any other degree or diploma in any university or institution.

All suggestions are incorporated in this copy
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Research Guide

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PREFACE

In recent years, based on proxy indicators, the reconstruction of paleoclimate on geological and historical time scales have gained importance as they provide a background of natural climatic variability over which impact of human beings could be evaluated. Amongst several proxies used for paleoclimatic reconstruction, foraminifera have great potential as indicator of ancient climate due to their sensitivity towards environmental conditions and their widespread abundance in space and time. Earlier foraminiferal studies have demonstrated that the distribution of foraminifera is not random but is controlled by the environment around them. The mineralized shell of foraminifera sensitively records physico-chemical properties of the environment that can be utilized for paleoenvironmental and paleoclimatic reconstruction.

In India, particularly from the eastern Arabian Sea, most of the studies on benthic foraminifera document their distribution in coastal sediments. Realizing the necessity to create a database for the distribution of deep water benthic foraminifera as well as to strengthen the existing database for shallow water benthic species, the present study was carried out wherein the distribution of foraminifera was studied from a wide range of water depth varying from inner shelf to bathyal region (15 to 3300 m) off Goa, central west coast of India. One of the major applied objectives is to document the interrelationship between the Oxygen Minima Zone (OMZ) and benthic foraminifera and the variations in distribution and intensity of OMZ through time, which is hitherto not studied from this region in detail.

Layout of Thesis

The present study deals with **fundamental** and **applied aspects** of foraminifera. The **fundamental aspect** includes the identification, illustration, taxonomic and quantitative distribution of foraminifera in the surface as well as subsurface sediment samples, whereas the **applied aspects** deal with the paleoenvironmental significance of foraminifera in the study area.

The work carried out and presented in this thesis has been divided into eight chapters for practical convenience.

Chapter 1 deals with the general introduction of foraminifera, their habitat and utility in deciphering marine environment and paleoclimatic reconstruction. Besides these, review of previous work, selection of study area, objective and scope of the present study have also been discussed. In brief the main objectives of the present work are:

- to catalogue and illustrate the distribution of foraminiferal species from both the surface and sub-surface sediment samples
- to develop site-specific proxies to understand the relationship between foraminifera and the ambient environment, especially with the reference to OMZ
- to employ foraminiferal proxies to reconstruct paleoclimate
- to delineate major climatic events of the past

Chapter 2 presents the general physiographic and oceanographic conditions including geology of the hinterland, climate, oceanographic parameters of the Arabian Sea and sediment characteristics of the western continental margin of India in particular. This background information helps to understand the modern oceanographic conditions and their possible influence on foraminiferal distribution in surface sediments.

Chapter 3 provides a general insight into the methodology adopted for on board collection of samples and laboratory procedures. In all 52 surface sediment samples (core tops; *i.e.* 0-2 cm) and 112 subsurface samples from 10 spade core samples were collected off Goa from 15 m to 3300 m water depth during the *ORV Sagarkanya* SK-117 cruise. These samples were analyzed in the laboratory and a total of 51,158 including both benthic and planktic foraminifera were picked and identified. The benthic foraminifera were separated into relict and Recent for further counting and statistical work.

Chapter 4 deals with the fundamental approach; systematic taxonomy, which has always been of special interest to paleontologists and forms an important and major part of the paleontological study. In order to study the systematic taxonomy, the classification and the diversity of foraminifera has been documented. Hereafter, the different genera of foraminifera have been arranged according to the classification proposed in 'Foraminiferal Genera and Their Classification' by Loeblich and Tappan (1988) where in different species within a single genus are arranged alphabetically. Synonymies have been reduced greatly with only those references, which refer to an important shift in the generic name along with all possible references from the Indian waters. All species encountered during the study are photographed by using a digital camera and are illustrated in number of plates, while photographs of relict foraminifera and Recent *Ammolagena clavata* were obtained using a Scanning Electron Microscope.

Chapter 5 deals with the use of relict benthic foraminifera to reconstruct the paleoclimate of the early Holocene. Certain characteristics of relict foraminifera that were utilized for this purpose are:

(i) Coral reef-indicating assemblage

As *Amphistegina-Operculina-Alveolinella* assemblage indicates the presence of ancient (early Holocene) coral reef at the present-day water depth of 85-135 m, the paleoshoreline (of early Holocene) can be marked at the present-day water depth of 80 m, based on the present-day coral reef morphology.

(ii) Barnacle fouling of relict foraminifera

Abundant relict foraminiferal specimens have been encrusted with inter-tidal sessile cirripedes (barnacles) in a depth zone between 60 and 90 m. The encrustation of barnacles on the relict foraminiferal specimens provides supporting evidence to delineate paleoshoreline.

(iii) Presence of the genus *Textularia*

Abundance of *Textularia* at the depth of 50-75 m indicates the decrease in the salinity, most probably due to high influx of fresh water into the sea. The fresh water influx consequently led to an increase in the turbidity and sea level rise, which eventually destroyed the coral reef.

Chapter 6 presents the distribution of the Recent benthic foraminifera in surface sediment and its potentials as an indicator of OMZ of central west coast of India. This attempt is the first of its kind along west coast of India. As a result, it has been recorded that the rectilinear forms of benthic foraminifera show a positive relation with the increase of oxygen concentration in the prominent OMZ of eastern Arabian Sea extending between the depths of 150 and 1500 m. On the basis of this result, the presence of shallow water oxygen depletion zone (from 50 to 60 m) has also been marked by the higher abundance of the rectilinear forms.

Chapter 7 deals with the down-core variation of the benthic foraminiferal assemblages to reconstruct the paleoclimatic variations. The down-core variation of the rectilinear forms, both, in deep and shallow water indicates a significant change in the extent and intensity of OMZ. This might have been caused by the change in food supply, and hence the reproduction. The core from shallow water OMZ shows a higher abundance of rectilinear forms, continuously throughout the last ~1800 years, which suggests a natural cause for the generation of the OMZ at shallow water depth. Moreover, the increased abundance of rectilinear forms is co-relatable with the change in sea level along the west coast of India, which reveals that the sea level changes regulates the intensity of OMZ at both, the deep and shallow water depths.

Chapter 8 presents the summary and conclusions of the present study along with ideas for future follow-up studies. This chapter is followed by the alphabetical arrangement of all references cited in literature (in text, figures, tables, systematic taxonomy), and the plates along with their explanations. Lastly, the distribution charts of the benthic foraminifera from surface sediments are appended as annexure.

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CHAPTER 1
INTRODUCTION

1.1 GENERAL INTRODUCTION

The climate is the weather averaged over a long period of time. A popular saying is that "climate is what you expect, weather is what you get".

In a given geographical region, the climate generally does not vary much on the scale of a human life span. However, over geological time, climate for a given place on the Earth can vary considerably. Climatic changes are results of the changing energy balance on the Earth. The primary source of energy on the Earth is the solar insolation in the form of short waves that sustain most of the biological activity on Earth. A major part of this incident solar radiation is utilized in heating up the Earth and in turn the earth radiates back this energy in the form of long waves that are absorbed by the green house gases (water vapour, CO_2, Chloro-fluoro-carbons, CH_4 etc.). This process helps in keeping the Earth's surroundings warm and makes the Earth habitable for various organisms including human beings. This balance between incident solar radiation and the amount of green house gases is crucial for the survival of mankind as it has been suggested that any change in this balance can lead to unusually high or low atmospheric temperatures.

Industrialization and consumerism, primarily during the 20th century, are suggested to have disturbed this balance. The resultant imbalance has led to the threat of global warming and associated phenomena such as sea-level rise, changing monsoonal rainfall pattern, increased intensity and frequency of storms etc, constantly looming over our heads. All these changes are likely to affect life everywhere including that in the seas. It is these ubiquitous effects of changing climate that make it necessary to understand the interrelationship between various climatic parameters and predict imminent climatic changes.

Climatic models help to better understand the relationship between various climatic components as well as the likely future climatic changes. Training and testing of these climatic models require unraveling such variations in the past. Recently, Morais (2005) while highlighting the importance of paleoclimatic studies noted that, "Understanding global changes requires knowledge of the past in order to assess ongoing processes and feedbacks and the sensitivity of various parts of the ocean-atmosphere-land components, and to correctly estimate human impact on this system." He further stated that, "In essence, past natural experiments in the Earth System, like "messages in a bottle" of climate and hydrologic change preserved in ice cores, tree rings, lake and marine sediments, etc, allow scientists to test the reproducibility of various models to reconstruct past events."

In view of the foregoing it is necessary to reconstruct past climatic changes on both short as well as long time scales. Since the instrumental records or the direct observations of the past climatic changes are available only for the past century, we have to rely on various indirect methods called "proxies" to generate past climatic records going beyond the last century.

The literature survey indicates that among various proxies used for paleoclimatic reconstruction, marine microfossils, foraminifera, being very sensitive to climatic changes can be used as excellent proxies to study the paleoclimate and other related phenomena. Because of their characteristics, foraminifera have become an efficient source for many ongoing research projects including the present study. A brief introduction of foraminifers is given in the next section.

1.2 FORAMINIFERA

Foraminifera are almost exclusively marine microorganisms with a single cell enclosed in a hard protective cover called 'test'. Depending on their mode of life, foraminifera can be divided into two broad categories, viz. planktic, those floating in the water column, and benthic, the ones dwelling on the sea floor or upper few centimeters of the sediments. Foraminifera have a geological range from the earliest Cambrian to the present day. Foraminifera are classified primarily on the basis of the composition and morphology of the test. The generally accepted classification of the foraminifera is based on that of Loeblich and Tappan (1988). The Order Foraminiferida (informally foraminifera) belongs to the Kingdom Protista, Subkingdom Protozoa, Phylum Sarcomastigophora, Subphylum Sarcodina, Superclass Rhizopoda, Class Granuloreticulosea.

Foraminifera have been utilized for biostratigraphy for many years, and have also been proven invaluable in paleoceanographic and paleoclimatological reconstruction.

Benthic foraminifera, since they dwell on the sea floor, are good indicators of bottom water conditions. Changes in species diversity, planktic to benthic ratios, shell-type ratios and test morphology have all been utilized to for number of problems of modern environment like pollution monitoring, as well as interpretation of fossil records.

Benthic foraminifera have been divided into morphogroups based on the shape of their test. The temporal variation of these morphogroups have been used to infer palaeo-habitats and substrates; infaunal species tend to be elongated and streamlined in order to burrow into the substrate and epifaunal species tend to be more rounded with relatively flatter side in order to facilitate movement on the substrate. It is this presence of characterstic morphogroups under particular environments that has led to extensive application of foraminifers for paleoclimatic reconstruction studies in different parts of the world oceans including the Indian Ocean. In order to get an idea about the foraminiferal studies carried out so far from the northern Indian Ocean, a detailed literature review was carried out and has been summarized in the following section.

1.3 HISTORICAL RESUME

India is bestowed with a coastline of approximately 6000 km and with abundant foraminiferal occurrences throughout the region. Considerable amount of data has been generated on the surface and sub-surface distribution of foraminifers in the past years, studies based on which have proved the utility of foraminifers.

An immense quantum of work on foraminifera has been and is being carried out in Indian waters by various research institutions and universities. The foraminiferal studies from the Indian waters started with the pioneering work of Chapman (1895), Hofker (1927, 1930) and Stubbings (1939a,b). Since then many researchers have contributed towards foraminiferal studies from the Indian Ocean including beaches, estuaries, backwater, creeks, shelf, slope and deep-sea off east and west coasts of India. Sastry (1963) prepared an annotated bibliography of the foraminiferal work published during 1939-1962 from the Indian region. Later, Bandy *et al.* (1971) presented an overview of the foraminiferal research carried out in Indian Ocean. Setty (1979, 1982a) provided a brief historical resume of foraminiferal studies in Arabian Sea. Nigam and Khare (1995a) provided a critical review on recent foraminiferal studies carried out off the west coast of India. Lahiri and Goyal (1997) discussed some of the popular applications of foraminiferal studies. Chaturvedi (2001) also summarised publications on foraminifera from the Indian waters. Manifold increase has been noted on various aspects of foraminiferal studies in the Indian region, including basic and applied research and a number of papers have been published in various journals during the past few years. Indeed a critical review of foraminiferal study will not only help to synthesize the literature but will also be of immense use to counter check the repetition of work. This would guide researchers to decide upon the thrust areas so as to take up multidirectional approaches to solve various outstanding problems of (Paleo) climate, environment, ecology, sea level, pollution, etc.

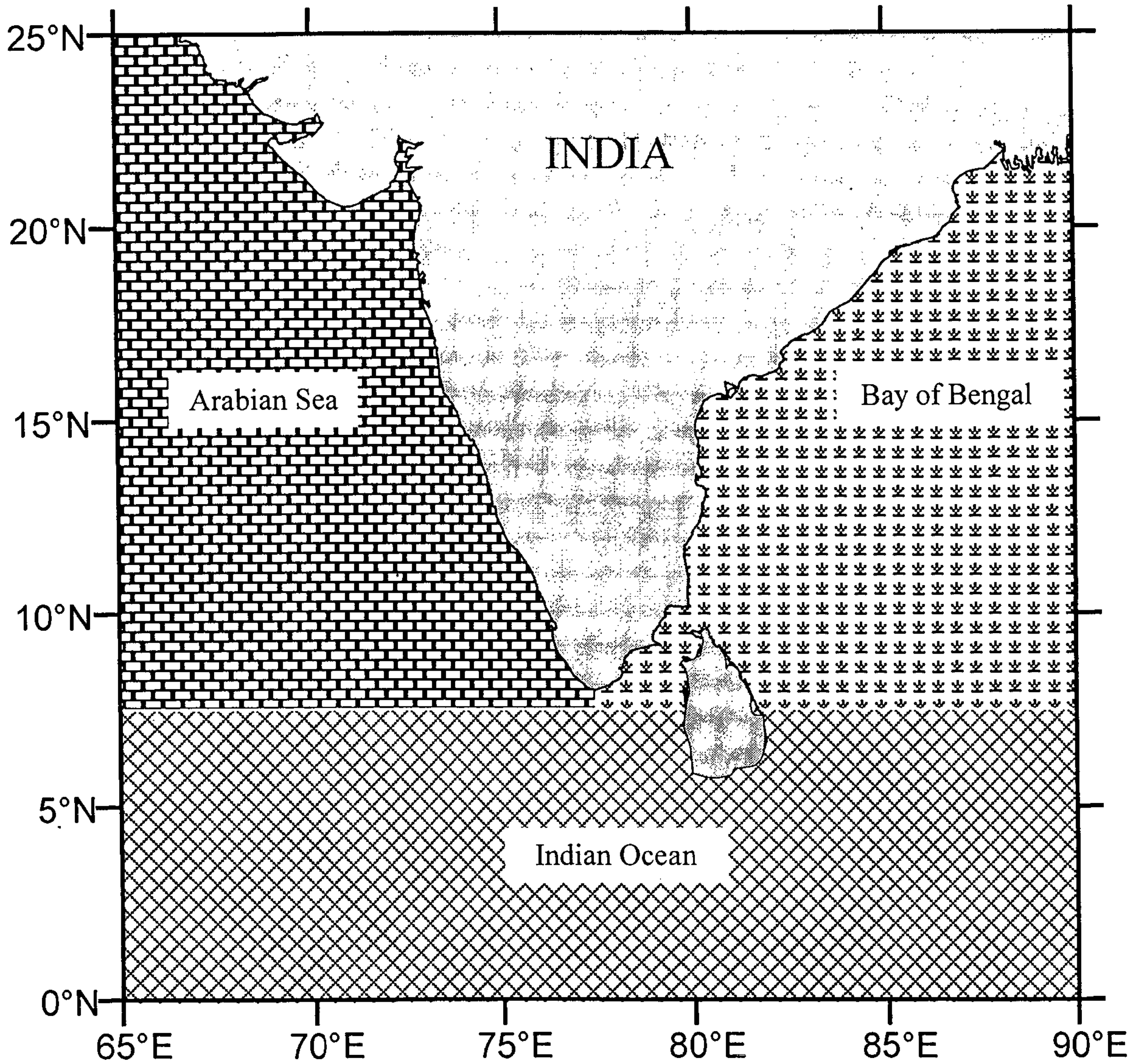


Figure 1.1 The regions for which the foraminiferal studies are summarised: Arabian Sea, Bay of Bengal and Indian Ocean

While summarizing, it is appropriate that studies be categorized under three broad headings, as per the geographic regions, viz. the Arabian Sea, the Bay of Bengal and the Indian Ocean as shown in figure 1.1. Efforts have been made to include all possible references on foraminifera from regions around India and emphasis has been given to major contributions. Tables 1.1a and 1.1b illustrate comprehensive summaries of the work carried out on the west coast of India (the Arabian Sea), whereas Tables 1.2a and 1.2b include the foraminiferal studies carried out on the east coast of India (the Bay of Bengal) while Table 1.3 contains review of the foraminiferal studies from the Indian Ocean.

1.3.1 FORAMINIFERAL STUDIES FROM THE ARABIAN SEA

One-tenth of the area of the Indian Ocean, which occupies nearly 7,50,000 km^2 in northwestern side of the ocean is named as the Arabian Sea. It is bounded to the west by the Arabia Peninsula and Africa, to the north by Iran and Pakistan, and to the east by India and Chagos-Laccadive Ridge. Towards south, it extends up to the Mascarene Plateau where it is open to the northern Indian Ocean. The major physiographic features of the Arabian Sea include the active Carlsberg Ridge, Owen Fracture Zone, Indus Fan, and the aseismic Laxmi, Chagos-Laccadive and Prathap Ridges. The literature review of foraminiferal studies on the west coast beaches / mud flats of India (Arabian Sea) are presented in Table 1.1a, whereas, the work carried out on western offshore regions of India are presented in Table 1.1b.

Table 1.1a Major work carried out on west coast beaches, estuaries and mudflats of India (Arabian Sea)

Sr.No	Year	Author	Area	Remarks
1	1954	Chaudhury & Biswas	Juhu Bombay	12 species of perforate foraminifera.
2	1956	Bhatia	Juhu, Bhogat & Chaupatty	Reported 46 species.
3	1960a	Sastry & Pant	Saurashtra	Investigated *Operculina* rich sand from the sub recent deposits.
4	1960b	Sastry & Pant	Saurashtra	Foraminifera from miliolitic limestone.
5	1964a	Rocha & Ubaldo	Diu, Gogola & Simbor	52 species were reported out of which 22 were already known from this area. The absence of agglutinated forms suggests low input of terrigenous sediment.
6	1964 b	Rocha & Ubaldo	Jampor and Baga (Goa)	24 species reported.
7	1972	Setty & Wagle	Goa coast	A brief list of foraminifera with other microfauna is given from beach rock.
8	1978	Jain & Bhatia	Mandvi, Kutch	37 species including one new species *Pararotalia boltovskoy*.
9	1979	Bhalla & Nigam	Calangute Goa	36 species identified. Fauna was compared with eastern beaches.

Table 1.1a (Contd.)

10	1980	Bhalla & Nigam	Calangute Goa	Planktic foraminifera and their paleoclimatic significance.
11	1980	Bhalla & Raghav	Malabar coast	Reported 25 species and suggested that salinity is the chief governing factor.
12	1982	Desai & Pandya	Saurashtra	Foraminifera of the coastline sediments.
13	1982	Desai & Shringarpure	Saurashtra	Used Recent foraminifera to study the impact of sedimentation on onshore environment.
14	1984	Badve *et al.*	Raigad district Maharashtra	A small portion foraminiferal content of beach rocks.
15	1984	Setty *et al.*	Miramar, Caranzalem	44 benthic and one planktic species of foraminifera from the intertidal area.
16	1984	Srivastava *et al.*	Veraval Saurashtra	26 species of benthic and one species of planktic foraminifera.
17	1985	Bhalla & Lal	Okha Gujarat	18 species of recent foraminifera, compared with the fauna of other beaches of west coast.
18	1985a	Pandya	Gujarat	Segment wise distribution is given which is controlled by various off shore and littoral processes.
19	1985b	Pandya	Saurashtra	95 species including 3 planktic, ecological control on the foraminiferal diversity.
20	1986	Bhalla & Nigam	Velsao Beach, Goa	Abnormal *Ammonia* as indicator of pollution
21	1987	Bhalla & Gaur	Colva, Goa	Detailed systematic study of 29 species.
22	1988	Bhalla & Nigam	West and east coast	Cluster analysis of published foraminiferal data from six beaches to study foramgeographical provinces.
23	1988	Shareef & Venkatachalapathy	Bhatkal & Devagad island	40 species from Bhatkal and 41 species from Devagad island, a checklist is provided.
24	1994	Talib & Farooqui	Dwarka Beach, Gujarat	Reported 26 species of benthic foraminifera.

Table 1.1a (Contd.)

25	1996a	Nigam *et al.*	Dias Beach, Goa	Studied the effect of different media, food, and antibiotic drug on *Rosalina leei* in the laboratory culture experiments.
26	1996b	Nigam *et al.*	Dias Beach, Goa	Laboratory culture experiments on *Rosalina leei* suggest Erdscheriber medium is conducive for general growth and chamber formation, food is also another governing factor.
27	1997	Raj & Chamyal	Mahi Valley, Gujarat	Based on foraminiferal studies concluded that sediments of Mahi Formation was deposited in an estuarine to marginal marine environment.
28	1998	Raj & Chamyal	Mahi Valley, Gujarat	Identified 25 genera of foraminifera from the mud unit of Mid to Late Holocene age.
29	2000	Kathal *et al.*	West and East coasts	Q-Mode cluster analysis of 160 foraminiferal species to separate two different foramgeographical realms for west and east coasts.
30	2002	Nigam *et al.*	Mandovi Estuary, Goa	Effect of Mining pollution on TFN from 10 surface samples.
31	2004	Saraswat *et al.*	Dias Beach, Goa	Effect of varying concentration of mercury on *Rosalina leei*
32	2005	Nigam *et al.*	Mandovi Estuary, Goa	Comparison of time series foraminiferal data, to infer mining impact.

Table 1.1b Major work carried out on western near shore and far off shore regions of India (Arabian Sea)

Sr. No.	Year	Author	Area	Remarks	Refer Fig. 1.2
1	1895	Chapman	Near Laccadive Island, Arabian Sea.	Foraminifera obtained by the Royal Indian Marine Survey *S.S. Investigator.*	f
2	1939a	Stubbings	Arabian Sea	Investigated the distribution of foraminifers of the Arabian Sea.	

Table 1.1b (Contd.)

3	1939b	Stubbings	Arabian Sea	Stratification of biological remains of marine deposits John Murray Expedition.	
4	1951	Kurian	Travancore coastal waters	Recorded presence of *Operculina granulose.*	e2
5	1953	Kurian	Travancore coastal waters	Recorded 22 species of foraminifera from bottom sediments.	e2
6	1958	Sethulekshmi Amma	Travancore coastal water	Described and sketched 114 species.	e2
7	1967	Chatterjee & Gururaja	Mangalore	Foraminifera comprises 90% of the assemblage, having 12 genera including one planktic form.	d2
8	1968	Antony	Kerala (Vizhingom to Cannanore)	Out of 164 species identified in surface sediments bathymetric distribution of few common species is given.	e3
9	1970a & b	Rao	Gulf of Cambay	Illustrated 84 species from four samples.	a3
10	1970c	Rao	North Eastern Arabian Sea	Rare species of *Triloculina echinata* d'Orbigny.	
11	1971a	Rao	Gulf of Cambay	Recent foraminifera with 16 figures.	a3
12	1971b	Rao	Saurashtra	Recent foraminifera from eight core top samples yielded 92 species.	a2
13	1971	Seibold	Cochin back waters	Sections and stereo-scan microphotographs revealed that only one species *Rotalia beccarii* var. *sobrina* is a true *Ammonia.*	e1
14	1971	Zobel	Arabian Sea	Planktic foraminifers and role of ocean water mass in their distribution.	
15	1972	Rao	Off Bombay	22 species of planktic foraminifera. Shows mixing of Antarctic water in this region.	b1
16	1972	Seibold	Cochin back waters	Report on the transport of foraminifera.	e1

Table 1.1b (Contd.)

17	1972	Setty	Shelf of Kerala	22 species of planktic foraminifera including *Globigerina hexagona* and *Globiquadrina conglomerata* which disappear from Atlantic are seen to be living today.	e3
18	1972	Setty & Guptha	Karwar and Mangalore	15 species of planktic foraminifera.	d1, d2
19	1972	Venkatachal-apathy & Shareef	Mangalore	Pyritization in certain foraminifera in recent sediments.	d2
20	1973a	Guptha	Kavaratti	20 species of benthic foraminifers.	f
21	1973b	Guptha	Shelf of Cochin	24 species of planktic foraminifers.	e1
22	1973	Rao	SE Arabian Sea	26 species of planktic foraminifers compared to Bay of Bengal, Arabian Sea has greater diversity of species which may be due to higher salinity in Arabian Sea.	
23	1973	Seibold & Seibold	Kerala shelf	A new species *Cassidella panikkeri.*	e3
24	1973	Setty	Western Shelf	Popular article on foraminifers as climatic indicators.	
25	1973	Zobel	Arabian Sea	24 sediment cores and 100 grab samples were studied to reconstruct the climatic conditions during late Quaternary.	
26	1974	Guptha	Continental slope off Bombay	25 species of planktic foraminifera.	b1
27	1974	Rao	Goa	Population of live foraminifera is poor in lower reach of Mandovi and Zuari estuaries.	c
28	1974	Setty	Kerala coast	32 species of recent benthic foraminifera including *Hyalinea balthica* from shelf sediments with a short account of important character of each species is recorded.	e3

Table 1.1b (Contd.)

29	1975	Antony	Kerala	Living *Ammonia beccarii* in the sediment of Kayamkulem lake.	e3
30	1975	Antony & Kurian	Vembanand estuary	*Ammonia beccarii* may cease to live in the estuaries.	
31	1975	Seibold	Cochin	Lagoon and coast of Cochin for benthic foraminifera, 69 species including one new species, more abundant forms of taxonomic /ecological interests are discussed.	e1
32	1975	Venkatachal-apathy & Shareef	West coast	Morphology, distribution and wall structure of *Ammonia beccarii.*	
33	1976	Bhatia & Kumar	Karwar	35 benthic species including *Caribeanella* species from Anjediv islands, Binge Bay.	d1
34	1976	Dalal	Goa	Statistical analysis of Rao's (1974) data.	c
35	1976 a	Setty	Goa	Foraminiferal response to the effect of industrial effluent in Cola Bay.	c
36	1976	Venkatachal-apathy & Shareef	Mangalore	Morphologic and micro structural characteristic feature of some smaller foraminifera.	d2
37	1978	Venkatachal-apathy & Shareef	Mangalore	Scanning electron microphotographs of Rotaliidae group.	d2
38	1979	Nigam *et al.*	Dabhol-Vengurla Sector	A checklist of 64 benthic foraminiferal species.	
39	1979	Rao & Rao	Trivandrum	85 species of foraminifera, 3 faunal grouping were recognised, solution effect on the test of foraminifera was observed near out fall area.	e2
40	1979	Setty *et al.*	Central west coast	Graphic pattern of eight foraminiferal dominant groups in near shore region.	
41	1980a	Antony	Kerala	Transport of inner shelf test in to lower estuary has been reported from Vembanand estuary.	e3

Table 1.1b (Contd.)

42	1980b	Antony	South west coast	17 species of living foraminifera in the intertidal area near Cochin.	
43	1980	Dalal	Goa	A statistical analysis of Rao's (1974) data.	c
44	1980	Nigam & Setty	Daman	Occurrence of Paleogene reworked foraminifera in recent sediments.	a4
45	1980a	Setty & Nigam	Western Continental margin	Observed eccentricity and twinning in *Virgulinella pertusa* (Reuss).	
46	1980b	Setty & Nigam	Dabhol-Vengurla	Distribution of 72 dead and 32 living benthic foraminiferal species within neritic regimes indicate the existence of microenvironment.	b4
47	1981	Nigam & Sarupria	Dabhol-Vengurla	Cluster analysis and ecology of living benthic foraminifera.	b4
48	1981	Seibold & Seibold	Cochin	Offshore to lagoonal benthic foraminifera, the distribution, transport and ecological aspects.	el
49	1982	Nigam & Setty	West coast	Distribution and ecology of *Virgulinella* species in inshore sediments, first report of *V. pertusa*.	
50	1982b	Setty	Bombay, Thane creek	Pollution shows pits and thinning of test wall of foraminifera.	b2
51	1982	Setty & Nigam	Western shelf	Relationship between foraminiferal assemblages and organic carbon.	
52	1983	Nigam & Thiede	Central west coast	Q-mode factor analysis of 72 species of recent foraminifera from the inner shelf revealed 4 assemblages which can be related to fresh water runoff and organic matter.	

Table 1.1b (Contd.)

53	1983	Setty	Western continental margin	The occurrence of *Globigerina bulloides* and the absence or irregular occurrence of *Globorotalia menardii* indicate upwelling in this region supported by benthic species.	
54	1983	Setty *et al.*	Bombay-Daman	An aberrant *Spiroloculina* species from recent sediments.	a4, b2
55	1984	Nigam	Gulf of Khambat	Response of living foraminifera in high tidal environment, a total of 60 species including 16 living.	a3
56	1984	Setty	Karwar	Larger foraminifera from the calcareous relict sediments invariably mixed with recent fauna.	d1
57	1984	Setty & Nigam	West coast	Foraminifera as indicator of pollution in marine environment of Thane creek, Cola Bay, Karwar and Trivandrum.	
58	1984	Sharma & Mishra	Arabian Sea	Occurrence of *Rotalia tinopsis seminulata* from the Pleistocene sediments.	
59	1985	Gare *et al.*	Coastal Maharashtra	Micro boring is studied on foraminiferal test from the Holocene deposits of Raigad district.	b3
60	1985	Guptha & Hashimi	North East Arabian Sea	28 species of planktic foraminifera in 74 cm long sediment core.	
61	1985	Rao *et al.*	Trivandrum	Frequency distribution of 52 species of Recent foraminifera, faunal trend in relation to pollution.	e2
62	1985	Setty	West coast	Planktic foraminifers are used to study climate control.	
63	1985	Setty & Nigam	Bombay	62 species of benthic foraminifera including 16 living, effects of river discharge is highlighted.	b2

Table 1.1b (Contd.)

64	1985	Srivastava *et al.*	Kavaratti island	Assemblages are dominated by hyaline forms with subsidiary porcellaneous and agglutinated taxa.	f
65	1985	Zhang	Eastern Arabian Sea	Seasonal and spatial distribution of living planktic foraminifera is governed by upwelling than by sea temperature and latitude.	
66	1986	Nigam	Navapur	Factor analysis of 60 species revealed 3 assemblages, developed a technique by comparing living and dead foraminifers for sediment movement.	
67	1987	Nigam	Vengurla-Bhatkal	Q-mode factor analysis of 102 species of benthic foraminifera revealed 6 assemblages.	
68	1987	Nigam & Rao	West coast	Mean proloculus size is inversely related to salinity and temperature in benthic foraminiferal species and can be used in paleoclimatic studies.	
69	1987	Rao *et al.*	Lakshadweep archipelago	107 species are reported.	f
70	1987a	Shareef & Venkatachal-apathy	Sunghiri Island, Karwar	12 agglutinated and 10 calcareous species of recent foraminifera.	d1
71	1987b	Shareef & Venkatachal-apathy	Karnataka	Litho and biostratigraphy of 25 boreholes, 90 species are grouped into three assemblages.	d1
72	1988a	Nigam	West coast	Reproductive behaviour of foraminifera as a new tool for reconstruction of paleoclimate.	
73	1988b	Nigam	Karwar	Foraminiferal variation in core from shelf region is used to decipher the monsoonal precipitation.	d1

Table 1.1b (Contd.)

74	1988c	Nigam	West coast	Influence of estuaries on shelf foraminiferal species (*C. annectens*) along Dabhol-Bhatkal sector.	
75	1988d	Nigam	Lothal	Utilised foraminifera to prove large rectangular structure at Lothal [a Harappan settlement] as a dockyard.	a3
76	1989	Naidu *et al.*	Southern Arabian Sea	Planktic foraminifers in deep sea core placed LGM at 165 cm. and below LGM 3 warm and 2 cold episodes are noticed.	
77	1989	Gupta & Bhattacharjee	Trivandrum & Cape Comorin	6 biofacies are delineated from east to west.	e2
78	1989a	Madabhusi	Outer shelf and upper slope Cochin	Based on benthic foraminifera paleoenvironment zones are distinguished.	e1
79	1989b	Madabhushi	Inner shelf Cannanore Calicut	Benthic foraminifera reflects variation in coastal geomorphic features.	e1
80	1989	Mathur & Gupta	Off Devgarh	Three major foraminiferal biofacies zone have been inferred, depth-wise distribution of benthic foraminifera is also discussed.	
81	1989	Nigam	Bombay - Ratnagiri	Benthic foraminifera from shelf region, their distribution, ecology and environmental significance.	b3
82	1989	Nigam & Nair	Karwar	Deciphered the cyclicity of 77 years in monsoons by using foraminifera as a tool.	d1
83	1989	Nigam & Rao	Karwar	Subsurface sediments showed an inverse relation between coiling direction and reproductive mode in benthic foraminifera (*C. annectens*).	d1

Table 1.1b (Contd.)

84	1989	Srinivasan	Tripriyer-Azikhode	Grab samples and a vibro core (355 cm long) from the inner shelf at 30 m depth are studied, presence of *Uvigerina* represented higher sea level.	e3
85	1989	Banerjee	Bombay	Heavy metals such as Cd, Co, Cr, Cu, Fe, Mn, Ni, Pb, and Zn in the shells of benthic foraminifera.	b2
86	1990	Naidu P.D.	West coast	Upwelling and planktic foraminifers from 21 surface sediment samples.	
87	1990	Guptha *et al.*	South East Arabian Sea	28 species of living planktic foraminifera, higher diversity during summer.	
88	1990	Khare	Karwar	An aberrant specimen of *Bulimina exilis.*	d1
89	1990	Sarkar *et al.*	Arabian Sea	Isotopic analysis of planktic foraminiferal test suggested that summer monsoon was weaker during the LGM (ca. 18000 years ago).	
90	1991	Naidu	Eastern Arabian Sea	Profiles of coarse fraction, $CaCO_3$ and *G. menardii* in two cores.	
91	1991	Rao *et al.*	Eastern Arabian Sea	30 species of living planktic foraminifers from 97 plankton tow samples.	
92	1991	Shareef & Sathyanara-yan	Karnataka	Paleoecological information on the predator-prey interaction in specific habitats.	d1
93	1992	Brock *et al.*	NW Arabian Sea	The digital hydrographic data in combination with satellite remote sensing data provide two distinct planktic foraminiferal environments.	
94	1992	Naidu *et al.*	West coast	27 species of planktic foraminifers are reported, upwelling related productivity is observed by using *G. bulloides.*	

Table 1.1b (Contd.)

95	1992a	Nigam & Khare	Karwar	High monsoonal rainfall inferred at ca. 2000 and 1,500 years BC, supported by archaeological findings.	d1
96	1992b	Nigam & Khare	Karwar	A reciprocity between coiling direction and dimorphic reproduction in benthic foraminifera.	d1
97	1992	Nigam & Henriques	Arabian Sea	Regional numerical model for paleodepth using planktic percentage of foraminiferal fauna in surface sediments is proposed and compared from other regions.	
98	1992a	Nigam *et al.*	Outer shelf off Bombay	Fluctuation of sea prior to 10,000 years BP was evidenced through the study of foraminifera in a core.	b1
99	1992b	Nigam *et al.*	Karwar	Discovered that morpho-groups of benthic foraminifera in a core correspond to rainfall data in catchment area of Kali river.	d1
100	1992	Srinivasan & Singh	DSDP site 219, Arabian Sea	Identified 12 Neogene planktic foraminiferal zones based on first and last appearance of selected taxa.	
101	1993	Naidu	Western continental margin	Distribution of 27 species of planktic foraminifera.	
102	1993	Nigam *et al.*	West coast	Fouling of inter tidal barnacles on relict foraminifera in surface sediment as a tool for deciphering paleo-shore line.	
103	1993	Bhat & Adiga	Lakshadweep	Recognised Pleistocene-Holocene transition in a core.	f
104	1993	Lahiri	Off Saurashtra, Bombay & Cochin	31 species of planktic foraminifera, *Globorotalia tumida flexuosa* has become extinct after Pleistocene in Arabian Sea.	a2, b2, e1

Table 1.1b (Contd.)

105	1993	Nigam & Sarkar	West Coast	Paleoclimatic potentials of mean proloculus size, $\delta^{13}C$ and $\delta^{18}O$ in *Cavarotalia annectens* are compared.	
106	1993	Nigam	Karwar	Reconstruction of paleomonsoon during the late Holocene, onset of dry climate ~3500 year B.P.	dl
107	1993	Sirocko *et al.*	Arabian Sea	Response of SW monsoon to solar insolation changes of past 2400 years BP from oxygen isotope records of *G. ruber* and carbonate variations.	
108	1994a	Nigam & Khare	Karwar	Studied the effect of river discharge on test morphology of benthic foraminifera.	dl
109	1994b	Nigam & Khare	Karwar	Based on planktic percentage and test morphology of benthic foraminifera, a change in monsoonal precipitation is inferred.	dl
110	1994	Guptha *et al.*	Arabian Sea	16 planktic foraminiferal species identified, low abundance of *G. bulloides* explained by the warming of the surface water in combination with deepening of the mixed layer.	
111	1995	Gupta *et al.*	DSDP site 220 & 223, Arabian Sea	Based on benthic foraminifera, identified relatively warm, oxygenated and less corrosive bottom water during earliest Pliocene and early Pleistocene.	
112	1995	Saraswati	Katch	Biometrical study of Oligocene *Lepidocyclina*	
113	1995a	Nigam & Khare	Arabian Sea	A critical review of foraminiferal studies from the west coast of India.	

Table 1.1b (Contd.)

114	1995b	Nigam & Khare	Karwar	Inferred a direct relationship between mean proloculus size (MPS) of *R. annectens* and 100 years record of rainfall data.	d1
115	1995	Nigam & Hashimi	Arabian Sea	Paleoclimatic variation over the Indian region based on many parameters of living (foraminifera) and non-living (minerals) components during last few thousand years.	
116	1995	Nigam *et al.*	Karwar	Major wet periods at 3500 and 1000 years BP punctuated by major dry climate at ~2000 BP and cyclicity of 77 years.	d1
117	1995	Khare *et al.*	Mangalore	Distribution pattern of test morphology of benthic foraminifera from 45 surface sediment samples at 20-86 m water depth show effect of dredging.	d2
118	1996	Bhandari *et al.*	Off Kachchh, Arabian Sea	Based on presence of larger foraminifera from Kachchh offshore area of two deep wells, nine chronostratigraphic stages of Tertiary are delineated.	a1
119	1996	Bhat	Eastern Arabian Sea	Based on down core variations in planktic foraminiferal assemblage evaluation of Late Pleistocene-Holocene transition is attempted.	
120	1996	Das & Narayanan	Bombay offshore, Arabian Sea	Observed larger foraminiferal thin limestone band close to Oligocene-Miocene unconformity.	b2
121	1996	Maharana	Northern Arabian Sea	Based on the study of foraminifera along with other faunal elements from three different cores, the sediments could be grouped into Holocene, Pleistocene and its substages.	

Table 1.1b (Contd.)

122	1996	Mehrotra	Bombay offshore, Arabian Sea	Based on foraminiferal study six transgressive-regressive cycles have been recognised in the Paleogene sequence of the Bombay offshore basin.	b2
123	1996	Mishra *et al.*	Arabian Sea	Carried out oxygen and carbon isotopic analysis of five foraminifera species and a gastropod from 13 recent samples. The ecological interpretations are made in respect of depth habitat and temperature.	
124	1996	Narayanan *et al.*	Bombay offshore, Arabian Sea	Based on foraminiferal study eight zones have been recognised in the Late Paleocene to Late Oligocene sequence with four intervening unconformities.	b2
125	1996	Nigam	Arabian Sea	Study highlights the application of foraminiferal distribution pattern in marine sediment to infer the paleo-sea level.	
126	1996	Shukla *et al.*	Bombay offshore, Arabian Sea	Age determination and paleoecological interpretations, based on foraminifera in Miocene sand, Bombay high.	b2
127	1996	Sirocko *et al.*	Arabian Sea	Based on oxygen isotope of *G. ruber* and other parameters inferred teleconnections between the subtropical monsoons and high-latitude climates during the last deglaciation.	
128	1997	Nigam & Khare	Off Karwar	Inferred monsoonal variability from the foraminiferal study of the core and compared with the archaeological records.	d1
129	1998	Gooday *et al.*	Arabian Sea	Presented benthic foraminiferal species diversity data from a deep sea core.	
130	1998	Jannink *et al.*	Arabian Sea	Distribution of benthic foraminifers with reference to	

Table 1.1b (Contd.)

				deep Oxygen Minima Zone in NW Arabian Sea.	
131	1998	Dulk *et al.*	Arabian Sea	The benthic foraminiferal record revealed two distinct assemblages that show variations in the precession frequency band.	
132	1998	Dave	Bombay offshore basin	Planktic foraminiferal biostratigraphy and biochronology of Neogene.	b2
133	1998	Singh	Eastern Arabian Sea	Based on the temporal variation in the composition of planktic foraminiferal assemblages discussed monsoonal-upwelling relationship.	
134	1999	Nigam & Khare	Karwar	Identified and illustrated 177 foraminiferal species from surface and subsurface sediments inferred the major dry and wet spells of last 3500 years.	d1
135	1999	Naidu *et al.*	East and West Coast of India	Time and space variations of monsoonal upwelling along the west and east coasts of India.	
136	1999	Peeters *et al.*	Arabian Sea	The composition of the total planktic foraminiferal fauna strongly changes along the size spectrum.	
137	1999	Cayre & Bard	Arabian Sea	Planktic foraminiferal and alkenone records of the last deglaciation from the eastern Arabian Sea.	
138	2000	Nigam and Chaturvedi	Kharo Creek, Kachchh	Identified 47 foraminiferal species including 7 live species.	a1
139	2000	Gooday *et al.*	Arabian Sea	Distribution of foraminifera in the Arabian Sea oxygen minimum zone and other oxygen-deficient settings.	

Table 1.1b (Contd.)

140	2000	Kurbjeweit *et al.*	Arabian Sea	Distribution, biomass and diversity of benthic foraminifera in relation to sediment geochemistry in the Arabian Sea.	
141	2000	Nigam *et al.*	Vengurla-Cochin Sector	Identified 204 foraminiferal species and generated proxy data for paleodepth using two different morphgroups.	
142	2000	Chaturvedi *et al.*	Kharo Creek, Kachchh	Identified 47 foraminiferal species.	al
143	2000	Rai & Srinivasan	Arabian Sea	Deep sea benthic foraminiferal response to the Pliocene paleoenvironments of the northern Indian Ocean.	
144	2000	Sarkar *et al.*	Arabian Sea	Reconstructed high resolution Holocene monsoon record from the eastern Arabian Sea, based on isotopic composition of foraminifers.	
145	2000	Dulk *et al.*	Arabian Sea	Benthic foraminifera as proxies of organic matter flux and bottom water oxygenation.	
146	2000	Saraswati and Patra	Kutch	Comparison of three closely resembling species of *Nummulites* from Middle Eocene of India.	
147	2001	Luckge *et al.*	Arabian Sea	Inferred monsoonal variability in the northeastern Arabian Sea during the past 5000 years, based on isotopic composition of planktic foraminifera.	
148	2002	Peeters *et al.*	Arabian Sea	The effect of upwelling on the distribution and stable isotope composition of *Globigerina bulloides* and *Globigerinoides ruber* (planktic foraminifera) in modern surface waters of the NW Arabian Sea.	

Table 1.1b (Contd.)

149	2003	Naidu & Niitsuma	Arabian Sea	Carbon and oxygen isotope time series records of planktic and benthic foraminifera from the Arabian Sea and its implications on upwelling processes.	
150	2003	Heinz & Hemleben	Arabian Sea	Regional and seasonal variations of recent benthic deep-sea foraminifera in the Arabian Sea.	
151	2003	Ivanova *et al.*	Arabian Sea	Variations in primary productivity (PP) have been reconstructed over the past 135,000 years applying principal component analysis and transfer function to planktic foraminiferal assemblages.	
152	2003	Gupta *et al.*	Arabian Sea	Abrupt changes in the Asian southwest monsoon during the Holocene and their links to the North Atlantic Ocean.	
153	2003	Mazumder *et al.*	Arabian Sea	Reported few benthic foraminiferal species typical of Oxygen Minima Zone.	
154	2003	Nigam *et al.*	Arabian Sea	Life-span of planktic foraminifers based on sediment traps.	
155	2004	Nigam *et al.*	Arabian Sea	Distribution of *Ammolagena clavata.*	
156	2004	Naidu & Niitsuma	Arabian Sea	Based on a typical $\delta^{13}C$ signature in *Globigerina bulloides* at the ODP site 723A (Arabian Sea), deciphered implications of environmental changes caused by upwelling.	
157	2004	Schiebel *et al.*	Arabian Sea	Distribution of planktic foraminifers along a trophic gradient during SW monsoon in the Arabian Sea.	
158	2004	Naidu	Arabian Sea	Isotopic evidences of past upwelling intensity in the Arabian Sea.	

Table 1.1b (Contd.)

159	2004	Chodankar *et al.*	Arabian Sea	Past 100 ky surface salinity-gradient response in the Eastern Arabian Sea to the summer monsoon variation recorded by $\delta^{18}O$ of *G. sacculifer.*	

1.3.2 FORAMINIFERAL STUDIES FROM THE BAY OF BENGAL

The Bay occupies an area of about 2332 km^2. It is bordered on the north by deltaic regions of the Ganges and Brahmaputra rivers, on the east by the Myanmar Peninsula and its extension to the south, the Andaman and Nicobar Ridges, which are submerged continuations of the Arakan Yoma Ranges. The southern boundary extends from Dondra Head at the south end of Ceylon to the north tip of Sumatra and opens to the Central Indian Ocean. According to International Hydrographic Bureau (Special Publication, 1953 *In* Fairbridge, 1966), the Bay of Bengal is the northeastern arm of the Indian Ocean lying between peninsular India and Myanmar. Tables 1.2a and b. comprise the compilation of work done in this region.

Table 1.2a Major work carried out on east coast beaches/estuaries of India (Bay of Bengal)

Sr. No.	Year	Author	Area	Remarks
1	1964	Bhatia & Bhalla	Beach sand of Puri (Orissa)	Recorded and illustrated 14 species of recent foraminifera.
2	1966	Ghosh	Digha beach Southern Bengal	*Asterorotalia trispinosa* (Thalmann) a spinose rotalid.
3	1966	Rao & Rao	Visakhapatnam	Living foraminifera from tidal creek near Pudimadka.
4	1968	Bhalla	Visakhapatnam	Recent foraminifera and its relation to foramogeographical province in Indian Ocean.
5	1969	Ramanathan	Vellar estuary, Madras	Abundance of Rotalids, Miliolids, Nonionoides and arenaceous foraminifera.
6	1970	Bhalla	Marina beach (Madras)	Identified 15 species of foraminifera including 4 intermediate species. Of these 4 species are recorded for the first time.
7	1970	Ramanathan	Vellar estuary, Tamil Nadu	Foraminiferal ecology and foraminiferal relationship.

Table 1.2a (Contd.)

8	1973	Ameer Hamsa	Palk Bay, Gulf of Mannar	12 species have been described and illustrated along with the list of 34 species from the beach sands.
9	1973	Reddy	Pennar estuary	Ecology of recent foraminifera.
10	1974	Reddy *et al.*	Pennar estuary	Out of total, 45 species identified only 21 have living representatives, most of the species are benthic.
11	1975	Reddy *et al.*	Pennar estuary Andhra Pradesh	Living and total foraminiferal fauna.
12	1978	Reddy & Rao	Pennar estuary	Size distribution among recent foraminifera.
13	1979	Reddy *et al.*	Pennar estuary	Foraminiferal and substrate relationship Pennar estuary.
14	1980	Reddy & Reddy	Pennar estuary	Recent *Textularia* and *Miliolina*.
15	1980	Reddy & Rao	Pennar estuary	45 foraminiferal species identified.
16	1980	Reddy *et al.*	Sediments of the Pulicat estuary, Tamil Nadu	Seasonal variation in the size distribution.
17	1981	Narappa *et al.*	Gautami and Nelareu estuaries of river Godavari	Living population is interpreted in view of ecological factors.
18	1982	Narappa *et al.*	Godavari and Krishna river estuary	90 species found of which 59 are found in living condition.
19	1982	Reddy & Reddy	Araniar estuary Tamilnadu	44 benthonic foraminifera.
20	1983	Naidu	Vamsadhara estuary and Bendi lagoon	Foraminifera from the Sanidanigedda Machilsm back water.
21	1983a	Reddy & Rao	Pennar estuary, Andhra Pradeh	Spatial and temporal distribution of recent foraminiferal species.
22	1983b	Reddy & Rao	Pennar estuary, Andhra Pradeh	Reported 45 foraminiferal species.
23	1984	Reddy & Rao	Pennar estuary, Andhra Pradeh	A total of 45 foraminiferal species were identified. Rotaliina is the dominant suborder, Miliolina occur less frequently and Textulariina are rare.

Table 1.2a (Contd.)

24	1987	Naidu	Vamsadhara estuary	56 foraminiferal species were identified, out of which Textularids 10, Miliolids 18, Rotalids 28.
25	1994	Reddy & Reddy	Araniar River estuary, SE coast of India.	Recorded 46 foraminifer species. Among various ecological parameters salinity, pH and calcium have close bearing on distribution and abundance of foraminifera in estuary.
26	1994	Rao *et al.*	Alikuppam and Kuvatturpettai back water, Tamil Nadu	Recorded 21 species of foraminifera.
27	1996	Kathal & Bhalla	East coast of India	Reported 56 foraminiferal species from 16 beaches and assigned the assemblages as 'Indo-Pacific' upto Vedranniyam and further south upto Kanniyakumari as 'Mixed zone'of foramgeographical province of the world.
28	1998	Kathal & Bhalla	Palk Strait & Kakinada Bay	Presented the taxonomic observations of *Rotorboides granulosum.*
29	1998	Jayaraju *et al.*	Pulicat Lake	Q-mode factor analysis of 23 foraminiferal genera and presented 6 assemblages for each season within Pulicat Lake.
30	2000	Jayaraju *et al.*	Pulicat lake	Q-mode factor analysis of relative abundance of 35 species.
31	2000	Kathal *et al.*	West and East coasts	Q-Mode cluster analysis of 160 foraminiferal species to separate two different foramgeographical realms for west and east coasts.
32	2002	Kathal	16 stations along east coast	54 recent and 1 relict benthic species from 96 surface samples from 0 to 3 m depth.
33	2004	Kumar and Srinivasan	Coleroon River Estuary, Tamil Nadu	Factor analysis of 56 foraminiferal species.

Table 1.2b Major work carried out on eastern near shore and far offshore regions of India (Bay of Bengal)

Sr.No	Year	Author	Area	Remarks
1	1866	Schwager	East coast of India	Fossil foraminifera from Varka Nicobar Expedition.
2	1939b	Cushman	Car Nicobar island	Notes of some Pliocene foraminifera by Schwager.
3	1943	Gnanamuthu	Krusadai island, Bay of Bengal	Description of 47 littoral benthic species.
4	1949a	Daniel	Krusadai island	Encrusted foraminifera.
5	1949b	Daniel	Krusadai island	Foraminifera of Krusadai and adjacent areas.
6	1951	Jacob & Sastry	Car Nicobar island	Tertiary foraminifera from Sawai Bay.
7	1958	Ganapati & Satyavati	East coast of India	103 species identified belong to 65 genera and 25 families.
8	1958	Rao	East coast of India	Distribution of $CaCO_3$ in the shelf sediments refers to foraminifera as sediment particles and as ecological indicator.
9	1958	Sarojini	Bay of Bengal	Studies on littoral foraminifera.
10	1959	Ganapati & Sarojini	Bay of Bengal	Ecology of foraminifera of Visakhapatnam coast.
11	1964	Chatterjee	Andaman island	Tertiary fauna in Andaman Sea.
12	1967	Belayeva	Shelf of Bay of Bengal	Distribution of shelf planktic foraminifera and methodological aspects of the analysis of foraminifera.
13	1968	Rao & Vedantam	Shelf of Visakhapatnam	32 species of foraminifera.
14	1969	Bhatt	Outer shelf of Vishakhapatnam	15 species, mixing of fauna during Pleistocene has been attributed to action of ocean currents.
15	1969	Srinivasan	Little Hut Bay, Andaman Island, Bay of Bengal	86 benthonic and 25 planktic species recorded from mudstone samples of middle Miocene (Tortonian) age.
16	1970	Be' & McIntyre	Northern Indian Ocean	*Globorotalia menardii flexuosa* (Koch) an extinct foraminiferal subspecies found living. Most of the

Table 1.2b (Contd.)

				samples are from Bay of Bengal very few are from Arabian Sea and Indian Ocean.
17	1970	Frerichs	Andaman sea	Distribution and ecology of benthonic foraminifera in sediments.
18	1970	Vedantam & Rao	Visakhapatnam	85 benthic species.
19	1971	Ameer Hamsa	Palk Bay	Some foraminifera from Palk Bay.
20	1971	Frerichs	Andaman sea	23 planktic species and 2 polyphyletic forms of planktic foraminifera have been recognized.
21	1972	Almeida & Setty	Kakinada	18 agglutinated species of foraminifera noticed.
22	1972	Rao & Rao	Kakinada	Recent foraminifera from the Kakinada Channel.
23	1972	Rao & Vedantam	Visakhapatnam & Kakinada east coast of India	Recent foraminifera from marginal marine environment.
24	1972	Setty & Almeida	Visakhapatnam - Masulipatnam	Abberent species like *Uvigerina sp. Siphonaperta sp* and *Nodosaria sp.* recorded.
25	1972	Srinivasan & Srivastava	Noncowry and Kamenka island	Foraminifera from Noncowry and Kamenka island and some aspects of early Neogene origin.
26	1974	Ragothaman	Tamil Nadu	The study of the foraminifera from Porto Nova.
27	1974	Rao & Rao	Suddagedda	A total of 40 species of foraminifera were identified from the estuary of which 11 species never found alive.
28	1976a	Rao & Rao	East coast of India	59 species of living foraminifera.
29	1976b	Rao & Rao	Chipurupale stream	Identified 39 species and studied their seasonal variation.
30	1976c	Rao & Rao	Dumalapeta creek	56 species of foraminifera were identified, of these 33 species were never found in living conditions.
31	1976b	Setty	Madras	Recent foraminifera from the shelf of Madras.
32	1976c	Setty	Off Pondicherry	Foraminiferal assemblages of continental margin.

Table 1.2b (Contd.)

33	1977	Ameer Hamsa & Nammalwar	Gulf of Mannar	7 species from 180 fathoms water depth.
34	1977	Rao & Rao	Pudimadka stream of east coast	Studies on foraminifera of Pudimadka stream east coast.
35	1977	Srinivasan	Andaman Nicobar	Standard planktic foraminiferal zone, Late Cenozoic.
36	1978	Rasheed & Ragothaman	Porto Nova	70 foraminiferal species and their relation to various ecological factors.
37	1978	Rao & Rao	Innershelf Visakhapatnam	A total of 133 benthic foraminiferal species identified.
38	1978	Setty	Pondicherry	19 planktic and 75 benthic foraminifera encountered in shelf sediment.
39	1978	Setty & Rao	Madras	Recent foraminifera largely cosmopolitan fauna dominated by Miliolids, *Ammonia,Cibicides* and *Elphidium.*
40	1979	Rao	Shelf off Visakhapatnam	Studies on foraminifera from the Gostani estuary.
41	1979	Rao *et al.*	Shelf off Visakhapatnam	124 benthonic species identified of which 17 species are abundant.
42	1980	Srinivasan & Singh	Andaman Island Bay of Bengal	5 new species of benthic foraminifera deep water assemblages characteristic of lower to middle bathyal depths.
43	1980	Rao & Rao	Visakhapatnam harbour channels	44 agglutinated foraminiferal species and subspecies have been identified.
44	1980	Narappa	Andhra Pradesh	Recent foraminifera from the Godavari and Krishna river.
45	1981	Cullen	Bay of Bengal	Microfaunal evidence for changing salinity pattern Bay of Bengal over the last 20,000 years monsoonal climate (precipitation and river run off), *Globigerina dutertrei* as indicator of low salinity.
46	1981	Kaladhar	East coast of India	Recent foraminifera from Balacheruva streams, Tandava river estuary and Rishikanda.

Table 1.2b (Contd.)

47	1982	Rao	Visakhapatnam	Foraminiferal ecology of Visakhapatnam harbour complex.
48	1982	Rao *et al.*	Visakhapatnam	44 species of foraminifera are found on algal rock pools.
49	1983	Reddy *et al.*	Araniar river Chigleput district Tamil Nadu	A list of 46 foraminifera are encountered.
50	1985	Naidu *et al.*	Visakhapatnam harbour	15 species of foraminifera are affected by pollution.
51	1985	Ragothaman & Kumar	Palk Bay Tamil Nadu	52 foraminiferal species from the coast of Rameshwaram.
52	1985	Ragothaman & Manivannan	Tamil Nadu	52 foraminiferal species from Mandapam.
53	1985	Rajshekhar	Baratong Island Andaman	Foraminifera from the ejected material of mud volcano.
54	1986	Fontugne & Duplessy	Arabian Sea Bay of Bengal	Isotopic studies indicated that during glacial time North East monsoon circulation was the dominant feature.
55	1987	Srinivasan & Dave	Noncowry & Kamurta island	Middle Miocene sediments of Noncowry and Kamurta island their biostratigraphy and climatic record.
56	1988	Naidu & Rao	Bendi lagoon	7 species are very abundant and wide spread in occurrence.
57	1988	Pal	North western Bay of Bengal	Ecological distributions of 4 abundent species like *Globigerina bulloides, Globigerinoides rubra, Globigerinoides triloba* and *Neogloboquadrina dutertrei* are encountered.
58	1989	Naidu *et al.*	Vishakhapatnam continental margin	Benthic foraminifera as bathymetric indicators, *Bulimina* is represented by 6 species and *Uvigerina* by 7 species.
59	1989	Pal	Northwestern part of Bay of Bengal	Distribution of benthic foraminifera in bottom sediments.
60	1989	Rajshekhar	Baratang island, Andaman	Systematic distribution of 10 planktic foraminifera.

Table 1.2b (Contd.)

61	1989	Rao *et al.*	Coromandal coast Bay of Bengal	Upwelling indicator species such as *Globigerina bulloides* and *Neogloboquadrina dutertrei* are described.
62	1989	Reddy & Reddy	Araniar river Tamil Nadu	Both living and dead foraminifera were collected from 15 sampling stations, Q-mode factor analysis of foraminifera.
63	1990	Kaladhar *et al.*	South of Visakhapatnam	42 species of foraminifera recognized.
64	1990	Naidu	Bendi lagoon	Foraminiferal diversity in living and total population recorded in all 4 seasons using statistical parameters.
65	1990	Srinivasan *et al.*	Nizamapatanam Bay, Andhra Pradesh	Distribution of 63 species and factor analysis.
66	1991	Jayalakshmy & Rao	Coromandal Coast	Q-mode factor analysis of planktic foraminifera of 17 species into 5 groups. 19 stations classified into five groups with two groups statistically significant by R-mode analysis.
67	1991	Madabhushi	Bay of Bengal	Observed anomalous zone in foraminifera content attributed to salinity change due to change in current direction.
68	1991	Naidu & Kamalakaran	East coast of India	Critical examination of living foraminiferal number, organic matter content relationship in the marginal marine environments.
69	1993	Bhattacharjee	Northern Andaman	In the present work foraminiferal biofacies distribution pattern prepared over an area of 20,000 sq. km. in the Bay of Bengal. North of Andaman reviewed in the light of its environmental significance.

Table 1.2b (Contd.)

70	1993	Ghosh & Bhattacherjee	Continental slope off Paradip, Northern Bay of Bengal	Based on foraminiferal studies of 5 sediment cores demarcated two environments of deposition.
71	1993	Madabhushi	Cuddalore	Pleistocene and Holocene boundaries inferred from foraminiferal dominance in core off Cuddalore.
72	1993	Raghav *et al.*	Innershelf of Orissa	Non marine subsurface sediments from innershelf sediments off Orissa and its bearing on a possible Pleistocene Holocene boundary.
73	1994	Naqvi *et al.*	Andaman Sea and Bay of Bengal	Carbon and oxygen isotopic records of benthic foraminifera from the Northeast Indian Ocean.
74	1995	Ahmad	Bay of Bengal	Based on stable Carbon & Oxygen isotopic records of *Globigerinoides ruber* inferred increased salinity (by ~2%) during LGM.
75	1995	Bera *et al.*	Western margin, Bengal Basin	6 planktic species and 16 genera of benthonic foraminifera identified in samples from 6 cores. Two planktic zones of earliest early Miocene and Late early Miocene-Pleistocene demarcated.
76	1995	Jayaraju & Reddy	Kovalam-Tuticorin	Reported 54 foraminiferal species from 180 bottom water and sediment samples in coastal and estuarine samples.
77	1996	Das	South west Bengal	Identified 57 foraminiferal species from core sediments of Late Pleistocene to Holocene.
78	1996	Jayaraju & Reddy	Kovalam-Tuticorin	Carried out the factor analysis on benthic foraminifera and presented 12 factor assemblages.

Table 1.2b (Contd.)

79	1996	Kumar *et al.*	Palk Bay, SE coast of India	Analyzed the living and the total population of foraminifera identified 108 species of foraminifera. The silt, sand and increased $CaCO_3$ in substrate suggested the abundance in living population.
80	1996	Manivannan *et al.*	Gulf of Mannar	Identified 104 foraminiferal species. $CaCO_3$ content of the sediment were suggested as the major governing factor for foraminiferal population.
81	1996	Raju and Dave	Krishna-Godavari and Cauvery basins	Reconstruction of paleodepth from Oligocene to Pleistocene on the basis of Uvigerinids.
82	1997	Jayaraju & Reddy	Off Pannikyal	Effect of river discharge on the morphology of benthic foraminiferal test.
83	1998	Bhalla & Kathal	Gulf of Mannar	Reported the 43 species of Recent foraminifera., Faunal assemblage reveal the 'mixed-zone' of the East African and Indo-Pacific realm.
84	1998	Rao *et al.*	Karikkattuppam	30 Lagenid species belonging to 3 genera (*Lagena, Procerolagena* and *Pygmaeoseistron*) from Bay of Bengal.
85	1999	Rao *et al.*	Karikkattuppam	Identified a rare foraminiferal species *Glandulina spinata* for the first time from Indian water.
86	2000	Dave	Krishna-Gadavari and Cauvery basins	Biozonation of benthic foraminifera from Oligocene to Pleistocene and its significance in paleobathymetry.
87	2000	Burton & Vance	Bay of Bengal	Glacial–interglacial variations in the Nd isotope composition of seawater in the Bay of Bengal recorded by planktic foraminifera.
88	2001	Rao & Periakali	Bay of Bengal	*Cocoarota madrasensis* a new foraminiferal taxon from the inner shelf of the Bay of Bengal
89	2002	Gandhi *et al.*	Palk Strait	Identified 102 benthic foraminiferal species from 42 sediment samples

Table 1.2b (Contd.)

90	2003	Chaudhari *et al.*	Bay of Bengal	Distribution of planktic foraminifera in the northern Bay of Bengal
91	2004	Gandhi and Rajamanickam	Palk Strait	Identified 102 species (including 36 living)
92	2004	Nagendra *et al.*	Tuticorin Coast	Identified 24 Pleistocene-Holocene deepwater benthic foraminiferal species

1.3.3 FORAMINIFERAL STUDIES FROM THE INDIAN OCEAN

The Indian Ocean is bounded to the north by Iran, Pakistan, India and Bangladesh; to the west by Arabia and Africa; to the east by Australia, the Sunda Island of Indonesia and the Malayan peninsula, Myanmar (Burma) and Thailand; and to the south by Antarctic continent. It is the smallest in aerial extent (~20% of the world ocean i.e. 73.6 x10^6 km^2) and youngest among the three major oceans of the world. In the southwest, the Indian Ocean opens into the Atlantic Ocean near the southern tip of South Africa. Eastwards it opens into the Pacific Ocean through straits and marginal seas. The gist of work carried out in that region is presented in Table 1.3.

Table 1.3 Major works carried out in the Northern Indian Ocean

Sr. No.	Year	Author	Area	Remarks
1	1973	Be' *et al.*	Indian Ocean	Spherical test of *Orbulina universa* in Indian Ocean water and surface sediments indicates a strongly inverse correlation between test size and latitude occurrence. Location of samples above and below equator.
2	1976	Be' & Duplessy	Mid latitudes of Indian Ocean	Fluctuation in the subtropical convergence between 31° south and its present southern limit reflected by shell size variation in *Orbulina universa*. Location of sample from Bay of Bengal, Arabian Sea and Indian Ocean. Most of samples are below the

Table 1.3 (Contd.)

				equator.
3	1976	Hecht *et al.*	Indian Ocean	Multivariate cluster analysis of various morphology indices of *Orbulina universa* population is an excellent indicator of oceanographic conditions. 3 stations above equator and remaining below the equator.
4	1977	Be' & Hutson	Indian Ocean	Quantitative study of distribution patterns and relative abundance of 32 species based on 154 planktic tows. Most of the stations are below the equator.
5	1977a	Hutson	Indian Ocean	Transfer functions under no-analog condition experiment with Indian Ocean planktic foraminifera.
6	1977b	Hutson	Indian Ocean	The spatial variability of 25 species of planktic foraminifera is analysed. The data are used to document the influence of season and depth on the distribution of planktic species in water column and the influence of dissolution on the relative abundance of species in the sediment. Most of the stations are below the equator and a few near Somali basin.
7	1977	Setty	Northern Indian Ocean	Occurrence of *Neogloboquadrina pachyderma*, a new subspecies in shelf slope sediments. Five samples, 4 in Arabian Sea and 1 in Bay of Bengal.
8	1978	Boltovskoy	Indian Ocean	170 species identified. One core near Bay of Bengal, one near equator and three core below equator.

Table 1.3 (Contd.)

9	1979	Thompson *et al.*	Indian Ocean	Planktic foraminiferal species *Globigerinoides oncar* pink pigmented test occupied a world wide warm water belt during Pleistocene. Most of the cores are from Pacific, one from Bay of Bengal and a few above and below equator.
10	1980	Prell *et al.*	Indian Ocean	Interpretation of changes in temperature, circulation pattern are based on the assemblage description matrix of planktic foraminifera.
11	1981a	Curry & Mathews	Indian Ocean	Strong positive correlation betwen $\delta^{13}C$ and $\delta^{18}O$ data and size fraction of *Globigerina bulloides* and *Globigerinoides oncar* Three cores in Arabian Sea of Oman and 4 core above equator and majority are below equator.
12	1981b	Curry & Mathews	Indian Ocean	Paleoceanographic utility of oxygen isotopic measurement on planktic foraminifera from core top samples. Most of the stations are from 12° North and a few near and below the equator.
13	1981	Duplessy *et al.*	Indian Ocean	5 planktic foraminiferal assemblages were encountered along the north south transect of the Indian Ocean.
14	1984	Cullen & Prell	Northern Indian Ocean	Systematic geographical and depth related variations are observed for the seventeen most abundant species.
15	1984	Peterson	Equatorial Indian Ocean	Study of Recent abyssal benthic foraminiferal core top samples has identified distinct fauna whose distribution pattern

Table 1.3 (Contd.)

				reflects the major hydrographic features of the area.
16	1985	Belayeva & Burmistrova	Indian Ocean	The boundary between carbonate and non-carbonate sediment is associated with an increase in rate of solution of calcium carbonate.
17	1985	Peterson & Prell	Equatorial Indian Ocean	Carbonate dissolution in recent sediments. Preservation patterns and carbonate loss above the lysocline. Four samples above equator and a majority below equator.
18	1988	Rao *et al.*	Northern Indian Ocean	23 species of living planktic foraminifera belonging to 11 genera were studied. Location of sample between 8°N and 6°N of equator.
19	1989	Kroon & Ganssan	Northern Indian Ocean	Oxygen and carbon isotopic ratio were determined of shells of living planktic foraminifera. Samples from northern Indian ocean between 10° north to equator.
20	1990	Hermelin & Shimmield	NW Indian Ocean	Benthic foraminiferal studies reveal specific faunal assemblages that are closely related to sediment/depositional environment type.
21	1990	Gupta & Srinivasan	Indian Ocean	New benthic foraminifera *Favocassidulina indica.* One sample above and one below equator.
22	1990	Kroon & Nederbragt	Indian Ocean	Morphology of stratigraphic distribution of triserial planktic foraminifera and ecology of living ones to draw parallel fossil counterparts. Samples are from Arabian Sea. Most of the stations are between 8°N of

Table 1.3 (Contd.)

				equator and some below equator.
23	1990	Nigam	Northern Indian Ocean	Sea temperature and salinity influence mean diameter of the external shell of planktic foraminiferal species *Orbulina universa* d'Orbigny.
24	1990	Srinivasan & Chaturvedi	Tropical Indian Ocean	The intervals and major faunal turnover observed reflect global climate and Paleoceanographic events coinciding with regional tectonism. One sample location in Bay of Bengal, one above equator and major below equator.
25	1991	Gupta	Northern Indian Ocean	The evolution of Pleistocene deep sea environment has been evaluated using quantitative analysis of deep sea foraminiferal fauna.
26	1992	Gupta	Indian Ocean	The benthic foraminiferal faunal pattern reveals two assemblages and one intermediate assemblage each one is associated with North Indian Deepwater and Antarctic Bottom Water (AABW).
27	1992	Rai & Srinivasan	Indian Ocean	Neogene deep sea benthic foraminiferal diversity and its pale oceanographic implications. 2 location samples above equator and 2 below equator.
28	1993	Gupta	Indian Ocean	Distribution pattern of *Stilostomella lepidula* (Schwager) at DSDP site 214, 216, 217, 219 and 223. The disappearance of *S. lepidula* at ca. 0.73 Ma near Brunhes/Matuyama boundary

Table 1.3 (Contd.)

				may be used as stratigraphic datum.
29	1993	Sarkar & Guha	Northern Indian Ocean	Abundance data of *Globorotalia menardii* and total planktic foraminifera.
30	1994a	Gupta	Indian Ocean & Red Sea	Recorded 226 taxa.
31	1994b	Gupta	Indian Ocean & Red Sea	Benthic deep sea foraminiferal assemblages with water mass of Indian Ocean and Red Sea.
32	1994	Nigam *et al.*	Near Carlsberg Ridge, Northern Indian Ocean	Based on mean diameter, isotopic composition (delta^{18}O) of *O. universa* and clay mineralogy low salinity brought by Indus river at about 1000 years was inferred from a 5 m long sediment core at 3869 m water depth.
33	1994	Rai & Srinivasan	Northern Indian Ocean	Recorded 150 benthic foraminifera species. Based on benthic foraminifera studies at core site DSDP 219 & 238 explained that Early Pleistocene bottom water are of North Indian Deepwater origin and Late Pleistocene water mass are intermediate between NIDW and Antarctic Bottom water (AABW).
34	1995	Singh & Srinivasan	DSDP sites 237 & 238, Central Indian Ocean	Based on planktic foraminifera biochronology of the recognized 20 zones ranging in age from Early Miocene to Pliocene.
35	1996	Badarees *et al.*	Northern Indian Ocean	Based on down core abundance study of *Globorotalia menardii* Pleistocene-Holocene boundary inferred.
36	1996	Gupta & Srinivasan	Eastern Indian Ocean	Pliocene-Pleistocene benthic foraminifera were subjected to

Table 1.3 (Contd.)

				R-mode factor analysis which reveals 8 environmentally significant species assemblages. 2-modes cluster analysis of same data reveal seven sample association.
37	1996	Rai & Srinivasan	Central Indian Ocean	Recorded 166 benthic foraminifera species from the Miocene sequence. The analysis of foraminiferal data integrated with stable isotope record reveal marked changes in physicochemical behavior of the Central Indian bottom waters during the Miocene.
38	1996	Sarkar *et al.*	Indian Ocean	Based on planktic foraminifera the Plio-Pleistocene boundary demarked.
39	1996	Guptha and Mohan	Northern Indian Ocean	Described seasonal variability depending on the vertical fluxes of *Globigerina bulloides.*
40	1997	Gupta	Indian Ocean	Benthic foraminiferal species from 40 Pliocene-Pleistocene samples were subjected to R-mode factor and 2-mode cluster analysis and defined 5 significant assemblages.
41	1999	Martínez *et al.*	Eastern Indian Ocean	Described paleoceanography of the last glacial maximum depending on planktic foraminifera.
42	2001	Gupta *et al.*	DSDP site 214	Spectral analysis of *Uvigerina proboscidea* to relate earth's eccentricity cycles with Indian summer monsoon variability.
43	2002	Rai and Srinivasan	Indian Ocean	Benthic foraminiferal genus *Favocassidulina* from seven Neogene deep sea DSDP sites.
44	2003	Gupta & Thomas	Indian Ocean	Initiation of Northern Hemisphere glaciation and

Table 1.3 (Contd.)

				strengthening of the northeast Indian monsoon.
45	2004	Gupta *et al.*	Indian Ocean	Linked Indian Ocean high-productivity event (10–8 Ma) to global cooling and the initiation of the Indian monsoons.
46	2004	Rai and Singh	Exmouth Plateau	Proposed four benthic foraminiferal biozones.

1.4 SELECTION OF THE STUDY AREA

The energy balance in different parts of the world plays a specific role in bringing about and regulating climatic changes. Therefore, it is necessary to reconstruct past climatic variations that have occurred globally. However, the signatures of climatic variations are region specific. It is with this objective that paleoclimatic studies were carried out from different parts of the world ocean including Indian Ocean.

Fig.1.2 summarizes the benthic foraminiferal studies carried out along the west coast of India. The colored blocks show the major study areas. Earlier workers have catalogued the foraminiferal species, from Kachchh to Mumbai and from Vengurla to Kochi along the west coast of India. However, limited efforts have been made to understand surface distribution of foraminifers and to utilize foraminiferal characteristics to generate climatic history from the off Goa region (central west coast of India) in general and deeper regions in particular. In view of the above, a detailed investigation for foraminiferal distribution in space and time in the shelf-bathyal region off Goa, central west coast of India has been undertaken. The micropaleontological analyses are focused on benthic foraminiferal associations with the aim of reconstructing the climatic fluctuations.

The region off Goa offers an added advantage for foraminifera-based paleoclimatic studies because of the presence of Oxygen Minima Zone (OMZ), a prominent bio-physico-chemical feature of the eastern Arabian Sea. The OMZ, characterized by significantly low dissolved oxygen concentration, leads to better preservation of foraminiferal tests, as such zones support extremely low biological activity and, thus low bioturbation. Detailed studies have been carried out on the interaction between OMZ and the benthic foraminifera from OMZs

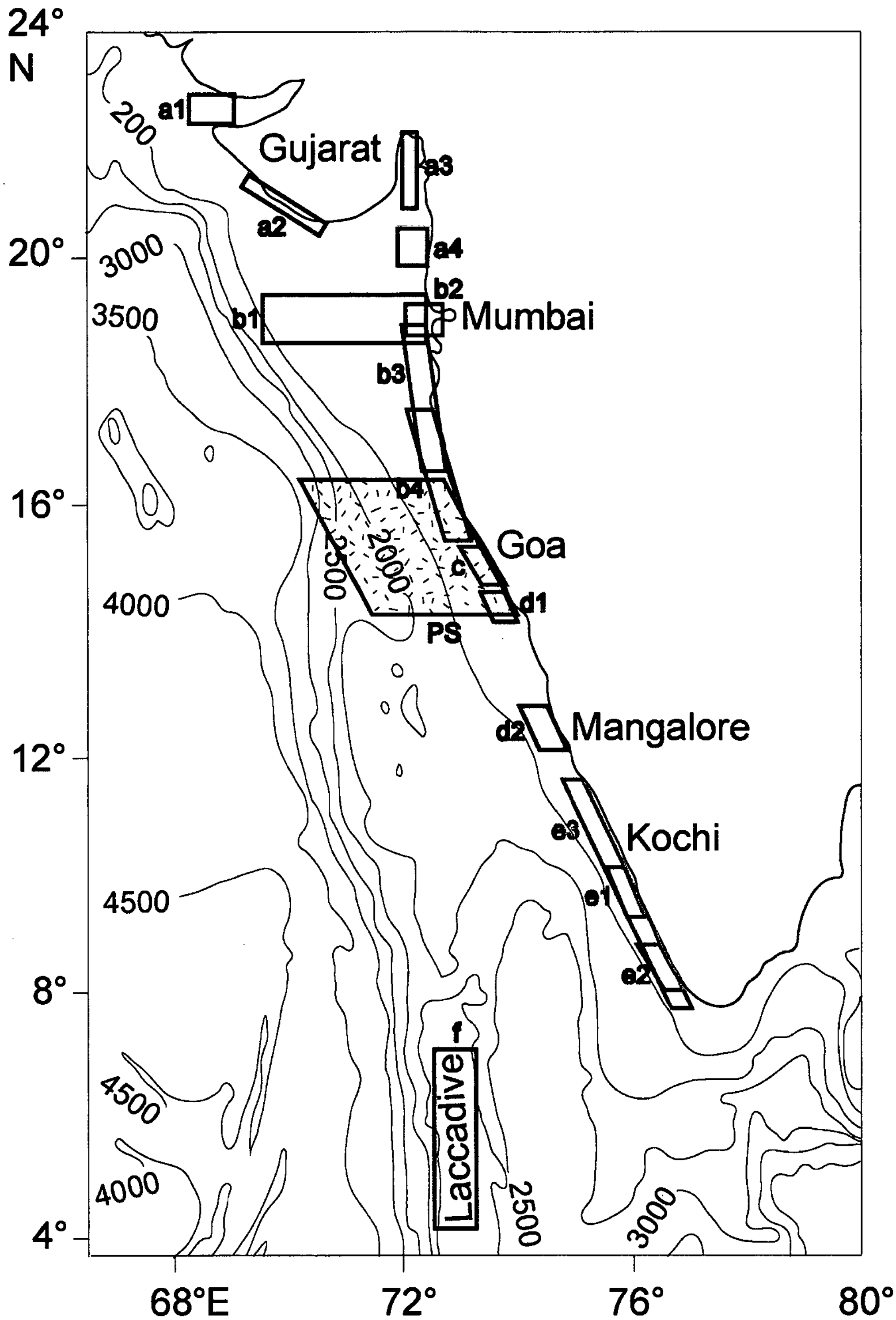


Figure 1.2 Locations for previous work along the west coast of India; a=Gujarat, a1=off Kachchh, a2=off Saurashtra, a3=off Gulf of Khambat, a4=off Daman; b=Maharashtra, b1=outer shelf and slope off Mumbai, b2=Mumbai offshore, b3=off Maharashtra, b4=off Vengurla-Dabhol; c=off Goa; d=Karnataka, d1=off Karwar, d2=off Mangalore; e=Kerala, e1=Kochi, e2=Thiruvananthapuram, e3=off Kerala; f=Laccadive Islands. PS=Present Study Area, off Goa region (shaded). Area depicted within boxes not to scale.

of the world oceans. But unfortunately, the west coast of India has remained untouched in this aspect. In view of this, the region off central west coast of India from the water depth ranging from 15 m to 3300 m has been chosen to study the interrelationship between OMZ and benthic foraminifera and the variations in intensity and extent of OMZ during the geologic past (the Holocene) with the help of foraminiferal characteristics.

1.5 OBJECTIVES OF THE STUDY

The present study was carried out with the following objectives in mind:

(a) To catalogue and illustrate the distribution of foraminiferal species from both the surface and sub-surface sediment samples

(b) To develop site-specific proxies to understand the relationship between foraminifera and the ambient environment, specially with reference to Oxygen Minima Zone

(c) To apply foraminiferal proxies to reconstruct the paleoclimate

(d) To delineate major climatic events in the past

1.6 SCOPE OF THE STUDY

The present study, documenting the surface and sub-surface distribution of foraminifers, especially benthic foraminifers, from off Goa region, will help in filling the gap in foraminiferal studies carried out along the west coast of India. Part of this study, which covers documentation of the surface distribution of foraminifers, will help in understanding the factors influencing the foraminiferal population in the study area. The understanding developed from the surface distribution of foraminifers can then be applied to develop efficient site-specific proxies and decipher past climatic variations through down-core variations of foraminiferal characteristics. Since it is the first effort to decipher past variations in the intensity and extent of OMZ from off Goa region, it will help in delineating the factors that govern the variation in OMZ in this region.

CHAPTER 2

GENERAL PHYSIOGRAPHIC AND OCEANOGRAPHIC CONDITIONS

2.1. INTRODUCTION

Foraminifera always live in close association with their ambient environment. Therefore, in order to understand the environmental influence over the spatial distribution of these organisms, the physiographic and oceanographic setting of the Arabian Sea in general is being described. However, within this broad framework, special emphasis has been laid on the study area off central [Vijaydurg-Karwar sector] West Coast of India.

2.2. GEOLOGY OF THE HINTERLAND

The coastal mountains to the west known as the "Western Ghats" border the coastal region between Vijaydurg and Karwar. The ghats trend roughly north-south with a width of 50-60 km. They are composed of Precambrian gneisses, schists, granites and charnockites covered by extensive laterite capping and rich iron ore deposits between Vijaydurg and Karwar (Krishnan, 1968). The coastal plain is narrow and dunes of Recent age dot the entire coastline, with alluvium deposits Recent in age occupy the river valleys (Oertel, 1958). The following group of formations (modified after Radhakrishnan and Vasudev, 1977) is encountered on the land bordering the shelf off the study area.

↑

Recent

Pleistocene Laterite

Deccan Traps

Bhima and Kalagdi Series

Younger Granite (Closepet Granite)

Chitradurga Group

Bababudan Group

Older Granite, Gneiss-Migmatite Complex (Peninsular Gneiss)

Charnockite

2.3 CLIMATE

The climate is tropical, with the Western Ghats playing a prominent role in governing the coastal climate. The southwest monsoon generally begins towards the end of May and continues for three to four months shedding much of its moisture to the west of the Western Ghats. Starting June the entire western region receives heavy rainfall.

The heavy seasonal precipitation is carried into the Arabian Sea through numerous rivers and rivulets along the central west coast of India. The annual discharge by these rivers into the Arabian Sea is given in Table 2.1.

Table 2.1: Discharge of major, medium and minor rivers into the Arabian Sea (after Rao, 1979)

Serial Number	Name of the river	Average annual discharge (in million cubic meters)
	MAJOR	
1	Indus	207,800
2	Narmada	40,705
3	Tapti	17,982
	AVERAGE	
4	Kalinadi	6,537
5	Gangavati	4,925
6	Sharavati	4,545
7	Netravati	4,615
8	Mandovi	1,320
	MINOR	
9	Others	966

2.4 GENERAL SETTING OF THE ARABIAN SEA

The Arabian Sea is located between Africa and India, covering an area of 3,863,000 sq. km, and has a mean water depth of 2734 m (Groves and Hunt, 1980). The Arabian Sea is connected to the Red Sea by a 125 m deep sill at the Strait of Bab-el-Mandab through the Gulf of Aden and to the Persian Gulf by a 50 m deep sill at the Hormuz Strait through the Gulf of Oman (UNEP-United Nations Environment Programme Report No. 59, 1985). The Indus, the Narmada and the Tapti rivers are the major sources of fresh water draining into the Arabian Sea. An important characteristic geomorphic feature of the Arabian Sea is the Indus Cone, one of the largest throughout the world oceans. The fan is bounded by the passive continental margin of Pakistan-India and Chagos-Laccadive Ridge on the east, by the Owen-Murray Ridge on the west and north, and by the Carlsberg Ridge on the south (Kolla and Coumes, 1985).

2.4.1. BATHYMETRY

The variation in the width and depth of the shelf break along the western continental margin appears to be controlled by resistance of the hinterland rocks (Wagle, 1987). The shelf width is variable, being widest in the north (~350 km) off Bombay and narrow (~60 km) off Cochin to the south (Naini and Talwani, 1983). In between, the shelf is wide (~80 km) off the Vijaydurg-Karwar sector. The topography of inner-shelf is smooth with a gentle slope, while the outer-shelf is characterized by numerous small-scale pinnacles and undulations (Nair *et al.*, 1978). The average shelf break along the western continental shelf of India occurs at about 200 m (Naini and Talwani, 1983). However, the shelf break occurs between 90 and 120 km from shore along central west coast (Nair *et al.*, 1978). Considering all the variations, the shelf covers an area of 310,000 sq. km.

Figure 2.1 shows the bathymetry off Goa region, central west coast of India. The bold black line represents the coastline, while the solids contour represents the altitude on land in meters. The broken contours represent the depth of water in meters. Color index representing the altitude is given next to the figure.

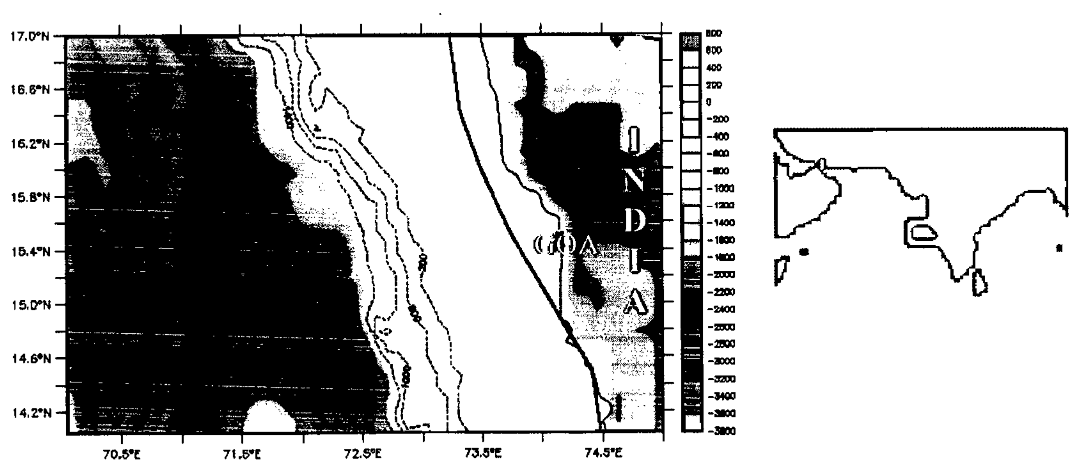


Figure 2.1: Bathymetry off Goa region, central west coast of India. (Levitus, 1994)

2.4.2. CIRCULATION

The Arabian Sea is a unique basin not only because of its characteristic chemical and biological properties but also due to the physical processes. One of the peculiar properties of the Arabian Sea is the semi-annual reversal of wind regimes caused by the monsoon. These reversals have significant impact on the upper ocean circulation and biological productivity of the region (Qasim, 1982; Madhupratap *et al.*, 1996). In the Arabian Sea, the major forcing mechanisms are the winds along the east and west coasts of the Indian subcontinent (Shankar, 2002).

The near-surface layer of the Arabian Sea near 8°N is influenced by three different water masses. When continental winds cool the ocean surface and strong evaporation causes the salinity to increase (Morrison, 1997), the saline component i.e. the Arabian Sea Water (ASW) is formed in the northern Arabian Sea during the northeast monsoon. The South Equatorial Current, the East African Coastal Current and the Somali Current during northern summer carry low-salinity water from the equatorial Indian Ocean into the Somali Basin. Finally, the eastern Arabian Sea receives low-salinity surface water from the Bay of Bengal (BBW) during winter (Kolla *et al.*, 1981, Swallow *et al.*, 1983, Chauhan and Gujar, 1996).

The intermediate depth layers are occupied by three water masses. Warm and saline Persian Gulf Water spreads at 200–400 m depth, reaching latitudes between 5° and 10°N. Red Sea Water (RSW) is also characterized by high salinity and spreads at a depth of about 500 m in the north and about 800 m at the equator. It can be traced as far south as the Agulhas Current (Beal *et al.*, 2000). The third intermediate depth water mass, 'Indian Central Water' (ICW) originates in the south. This lower-salinity ICW, sometimes also called the 'Subtropical Subsurface Water' (Warren et al., 1966), originates at and north of the Subtropical Convergence in the southern hemisphere. It is characterized by an almost linear temperature–salinity relationship and enters the northern hemisphere via a western boundary current off the East African coast (Swallow *et al.*, 1988). In the northern hemisphere this water mass is also referred to as 'Northern Indian Central Water' (e.g. Gordon, 1986). Another characteristic feature of the ICW is the 'weak oxygen maximum' at a temperature of 11°C at around 400 m depth. Although the absolute oxygen content of this water mass is quite low, it is the major source of dissolved oxygen in the Arabian Sea. The central and northern parts of the Arabian Sea are known for their low-oxygen layers occurring in the depth range between 200 and 1200 m. The oxygen content everywhere north of 3°N is ~1 ml/l (Wyrtki, 1973).

The deep waters in the Arabian Sea, in contrast to the upper and intermediate layers, show much less spatial and temporal variability. Warren (1993) identified the layer between 1500 and 3500m as 'North Indian Deep Water' (NIDW). Below that layer 'Circumpolar Deep Water' is found as the bottom water that enters the Arabian Sea through the Amirante Passage and flows northward along the western boundary of the Somali Basin (Johnson *et al.*, 1991a). Part of it continues across the Carlsberg Ridge to form the bottom water of the Arabian Basin (Johnson *et al.*, 1991b). For the Owen Fracture Zone, Quadfasel *et al.* (1997) estimated a transport of about 2Sv below 3000 m water depth from the Somali Basin to the Arabian Basin during the SW-monsoon of 1995.

Warren and Johnson (1992) described a broad southwestward flow in the deep-water layer of the eastern Arabian Basin during both monsoons. These patterns were not forced by the monsoons but reflected the mean circulation of the deep water as driven by upwelling of the bottom water from below. Because there is no other escape route from the deep Arabian Sea, the Bottom Water rises upward and is transformed into NIDW (Warren, 1993; Mantyla and Reid, 1995).

2.4.3 TEMPERATURE

Over the Arabian Sea region, annual surface temperature ranges from 22.5-28.5°C with a distinct increase from north to south. At deeper levels (500 and 1000 m), temperature decreases from north to south (Qasim, 1982). During the southwest monsoon the surface temperatures in the eastern Arabian Sea drop from 30°C in March to 27°C in August (Rao *et al.*, 1976; Ramesh Babu *et al.*, 1980). Murty *et al.* (1983) and Ramesh Babu and Sastry (1984) have investigated the various mechanisms responsible for lowering of water temperature in the upper layers in the eastern Arabian Sea during the southwest monsoon of 1979. They concluded that this lowering of temperature is primarily due to the downward transfer of heat, which accounts for 55% of the total heat loss in the upper layers while 45% of heat is lost to the atmosphere. The water temperature increases once again September onwards and reaches to about 29°C over most of the Arabian Sea by November and remains steady over the entire region. The surface layers once again start cooling from December. This cooling first sets in the western and central regions while the eastern parts maintain a relatively higher temperature. By January, the surface temperatures are about 25°C north of 10°N and west of 65°E. The central and eastern regions do not cool appreciably and the temperature remains around 27°C. This cooling process ceases by February and warming begins. By May, the warming is complete and the surface temperature increases to 30°C in the open sea while still higher temperatures are reported immediately off west coast of India.

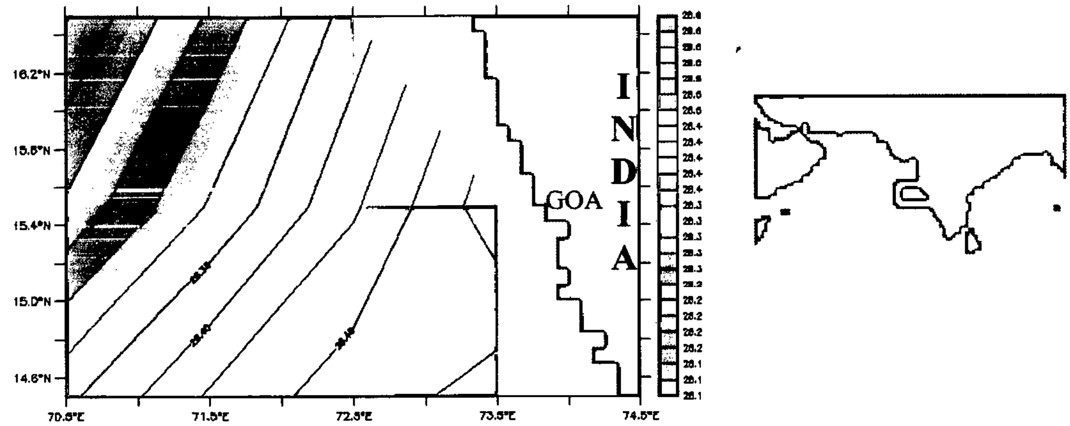


Figure 2.2: Annual mean sea surface temperature in off Goa region, central west coast of India. (Levitus, 1994)

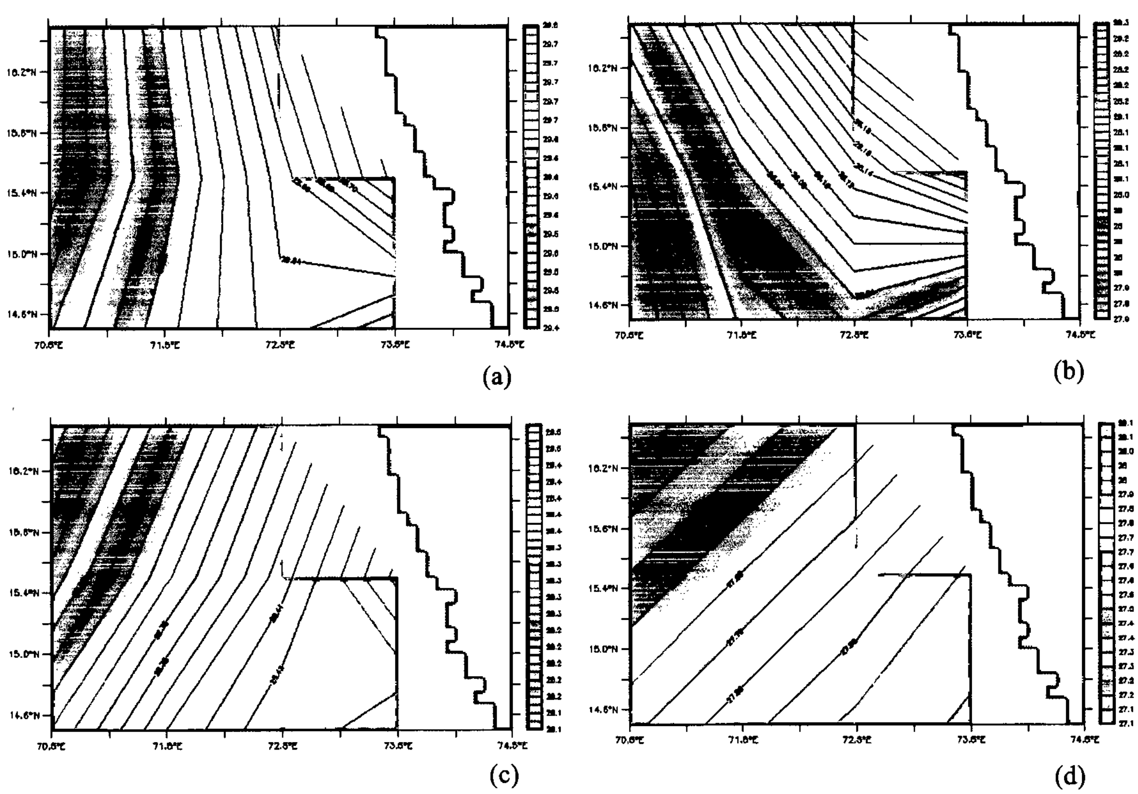


Figure 2.3: Seasonal mean sea surface temperature in off Goa region; (a) spring, (b) summer, (c) fall and (d) winter mean sea surface temperatures (Levitus, 1994)

Figure 2.2 provides the annual mean temperature variations in surface (0 m) water off Goa region, central west coast of India. Figure 2.3 shows the seasonal mean temperature variation in surface (0 m) water off Goa region; spring, summer, fall and winter mean temperatures are given in (a), (b), (c) and (d) respectively.

2.4.4 SALINITY

The entire Arabian Sea is composed of high salinity water (Wyrtki, 1973). The average salinity values for the Arabian Sea are 34-37‰ (Panikkar and Jayaraman, 1966). The structure of the upper layers of the Arabian Sea (Shetye *et al.*, 1994; Prasanna Kumar and Prasad, 1999) is dictated by the transport and mixing of the Arabian Sea high salinity water (ASHW, *rh* = 22.8–24.5), Persian Gulf water (PGW, *rh* = 26.2–26.8) and the Red Sea water (RSW, *rh* = 27.0–27.4). The Arabian Sea is an area of negative water balance where evaporation exceeds precipitation and runoff (Cullen and Prell, 1984). The excess of evaporation over precipitation is at its maximum (100-150 cm) along the western Arabian coast (NW Arabian Sea) and decreases steadily towards southeast (Warren *et al.*, 1966).

The salinity of the Arabian Sea does vary within the southwest and northeast monsoons. According to Wyrtki (1973), during the northeast monsoon a strong current carrying low salinity (<34.5‰) water from the Bay of Bengal turns north and flows along the west coast of India, into the eastern Arabian Sea during the period from November to January.

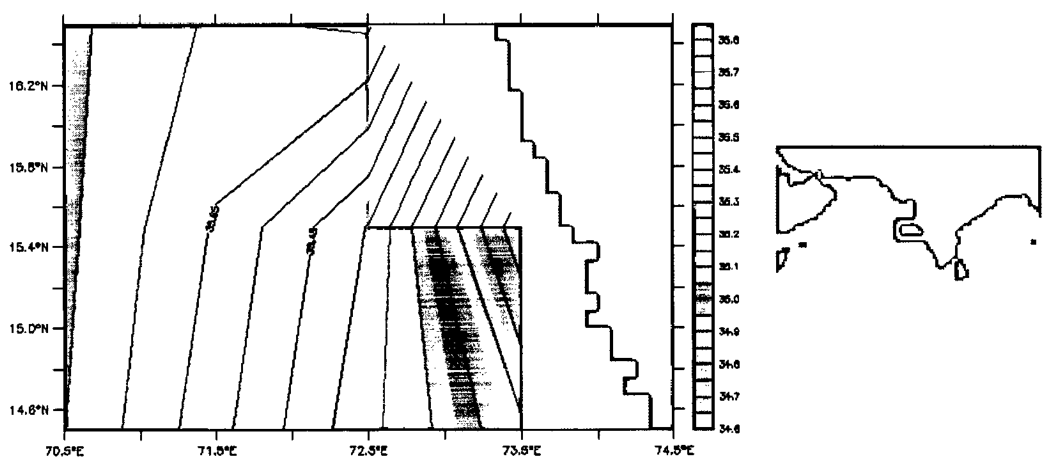


Figure 2.4: Annual mean sea surface salinity in the off Goa region, central west coast of India (Levitus, 1994)

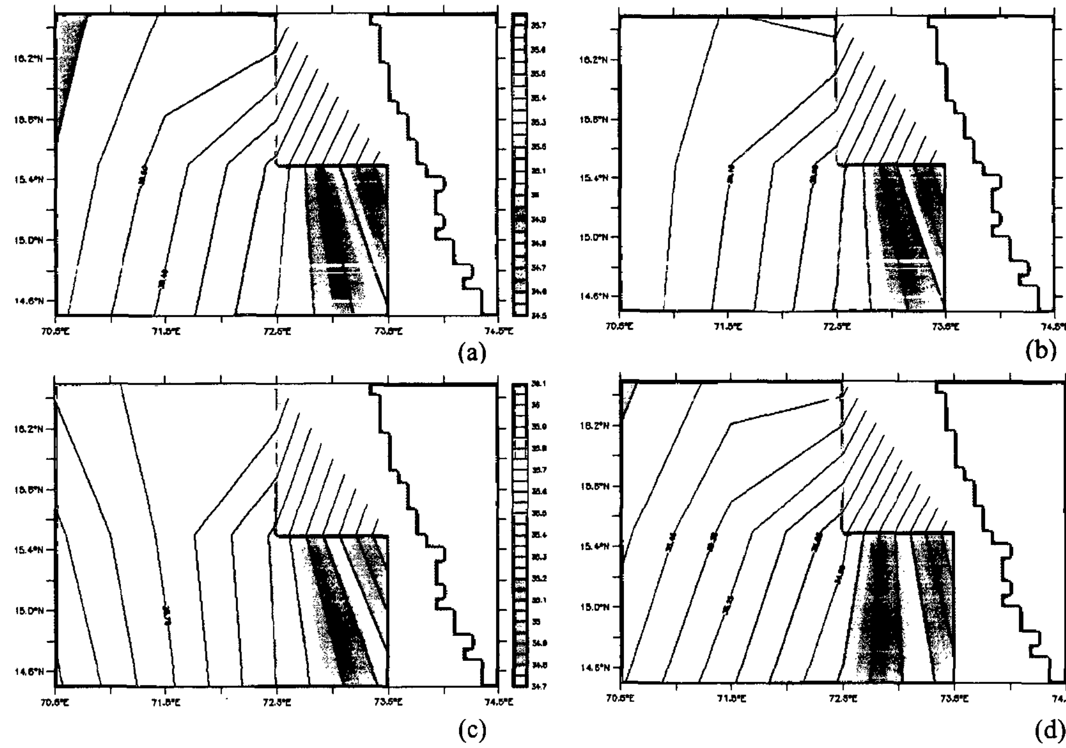


Figure 2.5: Seasonal mean sea surface salinity in off Goa region; (a) spring, (b) summer, (c) fall and (d) winter mean sea surface salinity (Levitus, 1994)

Figure 2.4 provides the annual mean salinity variations in surface (0 m) water off Goa region, central west coast of India. Figure 2.5 shows the seasonal mean temperature variations in surface (0 m) water off Goa region; spring, summer, fall and winter mean salinities are represented by (a), (b), (c) and (d) respectively.

2.4.5 DISSOLVED OXYGEN

The oxygen content of subsurface oceanic regions is controlled by input of water from areas where it interacts with the atmosphere and the consumption of free oxygen through oxidation. Thus, the oxygen concentration at any location depends on the rate at which water is transported from a region of atmospheric contact and the amount of organic matter decomposed during the transit. The combination of high surface water productivity and moderate rates of thermocline ventilation (You and Tomczak, 1993) leads to an intense Oxygen Minima Zone (OMZ) between 150 to 1200 m water depth (Wyrtki, 1971, 1973; Deuser *et al.*, 1978; Olson *et al.*, 1993; Dulk *et al.*, 1998), with oxygen level below 2 m*M* (Van Bennekom and Hiehle, 1994). According to Naqvi (1991, 1994), Morrison *et al.* (1999) and Rengarajan *et al.* (2003), a widespread OMZ occurs within the Arabian Sea, between the depths of 100 and 1200 m due to active denitrification. It has been also reported that the presence of well-marked OMZ between 250 and 1000 m water depth of northeastern Arabian Sea (Wyrtki, 1973; Rad *et al.*, 1999) results in preservation of mm-scale laminated (varved) sediments (Stackelberg, 1972; Schulz *et al.*, 1996; Rad *et al.*, 1999). Studies of Wyrtki (1971, 1973), Tchernia (1980), Hermelin and Shimmield (1990) and Gupta (1994a, b) show a pronounced OMZ at about 200-1200 m beneath the Arabian Sea High Salinity Water (Kurbjeweit *et al.*, 2000).

On the Oman margin the OMZ extends down from about 60 m to about 1000 m depth, with gradually increasing dissolved oxygen below this depth to a near-saturated normal oxygen level at0 2000-2500 m (Lamont and Gage, 2000). Bottom-water oxygen concentrations drop abruptly from 3 to ~0.1 ml l^{-1} at a water depth of ~100 m, rising gradually to 1ml l^{-1} at ~1500 m, and once again reaches to ~3 ml l^{-1} below 3000 m water depth (Smith *et al.*, 2000).

Figure 2.6 shows the annual mean oxygen concentration in surface (0 m) water off Goa region, central west coast of India. Figure 2.7 is the seasonal mean oxygen concentration variation in surface (0 m) seawater off Goa region; spring, summer, fall and winter mean temperatures are shown by (a), (b), (c) and (d) respectively.

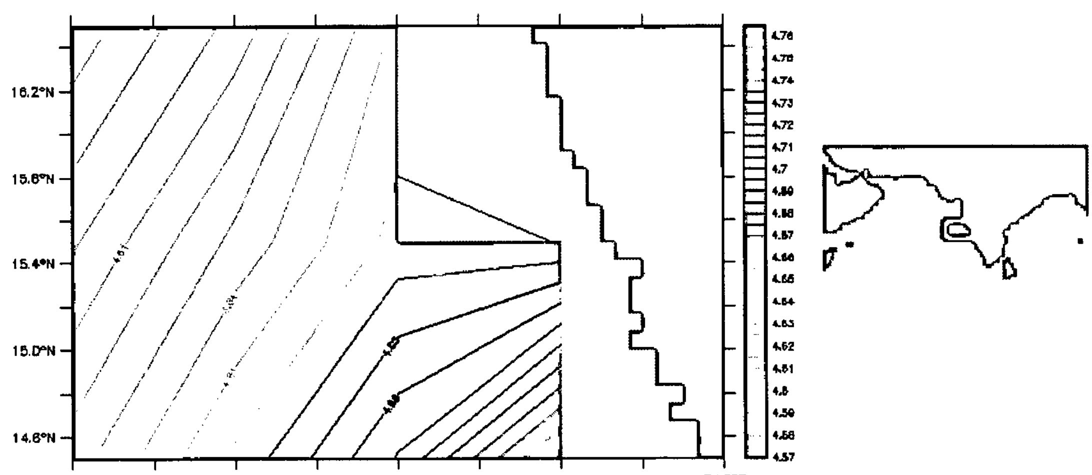


Figure 2.6: Annual mean sea surface oxygen concentration in off Goa region, central west coast of India. (Levitus, 1994)

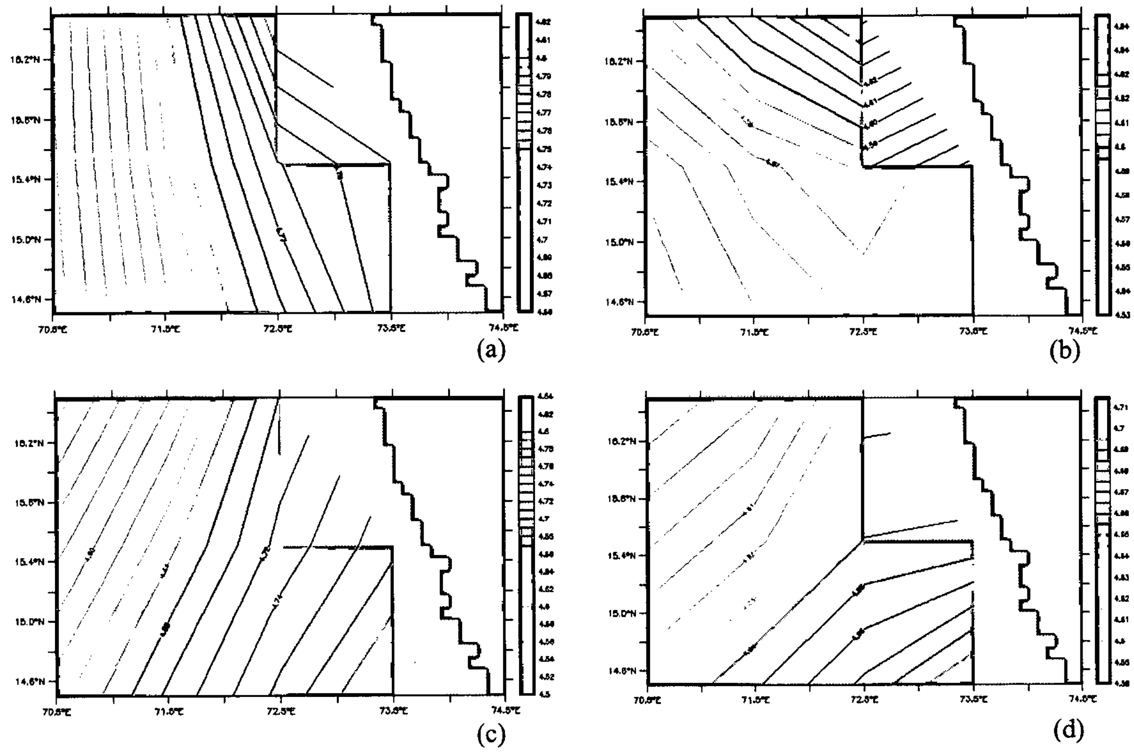


Figure 2.7: Seasonal mean sea surface oxygen concentration in off Goa region; (a) spring, (b) summer, (c) fall and (d) winter mean sea surface oxygen concentration (Levitus, 1994)

2.4.6 PRIMARY PRODUCTIVITY

The Indian Ocean monsoon circulation leads to intense seasonal variation in primary productivity. Chlorophyll data from ship observations (Banse, 1987) and satellite data (Brock *et al.,* 1991) clearly demonstrate monsoon-related productivity changes in the western and central Arabian Sea. A series of sediment trap studies in the Arabian Sea showed that the total sediment flux is strongly correlated with the flux of organic carbon (r = 0.9) and both in turn with wind intensity (Nair *et al.,* 1989; Sirocko and Ittekkot, 1992). The sediment traps show rather similar seasonal flux patterns in the western and central Arabian Sea, with higher fluxes during both SW and NE monsoon (Nair *et al.,* 1989; Ittekkot *et al.,* 1992; Ramaswamy and Nair, 1994). In the eastern Arabian Sea the particle flux is low during the NE monsoon; this is probably due to strong stratification resulting from the inflow of low-salinity water from the eastern tropical Indian Ocean (Nair et *al.,* 1989). As all three traps were located far offshore, the similarity of higher particle fluxes during the monsoons is not only related to coastal upwelling but also suggests a relationship between particle flux and wind speed. Higher wind speeds during the monsoon also lead to a deepening of the mixed layer and the injection of nutrient-rich water into the euphotic zone (Nair *et al.,* 1989; Rao *et al.,* 1989; Ramaswamy and Nair, 1994), which in turn increases primary productivity. Figure 2.8 provides the integrated primary production over the Arabian Sea.

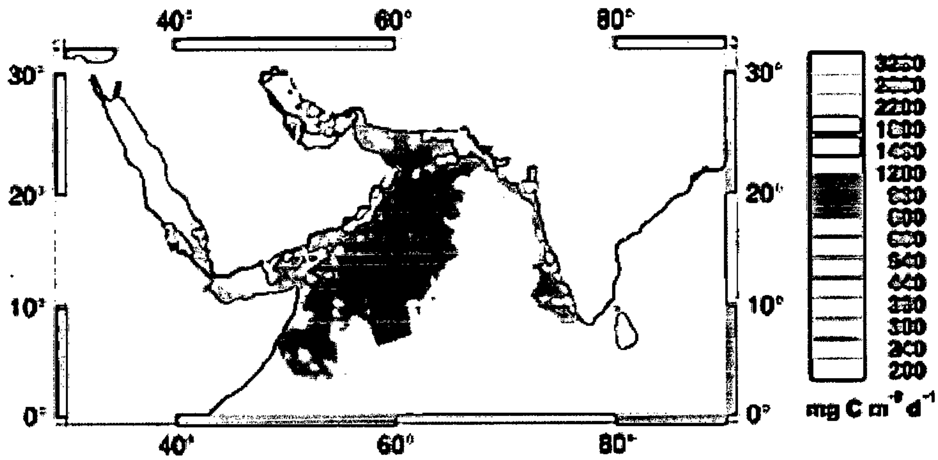


Figure 2.8: Integrated primary production over the Arabian Sea

2.5 SEDIMENT CHARACTERISTICS

2.5.1 NATURE OF THE SEDIMENT

Kolla *et al.* (1981) opined that the marginal areas of the northern and western Arabian Sea exhibit coarse-grained sediment, low in carbonate content (<10%) with large amount of quartz and feldspar indicating significant terrigenous sedimentation. The percentage of calcium carbonate in the sediments is low (<10%) on the continental shelf off India and near the Indus River, indicating dilution of marine sediment by terrigenous input. However, the continental slope is very rich in carbonate (~60-70%) indicating mostly marine sedimentation. The major input of terrestrial matter is from the Indus River (Slater and Kroopnick, 1984).

The western continental shelf of India has been extensively studied in order to understand the sediment types, their texture and origin with respect to Quaternary climatic changes (Nair and Pylee, 1968; Nair, 1971, 1974, 1975; Stackelberg, 1972; Nair *et al.*, 1978, 1982; Hashimi *et al.*, 1978; Nair and Hashimi, 1980; Hashimi and Nair, 1986; Mohapatra *et al.*, 1989).

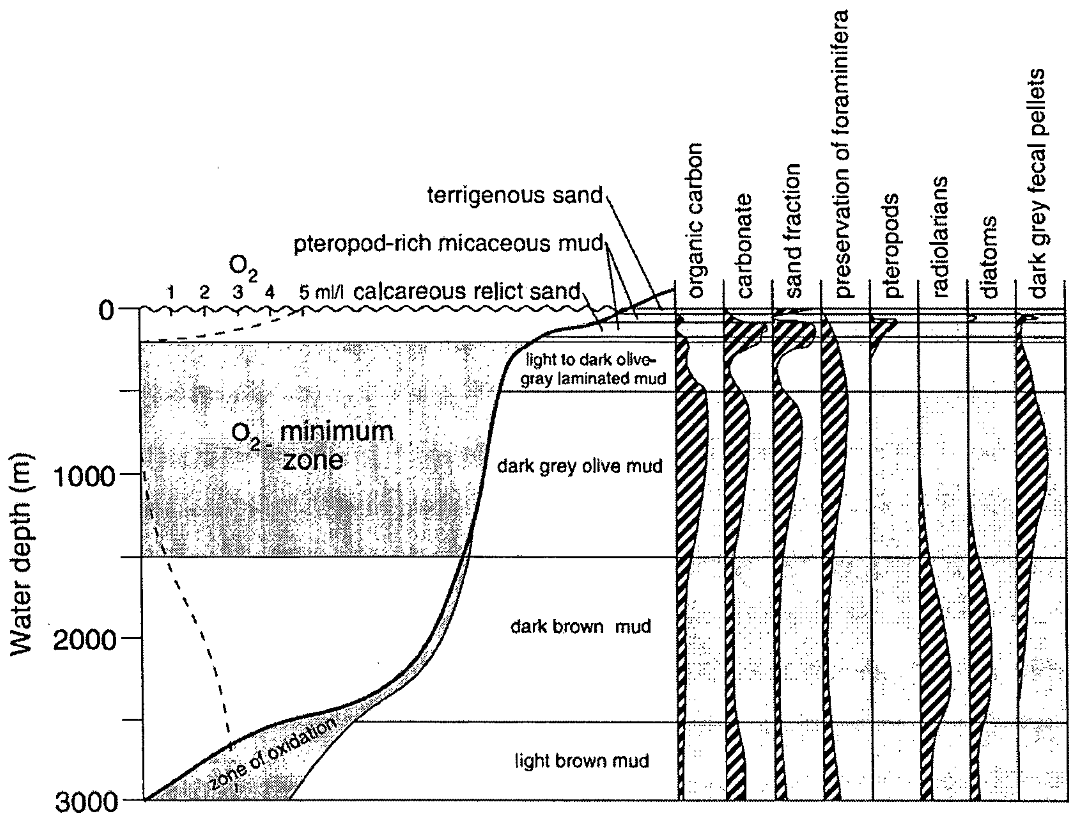


Figure 2.9: A summary of the relationship between dissolved oxygen concentrations and the types, colour, geochemical and biological properties of surface sediments from western continental margins off Indian and Pakistan (Cowie, 2005)

Figure 2.9 shows a summary of the relationship between typical water-column dissolved oxygen concentrations and the types, color, and geochemical and biological properties of surface sediments from the western continental margins off India and Pakistan (modified from Stackelberg, 1972). Schematic abundances of sediment components increase from left to right in each panel (Cowie, 2005).

On the basis of sediment texture, Satyanarayana and Ramana (1994) subdivided the north-eastern part of the Arabian Sea into three regions; (1) inner shelf, silty-clay with montmorillonite, (2) outer shelf, sand with illite, and (3) deep sea, clayey silt.

A detailed study of the surface sediments between Vengurla to Mangalore indicates that the inner shelf consists of silts and clays, calcareous sand on the outer shelf and silty sands on the upper continental slope (Nair *et al.*, 1978; Hashimi *et al.*, 1978). Furthermore, the coarse fraction is low in carbonate content in the inner shelf (<30%), intermediate on the outer shelf (30-90%) and high (>90%) on the upper continental slope. In the continental slope region, fine grained sediments (clayey silts, sandy clays) are encountered, which are olive grey to green in colour, and extend up to a depth of 1500 m beyond which muds occur (Rao and Murty, 1990).

2.5.2 ORGANIC CARBON

Considering the entire Arabian Sea, the high values of organic carbon (>4%) are reported in the coastal sediments that can even extend up to 500 km offshore (Slater and Kroopnick, 1984). The western (*i.e.*, off Africa) and northern (*i.e.*, off Pakistan) shelves and the northern slopes of the Arabian Sea are poor in organic carbon (<1-2%) while the sediments from a large part of the Arabian Peninsular slope and part of Pakistan slope have moderate organic carbon concentration (2-4%). Figure 2.10 shows the Total Organic Carbon distribution in the Arabian Sea (after Seiter *et al.*, 2005).

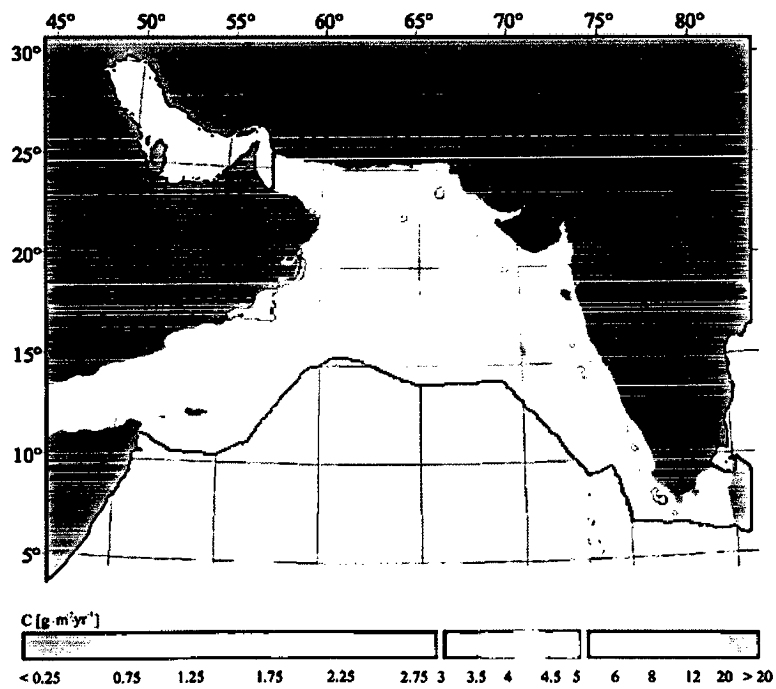


Figure 2.10: Total organic carbon distribution in the Arabian Sea (after Seiter *et al.*, 2005)

Along the Indian margin the organic carbon content in the sediments is very high. The inner shelf contains up to 4% organic carbon while on the outer shelf organic carbon concentration low (<1%). Along the shelf (from north to south) organic carbon content sediments north of Ratnagiri is <1-2%; between Ratnagiri and Quilon, 1-4%; and in the southern region <1%. In the slope regions, the zone of higher organic carbon content between Ratnagiri and Karwar is much wider than in other parts of the slope. In general the organic carbon content in the sediments is very high in the slope region (up to 12%), intermediate (2-4%) in the inner shelf sediments and low (<1%) in the outer shelf (Paropkari *et al.*, 1987).

CHAPTER 3
MATERIALS AND METHODS

To meet the objectives of the present study, quite a number of techniques were used and are described in the following sections chronologically.

3.1 WORK PLAN

A brief outline of the work carried out in the present study, beginning with the collection of the samples till the application of statistical methods to draw meaningful conclusions is given in the work plan in Figure 3.1. The summary of various field and laboratory methods is described step by step in the following sections.

3.2 SAMPLE COLLECTION

As part of the PAGES (Past Global Changes) program, 52 spade core samples within a water depth range of 15 m to 3300 m off Goa coast in the eastern Arabian Sea were collected on board *ORV Sagarkanya* during her 117 cruise in 1999. The area of operation covered 14°28'N to 16°14'N latitudes and 70°32'E to 74°15'E longitudes. During the collection wherever the corer was operated at depths more than 100 m, an ORE/BENTHOS pinger was attached to track the position of sample in relation to the seabed. A total of 164 sediment samples comprising of 52-core top and 112 subsurface samples from 10 cores were used for the present study. The location and depth of each core are given in Table 3.1 and shown graphically in Figure 3.2.

Normally grab samples are used for surface sediment collection. However, in order to have undisturbed samples we used spade cores.

3.3 LABORATORY METHODS

3.3.1 SUB SAMPLING

The upper two-centimeters (0-2 cm) of the 52 sediment cores was separated and treated as surface samples. Whenever the top comprised of unconsolidated sandy sediments, 0-4 or even 0-6 cm was considered as surface samples. Besides that, 10 full spade cores of average 25 cm length were sub-sampled at 2 cm interval, yielding 112 samples. Thus, a total of 164 samples were taken for the present study.

3.3.2 PROCESSING

After sub-sampling, ~5 g of each sample was taken in a watch glass and dried overnight at ~40-45°C. The dried samples were weighed and transferred to a 1000 ml beaker and soaked overnight in distilled water to disintegrate the sediments. Next day the overlying water was decanted with a narrow diameter rubber pipe without disturbing the sediments. Fresh distilled water was added to the sediments if the overlying water was not clear (turbidity due to the colloidal materials in sediments) and kept overnight. This process was continued until the overlying water became clear. Finally, the water was drained out and 10 ml. of 10% sodium hexametaphosphate [$(NaPO_3)_6$] was added to disperse the clay lumps. In case of high percentage of clay (specially in deepwater samples), excess sodium hexametaphosphate was added to completely disperse the clay particles. Next day 5 ml hydrogen peroxide (H_2O_2) was added to oxidize the organic matter. The following day, the samples were washed through a 63 μm (240-mesh) sieve using a gentle shower in order to prevent the foraminiferal test from breaking till the filtrate become clear (all clay-silt particles were removed from overlying sandy materials). The filtrate (containing clay and silt particles) was collected in 1000 ml measuring cylinder. The volume of the filtrate was leveled to 1000 ml by adding the desired amount of water and stirred vigorously with a stirrer. The stirred filtrate was kept undisturbed for a predetermined time depending upon the ambient temperature. Later, inserting the pipette upto 10 cm depth into the filtrate column, 25 ml of filtrate was pipetted out. This filtrate was placed on to a previously weighed 50 ml beaker and kept for drying at 40-45°C. Meanwhile, the cleaned and properly washed fraction retained over the 63 μm sieve was transferred over a previously weighed fresh filter paper, and kept for drying at 40-45°C (Krumbein and Pettijohn, 1938).

Next day, both, the 50 ml beaker with 25 ml filtrate and the filter paper with >63μm fraction were weighed to get the weight of clay (after recalculating from 25 ml to 1000 ml) and sand fractions, respectively. The weight of silt was calculated by subtracting the total weight of sand and clay from the total dry weight of the sample. Based on sand-silt-clay percentage the texture of the sediments was computed as per the procedure given by Shepard (1954) and presented in Table 3.1. The >63μm fraction (sand fraction) was transferred to plastic vials for use in foraminiferal studies.

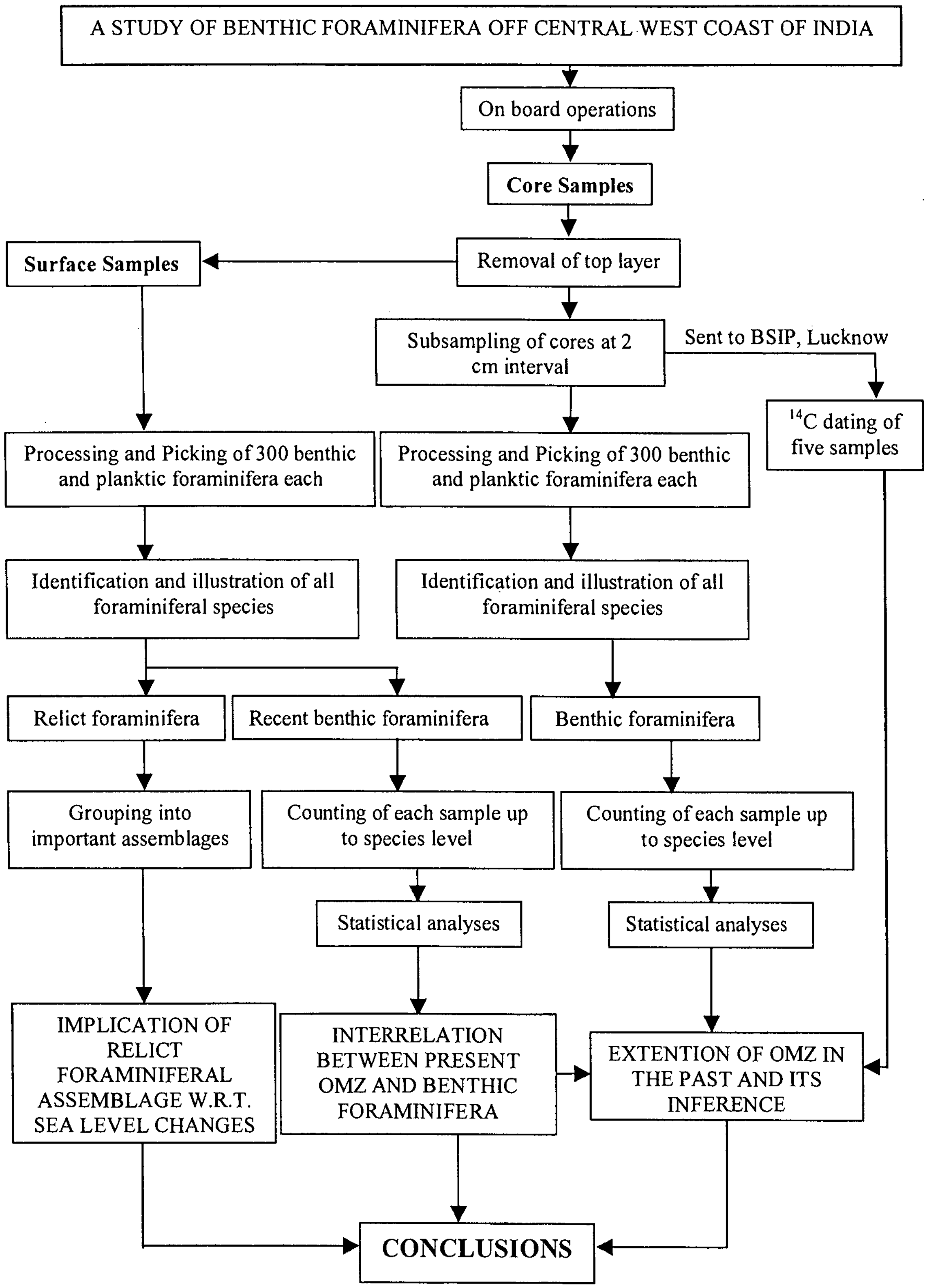


Figure 3.1: Flow chart of the work planned for the present study

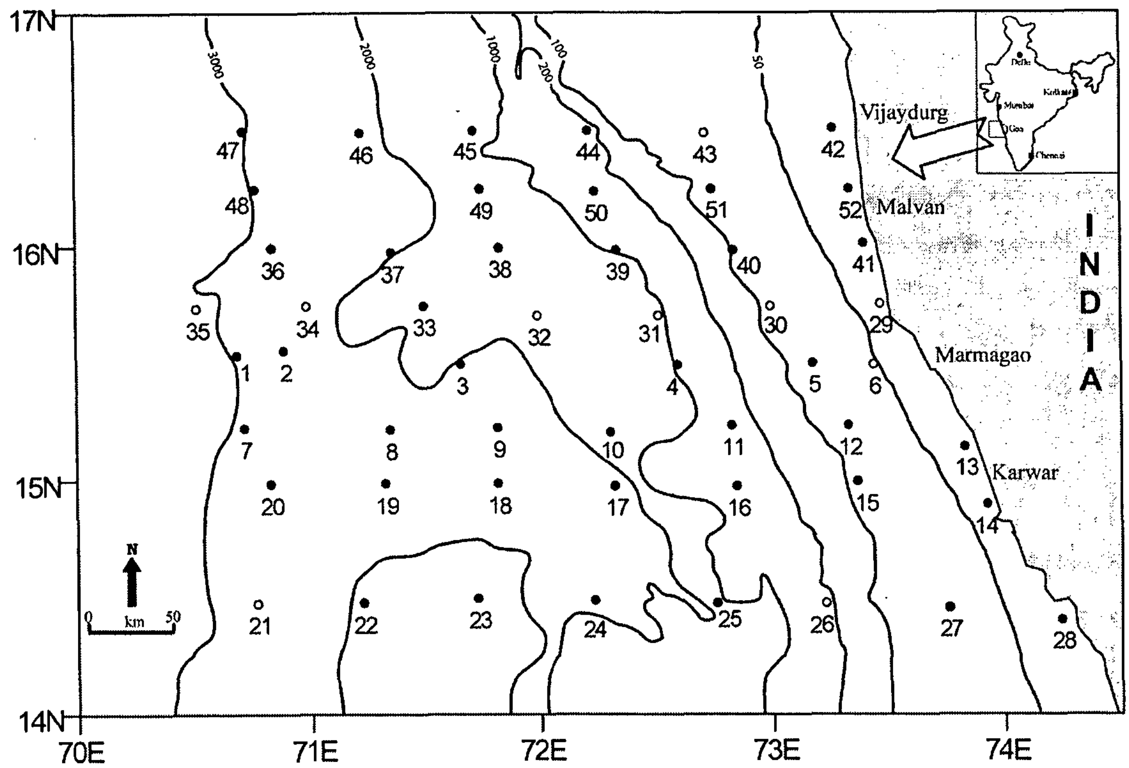


Figure 3.2: Location of surface and core samples analyzed. The shaded circles are the locations from which only the surface sediment samples were analyzed while the hollow circles represent the locations from which both, the surface as well as subsurface samples were analyzed. Depth contours are in meters.

Table 3.1: Geographical location and texture of the sediment samples of the study area

Sr. No	Sample No	Latitude (°N)	Longitude (°E)	Water Depth (m)	Length of the spade cores used for study	Texture of surface sediments
1	SC-01	15.53	70.69	3140		Silty Clay
2	SC-02	15.55	70.89	2775		Silty Clay
3	SC-03	15.49	71.66	2170		Silty Clay
4	SC-04	15.49	72.60	1000		Silty Clay
5	SC-05	15.50	73.18	86		Sand
6	SC-06	15.49	73.44	56	24 cm	Silty Clay
7	SC-07	15.22	70.72	2850		Sand-Silt-Clay
8	SC-08	15.21	71.35	2180		Silty Clay
9	SC-09	15.22	71.82	2050		Silty Clay
10	SC-10	15.20	72.31	2020		Silty Clay
11	SC-11	15.23	72.83	380		Clayey Sand
12	SC-12	15.23	73.33	70		Sand
13	SC-13	15.14	73.83	21		Silty Clay
14	SC-14	14.89	73.93	18		Silty Clay
15	SC-15	14.99	73.37	80		Sand
16	SC-16	14.97	72.85	780		Silty Clay
17	SC-17	14.97	72.33	1900		Sand-Silt-Clay
18	SC-18	14.98	71.82	1950		Silty Clay
19	SC-19	14.98	71.33	2300		Silty Clay
20	SC-20	14.98	70.83	2750		Silty Clay
21	SC-21	14.47	70.77	2750	20 cm	Silty Clay
22	SC-22	14.47	71.23	2040		Silty Clay
23	SC-23	14.49	71.73	1900		Silty Clay
24	SC-24	14.48	72.24	2050		Silty Clay
25	SC-25	14.47	72.76	1470		Silty Clay
26	SC-26	14.47	73.23	240	25 cm	Silty Sand
27	SC-27	14.45	73.76	62		Sand
28	SC-28	14.40	74.25	15		Silty Clay
29	SC-29	15.75	73.47	18	27 cm	Sandy Clay
30	SC-30	15.74	73.00	90	25 cm	Sand
31	SC-31	15.70	72.52	1130	27 cm	Silty Clay
32	SC-32	15.70	72.00	1650	28 cm	Sand-Silt-Clay
33	SC-33	15.74	71.50	2200		Sand-Silt-Clay
34	SC-34	15.74	70.99	2600	28 cm	Silty Clay
35	SC-35	15.73	70.52	3300	26 cm	Silty Clay
36	SC-36	15.99	70.84	2850		Sand-Silt-Clay
37	SC-37	15.97	71.36	2420		Silty Clay
38	SC-38	15.99	71.83	1920		Silty Clay
39	SC-39	15.98	72.34	1040		Clayey Silt
40	SC-40	15.98	72.84	100		Sand
41	SC-41	16.01	73.40	20		Silty Clay
42	SC-42	16.50	73.27	28		Sandy Clay
43	SC-43	16.48	72.72	75	25 cm	Sand
44	SC-44	16.49	72.22	325		Sand
45	SC-45	16.49	71.72	1650		Silty Clay
46	SC-46	16.48	71.23	2350		Silty Clay
47	SC-47	16.49	70.72	3000		Clayey Silt
48	SC-48	16.24	70.77	3000		Silty Clay
49	SC-49	16.24	71.75	1680		Silty Clay
50	SC-50	16.23	72.25	294		Sandy Silt
51	SC-51	16.24	72.75	80		Sand
52	SC-52	16.24	73.34	19		Silty Clay

3.3.3 PICKING

The dried >63μm fraction from each sample was taken for picking foraminifera. Since picking of foraminifera from total sample is a tedious and time-consuming job, a representative fraction was taken after coning and quartering total sample several times. The richness of the fauna in this representative fraction, decides the quantity to be taken for weighing so that approximately 300-500 specimens of foraminifera be available for quantifying the data.

The weighed material was then spread evenly over a gridded picking tray. With the help of a moist brush (000/00 fine art), approximately 300 to 500 foraminifera (each for benthic and planktonic) were picked and mounted onto different faunal slides. Thus, a total of 100,358 specimens were picked. Relict fauna were placed in same benthic slides, but in separate grids. The remaining portions of the samples were scanned for rare species (if any) and good specimens for the purpose of illustration.

3.3.4 IDENTIFICATION

After picking ~300 benthic and planktic specimens each from all samples, representative slides were prepared for identification. Representative slides contained benthic foraminiferal specimens of one genus or of almost similar genera in each chamber. Foraminiferal fauna from each representative slide was identified up to the species level, as described and illustrated by Loeblich and Tappan (1988). For identification, each specimen was compared with similar specimens described and illustrated with plates, by previous workers in available literatures (papers, books, treatises, monographs, reports etc.). Care was also taken to follow up any changes in scientific name of the specimens, if present and all the possible shifts were noted under its systematic taxonomic part with short remarks. The nomenclature of some specimens that were not matching with any reported species was kept open under the same genus. We restrained from assigning new names due to insufficient specimens in such cases.

The same procedure was followed for the relict fauna identification. Most of the specimens were identified up to species level. However, a few relict specimens were highly abraded and polished. Hence the specific characters for proper identification were obliterated. In such cases, only generic names were assigned.

3.3.5 PREPARATION OF ILLUSTRATIONS

For all the representative specimens, photographs were taken using Olympus Camedia C-5060 digital camera attached to a binocular reflected light microscope Olympus SZX12. The maximum possible views of each specimen were photographed. Relict foraminifera were examined using Scanning Electron Microscope JEOL TM 300, since their features were obliterated due to polishing and abrasion. All digital photographs were arranged following the systematic taxonomy of Loeblich and Tappan (1988) using Adobe Photoshop 7.0 and Adobe Illustrator 10.0. White length bar (100 μm in length, unless mentioned otherwise) was placed for each photograph.

All the holotypes were duly indexed with numbers and placed in the repository of Micropaleontology Laboratory, Geological Oceanography Division, National Institute of Oceanography, Goa.

3.3.6 COUNTING

After proper identification of representative specimens (both surface and subsurface samples), the abundance of each species (decided by comparing with representative specimens) was counted. The percentage abundance of all species was calculated for each surface and subsurface sediment sample against the total number of benthic foraminifera present. This data was used for statistical analyses.

3.4 STATISTICAL ANALYSES

In order to draw meaningful inferences, from the large set of foraminiferal data, cluster analysis was performed.

'Clustering' means to place objects into more or less homogeneous groups or assemblages to explain the relationship between the groups. It is an efficient way to display complex relationships amongst many objects (in this case percentage distribution of different genera). Percentage data of different genera form the basis for R-mode (genera to genera) cluster analysis. Relationship was computed by using the Euclidian distance coefficient (d_{ij}) as per the formula given below.

$$d_{ij} = \sqrt{\sum^{m}_{k=1} (X_{ik} - X_{jk})^2 / m}$$

where X_{ik} denotes the k^{th} variable measured on object i and X_{jk} is the k^{th} variable measured on object j. In all, m variables are measured on each object, and d_{ij} is the distance between object i and object j (Davis, 1973). Thus a matrix of 45 × 45 was obtained. Cluster analysis was performed using weighted pair group averaging method.

The results are plotted as two dimensional hierarchy dendrogram wherein locations are presented along X-axis while similarity level is plotted on Y-axis.

3.5 PROCUREMENT OF SUPPORTING DATA

To substantiate the findings of the present study and to provide a chronological framework, supporting evidences were obtained through various published and unpublished reports, including data on barnacles, ^{14}C dates and foraminiferal information from the surrounding region.

3.5.1 BARNACLES

It is a common name for several species of Crustaceans, which constitute the subclass Cirripedia. In the adult form, Crustaceans are encased in hard calcareous shells and are permanently attached to surfaces which are completely submerged or periodically wetted. Although barnacles appear like clams, they are in fact related to lobsters. But unlike latter, barnacles are unable to move from a site (*e.g.*, rock, piling, bottom of a ship) once they fix and attach themselves (Groves and Hunt, 1980).

The barnacle fouling on relict foraminifera (Nigam *et al.*, 1993) as shown in Figure 3.3 also found in the present study and necessary literatures have been consulted, which is eventually a good indicator to decipher the paleoclimate. This aspect is discussed in Chapter 5

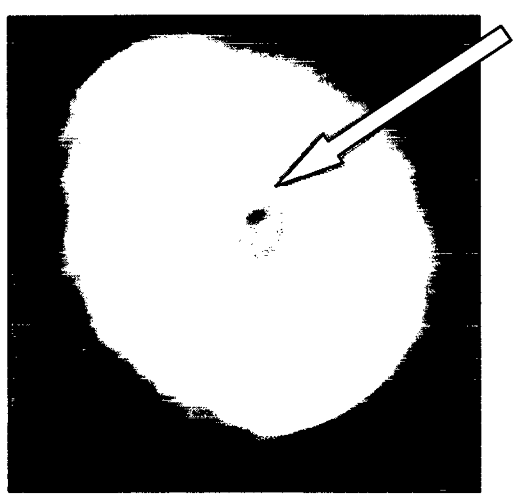


Figure 3.3: Barnacle species *Tetraclita squamosa* encrusted on relict foraminifera (after Nigam *et al.*, 1993)

3.5.2 RADIO CARBON DATING

Radioactive Carbon-14 gives us an opportunity to date the organic and inorganic processes involving Carbon over periods of the order of three to five times the half-life of ^{14}C, which is ~5730 years.

In order to give the precise time and age to the various climatic events, ^{14}C dating for five sediment samples from two selected cores were obtained. 5-10 gm of each sample with 75-90% calcium carbonate was sent to Birbal Sahani Institute of Paleobotany, Lucknow. The radiocarbon age of the samples are given in Table 3.2 below. The implications of the data are discussed in Chapter 7.

Table 3.2: Radiocarbon age determination of samples

Sample No. (Core level in cm)	Water depth	Radio Carbon ages based on half life = 5730±40 yrs	Reservoir corrected age (yrs BP)	Calibrated age (yrs BP)
SC-26 (10-12)	240 m	7130±110	6120±110	7170-6880
SC-26 (22-25)	240 m	11950±110	10800±110	12910-12640
SC-32 (0-2)	1650 m	3610±100	2700±100	2990-2750
SC-32 (12-14)	1650 m	6190±110	5210±110	6160-5890
SC-32 (26-28)	1650 m	10490±190	9380±180	11090-10290

3.5.3 FORAMINIFERAL DATA FROM SURROUNDING REGIONS

The foraminiferal distribution data from the surface sediments of the inner shelf off Vengurla-Mangalore (Henriques, 1993) was procured and used in the present study to understand the variations in foraminiferal population along the depth profile.

Table 3.3: Geographical location of the samples off Vengurla-Mangalore (Henriques, 1993)

Sr.No.	Samples No.	Latitude (°N)	Longitude (°E)	Water Depth (m)
1	18/1	15.91	73.28	54
2	18/2	15.90	73.23	68
3	18/3	15.84	73.17	78
4	18/4	15.78	73.12	88
5	18/5	15.86	72.88	100
6	18/7	15.91	72.70	220
7	18/9	15.91	72.51	990
8	18/10	15.92	72.42	1050
9	18/11	15.91	72.33	1330
10	18/13	15.73	72.98	115
11	18/16	15.75	73.38	62

Table 3.3 (Contd.)

12	18/17	15.73	73.26	61
13	18/19	15.53	73.46	57
14	18/20	15.53	73.37	58
15	18/21	15.53	73.28	64
16	18/22	15.53	73.18	80
17	18/24	15.53	73.08	115
18	18/26	15.53	72.81	332
19	18/27	15.33	72.94	126
20	18/30	15.33	73.25	80
21	18/31	15.33	73.35	65
22	18/32	15.33	73.46	56
23	18/33	15.33	73.56	51
24	18/36	15.16	73.36	75
25	18/38	15.17	73.20	93
26	18/39	15.16	73.08	111
27	18/42	14.97	73.17	112
28	18/43	14.96	73.28	99
29	18/46	14.93	73.55	61
30	18/47	14.95	73.73	54
31	18/48	14.78	73.80	48
32	18/49	14.76	73.73	58
33	18/55	14.93	73.09	206
34	18/56	14.55	73.14	210
35	18/57	14.55	73.24	140
36	18/58	14.55	73.35	105
37	18/59	14.55	73.45	96
38	18/60	14.55	73.39	82
39	18/63	14.55	73.87	46
40	18/68	14.36	73.45	110
41	18/69	14.36	73.35	146
42	18/70	14.37	73.25	218
43	18/71	14.16	73.31	210
44	18/72	14.16	73.41	109
45	18/73	14.22	73.60	85
46	18/75	14.22	73.73	71
47	18/76	14.20	73.81	61
48	18/79	14.00	74.10	52
49	18/82	14.00	73.79	66
50	18/85	14.00	73.50	117
51	18/86	14.00	73.40	176

The details of such selected samples are given in Table 3.3. The foraminiferal data from these samples are used in Chapter 5 and Chapter 6.

CHAPTER 4

COMPOSITION AND SYSTEMATIC TAXONOMY

4.1 INTRODUCTION

The systematic taxonomy of foraminifera is a fundamental requirement for using them in stratigraphic and ecological applications. Thus, the foraminiferal studies began with their taxonomic investigation. This is because paleoecological reconstruction based on biostratigraphy depends upon precise determination of species. It is therefore necessary to have a sound taxonomic foundation. With the tremendous increase in database, reference material and research reports on foraminifera coming in from all over the globe, it has become practically difficult to achieve this target. Thus, the establishment of the taxonomic status of foraminifera in different regions (sectors) of the world is required. For the systematic taxonomy of foraminifera the widely utilised classifications proposed by Loeblich and Tappan (1988) has been followed in the present study, as this classification embraces nearly all the observable characters and takes into consideration the phylogenetic relationship. Thus it has a horizontal approach and also is the most up dated database. However, the identification of species is based on the recent literature produced by various workers.

The synonymies have been greatly reduced and only those references which either refer to important shifts in the generic name or those which have species similar to the present study have been incorporated along with all possible references from the Indian waters. A brief note on taxonomy has been added wherever the need was felt. In systematic part, citation of reference starts from subfamily level only, as references above this level (order, suborder etc.) are well known, remained unchanged for long time and available in Treatise (Loeblich and Tappan, 1988).

Under the genus *Pyrgo* and *Dentalina* we have left many species unidentified as enough references are not available for comparison and such specimens though well developed are very few in numbers (kindly see 4.7).

4.2 CLASSIFICATION

In order to compile a comprehensive report on the foraminiferal occurrences from the shelf to abysal region off Goa, west coast of India, 52 surface sediment samples and 112 subsurface samples from 10 spade cores were analysed for their foraminiferal content. All the foraminiferal species encountered in the present study are described systematically below and references therein have been followed from the criteria adopted by Loeblich and Tappan (1988). In the systematics, the original references are given for all the species of foraminifera. The nomenclature of those species that could not be identified with any established taxa has been left open. Different species within a single genus are arranged alphabetically. To facilitate an accurate morphological comparison all the species were photographed using the Digital Camera and the Scanning Electron Microscope and are illustrated in Plates 1 to 23. This chapter presents in detail the over all composition of foraminifera.

4.2.1 REPOSITORY OF THE TYPE MATERIALS

All illustrated specimen have been deposited in the repository of the Micropaleontology Lab, Geological Oceanography Division, National Institute of Oceanography, Goa. In the text, each species is refered to by an identification number prefixed by the words "GOD NIO Cat No.GOA".

4.3 FORAMINIFERAL DIVERSITY

The detailed study of the foraminiferal fauna has revealed a total number of 423 species belonging to 163 genera, 73 families, 38 superfamilies and 6 suborders. Table 4.1, and Figures 4.1 to 4.4 show the detail composition of suborders, whereas Table 4.2 shows the distribution of families, genera and species under superfamilies.

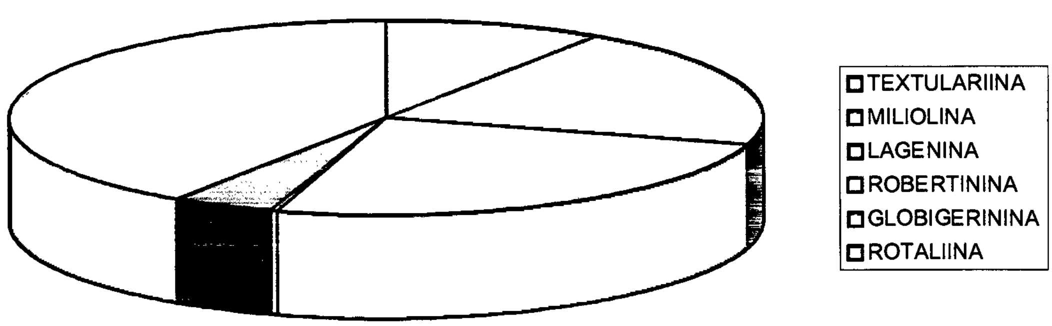


Figure 4.1: Relative abundance of Species under Suborders

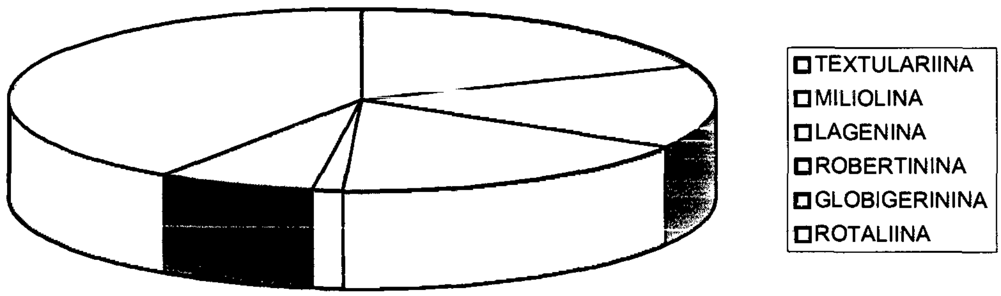


Figure 4.2: Relative abundance of Genus under Suborders

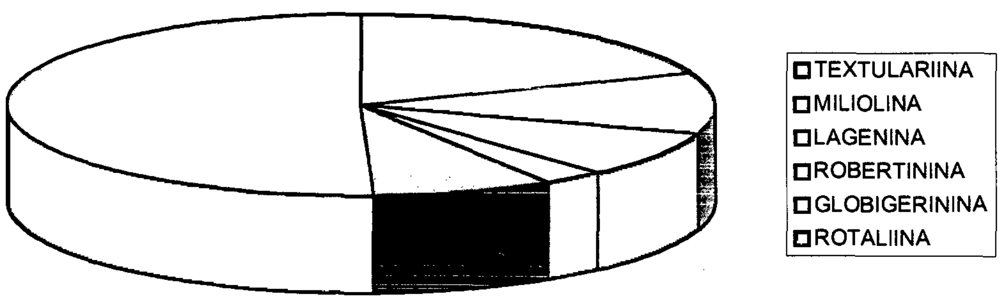


Figure 4.3: Relative abundance of Family under Suborders

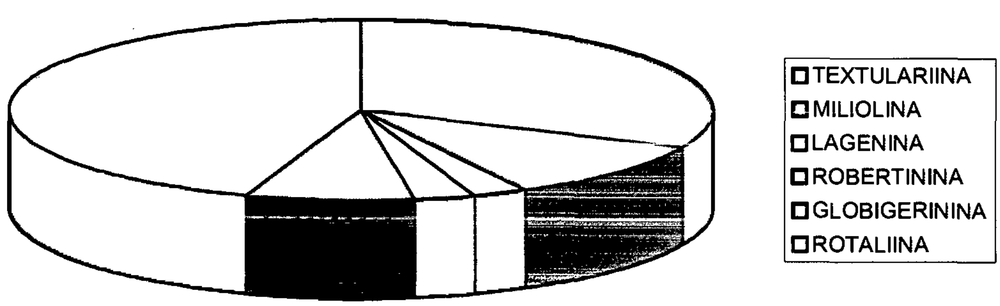


Figure 4.4: Relative abundance of Superfamily under Suborders

Table 4.1: Composition of Suborders of foraminifera

Sr. No.	Suborder	Percentage	Superfamilies	Families	Genera	Species
1	Rotaliina	40.66	17	37	66	172
2	Lagenina	24.82	1	6	28	105
3	Miliolina	20.33	4	8	24	86
4	Textulariina	09.46	12	14	31	40
5	Globigerinina	04.26	3	6	12	18
6	Robertinina	00.47	1	2	2	2

Table 4.2: Composition of Superfamilies of foraminifera

Sr. No.	Superfamily	Percentage	Families	Genera	Species
1	Nodosariacea	24.82269504	6	28	105
2	Miliolacea	17.73049645	3	15	75
3	Buliminacea	10.63829787	6	16	45
4	Nonionacea	5.200945626	1	5	22
5	Bolivinacea	4.964539007	1	2	21
6	Discorbinellacea	2.364066194	4	4	10
7	Rotaliacea	3.78250591	2	7	16
8	Discorbacea	3.309692671	5	7	14
9	Cassidulinacea	2.600472813	1	4	11
10	Globigerinacea	2.364066194	1	6	10
11	Chilostomellacea	2.364066194	5	6	10
12	Textulariacea	2.127659574	2	6	9
13	Hormosinacea	1.654846336	1	5	7
14	Cornuspiracea	1.891252955	3	6	8
15	Lituolacea	1.654846336	2	5	7
16	Globorotaliacea	1.654846336	4	5	7
17	Trochamminacea	1.182033097	1	3	5
18	Asterigerinacea	0.945626478	2	3	4
19	Ammodiscacea	0.709219858	1	3	3
20	Nummulitacea	0.709219858	1	2	3

Table 4.2 (Contd.)

21	Loftusiacea	0.472813239	1	2	2
22	Spiroplectamminacea	0.472813239	1	2	2
23	Verneuilinacea	0.236406619	1	1	1
24	Soritacea	0.472813239	1	2	2
25	Ceratobuliminacea	0.472813239	2	2	2
26	Astrorhizacea	0.236406619	1	1	1
27	Hippocrepinacea	0.236406619	1	1	1
28	Haplophragmiacea	0.236406619	1	1	1
29	Ataxophragmiacea	0.236406619	1	1	1
30	Alveolinacea	0.236406619	1	1	1
31	Heterohelicacea	0.236406619	1	1	1
32	Loxostomatacea	0.236406619	1	1	1
33	Bolivinitacea	0.236406619	1	1	1
34	Turrilinacea	0.236406619	1	1	1
35	Pleurostomellacea	0.236406619	1	1	1
36	Stilostomellacea	0.236406619	1	1	1
37	Glabratellacea	0.236406619	1	1	1
38	Planorbulinacea	2.364066194	3	4	10

Figure 4.5 represents the distribution of species under each superfamily. The dominance of species belong to families Hauerinidae, Ellipsolagenidae, Lagenidae, Nodosariidae, Nonionidae, Bolivinidae, Uvigerinidae, Vaginulinidae, Spiroloculinidae, Cassidulinidae and Buliminidae (which constitute more than 10 species each) is in decreasing order. But as far as species diversity is concerned the details are given in Table 4.3.

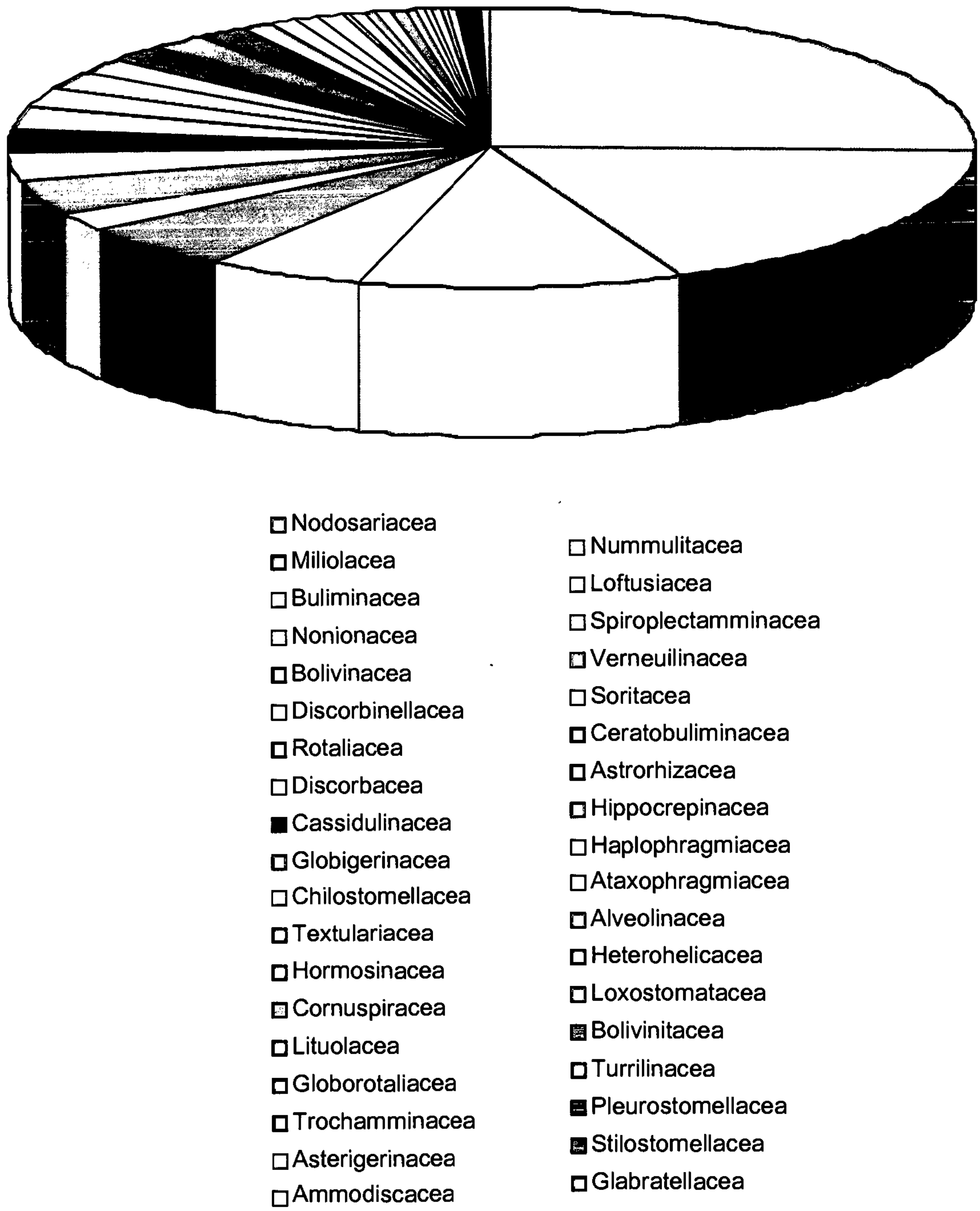


Figure 4.5: Relative abundance of Species under Superfamily

Table 4.3: Composition of major Families of foraminifera

Sr.No.	Family	Percentage	Genera	Species
1.	Hauerinidae	13.71158392	11	58
2.	Ellipsolagenidae	8.037825059	7	34
3.	Lagenidae	5.910165485	3	25
4.	Nodosariidae	5.200945626	6	22
5.	Nonionidae	5.200945626	5	22
6.	Bolivinidae	4.964539007	2	21
7.	Uvigerinidae	4.728132388	4	20
8.	Vaginulinidae	4.255319149	6	18
9.	Spiroloculinidae	3.78250591	3	16
10.	Cassidulinidae	2.600472813	4	11
11.	Globigerinidae	2.364066194	6	10
12.	Buliminidae	2.364066194	3	10
13.	Hormosinidae	1.654846336	5	7
14.	Rotaliidae	2.127659574	5	9
15.	Reussellidae	1.891252955	3	8
16.	Textulariidae	1.654846336	4	7
17.	Elphidiidae	1.654846336	2	7
18	Siphogerinoididae	1.182033097	4	5
19.	Bagginidae	1.182033097	2	5
20.	Parrelloididae	1.182033097	1	5
21.	Gavelinellidae	1.418439716	2	6
22.	Haplophragmoididae	1.182033097	3	5
23.	Trochamminidae	1.182033097	3	5
24.	Ophthalmidiidae	1.182033097	3	5
25.	Cibicididae	1.891252955	2	8
26.	Rosalinidae	0.945626478	2	4
27.	Ammodiscidae	0.709219858	3	3
28.	Polymorphinidae	0.709219858	3	3
29.	Glandulinidae	0.709219858	3	3
30.	Globorotaliidae	0.945626478	2	4
31.	Pseudoparrellidae	0.709219858	1	3
32.	Epistomariidae	0.472813239	2	2
33.	Nummulitidae	0.709219858	2	3
34.	Lituolidae	0.472813239	2	2
35.	Cyclamminidae	0.472813239	2	2

Table 4.3 Contd.)

36.	Spiroplectamminidae	0.472813239	2	2
37.	Eggerellidae	0.472813239	2	2
38.	Fischerinidae	0.472813239	2	2
39.	Soritidae	0.472813239	2	2

Families like Placentulinidae, Eponididae and Amphisteginidae are represented by 2 species belonging to only one genus and thus each contributes only 0.47% to the total foraminiferal population. Besides the above-mentioned families, the foraminifera belonging to the families like Discorbinellidae, Saccamminidae, Hippocrepinidae, Ammosphaeroidinidae, Prolixoplectidae, Globotextulariidae, Cornuspiridae, Riveroinidae, Alveolinidae, Ceratobuliminidae, Epistominidae, Guembelitriidae, Pulleniatinidae, Candeinidae, Bolivinellidae, Bolivinitidae, Stainforthiidae, Buliminellidae, Virgulinellidae, Pleurostoellidae, Stilostomellidae, Discorbidae, Glabratellidae, Planulinoididae, Planulinidae, Planorbulinidae, Chilostomellidae, Osangulariidae, Oridorsalidae, Heterolepidae and Catapsydracidae are also present. These all are rare families and each is represented by only one species and thus each contributes only 0.24% to the total foraminiferal population. Due to their low abundance, these families have not been listed in Table 4.3.

Amongst planktonic foraminifera, 6 families are present, *viz.* Guembelitriidae, Globorotaliidae, Pulleniatinidae, Candeinidae, Catapsydracidae and Globigerinidae. Family Globigerinidae is dominant and represented by 10 species belonging to 6 genera. This is followed by Globorotaliidae, which contains 4 species belonging to 2 genera. Family Catapsydracidae, Candeinidae, Guembelitriidae and Pulleniatinidae are represented only by one genus having one species each.

4.4 SPATIAL AND TEMPORAL DISTRIBUTION OF FORAMINIFERA

Both the surface and sub-surface sediment samples were analysed for foraminiferal content. A weighed fraction of all samples was taken such that the foraminiferal assemblage of each sample could be completely represented. Compositional study was divided into two categories; (1) composition of foraminifera in surfacial sediment and (2) composition of foraminifera in cores. The composition in surfacial sediments was further subdivided into two parts; (a) relict benthic foraminifera, (b) Recent foraminifera.

In the surface sedimens, some unique looking benthic foraminiferal specimens along with the recent ones have been found, which were identified as "relict". The term 'relict' is used for those foraminiferal specimens that have remained on the seafloor for thousands of years without any major transportation, and were identified by their earthy colour, dull luster, abraded or polished surface, broken parts with deposition of some secondary material (Murray, 1991). We report 32 species of relict foraminifera belonging to 14 genera. The following relict foraminiferal species occur from a water depth of 50-135 m in the study area:

Alveolinella quoyi d'Orbigny, 1826; *Ammonia tepida* (Cushman, 1926); *Amphistegina lessonii* d'Orbigny, 1826; *Amphistegina* sp.; *Elphidium advenum* (Cushman, 1922); *Elphidium craticulatum* (Fichtel and Moll, 1798); *Elphidium crispum* (Linne, 1758); *Elphidium discoidale* (d'Orbigny, 1840); *Elphidium macellum* (Fichtel and Moll, 1798); *Eponides* sp.; *Operculina complanata* (Defrance, 1822); *Operculina* sp.; *Quinqueloculina bicarinata* d'Orbigny, 1826; *Quinqueloculina intricata* Terquem, 1878; *Quinqueloculina kerimbatica* (Heron-Allen and Earland, 1915); *Quinqueloculina ludwigi* Reuss, 1866; *Quinqueloculina seminulum* (Linne, 1758); *Quinqueloculina vulgaris* d'Orbigny, 1826; *Quinqueloculina* sp.; *Rotalinoides papillosus* (Brady, 1884); *Sahulia conica* (d'Orbigny, 1839); *Siphonaperta agglutinans* (d'Orbigny, 1839); *Siphonaperta horrida* (Cushman, 1947); *Spiroloculina indica* Cushman and Todd, 1944; *Spiroplectinella sagittula* (d'Orbigny, 1839); *Textularia agglutinans* d'Orbigny, 1839; *Textularia bulbosa* (Hoglund, 1947); *Textularia cf. T.pseudogramen* Chapman and Parr, 1937; *Textularia* sp.; *Triloculina terqemiana* (Brady, 1884); *Triloculina tricarinata* d'Orbigny, 1826; *Triloculina* sp.

These relict foraminifera are not included in the descriptive part of systematic taxonomy. The distibution, ecology and paleolimatic significance of relict foraminifera will be discussed in Chapter 5.

The distribution (Annexure 1) and paleoclimatic significance of Recent benthic foraminifera from surface sediments will be discissed in Chapter 6.

The presence/absence of benthic foraminifera in the sub-surface sediments is given in Annexure 4. The complete, species wise percentage variations in a total of 112 samples from 10 cores are not given here due to limited space available, but the same is available in Micropaleontology lab of NIO. However, the down core variations of major genera in each core and their significance in paleoclimatic study are discussed in Chapter 7.

4.5 SYSTEMATIC TAXONOMY

4.5.1 SYSTEMATIC DESCRIPTIONS

Order FORAMINIFERIDA Eichwald, 1830
Suborder TEXTULARIINA Delage and Hérouard, 1896
Superfamily ASTRORHIZACEA Brady, 1881

4.5.1.1 Family SACCAMMINIDAE Brady, 1884
Subfamily PILULININAE Brady, 1884
Genus PILULINA Carpenter, 1870

***Pilulina* sp.**
Plate 1, Figure 1

Remarks: The specimens resemble *Pilulina jeffreysii* Carpenter described by Loeblich and Tappan (1988) only to a certain extent, *viz.* test shape and texture. Due of lack of prominent specific features in our specimens and lack of reference illustrations as well as number of species under this genus in the catalogue of foraminiferra and other literature, its nomenclature has been kept open under the genus *Pilulina.* A rounded shape, coarse agglutinated test and a sinuous aperture characterize these specimens.

Hypotype: Maximum diameter=0.3 mm.
Repository: GOD NIO Cat No.GOA-001

Superfamily HIPPOCREPINACEA Rhumbler, 1895

4.5.1.2 Family HIPPOCREPINIDAE Rhumbler, 1895
Subfamily HYPERAMMININAE Eimer and Fickert, 1899
Genus SACCORHIZA Eimer and Fickert, 1899

***Saccorhiza ramosa* (Brady)**
Plate 1, Figure 2

Hyperammina ramosa BRADY, 1879, p.33, pl.3, figs.14-15.
Saccorhiza ramosa (Brady) EIMER and FICKERT, 1899, p.670, v.65.

Hypotype: Maximum length=0.79 mm; diameter=0.11 mm

Repository: GOD NIO Cat No.GOA-002

Superfamily AMMODISCACEA Reuss, 1862

4.5.1.3 Family AMMODISCIDAE Reuss, 1862

Subfamily AMMODISCINAE Reuss, 1862

Genus AMMODISCUS Reuss, 1862

***Ammodiscus incertus* (d'Orbigny)**

Plate 1, Figure 3

Operculina incertus D'ORBIGNY, 1839, p.49, pl.6, figs.16-17.

Ammodiscus incertus (d'Orbigny) PARR, 1950, p.251.- RAO, 1998, p.40, pl.1, figs.8-9.

Remarks: Parr (1950) recorded this species and observed that the surface of this species is smooth and highly polished with no constituent sand grain being visible. He added that the Tasmanian specimens were reddish while the Antarctic ones are yellowish. In present study area, the specimens are yellowish in colour.

Hypotype: Maximum diameter=1.50 mm; thickness=0.30 mm

Repository: GOD NIO Cat No.GOA-003

Subfamily TOLYPAMMININAE Cushman, 1928

Genus AMMOLAGENA Eimer and Fickert, 1899

***Ammolagena clavata* (Jones and Parker)**

Plate 1, Figure 4

Trochammina irregularis var. *clavata* JONES and PARKER, 1860, p.304.

Webbiana clavata (Jones and Parker) BRADY, 1884, p.342, pl.41, figs.12-15.

Ammolagena clavata (Jones and Parker) EIMER and FICKERT, 1899, p.679.

Remarks: In off Goa region, this species is found to be attached to both planktonic (*Globorotalia menardii*) and benthic (*Ammodiscus tenuis*) foraminifera, with a large and ovoid proloculus followed by narrow tubular rectilinear second chamber of variable length but of nearly uniform diameter. The test wall is finely agglutinated, reddish brown in colour with a smooth glossy surface and a terminal, rounded aperture.

Hypotype: Length=1.00-1.30 mm, width of the proloculus=0.40-0.50 mm
Repository: GOD NIO Cat No.GOA-004

Subfamily USBEKISTANIINAE Vyalov, 1968
Genus USBEKISTANIA Suleymanov, 1960

***Usbekistania charoides* (Jones and Parker)**
Plate 1, Figure 5

Trochammina squamata var. *charoides* JONES and PARKER, 1860, p.304.
Gordiammina charoides (Jones and Parker) RHUMBLER, 1909.
Glomospira charoides (Jones and Parker) CUSHMAN, 1918.
Usbekistania charoides (Jones and Parker) CHARNOCK and JONES, 1990.

Remarks: *Usbekistania* differs from the irregularly coiled *Glomospira* in being strictly streptospiral that is in being characterized by regular changes in the axis of coiling.

Hypotype: Maximum diameter=0.63 mm; thickness=0.38 mm.
Repository: GOD NIO Cat No.GOA-005

Superfamily HORMOSINACEA Haeckel, 1894

4.5.1.4 Family HORMOSINIDAE Haeckel, 1894
Subfamily REOPHACINAE Cushman, 1910
Genus REOPHAX Montfort, 1808

***Reophax mortenseni* (Hofker)**
Plate 1, Figure 6

Hormosina mortenseni HOFKER, 1972, p.62, pl.18, figs.6-12.
Reophax mortenseni (Hofker) JONES, 1994, pl.31, fig.3-4.

Hypotype: Length=1.71 mm; maximum diameter=0.28 mm

Repository: GOD NIO Cat No.GOA-006

Reophax nodulosus **Brady**

Plate 1, Figure 7,12

Reophax nodulosus BRADY, 1884, pl.31, figs.3-4.

Hypotype: Length=1.75 mm; maximum diameter=0.24 mm

Repository: GOD NIO Cat No.GOA-007

Genus SCHEROCHORELLA Loeblich and Tappan, 1984

Scherochorella **sp.**

Plate 1, Figure 8

Remarks: These specimens were identified from the Treatise (1988) upto the generic level. Due to lack of specimens the species name was not assigned for this genus. Uniserial, agglutinated tests, undulated outer margins, fine-grained walls and rounded chambers characterize these specimens.

Hypotype: Maximum length=0.74 mm; maximum diameter=0.18 mm

Repository: GOD NIO Cat No.GOA-008

Genus SUBREOPHAX Saidova, 1975

Subreophax **cf.** ***S. monile*** **(Brady)**

Plate 1, Figure 9

Trochammina (*Hormosina*) *monile* BRADY, 1881, pl.39, fig.10-13.

Subreophax monile (Brady) JONES, 1994, pl.39, fig.10-13

Hypotype: Length=0.98 mm; maximum diameter=0.22 mm

Repository: GOD NIO Cat No.GOA-009

Subfamily HORMOSININAE Haeckel, 1894

Genus HORMOSINA Brady, 1879

***Hormosina globulifera* Brady**

Plate 1, Figure 10

Hormosina globulifera BRADY, 1879, p.60, pl.4, figs.4-5.

Hypotype: Maximum length=1.00 mm; maximum diameter=0.35 mm

Repository: GOD NIO Cat No.GOA-010

***Hormosina spiculifera* Hofker**

Plate 1, Figure 11

Hormosina spiculifera HOFKER, 1972, p.63, pl.19, figs.1-4.

Hypotype: Maximum length=1.05 mm; maximum diameter=0.28 mm

Repository: GOD NIO Cat No.GOA-011

Genus REOPHANUS Saidova, 1970

***Reophanus ovicula* (Brady)**

Plate 1, Figure 13

Hormosina ovicula BRADY, 1879, p. 61, pl.4, fig.6.

Reophanus ovicula (Brady) SAIDOVA, 1970, p.148.

Remarks: The type species of the genus *Reophanus* was included in the genus *Hormosinella* by Shchedrina (1969). But *Reophanus* has a finer grained wall with many layers, while *Hormosinella* has single layered wall with coarser grains. The specimens from the off Goa region have finer grained walls and *Hormosina ovicula* has been transferred under *Reophanus* by Saidova. So it has been placed under genus Reophanus in the present context.

Hypotype: Maximum length=1.5 mm; maximum diameter=0.33 mm

Repository: GOD NIO Cat No.GOA-012

Superfamily LITUOLACEA Blainville, 1827

4.5.1.5 Family HAPLOPHRAGMOIDIDAE Maync, 1952

Genus CRIBROSTOMOIDES Cushman, 1910

***Cribrostomoides* cf. *C. bradyi* Cushman**

Plate 1, Figure 14

Cribrostomoides bradyi CUSHMAN, 1910, p.108, pl.109, fig.167.

Remarks: The specimens from the present study area match well with *Cribrostomoides bradyi* described in Treatise (Loeblich and Tappan, 1988, pl.49, figs.1-3). However, according to the description and illustration given in Treatise, this species should normally have 6 chambers, while in our specimen only 4 chambers are present. Hence, the name of this specimen was given as *Cribrostomoides* cf. *C. bradyi*.

Hypotype: Length=1.19 mm; width=1.05 mm; thickness=1.09 mm.

Repository: GOD NIO Cat No.GOA-013

Genus HAPLOPHRAGMOIDES Cushman, 1910

***Haplophragmoides* cf. *H. tenuis* Cushman**

Plate 1, Figure 15

Haplophragmoides tenuis CUSHMAN, 1927, p.135, pl.1, fig.5.

Remarks: The specimens from off Goa region are closely related to *Haplophragmoides tenuis* described by Loeblich and Tappan (1988) and Ellis and Messina (1995). According to their illustration and description the number of chambers should be 6, but the number of chambers in our specimen is 4 and last whorl is conoidal. Hence the name *Haplophragmoides* cf. *H. tenuis* was assigned to these specimens.

Hypotype: Length=0.51 mm; width=0.36 mm; thickness=0.27 mm.

Repository: GOD NIO Cat No.GOA-014

Haplophragmoides **sp. A**

Plate 1, Figure 16

Remarks: These specimens were placed under the genus *Haplophragmoides*, after referring to the catalogue (Ellis and Messina, 1995) and different species of the same genus illustrated by Jones (1994). Due to the lack of species under this genus exactly matching with our specimens, the nomenclature was kept open. 4-5 chambers in outer whorl with involute test, globular chambers and slit-like aperture with lip characterize these specimens.

Hypotype: Length=0.52 mm.; width=0.39 mm; thickness=0.22 mm.
Repository: GOD NIO Cat No.GOA-015

Haplophragmoides **sp. B**

Plate 1, Figure 17

Remarks: These specimens from off Goa region were named under genus *Haplophragmoides*, after referring to the catalogue (Ellis and Messina, 1995) and different species of the same genus illustrated by Jones (1994). Medium sized grained walls; depressed umbilici, rounded and smooth outer margins and slit-like aperture characterize these specimens. Due to the lack of species under this genus exactly matching with our specimens, the nomenclature was kept open.

Hypotype: Length=0.23 mm; width=0.18 mm; thickness=0.09 mm.
Repository: GOD NIO Cat No.GOA-016

Genus VELERONINOIDES Saidova, 1981

Veleroninoides **sp.**

Plate 1, Figure 18

Remarks: Our specimens were placed under the genus *Veleroninoides*, after referring to the catalogue (Ellis and Messina, 1995). Due to lack of specimens from the present study area, the nomenclature was kept open. These specimens are very low trochospiral, with globular chambers and inclined sutures. 6 –7 chambers are seen on the dorsal side.

Hypotype: Length=0.85 mm.; width=0.73 mm; thickness=0.50 mm.
Repository: GOD NIO Cat No.GOA-017

4.5.1.6 Family LITUOLIDAE Blainville, 1827
Subfamily AMMOMARGINULININAE Podobina, 1978
Genus AMMOBACULITES Cushman, 1910

***Ammobaculites filiformis* Earland**
Plate 1, Figure 19

Ammobaculites agglutinans var. *filiformis* EARLAND 1934, p.92, pl.3, fig.11-13.
Ammobaculites filiformis Earland JONES, 1994, pl.32, figs.21?, 22-23.

Hypotype: Length=0.33 mm.; diameter of spiral chambers=0.10 mm.
Repository: GOD NIO Cat No.GOA-018

Genus ERATIDUS Saidova, 1975

***Eratidus* cf. *E. foliaceus* (Brady)**
Plate 1, Figure 20

Lituola (*Haplophragmium*) *foliaceum* BRADY, 1881, p.50, pl.33, figs.22-25.
Ammobaculites foliaceus (Brady) CUSHMAN, 1920, p.63, pt.2.
Ammomarginulina foliaceus (Brady) CUSHMAN, 1933a, pl.10, fig.6a-b.
Eratidus foliaceus (Brady) SAIDOVA, 1975, p.94.

Remarks: These specimens are comparable to *Eratidus foliaceus*, but are thinner than *E. foliaceus*.

Hypotype: Length=0.99 mm.; diameter of spiral chambers=0.51 mm.
Repository: GOD NIO Cat No.GOA-019

Superfamily HAPLOPHRAGMIACEA Eimer and Fickert, 1899

4.5.1.7 Family AMMOSPHAEROIDINIDAE Cushman, 1927
Subfamily AMMOSPHAEROIDININAE Cushman, 1927

Genus CYSTAMMINA Neumayr, 1889

Cystammina pauciloculata **(Brady)**
Plate 1, Figure 21

Trochammina pauciloculata BRADY, 1879, p.58, pl.5, figs.13-14.
Ammochilostoma pauciloculata (Brady) CUSHMAN, 1910, p.126, pl.1.
Cystammina pauciloculata (Brady) GALLOWAY, 1933, p.186.

Hypotype: Length=1.13 mm.; maximum width=0.80 mm.
Repository: GOD NIO Cat No.GOA-020

Superfamily LOFTUSIACEA Brady, 1884

4.5.1.8 Family CYCLAMMINIDAE Marie, 1941

Subfamily ALVEOLOPHRAGMIINAE Saidova, 1981

Genus ALVEOLOPHRAGMIUM Shchedrina, 1936

Alveolophragmium orbiculatum **Shchedrina**
Plate 1, Figure 22

Alveolophragmium orbiculatum SHCHEDRINA, 1936, p.315, pl.315, fig.1.

Hypotype: Length=0.69 mm.; width=0.65 mm; maximum thickness=0.46 mm.
Repository: GOD NIO Cat No.GOA-021

Subfamily CLYCLAMMININAE Marie, 1941

Genus CYCLAMMINA Brady, 1879

Cyclammina cancellata **Brady**
Plate 1, Figure 23

Cyclammina cancellata BRADY, 1879, p.62, pl.37, fig.8-16.- ANTONY, 1968, p.19, pl.1, fig.8.

Hypotype: Length=1.22 mm.; width=1.11 mm; maximum thickness=0.49 mm.
Repository: GOD NIO Cat No.GOA-022

Superfamily SPIROPLECTAMMINACEA Cushman, 1927

4.5.1.9 Family SPIROPLECTAMMINIDAE Cushman, 1927

Subfamily SPIROPLECTAMMININAE Cushman, 1927

Genus ORECTOSTOMINA Seiglie, 1965

***Orectostomina camposi* (Brönnimann and Beurlen)**

Plate 2, Figure 1

Spiroplectamminoides camposi BRÖNNIMANN and BEURLEN, 1977, p.87-88, pl.3, figs.1-3, 6-8, 10.

Orectostomina camposi (Brönnimann and Beurlen) SEIGLIE, 1965, p.70.

Hypotype: Length=1.13 mm.; maximum width=0.43 mm.

Repository: GOD NIO Cat No.GOA-023

Genus SPIROPLECTINELLA Kisel'man, 1972

***Spiroplectinella sagittula* (d'Orbigny)**

Plate 2, Figure 2

Textularia sagittula D'ORBIGNY, 1839, p.138, pl.1, figs.19-21.-ANTONY, 1968, p.21, pl.1, fig.10.

Spiroplectinella sagittula (d'Orbigny) CIMMERMAN and LANGER, 1991, p.19, pl.6, figs.5-6.- RAO, 1998, p.50, pl.3, fig.10.

Hypotype: Length=0.35 mm.; maximum width=0.19 mm

Repository: GOD NIO Cat No.GOA-024

Superfamily TROCHAMMINACEA Schwager, 1877

4.5.1.10 Family TROCHAMMINIDAE Schwager, 1877

Subfamily TROCHAMMININAE Schwager, 1877

Genus AMMOGLOBIGERINA Eimer and Fickert, 1899

***Ammoglobigerina globigeriniformis* (Parker and Jones)**

Plate 2, Figure 3

Lituola nautiloidea (Lamarck) var. *globigeriniformis* PARKER and JONES 1865, p.405, pl.15, figs.46-47; pl.17, figs.96-98.

Trochammina globigeriniformis (Parker and Jones) NIGAM and THIEDE, 1983, p.126, tab.3.

Ammoglobigerina globigeriniformis (Parker and Jones) BARKER, 1960, pl.35, figs.10-11.- RAO, 1998, p.52, pl.4, fig.4-5.

Hypotype: Length=0.47 mm.; maximum width=0.43 mm

Repository: GOD NIO Cat No.GOA-025

Genus TRITAXIS Schubert, 1921

***Tritaxis challengeri* (Hedley, Hurdle and Burdett)**

Plate 2, Figure 4

Trochammina challengeri HEDLEY, HURDLE and BURDETT, 1964.- BRADY, 1884, pl.41, fig.3a-c.

Tritaxis challengeri SCHUBERT, 1921.

Hypotype: Length=0.29 mm.; width=0.25 mm; maximum thickness=0.11 mm.

Repository: GOD NIO Cat No.GOA-026

Genus TROCHAMMINA Parker and Jones, 1859

***Trochammina hadai* Uchio**

Plate 2, Figure 6

Trochammina hadai UCHIO, 1962, p.387, pl.18, figs.9a-c.- SEIBOLD, 1975, p.180, pl.1, figs.2a-c.- NIGAM, 1982, p.34, pl.1, fig.2.

Hypotype: Length=0.52 mm.; width=0.44 mm; maximum thickness=0.30 mm.

Repository: GOD NIO Cat No.GOA-027

***Trochammina inflata* (Montagu)**

Plate 2, Figure 7

Nautilus inflatus MONTAGU 1808, p.8, pl.18, fig.3.

Trochammina inflata (Montagu) PARKER and JONES, 1859, p.347.- GANAPATI and SATYAVATI, 1958, p.107, pl.2, figs.53-55.- RAMANATHAN, 1970, p.131.- RAO, 1970a, p.595, pl.3, fig.29; 1971b, p.158; 1974, p.64, fig.20.- RAO and RAO, 1974, p.414, pl.1, fig.10.- BHATIA and KUMAR, 1976, p.241, pl.2, figs.5-6, tab.2,- NIGAM *et al.*, 1979, p.245.- RAO and RAO, 1980, p.564.- SETTY and NIGAM, 1980b, p.421; 1984, p.432, pl.32, figs.16-17,20.- NIGAM and SARUPRIA, 1981, p.180.- SEIBOLD and SEIBOLD, 1981, p.42, tab.3a.- NARAPPA *et al.*, 1982, p.221.- NIGAM and THIEDE, 1983, p.126, tab.3.- SHAREEF and VENKATACHALAPATHY, 1987a, p.194, pl.1, figs.12-13.- KUMAR *et al.*, 1990, p.56, pl.1, fig.4, tab.1.- KHARE, 1992, pp.51-52, pl.1, figs.8a-b.- HENRIQUES, 1993, p.37, pl.1, fig.4.- MAYENKAR, 1994, p.53, pl.1, fig.4.- RAO, 1998, p.53, pl.4, fig.6.- JAYARAJU *et al.*, 2000, p.335, tab.2.- MAZUMDER *et al.*, 2003, p.8, tab.1.- MALLIK *et al.*, 2003, p.42, tab.1.- KUMAR and SRINIVASAN, 2004, pp.299-312.

Hypotype: Length=0.19 mm.; width=0.18 mm.; maximum thickness=0.14 mm.

Repository: GOD NIO Cat No.GOA-028

***Trochammina* cf. *T. nana* (Brady)**

Plate 2, Figure 5

Lituola (*Haplophragmoides*) *nanum* BRADY, 1881.- HOFKER, 1922, p.144-145, pl.145, fig.37.

Trochammina nana (Brady) THALMANN, 1932.

Hypotype: Length=0.41 mm.; width=0.35 mm.

Repository: GOD NIO Cat No.GOA-029

Superfamily VERNEUILINACEA Cushman, 1911

4.5.1.11 Family PROLIXOPLECTIDAE Loeblich and Tappan, 1985

Genus KARRERULINA Finley, 1940

***Karrerulina erigona* (Saidova)**
Plate 2, Figure 8

Gaudryinoides erigonum SAIDOVA, 1975.
Karrerulina erigona (Saidova) LOEBLICH and TAPPAN, 1988, pl.139, figs.10-13.

Hypotype: Length=0.83 mm.; maximum width=0.26 mm.
Repository: GOD NIO Cat No.GOA-030

Superfamily ATAXOPHRAGMIACEA Schwager, 1877

4.5.1.12 Family GLOBOTEXTULARIIDAE Cushman, 1927
Subfamily GLOBOTEXTULARIINAE Cushman, 1927
Genus VERNEUILINULLA Saidova, 1975

***Verneuilinulla propinqua* (Brady)**
Plate 2, Figure 9

Verneuilina propinqua BRADY, 1884, p.387, pl.47, figs.8-14.
Eggerella propinqua (Brady) CUSHMAN, 1937a, p.53.
Verneuilinulla propinqua (Brady) CHARNOCK and JONES, 1990.

Hypotype: Length=0.98 mm.; maximum width=0.60 mm.
Repository: GOD NIO Cat No.GOA-031

Superfamily TEXTULARIACEA Ehrenberg, 1838

4.5.1.13 Family EGGERELLIDAE Cushman, 1937a
Subfamily EGGERELLINAE Cushman, 1937a
Genus EGGERELLA Cushman, 1933b

***Eggerella bradyi* (Cushman)**
Plate 2, Figure 10

Verneuilina bradyi CUSHMAN, 1911, pt.2, p.54.

Eggerella bradyi (Cushman) CUSHMAN, 1933b, v.9, p.33.- RAI and SINGH, 2004, pp.415-429, tab.1.

Hypotype: Length=0.71 mm.; maximum width=0.55 mm.
Repository: GOD NIO Cat No.GOA-032

Genus KARRERIELLA Cushman, 1933b

***Karreriella* cf. *K. chilostoma* (Reuss)**
Plate 2, Figure 11

Textularia chilostoma REUSS, 1852, p.18, pl.18, pl.a-b.
Gaudryina pupoides var. *chilostoma* (Reuss) BRADY, 1884.
Gaudryina chilostoma (Reuss) THALMANN, 1932.
Karreriella chilostoma (Reuss) THALMANN, 1942, p.463.

Hypotype: Length=0.34 mm.; width=0.35 mm.; maximum thickness=0.23 m.
Repository: GOD NIO Cat No.GOA-033

4.5.1.14 Family TEXTULARIIDAE Ehrenberg, 1838
Subfamily TEXTULARIINAE Ehrenberg, 1838
Genus SAHULIA Loeblich and Tappan, 1985

***Sahulia conica* (d'Orbigny)**
Plate 2, Figure 12

Textularia conica D'ORBIGNY, 1839, p.143, pl.1, figs.19-20.- BHATIA, 1956, p.17, pl.1, fig.2.- SETHULEKSHMI AMMA, 1958, p.40, pl.2, fig.59a-b.- ANTONY, 1968, p.23, pl.1, fig.13.- RAMANATHAN, 1970, p.130.- RAO, 1971b, p.156, figs.10.- ALMEIDA and SETTY, 1972, p.96, pl.1, figs.14-15.- SAING, 1972, p.102, pl.1, figs.15a-b.- SEIBOLD, 1975, pp.179-180.- RAO and RAO, 1978, p.426.- NIGAM *et al.*, 1979, p.246.- SETTY and NIGAM, 1980b, p.421.- NIGAM, 1982, p.31, pl.1, fig.3.- SEIBOLD and SEIBOLD, 1981, p.42, table 3a.- RAO *et al.*, 1985, p.76, table 1.- BHALLA and GAUR, 1987, p.123, pl.1, fig.2.- KHARE, 1992, p.55, pl.1, figs.12a-b.- HENRIQUES, 1993, p.40, pl.1, fig.9.- MAYENKAR, 1994, p.55, pl.1, fig.7.- NIGAM and KHARE, 1999, p.302, pl.1, figs.12a-b.- NIGAM and CHATURVEDI, 2000, p.134.- CHATURVEDI, 2001, p.109, pl.1, fig.11.-

KYAW and SAING, 2001, p.8, pl.II, fig.4.- MAZUMDER *et al.*, 2003, p.8, tab.1.- KUMAR and SRINIVASAN, 2004, pp.299-312.

Remarks: This species had been widely reported before as *Textularia conica.* Loeblich and Tappan changed the genera to *Sahulia* with the most prominent generic character being the low conical test. Hence the present species has been named as *Sahulia conica.*

Hypotype: Length=0.29 mm.; maximum width=0.32 mm.
Repository: GOD NIO Cat No.GOA-034

Genus TEXTULARIA Defrance, 1824

***Textularia agglutinans* d'Orbigny**
Plate 2, Figure 13

Textularia agglutinans D'ORBIGNY, 1839, p.144, pl.1, figs.17-18.- GANAPATI and SATYAVATI, 1958, p.106, pl.1, fig.14.- SETHULEKSHMI AMMA, 1958, p.39, pl.2, fig.57.- ANTONY, 1968, pp.20-21, pl.1, fig.9.- RASHEED, 1969-70a, pp.46-47.- FRERICHS, 1970, pp.146-147.- RAMANATHAN, 1970, p.130.- VEDANTAM and RAO, 1970, p.329, table 3.- RAO, 1971b, p.156, fig.9.- ALMEIDA and SETTY, 1972, p.96, pl.1, figs.6-8.- SAING, 1972, p.93, pl.1, figs.6a-c.- ZOBEL, 1973, p.16, pl.1, fig.28.- RAO and RAO, 1974, p.414, pl.1, fig.7; 1976a, p.298.- RAO and RAO, 1978, p.426.- RAO *et al.*, 1979, p.357, table 3.- NARAPPA *et al.*, 1982, p.22.- RAO *et al.*, 1982, p.216, table 3.- SETTY *et al.*, 1984, p.50, table 1.- RAGOTHAMAN and KUMAR, 1985, p.99, pl.1, fig.1.- RAO *et al.*, 1985, p.76, table 1; 1987, p.164, pl.1, figs.1-2.- NAIDU, 1987, p.27, table 7.- KUMAR, 1988, p.30, pl.1, figs.3-4.- PAL, 1989, p.109, table 1.- KHARE, 1992, p.54, pl.1, fig.11.- HENRIQUES, 1993, pp.39-40, pl.1, fig.8.- MAYENKAR, 1994, p.55, pl.1, fig.7.– RAO, 1998, pp.57-58, pl.5, figs.7-8.– GANDHI, 1999, pp.41-42, pl.1, figs.3-4.– JAYARAJU and REDDI, 1996, p.315, table 1.- NIGAM and KHARE, 1999, p.302, pl.1, fig.11.- CHATURVEDI, 2001, p.108, pl.1, fig.8.- KYAW and SAING, 2001, p.7, pl.II, fig.2.- MAZUMDER *et al.*, 2003, p.8, tab.1.- GANDHI and RAJAMANICKAM, 2004, p.293-304, tab.1,2.- RAI and SINGH, 2004, pp.415-429, tab.1.- NAGENDRA *et al.*, 2004, pp.51-60, pl.3, fig.7.- KUMAR and SRINIVASAN, 2004, pp.299-312.

Hypotype: Length=0.54 mm.; maximum width=0.31 mm.
Repository: GOD NIO Cat No.GOA-035

***Textularia foliacea* Heron-Allen and Earland**

Plate 2, Figure 14

Textularia foliacea HERON-ALLEN and EARLAND, 1915, p.628, pl.47, figs.17-20.- BHATIA, 1956, p.17, pl.1, figs.1a-b.- SETHULEKSHMI AMMA, 1958, p.41, pl.2, fig.61.- ANTONY, 1968, p.22, pl.1, fig.12.- VEDANTAM and RAO, 1970, p.329, tab.3.- RAO *et al.*, 1979, p.359, tab.3.- NIGAM, 1982, p.33, pl.1, fig.5.- VENKATACHALAPATHY and SHAREEF, 1981, p.44.- NARAPPA *et al.*, 1982, p.221.- RAO *et al.*, 1982, p.216, tab.3.- BHALLA and LAL, 1985, p.430.- BHALLA and GAUR, 1987, p.123, pl.1, fig.1.- SHAREEF and VENKATACHALAPATHY, 1988, p.433, pl.1, fig.2.- PAL, 1989, p.109, tab.1.- KHARE, 1992, p.56, pl.1, fig.13.- KYAW and SAING, 2001, p.8, pl.II, fig.5.- KUMAR and SRINIVASAN, 2004, pp.299-312.

Hypotype: Length=0.38 mm.; maximum width=0.24 mm.

Repository: GOD NIO Cat No.GOA-036

***Textularia* aff. *T. milletti* Cushman**

Plate 2, Figure 15

Textularia milletti CUSHMAN, 1911, p.561, pl.7, fig.8.- BOLTOVSKOY, 1978, p.170, pl.VII, figs.49-50.

Hypotype: Length=0.76 mm.; maximum width=0.56 mm.

Repository: GOD NIO Cat No.GOA-037

***Textularia pseudogramen* Chapman and Parr**

Plate 2, Figure 16

Textularia pseudogramen CHAPMAN and PARR, 1937, p.15, pl.1, figs.7-8.- MATHUR and GUPTA, 1989, p.121, tab.1.

Hypotype: Length=0.28 mm.; maximum width=0.19 mm.

Repository: GOD NIO Cat No.GOA-038

Subfamily SIPHOTEXTULARIINAE Loeblich and Tappan, 1985

Genus KERREROTEXTULARIA Calvez, Klasz and Brun, 1974

***Karrerotextularia* sp.**

Plate 2, Figure 17

Remarks: Due to lack of specimens the species name was not assigned for this genus. These specimens are broad and characterized by a medium grained wall, undulated outer margin and inclined sutures.

Hypotype: Length=0.19 mm.; width=0.18 mm.; thickness=0.06 mm

Repository: GOD NIO Cat No.GOA-039

Genus SIPHOTEXTULARIA Finlay, 1939

***Siphotextularia* cf. *S. concava* (Karrer)**

Plate 2, Figure 18

Plecanium concavum KARRER, 1868, p.192, pl.1, fig.3.

Textularia concava (Karrer) LACROIX, 1932, p.14, figs.10-12.

Siphotextularia concava (Karrer) BARKER, 1960, pl.42, figs.13-14.

Hypotype: Length=0.26 mm.; width=0.19 mm.; thickness=0.07 mm.

Repository: GOD NIO Cat No.GOA-040

Suborder MILIOLINA Delage and Hérouard, 1896

Superfamily CORNUSPIRACEA Schultze, 1854

4.5.1.15 Family CORNUSPIRIDAE Schultze, 1854

Subfamily CORNUSPIRINAE Schultze, 1854

Genus CORNUSPIRA Schultze, 1854

***Cornuspira involvens* (Reuss)**

Plate 2, Figure 19

Operculina involvens REUSS, 1850, p.370, pl.45, fig.20.

Cornuspira involvens (Reuss) CUSHMAN, 1917, p.25, pl.1, fig.2, pl.2, fig.2.- MAZUMDER *et al.*, 2003, p.8, tab.1.

Hypotype: Maximum diameter=0.57 mm; thickness=0.10 mm.
Repository: GOD NIO Cat No.GOA-041

4.5.1.16 Family FISCHERINIDAE Millett, 1898
Subfamily FISCHERININAE Millett, 1898
Genus PLANISPIRINELLA Wiesner, 1931

***Planispirinella exigua* (Brady)**
Plate 2, Figure 20

Planispirina exigua BRADY, 1879
Planispirinella exigua (Brady) WEISNER, 1931, p.69.

Hypotype: Maximum diameter=0.29 mm.; thickness=0.02 mm.
Repository: GOD NIO Cat No.GOA-042

Subfamily NODOBACULARIELLINAE Bogdanovich, 1981
Genus VERTEBRALINA d'Orbigny, 1826

***Vertebralina* sp.**
Plate 2, Figure 21

Remarks: Due to lack of specimens the species name was not assigned for this genus. A flattened round shape, porceleneous wall, wide gaping aperture and fine striations characterize these specimens.

Hypotype: Length=0.25 mm.; width=0.18 mm.; thickness=0.06 mm
Repository: GOD NIO Cat No.GOA-043

4.5.1.17 Family OPHTHALMIDIIDAE Wiesner, 1920
Genus EDENTOSTOMINA Collins, 1958

***Edentostomina cultrata* (Brady)**

Plate 3, Figure 1

Miliolina cultrata BRADY, 1881, p.45; 1884, p.161, figs.1-2, table 5.

Triloculina cultrata (Brady) BOLTOVSKOY, 1961, p.318.- RAO and RAO, 1976b, p.217.- NARAPPA *et al.*, 1982, p.221.

Edentostomina cultrata (Brady) COLLINS, 1958, p.370.- VENKATACHALAPATHY and SHAREEF, 1981, p.44.- SHAREEF and VENKATACHALAPATHY, 1988, p.435, pl.1, figs.3a-b.- KHARE, 1992, pp.59-60, pl.6, figs.7a-b.- RAO, 1998, pp.66-67, pl.8, figs.1-2.- GANDHI, 1999, p.45, pl.1, figs.12-13.- NIGAM and KHARE, 1999, p.302, pl.3, figs.3a-b.- CHATURVEDI, 2001, p.110, pl.2, fig.1.- GANDHI and RAJAMANICKAM, 2004, p.293-304, tab.1,2.

Hypotype: Length=0.59 mm.; width=0.23 mm.; thickness=0.16 mm.

Repository: GOD NIO Cat No.GOA-044

***Edentostomina rupertiana* (Brady)**

Plate 3, Figure 2

Miliolina rupertiana BRADY, 1881, p.46.

Triloculina rupertiana (Brady) CUSHMAN, 1921, p.464, pl.93, fig.2.- BHATIA, 1956, p.19, pl.2, fig.4.- GANAPATI and SATYAVATI, 1958, pl.2, fig.40.- BHATIA and KUMAR, 1976, tab.2.- RAO *et al.*, 1979, p.361.- SETTY and NIGAM, 1985, p.285.- NIGAM, 1986, p.424, tab.1.

Rupertianella rupertiana (Brady) GANDHI and RAJAMANICKAM, 2004, p.293-304, tab.1,2.

Edentostomina rupertiana (Brady) HAIG, 1988, p.218, pl.1, figs.18-21.- MAYENKAR, 1994, p.56, pl.1. fig.8.- MAZUMDER *et al.*, 2003, p.8, tab.1.

Hypotype: Length=1.00 mm.; width=0.39 mm.; thickness=0.32 mm.

Repository: GOD NIO Cat No.GOA-045

Genus OPHTHALMIDIUM Kübler and Zwingli, 1870

***Ophthalmidium* sp.**

Plate 3, Figure 3

Remarks: Due to lack of specimens the species name was not assigned for this genus. These specimens are characterized by almost a planispiral arrangement of semi-transparent chambers, broad last chamber, concave outer margin and simple, round aperture.

Hypotype: Length=0.96 mm.; width=0.52 mm.; thickness=0.10 mm.
Repository: GOD NIO Cat No.GOA-046

Genus SPIROPHTHALMIDIUM Cushman, 1927

***Spirophthalmidium acutimargo* (Brady)**
Plate 3, Figure 4

Spiroloculina acutimargo BRADY 1884, p.154, pl.10, figs.12-15.
Spirophthalmidium acutimargo (Brady) PAALZOW, 1932, p.99.- GANAPATI and SATYAVATI, 1958, p.107, pl.2, fig.51.- RAO, 1970a, p.595, fig.28.- MATHUR and GUPTA, 1989, pp.120-126, tab.1.- HENRIQUES, 1993, p.43, pl.1, fig.13.- MAYENKAR, 1994, p.57, pl.1, fig.9.- RAO, 1998, p.68, pl.8, fig.8.- MAZUMDER *et al.*, 2003, p.8, tab.1.- RAI and SINGH, 2004, pp.415-429, tab.1.

Hypotype: Length=0.37 mm.; width=0.12 mm.; thickness=0.02 mm.
Repository: GOD NIO Cat No.GOA-047

***Spirophthalmidium* sp.**
Plate 3, Figure 5

Remarks: This specimen to some extent resembles *Spirophthalmidium acutimargo*, except for its slender neck, more transparency and a more regular arrangment of earlier chambers than the latter.

Hypotype: Length=0.32 mm.; width=0.10 mm.; thickness=0.01 mm.
Repository: GOD NIO Cat No.GOA-048

Superfamily MILIOLACEA Ehrenberg, 1839

4.5.1.18 Family SPIROLOCULINIDAE Wiesner, 1920
Genus ADELOSINA d'Orbigny, 1826

Adelosina laevigata **d'Orbigny**
Plate 3, Figure 6

Adelosina laevigata D'ORBIGNY, 1826, p.303.- VEDANTAM and RAO, 1970, p.332, table 6.- YASSINI and JONES, 1995, p.80, figs.135-136.- RAO, 1998, p.69, pl.8, figs.9-10.- CHATURVEDI, 2001, p.112, pl.2, fig.3.- GANDHI *et al.*, 2002, p.52, pl.I, fig.6.- GANDHI and RAJAMANICKAM, 2004, p.293-304, tab.1,2.
Young miliolidae BARKAR, 1960, p.6, pl.3, fig.12.– KHARE, 1992, pp.82-83, pl.6, fig.2.– NIGAM and KHARE, 1999, p.302, pl.2, fig.18.

Remarks: This species was described as 'young miliolidae' in some literatures. Though a few specimens are slightly different in morphology, the name *Adelosina laevigata* has been assigned for all the specimens, in the present study area.

Hypotype: Length=0.47 mm.; width=0.35 mm.; thickness=0.19 mm.
Repository: GOD NIO Cat No.GOA-049

Genus PALEOMILIOLINA Antonova, 1959

***Paleomiliolina* sp.**
Plate 3, Figure 7

Remarks: Due to lack of specimens, the species name was not assigned for this genus. Elongated flattened tests, globular proloculous and rounded aperture with a projecting neck characterize these specimens.

Hypotype: Length=0.28 mm.; width=0.12 mm.; thickness=0.03 mm.
Repository: GOD NIO Cat No.GOA-050

Genus SPIROLOCULINA d'Orbigny, 1826

Spiroloculina angulata **(Cushman)**
Plate 3, Figure 8

Spiroloculina grata (Terquem) var.*angulata* CUSHMAN, 1917, p.36, pl.7, fig.5.

Spiroloculina angulata (Cushman) CUSHMAN and TODD, 1944, p.50, pl.7, fig.18-22.- MANIVANNAN *et al.*, 1996, p.381.- RAO, 1998, p.71, pl.9, fig.4.- KATHAL, 2002, p.432, pl.1, figs.1a-b.

Hypotype: Length=0.74 mm.; width=0.42 mm.; thickness=0.16 mm.
Repository: GOD NIO Cat No.GOA-051

***Spiroloculina angulosa* d'Orbigny**
Plate 3, Figure 9

Spiroloculina angulosa D'ORBIGNY, 1826, p.132, pl.11, fig.2.

Hypotype: Length=0.55 mm.; width=0.35 mm.; thickness=0.16 mm.
Repository: GOD NIO Cat No.GOA-052

***Spiroloculina antillarium* d'Orbigny**
Plate 3, Figure 10

Spiroloculina antillarium D'ORBIGNY 1839, p.166, pl.7, figs.3-4.- GANAPATI and SATYAVATI, 1958, p.114, pl.2, fig.34.- SETHULEKSHMI AMMA, 1958, p.3, pl.1, fig.2.- ROCHA and UBALDO, 1964a, p.647, pl.2, fig.6.- ANTONY, 1968, pp.34-35, pl.2, fig.7.- BHALLA, 1968, p.378, pl.1, figs.7a-b.- RAO, 1970a, p.592, pl.2, fig.20.- BHALLA and NIGAM, 1979, p.239; 1988, p.518, tab.1.- NIGAM *et al.*, 1979, p.246.- SETTY and NIGAM, 1980b, p.421; 1984, p.432, pl.32, fig.12.- VENKATACHALAPATHY and SHAREEF, 1981, p.44.- SETTY *et al.*, 1984, p.50, tab.1.- RAO *et al.*, 1987, p.164, pl.1, figs.14-15.- SHAREEF and VENKATACHALAPATHY, 1988, p.434, pl.1, fig.4.- KHARE, 1992, pp.61-62, pl.2, fig.5.- HENRIQUES, 1993, pp.44-45, pl.2, figs.2a-b.- MAYENKAR, 1994, p.59, pl.1, fig.12a-b.- KATHAL, 2002, p.432, pl.1, figs.2a-b.- GANDHI *et al.*, 2002, p.52, pl.I, fig.2.- MAZUMDER *et al.*, 2003, p.8, tab.1.- GANDHI and RAJAMANICKAM, 2004, p.293-304, tab.1,2.

Hypotype: Length=1.96 mm.; width=1.47 mm.; thickness=0.85 mm.
Repository: GOD NIO Cat No.GOA-053

***Spiroloculina aperta* Cushman and Todd**

Plate 3, Figure 11

Spiroloculina canaliculata CUSHMAN (not D'ORBIGNY), 1924, p.57, pl.21, fig.1.
Spiroloculina planissima var. *samoaensis* CUSHMAN (not CUSHMAN, 1924), 1925 (1926), p.137.
Spiroloculina aperta CUSHMAN and TODD, 1944, p.66, pl.9, figs.21-22.- SAID, 1950, p.14, pl.1, fig.35.

Hypotype: Length=0.75 mm.; width=0.39 mm.; thickness=0.17 mm.
Repository: GOD NIO Cat No.GOA-054

***Spiroloculina* aff. S. *caduca* Cushman**

Plate 3, Figure 12

Spiroloculina caduca CUSHMAN, 1922, p.61, pl.11, figs.3-4.

Hypotype: Length=0.62 mm.; width=0.30 mm.; thickness=0.18 mm.
Repository: GOD NIO Cat No.GOA-055

***Spiroloculina communis* Cushman and Todd**

Plate 3, Figure 13

Spiroloculina communis CUSHMAN and TODD, 1944, p.63, pl.9, figs.4-7.- BHALLA, 1968, p.380, pl.1, figs.6a-b.- FRERICHS, 1970, pp.116-117.- VEDANTAM and RAO, 1970, p.329, table 3.- REDDY *et al.*, 1974, p.18.- SETTY, 1974a, p.23.- SEIBOLD, 1975, pp.180-181.- RAO and RAO, 1976b, p.217.- NIGAM *et al.*, 1979, p.246.- RAO *et al.*, 1979, p.359, table 3.- NIGAM, 1982, p.38, pl.1, fig.6.- REDDY and RAO, 1980, p.164, pl.1, figs.7-8.- SETTY and NIGAM, 1980b, p.421.- VENKATACHALAPATHY and SHAREEF, 1981, p.44.- SEIBOLD and SEIBOLD, 1981, p.42, table 3a.- NIGAM, 1982, p.38, pl.1, fig.6.- SETTY *et al.*, 1984, p.50, table 1.- RAGOTHAMAN and KUMAR, 1985, p.99, pl.1, figs.4-5.- SHAREEF and VENKATACHALAPATHY, 1988, p.434, pl.1, fig.7.- KUMAR, 1988, p.42, pl.2, figs.5-6.- MATHUR and GUPTA, 1989, pp.120-126, table 1.- KUMAR *et al.*, 1990, p.57, pl.1, fig.5, table 1.- KHARE, 1992, pp.62-63, pl.2, fig.6.- HENRIQUES, 1993, p.45, pl.2, figs.3a-b.- JAYARAJU, 1993, p.90, pl.1, fig.4.- MAYENKAR, 1994, p.59, pl.2, fig.1.- DAS, 1996, p49, fig.2(1).- RAO, 1998, pp.72-73, pl.9, figs.6-7.- GANDHI, 1999, pp.46-47, pl.2, figs.2-3.- NIGAM and KHARE, 1999, p.302, pl.1, fig.20.- CHATURVEDI, 2001, p.113, pl.2, fig.6. KYAW and SAING, 2001, p.10, pl.II, fig.32.- MAZUMDER *et al.*, 2003, p.8, tab.1.- GANDHI and RAJAMANICKAM, 2004, p.293-304, tab.1,2.- KUMAR and SRINIVASAN, 2004, pp.299-312.

Hypotype: Length=0.67 mm.; width=0.33 mm.; thickness=0.20 mm.
Repository: GOD NIO Cat No.GOA-056

***Spiroloculina depressa* d'Orbigny**
Plate 3, Figure 14

Spiroloculina depressa D'ORBIGNY, 1826, p.298.- CUSHMAN, 1917, p.29, pl.3, figs.6-10.- SETHULEKSHMI AMMA, 1958, p.2, pl.11, fig.1.- ROCHA and UBALDO, 1964b, p.647, pl.2, figs.5 and 10.- ANTONY, 1968, p.36, pl.2, fig.9.- RAO, 1970a, p.590, pl.1, fig.16; 1971b, p.157.- VENKATACHALAPATHY and SHAREEF, 1981, p.44.- SETTY *et al.*, 1984, p.50, table 1.- BHALLA and GAUR, 1987, p.123, pl.1, fig.3.- SHAREEF and VENKATACHALAPATHY, 1987a, p.189; 1988, p.434, pl.1, fig.6.- KHARE, 1992, p.63, pl.2, fig.7.- HENRIQUES, 1993, pp.45-46, pl.3, figs.4a-b.- MAYENKAR, 1994, p.60, pl.2, fig.2.- RAO, 1998, p.74, pl.9, fig.9.- NIGAM and KHARE, 1999, p302, pl.1, fig.21.- NIGAM and CHATURVEDI, 2000, p.134.- CHATURVEDI, 2001, p.114, pl.2, fig.7.- KYAW and SAING, 2001, p.10, pl.II, fig.33.- KATHAL, 2002, p.432, pl.1, figs.3a-b.- MAZUMDER *et al.*, 2003, p.8, tab.1.

Hypotype: Length=1.12 mm.; width=0.89 mm.; thickness=0.35 mm.
Repository: GOD NIO Cat No.GOA-057

***Spiroloculina excavata* d'Orbigny**
Plate 3, Figure 15

Spiroloculina excavata D'ORBIGNY, 1846, p.271, pl.16, fig.19-21.- SETHULEKSHMI AMMA, 1958, p.3, pl.1, fig.3.- ANTONY, 1968, p.35, pl.2, fig.8.

Hypotype: Length=0.51 mm.; width=0.41 mm.; thickness=0.12 mm.
Repository: GOD NIO Cat No.GOA-058

Spiroloculina indica **Cushman and Todd**

Plate 3, Figure 16

Spiroloculina indica CUSHMAN and TODD, 1944, p.71, pl.9, figs.32a-b.- BHATIA, 1956, p.18, pl.2, fig.5.- ROCHA and UBALDO, 1964a, p.412, pl.2, fig.2; 1964b, p.647, pl.2, fig.9.- VEDANTAM and RAO, 1970, p.329, table 3.- ZOBEL, 1973, p.14, pl.1, figs.17 and 24.- BHATIA and KUMAR, 1976, p.249.- RAO and RAO, 1976b, p.217.- NIGAM *et al.*, 1979, p.246.- RAO *et al.*, 1979, p.361, table 3.- SETTY and NIGAM, 1980b, p.421.- NIGAM, 1982, p.42, pl.1, fig.15.- RAO *et al.*, 1982, p.216, table 3.- SETTY *et al.*, 1984, p.50, table 1.- BHALLA and LAL, 1985, p.430.- BHALLA and NIGAM, 1988, p.518, table 1.- KALADHAR *et al.*, 1990, p.72, table 1.- KHARE, 1992, p.65, pl.2, fig.10. - HENRIQUES, 1993, p.46, pl.2, figs.5a-b.- MAYENKAR, 1994, p.60, pl.21, figs.1a-b.- TALIB and FAROOQUI, 1994, p.91, table 1.- RAO, 1998, p.75, pl.10, fig.1.- NIGAM and KHARE, 1999, p.302, pl.1, fig. 24.- GANDHI, 1999, p.48, pl.2, fig.7.- CHATURVEDI, 2001, p.115, pl.2, fig.9.- KATHAL, 2002, p.432, pl.1, figs.4a-b.- GANDHI *et al.*, 2002, p.52, pl.I, fig.4.- MAZUMDER *et al.*, 2003, p.8, tab.1.- GANDHI and RAJAMANICKAM, 2004, p.293-304, tab.1,2.

Hypotype: Length=0.22 mm.; width=0.12 mm.; thickness=0.07 mm.

Repository: GOD NIO Cat No.GOA-059

Spiroloculina planissima **Wiesner**

Plate 3, Figure 17

Miliolites planulata LAMARCK var. *c.* LAMARCK, 1822, p.613, no.4 (c).

Spiroloculina planissima WIESNER, 1912, p.209; 1923, pl.5, fig.29.- RAO, 1974, pl.1, fig.10.- NIGAM, 1981, p.43, pl.1, fig.13.- NIGAM, 1986, p.424, tab.1.

Hypotype: Length=0.99 mm.; width=0.75 mm.; thickness=0.23 mm.

Repository: GOD NIO Cat No.GOA-060

Spiroloculina rotunda **d'Orbigny**

Plate 3, Figure 18

Spiroloculina rotunda D'ORBIGNY, 1826, p.299.- PARKER, JONES and BRADY, 1871, pl.8, fig.25.- NIGAM, 1981, p.44, pl.1, fig.12.

Hypotype: Length=0.23 mm.; width=0.22 mm.; thickness=0.17 mm.
Repository: GOD NIO Cat No.GOA-061

***Spiroloculina tricarinata* Terquem**
Plate 3, Figure 19

Spiroloculina tricarinata TERQUEM (part) (non d'Orbigny), 1882, p.158, pl.16, figs.19-20 (not 21).- BHALLA and NIGAM, 1979, p.239.- NIGAM, 1981, p.47, p.1, fig.11.

Hypotype: Length=1.90 mm.; width=1.45 mm.; thickness=0.33 mm.
Repository: GOD NIO Cat No.GOA-062

***Spiroloculina venusta* Cushman and Todd**
Plate 3, Figure 20

Spiroloculina venusta CUSHMAN and TODD 1944, pl.8, figs.16-17.

Hypotype: Length=0.46 mm.; width=0.19 mm.; thickness=0.10 mm.
Repository: GOD NIO Cat No.GOA-063

***Spiroloculina* sp.**
Plate 4, Figure 1

Remarks: The specimens have some affinity to *Spiroloculina indica,* but its outer margin is much more convex than that of *S .indica* and its neck is also longer than that of the latter. Moreover, the chambers of these specimens are cubical with raised sutures and convex outer margin. Hence, its nomenclature has been kept open under the genus *Spiroloculina.*

Hypotype: Length=0.33 mm.; width=0.20 mm.; thickness=0.08 mm.
Repository: GOD NIO Cat No.GOA-064

4.5.1.19 Family HAUERINIDAE Schwager, 1876
Subfamily SIPHONAPERTINAE Saidova, 1975
Genus SIPHONAPERTA Vella, 1957

***Siphonaperta* cf. *S. agglutinans* (d'Orbigny)**

Plate 4, Figure 2

Quinqueloculina agglutinate CUSHMAN, 1917, no.71, pl.9, fig.2.- ALMEIDA and SETTY, 1972, p.98, pl.2, figs.9-10.

Miliolina agglutinans BRADY, 1884, p.180, pl.8, figs.6-7.

Quinqueloculina agglutinans D'ORBIGNY, 1839, p.195, pl.12, figs.11-13.- GANAPATI and SATYAVATI, 1958, p.106, pl.2, fig.31.- SETHULEKSHMI AMMA, 1958, p.5, pl.1, fig.6.- ANTONY, 1968, p.30-31.- pl.1, fig.24.- VEDANTAM and RAO, 1970, p.329, tab.3.- RAO *et al.*, 1979, p.357, tab.3; 1985, p.76, tab.1; 1987, p.164, pl.1, figs.22-24.- REDDY and REDDY, 1982, p.250, tab.2.- REDDY *et al.*, 1983, p.107, SETTY and NIGAM, 1984, p.434, pl.33, fig.24.- RAGOTHAMAN and KUMAR, 1985, p.101, pl.1, fig.15.- KHARE, 1992, p.67, pl.3, fig.2a-c.- RAO, 1998, p.80, pl.11, figs.8-9.- JAYARAJU *et al.*, 2000, p.335, tab.2.- GANDHI and RAJAMANICKAM, 2004, p.293-304, tab.1,2.- KUMAR and SRINIVASAN, 2004, pp.299-312.

Siphonaperta agglutinans (d'Orbigny) CIMMERMAN and LANGER, 1991, pl.25, figs.1-3.

Remarks: This species had been widely reported from the Arabian Sea as well as the Bay of Bengal as *Quinqueloculina agglutinans*. Cimmerman and Langer (1991) moved this species and placed it under the genus *Siphonaperta*, which matches well with the description of the same genus given in Treatise (Loeblich and Tappan, 1988). Therefore, the specimens from the off Goa region have been named as *Siphonaperta agglutinans*.

Hypotype: Length=0.55 mm.; width=0.52 mm.; thickness=0.35 mm.

Repository: GOD NIO Cat No.GOA-065

***Siphonaperta horrida* (Cushman)**

Plate 4, Figure 3

Quinqueloculina horrida CUSHMAN, 1947, p.88, pl.19, fig.1.- MATHUR and GUPTA, 1989, pp.120-126, table 1.

Siphonaperta horrida (Cushman) HAAKE, 1975, p.34, pl.4, figs.67-74; pl.6, fig.125.- SEIBOLD, 1975, p.182.- SEIBOLD and SEIBOLD, 1981, p.43, table 36.- HENRIQUES, 1993, p.47, pl.2, figs.7a-c.- MAYENKAR, 1994, pp.61-62, pl.2, figs.4a-c.- RAO, 1998, pp.77-78, pl.10, fig.7.- CHATURVEDI, 2001, p.116, pl.3, fig.2.- MAZUMDER *et al.*, 2003, p.8, tab.1.

Hypotype: Length=0.80 mm.; width=0.46 mm.; thickness=0.13 mm.
Repository: GOD NIO Cat No.GOA-066

Subfamily HAUERININAE Schwager, 1876
Genus CYCLOFORINA Łuczkowska, 1972

***Cycloforina semiplicata* (McCulloch)**
Plate 4, Figure 4

Quinqueloculina semiplicata McCULLOCH 1977, p.507, pl.217, figs.7-8, 11, 13, 17; pl.218, figs.1, 13.
Cycloforina semiplicata (McCulloch) RAO, 1998, p.78, pl.11, fig.1,2.

Remarks: This species was first placed under the genera *Quinqueloculina*, but Rao (1998) placed the same species under the genera *Cycloforina*.

Hypotype: Length=1.43 mm; width=0.86 mm; thickness=0.68 mm
Repository: GOD NIO Cat No.GOA-067

Genus HAUERINA d'Orbigny, 1839

***Hauerina fragilissima* (Brady)**
Plate 4, Figure 5

Spiroloculina fragilissima BRADY, 1884, p.149, pl.9, figs.12-14.
Hauerina fragilissima (Brady) CUSHMAN. 1946, p.9, pl.2, figs.1-6,8.- SAID, 1950, p.17, pl.2, fig.9.- SETHULEKSHMI AMMA, 1958, p.11, pl.1, fig.18.- RAO, 1970, p.594, fig.26.- JONES, 1994, pl.2, figs.3-4.

Hypotype: Maximum diameter=0.32 mm; thickness=0.07 mm
Repository: GOD NIO Cat No.GOA-068

Genus QUINQUELOCULINA d'Orbigny, 1826

***Quinqueloculina* cf. *Q.annectens* (Schlumberger)**
Plate 4, Figure 6

Massilina annectens SCHLUMBERGER, 1893, p.220, pl.3, figs.77-79.- RAO *et al.*, 1987, tab.1, pl.I, figs.19-21.
Proemassilina annectens (Schlumberger) COLOM, 1974, p.206, figs.59a,b.
Quinqueloculina annectens (Schlumberger) CIMMERMAN and LANGER, 1991, pl.32, figs.1-2.

Remarks: The specimens from the off Goa region have similarity with *Quinqueloculina bicarinata* and *Q. annectens*. They differ from *Q. bicarinata* because of their two straight and one acute periphery and not a single carinate margin for any chamber. Cimmerman and Langer (1991) described this species vividly and the specimens under consideration display maximum similarity with their description. However, they described this species as one having a rough surface without an agglutinated outer coating, while our specimen has smooth wall. So these specimens were named as *Quinqueloculina* cf. *Q.annectens*.

Hypotype: Length=1.09 mm.; width=0.83 mm.; thickness=0.59 mm.
Repository: GOD NIO Cat No.GOA-069

***Quinqueloculina berthelotiana* d'Orbigny**
Plate 4, Figure 7

Quinqueloculina berthelotiana D'ORBIGNY, 1839, p.142, pl.3, figs.25-27.- RAO *et al.*, 1987, p.164, pl.1, figs.25-27.- HENRIQUES, 1993, p.49, pl.3, figs.2a-c.- MAYENKAR, 1994, p.63, pl.2, figs.7a-c.- MAZUMDER *et al.*, 2003, p.8, tab.1.

Hypotype: Length=0.98 mm; width=0.61 mm; thickness=0.42 mm.
Repository: GOD NIO Cat No.GOA-070

***Quinqueloculina bicarinata* d'Orbigny**
Plate 4, Figure 8

Quinqueloculina bicarinata D'ORBIGNY 1826, p.302.- BHATIA, 1956, p.671, pl.67, figs.12a-c.- HOFKER, 1968, p.19, pl.3, figs.24-34.- NIGAM, 1982, p.49, pl.2, fig.3.- CHATURVEDI, 2001, p.117, pl.3, fig.4.- KYAW and SAING, 2001, p.8, pl.II, fig.9.

Hypotype: Length=0.98 mm.; width=0.74 mm.; thickness=0.54 mm.

Repository: GOD NIO Cat No.GOA-071

***Quinqueloculina distorqueata* Cushman**

Plate 4, Figure 9

Quinqueloculina distorqueata CUSHMAN, 1954, p.333, pl.83, fig.27.

Quinqueloculina lachesis Karrer RASHEED, 1971, p.23, pl.5, fig.1.

Remarks: The original reference *Quinqueloculina distorqueata* Cushman, 1954 was quoted in Cushman *et al.* (1954) as described in catalogue (in the form of CDs). Therefore, Cushman (1954) is not in the reference list at the end of this thesis.

Hypotype: Length=0.41 mm.; width=0.33 mm.; thickness=0.25 mm.

Repository: GOD NIO Cat No.GOA-072

***Quinqueloculina echinata* (d'Orbigny)**

Plate 4, Figure 10

Triloculina echinata D'ORBIGNY, 1826, p.300, no.14.- RAO, 1970a, p.87, fig.1; 1971b, p.157.- RAO *et al.*, 1979, p.359, tab.3.- SHAREEF and VENKATACHALAPATHY, 1987b, p.189; 1988, p.434, pl.2, figs.9a-b.- KHARE, 1992, pp.85-86, pl.7, figs.1a-d.

Quinqueloculina echinata (d'Orbigny) – HAAKE, 1975, pl.3, fig.49. - HENRIQUES, 1993, p.49, pl.3, figs.3a-c.- MAYENKAR, 1994, p.63, pl.2, figs.8a-c.- RAO, 1998, p.83, pl.12, figs.9-10.- MAZUMDER *et al.*, 2003, p.8, tab.1.

Remarks: This species has been reported earlier as *Triloculina echinata* as well as *Quinqueloculina echinata*. However, the latest workers have reported it as *Quinqueloculina echinata* from both, the Arabian Sea (Mayenkar, 1994) and the Bay of Bengal (Rao, 1998). Following this nomenclature, the specimens from off Goa region were also named as *Q. echinata*.

Hypotype: Length=0.69 mm.; width=0.51 mm.; thickness=0.44 mm.

Repository: GOD NIO Cat No.GOA-073

***Quinqueloculina elegens* d'Orbigny**

Plate 4, Figure 11

Quinqueloculina elegans D'ORBIGNY, 1826, p.301.- DANIELS, 1970, p.73, pl.12, fig.13.- HAAKE, 1975, p.33, pl.3, figs.51-57.- SETTY and NIGAM, 1984, p.432, pl.32, fig.13.-

HENRIQUES, 1993, pp.49-50, pl.3, figs.5a-c.- MAYENKAR, 1994, pp.63-64, pl.3, figs.1a-c.- RAO, 1998, p.84, pl.13, fig.1.- GANDHI, 1999, p.52, pl.2, fig.16.- CHATURVEDI, 2001, p.118, pl.3, fig.5.- GANDHI *et al.*, 2002, p.53, pl.I, fig.8.- MAZUMDER *et al.*, 2003, p.8, tab.1.- GANDHI and RAJAMANICKAM, 2004, p.293-304, tab.1,2.

Hypotype: Length=0.58 mm.; width=0.43 mm.; thickness=0.29 mm.
Repository: GOD NIO Cat No.GOA-074

***Quinqueloculina* cf. Q. *inaequalis* d'Orbigny**
Plate 4, Figure 12

Quinqueloculina inaequalis D'ORBIGNY, 1839, p.142, pl.3, fig.28-30.

Remarks: The specimens from the off Goa region are similar to *Quinqueloculina inaequalis* described by Haake (1975). The only difference is that the specimens from off Goa do not have a neck, because of which the name of our specimen has been suggested as *Quinqueloculina* cf. *Q. inaequalis.*

Hypotype: Length=0.28 mm.; width=0.24 mm.; thickness=0.18 mm.
Repository: GOD NIO Cat No.GOA-075

***Quinqueloculina kerimbatica* (Heron-Allen and Earland)**
Plate 4, Figure 13

Miliolina kerimbatica HERON-ALLEN and EARLAND, 1915, p.574. pl.43, figs.13-23.
Quinqueloculina kerimbatica (Heron-Allen and Earland) CUSHMAN, 1921, p.437.- HOFKER, 1968, pp.18-19, pl.3, figs.8-22.- ZOBEL, 1973, p.16, pl.1, fig.57.- NIGAM, 1982, p.54, pl.2, fig.29.- BHALLA and LAL, 1985, p.430.- KHARE, 1992, p.71, pl.4, fig.1.- MAYENKAR, 1994, p.64, pl.3, fig.4.- RAO, 1998, p.86, pl.13, fig.6.- NIGAM and KHARE, 1999, p.302, pl.2, fig.3.- CHATURVEDI, 2001, p.119, pl.3, fig.7.- MAZUMDER *et al.*, 2003, p.8, tab.1.

Hypotype: Length=0.65 mm.; width=0.53 mm.; thickness=0.34 mm.
Repository: GOD NIO Cat No.GOA-076

***Quinqueloculina lamarckiana* d'Orbigny**
Plate 5, Figure 1

Quinqueloculina lamarckiana D'ORBIGNY, 1839, p.189, pl.11, figs.14-15.- BHATIA, 1956, p.17, pl.2, fig.10.- GANAPATI and SATYAVATI, 1958, p.106, pl.1, figs.21-23.- GANAPATI and SAROJINI, 1962, p.312.- ROCHA and UBALDO, 1964a, p.410, pl.1, figs.3a-b; 1964b, p.647, pl.2, figs.1-2.- VEDANTAM and RAO, 1970, p.329, table 3.- RAO, 1970a, pp.588-589, figs.10a-b; 1971b, p.157; 1974, p.63, fig.13.- BHATIA and KUMAR, 1976, p.249.- RAO and RAO, 1976a, p.298; 1976b, p.217.- RAO and RAO, 1978, p.426.- RAO *et al.*, 1979, p.358, table 3.- VENKATACHALAPATHY and SHAREEF, 1981, p.44.- NARAPPA *et al.*, 1982, p.221.- NIGAM, 1982, pp.57-59, pl.2, fig. 5.- REDDY and REDDY, 1982, p.250, pl.2.- RAO *et al.*, 1982, p.215, table 3.- REDDY *et al.*, 1983, p.107.- SETTY *et al.*, 1984, p.50, table 1.- SRIVASTAVA *et al.*, 1984, p.36, pl.1, fig.1.- RAGOTHAMAN and KUMAR, 1985, p.101, pl.1, figs.7-8.- RAO *et al.*, 1985, p.76, table 1; 1987, p.165, pl.2, figs.6-8.- NIGAM, 1986, p.424, table 1.- SHAREEF and VENKATACHALAPATHY, 1987b, p.189; 1988, p.434, pl.1, figs.11a-b.- BHALLA and NIGAM, 1988, p.518, table 1.- KUMAR, 1988, p.52, pl.3, figs.10-11.- PAL, 1989, p.109, table 1.- KALADHAR *et al.*, 1990, p.72, table 1.- KHARE, 1992, pp.72-73,pl. 4, figs.2a-c.- HENRIQUES, 1993, pp.51-52, pl.4, figs.1a-d.- JAYARAJU, 1993, p.96, pl.1, fig.11.- MAYENKAR, 1994, p.65, pl.3, figs.5a-d.- DAS, 1996, p.49, table 1.– JAYARAJU and REDDI, 1996, p.315, table 1.- RAO, 1998, pp.86-87, pl.13, figs.7-8.- GANDHI, 1999, pp.54-55, pl.3, figs.4-5.- NIGAM and KHARE, 1999, p.302, pl.2, figs.4a-c.- CHATURVEDI, 2001, p.119, pl.3, fig.8.- KYAW and SAING, 2001, p.8, pl.II, fig.14.- MAZUMDER *et al.*, 2003, p.8, tab.1.- GANDHI and RAJAMANICKAM, 2004, p.293-304, tab.1,2.- KUMAR and SRINIVASAN, 2004, pp.299-312.

Hypotype: Length=0.84 mm.; width=0.64 mm.; thickness=0.29 mm.
Repository: GOD NIO Cat No.GOA-077

***Quinqueloculina mosharrafai* Said**
Plate 5, Figure 2

Quinqueloculina mosharrafai SAID, 1950, p.10, pl.1, fig.23.

Hypotype: Length=0.25 mm.; width=0.20 mm.; thickness=0.16 mm.
Repository: GOD NIO Cat No.GOA-078

***Quinqueloculina multimarginata* Said**
Plate 5, Figure 3

Quinqueloculina multimarginata SAID, 1950, p.10, pl.1, fig.34.

Hypotype: Length=0.53 mm.; width=0.29 mm.; thickness=0.29 mm.
Repository: GOD NIO Cat No.GOA-079

***Quinqueloculina parkeri* (Brady)**
Plate 5, Figure 4

Miliolina parkeri BRADY, 1881, p.46; 1884, p.177, pl.7, fig.14.
Quinqueloculina parkeri (Brady) CUSHMAN, 1917, p.50, pl.15, fig.3.- GUPTHA, 1973a, p.782.- REDDY *et al.*, 1974, p.18.- SEIBOLD, 1975, p.182, pl.1, fig.6.- RAO and RAO, 1976b, pp.217.- RAO *et al.*, 1979, p.361, tab.3.- REDDY and RAO, 1980, p.164, pl.2, figs.1-3.- SEIBOLD and SEIBOLD, 1981, p.43, tab.3b.- REDDY and REDDY, 1982, p.250, tab.2.- REDDY *et al.*, 1983, p.107, RAGOTHAMAN and KUMAR, 1985, p.101, pl.1, figs.10-11.- RAO *et al.*, 1987, p.165, pl.2, figs.12-14.- KALADHAR *et al.*, 1990, p.72, tab.1.- KHARE, 1992, p.75, pl.4, figs.6a-c.- RAO, 1998, p.88, pl.14, fig.1.- GANDHI and RAJAMANICKAM, 2004, p.293-304, tab.1,2.

Hypotype: Length=0.55 mm.; width=0.49 mm.; thickness=0.38 mm.
Repository: GOD NIO Cat No.GOA-080

***Quinqueloculina polygona* d'Orbigny**
Plate 5, Figure 5

Quinqueloculina polygona D'ORBIGNY 1839, p.198, pl.12, figs.21-23.- CUSHMAN, 1929, p.28, pl.3, figs.5a-c.- RAO *et al.*, 1987, tab.1, pl.II, fig.15-17.- MANIVANNAN *et al.*, 1996, p.382.- RAO, 1998, p.88, pl.14, fig.2.- KYAW and SAING, 2001, p.8, pl.II, fig.16.- GANDHI and RAJAMANICKAM, 2004, p.293-304, tab.1,2.

Hypotype: Length=0.44 mm.; width=0.31 mm.; thickness=0.21 mm.
Repository: GOD NIO Cat No.GOA-081

***Quinqueloculina pseudoreticulata* Parr**
Plate 5, Figure 6

Quinqueloculina pseudoreticulata PARR, 1941, p.177, pl.9, figs.2-3.- ROCHA and UBALDO, 1964a, p.412, pl.1, figs.4a-b; 1964b, p.647, pl.2, figs.3-4.- BHALLA and NIGAM, 1979, p.239.- RAO *et al.*, 1979, p.360, table 3.- RAGOTHAMAN and KUMAR, 1985, p.102, pl.1, fig.14.- SETTY and NIGAM, 1985, p.285.- NIGAM, 1982, p.68, pl.2, fig.1; 1986, p.424.- SHAREEF and VENKATACHALAPATHY, 1988, p.434, pl.2, figs.3a-b.- KHARE, 1992, p.76, pl.4, figs.7a-c; pl.5, fig.1.- HENRIQUES, 1993, p.53, pl.4, figs.4a-b.- MAYENKAR, 1994, p.67, pl.3, figs.6a-c.- TALIB and FAROOQUI, 1994, p.91, table 1.– JAYARAJU and REDDI, 1996, p.315, table 1.- RAO, 1998, p.89, pl.14, figs.3-4.- NIGAM and KHARE, 1999, p.302, pl.2, figs.9a-c.- CHATURVEDI, 2001, p.121, pl.3, fig.11.- KATHAI, 2002, p.433, pl.1, figs.6a-c.- MAZUMDER *et al.*, 2003, p.8, tab.1.

Hypotype: Length=0.68 mm.; width=0.61 mm.; thickness=0.43 mm.
Repository: GOD NIO Cat No.GOA-082

***Quinqueloculina quadrilateralis* (d'Orbigny)**
Plate 5, Figure 7

Triloculina quadrilateralis D'ORBIGNY, 1839, p.173, pl.9, figs.14-16.
Quinqueloculina quadrilateralia (d'Orbigny) MARTINOTTI, 1921, p.301, pl.3, fig.12-14.

Hypotype: Length=0.48 mm.; width=0.35 mm.; thickness=0.28 mm.
Repository: GOD NIO Cat No.GOA-083

***Quinqueloculina rhodiensis* Parker**
Plate 5, Figure 8

Quinqueloculina rhodiensis PARKER, 1953, p.12, figs.15-17.- RAO *et al.*, 1987, pl.II, figs.21-23.- GANDHI *et al.*, 2002, p.54, pl.I, fig.14.- GANDHI and RAJAMANICKAM, 2004, p.293-304, tab.1,2.

Hypotype: Length=0.25 mm.; width=0.15 mm.; thickness=0.13 mm.
Repository: GOD NIO Cat No.GOA-084

***Quinqueloculina schlumbergeri* (Wiesner)**
Plate 5, Figure 9

Miliolina schlumbergeri WIESNER, 1923, pl.6, fig.73.
Quinqueloculina schlumbergeri (Weisner) DANIELS, 1970, p.75, pl.3, figs3a-b.- RAO, 1998, p.89, pl.14, fig.5.- KATHAL, 2002, p.433, pl.1, figs.7a-c.

Hypotype: Length=0.25 mm.; width=0.16 mm.; thickness=0.12 mm.
Repository: GOD NIO Cat No.GOA-085

***Quinqueloculina seminulum* (Linne)**
Plate 6, Figure 3

Serpula seminulum LINNE, 1758, p.786 (fide Ellis and Messina).
Miliolina seminulum WILLIAMSON, 1858, p.85, pl.7, figs.183-185.- BRADY, 1884, p.157, pl.5, figs.6a-c.
Quinqueloculina seminulum (Linne) D'ORBIGNY, 1826, p.303.- GNANAMUTHU, 1943, p.10, pl.2, figs.4-8.- BHATIA, 1956, p.17, pl.2, fig.9.- BHATIA and BHALLA, 1959, p.79, pl.1, figs.1a-b.- ANTONY, 1968, p.30, pl.1, fig.23.- BHALLA, 1968, pp.380-381, pl.1, figs.1a-b; 1970, pp.156-157, pl.20, figs.1a-b.- FRERICHS, 1970, p.136, table 3.- RAO, 1970a, p.589, figs.12a-b; 1971b, p.157; 1974, p.63, fig.11.- RAO and RAO, 1974, p.414, pl.1, fig.11; 1976a, p.300, table 7; 1976b, p.218.- REDDY *et al.*, 1974, p.18.- BHATIA and KUMAR, 1976, p.249.- RAO and RAO, 1978, p.426.- BHALLA and NIGAM, 1979, p.239; 1988, p.518.- NIGAM *et al.*, 1979, p.246.- RAO *et al.*, 1979, p.358, table 3.- REDDY and RAO, 1980, p.164, pl.2, figs.4-6.- NIGAM, 1982, pp.71-73, pl.1, fig.18; SETTY and NIGAM, 1980b, p.421; 1984, p.432, pl.32, fig.11; 1985, p.285.- VENKATACHALAPATHY and SHAREEF, 1981, p.44.- RAO *et al.*, 1982, p.216.- REDDY and REDDY, 1982, p.250, table 2.- NIGAM and THEIDE, 1983, p.126, table 3.- SETTY *et al.*, 1984, p.50, table 1.- SRIVASTAVA *et al.*, 1984, p.36.- BHALLA and LAL, 1985, p.430.- RAO *et al.*, 1985, p.76, table 1.- SETTY and NIGAM, 1985, p.285.- NIGAM, 1986, p.424.- RAO *et al.*, 1987, p.165, pl.2, figs.24- 26.- BHALLA and GAUR, 1987, p.123, pl.1, fig.6.- NAIDU, 1987, p.27, table 7.- SHAREEF and VENKATACHALAPATHY, 1987a, p.193; 1987b, p.191; 1988, p.434, pl.1, fig.9.- BHALLA and NIGAM, 1988, p.518.- KUMAR, 1988, p.57, pl.4, figs.9.- NAIDU and RAO, 1988, p.855.- MADABHUSHI, 1989b, p.103.- KALADHAR *et al.*, 1990, p.72, table 1.- KUMAR *et al.*, 1990, p.57, pl.1, fig.6, table 1.- KHARE, 1992, pp.77-79, pl.5, figs.2a-c, 3a-c.- HENRIQUES, 1993, pp.54-55, pl.4, figs.5a-c.- JAYARAJU, 1993, p.100, pl.2, fig.6.- MAYENKAR, 1994, p.68, pl.4, figs.3a-c.- TALIB AND FAROOQUI, 1994, p.91, table 1.- DAS, 1996, p.49, table 1.– JAYARAJU and REDDI, 1996, p.315, table 1.- RAO, 1998,

pp.90-91, pl.14, figs.6,7.- GANDHI, 1999, pp.57-58, pl.3, figs.11-12.- NIGAM and KHARE, 1999, p.302, pl.2, figs.11a-c, 12a-c.- JAYARAJU *et al.*, 2000, p.335, tab.2.- NIGAM and CHATURVEDI, 2000, p.134.- CHATURVEDI, 2001, p.122, pl.3, fig.13, pl.4, fig.1.- KYAW and SAING, 2001, p.9, pl.II, fig.17.- MAZUMDER *et al.*, 2003, p.8, tab.1.- GANDHI and RAJAMANICKAM, 2004, p.293-304, tab.1,2.- RAI and SINGH, 2004, pp.415-429, tab.1.- KUMAR and SRINIVASAN, 2004, pp.299-312.

Hypotype: Length=0.45 mm.; width=0.31 mm.; thickness=0.13 mm.
Repository: GOD NIO Cat No.GOA-086

***Quinqueloculina subpolygona* Parr**
Plate 5, Figure 10

Quinquiloculina subpolygona PARR, 1945, p.196, pl.12, fig.2.

Hypotype: Length=0.47 mm.; width=0.37 mm.; thickness=0.24 mm.
Repository: GOD NIO Cat No.GOA-087

***Quinqueloculina sulcata* d'Orbigny**
Plate 5, Figure 11

Quinqueloculina sulcata D'ORBIGNY, 1826, v.7, p.301, no.17.- RAO *et al.*, 1987, tab.1, pl.II, figs.27-29.- MANIVANNAN *et al.*, 1996, p.382.- RAO, 1998, p.91, pl.14, figs.9-10.- KATHAL, 2002, p.433, pl.1, figs.9a-c.- KUMAR and SRINIVASAN, 2004, pp.299-312.

Hypotype: Length=0.60 mm.; width=0.38 mm.; thickness=0.31 mm.
Repository: GOD NIO Cat No.GOA-088

***Quinqueloculina trigonula* Terquem**
Plate 5, Figure 12

Quinqueloculina trigonula TERQUEM, 1876, p.84, pl.12, fig.4.- HENRIQUES, 1993, p.55, pl.4, figs.6a-c.- MAYENKAR, 1994, p.69, pl.4, figs.4a-c.- CHATURVEDI, 2001, p.123, pl.4, fig.4.- MAZUMDER *et al.*, 2003, p.8, tab.1.

Hypotype: Length=0.26 mm.; width=0.20 mm.; thickness=0.15 mm.

Repository: GOD NIO Cat No.GOA-089

***Quinqueloculina undulose costata* Terquem**

Plate 6, Figure 1

Quinqueloculina undulosa costata TERQUEM, 1882, p.185, pl.20, figs.18-19.- BHATIA, 1956, p.17, pl.2, fig.8; ROCHA and UBALDO, 1964a, p.412, pl.1, figs.5a-b.- REDDY *et al.*, 1974, p.18.- BHATIA and KUMAR, 1976, p.249.- REDDY and RAO, 1980, p.164, pl.2, figs.7-9.- NIGAM, 1982, p.70, pl.2, fig.6a-c.- RAGOTHAMAN and KUMAR, 1985, p.102, pl.1, fig.12.- BHALLA and NIGAM, 1988, p.518, table 1.- SHAREEF and VENKATACHALAPATHY, 1988, p.434, pl.2, figs.4a-b.- KHARE, 1992, p.80, pl.5, figs.6a-b.- MAYENKAR, 1994, p.69, pl.4, figs.5a-b.- NIGAM and KHARE, 1999, p.302, pl.2, figs.15a-b.- CHATURVEDI, 2001, p.124, pl.17, fig.7.- KATHAL, 2002, p.433, pl.1, figs.10a-c.- MAZUMDER *et al.*, 2003, p.8, tab.1.

Hypotype: Length=1.25 mm.; width=0.88 mm.; thickness=0.53 mm.
Repository: GOD NIO Cat No.GOA-090

***Quinqueloculina venusta* Karrer**

Plate 6, Figure 2

Quinqueloculina venusta KARRER, 1868, p.147, pl.2, fig.6.- CUSHMAN, 1916, p.45, pl.11, fig.1.- BHATIA, 1956, p.17, pl.2, fig.6.- RAO, 1971b, p.157, fig.12.- ZOBEL, 1973, p.19, pl.2, fig.65, - BHALLA and NIGAM, 1979, p.239.- NIGAM *et al.*, 1979, p.246.- SETTY and NIGAM, 1980b, p.421; 1985, p.285.- NIGAM, 1982, pp.77-78, pl.2, fig.10.- BHALLA and NIGAM, 1988, p.518, table 1.- KHARE, 1992, pp.80-81, pl.5, fig.7a-c.- NIGAM and KHARE, 1999, p.302, pl.2, figs.16a-c.- NIGAM and CHATURVEDI, 2000, p.134.- CHATURVEDI, 2001, p.124, pl.4, fig.3.- KATHAL, 2002, p.434, pl.2, figs.2a-c.- RAI and SINGH, 2004, pp.415-429, tab.1.

Hypotype: Length=1.01 mm.; width=0.66 mm.; thickness=0.42 mm.
Repository: GOD NIO Cat No.GOA-091

***Quinqueloculina vulgaris* d'Orbigny**

Plate 6, Figure 4

Quinqueloculina vulgaris D'ORBIGNY, 1826, p.302, fig.33.- SETHULEKSHMI AMMA, 1958, pp.4-5, pl.1, fig.5.- GANAPATI and SATYAVATI, 1958, p.106, pl.1, figs.24-26.- ROCHA and UBALDO,1964a, p.412, pl.1, figs.6a-b.- ANTONY, 1968, p.29, pl.1, fig.22.- BHALLA, 1970, p.157, pl.20, figs.3a-b.- RAO, 1970a, p.589, pl.1, figs.11a-b., 1971b, p.157; 1974, p.63, fig.12.- VEDANTAM and RAO, 1970, p.329, table 3.- BHALLA and NIGAM, 1979, p.239; 1988, p.518, table 1.- NIGAM *et al.*, 1979, p.246.- RAO *et al.*, 1979, p.357, table 3.- BHALLA and RAGHAV, 1980, p.289, table 1.- SETTY and NIGAM, 1980b, p.421; 1984, p.434, pl.33, figs.35-36; 1985, p.285.- NIGAM, 1982, pp.80-81, pl.1, fig19.- VENKATACHALAPATHY and SHAREEF, 1981, p.44.- NARAPPA *et al.*, 1982, p.221.- NIGAM, 1984, p.424, appendix 1.- SETTY *et al.*, 1984, p.50, table 1.- RAO *et al.*, 1985, p.76, table 1.- SHAREEF and VENKATACHALAPATHY, 1988, p.434, pl.1, fig.10a-c.- PAL, 1989, p.109, table 1.- KHARE, 1992, pp.81-82, pl.6, figs.1a-c.- HENRIQUES, 1993, pp.56-57, pl.5, figs.3a-c.- MAYENKAR, 1994, p.70, pl.4, figs.6a-c.- TALIB AND FAROOQUI, 1994, p.91, table 1.- DAS, 1996, p.49, table 1.- NIGAM and KHARE, 1999, p.302, pl.2, figs.17a-c.- CHATURVEDI, 2001, p.125, pl.4, fig.5.- KATHAL, 2002, p.434, pl.2, figs.3a-c.- MAZUMDER *et al.*, 2003, p.8, tab.1.

Hypotype: Length=0.41 mm.; width=0.38 mm.; thickness=0.29 mm.
Repository: GOD NIO Cat No.GOA-092

***Quinqueloculina* sp.**
Plate 6, Figure 5

Remarks: These specimens are almost similar to *Quinqueloculina bicarinata,* except that the corners of these specimens are more blunt than *Q. bicarinata*. So the nomenclature to these specimens was kept open nomenclature under the genus *Quinqueloculina*.

Hypotype: Length=0.61 mm.; width=0.48 mm.; thickness=0.22 mm.
Repository: GOD NIO Cat No.GOA-093

Subfamily MILIOLINELLINAE Vella, 1957
Genus CRIBROMILIOLINELLA Saidova, 1981

***Cribromiliolinella* sp.**
Plate 6, Figure 6

Remarks: Due to lack of specimens from the present study area, the nomenclature of these specimens was kept open unde the genus *Cribromiliolinella.* An ovate test, porcelaneous wall, externally three visible chambers and a terminal aperture with flap characterize these specimens.

Hypotype: Length=0.55 mm.; width=0.47 mm.; thickness=0.33 mm.
Repository: GOD NIO Cat No.GOA-094

Genus MILIOLINELLA Wiesner, 1931

***Miliolinella australis* (Parr)**
Plate 6, Figure 7

Quinqueloculina australis PARR, 1932, p.7, pl.1, fig.8.
Miliolinella australis (Parr) BARKER, 1960, p.10, pl.5, figs.10-11.- NIGAM, 1982, p.100, pl.4, fig.1.- REDDY and REDDY, 1982, p.250, table 2.- KHARE, 1992, p.84, pl.6, figs.5a-c.- HENRIQUES, 1993, p.57, pl.5, figs.2a-b.- MAYENKAR, 1994, p.70, pl.5, figs.1a-b.- DAS, 1996, p.49, table 1.- RAO, 1998, p.95, pl.16, fig.5.- GANDHI, 1999, p.62, pl.4, fig.6. NIGAM and KHARE, 1999, p.302, pl.3, figs.1a-b.- CHATURVEDI, 2001, p.127, pl.4, fig.10.- GANDHI *et al.*, 2002, p.56, pl.I, fig.20.- MAZUMDER *et al.*, 2003, p.8, tab.1.- GANDHI and RAJAMANICKAM, 2004, p.293-304, tab.1,2.

Hypotype: Length=0.29 mm.; width=0.23 mm.; thickness=0.12 mm.
Repository: GOD NIO Cat No.GOA-095

***Miliolinella circularis* (Bornemann)**
Plate 6, Figure 8

Triloculina circularis BORNEMANN 1855, v.7, pt.2, p.349, pl.19, figs.4a-c.
Miliolinella circularis (Bornemann) GRAHAM and MILITANTE, 1959, p.37, pl.3, figs.17,18a-c.- RAO *et al.*, 1987, tab.1, pl.III, figs.20-22.- MANIVANNAN *et al.*, 1996, p.382.- RAO, 1998, p.96, pl.16, fig.6-7.- KYAW and SAING, 2001, p.10, pl.II, fig.42.- GANDHI and RAJAMANICKAM, 2004, p.293-304, tab.1,2.- KUMAR and SRINIVASAN, 2004, pp.299-312.

Hypotype: Length=0.24 mm.; width=0.23 mm.; thickness=0.14 mm.

Repository: GOD NIO Cat No.GOA-096

***Miliolinella labiosa* (d'Orbigny)**

Plate 6, Figure 9

Triloculina labiosa D'ORBIGNY 1839, p.178, pl.10, fig.12-14.

Miliolinella labiosa (d'Orbigny) PONDER, 1974a, figs.1,2,5.- RAO *et al.*, 1987, tab.1, pl.III, figs. 25-27.- MANIVANNAN *et al.*, 1996, p.382.- RAO, 1998, p.96, pl.16, figs.8-9.- GANDHI and RAJAMANICKAM, 2004, p.293-304, tab.1,2.

Hypotype: Length=0.48 mm.; width=0.42 mm.; thickness=0.31 mm.

Repository: GOD NIO Cat No.GOA-097

***Miliolinella lamellidens* (Reuss)**

Plate 6, Figure 10

Quinqueloculina lamellidens REUSS, 1863, p.41, pl.1, fig.7.

Miliolinella lamellidens (Reuss) HAAKE, 1975, p.40, pl.5, fig.104.

Hypotype: Length=0.26 mm.; width=0.22 mm.; thickness=0.16 mm.

Repository: GOD NIO Cat No.GOA-098

***Miliolinella lutea* (d'Orbigny)**

Plate 6, Figure 11

Triloculina lutea D'ORBIGNY, 1839, p.70, pl.9, fig.6-8.

Milliolinella lutea (d'Orbigny) HAAKE, 1975, p.40, pl.5, fig.98-100.

Hypotype: Length=0.31 mm.; width=0.21 mm.; thickness=0.13 mm.

Repository: GOD NIO Cat No.GOA-099

***Miliolinella oblonga* (Montagu)**

Plate 6, Figure 12

Vermiculum oblongum MONTAGU, 1803, p.522, pl.14, fig.9.

Triloculina oblonga (Montagu) NIGAM, 1984, p.424.

Miliolinella oblonga (Montagu) MATOBA, 1970, p.56, pl.3, figs.6a-b.- BHATIA, 1956, p.671, pl.67, fig.17.- NIGAM, 1981, p.101, pl.4, fig.2.- RAO *et al.*, 1982, p.215, tab.3.

Hypotype: Length=0.34 mm.; width=0.15 mm.; thickness=0.09 mm.
Repository: GOD NIO Cat No.GOA-100

***Miliolinella* cf. *M.oceanica* (Cushman)**
Plate 7, Figure 1

Triloculina oceanica CUSHMAN, 1932, p.54, pl.12, fig.3.
Miliolinella oceanica (Cushman) PONDER, 1974b, p.133-137, pl.14, figs.1-5; pl.5, figs.1-11.

Hypotype: Length=0.44 mm.; width=0.31 mm.; thickness=0.21 mm.
Repository: GOD NIO Cat No.GOA-101

***Miliolinella subrotunda* (Montagu)**
Plate 7, Figure 2

Vermiculum subrotundum MONTAGU, 1803, p.521.
Miliolinella subrotunda (Montagu) FRERICHS, 1970, pp.138-139, table 4.- VEDANTAM and RAO, 1970, p.329, table 3.- RAO et al., 1979, p.356, fig.2.- MATHUR and GUPTA, 1989, p.121.- HENRIQUES, 1993, pp.57-58, pl.5, figs.4a-b.- MAYENKAR, 1994, p.71, pl.5, figs.2a-b.- RAO, 1998, p.98, pl.17, fig.4.- CHATURVEDI, 2001, p.128, pl.4, fig.11.- MAZUMDER *et al.*, 2003, p.8, tab.1.

Hypotype: Length=0.22 mm.; width=0.19 mm.; thickness=0.14 mm.
Repository: GOD NIO Cat No.GOA-102

***Miliolinella warreni* Andersen**
Plate 7, Figure 3

Miliolinella warreni ANDERSEN, 1961, p.37, pl.7, fig.4.

Hypotype: Length=0.27 mm.; width=0.17 mm.; thickness=0.13 mm.
Repository: GOD NIO Cat No.GOA-103

***Miliolinella* sp.**

Plate 7, Figure 4

Remarks: These specimens are similar to *Miliolinella circularis*, though it differs by being broader than long, which gives it a shape like an ellipsoid. Hence the nomenclature of these specimens was kept open under the genus *Miliolinella.*

Hypotype: Length=0.44 mm.; width=0.62 mm.; thickness=0.18 mm.

Repository: GOD NIO Cat No.GOA-104

Genus PYRGO Defrance, 1824

***Pyrgo* cf. *P. denticulata* (Brady)**

Plate 7, Figure 5

Biloculina ringens var. *denticulata* BRADY 1884, p.143, pl.3, fig.4-5.

Pyrgo denticulata (Brady) CUSHMAN, 1929, p.69, pl.18, figs.3-4.- BARKER, 1960, p.6, pl.3, fig.4.- RAO, 1998, p.101, pl.18, fig.3.- KYAW and SAING, 2001, p.10, pl.I, fig.18.

Remarks: These specimens are similar to *Pyrgo denticulata* and *P. serrata*, but differ from the latter on the basis of aperture. Hence the name *Pyrgo* cf. *P. denticulata* has been given to these specimens.

Hypotype: Length=0.64 mm.; width=0.59 mm.; thickness=0.35 mm.

Repository: GOD NIO Cat No.GOA-105

***Pyrgo elongata* (d'Orbigny)**

Plate 7, Figure 6

Biloculina elongata D'ORBIGNY, 1826, p.298.

Pyrgo elongata (d'Orbigny) JONES, 1994, pl.2, fig.9.

Hypotype: Length=0.31 mm.; width=0.21 mm.; thickness=0.17 mm.

Repository: GOD NIO Cat No.GOA-106

Pyrgo laevis **Defrance**

Plate 7, Figure 7

Pyrgo laevis DEFRANCE 1824, p.273, pl.88, fig.2.- MATHUR and GUPTA, 1989, p.122.- HENRIQUES, 1993, p.58, pl.5,6a-b.- MAYENKAR, 1994, p.72, pl.5, figs.3a-b.- RAO, 1998, p.102, pl.18, fig.7.- MAZUMDER *et al.*, 2003, p.8, tab.1.

Hypotype: Length=0.34 mm.; width=0.33 mm.; thickness=0.24 mm.

Repository: GOD NIO Cat No.GOA-107

Pyrgo **cf.** ***P. nasutus*** **Cushman**

Plate 7, Figure 8

Pyrgo nasutus CUSHMAN, 1935, p.7, pl.3, figs.1-4.- BOLTOVSKOY, 1978, p.167, pl.VI, figs.27-28.

Remarks: Our specimens resemble closely with Parker's (1954) *Pyrgo nasutus*; both have the similar elongated apertural portion and basal opening. So our specimen was referred as *Pyrgo* cf. *P.nasutus*.

Hypotype: Length=0.24 mm.; width=0.19 mm.; thickness=0.14 mm.

Repository: GOD NIO Cat No.GOA-108

Pyrgo striolata **(Brady)**

Plate 7, Figure 9

Biloculina ringens (Lamarck) var. *striolata* BRADY, 1884, p.143, pl.3, figs.4-5.

Pyrgo striolata (Brady) HAIG, 1988, p.233, pl.4, figs.1-4.

Hypotype: Length=0.41 mm.; width=0.32 mm.; thickness=0.25 mm.

Repository: GOD NIO Cat No.GOA-109

Pyrgo **sp. A**

Plate 7, Figure 10

Remarks: These specimens are characterized by a slight elongation in shape, a rounded aperture with a very short neck-like projection and a prominent notch at the end of the chamber with two small spine-like projections on either side.

Hypotype: Length=0.28 mm.; width=0.26 mm.; thickness=0.16 mm.
Repository: GOD NIO Cat No.GOA-110

***Pyrgo* sp. B**
Plate 8, Figure 1

Remarks: These specimens are ovate in outline, have compressed tests, an elongated aperture without neck and a prominent notch at the end of the chamber without any spine.

Hypotype: Length=0.47 mm.; width=0.47 mm.; thickness=0.30 mm.
Repository: GOD NIO Cat No.GOA-111

***Pyrgo* sp. C**
Plate 8, Figure 2

Remarks: These specimens are characterized by their tests being compressed, ovate in outline, a round aperture with short neck-like projection and a continuous smooth periphery.

Hypotype: Length=0.64 mm.; width=0.62 mm.; thickness=0.30 mm.
Repository: GOD NIO Cat No.GOA-112

***Pyrgo* sp. D**
Plate 8, Figure 3

Remarks: The elongation in their shape, a slighty elongated aperture with a very short neck, characterizes these specimens.

Hypotype: Length=0.16 mm.; width=0.12 mm.; thickness=0.11 mm.
Repository: GOD NIO Cat No.GOA-113

***Pyrgo* sp. E**
Plate 8, Figure 4

Remarks: These specimens have some resemblances with *Pyrgo denticulata* and *P. serrata*. But the serrate margin of these specimens is much more pronounced as compared to the other two whose margins have very irregular patterns. Hence its nomenclature has been kept open under the genus *Pyrgo*.

Hypotype: Length=0.46 mm.; width=0.44 mm.; thickness=0.29 mm.
Repository: GOD NIO Cat No.GOA-114

Genus TRILOCULINA d'Orbigny, 1826

***Triloculina insignis* (Brady)**
Plate 8, Figure 5

Miliolina insignis BRADY, 1884, p.165, pl.4, figs.8-10.
Triloculina insignis (Brady) CUSHMAN, 1917, p.64, pl.17, figs.3a-b.- SETHULEKSHMI AMMA, 1958, p.8, pl.1, figs.14a-b.- ANTONY, 1968, pp.37-38, pl.2, figs.12a-b.- VENKATACHALAPATHY and SHAREEF, 1981, p.44.- NIGAM, 1982, pp.85-86, pl.3, fig.13.- RAO *et al.*, 1987, p.165, pl.2, figs.36-38.- SHAREEF and VENKATACHALAPATHY, 1988, p.434, pl.2, figs.7a-b.- KUMAR, 1988, p.66, pl.6, figs.10-11.- KHARE, 1992, p.86, pl.6, figs.8a-b.- HENRIQUES, 1993, p.60, pl.6, figs.2a-b.- MAYENKAR, 1994, p.73, pl.5, figs.6a-b.- RAO, 1998, p.105, pl.19, figs.5-6.- GANDHI, 1999, p.65, pl.4, figs.14-15.- NIGAM and KHARE, 1999, p.302, pl.3, figs.4a-b.- CHATURVEDI, 2001, p.129, pl.5, fig.4.- MAZUMDER *et al.*, 2003, p.8, tab.1.- GANDHI and RAJAMANICKAM, 2004, p.293-304, tab.1,2.- KUMAR and SRINIVASAN, 2004, pp.299-312.

Hypotype: Length=0.43 mm.; width=0.35 mm.; thickness=0.34 mm.
Repository: GOD NIO Cat No.GOA-115

***Triloculina striatotrigonula* Parker and Jones**
Plate 8, Figure 6

Triloculina striatotrigonula PARKER and JONES 1865, p.438.- RAO, 1998, p.107, pl.20, figs.3-4.

Hypotype: Length=0.37 mm.; width=0.30 mm.; thickness=0.30 mm.
Repository: GOD NIO Cat No.GOA-116

***Triloculina terquemiana* (Brady)**
Plate 8, Figure 7

Miliolina terquemiana BRADY, 1884, p.166, pl.114, fig.1.
Triloculina terquemiana (Brady) CUSHMAN, 1917, p.72.- BHATIA, 1956, p.19, pl.2, fig.3.- SETHULEKSHMI AMMA, 1958, p.9, pl.2, figs.15a-b.- ROCHA and UBALDO, 1964a, pl.2, fig.5.- BHALLA, 1968, p.381, pl.1, figs.5a-b- RAO, 1971b, p.157, fig.15.- REDDY *et al.*, 1974, p.18.- BHALLA and NIGAM, 1979, p.239; 1988, p.518, tab.1.- RAO *et al.*, 1979, p.359, tab.3.- REDDY and RAO, 1980, p.165, pl.3, figs.3-4.- REDDY and REDDY, 1982, p.250, tab.2.- REDDY *et al.*, 1983, p.107.- BHALLA and LAL, 1985, p.430.- BHALLA and GAUR, 1987, p.123, pl.1, fig.8.- KHARE, 1992, pp.86-88, pl.7, fig.3.- HENRIQUES, 1993, p.60, pl.6, figs.4a-b.- MAYENKAR, 1994, p.73, pl.5, fig.7.- RAO, 1998, p.107, pl.20, figs.5-6.- KATHAL, 2002, p.441, pl.2, fig.9a-c.- MAZUMDER *et al.*, 2003, p.8, tab.1.- GANDHI and RAJAMANICKAM, 2004, p.293-304, tab.1,2.

Hypotype: Length=0.56 mm.; width=0.43 mm.; thickness=0.39 mm.
Repository: GOD NIO Cat No.GOA-117

***Triloculina tricarinata* d'Orbigny**
Plate 8, Figure 8

Triloculina tricarinata D'ORBIGNY 1826, p.299, no.6.- BHATIA, 1956, p.19, pl.1, fig.16.- GANAPATI and SATYAVATI, 1958, p.106, pl.2, fig.38.- SETHULEKSHMI AMMA, 1958, p.8, pl.1, figs.12-13.- ROCHA and UBALDO, 1964a, p.413, pl.2, figs.6a-b; 1964b, p.647, pl.2, figs.11-12.- ANTONY, 1968, pl.2, figs.13a-b.- BHALLA, 1968, pp.381-382, pl.1, figs.3a-b.- DANIELS, 1970, pl.3, fig.12.- RAO, 1970a, pp.592-593, pl.3, fig.22; 1971b, p.157; 1974, p.63, fig.17.- VEDANTAM and RAO, 1970, p.329, tab.3.- REDDY *et al.*, 1974, p.18.- SETTY, 1974a, p.23, SEIBOLD, 1975, p.182.- BHATIA and KUMAR, 1976, p.249.- RAO and RAO, 1976a, p.298; 1976b, p.217; 1978, p.426.- BHALLA and NIGAM, 1979, p.239; 1988, p.518, tab.1.- NIGAM *et al.*, 1979, p.246.- RAO *et al.*, 1979, p.359, tab.3; 1985, p.76, tab.1; 1987, p.166, pl.3, figs.16-17.- REDDY and RAO, 1980, p.165, pl.3, figs.5-6.- SETTY and NIGAM, 1980b, p.421; 1984, p.434, pl.33, figs.32-33;

1985, p.285.- VENKATACHALAPATHY and SHAREEF, 1981, p.44. SEIBOLD and SEIBOLD, 1981, p.42, tab.3a.- NARAPPA *et al.*, 1982, p.221.- REDDY and REDDY, 1982, p.250, tab.2.- REDDY *et al.*, 1983, p.107.- SETTY *et al.*, 1984, p.50, tab.1.- RAGOTHAMAN and KUMAR, 1985, p.102, pl.1, figs.18-19.- NIGAM, 1986, p.424, tab.1.- BHALLA and GAUR, 1987, p.123, pl.1, fig.9.- SHAREEF and VENKATACHALAPATHY, 1988, p.434, pl.2, figs.6a-b.- PAL, 1989, tab.1.- KALADHAR *et al.*, 1990, p.72, tab.1.- KHARE, ,1992, pp.88-89, pl.7, figs.4a-b.- HENRIQUES, 1993, p.61, pl.6, fig.3.- MAYENKAR, 1994, p.74, pl.5, figs.8a-b.- RAO, 1998, p.108, pl.20, figs.7-8.- KATHAL, 2002, p.441, pl.2, figs.8a-b.- MAZUMDER *et al.*, 2003, p.8, tab.1.- GANDHI and RAJAMANICKAM, 2004, p.293-304, tab.1,2.- KUMAR and SRINIVASAN, 2004, pp.299-312.

Hypotype: Length=0.51 mm.; width=0.36 mm.; thickness=0.36 mm.
Repository: GOD NIO Cat No.GOA-118

***Triloculina trigonula* (Lamarck)**
Plate 8, Figure 9

Miliolites trigonula LAMARCK, 1804, p.151, pl.17, fig.4a-c.
Miliolina trigonula (Lamarck) BRADY, 1884, p.164, pl.3, figs.14-16.
Triloculina trigonula (Lamarck) D'ORBIGNY, 1826, p.229, pl.16, figs.5-9.- BHATIA and BHALLA, 1959, p.79, pl.1, figs.5a-b.- ROCHA and UBALDO, 1964a, p.413, pl.5, fig.5a-b.- BHALLA, 1968, p.382, pl.1, figs.2a-b; 1970, p.157, pl.20, figs.4a-b.- RAO, 1970a, pp.592, pl.3, figs.21a-b; 1971b, p.157; 1974, p.63, fig.16.- VEDANTAM and RAO, 1970, p.329, table 3.- REDDY *et al.*, 1974, p.18.- SEIBOLD, 1975, p.182.- RAO and RAO, 1976b, p.217.- RAO and RAO, 1978, p.426.- RAO *et al.*, 1979, p.361, table 3.- REDDY and RAO, 1980, p.165, pl.3, figs.7-8.- SEIBOLD and SEIBOLD, 1981, p.42, table 3a.- VENKATACHALAPATHY and SHAREEF, 1981, p.44, table 3a- NARAPPA at al., 1982, p.221.- NIGAM, 1982, p.99, pl.3, fig.11.- RAO *et al.*, 1982, p.216, table 3.- REDDY and REDDY, 1982, p.250, table 2.- REDDY *et al.*, 1983, p.107.- SETTY and NIGAM, 1984, p.434, pl.33, figs.30-31; 1985, p.285.- SETTY *et al.*, 1984, p.50, table 1.- SRIVASTAVA *et al.*, 1984, p.36, pl.1, fig.3.- BHALLA and LAL, 1985, p.430.- RAGHOTHAMAN and KUMAR, 1985, p.103, pl.1, fig.20-21.- RAO *et al.*, 1985, p.76, table 1; 1987, p.116, pl.3, figs.18-19.- SHAREEF and VENKATACHALAPATHY, 1987b, p.191; 1988; p.434, pl.2, fig.5.- BHALLA and NIGAM, 1988, p.518, table 1.- KUMAR, 1988, p.71. pl.6, fig.8.- KALADHAR *et al.*, 1990, p.72, table 1.- KHARE, 1992, p.89-91, pl.7, figs.5a-b.- JAYARAJU, 1993, p.109, pl.3, fig.12. –

JAYARAJU and REDDI, 1996, p.315, table 1.- RAO, 1998, pp.108-109, pl.20, figs.9-10.- GANDHI, 1999, p.68, pl.5, fig.6-7.- NIGAM and KHARE, 1999, p.302, pl.3, figs.9a-c.- CHATURVEDI, 2001, p.131, pl.5, fig.8.- KYAW and SAING, 2001, p.9, pl.II, fig.29.- KATHAL, 2002, p.441, pl.2, figs.10a-c.- GANDHI and RAJAMANICKAM, 2004, p.293-304, tab.1,2.- KUMAR and SRINIVASAN, 2004, pp.299-312.

Hypotype: Length=0.51 mm.; width=0.39 mm.; thickness=0.38 mm.
Repository: GOD NIO Cat No.GOA-119

Genus TRILOCULINELLA Riccio, 1950

***Triloculinella* sp.**
Plate 8, Figure 10

Remarks: The genus of these specimens was confirmed from the Treatise (Loeblich and Tappan, 1988). However, due to lack of specimens the nomenclature was kept open under the genus *Triloculinella*. These speciemens are characterized by an angular periphery, porceneous wall, and an aperture like an arch at the end of the final chamber largely covered by a broad apertural flap.

Hypotype: Length=0.38 mm.; width=0.32 mm.; thickness=0.20 mm.
Repository: GOD NIO Cat No.GOA-120

Subfamily SIGMOILINITINAE Łuczkowska, 1974
Genus MESOSIGMOILINA Zheng, 1981

***Mesosigmoilina minuta* (Collins)**
Plate 8, Figure 11

Massilina minuta COLLINS, 1958, p.362, pl.3, figs.1a-b.
Mesosigmoilina minuta ZHENG, 1981.

Hypotype: Length=0.68 mm.; width=0.25 mm.; thickness=0.07 mm.
Repository: GOD NIO Cat No.GOA-121

Genus SPIROSIGMOILINA Parr, 1942

***Spirosigmoilina tenuis* (Cžjžek)**
Plate 8, Figure 12

Quinqueloculina tenuis CZJZEK, 1848, p.149, pl.31, figs.31-34.
Spiroloculina tenuis (Czjzek) BRADY, 1884, p.152, pl.10, Fig.8
Sigmoilopsis tenuis (Czjzek) HAAKE, 1975, p.37, pl.6, figs.119, 120, 123, 124.
Sigmoilinita tenuis (Czjzek) SEIGLIE, 1965, p.72- VEDANTAM and RAO, 1970, p.329, table 3, no.34.- RAO *et al.*, 1979, p.358, table 3.- HENRIQUES, 1993, p.63, pl.6a-c.- MAYENKAR, 1994, p.75-76, pl.6, figs.1a-c.- HERMELIN and SHIMMIELD, 1990, pp. 8-11, table 4.- RAO, 1998, pp.110-111, pl.21, fig.4.- CHATURVEDI, 2001, p.132, pl.5, fig.8.- MAZUMDER *et al.*, 2003, p.8, tab.1.

Hypotype: Length=0.36 mm.; width=0.21 mm.; thickness=0.05 mm.
Repository: GOD NIO Cat No.GOA-122

4.5.1.20 Family RIVEROINIDAE Saidova, 1981

Genus PSEUDOHAUERINA Ponder, 1972

***Pseudohauerina orientalis* (Cushman)**
Plate 8, Figure 13

Hauerina orientalis CUSHMAN, 1946, p.12, pl.2, figs.22-24.
Pseudohauerina orientalis (Cushman) PONDER, 1972, p.153-154.- HENRIQUES, 1993, p.64, pl.6. figs.19-20.- RAO, 1998, p.113, pl.21, fig.11.- MAZUMDER *et al.*, 2003, p.8, tab.1.

Hypotype: Length=0.27 mm.; width=0.25 mm.; thickness=0.18 mm.
Repository: GOD NIO Cat No.GOA-123

Superfamily ALVEOLINACEA Ehrenberg, 1839

4.5.1.21 Family ALVEOLINIDAE Ehrenberg, 1839

Genus BORELIS Montfort, 1808

Borelis **sp.**

Plate 8, Figure 14

Remarks: These specimens are very rare in the off Goa region and their surfaces are also quite polished. Hence they cannot be identified upto the species level. These specimens are characterized by small fusiform test and the presence of preseptal passages.

Hypotype: Length=0.45 mm.; maximum diameter=0.28 mm.
Repository: GOD NIO Cat No.GOA-124

Superfamily SORITACEA Ehrenberg, 1839

4.5.1.22 Family SORITIDAE Ehrenberg, 1839

Subfamily ARCHAIASINAE Cushman, 1927

Genus PARASORITES Seiglie and Rivera, 1977

***Parasorites marginalis* (Lamarck)**

Plate 9, Figure 1

Orbulites marginalis LAMARCK, 1816, p.196.
Sorites marginalis (Lamarck) SETHULESHMI AMMA, 1958, p.28, pl.1, fig.41.- ANTONY, 1968, p.41, pl.1, fig.41.- RAO, 1970b, p.265, fig.50.- RAO *et al.*, 1987, tab.1, pl.IV, fig.2.
Parasorites marginalis (Lamarck) JONES, 1994, pl.15, figs.1-3,5.

Hypotype: Maximum diameter=1.59 mm.; thickness=0.04 mm.
Repository: GOD NIO Cat No.GOA-125

Subfamily SORITINAE Ehrenberg, 1839

Genus MARGINOPORA Quoy and Gaimard, 1830

***Marginopora vertebralis* Quoy and Gaimard**

Plate 9, Figure 2

Marginopora vertebralis QUOY and GAIMARD, 1830.- BARKER, 1960, p.32, pl.16, figs.1-6.- KYAW and SAING, 2001, p.17, pl.I, fig.32.

Hypotype: Maximum diameter=0.53 mm.; thickness=0.04 mm.
Repository: GOD NIO Cat No.GOA-126

Suborder LAGENINA Delage and Hérouard, 1896

Superfamily NODOSARIACEA Ehrenberg, 1838

4.5.1.23 Family NODOSARIIDAE Ehrenberg, 1838
Subfamily NODOSARIINAE Ehrenberg, 1838
Genus BOTULOIDES Zheng, 1979

***Botuloides pauciloculus* Zheng**
Plate 9, Figure 3

Botuloides pauciloculus ZHENG, 1979, p.141, 210.

Hypotype: Length=0.31 mm; maximum diameter=0.08 mm.
Repository: GOD NIO Cat No.GOA-127

Genus DENTALINA Risso, 1826

***Dentalina cf. D. albatrossi* (Cushman)**
Plate 9, Figure 4

Nodosaria vertebralis (Batsch) var. *albatrossi* CUSHMAN, 1923, p.312, pl.57, fig.5.
Dentalina albatrossi (Cushman) JONES, 1994, pl.64, figs.11-14.

Hypotype: Length=2.21 mm; maximum diameter=0.32 mm.
Repository: GOD NIO Cat No.GOA-128

***Dentalina ariena* Patterson and Pettis**
Plate 9, Figure 15

Dentalina ariena PATTERSON and PETTIS, 1986, p.74-75.- BARKER, 1960, p.130, pl.62, fig.27-31.

Hypotype: Length=0.42 mm; maximum diameter=0.11 mm.
Repository: GOD NIO Cat No.GOA-129

***Dentalina bradyensis* (Dervieux)**
Plate 9, Figure 16

Nodosaria inornata var. *bradyensis* DERVIEUX, 1893-94, p.610, pl.5, figs.30-31.
Dentalina bradyensis (Dervieux) HOFKER, 1976.

Hypotype: Length=1.84 mm; maximum diameter=0.30 mm.
Repository: GOD NIO Cat No.GOA-130

***Dentalina inflexa* (Reuss)**
Plate 9, Figure 5

Nodosaria (*Dentalina*) *inflexa* REUSS, 1866, p.131, pl.2, fig.1.
Dentalina inflexa (Reuss) JONES, 1994, pl.62, fig.9.

Hypotype: Length=0.67 mm; maximum diameter=0.14 mm.
Repository: GOD NIO Cat No.GOA-131

***Dentalina turgoidea* Kristan-Tollmann**
Plate 9, Figure 6

Dentalina turgoidea KRISTAN-TOLLMANN, 1964, p.94-95.
Dentalina ex gr. *subsiliqua* FRANKE-OBERHAUSER, 1960 (part), p.24, pl.6, fig.3.

Hypotype: Length=0.51 mm; maximum diameter=0.14 mm.
Repository: GOD NIO Cat No.GOA-132

***Dentalina* sp. A**
Plate 9, Figure 8

Remarks: These specimens are quite long and straight. Sutures are depressed, slightly curved and oblique to the periphery. There is a small spine at the end of the chambers.

Hypotype: Length=1.19 mm; maximum diameter=0.20 mm.
Repository: GOD NIO Cat No.GOA-133

Dentalina **sp. B**
Plate 9, Figure 9

Remarks: These specimens are slightly curved. The inner margin is smooth while the outer one is slightly undulated. The last chamber is significantly big. The sutures are depressed, slightly curved and oblique to the periphery. There is a small spine at the end of the chambers.

Hypotype: Length=0.59 mm; maximum diameter=0.12 mm.
Repository: GOD NIO Cat No.GOA-134

Dentalina **sp. C**
Plate 9, Figure 10

Remarks: These specimens are curved, quite long with a lobate outer margin. The last chamber is elongated and big and bears a neck-like projection terminating into an aperture. The proloculus is rounded. The sutures are depressed, curved and make acute angles with the outline.

Hypotype: Length=1.10 mm; maximum diameter=0.20 mm.
Repository: GOD NIO Cat No.GOA-135

Dentalina **sp. D**
Plate 9, Figure 11

Remarks: These specimens are comparatively very short and straight.Depressed and slightly curved sutures are oblique to the outline. The neck is significantly long and prominent. The proloculus bears a blunt spine-like projection.

Hypotype: Length=0.22 mm; maximum diameter=0.05 mm.
Repository: GOD NIO Cat No.GOA-136

Dentalina **sp. E**
Plate 9, Figure 12

Remarks: These specimens are elongated and comparatively broader, with a straight outline. They bear a very short neck. The sutures are depressed but almost straight highly oblique to the margin.

Hypotype: Length=0.90 mm; maximum diameter=0.20 mm.
Repository: GOD NIO Cat No.GOA-137

***Dentalina* sp. F**
Plate 9, Figure 13

Remarks: These specimens are characterized by elongation in their shape, lobate outer margin, rounded proloculous; horizontal sutures perpendicular to outer margin and earlier chambers fused together.

Hypotype: Length=0.98 mm; maximum diameter=0.14 mm.
Repository: GOD NIO Cat No.GOA-138

Genus LAEVIDENTALINA Loeblich and Tappan, 1986

***Laevidentalina aphelis* Loeblich and Tappan**
Plate 9, Figure 14

Laevidentalina aphelis LOEBLICH and TAPPAN, 1986, p.396, pl.439.- HENRIQUES, 1993, p.67, pl.7, fig.6.- MAZUMDER *et al.*, 2003, p.8, tab.1.

Hypotype: Length=2.09 mm; maximum diameter=0.34 mm.
Repository: GOD NIO Cat No.GOA-139

***Laevidentalina filiformis* (d'Orbigny)**
Plate 9, Figure 17

Nodosaria filiformis D'ORBIGNY 1826, v.7, p.235, no.14.
Laevidentalina filiformis (d'Orbigny) YASSINI and JONES, 1995, p.99, fig.257-258.- HAYWARD *et al.*, 1997, p.109, pl.6, figs.18-19.- RAO, 1998, p.117, pl.22, fig.3.

Hypotype: Length=1.81 mm; maximum diameter=0.17 mm.
Repository: GOD NIO Cat No.GOA-140

Genus NODOSARIA Lamarck, 1812

Nodosaria catesbyi **d'Orbigny**
Plate 9, Figure 18

Nodosaria (*Nodosaria*) *catesbyi* D'ORBIGNY 1839, v.7, p.16, pl.11, figs.8-10.- ANTONY, 1968, pp.46-47, pl.3, fig.6.- VEDANTAM and RAO, 1970, p.329, tab.3.- SAING, 1972, p.206, pl.2, fig.3a-b.- RAO and RAO, 1978, p.426.- NARAPPA *et al.*, 1982, p.221.- KHARE, 1992, p.93, pl.8, fig.2.- HENRIQUES, 1993, p.69, pl.7, fig.12a-b.- KYAW and SAING, 2001, p.11, pl.I, fig.7.- MAZUMDER *et al.*, 2003, p.8, tab.1.
Lagenonodosaria catesbyi (d'Orbigny) CALVEZ, 1977a, figs.1-5.
Pyramidulina catesbyi (d'Orbigny) HOTTINGER *et al.*, 1993, p.76, pl.88, fig.1-19.

Hypotype: Length=0.48 mm; maximum diameter=0.21 mm.
Repository: GOD NIO Cat No.GOA-141

Nodosaria lamnulifera **Thalmann**
Plate 9, Figure 19

Nodosaria bradyi BOOMGAART, 1949, p.79, pl.6, fig.11.
Nodosaria lamnulifera THALMANN, 1950, p.42

Hypotype: Length=0.93 mm; maximum diameter=0.33 mm.
Repository: GOD NIO Cat No.GOA-142

Nodosaria pausiloculata **Cushman**
Plate 9, Figure 20

Nodosaria pausiloculata CUSHMAN, 1917, p.36, figs.10-12.- GANAPATI and SATYAVATI, 1958, p.108, pl.3, fig.71.- HENRIQUES, 1993, p.70, pl.7, figs.10a-b.- MAYENKAR, 1994, p.81, pl.6, figs.12a-b.- MAZUMDER *et al.*, 2003, p.8, tab.1.

Hypotype: Length=0.95 mm; maximum diameter=0.21 mm.
Repository: GOD NIO Cat No.GOA-143

***Nodosaria vertebralis* Batsch**
Plate 9, Figure 7

Nautilus (*Orthoceras*) *vertebralis* BATSCH, 1791, p.1-2, figs.6a-b.- GANAPATI and SATYAVATI, 1958, p.115, pl.3, fig.69.- SETHULEKSHMI AMMA, 1958, p.52, pl.2, fig.78.- ANTONY, 1968, p.48, pl.3, fig.8.- RAO, 1998, p.119, pl.22, fig.9.

Hypotype: Length=0.84 mm; maximum diameter=0.16 mm.
Repository: GOD NIO Cat No.GOA-144

***Nodosaria* sp.**
Plate 9, Figure 21

Remarks: This species is more or less similar to *Nodosaria catesbyi*. But it has a smooth surface as compared to that of *Nodosaria catesbyi*. Hence its nomenclature was kept open under the genus *Nodosaria*.

Hypotype: Length=0.36 mm; maximum diameter=0.09 mm.
Repository: GOD NIO Cat No.GOA-145

Genus PYRAMIDULINA Fornasini, 1894

***Pyramidulina cancellata* (d'Orbigny)**
Plate 9, Figure 22

Nodosaria (*Nodosaire*) *cancellata* D'ORBIGNY, 1826, p.254, pl.9, fig.33.

Remarks: According to Treatise (Loeblich and Tappan, 1988), part of genus *Nodosaria* was clubbed with genus *Pyramidulina*. The present specimen shows the characters of *Pyramidulina* like prominent longitudinal ribs, hence it has been placed under the genus *Pyramidulina*.

Hypotype: Length=0.46 mm; maximum diameter=0.21 mm.

Repository: GOD NIO Cat No.GOA-146

***Pyramidulina* cf. *P. eptagona* Costa**

Plate 9, Figure 23

Pyramidulina eptagona COSTA, 1894, pl.3, fig.6.

Hypotype: Length=0.87 mm; maximum diameter=0.35 mm.

Repository: GOD NIO Cat No.GOA-147

Subfamily PLECTOFRONDICULARIINAE Cushman, 1927

Genus PROXIFRONS Vella, 1963

***Proxifrons advena* (Cushman)**

Plate 9, Figure 24

Frondicularia advena CUSHMAN, 1923, p.141.

Plectofrondicularia (Proxifrons) advena (Cushman) HORNIBROOK, 1971, p.45.

Proxifrons advena (Cushman) VELLA, 1963, p.5.

Remarks: The specimens from off Goa region are quite similar to that of Loeblich and Tappan (1988) described as *Proxifrons advena.* Later Jones (1994) transferred this species under genus *Plectofrondicularia.* But the illustration given by Loeblich and Tappan (1988) of the genus *Plectofrondicularia* is not matching with our specimen; so the name of these specimens was assigned as *Proxifrons advena.*

Hypotype: Length=0.50 mm; width=0.25 mm; thickness=0.03 mm

Repository: GOD NIO Cat No.GOA-148

4.5.1.24 Family VAGINULINIDAE Reuss, 1860

Subfamily LENTICULININAE Chapman, Parr and Collins, 1934

Genus LENTICULINA Lamarck, 1804

***Lenticulina angulata* (Reuss)**

Plate 9, Figure 25

Robulina angulata REUSS, 1851, p.154, pl.8, fig.6.

Lenticulina angulata (Reuss) HANSSEN, 1964, p.227, pl.9, figs.9.- COLE, 1981, p.67, pl.13, fig.12.

Hypotype: Length=0.23 mm; width=0.18 mm; thickness=0.11 mm

Repository: GOD NIO Cat No.GOA-149

***Lenticulina calcar* (Linne)**

Plate 9, Figure 26

Nautilus calcar LINNE 1758, v.1, p.709.

Robulus calcar (Linnaeus) BOLTOVSKOY, 1961, p.307, pl.8, fig.10.- GANAPATI and SATYAVATI, 1958, p.104, pl.3, fig.63.- FRERICHS, 1970, pp.146-147.- RAO, 1970a, p.596, fig.30.- VEDANTAM and RAO, 1970, p.329, tab.3, no.50.- KYAW and SAING, 2001, p.11, pl.II, fig.49.

Lenticulina calcar (Linnaeus) BARKER, 1960, p.146, pl.70, figs.9-12.- RAO *et al.*, 1979, p.358, tab.3.- MATHUR and GUPTA, 1989, pp.120-126, tab.1.- HERMELIN and SHIMMIELD, 1990, pp.8-11, tab.4.- HENRIQUES, 1993, p.71, pl.8, fig.1.- MAYENKAR, 1994, p.82, pl.7, fig.1.- RAO, 1998, p.121, pl.23, figs.1-2.- MAZUMDER *et al.*, 2003, p.8, tab.1.

Hypotype: Length=0.37 mm; width=0.33 mm; thickness=0.20 mm

Repository: GOD NIO Cat No.GOA-150

***Lenticulina crassa* (d'Orbigny)**

Plate 9, Figure 27-28

Cristellaria crassa D'ORBIGNY, 1846, p.30, pl.4, fig.1-3.

Lenticulina crassa (d'Orbigny) LOEBLICH and TAPPAN, 1988, p.405.

Hypotype: (Megalospheric) Length=0.38 mm; width=0.31 mm; thickness=0.21 mm

(Microspheric) Length=0.29 mm; width=0.21 mm; thickness=0.15 mm

Repository: GOD NIO Cat No.GOA-151

***Lenticulina cultrata* (Montfort)**

Plate 9, Figure 29

Robulus cultratus MONTFORT, 1808, p.214, pl.25.

Robulina cultrata (Montfort) D'ORBIGNY, 1839, p.26, pl.5, figs.19-20.

Lenticulina cultrata (Montfort) CALVEZ, 1974, p.58, fig.1.- CIMERMAN and LANGER, 1991, p.51, pl.53, figs.5-6.

Hypotype: Length=0.45 mm; width=0.31 mm; thickness=0.22 mm

Repository: GOD NIO Cat No.GOA-152

***Lenticulina* cf. *L. gibba* (d'Orbigny)**

Plate 9, Figure 30

Cristellaria gibba D'ORBIGNY 1826, p.292, no.17, 1839, p.40, pl.7, figs.20-21.

Robulus gibbus (d'Orbigny) COLOM, 1974, p.96, fig.11g.

Lenticulina crassa (d'Orbigny) CALVEZ, 1977b, p.25, fig.1.- LOEBLICH and TAPPAN, 1988, p.405.- RAO, 1998, p.121, pl.23, fig.3.

Hypotype: Length=0.36 mm; width=0.28 mm; thickness=0.19 mm

Repository: GOD NIO Cat No.GOA-153

***Lenticulina limbosa* (Reuss)**

Plate 9, Figure 31

Cristellaria (*Robulina*) *limbosa* REUSS 1863, v.48, p.55, pl.6, figs.69a-b.

Robulus limbosus (Reuss) RAO, 1971b, p.174, fig.32.

Lenticulina limbosa (Reuss) YASSINI and JONES, 1995, p.134, fig.726.- RAO *et al.*, 1979, p.358, tab.III.- RAO, 1998, p.122, pl.23, figs.4-5.

Hypotype: Length=0.73 mm; width=0.68 mm; thickness=0.39 mm

Repository: GOD NIO Cat No.GOA-154

***Lenticulina limbosus chiriguanoi* (Boltovskoy)**

Plate 9, Figure 32

Robulus limbosus (Reuss) subsp. *chiriguanoi* BOLTOVSKOY, 1954, p.249, pl.11, fig.5.

Remarks: The genus *Robulus* has been clubbed with genus *Lenticulina* according to Treatise (Loeblich and Tappan, 1988). Thus this species has been named as *Lenticulina limbosus chiriguanoi.*

Hypotype: Length=0.36 mm; width=0.28 mm; thickness=0.18 mm
Repository: GOD NIO Cat No.GOA-155

***Lenticulina macrodiscus* Cushman**
Plate 10, Figure 1

Lenticulina macrodiscus CUSHMAN 1948, pl.20, fig.1.- GANAPATI and SATYAVATI. 1958, p.107, pl.3, figs.59-60.- ANTONY, 1968, p.42, pl.1, fig.18.- KHARE, 1992, p.95, pl.8, fig.5.- RAO, 1998, p.122, pl.23, figs.6-7.

Hypotype: Length=0.36 mm; width=0.35 mm; thickness=0.20 mm
Repository: GOD NIO Cat No.GOA-156

***Lenticulina pliocaena* (Silvestri)**
Plate 10, Figure 3

Polymorphina pliocaena SILVESTRI, 1898, p.234, pl.4, figs.3a-c.
Lenticulina pliocaena (Silvestri) JONES, 1994, pl.69, fig.5.

Hypotype: Length=0.79 mm; width=0.56 mm; thickness=0.21 mm
Repository: GOD NIO Cat No.GOA-157

***Lenticulina subcarinata* (Cushman)**
Plate 10, Figure 2

Critellaria orbicularis (D'ORBIGNY) var. *subcarinata* CUSHMAN, 1917, p.657, pl.44, fig.1.

Remarks: Some part of the genus *Critellaria* was clubbed with genus *Lenticulina* (Loeblich and Tappan, 1988). The present specimens have been placed under genus *Lenticulina* due to presence of umbonal boss, carinate periphery and radiate aperture. Cushman (1917) had assigned it the status of variety *C.orbicularis*. Since the concept of 'variety' is now obsolete, these specimens were named *Lenticulina subcrinata.*

Hypotype: Length=0.57 mm; width=0.47 mm; thickness=0.26 mm
Repository: GOD NIO Cat No.GOA-158

***Lenticulina thalmanni* (Hessland)**
Plate 10, Figure 4

Robulus thalmanni HESSLAND, 1943, p.265, pl.69, fig.13.
Lenticulina thalmani (Hessland) JONES, 1994, pl.69, fig.13.- MATHUR and GUPTA, 1989, p.112, tab.1.

Hypotype: Length=0.72 mm; width=0.64 mm; thickness=0.38 mm
Repository: GOD NIO Cat No.GOA-159

***Lenticulina* sp.**
Plate 10, Figure 5

Remarks: The specimens are quite similar to *Lenticulina macrodiscus*. But comaparatively more transparent (such that the earlier chambers can be seen) and more flattened. Hence the nomenclature has been kept open under the genus *Lenticulina.*

Hypotype: Length=0.31 mm; width=0.30 mm; thickness=0.14 mm
Repository: GOD NIO Cat No.GOA-160

Genus SARACENARIA Defrance, 1824

***Saracenaria latifrons* (Brady)**
Plate 10, Figure 6

Cristellaria latifrons BRADY, 1884, p.544, pl.68, fig.19.
Saracenaria latifrons (Brady) JONES, 1994, pl.68, fig.19.

Hypotype: Length=0.62 mm; width=0.35 mm; thickness=0.25 mm
Repository: GOD NIO Cat No.GOA-161

Subfamily MARGINULININAE Wedekind, 1937
Genus AMPHICORYNA Schlumberger, 1881

***Amphicoryna intercellularis* (Brady)**
Plate 10, Figure 7-8

Nodosaria intercellularis BRADY, 1881, p.63.- HENRIQUES, 1993, p.70, pl.7, figs.11a-b.- MAYENKAR, 1994, p.80, pl.6, figs.11a-b.- MAZUMDER *et al.*, 2003, p.8, tab.1.
Amphicoryna intercellularis (Brady) BARKER, 1960.

Remarks: From the present study area two types of this species have been reported. Type A has two transparent globular chambers with slender long neck. Type B has four opaque chambers the last chamber being large, with depressed sutures and a short stout neck.

Hypotype: (Type A) Length=0.63 mm; maximum diameter=0.14 mm
(Type B) Length=0.33 mm; maximum diameter=0.10 mm
Repository: GOD NIO Cat No.GOA-162

Genus ASTACOLUS Montfort, 1808

***Astacolus crepidulus* (Fichtel and Moll)**
Plate 10, Figure 9

Nautilus crepidula FICHTEL and MOLL, 1798.
Astacolus crepidulus (Fichtel and Moll) JONES, 1994, pl.68, figs.1-2.- RAI and SINGH, 2004, pp.415-429, tab.1.

Hypotype: Length=0.36 mm; width=0.15 mm; thickness=0.04 mm
Repository: GOD NIO Cat No.GOA-163

Subfamily VAGINULININAE Reuss, 1860
Genus PLANULARIA Defrance, 1826

***Planularia australis* Chapman**
Plate 10, Figure 10

Planularia australis CHAPMAN, 1941, p.158, pl.9, fig.1.

Hypotype: Length=0.36 mm; width=0.22 mm; thickness=0.03 mm
Repository: GOD NIO Cat No.GOA-164

Genus VAGINULINA d'Orbigny, 1826

***Vaginulina* aff. *V. badenensis* d'Orbigny**
Plate 10, Figure 11

Vaginulina badenensis D'ORBIGNY, 1846, p.65, pl.3, figs.6-8.

Hypotype: Length=0.88 mm; maximum diameter=0.22 mm
Repository: GOD NIO Cat No.GOA-165

***Vaginulina* cf. *V. hemitemna* Kristan-Tollmann**
Plate 10, Figure 12

Vaginulina hemitemna KRISTAN-TOLLMANN, 1964, p.138, pl.29, figs.1a-c.

Hypotype: Length=0.98 mm; maximum diameter=0.28 mm
Repository: GOD NIO Cat No.GOA-166

4.5.1.25 Family LAGENIDAE Reuss, 1862
Genus LAGENA Walker and Jacob, 1798

***Lagena alticostata* Cushman**
Plate 10, Figure 30

Lagena sulcata (Walker and Jacob) var. *alticostata* CUSHMAN, 1913, p.23, pl.9, fig.5.

Remarks: As the concept of 'variety' is now obsolete, these specimens are named as *Lagena alticostata*.

Hypotype: Length=0.23 mm; maximum diameter=0.22 mm
Repository: GOD NIO Cat No.GOA-167

Lagena caudata **(d'Orbigny)**
Plate 10, Figure 13

Oolina caudata D'ORBIGNY, 1839, p.19, pl.5, fig.6.
Lagena caudate (d'Orbigny) BOLTOVSKOY, 1983, pl.19, fig.4-7.

Hypotype: Length=0.30 mm; maximum diameter=0.12 mm
Repository: GOD NIO Cat No.GOA-168

Lagena doveyensis **Haynes**
Plate 10, Figure 14

Lagena doveyensis HAYNES, 1973, p.82, pl.12, figS.7-8.- RAO, 1998, p.125, pl.24, fig.6.- CHATURVEDI, 2001, p.135, pl.5, fig.13, pl.6, fig.1.- KUMAR and SRINIVASAN, 2004, pp.299-312.

Hypotype: Length=0.74 mm; maximum diameter=0.28 mm
Repository: GOD NIO Cat No.GOA-169

Lagena elongata **(Dunikowski)**
Plate 10, Figure 15

Lagena elongata DUNIKOWSKI, 1879, p.105, fig.2
Lagena elongata (Ehrenberg) VOORTHUYSEN, 1958, p.6, pl.2, fig.17.- BARKER, 1960, p.116, pl.56, figs.27-29.- SEIBOLD, 1975, p.183.- ROCHA and UBALDO, 1964, p.57, pl.IV, fig.4.

Hypotype: Length=0.74 mm; maximum diameter=0.07 mm
Repository: GOD NIO Cat No.GOA-170

Lagena favosiformis proba **McCulloch**
Plate 10, Figure 16

Lagena favosiformis proba McCULLOCH, 1977, p.34-35, pl.51, fig.31.

Hypotype: Length=0.27 mm; maximum diameter=0.12 mm
Repository: GOD NIO Cat No.GOA-171

***Lagena flatulenta* Loeblich and Tappan**
Plate 10, Figure 17

Lagena flatulenta LOEBLICH and TAPPAN, 1953, p.60, pl.11, fig.10.- YASSINI and JONES, 1995, p.104, fig.302.

Hypotype: Length=0.35 mm; maximum diameter=0.24 mm
Repository: GOD NIO Cat No.GOA-172

***Lagena gibbera* Buchner**
Plate 10, Figure 18

Lagena gibbera BUCHNER, 1940, p.423, pl.3, figs.48-50.

Hypotype: Length=0.34 mm; maximum diameter=0.23 mm
Repository: GOD NIO Cat No.GOA-173

***Lagena hispida* Reuss**
Plate 10, Figure 20

Lagena hispida REUSS, 1858, p.434.- GRAHAM and MILITANTE, 1959, p.67, pl.10, fig.14.- KYAW and SAING, 2001, p.10, pl.I, fig.1.

Hypotype: Length=0.56 mm; maximum diameter=0.31 mm
Repository: GOD NIO Cat No.GOA-174

***Lagena laevis* (Montagu)**
Plate 10, Figure 21

Vermiculum laeve MONTAGU, 1803, p.524.

Lagena laevis (Montagu) BRADY, 1884, p.455, pl.56, figs.9-10.- SETHULEKSHMI AMMA, 1958, p.55, pl.2, figs.84a-b.- ANTONY, 1968, pp.56-57, pl.3, fig.5, 23a-b.- RAO, 1971b, p.158, fig.22; 1974, p.64, fig.23.- SEIBOLD, 1975, p.183.- BHATIA and KUMAR, 1976, p.249, pl.2, fig.9.- RAO and RAO, 1978, p.426.- NIGAM *et al.*, 1979, p.246.- RAO *et al.*, 1979, p.358, table 3. SETTY and NIGAM, 1980b, p.421.- SEIBOLD and SEIBOLD, 1981, p.43, table 3b.- VENKATACHALAPATHY and SHAREEF, 1981, p.44.- NARAPPA *et al.*, 1982, p.221.-NIGAM, 1982, pp.104-105, pl.4, fig.7.- SETTY *et al.*, 1984, p.50, table 1.- SHAREEF and VENKATACHALAPATY, 1987a, p.194, table 1; 1987b, p.189.- KHARE, 1992, p.97-98, pl.8, figs.11a-b.- HENRIQUES, 1993, pp.77-78, pl.8, fig.13.- MAYENKAR, 1994, p.88, pl.7, fig.11a-b.- DAS, 1996, p.49, table 1.- RAO, 1998, p.126, pl.24, fig.10.- NIGAM and KHARE, 1999, p.302, pl.3, figs.22a-b.- CHATURVEDI, 2001, p.135, pl.6, fig.2.- MAZUMDER *et al.*, 2003, p.8, tab.1.

Hypotype: Length=0.26 mm; maximum diameter=0.13 mm
Repository: GOD NIO Cat No.GOA-175

***Lagena lyellii* (Seguenza)**
Plate 10, Figure 31

Amphorina lyellii SEGUENZA, 1862, p.52, pl.1, fig.40.
Lagena lyellii (Seguenza) BRADY, 1870, p.292, pl.11, fig.7.- SAID, 1950, p.21, pl.2, fig.24.

Hypotype: Length=0.84 mm; maximum diameter=0.42 mm
Repository: GOD NIO Cat No.GOA-176

***Lagena multilatera* McCulloch**
Plate 10, Figure 22

Lagena multilatera McCULLOCH, 1977, p.40-41, pl.50, fig.5.

Hypotype: Length=0.43 mm; maximum diameter=0.14 mm
Repository: GOD NIO Cat No.GOA-177

***Lagena* cf. *L. multilatera chathamensis* McCulloch**
Plate 10, Figure 23

Lagena multilatera chathamensis McCULLOCH, 1977, p.41, pl.50, fig.6.

Hypotype: Length=0.39 mm; maximum diameter=0.15 mm
Repository: GOD NIO Cat No.GOA-178

***Lagena* cf. *L. oceanica* Albani**
Plate 10, Figure 24

Lagena oceanica ALBANI 1974, p.37-38, pl.1, figs.7-11.- RAO, 1998, p.126, pl. 24, fig.11.

Hypotype: Length=0.28 mm; maximum diameter=0.14 mm
Repository: GOD NIO Cat No.GOA-179

***Lagena paradoxa* (Sidebottom)**
Plate 10, Figure 25

Lagena foveolata Reuss var. *paradoxa* SIDEBOTTOM, 1912, p.395, pl.16, figs.22-23.
Lagena paradoxa (Sidebottom) CUSHMAN, 1933b, p.29, pl.7, figs.9-10.- ROCHA and UBALDO, 1964a, p.59, pl.IV, fig.10.

Hypotype: Length=0.33 mm; maximum diameter=0.15 mm
Repository: GOD NIO Cat No.GOA-180

***Lagena pecularis* Cushman and McCulloch**
Plate 10, Figure 32

Lagena sulcata (Walker and Jacob) var. *pecularis* CUSHMAN and McCULLOCH 1950, v.6, p.361, pl.48, figs.11-13.- RAO, 1998, p.132, pl.26, figs.4-5.

Remarks: The original name of this species was *Lagena sulcata* var. *pecularis*. Since the concept of 'variety' has become obsolete in modern taxonomic literature, it has been named as *Lagena pecularis*.

Hypotype: Length=0.55 mm; maximum diameter=0.28 mm
Repository: GOD NIO Cat No.GOA-181

***Lagena spiratiformis* McCulloch**

Plate 10, Figure 26

Lagena spiratiformis McCULLOCH, 1981, p.96, pl.32, figs.15-16.- RAO, 1998, p.129, pl.25, fig.4.

Hypotype: Length=0.72 mm; maximum diameter=0.22 mm

Repository: GOD NIO Cat No.GOA-182

***Lagena striata* (d'Orbigny)**

Plate 10, Figure 27

Oolina striata D'ORBIGNY, 1839, p.21, pl.5, fig.12.

Lagena striata (d'Orbigny) - CUSHMAN, 1923, p.54, pl.10, fig.9.- SETHULEKSHMI AMMA, 1968, p.56, pl.2, fig.86.- ANTONY, 1968, pp.53-54, pl.3, fig.19.- VEDANTAM and RAO, 1970, p.329, table 3.- RAO, 1970b, p.271, pl.4, fig.39.- RAO, 1971b, p.158. RAO and RAO, 1978, p.426.- RAO *et al.*, 1979, p.361, table 3.- NARAPPA *et al.*, 1982, p.221.- RAGOTHAMAN and KUMAR, 1985, p.107, pl.2, fig.2.- KUMAR, 1988, p.91, pl.8, fig.9.- KUMAR *et al.*, 1990, p.55, table 1.- KHARE, 1992, p.98, pl.8, figs.13a-b.- HENRIQUES, 1993, p.78, pl.8, figs.14a-b.- MAYENKAR, 1994, p.88, pl.7, figs.12a-c.- DAS, 1996, p.49, pl.2, fig.3.- RAO, 1998, p.130, pl.25, figs.5-6.- NIGAM and KHARE, 1999, p.302, pl.3, figs.24a-b.- CHATURVEDI, 2001, p.137, pl.6, fig.6.- KYAW and SAING, 2001, p.11, pl.I, fig.2.- MAZUMDER *et al.*, 2003, p.8, tab.1.- GANDHI and RAJAMANICKAM, 2004, p.293-304, tab.1,2.- KUMAR and SRINIVASAN, 2004, pp.299-312.

Hypotype: Length=0.33 mm; maximum diameter=0.17 mm

Repository: GOD NIO Cat No.GOA-183

***Lagena substriata elegantula* Jones**

Plate 10, Figure 28

Lagena substriata elegantula JONES, 1984, pl.7, figs.15-16.- IGARASHI *et al.*, 2001, p.157, pl.7, figs5a-b.-

Hypotype: Length=0.39 mm; maximum diameter=0.11 mm

Repository: GOD NIO Cat No.GOA-184

***Lagena sulcata* (Walker and Jacob)**

Plate 10, Figure 29

Serpula (Lagena) sulcata WALKER and JACOB, 1798, (fide Ellis and Messina, 1940, et seq).

Lagena sulcata (Walker and Jacob) BRADY, 1884, p.462, pl.57, figs.23 and 26.

Lagena laevis (Montagu) forma sulcata (Walker and Jacob) BUCHNER, 1940, p.418-420, pl.3, figs.44-46.

Lagena sulcata spirata BANDY, 1949, p.57, pl.7, fig.10.

Lagena sulcata (d'Orbigny) RAO and RAO, 1978, p.426.- KHARE, 1992, p.101-102, pl.9, figs.2a-b. – NIGAM and KHARE, 1999, p.302, pl.3, figs.26a-b.- CHATURVEDI, 2001, p.138, pl.6, fig.7.

Hypotype: Length=0.32 mm; maximum diameter=0.11 mm

Repository: GOD NIO Cat No.GOA-185

***Lagena* aff. *L.undulata* Sidebottom**

Plate 10, Figure 19

Lagena hertwigiana BRADY var. *undulata* SIDEBOTTOM, 1912, p.397, pl.16, figs.26-28.

Remarks: These specimens from off Goa are more elongated than the original ones described by Sidebottom (1912), hence these have been named as *Lagena* aff. *L.undulata*. This species was earlier identified as the variety of the species *Lagena hertwigiana*. Since the concept of 'variety' is no longer in use, they are now designated as 'species'.

Hypotype: Length=0.30 mm; maximum diameter=0.08 mm

Repository: GOD NIO Cat No.GOA-186

Genus PROCEROLAGENA Puri, 1954

***Procerolagena distoma* (Parker and Jones)**

Plate 10, Figure 33

Lagena distoma PARKER and JONES, 1864, p.467, pl.48, fig.6.- ROCHA and UBALDO, 1960, pl.IV, fig.3.

Procerolagena distomapolita (Parker and Jones) RAO, 1998, pp.134-135, pl.27, fig.2.

Procerolagena distoma (Parker and Jones) IGARASHI *et al.*, 2001, pl.7, fig.12.

Hypotype: Length=0.38 mm; maximum diameter=0.07 mm

Repository: GOD NIO Cat No.GOA-187

***Procerolagena gracilis* (Williamson)**

Plate 10, Figure 35

Lagena gracilis WILLIAMSON, 1848, p.13.

Procerolagena gracilis (Williamson) LOEBLICH and TAPPAN, 1988, p.416, pl.455, fig.2.- HENRIQUES, 1993, p.80, pl.9, fig.2.- MAYENKAR, 1994, p.90, pl.8, fig.7.- MAZUMDER *et al.*, 2003, p.8, tab.1.

Hypotype: Length=0.34 mm; maximum diameter=0.08 mm

Repository: GOD NIO Cat No.GOA-188

***Procerolagena ingens* (Buchner)**

Plate 10, Figure 34

Lagena distoma Parker and Jones var. *ingens* BUCHNER, 1940, p.415, pl. 2, fig.22.

Remarks: Since *Lagena distoma* has been placed under new genus *Procerolagena*, the variety *Lagena distoma* var. *ingens* has also been renamed as *Procerolagena distoma* var. *ingens*. Since the concept of 'variety' concept is no longer being used in modern taxomonic description, the name *Procerolagena ingens* has been suggested for the same.

Hypotype: Length=0.57 mm; maximum diameter=0.09 mm

Repository: GOD NIO Cat No.GOA-189

Genus PYGMAEOSEISTRON Patterson and Richerdson, 1987

***Pygmaeoseistron hispidulum* (Cushman)**

Plate 11, Figure 1

Lagena hispidula CUSHMAN, 1913, p.14, pl.5, figs.2-3.

Pygmaeoseistron hispidula (Cushman) PATTERSON and RICHARDSON, 1987, p.243, figs.5-6.- HENRIQUES, 1993, p.80, pl.9, figs.3a-b.- MAYENKAR, 1994, p.90, pl.8, figs.1a-b.- MAZUMDER *et al.*, 2003, p.8, tab.1.

Pygmaeoseistron hispidulum (Cushman) LOEBLICH and TAPPAN, 1988.- RAO, 1998, p.137, pl.27, figs.14-15.

Hypotype: Length=0.62 mm; maximum diameter=0.27 mm

Repository: GOD NIO Cat No.GOA-190

***Pygmaeoseistron nebulosum* (Cushman)**

Plate 11, Figure 2

Lagena laevis (Montagu) var. *nebulosa* CUSHMAN, 1923, p.29, pl.5, figs.4-5.

Pygmaeoseistron nebulosum (Cushman) IGARASHI *et al.*, 2001, p.159, pl.7, figs.14a-b.

Hypotype: Length=0.46 mm; maximum diameter=0.15 mm

Repository: GOD NIO Cat No.GOA-191

4.5.1.26 Family POLYMORPHINIDAE d'Orbigny, 1839

Subfamily POLYMORPHININAE d'Orbigny, 1839

Genus FRANCUSCIA McCulloch, 1981

***Francuscia extensa* (Cushman)**

Plate 11, Figure 3

Polymorphina extensa CUSHMAN, 1923.

Francuscia extensa (Cushman) JONES, 1994, pl.73, figs.18-19.

Hypotype: Length=0.47 mm; maximum diameter=0.22 mm

Repository: GOD NIO Cat No.GOA-192

Genus METAPOLYMORPHINA McCulloch, 1977

***Metapolymorphina* sp.**

Plate 11, Figure 4

Remarks: The genus these specimens was confirmed as *Metapolymorphina* from Treatise (Loeblich and Tappan, 1988). Since the aperture is not prominent (probably broken), it was not identified upto species level. These specimens are characterized by a large compressed ovate test, biserially arranged chambers, strong oblique sutures, smooth and transparent walls and a terminal radiate aperture with a collar.

Hypotype: Length=0.58 mm; maximum diameter=0.22 mm
Repository: GOD NIO Cat No.GOA-193

Genus PYRULINA d'Orbigny, 1839

***Pyrulina gutta* (d'Orbigny)**

Plate 11, Figure 5

Polymorphina (Pyrulina) gutta D'ORBIGNY, 1826, p.117, pl.11, fig.107.
Pyrulina gutta (d'Orbigny) JONES, 1994, pl.71, fig.14.- RAI and SINGH, 2004, pp.415-429, tab.1.

Hypotype: Length=0.38 mm; maximum diameter=0.16 mm
Repository: GOD NIO Cat No.GOA-194

4.5.1.27 Family ELLIPSOLAGENIDAE Silvestri, 1923
Subfamily OOLININAE Loeblich and Tappan, 1961
Genus CUSHMANINA Jones, 1984

***Cushmanina plumigera* (Brady)**

Plate 11, Figure 6

Lagena plumigera BRADY, 1881, p.62, pl.58, figs.25-27.
Cushmanina plumigera (Brady) JONES, 1994, pl.58, figs.25,27.

Hypotype: Length=0.42 mm; maximum diameter=0.18 mm
Repository: GOD NIO Cat No.GOA-195

Genus HETEROMORPHINA Jones, 1984

***Heteromorphina* sp.**
Plate 11, Figure 7

Remarks: Due to lack of prominent features in these specimens they have been identified upto the genus level. These specimens are characterized by an ovoid test with a circular cross-section, fine striations on the surface, very short neck with a rounded terminal aperture.

Hypotype: Length=0.29 mm; maximum diameter=0.13 mm
Repository: GOD NIO Cat No.GOA-196

Genus OOLINA d'Orbigny, 1839

***Oolina apiopleura* (Loeblich and Tappan)**
Plate 11, Figure 8

Lagena apiopleura LOEBLICH and TAPPAN, 1953, p.59, pl.10, figs.14-15.
Oolina apiopleura (Loeblich and Tappan) JONES, 1994, pl.57, fig.32.- YASSINI and JONES, 1995, p.111, figs.367-368,373.

Hypotype: Length=0.18 mm; maximum diameter=0.14 mm
Repository: GOD NIO Cat No.GOA-197

***Oolina felsinea* (Fornasini)**
Plate 11, Figure 9

Lagena felsinea FORNASINI, 1894, p.47.
Oolina felsinea (Fornasini) ANDERSON, 1975, pl.7, fig.12.- IGARASHI *et al.*, 2001, p.158, pl.8, figs.2a-b.
Parafissurina felsinea (Fornasini) JONES, 1994, pl.56, fig.4.

Hypotype: Length=0.42 mm; maximum diameter=0.13 mm

Repository: GOD NIO Cat No.GOA-198

***Oolina globosa* (Montagu)**

Plate 11, Figure 10

Vermiculum globosum MONTAGU 1803, p.523.

Lagena globosa (Montagu) BRADY, 1884, p.452, pl.56, fig.1-3.- SETHULEKSHMI AMMA, 1958, p.54, pl.2, fig.80.- RAO, 1970b, p.260, fig.37.

Oolina globosa (Montagu) BARKER, 1960, p.114, pl.56, figs.1-3.- SEIBOLD, 1975, p.183.- RAO, 1998, p.142, pl.29, figs.1-2.

Hypotype: Length=0.18 mm; maximum diameter=0.17 mm

Repository: GOD NIO Cat No.GOA-199

***Oolina lineata* (Williamson)**

Plate 11, Figure 12

Entosolenia lineata WILLIAMSON, 1848, p.190.- JONES, 1994, pl.57, fig.13.

Oolina lineata (Williamson) LOEBLICH and TAPPAN, 1988, p.427.- SAID, 1950, p.27, pl.2, fig.30.

Hypotype: Length=0.28 mm; maximum diameter=0.18 mm

Repository: GOD NIO Cat No.GOA-200

***Oolina setosa* (Earland)**

Plate 11, Figure 11

Lagena globosa Montagu var. *setosa* EARLAND,1934, p.150, pl.6, fig.52.

Oolina globosa var. *setosa* (Earland) JONES, 1994, pl.56, figs.33-35,?36.

Remarks: Since the concept of assigning varieties under species is now obsolete this species was renamed as *Oolina setosa.*

Hypotype: Length=0.44 mm; maximum diameter =0.33 mm
Repository: GOD NIO Cat No.GOA-201

Oolina truncata **(Brady)**
Plate 11, Figure 13

Lagena truncata BRADY, 1884, p.457, pl.56, fig.31-32.
Oolina truncata (Brady) JONES, 1994, pl.56, fig.32.

Hypotype: Length=0.43 mm; maximum diameter=0.23 mm
Repository: GOD NIO Cat No.GOA-202

Subfamily ELLIPSOLAGENINAE Silvestri, 1923
Genus FISSURINA Reuss, 1850

Fissurina annectens **(Burrows and Holland)**
Plate 11, Figure 14

Lagena annectens BURROWS and HOLLAND 1895, pt.2, p.203, pl.7, figs.11a-b.
Fissurina annectens (Burrows and Holland) BARKER, 1960, p.122, pl.59, fig.7.- GUPTA and BHATTACHARJEE, 1989, p.130, pl.1, fig.3.- MATHUR and GUPTA, 1989, pp.120-126.- HENRIQUES, 1993, p.82, pl.9, figs.5a-b.- MAYENKAR, 1994, p.92, pl.8, figs.3a-b.- RAO, 1998, p.144, pl.29, fig.11-12.- MAZUMDER *et al.*, 2003, p.8, tab.1.

Hypotype: Length=0.19 mm; width=0.18 mm; thickness=0.12 mm
Repository: GOD NIO Cat No.GOA-203

Fissurina bradyiformata **(McCulloch)**
Plate 11, Figure 16

Lagenosolenia bradyiformata McCULLOCH, 1977, p.53, pl.61, fig.15.
Fissurina bradyiformata (McCulloch) JONES, 1994, p.59, fig.26.

Hypotype: Length=0.27 mm; width=0.11 mm; thickness=0.07 mm
Repository: GOD NIO Cat No.GOA-204

***Fissurina cucullata* Silvestri**

Plate 11, Figure 17

Fissurina cucullata SILVESTRI 1902, p.146, fig.23-25.- SEIBOLD, 1975, p.184, pl.1, fig.11.- RAO *et al.*, 1979, p.360, tab.3.- SEIBOLD and SEIBOLD, 1981, p.43, tab.3b.- KHARE, 1992, p.105, pl.9, figs.5a-b.- HENRIQUES, 1993, p.82, pl.9, figs.6a-d.- MAYENKAR, 1994, p.92, pl.8, figs.4a-b.- RAO, 1998, p.145, pl.30, figs.1-2.- MAZUMDER *et al.*, 2003, p.8, tab.1.

Lagena orbignyana (Seguenza) BRADY, 1884, p.484, pl.59, fig.25.

Lagen marginata (Walker and Jacob) SETHULEKSHMI AMMA, 1958, p.56, pl.2, fig.85.

Lagena quadrata (Williamson) ANTONY, 1968, p.53, pl.3, fig.18.

Hypotype: Length=0.26 mm; width=0.19 mm; thickness=0.10 mm

Repository: GOD NIO Cat No.GOA-205

***Fissurina* aff. *F. duplicata* (Sidebottom)**

Plate 11, Figure 15

Lagena auriculata var. *duplicata* SIDEBOTTOM, 1912, p.422, pl.20, figs.23a-b.

Fissurina auriculata var. *duplicata* (Sidebottom) JONES, 1994, pl.60, fig.33.

Remarks: The concept of 'variety' is now obsolete in modern taxonomy and hence this species was given the name *Fissurina duplicata.*

Hypotype: Length=0.26 mm; width=0.15 mm; thickness=0.06 mm

Repository: GOD NIO Cat No.GOA-206

***Fissurina earlandi* Parr**

Plate 11, Figure 18

Fissurina earlandi PARR, 1950, p.306, pl.VIII, figs.8a-b.

Hypotype: Length=0.40 mm; width=0.27 mm; thickness=0.11 mm

Repository: GOD NIO Cat No.GOA-207

***Fissurina fissicarinata* Parr**

Plate 11, Figure 19

Fissurina fissicarinata PARR, 1950, p.309, pl.VIII, figs.11a-b.

Hypotype: Length=0.32 mm; width=0.28 mm; thickness=0.19 mm

Repository: GOD NIO Cat No.GOA-208

***Fissurina imporcata* McCulloch**

Plate 11, Figure 20

Fissurina imporcata McCULLOCH, 1977, p.109, figs.6c-d.

Remarks: The specimens from off Goa region match well with the specimens reported by Yassini and Jones (1995), the only difference being their slightly more elongation.

Hypotype: Length=0.62 mm; width=0.43 mm; thickness=0.38 mm

Repository: GOD NIO Cat No.GOA-209

***Fissurina lagenoides* (Williamson)**

Plate 11, Figure 21

Entosolenia marginata Montagu var. *lagenoides* WILLIAMSON, 1858, p.11, pl.1, figs.25-26.

Lagena lagenoides (Williamson) RAO, 1971b, fig.31.

Fissurina lagenoides (Williamson) JONES, 1994, pl.60, figs.6-7,9.

Hypotype: Length=0.24 mm; width=0.09 mm; thickness=0.07 mm

Repository: GOD NIO Cat No.GOA-210

***Fissurina milletti* Todd**

Plate 11, Figure 22

Fissurina milletti TODD, 1954, p.351, pl.87, fig.30.

Hypotype: Length=0.22 mm; width=0.13 mm; thickness=0.08 mm

Repository: GOD NIO Cat No.GOA-211

***Fissurina orbignyana* Sequenza**

Plate 11, Figure 23

Fissurina orbignyana SEGUENZA, 1862, p.66, pl.2, figs.25-26.- RAO, 1970b, p.262, fig.41.

Hypotype: Length=0.64 mm; width=0.47 mm; thickness=0.28 mm

Repository: GOD NIO Cat No.GOA-212

***Fissurina* aff. *F. pulchella* (Brady)**

Plate 11, Figure 24

Lagena pulchella BRADY, 1867, p.70.

Fissurina pulchella (Brady) BOLTOVSKOY, 1966, pl.24, figs.9-11.

Hypotype: Length=0.19 mm; width=0.14 mm; thickness=0.07 mm

Repository: GOD NIO Cat No.GOA-213

***Fissurina seguenziana* (Fornasini)**

Plate 11, Figure 25

Lagena seguenziana FORNASINI, 1887, p.351.

Fissurina seguenziana (Fornasini) JONES, 1994, pl.59, fig.1.

Hypotype: Length=0.49 mm; width=0.34 mm; thickness=0.11 mm

Repository: GOD NIO Cat No.GOA-214

***Fissurina semimarginata* (Reuss)**

Plate 11, Figure 26

Lagena marginata Montagu var. *semimarginata* REUSS, 1870, p.468.

Fissurina semimarginata (Reuss) JONES, 1994, pl.59, figs.17,19.

Hypotype: Length=0.32 mm; width=0.17 mm; thickness=0.06 mm

Repository: GOD NIO Cat No.GOA-215

***Fissurina staphyllearia* Schwager**

Plate 11, Figure 27

Fissurina staphyllearia SCHWAGER, 1866, p.209, pl.5, fig.24.- JONES, 1994, pl.59, figs.8-11.

Hypotype: Length=0.27 mm; width=0.19 mm; thickness=0.12 mm

Repository: GOD NIO Cat No.GOA-216

***Fissurina* aff. *F. striolata* (Sidebottom)**

Plate 11, Figure 28

Lagena marginata Walker and Boys var. *striolata* SIDEBOTTOM, 1912, p.408, pl.18, figs.10-11.

Fissurina striolata (Sidebottom) JONES, 1994, pl.60, fig.35,37.

Remarks: The specimens from the present study area are comparable to *Fissurina striolata* of Jones (1994), except for the fact that thye have striations on the wing.

Hypotype: Length=0.28 mm; width=0.14 mm; thickness=0.14 mm

Repository: GOD NIO Cat No.GOA-217

***Fissurina submarginata* Boomgaart**

Plate 11, Figure 29

Fissurina submarginata BOOMGAART, 1949.- JONES, 1994, pl.59, figs.21-22.

Hypotype: Length=0.43 mm; width=0.40 mm; thickness=0.19 mm

Repository: GOD NIO Cat No.GOA-218

***Fissurina wrightiana* (Brady)**

Plate 11, Figure 30

Lagena wrightiana BRADY, 1881, p.62, pl.9, fig.61.- SETHULEKSHMI AMMA, 1958, p.59, pl.3, fig.91.- ANTONY, 1968, p.55, pl.3, fig.21.

Fissurina wrightiana (Brady) JONES, 1994, pl.61, figs.6-7.

Hypotype: Length=0.36 mm; width=0.26 mm; thickness=0.26 mm
Repository: GOD NIO Cat No.GOA-219

***Fissurina* sp.**
Plate 11, Figure 31

Remarks: These specimens have similarities with quite a few species of *Fissurina*, like *F. annectens*, *F. lucida*, *F. crassiannulata*, *F. submarginata*, *F. goreani*, *F. castanea*, *F. marginata*, but do not exactly match with any of them. Hence, their nomenclature was kept open under the genus *Fissurina*.

Hypotype: Length=0.63 mm; width=0.59 mm; thickness=0.31 mm
Repository: GOD NIO Cat No.GOA-220

Subfamily PARAFISSURININAE Jones, 1984
Genus PARAFISSURINA Parr, 1947

***Parafissurina* aff. *P. arctica* Green**
Plate 11, Figure 32

Parafissurina arctica GREEN, 1959, p.76,78, pl.1, figs.2a-b.- JONES, 1984, pl.6, fig3.- IGARASHI *et al.*, 2001, p.158, pl.9, figs.3a-b.

Hypotype: Length=0.22 mm; width=0.19 mm; thickness=0.12 mm
Repository: GOD NIO Cat No.GOA-221

***Parafissurina fusiformis* (Wiesner)**
Plate 11, Figure 33

Ellipsolagena fusiformis WIESNER, 1931, p.126, pl.24, fig.j.
Parafissurina fusiformis (Wiesner) IGARASHI *et al.*, 2001, p.158, pl.p, figs.5a-b.

Hypotype: Length=0.61 mm; width=0.48 mm; thickness=0.35 mm
Repository: GOD NIO Cat No.GOA-222

***Parafissurina himatiostoma* Loeblich and Tappan**

Plate 12, Figure 1

Parafissurina himatiostoma LOEBLICH and TAPPAN, 1953, p.80, pl.14, figs.12-14.- JONES, 1984, pl.6, figs.9-10.- IGARASHI *et al.*, 2001, p.158, pl.9, figs.7a-b.

Hypotype: Length=0.62 mm; width=0.31 mm; thickness=0.22 mm

Repository: GOD NIO Cat No.GOA-223

***Parafissurina lateralis* (Cushman)**

Plate 12, Figure 2

Lagena lateralis CUSHMAN, 1913, p.9, pl.1, fig.1.

Parafissurina lateralis (Cushman) HANSSEN, 1964, pl.15, figs.23-24.

Remarks: The specimens under consideration have a very prominent fallopian tube. It has been named *Parafissurina lateralis* as it matches best with that of Hanssen (1964).

Hypotype: Length=0.18 mm; width=0.14 mm; thickness=0.09 mm

Repository: GOD NIO Cat No.GOA-224

***Parafissurina subcarinata* Parr**

Plate 12, Figure 3

Parafissurina subcarinata PARR, 1950, p.318, pl.X, figs.9a-c.

Hypotype: Length=0.26 mm; width=0.16 mm; thickness=0.12 mm

Repository: GOD NIO Cat No.GOA-225

Genus PSEUDOFISSURINA Jones, 1984

***Pseudofissurina* sp.**

Plate 12, Figure 4

Remarks: The genus is confirmed from Treatise (Loeblich and Tappan, 1988). However the specimens from the present study area do not match the species decription in Treatise and

Igarashi *et al.* (2001). They are more elongated and lack of trifurcation. Hence their nomenclature was kept open under the genus *Pseudofissurina*.

Hypotype: Length=0.32 mm; width=0.25 mm; thickness=0.12 mm
Repository: GOD NIO Cat No.GOA-226

Subfamily SIPHOLAGENINAE Patterson and Richardson, 1987
Genus BIFARILAMINELLA Patterson and Richardson, 1987

***Bifarilaminella advena* (Cushman)**
Plate 12, Figure 5

Lagena advena CUSHMAN, 1923, p.6, pl.1, fig.4.
Bifarilaminella advena (Cushman) PATTERSON and RICHARDSON, 1987.- LOEBLICH and TAPPAN, 1988, p.431, pl.467, figs.13-15.

Hypotype: Length=0.61 mm; maximum diameter=0.41 mm
Repository: GOD NIO Cat No.GOA-227

4.5.1.28 Family GLANDULINIDAE Reuss, 1860
Subfamily GLANDULININAE Reuss, 1860
Genus GLANDULINA d'Orbigny, 1839

***Glandulina ovula* d'Orbigny**
Plate 12, Figure 6

Glandulina ovula D'ORBIGNY, 1846, p.29, pl.1, figs.6-7.

Hypotype: Length=0.21 mm; maximum diameter=0.15 mm
Repository: GOD NIO Cat No.GOA-228

Genus GLOBULOTUBA Collins, 1958

***Globulotuba* sp.**
Plate 12, Figure 7

Remarks: Due to lack of specimens, the nomenclature of these specimens has been kept open under the genus *Globulotuba.* These specimens are characterized by fusiform tests circular in cross-section. Their last chambers occupy almost two-third of the whole test. The sutures are oblique and flushed. The aperture is terminal, narrow and tubular.

Hypotype: Length=0.25 mm; maximum diameter=0.12 mm
Repository: GOD NIO Cat No.GOA-229

Subfamily ENTOLINGULININAE Saidova, 1981
Genus BOMBULINA Mikhalevich, 1983

***Bombulina spinata* (Cushman)**
Plate 12, Figure 8

Glandulina spinata CUSHMAN 1935, v.91, no.21, p.8, pl.3, figs.8-9.
Bombulina spinata (Cushman) MIKHALEVICH, 1983.- RAO, 1998, p.150, pl.32, figs.1-3.- RAO *et al.*, 1999, p.309-313.

Remarks : *Bombulina spinata* (Cushman) and *Glandulina spinata* Cushman are two separate species. The present identification is based on the report of Rao (1998). Rao *et al.* (1999) later dissected the specimen to check whether his specimens belonged to the genus Bombulina or not. On dissection, he found that the specimens were actually those of the genus Glandulina. As sectioning of the specimens in the present study, could not be attempted, the original identification is maintained. However, Dr. Rao (Personal communication) agreed to dissect our specimens and if required, necessary generic shift will be made later.

Hypotype: Length=0.30 mm; maximum diameter=0.23 mm
Repository: GOD NIO Cat No.GOA-230

Suborder ROBERTININA Loeblich and Tappan, 1984

Superfamily CERATOBULIMINACEA Cushman, 1927

4.5.1.29 Family CERATOBULIMINIDAE Cushman, 1927
Subfamily CERATOULIMININAE Cushman, 1927

Genus CERATOBULIMINA Toula, 1915

***Ceratobulimina jonesiana* (Brady)**

Plate 12, Figure 9

Cassidulina jonesiana BRADY, 1881, p.59, pl.9, fig.54.
Cerotobulimina jonesiana (Brady) JONES, 1994, p.54, fig.18.

Hypotype: Length=0.92 mm; width=0.67 mm; thickness=0.71 mm
Repository: GOD NIO Cat No.GOA-231

4.5.1.30 Family EPISTOMINIDAE Wedekind, 1937
Subfamily EPISTOMININAE Wedekind, 1937
Genus HOEGLUNDINA Brotzen, 1948

***Hoeglundina* cf. *H. elegans* (d'Orbigny)**

Plate 12, Figure 10

Rotalia (*Turbinuline*) *elegans* D'ORBIGNY, 1826, p.276, no.54.
Epistomina elegans (d'Orbigny) CUSHMAN, 1931, p.65, pl.13, figs.6a-i.
Hoglündina elegans (d'Orbigny) BARKER, 1960, pl.105, figs.3-6.
Hoeglundina elegans (d'Orbigny) COLOM, 1974, p.173, figs.44v-w.- RAI and SINGH, 2004, pp.415-429, tab.1.- NAGENDRA *et al.*, 2004, pp.51-60, pl.2, figs.1a-b, tab.1.

Remarks: These specimens have slightly elongated aperture than *Hoeglundina elegans*.

Hypotype: Length=1.27 mm; width=1.13 mm; thickness=0.71 mm
Repository: GOD NIO Cat No.GOA-232

Suborder GLOBIGERININA Delage and Hérouard, 1896

Superfamily HETEROHELICACEA Cushman, 1927

4.5.1.31 Family GUEMBELITRIIDAE Montanaro Gallitelli, 1957
Genus GALLITELLIA Loeblich and Tappan, 1986

Gallitellia vivans **(Cushman)**

Plate 12, Figure 11

Guembelitria? vivans CUSHMAN, 1934, p.105, pl.13, figs.9-10.- FRERICHS, 1970, p.141, table 6.

Gallitellia vivans (Cushman) LOEBLICH and TAPPAN, 1986, p.249; 1988, p.453, pl.485, fig.1-3.- KROON and NEDERBRAGT, 1990, pp.31-32, pl.1, figs.1-10.- HENRIQUES, 1993, p.85, pl.10, fig.4.- MAYENKAR, 1994, p.95, pl.9, fig.1.- CHATURVEDI, 2001, p.140, pl.7, fig.1.

Hypotype: Length=0.14 mm; maximum diameter=0.08 mm

Repository: GOD NIO Cat No.GOA-233

Superfamily GLOBOROTALIACEA Cushman, 1927

4.5.1.32 Family GLOBOROTALIIDAE Cushman, 1927

Genus GLOBOROTALIA Cushman, 1927

Globorotalia menardii **(d'Orbigny)**

Plate 12, Figure 12

Rotalia menardii D'ORBIGNY, 1826, p.96.

Palvinulina menardii (d'Orbigny) BRADY, 1884, p.690, pl.103, figs.1-2.

Globorotalia menardii (d'Orbigny) CUSHMAN, 1931, p.91, pl.12, figs.1a-c.- SETHULEKSHMI AMMA, 1958, p.17, pl.1, figs.28a-c.- GANAPATI and SATYAVATI, 1958, p.103, pl.5, figs.136-137.- ANTONY, 1968, p.110, pl.8, figs.4a-b.- BHATT, 1969, p.32, pl.11, figs.5a-b.- VENDANTAM and RAO, 1970, p.329, tab.3.- RAO, 1971a, p.12, fig.77; 1971b, p.161; 1972, p.5, fig.26; 1973, p.56.- SETTY, 1972, p.136, pl.2, fig.19.- SETTY and GUPTHA, 1972, p.158, pl.23, figs.11-12.- GUPTHA, 1973b, p.148, tab.2; 1974, p.8, tab.1.- VENKATACHALAPATHY and SHAREEF, 1981, p.44.- NARAPPA *et al.*, 1982, p.221.- PAL, 1988, p.321, tab.1.- RAO *et al.*, 1988, p.68, tab.1.- SHAREEF and VENKATACHALAPATHY, 1988, p.434, pl.3, fig.6.- NAIDU *et al.*, 1989, p.395.- JAIPRAKASH *et al.*, 1989, p.87.- GUHA and SARKAR, 1990, p.170.- GUPTHA *et al.*, 1990, p.658.- NAIDU, 1990, pp.328-329.- KROON, 1991, p.58, pl.6, figs.1-6.- RAO *et al.*, 1991, p.30, tab.3.- KHARE, 1992, p.108, pl.9, figs.8a-b.- HENRIQUES, 1993, p.86, pl.10, fig.5a-c.- MAYENKAR, 1994, p.95, pl.9, figs.2a-b.- RAO, 1998, p.152, pl.33, figs.1-2; pl.34, fig.1.- CHOWDHURY *et al.*, 2003, pl.2, fig.17, tab.2.

Hypotype: Length=0.93 mm; width=0.72 mm; thickness=0.15 mm
Repository: GOD NIO Cat No.GOA-234

Genus NEOGLOBOQUADRINA Bandy, Frerichs and Vincent, 1967

Neogloboquadrina dutertrei **(d'Orbigny)**
Plate 12, Figure 13

Globigerina dutertrei D'ORBIGNY, 1839, pp.84.
Globoquadrina dutertrei (d'Orbigny) PARKER, 1962, p.219.- BHATT, 1969, p.33, pl.12, figs.7a-c, 8.- RAO, 1971b, p.161; 1972, p.4, fig.21; 1973, p.57.- SETTY, 1972, p.134, pl.2, figs.5-6.- SETTY and GUPTHA, 1972, p.156, pl.23, figs.1-3.- GUPTHA, 1973b, p.148, table 2; 1974, p.11, pl.1, figs. 14-15, table 1.- ZOBEL, 1973, p.34, pl.3, figs. 16-20.- PAL, 1988, p.321, table 1.- NAIDU *et al.*, 1989, p.395.- GUPTHA *et al.*, 1990, p.656.- KROON, 1991, p.91, pl.3.
Neogloboquadrina dutertrei (d'Orbigny) BANDY *et al.*, 1967, p.152.- RAO *et al.* 1988, p.68.- JAIPRAKASH *et al.*, 1989, p.87.- GUHA and SARKAR, 1990, p. 170.- KHARE, 1992, pp.109-110, pls.9,10, figs. 10,1.- NAIDU,1993, pp.407, 412.- HENRIQUES, 1993, pp.86-87, pl.10, figs.7a-c.- MAYENKAR, 1994, pp.96-97, pl.9, fig.4a-c.- KROON and DARLING, 1995, pp.39-52.- MARTINEZ *et al.*, 1998, pp.121-151, tab.3.- NIGAM and KHARE, 1999, p.302, pl.4, figs.5a-b.- CHATURVEDI, 2001, p.141, pl.7, fig.3.- KYAW and SAING, 2001, p.17, pl.IV, fig.112.- CHOWDHURY *et al.*, 2003, pl.2, fig.21, tab.2.

Hypotype: Length=0.35 mm; width=0.30 mm; thickness=0.17 mm
Repository: GOD NIO Cat No.GOA-235

Neogloboquadrina hexagona **(Natland)**
Plate 12, Figure 18

Globigerina hexagona NATLAND, 1938, p.149, pl.7, figs.1a-c.- SETTY, 1974, p.21.
Globoquadrina hexagona (Natland) PARKER, 1962, p.244, pl.8, figs.5-13.- VEDANTAM and RAO, 1970, p.329, tab.3.- RAO, 1973, p.60.- SETTY, 1978, p.303.

Neogloboquadrina hexagona (Natland) HAYNES, 1981, p.329.- HENRIQUES, 1993, p.87, fig.10, fig.8a-c.- MAYENKAR, 1994, p.97, pl.9, fig.5a-c.- RAO, 1998, p.154, pl.33, figs.7-8.

Hypotype: Length=0.44 mm; width=0.35 mm; thickness=0.21 mm
Repository: GOD NIO Cat No.GOA-236

Neogloboquadrina pachyderma **(Ehrenberg)**
Plate 12, Figure 14

Aristerospira pachyderma EHRENBERG, 1873, p.386, tab.1, fig.4.
Globigerina pachyderma (Ehrenberg) PARKER, 1962, p.219.- BHATT, 1969, p.31, pl.10, figs.5a-c,8a-c.- SETTY and GUPTHA, 1972, p.155, pl.22, fig.7.- RAO, 1972, p.3, fig.14; 1973, p.55.- SETTY, 1972, p.132, pl.1, figs.3-4.- GUPTHA, 1973b, p.148, tab.2; 1974, p.11, pl.1, figs.1-2, tab.1.- ZOBEL, 1973, p.34, pl.3, fig.14.
Neogloboquadrina pachyderma (Ehrenberg) NAIDU *et al.*, 1989, p.395.- GUPTHA *et al.*, 1990, p.658.- NAIDU, 1990, p.329.- KHARE, 1992, p.111, pl.10, figs.3a-c.- HENRIQUES, 1993, p.88, pl.11, figs.1a-b.- MAYENKAR, 1994, p.97, pl.9, figs.6a-b.- MARTINEZ *et al.*, 1998, pp.121-151, tab.3.- SRINIVASAN and SINHA, 2003, p.28.

Hypotype: Length=0.21 mm; width=0.21 mm; thickness=0.12 mm
Repository: GOD NIO Cat No.GOA-237

4.5.1.33 Family PULLENIATINIDAE Cushman, 1927
Genus PULLENIATINA Cushman, 1927

Pulleniatina obliquiloculata **Parker and Jones**
Plate 12, Figure 15

Pulleniatina obliquiloculata PARKER and JONES, 1865, p.368.- GANAPATI and SATYAVATI, 1958, p.117, pl.4, figs.157-158.- SETTY, 1972, p.135, pl.2, figs.9-10; 1978, p.303.- SAING, 1972, p.405, pl.6, fig.19.- CULLEN and PRELL, 1984, p.21.- GUPTHA and HASHIMI, 1985, p.68.- NAIDU and GUPTHA, 1989, p.134.- NAIDU *et al.*, 1989, p.395.- JAIPRAKASH *et al.* 1989, p.87.- NAIDU, 1990, p.329.- KROON, 1991, p.59, pl.3, figs.14-17.- RAO *et al.*, 1991, pp.28-31.- HENRIQUES, 1993, pp.88-89, pl.11, figs.2a-c.- MAYENKAR, 1994, pp.98-99, pl.9, figs.7a-c.- RAO, 1998, p.155, pl.33, figs.9-10.-

MARTINEZ *et al.*, 1998, pp.121-151, tab.3.- CHATURVEDI, 2001, p.142, pl.7, fig.4.- KYAW and SAING, 2001, p.17, pl.IV, fig.113.- CHOWDHURY *et al.*, 2003, pl.2, fig.23, tab.2.- NAIDU and NIITSUMA, 2003, pp.85-95, tab.3,5.

Hypotype: Length=0.41 mm; width=0.36 mm; thickness=0.41 mm
Repository: GOD NIO Cat No.GOA-238

4.5.1.34 Family CANDEINIDAE Cushman, 1927
Subfamily GLOBIGERINITINAE Bermúdez, 1961
Genus GLOBIGERINITA Brönnimann, 1951

***Globigerinita glutinata* (Egger)**
Plate 12, Figure 16

Globigerina glutinata EGGER, 1893, p.371, pl.13, fig.19-21, - RHUMBLER, 1911, p.148, pl.29, figs.14-26; pl.33, fig.20; pl.34, fig.1.
Tinophodella ambitacrena LOEBLICH and TAPPAN, 1957, p.114, figs.2-3.
Globigerinita glutinata (Egger) BRADSHAW, 1959, p.40, pl.7, figs.7-8.- PARKER, 1962, pp.246-247, pl.9, fig.16.- BÉ and HAMLIN, 1967, p.102, text fig.24.- BHATT, 1969, p.33, pl.12, fig.10a-b.- ZOBEL, 1973, p.33, pl.3, figs.32-35.- RAO, 1972, p.2, fig.19; 1973, p.57.- MARTINEZ *et al.*, 1998, pp.121-151, tab.3.- CHATURVEDI, 2001, p.145, pl.7, fig.7.- CHOWDHURY *et al.*, 2003, pl.2, fig.24, tab.2.

Hypotype: Length=0.28 mm; width=0.24 mm; thickness=0.23 mm
Repository: GOD NIO Cat No.GOA-239

4.5.1.35 Family CATAPSYDRACIDAE Bolli, Loeblich and Tappan, 1957
Genus GLOBOQUADRINA Finlay, 1947

***Globoquadrina conglomerata* (Schwager)**
Plate 12, Figure 17

Globigerina conglomerata SCHWAGER 1866, v.2, pt.2, p.255, pl.7, fig.113.- VENDANTAM and RAO, 1970, p.329, tab.3.- JAIPRAKASH *et al.*, 1989, p.87.
Globoquadrina conglomerata (Schwager) PARKER, 1962, p.219.- RAO, 1972, p.4, fig.22; 1973, p.57.- SETTY, 1972, p.135, pl.2, figs.7-8.- SETTY and GUPTHA, 1972, p.157, pl.23,

figs.5-6.- GUPTHA, 1973b, p.148, tab.2; 1974, p.11, pl.1, figs.12-13, tab.1.- RAO *et al.*, 1988, p.68, tab.1.- NAIDU *et al.*, 1989, p.395.- GUHA and SARKAR, 1990, p.170.- GUPTHA *et al.*, 1990, p.658.- NAIDU, 1990, p.329.- KROON, 1991, p.58, pl.3, figs.18-19.- RAO *et al.*, 1991, p.28, tab.1.- KHARE, 1992, p.112, pl.10, figs.2a-b.- NAIDU, 1993, p.407.- HENRIQUES, 1993, p.90, pl.10, figs.10a-b.- MAYENKAR, 1994, p.100, pl.9, figs.3a-b.- RAO, 1998, p.158, pl.35, fig.8-9.- MARTINEZ *et al.*, 1998, pp.121-151, tab.3.- CHOWDHURY *et al.*, 2003, pl.2, fig.20, tab.2.

Hypotype: Length=0.31 mm; width=0.30 mm; thickness=0.30 mm
Repository: GOD NIO Cat No.GOA-240

Superfamily GLOBIGERINACEA Carpenter, Parker and Jones, 1862

4.5.1.36 Family GLOBIGERINIDAE Carpenter, Parker and Jones, 1862
Subfamily GLOBIGERININAE Carpenter, Parker and Jones, 1862
Genus BEELLA Banner and Blow, 1960

***Beella digitata* (Brady)**
Plate 13, Figure 2

Globigerina digitata BRADY, 1879, p.286, pl.80, figs.6,8.- GUPTHA and HASHIMI, 1985, p.68.- MARTINEZ *et al.*, 1998, pp.121-151, tab.3.
Globorotalia (Beella) digitata (Brady) BANNER and BLOW, 1960, p.26.
Beella digitata (Brady) LOBLICH and TAPPAN, 1964, p.669.- 1988, p.488, pl.534, figs.1-4.- HENRIQUES, 1993, p.91, pl.11, fig.5.- MAYENKAR, 1994, p.101, pl.10, fig.3.

Hypotype: Length=0.46 mm; width=0.30 mm; thickness=0.30 mm
Repository: GOD NIO Cat No.GOA-241

Genus GLOBIGERINA d'Orbigny, 1826

***Globigerina bulloides* d'Orbigny**
Plate 12, Figure 19

Globigerina bulloides D'ORBIGNY, 1826, p.277.- GANAPATI and SATYAVATI, 1958, p.110, pl.6, figs.142-146.- SETHULEKSHMI AMMA, 1958, p.12, pl.1, figs.20a-b.-

GANAPATI and SAROJINI, 1962, p.312.- ANTONY, 1968, p.104, pl.7, figs.13a-b.- BHATT, 1969, p.31, pl.10, figs.1a-b.- VEDANTAM and RAO, 1970, p.329, table 3.- RAO, 1971a, p.11, figs.74a-b; 1971b, p.161; 1972, p.4, fig.16; 1973, p.55.- ZOBEL, 1971, p.1326, pl.1, figs.8-9.- SETTY, 1972, p.132, pl.1, figs.1-2.- SETTY and GUPTHA, 1972, p.152, pl.22, figs.1-2.- GUPTHA, 1973b, p.148, table 2.; 1974, p.8, table 1.- ZOBEL, 1973, p.34, pl.3, figs.38-39.- RAO and RAO, 1976a, p.298; 1976; p.217.- BHALLA and NIGAM, 1979, p.239; 1980, p.147.- BHALLA and RAGHAV, 1980, p.289, table 1.- VENKATACHALAPATHY and SHAREEF, 1981, p.44.- NARAPPA *et al.*, 1982, p.221.- REDDY *et al.*, 1983, p.107.- NIGAM, 1982, pp.181-182, pl.5, fig.7.- SETTY *et al.*, 1984, p.50, table 1.- RAO *et al.*, 1985, p.76, table 1; 1988, p.68, table 1.- BHALLA and GAUR, 1987, p.124, pl.1, fig.14.- SHAREEF and VENKATACHALAPATHY, 1988, p.434, pl.3, fig.3.- PAL, 1988, p.321, table 1.- NAIDU and GUPTHA, 1989, pp.134-135.- NAIDU *et al.*, 1989, p.395.- JAIPRAKASH *et al.*, 1989, p.87.- GUHA and SARKAR, 1990, p.170.- GUPTHA *et al.*, 1990, p.656.- KALADHAR *et al.*, 1990, p.72. table 1.- NAIDU, 1990, pp.328-331.- RAO *et al.*, 1991, p.28, table 1.- KHARE, 1992, pp.113-114, pl.10, figs.4a-b.- HENRIQUES, 1993, p.92, pl.11, figs.7a-c.- MAYENKAR, 1994, pp.101-102, pl.10, figs.5a-b.- KROON and DARLING, 1995, pp.39-52.- DAS, 1996, p.49, tab.1.- NAIDU, 1998, pp.263-265. – SINGH, 1998, pp.205,208.- RAO, 1998, pp.157-158, pls.35,37, figs.3-4,1.- MARTINEZ *et al.*, 1998, pp.121-151, tab.3.- GANDHI, 1999, pp.74-75, pl.6, figs.1-2.- NIGAM and KHARE, 1999, p.303, pl.6, fig.6.- NIGAM and CHATURVEDI, 2000, p.134.- CHATURVEDI, 2001, p.144, pl.7, fig.4.- PEETERS *et al.*, 2002, pp.269-291.- KATHAL, 2002, p.442, pl.3, fig.2.- CHOWDHURY *et al.*, 2003, pl.1, fig.2, tab.2.- NAIDU and NIITSUMA, 2003, pp.85-95, tab.3,5.- SRINIVASAN and SINHA, 2003, p.28.- MALLIK *et al.*, 2003, p.42, tab.1.- GANDHI and RAJAMANICKAM, 2004, p.293-304, tab.1,2.

Hypotype: Length=0.31 mm; width=0.26 mm; thickness=0.24 mm
Repository: GOD NIO Cat No.GOA-242

***Globigerina falconensis* Blow**
Plate 12, Figure 20

Globigerina falconensis BLOW 1959, p.177, pl.9, figs.40a-c, 41.- RAO, 1972, p.2, fig.15; 1973, p.55.- ZOBEL, 1973, p.34, pl.3, fig.40.- SETTY, 1978, p.2.- NAIDU, 1993, p.407.- HENRIQUES, 1993, p.93, pl.11, figs.8a-b.- MAYENKAR, 1994, p.103, pl.10, figs.7a-b.-

RAO, 1998, p.158, pl.35, fig.10-11; pl.37, fig.2.- MARTINEZ *et al.*, 1998, pp.121-151, tab.3.

Hypotype: Length=0.37 mm; width=0.33 mm; thickness=0.33 mm
Repository: GOD NIO Cat No.GOA-243

Genus GLOBIGERINELLA Cushman, 1927

Globigerinella aequilateralis **(Brady)**
Plate 12, Figure 21

Globigerina aequilateralis BRADY 1879, v.19, p.285, figured in BRADY, 1884, v.9, pl.80, figs. 18-21.- GANAPATI and SATYAVATI, 1958, p.111, pl.6, figs.152-154.- SETHULEKSHMI AMMA, 1958, p.15, pl.1, fig.25.- VEDANTAM and RAO, 1970, tab.3.- RAO, 1971a, p.12, fig.76; 1971b, p.161; 1972, p.4, fig.18; 1973, p.55.- SETTY, 1972, p.135, pl.2, figs.11-13.- SETTY and GUPTHA, 1972, p.157, pl.23, figs.9-10.- GUPTHA, 1973b, p.148, tab.2; 1974, p.8, tab.1.- RAO and RAO, 1976b, p.217.- NARAPPA *et al.*, 1982, p.221.- RAO *et al.*, 1988, p.68, tab.1; 1991, p.28, tab.1.- NAIDU *et al.*, 1989, p.395.- GUPTHA *et al.*, 1990, p.656.- NAIDU, 1990, pp.328-329.- KHARE, 1992, p.114, pl.10, figs.5a-b.- NAIDU, 1993, pp.407,412.- HENRIQUES, 1993, p.93, pl.12, fig.2a-c.- MAYENKAR, 1994, p.103, pl.10, figs.8a-b.- RAO, 1998, p.159, pl.36, fig.1-2; pl.37, fig.4.- CHOWDHURY *et al.*, 2003, pl.1, fig.9, tab.2.

Hypotype: Length=0.62 mm; width=0.48 mm; thickness=0.46 mm
Repository: GOD NIO Cat No.GOA-244

Globigerinella calida **(Parker)**
Plate 13, Figure 1

Globigerina calida PARKER, 1962, pp.221-222, pl.1, figs.9-13, 15.- RAO, 1971b, p.171, fig.53; 1972, p.2, fig.17; 1973, p.55.- SETTY, 1978, p.303.- NAIDU, 1990, pp.328-329; 1993, p.407.- HENRIQUES, 1993, p.92, pl.12, fig.1.- MAYENKAR, 1994, p.102, pl.10, fig.6.- MARTINEZ *et al.*, 1998, pp.121-151, tab.3.
Globigerinella calida (Parker) BHATT, 1969, p.31, pl.10, figs.2a-c.- KROON, 1991, p.56, pl.4, figs.10-14.- RAO, 1998, p.160, pl.36,37, figs.3-4,5-6.- CHATURVEDI, 2001, p.145, pl.7, fig.8.- CHOWDHURY *et al.*, 2003, pl.1, fig.10, tab.2.

Hypotype: Length=0.42 mm; width=0.31 mm; thickness=0.24 mm
Repository: GOD NIO Cat No.GOA-245

Genus GLOBIGERINOIDES Cushman, 1927

***Globigerinoides conglobatus* (Brady)**
Plate 13, Figure 3

Globigerina conglobata BRADY 1879, v.19, p.286, 1884, v.9, pl.80, figs.1-5; pl.82, fig.5.
Globigerinoides conglobatus (Brady) PARKER, 1962, p.219.- VEDANTAM and RAO, 1970, p.329, tab.3.- SETTY, 1972, p.134, pl.2, figs.3-4.- SETTY and GUPTHA, 1972, p.156, pl.22, figs.14-15.- RAO, 1972, p.3, fig.9; 1973, p.56.- GUPTHA, 1973b, p.148, tab.2; 1974, p.11, pl.1, fig.5, tab.1.- ZOBEL, 1973, p.34, pl.3, figs.41,45.- RAO *et al.*, 1988, p.68, tab.1; 1991, p.28, tab.1.- NAIDU *et al.*, 1989, p.395.- JAIPRAKASH *et al.*, 1989, p.87.- GUPTHA *et al.*, 1990, p.658.- GUHA and SARKAR, 1990, p.170.- NAIDU, 1990, p.328-329.- KHARE, 1992, p.115, pl.10, figs.6a-b.- NAIDU, 1993, p.407.- HENRIQUES, 1993, p.94, pl.12, fig.3.- MAYENKAR, 1994, p.104, pl.11, figs.1a-b.- RAO, 1998, p.161, pl.36, figs.5-6; pl.39, fig.1.- MARTINEZ *et al.*, 1998, pp.121-151, tab.3.- CHOWDHURY *et al.*, 2003, pl.1, fig.1, tab.2.
Globigerinoides conglobata (Brady) GANAPATI and SATYAVATI, 1958, p.110, pl.6, fig.151.- ROCHA and UBALDO, 1964b, p.649, pl.1, figs.12-13.- PAL, 1988, p.321, tab.1.- KYAW and SAING, 2001, p.18, pl.IV, fig.117.

Hypotype: Length=0.41 mm; width=0.38 mm; thickness=0.37 mm
Repository: GOD NIO Cat No.GOA-246

***Globigerinoides ruber* (d'Orbigny)**
Plate 13, Figure 4

Globigerina rubra D'ORBIGNY, 1839, p.82, pl.4, figs.12-14.
Globigerinoides rubra (d'Orbigny) CUSHMAN, 1927, p.87.- GANAPATI and SATYAVATI, 1958, p.110, pl.6, figs.149-150.- ANTONY, 1968, p.107, pl.7, figs 16a-b.- VENKATACHALAPATHY and SHAREEF, 1981, p.44.- SHAREEF and VENKATACHALAPATHY, 1987b, p.189; 1988, p.434, pl.3, fig.4.- PAL, 1988, p.321, table 1, - GUPTHA *et al.*, 1990, p.656. KALADHAR *et al.*, 1990, p.72, table 1.

Globigerinoides ruber (d'Orbigny) PARKER, 1962, p.230, pl.3, figs.11-14, pl.4, figs.1-10.- BHATT, 1969, p.32, pl.12, figs.2a-c.- VEDANTAM and RAO, 1970, p.329, table 3.- RAO, 1971b, p.161, fig.54; 1972, p.3, fig.11; 1973, p.56.- ZOBEL, 1971, p. 1331, pl.1, figs. 11-13; 1973, p.34, pl.3 figs.44, 46-48.- SETTY, 1972, p.133, pl.1, figs.17-18.- SETTY and GUPTHA, 1972, p.155, pl.22, figs.5-6- SAING, 1972, p.401, pl.6, fig.21a-c.- GUPTHA, 1973b, p.148, table 2; 1974, p.8.- REDDY *et al.* 1974, p.19, BHALLA and NIGAM, 1979, p.239; 1980, p.147.- BHALLA and RAGHAV, 1980, p.289, table 1.- REDDY and RAO, 1980, p.169, pl.5, figs. 7-8.- NARAPPA *et al.*, 1982, p.212.- NIGAM, 1982, pp.183-184, pl.5, fig.8.- BHALLA and GAUR, 1987, p.128, pl.1, fig.15.- RAO et al, 1987, p.169, pl.6, figs. 14-15; 1988, p.68; 1991, p.28, table 1.- NAIDU *et al.*, 1989, p.395.- JAIPRAKASH *et al.*, 1989, p.87.- NAIDU and GUPTA, 1989, p.134.- GUHA and SARKAR, 1990, p.170.- NAIDU, 1990, p.328-329.- KROON, 1991, p.58, pl.5, figs.9-12.- NAIDU *et al.*, 1992, p.716.- KHARE, 1992,p.116-117, pl.10, figs.7a-b.- HENRIQUES, 1993, p.95, pl.12, figs.4a-d.- MAYENKAR, 1994, pp.104-105, pl.11, figs.2a-b.- KROON and DARLING, 1995, pp.39-52.- DAS, 1996, p.49, table 1.- MARTINEZ *et al.*, 1998, pp.121-151,.tab.3.- NIGAM and KHARE, 1999, p.302, pl.4, fig.11.- NIGAM and CHATURVEDI, 2000, p.134.- CHATURVEDI, 2001, p.146, pl.8, fig.2.- RAO, 1998, p.161, pl.36, figs.7-8, pl.39, fig.2.- KYAW and SAING, 2001, p.17, pl.IV, fig.115.- PEETERS *et al.*, 2002, pp.269-291.- KATHAL, 2002, p.442, pl.3, fig.1.- CHOWDHURY *et al.*, 2003, pl.1, fig.1, tab.2.

Hypotype: Length=0.38 mm; width=0.29 mm; thickness=0.29 mm
Repository: GOD NIO Cat No.GOA-247

***Globigerinoides sacculifer* (Brady)**
Plate 13, Figure 5-6

Globigerina sacculifer BRADY, 1877, p.535.- JAIPRAKASH *et al.*, 1989, p.87.
Globigerinoides sacculifer (Brady) BÉ and HAMLIN, 1967, p.87.- GANAPATI and SATYAVATI, 1958, p.110, pl.6, figs.147-148.- SETHULAKSHMI AMMA, 1958, p.14, pl.1, fig.23.- ANTONY, 1968, p.106, pl.8, figs.1a-b.- VEDANTAM and RAO, 1970, p.329, table 3.- RAO, 1971b, p.161, fig.55; 1972, p.3, fig.10; 1973, p.56.- SETTY and GUPTHA, 1972, p.156, pl.22, figs.9-12.- GUPTHA, 1973b, p.148, table 2; 1974, pl.11, pl.1, figs.6-9, table 11.- ZOBEL, 1973, p.34, pl.3, figs.49-51.- VENKATACHALAPATHY and SHAREEF, 1981, p.44.- NARAPPA *et al.*, 1982, p.221.- RAO *et al.*, 1987, p.169, pl.6, figs.16-17; 1988, p.68, table 1; 1991, p.28, table1.- SHAREEF and VENKATACHALAPATHY, 1987a, p.194, table 1; 1987b, p.189; 1988, p.434, pl.3, fig.5.-

PAL, 1988, p.321, table 1.- NAIDU *et al.*, 1989, p.395.- NAIDU and GUPTHA, 1989, p.134.- GUPTHA *et al.*, 1990, p.656.- NAIDU, 1990, pp.328-329; 1991, fig.3a-c.- NAIDU *et al.*, 1992, p.716.- KHARE, 1992, pp.117-118, pl.10, figs.8a-b.- NAIDU, 1993, pp.407,409.- HENRIQUES, 1993, pp.95-96, pl.12, figs.5a-c.- MAYENKAR, 1994, pp.105-106, pl.11, figs.3a-b.- RAO, 1998, p.162, pl.36, figs.9-11, pl.39, fig.3.- MARTINEZ *et al.*, 1998, pp.121-151, tab.3.- NIGAM and KHARE, 1999, pl.302, pl.4, figs.12a-b.- CHATURVEDI, 2001, p.147, pl.8, fig.1.- KYAW and SAING, 2001, p.17, pl.IV, fig.116.- CHOWDHURY *et al.*, 2003, pl.1, fig.4, tab.2.

Hypotype: Length=0.52 mm; width=0.39 mm; thickness=0.42 mm
Repository: GOD NIO Cat No.GOA-248

Genus GLOBOTURBOROTALITA Hofker, 1976

***Globoturborotalita rubescens* (Hofker)**
Plate 13, Figure 7

Globigerina rubescens HOFKER, 1956, p.234, pl.35, figs.18-21.- RAO, 1972, p.3, fig.12.- SETTY, 1972, p.132, pl.1, figs.5-6.- SETTY and GUPTHA, 1972, p.155, pl.22, fig.13.- GUPTHA, 1973b, p.148, tab.2; 1974, p.8, tab.1.- RAO, 1973, p.55.- ZOBEL, 1973, p.34.- VENKATACHALAPATHY and SHAREEF, 1981, p.44.- GUPTHA *et al.*, 1990, p.658.- NAIDU, 1990, p.329.- RAO *et al.*, 1991, p.28, tab.1.
Globoturborotalita rubescens (Hofker) HOFKER, 1976, p.52.- KROON, 1991, p.59, pl.6, figs.16-20.- MAYENKAR, 1994, p.106, pl.11, fig.4.- MARTINEZ *et al.*, 1998, pp.121-151, tab.3.

Hypotype: Length=0.21 mm; width=0.19 mm; thickness=0.16 mm
Repository: GOD NIO Cat No.GOA-249

Subfamily ORBULININAE Schultze, 1854
Genus ORBULINA d'Orbigny, 1839

***Orbulina universa* d'Orbigny**
Plate 13, Figure 8

Orbulina uvigerina D'ORBIGNY, 1839, v.8, p.3, pl.1, fig.1.- GANAPATI and SATYAVATI, 1958, p.111, pl.6, figs.155-156.- SETHULEKSHMI AMMA, 1958, p.16, pl.1, fig.26.- ANTONY, 1968, p.108, pl.8, fig.3.- VEDANTAM and RAO, 1970, p.329.- RAO, 1971b, p.161, fig.56; 1972, p.3, fig.8; 1973, p.56.- SETTY, 1972, p.135.- SETTY and GUPTHA, 1972, p.156, fig.16.- GUPTHA, 1973b, p.148, tab.2; 1974, p.8, tab.1.- ZOBEL, 1973, p.34, pl.3, fig.43.- RAGOTHAMAN and KUMAR, 1985, p.113, pl.3, fig.9.- PAL, 1988, p.321, tab.1.- JAIPRAKASH *et al.*, 1989, p.87.- GUHA and SARKAR, 1990, p.170.- NAIDU, 1990, pp.328-329.- NIGAM, 1990, p.46.- KROON, 1991, p.59, pl.4, figs.15-18.- RAO *et al.*, 1991, p.29, tab.2.- KHARE, 1992, pp.119-120, pl.11, fig.2.- HENRIQUES, 1993, p.99, pl.13, fig.4.- MAYENKAR, 1994, p.109, pl.11, fig.8.- RAO, 1998, p.163, pl.38, figs.5-8.- MARTINEZ *et al.*, 1998, pp.121-151, tab.3.- KYAW and SAING, 2001, p.17, pl.IV, fig.106.- CHOWDHURY *et al.*, 2003, pl.1, fig.12, tab.2.

Hypotype: Maximum diameter=0.91 mm
Repository: GOD NIO Cat No.GOA-250

Suborder ROTALIINA Delage and Hérouard, 1896

Superfamily BOLIVINACEA Glaessner, 1937

4.5.1.37 Family BOLIVINIDAE Glaessner, 1937

Genus BOLIVINA d'Orbigny, 1839

***Bolivina dilatata* Reuss**
Plate 13, Figure 9

Bolivina dilatata REUSS, 1850, p.381, pl.48, figs.15a-c.- CUSHMAN, 1937b, p.78, pl.9, figs.17-20.- ANTONY, 1968, p.71, pl.5, fig.2.

Hypotype: Length=0.22 mm; width=0.13 mm; thickness=0.09 mm
Repository: GOD NIO Cat No.GOA-251

***Bolivina doniezi* Cushman and Wickenden**
Plate 13, Figure 10

Bolivina doniezi CUSHMAN and WICKENDEN, 1929, p.9, pl.4, fig.3.- CHATURVEDI, 2001, p.148, pl.8, fig.4.- KUMAR and SRINIVASAN, 2004, pp.299-312.

Hypotype: Length=0.39 mm; width=0.18 mm; thickness=0.08 mm
Repository: GOD NIO Cat No.GOA-252

***Bolivina* cf. *B. inflata* Heron-Allen and Earland**
Plate 13, Figure 11

Bolivina inflata HERON-ALLEN and EARLAND, 1913, p.68, pl.4, figs.16-19.- CUSHMAN, 1937b, p.166, pl.18, fig.16.

Remarks: These specimens resemble with *Bolivina inflata* described by Cushman (1937b) except for their slightly higher width : length ratio.

Hypotype: Length=0.39 mm; width=0.18 mm; thickness=0.08 mm
Repository: GOD NIO Cat No.GOA-253

***Bolivina kuriani* Seibold**
Plate 13, Figure 12

Bolivina kuriani SEIBOLD, 1975, p.185, text fig.2a-b.- SEIBOLD and SEIBOLD, 1981, p.42, table3.- KHARE, 1992, p.121, pl.11, figs.4a-b.- HENRIQUES, 1993, p.101, pl.13, figs.8a-b.- MAYENKAR, 1994, p.111, pl.12, figs.3a-b.- DAS, 1996, p.49, table1.- RAO, 1998, p165-166, pl.40, figs.4-5.- NIGAM and KHARE, 1999, p.302, pl.4, figs.16a-b.- NIGAM and CHATURVEDI, 2000, p.134. - CHATURVEDI, 2001, p.148, pl.8, fig.6.- MAZUMDER *et al.*, 2003, p.8, tab.1.

Hypotype: Length=0.47 mm; width=0.17 mm; thickness=0.11 mm
Repository: GOD NIO Cat No.GOA-254

***Bolivina lowmani* Phleger and Parker**
Plate 13, Figure 13

Bolivina lowmani PHLEGER and PARKER, 1951, p.13, pl.6, figs.20-21.- MATHUR and GUPTA, 1989, p.122, tab.1.

Hypotype: Length=0.26 mm; width=0.11 mm; thickness=0.07 mm
Repository: GOD NIO Cat No.GOA-255

***Bolivina marginata* Cushman**
Plate 13, Figure 14

Bolivina marginata CUSHMAN, 1918, p.48, pl.10, fig.1; CUSHMAN, 1937b, p.86, pl.10, figs.4-6- ANTONY, 1968, p.72, pl.4, fig.19.

Hypotype: Length=0.26 mm; width=0.14 mm; thickness=0.10 mm
Repository: GOD NIO Cat No.GOA-256

***Bolivina* cf. *B. oceanica* Cushman**
Plate 13, Figure 15

Bolivina oceanica CUSHMAN, 1933a, p.81, pl.8, figs.10a-b; 1937b, p.147, pl.19, fig.31.

Remarks: The specimens from the off Goa region are quite similar to *Bolivina oceanica*, described by Cushman (1937b). Since the number of chambers in these specimens are less than those reported by Cushman, they have been named *Bolivina* cf. *B.oceanica.*

Hypotype: Length=0.25 mm; width=0.13 mm; thickness=0.09 mm
Repository: GOD NIO Cat No.GOA-257

***Bolivina ordinaria* Phleger and Parker**
Plate 13, Figure 16

Bolivina ordinaria PHLEGER and PARKER, 1951, p.14, pl.2, fig.3.- SEIBOLD, 1975, p.186.- SEIBOLD and SEIBOLD, 1981, p.12, tab.3b.- KHARE, 1992, p.123, pl.11, figs.7a-c.- GANDHI *et al.*, 2002, p.57, pl.II, fig.6.- GANDHI and RAJAMANICKAM, 2004, p.293-304, tab.1,2.

Remarks: These specimens have depressed sutures, which perfectly match with *Bolivina ordinaria* described by Khare (1992).

Hypotype: Length=0.23 mm; width=0.14 mm; thickness=0.09 mm
Repository: GOD NIO Cat No.GOA-258

***Bolivina* cf. *B. pacifica* Cushman and McCulloch**
Plate 13, Figure 17

Bolivina pacifica CUSHMAN & MCCULLOCH, 1942, p.185, pl.21, fig.2-3.- UCHIO, 1960, pl.7, fig.2.- LUTZE, 1974, p.24, pl.5, fig.78-80 and pl.6, fig.96-97.- HAAKE, 1980, p.11, pl.2, fig.13.- CHATURVEDI, 2001, p.150, pl.8, fig.10.

Hypotype: Length=0.38 mm; width=0.13 mm; thickness=0.08 mm
Repository: GOD NIO Cat No.GOA-259

***Bolivina persiensis* Lutze**
Plate 13, Figure 18

Bolivina persiensis LUTZE, 1974, p.20, pl.5, figs. 86-89; p.22, pl.6, fig.98.- SEIBOLD, 1975, p.186, pl.1, fig.16.- SEIBOLD and SEIBOLD, 1981, p.43.- NIGAM, 1982, p.115, pl.4, fig.9.- NIGAM *et al.*, 1992b, p. 536, pl.1, fig.c.- KHARE, 1992, pp.124-125, pl.11, figs.8a-b.- HENRIQUES, 1993, pp.101-102, pl.13, fig.9.- MAYENKAR, 1994, pp.111-112, pl.12, fig.4.- DAS, 1996, p.49, tab.1.- RAO, 1998, p.166, pl.40, figs.6-7.- CHATURVEDI, 2001, p.150, pl.8, fig.12.- MAZUMDER *et al.*, 2003, p.8, tab.1.

Hypotype: Length=0.37 mm; width=0.26 mm; thickness=0.17 mm
Repository: GOD NIO Cat No.GOA-260

***Bolivina pseudoplicata* Heron-Allen and Earland**
Plate 13, Figure 19

Bolivina pseudoplicata HERON-ALLEN and EARLAND, 1930, p.81, pl.3, figs.36-40.- CUSHMAN, 1937, p.166, pl.19, figs.12-20.- BHATIA, 1956, pl.1, fig.10.- RAGOTHAMAN and KUMAR, 1985, pl.2, fig.3.- RAGOTHAMAN and MANIVANNAN, 1985, pp.133-134, pl.2, fig.17.- MATHUR and GUPTA, 1989, p.121, pl.I, fig.6, tab.1.

Hypotype: Length=0.35 mm; width=0.16 mm; thickness=0.10 mm
Repository: GOD NIO Cat No.GOA-261

Bolivina robusta **Brady**
Plate 13, Figure 20

Bolivina robusta BRADY, 1881, p.27.- FRERICHS, 1970, p.139, tab.5.- VEDANTAM and RAO, 1970, p.334.- SETTY, 1974, p.25; 1978, p.303.- RAO *et al.*, 1979, p.358, tab.3.- KYAW and SAING, 2001, p.13, pl.I, fig.15.- MAZUMDER *et al.*, 2003, p.8, tab.1.- RAI and SINGH, 2004, pp.415-429, tab.1.- NAGENDRA *et al.*, 2004, pp.51-60, pl.1, fig.8, tab.1.

Hypotype: Length=0.31 mm; width=0.17 mm; thickness=0.13 mm
Repository: GOD NIO Cat No.GOA-262

Bolivina seminuda **Cushman**
Plate 13, Figure 21

Bolivina seminuda CUSHMAN, 1911, p.34, fig.55.- VEDANTAM and RAO, 1970, p.334.- RAO *et al.*, 1979, p.356, fig.2.- MADABHUSHI, 1989b, p.102, pl.3, fig.1.- MAYENKAR, 1994, p.112, pl.12, fig.6.- MAZUMDER *et al.*, 2003, p.8, tab.1.

Hypotype: Length=0.26 mm; width=0.08 mm; thickness=0.06 mm
Repository: GOD NIO Cat No.GOA-263

Bolivina silvestrina **Cushman**
Plate 13, Figure 22

Bolivina silvestrina CUSHMAN, 1936, p.56, pl.8, figs.5a-b; 1937b, p.109, pl.13, figs.14-16.- BOLTOVSKOY, 1977, pl.I, figs.20-23.

Hypotype: Length=0.21 mm; width=0.09 mm; thickness=0.07 mm
Repository: GOD NIO Cat No.GOA-264

Bolivina spinata **Cushman**
Plate 13, Figure 23

Bolivina striatula Cushman var. *spinata* CUSHMAN, 1936, p.59, pl.8, figs.9a-b; 1937b, p.155, pl.18, fig.32.

Remarks: This species had earlier been named as *Bolivina striatula* var. *spinata*; but since the variety concept is no longer being used in taxonomic nomenclature, this species has been named as *Bolivina spinata.*

Hypotype: Length=0.35 mm; width=0.13 mm; thickness=0.05 mm
Repository: GOD NIO Cat No.GOA-265

***Bolivina spinescens* Cushman**
Plate 13, Figure 24

Bolivina textilarioides BRADY, 1884, p.419, pl.52, figs.24-25.
Bolivina spinescens CUSHMAN, 1911, p.46; 1937b, pp.142-143, pl.18, figs.17-19.- MAYENKAR, 1994, p.114, pl.12, fig.9.- MAZUMDER *et al.*, 2003, p.8, tab.1.

Hypotype: Length=0.31 mm; width=0.14 mm; thickness=0.08 mm
Repository: GOD NIO Cat No.GOA-266

***Bolivina variabilis* (Williamson)**
Plate 13, Figure 25

Textularia variabilis WILLIAMSON, 1858, p.76, pl.6, figs.162-163.
Bolivina variabilis (Williamson) CHASTER, 1890-91 (1892), pp.59-60.- BHATIA, 1956, p.21, pl.1, fig.8.- NIGAM, 1982, p.120, pl.4, fig.12.- MAYENKAR, 1994, p.114, pl.12, fig.10.- CHATURVEDI, 2001, p.152, pl.17, fig.8.- MAZUMDER *et al.*, 2003, p.8, tab.1.

Hypotype: Length=0.45 mm; width=0.16 mm; thickness=0.11 mm
Repository: GOD NIO Cat No.GOA-267

***Bolivina* sp.**
Plate 13, Figure 26

Remarks: These specimens show scanty occurrence in few samples. So their nomenclature was kept open under the genus *Bolivina*. The characteristic features of these specimens are serrate outer margins, inclined rectangular chambers and a very rough surface.

Hypotype: Length=0.27 mm; width=0.16 mm; thickness=0.08 mm
Repository: GOD NIO Cat No.GOA-268

Genus BRIZALINA Costa, 1856

***Brizalina difformis* (Williamson)**
Plate 13, Figure 27

Textularia variabilis var. *difformis* WILLIAMSON, 1858, p.77, pl.6, figs.166-167.
Bolivina difformis (Williamson) HERON-ALLEN and EARLAND, 1930, p.80.
Brizalina difformis (Williamson) CIMERMAN and LANGER, 1991, p.59, pl.61, figs.9-11.

Hypotype: Length=0.24 mm; width=0.14 mm; thickness=0.07 mm
Repository: GOD NIO Cat No.GOA-269

***Brizalina spathulata* (Williamson)**
Plate 13, Figure 28

Textularia variabilis var. *spathulata* WILLIAMSON, 1858, p.76, figs.164,165, table 6.
Bolivina spathulata (Williamson) CUSHMAN, 1937b, p.162, figs.20-24, table 15.- FRERICHS, 1970, p.135-142, tables 2,7.- VEDANTAM and RAO, 1970, p.329, table 3.- RAO and RAO, 1976a, p.300, table7; 1976b, p.217.- RAO and RAO, 1978, p. 426.- RAO *et al.*, 1979, p.358, table, 3.- VENKATACHALAPATHY and SHAREEF, 1981, p.44.- NARAPPA *et al.*, 1982, p.221.- SHAREEF and VENKATACHALAPATHY, 1987b, p. 189.- KHARE, 1992, p.125, pl.11, fig.9.- HENRIQUES, 1993, p.103, pl.14, fig.3.- MAYENKAR, 1994, p.113, pl.12, fig.7.- GANDHI, 1999, p.77, pl.6, fig.7.- CHATURVEDI, 2001, p.151, pl.8, fig.11.- GANDHI *et al.*, 2002, p.57, pl.II, fig.7.- MAZUMDER *et al.*, 2003, p.8, tab.1.- GANDHI and RAJAMANICKAM, 2004, p.293-304, tab.1,2.
Brizalina spathulata (Williamson) RAO, 1998, p.168, pl.41, fig.1.

Hypotype: Length=0.25 mm; width=0.15 mm; thickness=0.07 mm
Repository: GOD NIO Cat No.GOA-270

***Brizalina striatula* (Cushman)**

Plate 13, Figure 29

Bolivina striatula CUSHMAN, 1922, p.27, pl.3, fig.10.- BHATIA, 1956, p.21, pl.1, fig.9.- RAO, 1971b, p.160, fig.45.- SEIBOLD, 1972, p.453.- RAO and RAO, 1974, p.416, pl2, fig.1; 1976A, p.300, table 7.- REDDY *et al.*, 1974, p.18. - SEIBOLD, 1975, pp.186-187, pl.1, fig.17.- RAO and RAO, 1978, p.426.- NIGAM *et al.*, 1979, p.245.- SETTY and NIGAM, 1980b, p.421.- NIGAM and SARUPRIA, 1981, p.179, appendix 1.- SEIBOLD and SEIBOLD, 1981, p.12, table 3a.- NARAPPA *et al.*, 1982, p.221.- NIGAM, 1982, pp.116-119, pl.4, fig.11.- REDDY and REDDY, 1982, p.250, table 2.- NIGAM and THEIDE, 1983, p.126, table 3.- REDDY *et al.*, 1983, p.107.- NIGAM, 1984, p.423; 1986, p.424, table 1.- SETTY at al., 1984, p.50, table 1.- BHALLA and LAL, 1985, p.430.- NAIDU at al., 1985, p.95, pl.2, fig.7.- MADABHUSHI, 1989b, p.104.- KALADHAR *et al.*, 1990, p.72, table 1.- KUMAR *et al.*, 1990, p.55, pl.1, fig.16, table 1.- KHARE, 1992, pp.125-127, pl.11, figs.10-11.- NIGAM *et al.*, 1992b, p.536, pl.11, fig.a.- NIGAM and KHARE, 1999, p.302, pl.4, figs.22-23.- JAYARAJU *et al.*, 2000, p.335, table 1.- GANDHI, 1999, p.78, pl.6, fig.8.- KYAW and SAING, 2001, p.13, pl.I, fig.16.- GANDHI and RAJAMANICKAM, 2004, p.293-304, tab.1,2.

Bolivina nobiius (Hantken) SETHULEKSHMI AMMA, 1958, p.45, pl.2, fig.68.- ANTONY, 1968, p.73, pl.4, fig.20.- RAO, 1970b, p.267, pl.5, fig.54; 1971b, p.160; 1974, p.62, 65,66.- REDDY and RAO, 1980, p.165, pl.3, fig.12.- MADABHUSHI, 1989b, p.104.

Brizalina striatula (Cushman) SLITER, 1970, p.170, pl.7, figs.6a-d, pl.8, fig.19.- SHAREEF and VENKATACHALAPATHY, 1987, p.189.- MURRAY, 1991, p.329.- HENRIQUES, 1993, pp.105-106, pl.14, fig.4.- MAYENKAR, 1994, pp.115-116, pl.12, fig.12.– JAYARAJU and REDDI, 1996, p.315, table 1.- RAO, 1998, p.169, pl.4, figs.2-3.- NIGAM and CHATURVEDI, 2000, p.134.- CHATURVEDI, 2001, p.153, pl.9, fig.4.- MAZUMDER *et al.*, 2003, p.8, tab.1.- KUMAR and SRINIVASAN, 2004, pp.299-312.

Hypotype: Length=0.27 mm; width=0.12 mm; thickness=0.05 mm

Repository: GOD NIO Cat No.GOA-271

Superfamily LOXOSTOMATACEA Loeblich and Tappan, 1962

4.5.1.38 Family BOLIVINELLIDAE Hayward, 1980

Genus BOLIVINELLA Cushman, 1927

***Bolivinella elegans* Parr**

Plate 14, Figure 1

Bolivinella elegans PARR, 1932, p.223-224, pl.5, figs.1-2.

Hypotype: Length=0.29 mm; width=0.34 mm; thickness=0.05 mm
Repository: GOD NIO Cat No.GOA-272

Superfamily BOLIVINITACEA Cushman, 1927

4.5.1.39 Family BOLIVINITIDAE Cushman, 1927
Genus BOLIVINITA Cushman, 1927

***Bolivinita quadrilatera* (Schwager)**

Plate 14, Figure 2

Textularia quadrilatera SCHWAGER, 1866, p.258, pl.7, fig.10.- GANAPATI and SATYAVATI, 1958, p.106, pl.1, fig.15.
Bolivinita quadrilatera (Schwager) FRERICHS, 1970, p.140, tab.5.- RAO *et al.*, 1987, tab.1, pl.IV, fig.7-9.- MAYENKAR, 1994, p.118, pl.12, fig.13.

Hypotype: Length=0.27 mm; width=0.16 mm; thickness=0.06 mm
Repository: GOD NIO Cat No.GOA-273

Superfamily CASSIDULINACEA d'Orbigny, 1839

4.5.1.40 Family CASSIDULINIDAE d'Orbigny, 1839
Subfamily CASSIDULININAE d'Orbigny, 1839
Genus CASSIDULINA d'Orbigny, 1826

***Cassidulina* aff. *C. algida* Cushman**

Plate 14, Figure 3

Cassidulina algida CUSHMAN, 1944, p.35, pl.4, fig.24.- MATHUR and GUPTA, 1989, p.121, pl.II, fig.8, tab.1.

Hypotype: Length=0.39 mm; width=0.34 mm; thickness=0.22 mm
Repository: GOD NIO Cat No.GOA-274

***Cassidulina* cf. *C. crassa* d'Orbigny**
Plate 14, Figure 4

Cassidulina crassa D'ORBIGNY, 1839.
Globocassidulina crassa (d'Orbigny) RAI and SINGH, 2004, pp.415-429, tab.1.

Remarks: Rai and Singh (2004) placed this species under genus *Globocassidulina*. However, these specimens have a better resemblance with the genus *Cassidulina* than *Globocassidulina*. Hence, it has been placed under genus *Cassidulina*.

Hypotype: Length=0.40 mm; width=0.33 mm; thickness=0.18 mm
Repository: GOD NIO Cat No.GOA-275

***Cassidulina laevigata* d'Orbigny**
Plate 14, Figure 5

Cassidulina laevigata D'ORBIGNY, 1826, p.282, no.1, pl.15, figs.4-5.- GANAPATI and SATYAVATI, 1958, p.116, pl.6, figs.140-141.- ANTONY, 1968, p.102, pl.7, fig.10.- FRERICHS, 1970, p.136, tab.3.- ZOBEL, 1973, p.16, pl.1, fig.32.- RAO *et al.*, 1979, p.356, fig.2.- MAYENKAR, 1994, p.119, pl.13, fig.2.- MAZUMDER *et al.*, 2003, p.8, tab.1.- RAI and SINGH, 2004, pp.415-429, tab.1.

Hypotype: Length=0.28 mm; width=0.25 mm; thickness=0.14 mm
Repository: GOD NIO Cat No.GOA-276

***Cassidulina sicula* Seguenza**
Plate 14, Figure 6

Cassidulina sicula SEGUENZA, 1862, pp.111, 125, pl.1, fig.7,7a.- PARKER, 1958, p.272, pl.4, figs.16-17.

Hypotype: Length=0.41 mm; width=0.39 mm; thickness=0.20 mm

Repository: GOD NIO Cat No.GOA-277

***Cassidulina subcarinata* Uchio**

Plate 14, Figure 7

Cassidulina subcarinata UCHIO, 1960, p.68, pl.9, figs.15-16.- MATOBA and YAMAGUCHI, 1982, p.1041, pl.3, figs.11A-B.

Hypotype: Length=0.34 mm; width=0.30 mm; thickness=0.17 mm

Repository: GOD NIO Cat No.GOA-278

***Cassidulina teretis* Tappan**

Plate 14, Figure 8

Cassidulina teretis TAPPAN, 1951, p.121.- FRERICHS, 1970, p.136, tab.3.- MATHUR and GUPTA, 1989, pp.120-126, tab.1.- MAYENKAR, 1994, p.120, pl.13, fig.4.- MAZUMDER *et al.*, 2003, p.8, tab.1.

Hypotype: Length=0.31 mm; width=0.30 mm; thickness=0.19 mm

Repository: GOD NIO Cat No.GOA-279

***Cassidulina tortuosa* Cushman and Hughes**

Plate 14, Figure 9

Cassidulina tortuosa CUSHMAN and HUGHES, 1925, p.14, pl.2, fig.4.- BANDY, 1953, p.176, pl.25, fig.3.

Hypotype: Length=0.41 mm; width=0.35 mm; thickness=0.23 mm

Repository: GOD NIO Cat No.GOA-280

Genus CASSIDULINOIDES Cushman, 1927

***Cassidulinoides bradyi* (Norman)**

Plate 14, Figure 10

Cassidulina bradyi NORMAN, 1881, p.59, pl.54, fig.6-10.

Cassidulinoides bradyi (Norman) JONES, 1994, p.60, pl.54, figs.6-9.

Hypotype: Length=0.59 mm; maximum diameter=0.25 mm
Repository: GOD NIO Cat No.GOA-281

Genus GLOSOCASSIDULINA Voloshinova, 1960

***Globocassidulina oriangulata* Belford**
Plate 14, Figure 11

Globocassidulina oriangulata BELFORD, 1966, p.148, pl.25, figs.1-5.- HOTTINGER *et al.*, 1993, p.94, pl.115, figs.1-2.

Hypotype: Length=0.36 mm; width=0.32 mm; thickness=0.33 mm
Repository: GOD NIO Cat No.GOA-282

***Globocassidulina subglobosa* (Brady)**
Plate 14, Figure 12

Cassidulina subglobosa BRADY, 1881, p.60.- FRERICHS, 1970, p.136, tab.3.
Globocassidulina subglobosa (Brady) ZOBEL, 1973, p.19, pl.2, fig.50.- GUPTA and BHATTACHARJEE, 1989, p.130, pl.1, fig.4.- MATHUR and GUPTA, 1989, pp.120-126, tab.1.- HERMELIN and SHIMMIELD, 1990, pp.8-11, pl.3, fig.5, tab.4.- MAYENKAR, 1994, p.120, pl.13, figs.5a-b.- MAZUMDER *et al.*, 2003, p.8, tab.1.- RAI and SINGH, 2004, pp.415-429, tab.1.

Hypotype: Length=0.14 mm; width=0.11 mm; thickness=0.08 mm
Repository: GOD NIO Cat No.GOA-283

Genus ISLANDIELLA Nørvang, 1959

***Islandiella* sp.**
Plate 14, Figure 13

Remarks: Due to lack of enough number of specimens in the present study area, their nomenclature was kept open under the genus *Islandiella*. These specimens are characterized by a lenticular test, slightly carinate sinuous periphery, smooth and polished surface and an aperture with a toothplate.

Hypotype: Length=0.36 mm; width=0.31 mm; thickness=0.18 mm
Repository: GOD NIO Cat No.GOA-284

Superfamily TURRILINACEA Cushman, 1927

4.5.1.41 Family STAINFORTHIIDAE Reiss, 1963
Genus STAINFORTHIA Hofker, 1956

Stainforthia concava **(Hoglund)**
Plate 14, Figure 14

Virgulina concava HOGLUND, 1947, p.257.- RAO, 1971b, p.160, fig.41.
Stainforthia concava (Hoglund) HOFKER, 1956, p.908.- DANIELS, 1970, p.83, pl.6, fig.1.- KHARE, 1992, pp.129-130, pl.12, fig.6.- MAYENKAR, 1994, p.122, pl.13, fig.8a-b.- RAO, 1998, p.172, pl.41, figs.9-10.- RAO, 1998, p.172, pl.41, figs.9-10.- NIGAM and KHARE, 1999, p302, pl.4, fig.29.- CHATURVEDI, 2001, p.155, pl.9, fig.6, pl.11, fig.7.

Hypotype: Length=0.39 mm; maximum diameter=0.10 mm
Repository: GOD NIO Cat No.GOA-285

Superfamily BULIMINACEA Jones, 1875

4.5.1.42 Family SIPHOGERINOIDIDAE Saidova, 1981
Subfamily SIPHOGENERINOIDINAE Saidova, 1981
Genus HOPKINSINELLA Bermúdez and Fuenmayor, 1966

Hopkinsinella glabra **(Millett)**
Plate 14, Figure 15

Uvigerina auberiana d'Orbigny var. *glabra*, MILLETT, 1903, p.268, pl.5, figs.8-9.
Uvigerina glabra (Millett) MATOBA, 1970, p.63, pl.3, figs.35a-b.

Hopkinsina glabra (Millett) LUTZE, 1974, p.22, p.22, pl.6, fig.107.- SEIBOLD, 1975, p.188, pl.3, fig.1.- SEIBOLD and SEIBOLD, 1981, p.42, table 3a.- NIGAM, 1982, pp.126-127, pl.4, fig.17.

Hopkinsinella glabra (Millett) KHARE, 1992, pp.130-131, pl.12, fig.5.- HENRIQUES, 1999, pp.112-113, pl.15, fig.6.- MAYENKAR, 1994, p.123, pl.13, fig.9.- GANDHI, 1999, p.81, pl.6, fig.13.- CHATURVEDI, 2001, p.156, pl.9, fig.7.- GANDHI *et al.*, 2002, p.57, pl.II, fig.10.- MAZUMDER *et al.*, 2003, p.8, tab.1.- GANDHI and RAJAMANICKAM, 2004, p.293-304, tab.1,2.

Hypotype: Length=0.25 mm; maximum diameter=0.11 mm

Repository: GOD NIO Cat No.GOA-286

Genus LOXOSTOMINA Sellier de Civrieux, 1969

Loxostomina limbata **(Brady)**

Plate 14, Figure 16

Bolivina limbata BRADY 1881, v.21, p.27; 1884, v.9, p.419, pl.52, figs.26-28.- LUTZE, 1974, p.20, pl.5, figs.90-91.- SEIBOLD, 1975, pp.185-186.- SEIBOLD and SEIBOLD, 1981, p.43, tab.3b.- KHARE, 1992, p.121, pl.11, fig.5.

Bolivina limbata Brady var. *costulata* CUSHMAN, pub.no.313, vol.17, p.26, fig.2.

Loxostomum limbatum (Brady) var. *costulatum* (Cushman) CUSHMAN, 1942, p.35, pl.10.- *Loxostomum limbatum* (Brady) BHATIA, 1956, pl.1, fig.11.- GANAPATI and SATYAVATI, 1958, fig.102.- ROCHA and UBALDO, 1964a, p.8, pl.2, fig.9.- ANTONY, 1968, p.75, pl.4, figs.22a-b.- SAING, 1972, p.243, pl.3, fig.10.- RAO *et al.*, 1987, tab.1, pl.VIII, fig.5.- RAO, 1998, p.173, pl.42, figs.4-6.- KYAW and SAING, 2001, p.12, pl.III, fig.56.- KATHAL, 2002, p.443, pl.4, fig.11.- GANDHI *et al.*, 2002, p.57, pl.II, fig.8.- GANDHI and RAJAMANICKAM, 2004, p.293-304, tab.1,2.

Hypotype: Length=0.56 mm; width=0.21 mm; thickness=0.11 mm

Repository: GOD NIO Cat No.GOA-287

Genus RECTOBOLIVINA Cushman, 1927

Rectobolivina **sp.**

Plate 15, Figure 1

Remarks: Due to lack of sufficient specimens, their nomenclature was kept open under the genus *Rectobolivina.* These specimens are characterized by an elongated test oval in cross-section, very prominent median groove, biserial to uniserial chamber arrangement, slightly curved and depressed sutures and a broad circular aperture with a lip.

Hypotype: Length=0.42 mm; maximum diameter=0.10 mm
Repository: GOD NIO Cat No.GOA-288

Genus SAGRINELLA Saidova, 1975

***Sagrinella convallaria* (Millett)**
Plate 15, Figure 3

Bolivina convallaria MILLETT, 1900, p.97, pl.4, fig.6.
Brizalina (Pseudobrizalina) convallaria (Millett) ZWEIG-STRYKOWSKI and REISS, 1975, p.110, pl.8, figs.5-7.
Brizalina convallaria (Millett) BACCAERT, 1987, p.185, pl.74, figs.7-8 (not 6).
Sagrinella convallaria (Millett) HOTTINGER *et al.*, 1993, p.98, pl.122, figs.8-11.- RAO, 1998, p.175, pl.42, figs.12-14.

Hypotype: Length=0.21 mm; width=0.06 mm; thickness=0.02 mm
Repository: GOD NIO Cat No.GOA-289

***Sagrinella* cf. *S. guinai* Saidova**
Plate 15, Figure 2

Sagrinella guinai SAIDOVA, 1975, p.309.- LOEBLICH and TAPPAN, 1988, p.148, pl.567, fig.18.- HENRIQUES, 1993, p.113, pl.15, fig.5a-b.- MAYENKAR, 1994, p.123, pl.13, figs.10a-b.- CHATURVEDI, 2001, p.157, pl.9, fig.8.- MAZUMDER *et al.*, 2003, p.8, tab.1.

Hypotype: Length=0.33 mm; width=0.31 mm; thickness=0.09 mm
Repository: GOD NIO Cat No.GOA-290

4.5.1.43 Family BULIMINIDAE Jones, 1875
Genus BULIMINA b'Orbigny, 1826

***Bulimina aculeata* d'Orbigny**
Plate 15, Figure 4

Bulimina aculeata D'ORBIGNY, 1826, p.269, no.7.- FRERICHS, 1970, p.138, table 4.- ZOBEL, 1973, p.19, pl.2, fig.3.- MATHUR AND GUPTA, 1989, pp.120-126, pl.2, fig.5.- HERMELIN and SHIMMIELD, 1990, pp.8-11, pl.2, figs.9,13, table 4, - GUPTA, 1991, p.390, pl.1, fig.3; 1992, p.281, pl.1, figs.5-6, table 2.- HENRIQUES, 1993, p.114-115, pl.15, fig.9.- MAYENKAR, 1994, p.125, pl.14, fig.1.- CHATURVEDI, 2001, p.157, pl.9, fig.9.- MAZUMDER *et al.*, 2003, p.8, tab.1.- RAI and SINGH, 2004, pp.415-429, tab.1.- NAGENDRA *et al.*, 2004, pp.51-60, pl.1, fig.5, tab.1.

Hypotype: Length=1.26 mm; maximum diameter=0.54 mm
Repository: GOD NIO Cat No.GOA-291

***Bulimina alazanensis* Cushman**
Plate 15, Figure 5

Bulimina alazanensis CUSHMAN, 1927, p.161, pl.25, fig.4.- CUSHMAN, 1946, p.103, pl.24, figs.14-16.- RAI and SINGH, 2004, pp.415-429, tab.1.

Hypotype: Length=0.40 mm; maximum diameter=0.27 mm
Repository: GOD NIO Cat No.GOA-292

***Bulimina biserialis* Millett**
Plate 15, Figure 6

Bulimina marginata d'Orbigny var. *biserialis* MILLET, 1900, p.278, pl.2, figs.7 a-c.- SEIBOLD, 1975, pl.2, fig.3.
Bulimina marginata biserialis Millet LUTZE, 1974, pp.27-28. pl.6, figs.100-104.- SEIBOLD, 1975, p.187, pl.2, fig.3.
Bulimina biserialis Millet CHATURVEDI, 2001, p.158, pl.10, fig.4.

Hypotype: Length=0.34 mm; maximum diameter=0.17 mm
Repository: GOD NIO Cat No.GOA-293

Bulimina exilis **Brady**

Plate 15, Figure 7

Bulimina elegans d'Orbigny var. *exilis* BRADY, 1884, p.399, pl.50, figs.5-6.

Bulimina exilis Brady CUSHMAN and PARKER, 1940, p.11, pl.2, figs.18-21.- NIGAM *et al.*, 1979, p.245; 1992b, p.536, table 1.- SETTY and NIGAM, 1980b, p.421.- NIGAM and SARUPRIA, 1981, p.179.- NIGAM and THIEDE, 1983, p.126, table 3.- SETTY *et al.*, 1984, p.50, table 1.- KHARE, 1992, pp.132-133, pl.12, fig.8.- HENRIQUES, 1993, pp.115-116, pl.15, fig.12.- MAYENKAR, 1994, p.126, pl.14, fig.3.- RAO, 1998, p.178, pl.44, fig.1.- NIGAM and KHARE, 1999, p.302, pl.4, fig.31.- NIGAM and CHATURVEDI, 2000, p.134.- CHATURVEDI, 2001, p.159, pl.8, fig.3, pl.10, fig.1.- MAZUMDER *et al.*, 2003, p.8, tab.1.

Hypotype: Length=0.23 mm; maximum diameter=0.09 mm

Repository: GOD NIO Cat No.GOA-294

Bulimina gibba **Fornasini**

Plate 15, Figure 8

Bulimina gibba FORNASINI, 1901, p.378, pl.10, figs.32,34.- CUSHMAN and PARKER, 1940, p.48; 1946, p.125, pl.29, figs.1-5.- BARKER, 1960, p.102, pl.50, figs.1-4.- CHATURVEDI, 2001, p.159, pl.10, fig.2.

Hypotype: Length=0.28 mm; maximum diameter=0.16 mm

Repository: GOD NIO Cat No.GOA-295

Bulimina marginata **d'Orbigny**

Plate 15, Figure 9

Bulimina marginata D'ORBIGNY, 1826, p.269, pl.12, figs.1-12., - BHATIA, 1956, p.20, pl.1, fig.4.- SETHULEKSHMI AMMA, 1958, p.44, pl.2, figs.66a-b.- ANTONY, 1968, p.67, pl.4, fig.11.- FRERICHS, 1970, pp.135-139, table 2-4.- RAO, 1970b, p.266. pl.5, fig.51; 1971b, p.159.- VEDANTAM and RAO, 1970, p.329, table 3.- RAO and RAO, 1978, p.426.- NIGAM *et al.*, 1979, p.245; 1992b, p.536, pl.1, table 1.- RAO *et al.* 1979, p.358, table 3.- SETTY and NIGAM, 1980b, p.421.- SEIBOLD and SEIBOLD, 1981, p.50, table 11b.-

VENKATACHALAPATHY and SHAREEF, 1981, p.44.- NARAPPA *et al.*, 1982, p.221.- NIGAM, 1983, pp.121-123, pl.4, fig.15.- NIGAM and THIEDE, 1983, p.126, table 3.- NIGAM, 1986, p.424, table 1.- RAO *et al.*, 1987, p.167, pl.4, fig.20.- SHAREEF AND VENKATACHALAPATHY, 1987b, p.189.- NAIDU *et al.*, 1989, p.680, table 1.- KHARE, 1992, p.133, pl.12, FIG.9.- HENRIQUES, 1993, pp.116-117, pl.16, figs.1a0-b.- MAYENKAR, 1994, p.126, pl.14, fig.4.- RAO, 1998, p.178-179, pl.44, fig.3.- NIGAM and KHARE, 1999, p.302, pl.5, fig.1.- NIGAM and CHATURVEDI, 2000, p.134.- CHATURVEDI, 2001, p.159, pl.10, fig.3.- KYAW and SAING, 2001, p.12, pl.I, fig.11.- MAZUMDER *et al.*, 2003, p.8, tab.1.

Hypotype: Length=0.23 mm; maximum diameter=0.16 mm
Repository: GOD NIO Cat No.GOA-296

Bulimina mexicana **Cushman**
Plate 15, Figure 10

Bulimina inflata Seguenza var. *mexicana* CUSHMAN, 1922, p.95, pl.21, fig.2.
Bulimina striata d'Orbigny var. *mexicana* CUSHMAN and PARKER, 1940, p.16, pl.3, fig.9.- CUSHMAN, 1946, p.118, pl.28, fig.4.
Bulimina mexicana Cushman JONES, 1994, p.51, figs.10-13.

Hypotype: Length=0.32 mm; maximum diameter=0.28 mm
Repository: GOD NIO Cat No.GOA-297

Genus GLOBOBULIMINA Cushman, 1927

Globobulimina* cf. *G. pacifica **Cushman**
Plate 15, Figure 11

Globobulimina pacifica CUSHMAN, 1927, p.67, pl.12, fig.12.- MATHUR and GUPTA, 1989, p.123.- KHARE, 1992, p.134, pl.12, fig.11.- MAYENKAR, 1994, p.128, pl.14, fig.6.

Hypotype: Length=1.09 mm; maximum diameter=0.70 mm
Repository: GOD NIO Cat No.GOA-298

Genus PRAEGLOBOBULIMINA Hofker, 1951

Praeglobobulimina ovata **(d'Orbigny)**
Plate 15, Figure 12

Bulimina ovata D'ORBIGNY, 1846, p.185, pl.11, figs.13-14.- ANTONY, 1968, p.67, pl.4, fig.12.
Globobulimina ovata (d'Orbigny) RAO, 1998, 179, pl.44, fig.4.
Praeglobobulimina ovata (d'Orbigny) JONES, 1994, p.54, pl50, fig.13.

Hypotype: Length=1.93 mm; maximum diameter=1.25 mm
Repository: GOD NIO Cat No.GOA-299

***Praeglobobulimina pupoides* (d'Orbigny)**
Plate 15, Figure 13

Bulimina pupoides D'ORBIGNY, 1846, p.185, pl.11, figs.11-12.- MAYENKAR, 1994, p.127, pl.14, fig.5a-b.- MAZUMDER *et al.*, 2003, p.8, tab.1.
Praeglobobulimina pupoides (d'Orbigny) JONES, 1994, p.55, pl.50, figs.14-15.

Hypotype: Length=1.41 mm; maximum diameter=1.23 mm
Repository: GOD NIO Cat No.GOA-300

4.5.1.44 Family BULIMINELLIDAE Hofker, 1951
Genus BULIMINELLA Cushman, 1911

***Buliminella* cf. *B. milletti* Cushman**
Plate 15, Figure 14

Buliminella milletti CUSHMAN, 1933a, p.78, pl.8, figs.5-6.- CUSHMAN, 1946, p.69, pl.17, figs.20-21.

Hypotype: Length=0.18 mm; maximum diameter=0.11 mm
Repository: GOD NIO Cat No.GOA-301

4.5.1.45 Family UVIGERINIDAE Haeckel, 1894
Subfamily UVIGERININAE Haeckel, 1894
Genus NEOUVIGERINA Thalmann, 1952

***Neouvigerina ampullacea* (Brady)**
Plate 15, Figure 16

Uvigerina asperula var. ampullacea BRADY, 1884, p.579, pl.75, figs.10-11.
Uvigerina ampullacea (Brady) CUSHMAN *et al.*, 1954, p.355, pl.84, fig.19.- GANAPATI and SATYAVATI, 1958, p.109, pl.4, fig.103, - ANTONY, 1968, p.78, pl.5, fig.9.- RAO, 1971b, p.160, fig.47.- KYAW and SAING, 2001, p.12, pl.III, fig.53.
Neouvigerina ampullacea (Brady) HOFKER, 1951, pp.208-212, figs.136-138.- SAING, 1972, p.226, pl.3, fig.4.- GUPTA and SRINIVASN, 1990, p.82.- KHARE, 1992, pp.136-137, pl.12, fig.14.- HENRIQUES, 1993, pp.118-119, pl.16, fig.5.- MAYENKAR, 1994, pp.129-130, pl.14, fig.9.- CHATURVEDI, 2001, p.160, pl.10, fig.5.- MAZUMDER *et al.*, 2003, p.8, tab.1.

Hypotype: Length=0.53 mm; maximum diameter=0.19 mm
Repository: GOD NIO Cat No.GOA-302

***Neouvigerina interrupta* Brady**
Plate 15, Figure 17

Neouvigerina interupta BRADY, 1879, p.60, pl.8, figs.17-18.- HAIG, 1993, p.170, pl.4, figs.1-3 - RAO, 1998, p.180, pl.44, figs.5-6.- CHATURVEDI, 2001, p.161, pl.10, fig.6.

Hypotype: Length=0.45 mm; maximum diameter=0.16 mm
Repository: GOD NIO Cat No.GOA-303

Genus SIPHOUVIGERINA Parr, 1950

***Siphouvigerina porrecta* (Brady)**
Plate 15, Figure 18

Uvigerina porrecta BRADY, 1879, v.19, p.274, pl.8, figs.15-16.- SETHULEKSHMI AMMA, 1958, p.51, pl.8, fig.76.- ANTONY, 1968, p.79, pl.5, figs.11a-b.- RAO *et al.*, 1987, p.167, pl.4, fig.22.- KYAW and SAING, 2001, p.12, pl.III, fig.54.- RAI and SINGH, 2004, pp.415-429, tab.1.
Neouvigerina porrecta (Brady) HOFKER, 1951, pp.213-216, figs.140-142.- NAIDU *et al.*, 1989, p.680, tab.1.- SEIBOLD and SEIBOLD, 1981, p.37.

Siphouvigerina porrecta (Brady) MATHUR and GUPTA, 1989, pp.120-126, tab.1.- KHARE, 1992, p.137, pl.12, fig.15.- HENRIQUES, 1993, p.119, pl.16, figs.6a-b.- MAYENKAR, 1994, p.130, pl.14, figs.10a-b.- RAO, 1998, p.180, pl.44, fig.7-8.- MAZUMDER *et al.*, 2003, p.8, tab.1.

Hypotype: Length=0.30 mm; maximum diameter=0.15 mm
Repository: GOD NIO Cat No.GOA-304

Genus UVIGERINA d'Orbigny, 1826

***Uvigerina aculeata* d'Orbigny**
Plate 15, Figure 15

Uvigerina aculeata D'ORBIGNY, 1846, p.191, pl.11, fig.27-28.- BOLTOVSKOY, 1978, p.171, pl.VIII, figs.2-3.- JONES, 1994, p.86, pl.75, figs.1-3.

Hypotype: Length=0.41 mm; maximum diameter=0.31 mm
Repository: GOD NIO Cat No.GOA-305

***Uvigerina asperula* Czjzek**
Plate 15, Figure 19

Uvigerina asperula CZJZEK, 1848, p.146, pl.13, figs.14-15.- MAYENKAR, 1994, p.131, pl.15, fig.1.- MAZUMDER *et al.*, 2003, p.8, tab.1.

Hypotype: Length=0.51 mm; maximum diameter=0.23 mm
Repository: GOD NIO Cat No.GOA-306

***Uvigerina* cf. *U. auberiana* d'Orbigny**
Plate 15, Figure 20

Uvigerina auberiana D'ORBIGNY, 1839, p.106, pl.2, figs.23-24.- FRERICHS, 1970, pp.138-139, tab.4.- ZOBEL, 1973, p.16, pl.1, figs.64,66, p.19, pl.2, fig.19.- MATHUR and GUPTA, 1989, p.118, pl.3, fig.4.- KHARE, 1992, p.138, pl.13, figs.1a-b.- MAYENKAR, 1994, p.131, pl.14, figs.11a-b.- MAZUMDER *et al.*, 2003, p.8, tab.1.

Hypotype: Length=0.31 mm; maximum diameter=0.25 mm
Repository: GOD NIO Cat No.GOA-307

Uvigerina bassensis **Parr**
Plate 15, Figure 21

Uvigerina bassensis PARR, 1950, v.5, pt.6, p.340, pl.12, figs.19-20. RAO, 1998, p.181, pl.44, fig.9.

Hypotype: Length=0.39 mm; maximum diameter=0.19 mm
Repository: GOD NIO Cat No.GOA-308

Uvigerina bifurcata **d'Orbigny**
Plate 15, Figure 22

Uvigerina bifurcata D'ORBIGNY, 1839, p.53, pl.7, fig.17.- BOLTOVSKOY, 1959, pp.473-481, pl.2.

Hypotype: Length=0.38 mm; maximum diameter=0.18 mm
Repository: GOD NIO Cat No.GOA-309

Uvigerina brunnensis **Karrer**
Plate 15, Figure 23

Uvigerina brunnensis KARRER, 1877, p.385, pl.17b, fig.39.

Hypotype: Length=0.54 mm; maximum diameter=0.22 mm
Repository: GOD NIO Cat No.GOA-310

Uvigerina canariensis **d'Orbigny**
Plate 15, Figure 24

Uvigerina canariensis D'ORBIGNY, 1839, p.138, pl.1, figs.25-27.- BRADY, 1884, p.523, pl.74, figs.1-3.- SETHULEKSHMI AMMA, 1958, p.50, pl.2, fig.75.- ANTONY, 1968, p.77, pl.5, fig.7.

Hypotype: Length=0.48 mm; maximum diameter=0.21 mm
Repository: GOD NIO Cat No.GOA-311

Uvigerina hollicki **Thalmann**
Plate 15, Figure 25

Uvigerina hollicki THALMANN, 1950, p.45.- BANDY, 1953, p.177, pl.25, fig.8.- JONES, 1994, p.85, pl.74, figs.4-7.

Hypotype: Length=0.41 mm; maximum diameter=0.20 mm
Repository: GOD NIO Cat No.GOA-312

Uvigerina mediterranea **Hofker**
Plate 15, Figure 26

Uvigerina mediterranea HOFKER, 1932, p.118, figs.32a-g.- HENRIQUES, 1993, p.121, pl.16, figs.9a-b.- MAYENKAR, 1994, p.131, pl.15, fig.2a-b.- JONES, 1994, p.86, pl.74, figs.11-12.- MAZUMDER *et al.*, 2003, p.8, tab.1.

Hypotype: Length=0.49 mm; maximum diameter=0.31 mm
Repository: GOD NIO Cat No.GOA-313

Uvigerina peregrina **Cushman**
Plate 15, Figure 27

Uvigerina peregrina CUSHMAN, 1923, p.166, pl.42, figs.7-10. ZOBEL, 1973, p.16, pl.1, fig.66.- MATHUR and GUPTA, 1989, pp.120-126, tab.1.- HERMELIN and SHIMMIELD, 1990, p.8-11, pl.2, fig.12, tab.4.- HENRIQUES, 1993, p.121, pl.16, fig.10.- MAYENKAR, 1994, p.132, pl.15, fig.3.0- RAO, 1998, p.181, pl.44, figs.10-11.- MAZUMDER *et al.*, 2003, p.8, tab.1.- RAI and SINGH, 2004, pp.415-429, tab.1.

Hypotype: Length=0.31 mm; maximum diameter=0.14 mm
Repository: GOD NIO Cat No.GOA-314

Uvigerina proboscidea **Schwager**
Plate 15, Figure 28

Uvigerina proboscidea SCHWAGER, 1866, p.250, pl.7, fig.96.- VEDANTAM and RAO, 1970, p.329, table 3.- RAO, 1971b, p.160, fig.48.- RAO *et al.*, 1979, p.359.- NARAPPA *et al.*, 1982, p.221.- NAIDU *et al.*, 1989, p.680, table 1.- KALADHAR *et al.*, 1990, p.72.- GUPTA, 1992, p.482, pl.1, fig.9, table 2.- KHARE, 1992, pp.139-140, pl.12, fig.16.- RAO, 1998, p.182, pl.45, figs.1-4.- NIGAM and KHARE, 1999, p.302, pl.5, fig.8.- CHATURVEDI, 2001, p.162, pl.10, fig.8.- GUPTA *et al.*, 2001, pp.4131-4134.- RAI and SINGH, 2004, pp.415-429, tab.1.- NAGENDRA *et al.*, 2004, pp.51-60, pl.3, fig.5.- KUMAR and SRINIVASAN, 2004, pp.299-312.

Hypotype: Length=0.80 mm; maximum diameter=0.48 mm
Repository: GOD NIO Cat No.GOA-315

***Uvigerina schwageri* Brady**
Plate 15, Figure 30

Uvigerina scwageri BRADY, 1884, p.575, pl.76, figs.8-10.- FRERICHS, 1970, p.146.- MATHUR and GUPTA, 1989, pp.120-126, tab.1,- MAYENKAR, 1994, p.132, pl.15, figs.4a-b.- MAZUMDER *et al.*, 2003, p.8, tab.1.

Hypotype: Length=0.62 mm; maximum diameter=0.34 mm
Repository: GOD NIO Cat No.GOA-316

***Uvigerina vadescens* Cushman**
Plate 15, Figure 29

Uvigerina proboscidea Schwager var. *vadescens* CUSHMAN, 1933a, p.85, pl.8, figs.14.

Remarks: Since the concept of keeping variety in the taxonomic name is no longer varied, this species was named as *Uvigerina vadescens*.

Hypotype: Length=0.32 mm; maximum diameter=0.13 mm
Repository: GOD NIO Cat No.GOA-317

***Uvigerina* sp. A**
Plate 15, Figure 31

Remarks: These specimens are resembled with *Uvigerina schwageri*, but the specimens under consideration have a narrower neck giving it a fusiform appearance.

Hypotype: Length=0.37 mm; maximum diameter=0.20 mm
Repository: GOD NIO Cat No.GOA-318

Uvigerina sp. B
Plate 15, Figure 32

Remarks: These specimens are also comparable to *Uvigerina scwageri*, but they are more slender than the latter. So their nomenclature has been kept open under the genus *Uvigerina*.

Hypotype: Length=0.40 mm; maximum diameter=0.17 mm
Repository: GOD NIO Cat No.GOA-319

Subfamily ANGULOGERININAE Galloway, 1933
Genus TRIFARINA Cushman, 1923

***Trifarina carinata* (Cushman)**
Plate 15, Figure 33

Angulogerina carinata CUSHMAN, 1927, p.159.- MATHUR and GUPTA, 1989, pp.120-126. tab.1.- RAO, 1998, p.183, pl.45, figs.9-10.
Trifarina carinata (Cushman) MURRAY, 1991, p.339.- MAYENKAR, 1994, p.134, pl.15, fig.7.- MAZUMDER *et al.*, 2003, p.8, tab.1.

Hypotype: Length=0.23 mm; maximum diameter=0.12 mm
Repository: GOD NIO Cat No.GOA-320

***Trifarina* sp.**
Plate 15, Figure 34

Remarks: Due to lack of enough number of specimens from the study area, the nomenclature of these specimens was kept open under the genus *Trifarina*. These specimens are characterized by an elongated test slightly tapering towards the trailing chambers, sharply triangular in cross-section. The sutures are slightly depressed and the aperture is rounded.

Hypotype: Length=0.47 mm; maximum diameter=0.19 mm
Repository: GOD NIO Cat No.GOA-321

4.5.1.46 Family REUSSELLIDAE Cushman, 1933
Genus REUSSELLA Galloway, 1933

Reussella laevigata **Cushman**
Plate 15, Figure 35

Reussella spinulosa (Reuss) var. *laevigata* CUSHMAN, 1945, p.34, pl.6, fig.10.

Remarks: It has been described and illustrated by Cushman (1945) as *Reussella spinulosa* var. *laevigata*. Since in modern taxonomic system, the variety of any species is considered as new species under the same genus, these has been given the name *Reussella laevigata*.

Hypotype: Length=0.38 mm; width=0.30 mm; thickness=0.17 mm
Repository: GOD NIO Cat No.GOA-322

Reussella spinulosa **(Reuss)**
Plate 16, Figure 1

Verneuilina spinulosa REUSS, 1850, v.1, p.347, pl.47, figs.12a-c.
Reussella spinulosa (Reuss) CUSHMAN, 1942, p.40, pl.1, figs.5-8. SETHULEKSHMI AMMA, 1958, p.48, pl.2, fig.73.- ANTONY, 1968, p.83, pl.5, fig.16.- VENKATACHALAPATHY and SHAREEF, 1981, p.44.- RAO *et al.*, 1985, p.76, tab.1.- RAO *et al.*, 1987, p.167, pl.4, fig.21.- SHAREEF and VENKATACHALAPATHY, 1987b, p.189.- RAO, 1998, p.186, pl.45, fig.13.- KYAW and SAING, 2001, p.12, pl.I, fig.14.- KUMAR and SRINIVASAN, 2004, pp.299-312.

Hypotype: Length=0.41 mm; width=0.54 mm; thickness=0.22 mm
Repository: GOD NIO Cat No.GOA-323

Genus FURSENKOINA Loeblich and Tappan, 1961

***Fursenkoina bradyi* (Cushman)**

Plate 16, Figure 2

Virgulina subsquamosa BRADY (not Egger, 1857), 1884, p.415, pl.52, figs.9a-c.
Virgulina bradyi CUSHMAN, 1922, p.115, pl.24, fig.1.
Fursenkoina bradyi (Cushman) JONES, 1994, p.57, pl.52, fig.9.

Hypotype: Length=0.24 mm; maximum diameter=0.09 mm
Repository: GOD NIO Cat No.GOA-324

***Fursenkoina complanata* (Egger)**

Plate 16, Figure 3

Virgulina schreibersiana Czjzek var. *complanata* EGGER, 1893, p.292, pl.8, figs.91-92.
Virgulina complanata (Egger) CUSHMAN, 1937b, p.26, pl.4, figs.13-17.
Fursenkoina complanata (Egger) JONES, 1994, p.56, pl.52, figs.1-3.

Hypotype: Length=0.35 mm; maximum diameter=0.11 mm
Repository: GOD NIO Cat No.GOA-325

***Fursenkoina pontoni* (Cushman)**

Plate 16, Figure 4

Virgulina pontoni CUSHMAN, 1932b, p.17, pl.3, fig.7.
Fursenkoina pontoni (CUSHMAN) SETTY, 1976a, p.229.- NIGAM *et al.*, 1979, p.245.- SETTY and NIGAM, 1980b, p.421.- NIGAM, 1982, pp.210-211, pl.7, fig.5.- NIGAM and THIEDE, 1983, p.126, table 3.- KHARE, 1992, p.145, pl.13, fig.8.- HENRIQUES, 1993, p.125, pl.17, fig.7.- MAYENKAR, 1994, p.135, pl.15, fig.9.- NIGAM and KHARE, 1999, p.302, pl.5, fig.16.- CHATURVEDI, 2001, p.165, pl.11, fig.4.- MAZUMDER *et al.*, 2003, p.8, tab.1.

Hypotype: Length=0.39 mm; maximum diameter=0.12 mm
Repository: GOD NIO Cat No.GOA-326

***Fursenkoina* cf. *F. schreibersiana* (Czjzek)**
Plate16, Figure 5

Virgulina schreibersiana CZJZEK, 1848, p.147, pl.13, figs. 18-21.
Fursenkoina schreibersiana (Czjzek) HAYWARD *et al.*, 1999, pl.9, fig.29.- RAO, 1998, p.189, pl.13, figs.18-21.

Hypotype: Length=0.26 mm; maximum diameter=0.11 mm
Repository: GOD NIO Cat No.GOA-327

***Fursenkoina texturata* (Brady)**
Plate 16, Figure 6

Virgulina texturata BRADY, 1884, p.415, pl.52, figs.6a-b.
Fursenkoina texturata (Brady) JONES, 1994, p.56, pl.52, figs.6, 14-17.- RAI and SINGH, 2004, pp.415-429, tab.1.

Hypotype: Length=0.25 mm; maximum diameter=0.13 mm
Repository: GOD NIO Cat No.GOA-328

Genus SIGMAVIRGULINA Loeblich and Tappan, 1957

***Sigmavirgulina tortuosa* (Brady)**
Plate 16, Figure 7

Bolivina tortuasa BRADY, 1881, p.57; 1884, v.9, p.420, pl.52, figs.31-32.- STHULEKSHMI AMMA, 1958, pl.46, fig.70.- RAO *et al.*, 1987, tab.1, pl.IV, figs.18-19.
Sigmavirgulina tortuosa (Brady) LOEBLICH and TAPPAN, 1964, p.733, fig.601,1-3.- MANIVANNAN *et* al, 1996, p.383.- RAO, 1998, p.190, pl.46, figs.12-13.- KATHAL, 2002, p.442, pl.3, figs.3a-c.- GANDHI and RAJAMANICKAM, 2004, p.293-304, tab.1,2.

Hypotype: Length=0.32 mm; width=0.21 mm; thickness=0.12 mm
Repository: GOD NIO Cat No.GOA-329

4.5.1.47 Family VIRGULINELLIDAE Loeblich and Tappan, 1984
Genus VIRGULINELLA Cushman, 1932

Virgulinella pertusa **(Reuss)**
Plate 16, Figure 8

Virgulina pertusa REUSS, 1861, p.362, pl.2, figs.16a-b.
Virgulinella pertusa (Reuss) CUSHMAN, 1932 b, p.22, pl.3, figs.16a-b.- NIGAM *et al.*, 1979, p.245.- SETTY and NIGAM, 1980a, p.421; 1980b, p.433.- NIGAM and SARUPRIA, 1981, p.180, appendix 1.- NIGAM and SETTY, 1982, p.60.- NIGAM and THIEDE, 1983, p.126, table 3.- SETTY *et al.*, 1984, p.50, table 1.- KHARE, 1992, p.145, pl.14, fig.1.- HENRIQUES, 1993, p.126, pl.17, fig.8.- MAYENKAR, 1994, pp.136-137, pl.15, fig.12.- NIGAM and KHARE, 1999, p.302, pl.5, fig.17b.- CHATURVEDI, 2001, p.166, pl.11, fig.5.- MAZUMDER *et al.*, 2003, p.8, tab.1.

Hypotype: Length=0.31 mm; maximum diameter=0.12 mm
Repository: GOD NIO Cat No.GOA-330

Superfamily PLEUROSTOMELLACEA Reuss, 1860

4.5.1.48 Family PLEUROSTOMELLIDAE Reuss, 1860
Subfamily PLEUROSTOMELLINAE Reuss, 1860
Genus PLEUROSTOMELLA Reuss, 1860

***Pleurostomella* sp.**
Plate 16, Figure 9

Remarks: These specimens have a very rare occurrence in the present study area, and thus their nomenclature was kept open under the genus *Pleurostomella*. Elongated tests with circular cross-sections, biserial to uniserially-arranged chambers, oblique depressed sutures, a rounded proloculous and a terminal aperture with a hood characterize these specimens.

Hypotype: Length=0.80 mm; maximum diameter=0.17 mm
Repository: GOD NIO Cat No.GOA-331

Superfamily STILOSTOMELLACEA Finley, 1947

4.5.1.49 Family STILOSTOMELLIDAE Finley, 1947
Genus ORTHOMORPHINA Stainforth, 1952

***Orthomorphina* aff. *O. parvula* (Todd)**
Plate 16, Figure 10

Orthomorphina parvula TODD, 1966, p.I29, pl.12, fig.4.

Hypotype: Length=0.31 mm; maximum diameter=0.09 mm
Repository: GOD NIO Cat No.GOA-332

Superfamily DISCORBACEA Ehrenberg, 1838

4.5.1.50 Family PLACENTULINIDAE Kasimova, Poroshina and Geodakchan, 1980
Subfamily ASHBROOKIINAE Loeblich and Tappan, 1984
Genus PATELLINELLA Cushman, 1928

***Patellinella inconspicua* (Brady)**
Plate 16, Figure 11

Textularia inconspicua BRADY, 1884, p.357, pl.42, fig.6.
Patellinella inconspicua (Brady) CUSHMAN, 1928, p.5.

Hypotype: Length=0.69 mm; width=0.92 mm; thickness=0.40 mm
Repository: GOD NIO Cat No.GOA-333

***Patellinella* sp.**
Plate 16, Figure 12

Remarks: These specimens are more trochospiral than *Patellinella inconspicua* and have a circular cross-section and a planer apertural face. Therefore, its nomenclature was kept open under the genus *Patellinella.*

Hypotype: Length=0.28 mm; width=0.29 mm; thickness=0.29 mm
Repository: GOD NIO Cat No.GOA-334

4.5.1.51 Family BAGGINIDAE Cushman, 1927
Subfamily BAGGININAE Cushman, 1927

Genus BAGGINA Cushman, 1926

***Baggina indica* (Cushman)**

Plate 16, Figure 13

Pulvinulina indica CUSHMAN, 1921, p.332.

Baggina indica (Cushman) GRAHAM and MILITANTE, 1959, p.91. pl.13, figs.17a-c.- JONES, 1994, p.105, pl.106, fig.6.- KYAW and SAING, 2001, p.14, pl.III, fig.67.

Hypotype: Length=0.24 mm; width=0.19 mm; thickness=0.11 mm

Repository: GOD NIO Cat No.GOA-335

***Baggina philippiensis* (Cushman)**

Plate 16, Figure 14

Pulvinula philippinensis CUSHMAN, 1921, v.4, p.331, pl.58, figs.2a-c.

Baggina philippinensis (Cushman) LEROY, 1941, p.84.- MATHUR and GUPTA, 1989, p.121.- HENRIQUES, 1993, p.127, pl.17, figs.10a-b.- MAYENKAR, 1994, p.137, pl.15, fig.13a-b.- RAO, 1998, p.191, pl.47, figs.3-4.- MAZUMDER *et al.*, 2003, p.8, tab.1.

Hypotype: Length=0.50 mm; width=0.40 mm; thickness=0.24 mm

Repository: GOD NIO Cat No.GOA-336

Genus CANCRIS de Montfort, 1808

***Cancris auricula* (Fichtel and Moll)**

Plate 16, Figure 15

Nautilus auriculus var. *alpha* FICHTEL and MOLL, 1798 p.108, pl.20, figs.a-c ; var *beta*, p.110, pl.20, figs.d-f.

Cancris auriculus (Fichtel and Moll) LEROY, 1941, p.117, pl.3, figs.7-9, 16-18.- ANTONY, 1968, pp.97-98, pl.7, figs.5a-b.- ZOBEL, 1973, p.16, pl.1, figs.18-20.- SEIBOLD and SEIBOLD, 1981, p.12, table 3a.- VENKATACHALAPATHY and SHAREEF, 1981, p.44.- NIGAM, 1982, pp.129-130, pl.4, fig.18.- SETTY and NIGAM, 1984, p.434, pl.33, fig.22.- SHAREEF and VENKATACHALAPATHY, 1987b, p.189, table 1; 1988, p.435, pl.3, figs.9a-b.- KYAW and SAING, 2001, p.14, pl.III, fig.68.

Cancris auricula (Fichtel and Moll, 1798) - CUSHMAN, 1927, p.164, pl.5, fig.10.- BHATIA, 1956, p.23, pl.5, figs.5a-b.- RAO, 1971b, p.161, fig.52.- BHALLA and RAGHAV, 1980, p.289, pl.1.- SEIBOLD, 1975, p.190. pl.4, figs.1a-b.- BHALLA and NIGAM, 1979, p.239, pl.1.- NIGAM *et al.*, 1979, p.245.- SETTY and NIGAM, 1980b, p.421.- NIGAM and SARUPRIA, 1981, p.179, appendix 1.- NARAPPA *et al.*, 1982, p.221.- NIGAM and THEIDE, 1983, p.126, table 3.- BHALLA and LAL, 1985, P.430.- KHARE, 1992, pp.148-149, pl.13, figs.10a-b.- MAYENKAR, 1994, p.138, pl.15, figs.14a-b- RAO, 1998, p.192, pl.47, figs.5-6.- GANDHI, 1999, p.84-85, pl.7, fig.1.- NIGAM and KHARE, 1999, p.302, pl.5, figs.18a-b.- NIGAM and CHATURVEDI, 2000, p.134.- CHATURVEDI, 2001, p.167, pl.11, fig.8.- GANDHI *et al.*, 2002, p.58, pl.II, fig.12.- MAZUMDER *et al.*, 2003, p.8, tab.1.- GANDHI and RAJAMANICKAM, 2004, p.293-304, tab.1,2.

Remarks: This species has been referred to as *Cancris auriculus* as well as *Cancris auricula.* Since the latter has been used in most of the recent literature from Arabian Sea as well as Bay of Bengal, the specimens from off Goa were also named the same.

Hypotype: Length=0.28 mm; width=0.22 mm; thickness=0.15 mm
Repository: GOD NIO Cat No.GOA-337

Cancris oblonga **(Williamson)**
Plate 16, Figure 16

Rotalia oblonga WILLIAMSON, 1858, p.51, pl.4, figs.98-100.
Cancris oblonga (Williamson) PARKER, 1954, p.532, pl.10, figs.13-14.- VEDANTAM and RAO, 1970, p.329, table3.- REDDY and RAO, 1980, p.168, pl.4, figs.1-2.- MATHUR and GUPTA, 1989, p.123.- HENRIQUES, 1993, pp.128-129, pl.18, figs.1a-b.- MAYENKAR, 1994, p.139, pl.16, figs.2a-b.- CHATURVEDI, 2001, p.167, pl.11, fig.9.- MAZUMDER *et al.*, 2003, p.8, tab.1.- KUMAR and SRINIVASAN, 2004, pp.299-312.

Hypotype: Length=0.35 mm; width=0.27 mm; thickness=0.16 mm
Repository: GOD NIO Cat No.GOA-338

Cancris sagra **(d'Orbigny)**
Plate 16, Figure 17

Rotalina (Rotalina) sagra D'ORBIGNY, 1839, p.77, pl.5, figs.13-15.

Cancris sagra (d'Orbigny) CUSHMAN and TODD, 1942, p.77, pl.19, figs.3-7.- RAO and RAO, 1974, p.404, tab.7, pl.2, fig.6.

Hypotype: Length=0.42 mm.; width=0.33 mm; maximum thickness=0.20 mm.
Repository: GOD NIO Cat No.GOA-339

***Cancris* sp.**
Plate 16, Figure 18

Remarks: These specimens are comparable with *Cancris sagra*, but these have a width equal to the length and their last chamber is flattened, which differentiate these from *C.sagra.*

Hypotype: Length=0.41 mm.; width=0.41 mm; maximum thickness=0.20 mm.
Repository: GOD NIO Cat No.GOA-340

4.5.1.52 Family EPONIDIDAE Hofker, 1951
Subfamily EPONODINAE Hofker, 1951
Genus EPONIDES de Montfort, 1808

***Eponides repandus* (Fichtel and Moll)**
Plate 17, Figure 1

Nautilus repandus FICHTEL and MOLL, 1798, p.34, pl.3, figs.a-d.

Eponides repandus (FICHTEL and MOLL) CUSHMAN, 1931, p.49, pl.10, figs.7a-c.- KURIAN, 1953, p.756.- CHAUDHURY and BISWAS, 1954, p.81.- SETHULEKSHMI AMMA, 1958, p.72, pl.3, figs.111a-b.- ROCHA and UBALDO, 1964a, p.414, pl.2, figs.10a-b; 1964b, p.647, pl.1, figs.8-9.- RAO, 1971b, p. 160. figs.51.- ZOBEL, 1973, p.16, pl.1, fig.59.- REDDY *et al.*, 1974, p.19.- VENKATACHALAPATHY and SHAREEF, 1976, pp.375-378, pl.1, figs.4a-c; 1981, p.44.- BHALLA and NIGAM, 1979, p.239; 1988, p.518, table 1.- NIGAM *et al.*, 1979, p.246, BHALLA and RAGHAV, 1980, p. 289, table1.- REDDY and RAO, 1980, p.169, pl.5, figs, 11-12.- SETTY and NIGAM, 1980b, p.421; 1984, p.434, pl.33, fig.14.- NIGAM, 1982, pp.187-188, pl.7, fig.1.- NIGAM and THIEDE, 1983, p.126, table 3.-NIGAM, 1984, p.423; 1986, p.424, table 1.- SETTY *et al.*, 1984, p.50, table 1.-

SRIVASTAVA *et al.*, 1984, p.36, - RAO *et al.*, 1985, p.76, table 1; 1987, p.169, pl.6, figs. 26-28.- SHAREEF and VENKATACHALAPATHY, 1987b, p.191; 1988, p.435, pl.3, fig.10a-b.- KHARE, 1992, pp.149-150, pl.14, figs.2a-b.- HENRIQUES, 1993, p.130, pl.18, figs.5a-c.- MAYENKAR, 1994, pp.140-141, pl.17, fig.1a-b.- NIGAM and KHARE, 1999, p.302, pl.5, figs.20a-b.- CHATURVEDI, 2001, p.168, pl.11, fig.10.- KYAW and SAING, 2001, p.15, pl.III, fig.83.- MAZUMDER *et al.*, 2003, p.8, tab.1.

Hypotype: Length=0.33 mm; width=0.34 mm; maximum thickness=0.23 mm.
Repository: GOD NIO Cat No.GOA-341

***Eponides* sp.**
Plate 17, Figure 2

Remarks: These specimens resemble *Eponides repandus*. However they are smaller, have a lesser thickness and the outer margin is slightly lobate. Due to these differences their nomenclature has been kept open under the genus *Eponides*.

Hypotype: Length=0.15 mm; width=0.15 mm; maximum thickness=0.07 mm.
Repository: GOD NIO Cat No.GOA-342

4.5.1.53 Family DISCORBIDAE Ehrenberg, 1838
Genus NEOEPONIDES Reiss, 1960

Neoeponides praecinctus **(Karrer)**
Plate 17, Figure 3

Rotalia praecincta KARRER, 1868, p.189, pl.5, fig.7.
Eponides praecinctus (Karrer) BHATIA, 1956, p.16, pl.5, fig.2.- SRIVASTAVA *et al.*, 1984, pp.36-37, pl.I, fig.9.
Neoeponides praecinctus (Karrer) JONES, 1994, p.99, pl.95, fig.1-3.

Hypotype: Length=0.44 mm; width=0.43 mm; maximum thickness=0.25 mm.
Repository: GOD NIO Cat No.GOA-343

4.5.1.54 Family ROSALINIDAE Reiss, 1963

Genus NEOCONORBINA Hofker, 1951

Neoconorbina parkerae **(Natland)**

Plate 17, Figure 4

Discorbis parkeri NATLAND, 1950, p.27, pl.6, fig.11.

Rosalina parkerae (Natland) PARKER, 1954, p.525, pl.8, figs.24-25.

Neoconorbina parkerae (Natland) LANKFORD and PHLEGER, 1973, p.123, pl.4, fig.24.

Hypotype: Length=0.24 mm; width=0.20 mm; maximum thickness=0.11 mm.

Repository: GOD NIO Cat No.GOA-344

Neoconorbina terquemi **(Rzehak)**

Plate 17, Figure 5

Discorbina terquemi RZEHAK, 1888, p.228.

Neoconorbina terquemi (Rzehak) LANKFORD and PHLEGER, 1973, p.123, pl.4, fig.23.- RAO, 1998, p.198, pl.49, fig.3-4.

Hypotype: Length=0.27 mm; width=0.26 mm; maximum thickness=0.09 mm.

Repository: GOD NIO Cat No.GOA-345

Genus ROSALINA d'Orbigny, 1826

Rosalina globularis **d'Orbigny**

Plate 17, Figure 6

Rosalina globularis - D'ORBIGNY, 1826, p.271, pl.13, figs.1-4.

Discorbis globularis (d'Orbigny) - CUSHMAN, 1910-17, p.11, pl.9, fig.4.- RASHEED, 1969-70b, p.152, pl.1, figs.5-6.- RAO, 1970b, p.271, fig.63.

Rosalina globularis (d'Orbigny) - RAGOTHAMAN and KUMAR, 1985, p.108, pl.2, figs.6-7.- RAGOTHAMAN and MANIVANNAN, 1985, pp.133- 134, pl.2, fig.21.- RAO *et al.*, 1987, tab.1, pl.V, figs.4-6.- KUMAR, 1988, p.103, pl.9, figs.9-10.- RAO, 1998, pp.174-175, pl.42, figs.10-11.- GANDHI, 1999, p.85, pl.7, fig.2.- CHATURVEDI, 2001, p.172, pl.12, fig.2.- GANDHI and RAJAMANICKAM, 2004, p.293-304, tab.1,2.

Hypotype: Length=0.21 mm; width=0.21 mm; maximum thickness=0.09 mm.
Repository: GOD NIO Cat No.GOA-346

Rosalina **sp.**
Plate 17, Figure 7

Remarks: These specimens are similar to *Rosalina bradyi.* These are identified upto the generic level using Treatise (1998), but as they would not match with any species listed under this genus their nomenclature was kept open. These specimens are characterized by a concavoconvex plate.

Hypotype: Length=0.42 mm; width=0.35 mm; maximum thickness=0.22 mm.
Repository: GOD NIO Cat No.GOA-347

Superfamily GLABRATELLACEA Loeblich and Tappan, 1964

4.5.1.55 Family GLABRATELLIDAE Loeblich and Tappan, 1964
Genus MURRAYINELLA Farías, 1977

***Murrayinella* cf. *M. murrayi* (Heron-Allen and Earland)**
Plate 17, Figure 8

Rotalia murrayi HERON-ALLEN and EARLAND, 1915, p.721.
Murrayinella murrayi (Heron-Allen and Earland) LOEBLICh and TAPPAN, 1988, p.568, pl.621, fig.12-17.

Hypotype: Length=0.41 mm; width=0.34 mm; maximum thickness=0.24 mm.
Repository: GOD NIO Cat No.GOA-348

Superfamily DISCORBINELLACEA Sigal, 1952

4.5.1.56 Family PARRELLOIDIDAE Hofker, 1956
Genus CIBICIDOIDES Thalmann, 1939

***Cibicidoides bradii* (Tolmachoff)**

Plate 17, Figure 9

Planulina bradii TOLMACHOFF, 1934, p.333, pl.41, fig.32-34.

Remarks: Barker (1960) used the name *Planulina bradii* for the same species. But Jones (1994) clubbed this to *Cibicidoides wuellerstorfi*. The specimens from off Goa are quite different from *C. wuellerstorfi*. Moreover, their generic characters (*viz.* lenticular test, carinate periphery, coarselt perforation on spiral side *etc.*) match with *Cibicidoides* rather than *Planulina*. Hence they have been named *Cibicidoides bradii.*

Hypotype: Length=0.41 mm; width=0.35 mm; maximum thickness=0.23 mm.

Repository: GOD NIO Cat No.GOA-349

***Cibicidoides cicatricosus* (Schwager)**

Plate 17, Figure 10

Anomalina cicatricosa SCHWAGER, 1866, p.260, pl.7, figs.4,108.

Cibicidoides cicatricosus (Schwager) MORKHOVEN *et al.*, 1986.- JONES, 1994, p.98, pl.94, fig.8.

Cibicides cicatricosus (Schwager) RAI and SINGH, 2004, pp.415-429, tab.1.

Hypotype: Length=0.34 mm; width=0.29 mm; thickness=0.18 mm.

Repository: GOD NIO Cat No.GOA-350

***Cibicidoides globulosus* (Chapman and Parr)**

Plate 17, Figure 11

Anomalina globulosa CHAPMAN and PARR, 1937, p.673, pl.XCIV, figs.4-5.

Cibicidoides globulosus (Chapman and Parr) JONES, 1994, p.98, pl.94, fig.4-5.

Hypotype: Length=0.34 mm; width=0.31 mm; thickness=0.19 mm.

Repository: GOD NIO Cat No.GOA-351

***Cibicidoides* cf. *C. kullenbergi* (Parker)**

Plate 18, Figure 1

Cibicides kullenbergi PARKER, 1953, p.49, pl.11, figs.7-8.- RAI and SINGH, 2004, pp.415-429, tab.1.
Cibicidoides kullenbergi (Parker) NAGENDRA *et al.*, 2004, pp.51-60, pl.2, figs.3a-b, tab.1.

Remarks: These specimens are almost similar to *Cibicidoides kullenbergi*, but they have comparatively larger pores at the base of last whorl in dorsal view. Hence it has been named as *Cibicidoides* cf. *C. kullenbergi.*

Hypotype: Length=0.41 mm; width=0.36 mm; thickness=0.20 mm.
Repository: GOD NIO Cat No.GOA-352

***Cibicidoides wuellerstorfi* (Schwager)**
Plate 18, Figure 3

Anomalina wuellerstorfi SCHWAGER,1866, p.258, pl.7, figs.105, 107.
Cibicides wuellerstorfi (Schwager) SRINIVASAN and SHARMA, 1980.- RAI and SINGH, 2004, pp.415-429, tab.1.
Cibicidoides wuellerstorfi (Schwager) JONES, 1994, p.98, pl.93, figs.9.- NAGENDRA *et al.*, 2004, pp.51-60, pl.2, figs.5a-b, tab.1.

Hypotype: Length=0.61 mm; width=0.51 mm; thickness=0.16 mm.
Repository: GOD NIO Cat No.GOA-353

4.5.1.57 Family PSEUDOPARRELLIDAE Voloshinova, 1952
Subfamily PSEUDOPARRELLINAE Voloshinova, 1952
Genus EPISTOMINELLA Husezima and Maruhasi, 1944

***Epistominella decorata* (Phleger and Parker)**
Plate 18, Figure 4

Pseudoparrella decorata PHLEGER and PARKER, 1951, p.28, pl.15, figs.4a-b, 5a-b.
Epistominella decorata (Phleger and Parker) PARKER, 1954, p.533, pl.10, figs.18-19.- MATHUR, 1989, p.113.

Hypotype: Length=0.29 mm; width=0.26 mm; thickness=0.15 mm.
Repository: GOD NIO Cat No.GOA-354

Epistominella exigua **(Brady)**

Plate 18, Figure 5

Pulvinulina exigua BRADY, 1884, p.696, pl.103, fig.13-14.

Epistominella exigua (Brady) PARKER, 1954, p.533, pl.10, figs.22-23.- RAI and SINGH, 2004, pp.415-429, tab.1.

Hypotype: Length=0.32 mm; width=0.27 mm; thickness=0.17 mm.

Repository: GOD NIO Cat No.GOA-355

Epistominella minuta **(Olsson)**

Plate 18, Figure 6

Pseudoparrella minuta OLSSON, 1960, p.40, pl.6, figs.7-9.

Epistominella minuta (Olsson) BOLTOVSKOY, 1980, pl.1, figs.26-28.

Hypotype: Length=0.38 mm; width=0.38 mm; thickness=0.15 mm.

Repository: GOD NIO Cat No.GOA-356

4.5.1.58 Family PLANULINOIDIDAE Saidova, 1981

Genus PLANULINOIDES Parr, 1941

Planulinoides **sp.**

Plate 18, Figure 7

Remarks: A flat trochospiral test with an ovate outline, elevated oblique sutures and an oval slit-like aperture characterize these specimens. Due to less number of these specimens their nomenclature has been kept open under the genus *Planulinoides*.

Hypotype: Length=0.22 mm; width=0.19 mm; thickness=0.05 mm.

Repository: GOD NIO Cat No.GOA-357

4.5.1.59 Family DISCORBINELLIDAE Sigal, 1952

Subfamily DISCORBINELLINAE Sigal, 1952

Genus LATICARININA Galloway and Wissler, 1927

***Laticarinina pauperata* (Parker and Jones)**

Plate 18, Figure 8-11

Pulvinulina repanda var. *menardii* subvar. *pauperata* PARKER and JONES, 1865, p.395, pl.16, figs.50-51.

Pulvinulina pauperata (Parker and Jones) BRADY, 1884, p.696, pl.104, figs.3-11.

Laticarinina pauperata (Parker and Jones) COLOM, 1956, p.179, pl.16, figs.1-3.- ROCHA and UBALDO, 1964c, p.124, pl.XIII, figs.1-2.- JONES, 1994, p.104, pl.104, figs.3-11.- RAI and SINGH, 2004, pp.415-429, tab.1.

Remarks: Four different types of *Laticarinina pauperata* have been recorded from the off Goa region. Type A has a smooth periphery, bulging chambers, opaque appearance and a large size. Type B too has a smooth periphery, but less bulging chambers, semi-transparent appearance and a more elongated shape. Similarly Type C has a smooth periphery, less bulging chambers, a transparent appearance along with more elongation in shape. However, Type D has a rough periphery, irregularly bulging chambers and an opaque appearance.

Hypotype: (Type A) Length=1.98 mm; width=1.62 mm

(Type B) Length=1.07 mm; width=0.87 mm

(Type C) Length=1.57 mm; width=0.97 mm

(Type D) Length=1.37 mm; width=0.94 mm

Repository: GOD NIO Cat No.GOA-358

Superfamily PLANORBULINACEA Schwager, 1877

4.5.1.60 Family PLANULINIDAE Bermúdez, 1952

Genus HYALINEA Hofker, 1951

***Hyalinea balthica* (Schroter)**

Plate 18, Figure 12

Nautilus balthicus SCHROTER, 1783, p.20.

Hyalinea balthica (Schroter) BARKER, 1960, p.230, pl.112, figs.1,2.- SETTY, 1974a, p.23, pl.1, figs.6-7.- NIGAM, 1982, p.1999, pl.7, fig.6.- GUPTA and BHATTACHARJEE, 1989, p.130, pl.1, fig.5.- MATHUR and GUPTA, 1989, pp.120-126, table 1.- HERMELIN and SHIMMIELD, 1990, pp.8-11, pl.2, figs.15-16, table 4.- HENRIQUES, 1993, p.134, pl.19, fig.6.- MAYENKAR, 1994, p.144, pl.17, fig.7.- CHATURVEDI, 2001, p.174, pl.12, fig.7.- MAZUMDER *et al.*, 2003, p.8, tab.1.- NAGENDRA *et al.*, 2004, pp.51-60, pl.1, fig.3, tab.1.

Hypotype: Length=0.55 mm; width=0.45 mm; thickness=0.10 mm.
Repository: GOD NIO Cat No.GOA-359

4.5.1.61 Family CIBICIDIDAE Cushman, 1927
Subfamily CIBICIDINAE Cushman, 1927
Genus CIBICIDES Montfort, 1808

***Cibicides* cf. *C. fletcheri* Cushman and McCulloch**
Plate 18, Figure 13

Cibicides fletcheri CUSHMAN and MCCULLOCH, 1948, p.64, pl.10, figs.8-9.- LANKFORD and PHLEGER, 1973, p.117, pl.6, fig.11.

Hypotype: Length=0.46 mm; width=0.40 mm; thickness=0.20 mm.
Repository: GOD NIO Cat No.GOA-360

***Cibicides* cf. *C. labatulus* (Walker and Jacob)**
Plate 19, Figure 1

Nautilus lobatulus WALKER and JACOB, 1798, p.642, pl.14, fig.36 (Fide, Graham and Militante 1959).
Cibicides lobatulus (Walker and Jacob) CUSHMAN, 1946, p.9, pl.2, figs.6-7.- BHATIA, 1956, p.24, pl.5, fig.7.- GANAPATI and SATYAVATI, 1958, p.111, pl.6, figS.164-166.- ROCHA and UBALDO, 1964a, p.415, pl.3, fig.1; 1964b, p.647, pl.1, figs.1-2.- ANTONY, 1968, p.114-115, pl.8, figs.11a-b.- VEDANTAM and RAO, 1970, p.329, table 3.- RAO, 1970a, p.14-15, fig.82; 1971b, p.162.- AMEER HAMSA, 1973, p.422, fig.k.- REDDY *et al.*, 1974, p.19.- RAO and RAO, 1978, p.426.- BHALLA and NIGAM, 1979, p.239; 1988, p.518, table 1.- NIGAM *et al.*, 1979, p.246, - RAO *et al.*, 1979, p.357, table 3.- REDDY and RAO, 1980, p.170, pl.6, figs.12-14.- VENKATACHALAPATHY and SHAREEF, 1981, p.44.- NIGAM, 1982, pp.200-203, pl.7, fig.10.- NARAPPA *et al.*, 1982, p.221.- RAO *et al.*, 1982,

p.215, table 3.- REDDY and REDDY, 1982, p.250, table 2.- NIGAM and THIEDE, 1983, p.126, table 3.- REDDY *et al.*, 1983, p.107.- SETTY and NIGAM, 1984, p.434, pl.33, fig.19.- SETTY *et al.*, 1984, p.50, table 1.- BHALLA and LAL, 1985, p.430.- NAIDU *et al.*, 1985, p.95, pl.2, figs, 17-18.- RAGOTHAMAN and KUMAR, 1985, p.113, pl.3, figs.13-14.- RAO *et al.*, 1987, p.170, pl.7, figs.10-12.- NAIDU and RAO, 1988, p.855.- SHAREEF and VENKATACHALAPATHY, 1988, p.435, pl.3, fig.12.- KUMAR *et al.* 1990, p.55, pl.2, figs.8-9, table 1.- KALADHAR *et al.*, 1990, p.72, table 1.- KHARE, 1992, p.155-156, pl.14, figs 8a-b.- HENRIQUES, 1993, pp.134-135, pl.19, fig.7.- MAYENKAR, 1994, pp.145-146, pl.17, fig.8a-b.- TALIB and FAROOQUI, 1994, pl.1 table 1.- DAS, 1996, p.49, fig.1(6-7), table 1.- NIGAM and KHARE, 1999, p.302, pl.5, figs.26a-b.- GANDHI, 1999, pp.88-89, pl.7, fig.7.- JAYARAJU *et al.*, 2000, p.335, table 2.- NIGAM and CHATURVEDI, 2000, p.134.- CHATURVEDI, 2001, p.174, pl.12, fig.8.- KYAW and SAING, 2001, p.14, pl.III, fig.74.- MAZUMDER *et al.*, 2003, p.8, tab.1.- GANDHI and RAJAMANICKAM, 2004, p.293-304, tab.1,2.- RAI and SINGH, 2004, pp.415-429, tab.1.- KUMAR and SRINIVASAN, 2004, pp.299-312.

Hypotype: Length=0.60 mm; width=0.50 mm; thickness=0.23 mm.
Repository: GOD NIO Cat No.GOA-361

***Cibicides lucida* (Reuss)**
Plate 18, Figure 2

Truncatulina lucida REUSS, 1866, p.160, pl.4, fig.15.
?Cibicides lucidus (Reuss) BOLTOVSKOY, 1978, p.157, pl.III, figs.13-15.

Hypotype: Length=0.85 mm; width=0.64 mm; thickness=0.20 mm.
Repository: GOD NIO Cat No.GOA-362

***Cibicides pachyderma* (Rzehak)**
Plate 19, Figure 2

Trancatulina pachyderma RZEHAK, 1886, p.87, pl.1, figs.5a-c.
Cibicides pachyderma (Rzehak) JONES, 1994, p.98, pl.94, fig.9.

Hypotype: Length=0.66 mm; width=0.60 mm; maximum thickness=0.30 mm.
Repository: GOD NIO Cat No.GOA-363

Cibicides refulgens **Montfort**

Plate 19, Figure 3

Cibicides refulgens MONTFORT, 1808, p.122, fig.31c.- GANAPATI and SATYAVATI, 1958, p.111, pl.6, figs.161-163.- ROCHA and UBALDO, 1964a, p.416.- ANTONY, 1968, p.114, pl.8, figs.10a-b.- RAO, 1971a, p.14, figs.81a-b.- ZOBEL, 1973, p.16, pl.1, fig.48.- SETTY, 1974, p.23, pl.1, figs.8-9.- BHALLA and NIGAM, 1979, p.239.- NIGAM, 1982, pp.204-205, pl.7, fig.11.- SETTY and NIGAM, 1984, p.434, pl.33, fig.18.- RAO *et al.*, 1985 p.76, table 1; 1987, p.170, pl.7, figs.13-14.- BHALLA and GAUR, 1987, p.125, pl.2, figs.9a-b.- KHARE, 1992, pp.156-157, pl.15, figs.2a-b.- HENRIQUES, 1993, p.136, pl.20, fig.1a-b.- MAYENKAR, 1994, pp.146-147, pl.18, fig.2a-b.- DAS, 1996, p.49, table1.- NIGAM and KHARE, 1999, p.302, pl.5, figs.28a-b.- NIGAM and CHATURVEDI, 2000, p.134.- CHATURVEDI, 2001, p.175, pl.12, fig.9.- KYAW and SAING, 2001, p.14, pl.III, fig.69.- MAZUMDER *et al.*, 2003, p.8, tab.1.- KUMAR and SRINIVASAN, 2004, pp.299-312.

Hypotype: Length=0.55 mm; width=0.48 mm; thickness=0.25 mm.
Repository: GOD NIO Cat No.GOA-364

Cibicides **sp. A**

Plate 19, Figure 5

Remarks: These specimens are comparable to *Cibicidoides kullenbergi.* However, the specimens vary from *C.kullenbergi* due to their semi-transparency, flushed thick sutures, lesser pores and planoconvex shape. Overall, it matches with the genus *Cibicides* more and hence it has been named as *Cibicides* sp. A.

Hypotype: Length=0.32 mm; width=0.22 mm; thickness=0.10 mm.
Repository: GOD NIO Cat No.GOA-365

Cibicides **sp. B**

Plate 19, Figure 6

Remarks: These specimens are comparable to *Cibicidoides cicatricosus*, *Cibicidoides globulosus* and *Cibicides labatulus*. But these specimens are characterized by a lobate margin, lesser chambers in the last whorl, planoconvex shape and a semi-globulous last chamber. Since the generic characters match with *Cibicides*, it has been named *Cibicides* sp. B.

Hypotype: Length=0.55 mm; width=0.48 mm; thickness=0.25 mm.
Repository: GOD NIO Cat No.GOA-366

Genus CIBICIDINA Bandy, 1949

Cibicidina walli **Bandy**
Plate 19, Figure 4

Cibicidina walli BANDY, 1949, p.91.- LOEBLICH and TAPPAN, 1988, p.582, pl.634, figs.13-15.

Hypotype: Length=0.40 mm; width=0.30 mm; thickness=0.18 mm.
Repository: GOD NIO Cat No.GOA-367

4.5.1.62 Family PLANORBULINIDAE Schwager, 1877
Subfamily PLANORBULININAE Schwager, 1877
Genus PLANORBULINA d'Orbigny, 1826

Planorbulina mediterranensis **d'Orbigny**
Plate 19, Fiure 7

Planorbulina mediterranensis D'ORBIGNY, 1826.- GANAPATI and SATYAVATI, 1958, p.117, pl.4, fig.169.- SETHULEKSHMI AMMA, 1958, p.26, pl.1, fig.39.- ANTONY, 1968, p.118, p.8, fig.17.- KYAW and SAING, 2001, p.15, pl.III, fig.88.

Hypotype: Maximum diameter=0.80 mm; thickness=0.18 mm.
Repository: GOD NIO Cat No.GOA-368

Superfamily ASTERIGERINACEA d'Orbigny, 1839

4.5.1.63 Family EPISTOMARIIDAE Hofker, 1954
Subfamily EPISTOMARIIDAE Hofker, 1954

Genus PSEUDOEPONIDES Uchio, 1950

Pseudoeponides pauciloculata **(Phlegar and Parker)**
Plate 19, Figure 8

Rotalia pauciloculata PHLEGER and PARKER, 1951, p.23, pl.12, figs.8a-b, 9a-b.
Strebulus pauciloculata (Phleger and Parker) TODD and BRONNIMANN, 1957, p.38, pl.10, fig.12.
Strebulus catesbyanus (d'Orbigny) ROCHA and UBALDO, 1964a, p.12, pl.4, fig.4.
Pseudoeponides pauciloculata (Phleger and Parker), SEIBOLD, 1971, p.47, pl.7, figs.3-6.- ZOBEL, 1973, p.16, pl.1, fig.1.- HENRIQUES, 1993, p.138, pl.20, fig.12.- MAYENKAR, 1994, p.147-148, pl.18, figs.4a-b.- RAO, 1998, p.206, pl.51, fig.10-11.- CHATURVEDI, 2001, p.176, pl.12, fig.11.- KATHAL, 2002, p.445, pl.4, fig.6a-c.- MAZUMDER *et al.*, 2003, p.8, tab.1.

Hypotype: Maximum diameter=0.24 mm; thickness=0.15 mm.
Repository: GOD NIO Cat No.GOA-369

Subfamily ASTERIGERINATIDAE Reiss, 1963
Genus ASTERIGERINATA Bermúdez, 1949

Asterigerinata **sp.**
Plate 19, Figure 9

Remarks: Due to the small size of these specimens, the identifying features are not so prominent so as to help determination of their species level. Hence their nomenclature has been kept open under the genus *Asterigerinata.* A very low trochospiral planoconvex test, curved sutures, angular periphery and an interiomarginal arch-shaped aperture characterize these specimens.

Hypotype: Length=0.17 mm; width=0.14 mm; thickness=0.05 mm.
Repository: GOD NIO Cat No.GOA-370

4.5.1.64 Family AMPHISTEGINIDAE Cushman, 1927
Genus AMPHISTEGINA d'Orbigny, 1826

Amphistegina lessonii **d'Orbigny**

Plate 19, Figure 10

Amphistegina lessonii D'ORBIGNY, 1826, p.304, pl.17, figs.1-4.- GANAPATI and SATYAVATI, 1958, p.116, figs.138-139.- SETHULEKSHMI AMMA, 1958, p.17, pl.1, fig.27.- ANTONY, 1968, p.99, pl.7, figs.7a-b.- RAO *et al.*, 1987, tab.1, pl.VII, figs.4-5.- RAO, 1998, p.207, pl.52, fig.1.- RAJSHEKHAR and REDDY, 2003, p.36.

Hypotype: Maximum diameter=0.24 mm; thickness=0.07 mm.

Repository: GOD NIO Cat No.GOA-371

Amphistegina radiata **(Fichtel and Moll)**

Plate 19, Figure 11

Nautilus radiatus FICHTEL and MOLL, 1798, p.58, pl.8, figs.a-d.

Amphistegina radiata (Fichtel and Moll)- CHAPMAN, 1895, p.45, pl.1, figs.8-10.- ROCHA and UBALDO, 1964a, p.417, pl.4, figs.1a- b.- VEDANTAM AND RAO, 1970, p.329, table 3.- GUPTHA, 1973a, p.781.- BHALLA and NIGAM, 1979, p.239.- NIGAM *et al.*, 1979, p.246.- RAO *et al.*, 1979, p.357, table 3.- BHALLA and RAGHAV, 1980, p.289, table 1.- SETTY and NIGAM, 1980b, p.421.- NIGAM, 1982, pp.197-198, pl.7, fig.7.- NIGAM and THIEDE, 1983, p.126, table 3.- SRIVASTAVA *et al.*, 1984, p.36.- BHALLA and LAL, 1985, p.430.- RAO *et al.*, 1985, p.76, table 1; 1987, p.170, pl.7, fig.9.- BHALLA and GAUR, 1987, p.125, figs.8a-b.- KHARE, 1992, p.159, pl.15, fig.6.- HENRIQUES, 1993, p.139, pl.20, fig.6.- MAYENKAR, 1994, pp.148, pl.18, fig.5.- GANDHI, 1999, pp.90-91, pl.7, fig.12.- CHATURVEDI, 2001, p.177, pl.13, fig.1.- KYAW and SAING, 2001, p.17, pl.I, fig.27.- KATHAL, 2002, p.445, pl.4, fig.3a-b.- GANDHI *et al.*, 2002, p.60, pl.II, fig.16.- MAZUMDER *et al.*, 2003, p.8, tab.1.- RAJSHEKHAR and REDDY, 2003, p.36.- GANDHI and RAJAMANICKAM, 2004, p.293-304, tab.1,2.

Hypotype: Maximum diameter=0.46 mm; thickness=0.14 mm.

Repository: GOD NIO Cat No.GOA-372

Superfamily NONIONACEA Schultze, 1854

4.5.1. 65 Family NONIONIDAE Schultze, 1854

Subfamily NONIONINAE Schultze, 1854

Genus NONION Montfort, 1808

***Nonion* cf. *N. asterizans* (Fichtel and Moll)**

Plate 19, Figure 12

Nautilus asterizans FICHTEL and MOLL, 1798, p.37, pl.3, figs.e-h.

Noinionina asterizans (Fichtel and Moll) BRADY, 1884, p.278, pl.109, figs.12-13.

Nonion asterizans (Fichtel and Moll) CUSHMAN, 1930, p.6, pl.2, figs.5-7.- SEIBOLD, 1972, p.453; 1975, p.1999, pl.2, fig.9, pl.5, fig.3.- BHALLA and RAGHAV, 1980, p.289, table 1.- SEIBOLD and SEIBOLD, 1981, p.30, tables 3a and 5.- RAO *et al.*, 1982, p.215, table 3.- NAIDU *et al.*, 1985, p.95, pl.2, fig.9.- RAO *et al.*, 1985, p.76, table 1.- NAIDU and RAO, 1988, p.856.- KHARE, 1992, p.160-161, pl.15, figs.7.-HENRIQUES, 1993, pp.139-140, pl.20, figs.7a-b.- MAYENKAR, 1994, p.149, pl.18, fig.6.- RAO, 1998, pp.208-209, pl.52, fig.6.- CHATURVEDI, 2001, p.178, pl.13, fig.3.- KATHAL, 2002, pl.4, figs.7a-b.- MAZUMDER *et al.*, 2003, p.8, tab.1.

Florilus asterizans KALADHAR *et al.*, 1990, p.72, table 1.

Hypotype: Length=0.40 mm; width=0.32 mm; thickness=0.18 mm.

Repository: GOD NIO Cat No.GOA-373

***Nonion* aff. *N. depressulum* (Walker and Jacob)**

Plate 19, Figure 13

Nautilus depressulus WALKER and JACOB, 1798, p.641, pl.14, fig.33.

Nonionina depressula BRADY, 1884, p.725, pl.109, figs.6-7.

Nonion depressulum (Walker and Jacob) CUSHMAN, 1930, p.3, pl.1, figs.3-6.- RAO, 1970 b., p.263b, pl.4, fig.45, - RAO *et al.*, 1987, p.171, pl.8, figs.13-15.- KHARE, 1992, p.163, pl.15, fig.9. - DAS, 1996, p.49, table1.- NIGAM and KHARE, 1999, p.303, pl.5, fig.5.- CHATURVEDI, 2001, p.179, pl13, fig.4.

Nonion depressulus SETTY and NIGAM, 1985, p.286.- RAO, 1998, p.209, pl.52, figs.7-8.

Hypotype: Length=0.33 mm; width=0.23 mm; thickness=0.15 mm.

Repository: GOD NIO Cat No.GOA-374

***Nonion incisum* (Cushman)**

Plate 19, Figure 14

Nonionina incisa CUSHMAN, 1926, p.90, pl.13, figs.13a-c.

Nonion incisa CUSHMAN and CAHIL, 1933, p.20, pl.7, figs.4a-b.

Nonion incisum CUSHMAN, 1939, p.15, pl.4, fig.6.- ANTONY, 1968, p.59, pl.4, fig.2.- VEDANTAM and RAO, 1970b, p.329, table 3.- KHARE, 1992, pp.165-166, pl.15, fig.11.- HENRIQUES, 1993, p.140, pl.20, fig.8a-b.- MAYENKAR, 1994, pp.149-150, pl.18, fig.7a-b.- NIGAM and KHARE, 1999, p.303, pl.6, fig.7.- CHATURVEDI, 2001, p.179, pl.13, fig.5.- MAZUMDER *et al.*, 2003, p.8, tab.1.

Florilus incisum RAO *et al.*, 1982, p.215, table 3.

Hypotype: Length=0.35 mm; width=0.24 mm; thickness=0.19 mm.

Repository: GOD NIO Cat No.GOA-375

***Nonion pacificum* (Cushman)**

Plate 20, Figure 1

Noinionina umbilicatula (Montagu) var. *pacifica* CUSHMAN, 1924, p.48, pl.16, fig.3.

Nonion umbilicatulum (Montagu) var. *pacificum* (Cushman) CUSHMAN, 1927, p.49, pl.2, fig.5.

Nonion pacificum (Cushman) CUSHMAN, 1933b, p.44, pl.10, figs.91-b; 1934, p.120, pl.14, figs.7a-b; 1939a, p.25, pl.6, fig.25.- RAO, 1970, p.263, fig.44.

Hypotype: Length=0.38 mm; width=0.25 mm; thickness=0.18 mm.

Repository: GOD NIO Cat No.GOA-376

***Nonion scaphum* (Fichtel and Moll)**

Plate 20, Figure 2

Nautilus scapha FICHTEL and MOLL, 1798, p.105, pl.19, figs.d-f.

Nonion scapha (Fichtel and Moll) CUSHMAN, 1937b, p.20, pl.5, figs.18-21.- BHATIA, 1956, p.19, pl.5, fig.15.- ROCHA and UBALDO, 1964a, p.416, pl.3 figs.4a-b; 1964b, p.647, pl.1 fig.17.- RAO, 1971b, p.159, fig.34; 1974, p.64, fig.26.

Nonion scaphum (Fichtel and Moll) CUSHMAN, 1930, p.5, pl.2, figs.3-4, pp.11,14, pl.3, figs.7-10.- BHATIA and BHALLA, 1959, p.79, pl.1, figs.6a-b.- ANTONY, 1968, p.58-59, pl.4, fig.1.- KHARE, 1992, pp.166-167, pl.5, fig.12a-b.- HENRIQUES, 1993, p.140-141, pl.20, fig.9.- MAYENKAR, 1994, pp.150-151, pl.18, fig.8.- NIGAM and KHARE, 1999, p.303, pl.6, figs.8a-b.- CHATURVEDI, 2001, p.180, pl.13, fig.7.- MAZUMDER *et al.*, 2003, p.8, tab.1.

Florilus scaphum (Fichtel and Moll) BHALLA, 1970, p.160, pl.21, figs.5a-b.- BHATIA and KUMAR, 1976, p.249.- BHALLA nad NIGAM, 1979, p.239; 1988, p.518, table 1.- NIGAM *et al.*, 1979, p.245.- RAO *et al.*, 1979, p.361, table 3.- BHALLA and RAGHAV, 1980, p.289, table 1.- SETTY and NIGAM, 1980b, p.421; 1985, p.286. NIGAM and SARUPRIA, 1981, p.179,- VENKATACHALAPATHY and SHAREEF, 1981, p.44.- RAO *et al.*, 1982, p.215, table 3.- NIGAM and THIEDE, 1983, p.126, table 3.- SETTY and NIGAM, 1984, p.432, pl.32, fig.22.- SETTY *et al.*, 1984, p.50, table 1.- BHALLA and LAL, 1985, p.430.- NIGAM, 1986, p.424, table 1.- BHALLA and GAUR, 1987, p.125, pl.1, fig.19.- SHAREEF and VENKATACHELAPATHY, 1988, p.435, pl.4, fig.1.- KALADHAR *et al.*, 1990.

Remarks: This is one of the most common species in the Arabian Sea including the present study area. It has been reported before as both, *Nonion scaphum* and *Florilus scaphum*; but the genus *Florilus* is no longer being used. Hence the specimens from off Goa were named as *Nonion scaphum.*

Hypotype: Length=0.34 mm; width=0.27 mm; thickness=0.18 mm.
Repository: GOD NIO Cat No.GOA-377

***Nonion sloanii* (d'Orbigny)**
Plate 20, Figure 3

Nonionina sloanii D'ORBIGNY, 1839, p.68, pl.6, figs.18.
Nonion sloanii (d'Orbigny) CUSHMAN, 1930, p.9, pl.3, figs.6-8.- CUSHMAN, 1939a, p.22, pl.6, figs.9-10.- SAID, 1950, p.23, pl.2, fig.27.

Hypotype: Length=0.22 mm; width=0.16 mm; thickness=0.10 mm.
Repository: GOD NIO Cat No.GOA-378

Genus NONIONELLA Cushman, 1926

***Nonionella auricula* Heron-Allen and Earland**
Plate 20, Figure 4

Nonionella auricula HERON-ALLEN and EARLAND, 1930, p.192, pl.5, figs.68-70.- CUSHMAN, 1939a, p.33, pl.9, figs.7-9.

Hypotype: Length=0.26 mm; width=0.19 mm; thickness=0.14 mm.
Repository: GOD NIO Cat No.GOA-379

***Nonionella auris* (d'Orbigny)**
Plate 20, Figure 5

Valvulinaria auris D'ORBIGNY, 1839, p.47, pl.2, figs.15-17.
Nonionina auris CUSHMAN, 1925, p.44, pl.7, figs.3a-c.
Nonionella auris CUSHMAN and KELLETT, 1929, p.5, pl.1, figs.9a-c; pl.2, figs.2-3.- CUSHMAN and CAHILL, 1933, p.21, pl.7, figs.6a,b.- CUSHMAN, 1939a, p.33, pl.9, figs.4.- SETTY and NIGAM, 1980b, p.421.- HENRIQUES, 1993, p.142, pl.20, fig.10.- MAYENKAR, 1994, p.151, pl.18, fig.9.- CHATURVEDI, 2001, p.181, pl.13, fig.9.- MAZUMDER *et al.*, 2003, p.8, tab.1.- RAI and SINGH, 2004, pp.415-429, tab.1.

Hypotype: Length=0.31 mm; width=0.27 mm; thickness=0.15 mm.
Repository: GOD NIO Cat No.GOA-380

***Nonionella basispinata* (Cushman and Moyer)**
Plate 20, Figure 6

Nonion pizarrense Berry var. *basispinata* CUSHMAN and MOYER, 1930, p.54, pl.7, figs.18a-b.- CUSHMAN, 1939a, p.25, pl.6, fig.28.
Nonionella basispinata (Cushman and Moyer) BANDY, 1953, pl.21, fig.13, tab.1.- SETTY and NIGAM, 1980, p.421, fig.3; p.422, fig.4.- NIGAM and SARUPRIA, 1981, p.180.- NIGAM and THIEDE, 1983, p.126, tab.3.- NIGAM, 1984, p.424.

Hypotype: Length=0.31 mm; width=0.24 mm; thickness=0.16 mm.
Repository: GOD NIO Cat No.GOA-381

***Nonionella hantkeni* (Cushman and Applin)**
Plate 20, Figure 9

Nonionina hantkeni CUSHMAN and APPLIN, 1926, p.182, pl.10, figs.10-11.
Nonionella hantkeni (Cushman and Applin) CUSHMAN, 1935, p.31, pl.12, figs.1-2.- CUSHMAN, 1939a, p.30, pl.8, fig.4.- ANTONY, 1968, p.59, pl.3, fig.26.- MAYENKAR, 1994, p.151, pl.18, figs.10a-c.- MAZUMDER *et al.*, 2003, p.8, tab.1.

Hypotype: Length=0.30 mm; width=0.21 mm; thickness=0.15 mm.
Repository: GOD NIO Cat No.GOA-382

***Nonionella* cf. *N. japonica* (Asano)**
Plate 20, Figure 7

Pseudononion japonicum ASANO, 1936, p.347, figs.A-C.S.- BOLTOVSKOY, 1978, p.166, pl.VI, figs.10-11.
Nonionella japonica (Asano) CUSHMAN, 1939a, p.32, pl.9, fig.1.

Hypotype: Length=0.20 mm; width=0.15 mm; thickness=0.09 mm.
Repository: GOD NIO Cat No.GOA-383

***Nonionella* cf. *N. limbato-striata* Cushman**
Plate 20, Figure 8

Nonionella limbato-striata CUSHMAN, 1934, p.121, pl.14, figs.10a-c.- CUSHMAN, 1939a, p.32, pl.8, figs.13-14.

Hypotype: Length=0.30 mm; width=0.18 mm; thickness=0.12 mm.
Repository: GOD NIO Cat No.GOA-384

***Nonionella opima* Cushman**
Plate 20, Figure 10

Nonionella opima CUSHMAN, 1947, p.90, pl.20, figs.1-3.- VENKATACHALAPATHY and SHAREEF, 1981, p.44.- NIGAM, 1984, p.424.- SHAREEF and VENKATACHALAPATHY, 1987b, p.189.- KHARE, 1992, p.168, pl.16, figs.4a-b.- MAYENKAR, 1994, p.152, pl.19, fig.2a-c.- MAZUMDER *et al.*, 2003, p.8, tab.1.

Hypotype: Length=0.25 mm; width=0.21 mm; thickness=0.14 mm.

Repository: GOD NIO Cat No.GOA-385

***Nonionella turgida* (Williamson)**

Plate 20, Figure 11

Rotalia turgida WILLIAMSON, 1858, p.50, pl.4, figs.95-97.

Nonionina asterizans var *turgida* (Williamson) CARPENTER, PARKER and JONES, 1862, p.17-18.

Nonionina turgida (Williamson) BRADY, 1884, p.474, pl.109, figs.17-19.- TERQUEM and TERQUEM, 1886, p.331, pl.11, figs.7-8.- MILLETT, 1908, p.7.- HERON-ALLEN and EARLAND, 1913, p.145; 1916, p.281.

Nonionella turgida CUSHMAN, 1930, p.15, pl..6, figs.1-4.- HOWE and WALLACE, 1932, p.53, pl.9, figs.2a-c.- EARLAND, 1933, p.53; 1934, p.190.- CUSHMAN, 1939a, pp.32-33, pl.9, figs.2-3.- NAIDU *et al.*, 1985, p.92, pl.1, figs.15-16.- CHATURVEDI, 2001, p.181, pl.13, fig.10.- KATHAL, 2002, p.446, pl.4, figs.10a-c.

Hypotype: Length=0.29 mm; width=0.18 mm; thickness=0.11 mm.

Repository: GOD NIO Cat No.GOA-386

Genus NONIONOIDES Saidova, 1975

***Nonionoides boueanum* (d'Orbigny)**

Plate 20, Figure 12

Nonionina boueanum D'ORBIGNY, 1846, p.108, pl.5, figs.11-12.

Nonion boueanum (d'Orbigny) CUSHMAN, 1939a, pp.12-13, pl.3, figs.7-8.- SETHULEKSHMI AMMA, 1958, p.21, pl.1, fig.32.- ROCHA and UBALDO, 1964a, p.647, pl.1, figs.16 - ANTONY, 1968, pp.57-58, pl.3, fig.25.- RAO, 1970b, p.262, pl.4, fig.42; 1971b, p.159; 1974, p.64, fig.25.- BHALLA and NIGAM, 1979, p.239.- BHALLA and RAGHAV, 1980, p.289, table 1.- NIGAM and SARUPRIA, 1981, p.179.- NIGAM and THIEDE, 1983, p.126, table 3.- SETTY *et al.*, 1984, p.50, table 1.- BHALLA and GAUR, 1987, p.125, pl.1, fig.17.- KHARE, 1992, p.161, pl.15, fig.8.- NIGAM *et al.*, 1992b, p.536, plate.1, fig.g.- NIGAM and KHARE, 1999, p.302, pl.6, fig.4.- KYAW and SAING, 2001, p.16, pl.IV, fig.99.- KATHAL, 2002, p.445, pl.4, figs.8a-b.- MALLIK *et al.*, 2003, p.42, tab.1.

Florilus boueanum (d'Orbigny) - NIGAM *et al.*, 1979, p.245.- SETTY and NIGAM, 1980b, p.421.- VENKATACHALAPATHY and SHAREEF, 1981, p.44.- SETTY and NIGAM, 1984, p.432, figs.24-26; 1985, p.286.- RAGOTHAMAN and KUMAR, 1985, p.114, pl.3, figs.19-20.- NIGAM, 1986, p.424, table 1.- SHAREEF and VENKATACHALAPATHY, 1987a, p.194, table 1; 1987b, p.191.- JAYARAJU, 1993, p.131, pl.5, fig.15.- JAYARAJU and REDDI, 1996, p.315, table 2.- KUMAR and SRINIVASAN, 2004, pp.299-312.

Florilus boueanus (d'Orbigny) - SHAREEF and VENKATACHALAPATHY, 1988, p.435, pl.4, fig.1.

Nonionoides boueanum (d'Orbigny) - MURRAY, 1991, p.336.- HENRIQUES, 1993, pp.144-145, pl.21, figs.6a-c.- MAYENKAR, 1994, pp.153-154, pl.19, figs.6a-b.- RAO, 1998, pp.211-212, pl.53, fig.1.- GANDHI, 1999, pp.91-92, pl.7, figs.13-14.- CHATURVEDI, 2001, p.182, pl.13, fig.11.- MAZUMDER *et al.*, 2003, p.8, tab.1.- GANDHI and RAJAMANICKAM, 2004, p.293-304, tab.1,2.

Hypotype: Length=0.38 mm; width=0.31 mm; thickness=0.19 mm.
Repository: GOD NIO Cat No.GOA-387

***Nonionoides elongatum* (d'Orbigny)**
Plate 20, Figure 13

Nonionina elongata D'ORBIGNY, 1826, p.294.

Nonion elongatum (d'Orbigny) CUSHMAN, 1939a, p.11, pl.3, figs.4- 6.- NIGAM *et al.*, 1979, p.245.- SETTY and NIGAM, 1980b, p.421.- NIGAM and SARUPRIA, 1981, p.179.- NIGAM and THIEDE, 1983, p.126, table 3.- SETTY *et al.*, 1984, p.50, table 1.- SETTY and NIGAM, 1984, p.434, pl.33, fig.21; 1985, p.286.- NIGAM, 1986, p.424, table 1.- KHARE, 1992, p.164, pl.15, fig.10.- NIGAM *et al.*, 1992b, p.536, pl.1, fig.i.- NIGAM and KHARE, 1999, p.303, pl.6, fig.6.- GANDHI *et al.*, 2002, p.60, pl.II, fig.17.

Florilus elongatus (d'Orbigny) BHALLA and NIGAM, 1979, p.239.- BHALLA and GAUR, 1987, p.125, pl.1, fig.18.- SHAREEF and VENKATACHALAPATHY, 1987b, p.191.

Nonionoides elongatum (d'Orbigny) MURRAY, 1991, p.336.- MAYENKAR, 1994, p.154, pl.20, figs.1a-c.- CHATURVEDI, 2001, p.184, pl.14, fig.1.- MAZUMDER *et al.*, 2003, p.8, tab.1.- GANDHI and RAJAMANICKAM, 2004, p.293-304, tab.1,2.

Hypotype: Length=0.33 mm; width=0.24 mm; thickness=0.15 mm.
Repository: GOD NIO Cat No.GOA-388

Nonionoides grateloupi **(d'Orbigny)**

Plate 20, Figure 14

Nonionina grateloupi D'ORBIGNY, 1826, p.294 ; 1839, p.46, pl.6, figs.6-7.

Nonion grateloupi (d'Orbigny) CUSHMAN, 1939a, p.21, pl.6, figs.1-7.- KURIAN, 1953, p.755.- VEDANTAM and RAO, 1970, p.329, table 3.- REDDY *et al.*, 1974, p.90.- RAO and RAO, 1978, p.426, RAO *et al.*, 1982, p.215, table 3.- PAL, 1989, p.109, table 1.- KHARE, 1992, p.164-165, p.16, fig.2.- JAYARAJU and REDDI, 1996, p.315, table 1.- NIGAM and KHARE, 1999, p.302, pl.6, fig.10.

Florilus grateloupi REDDY and REDDY, 1982, p.250, table 2.- NIGAM and THIEDE, 1983, p.126, table 3.- KUMAR *et al.*, 1990, p.58, pl.2 fig.13 table 1.- JAYARAJU *et al.*, 2000, p.335, tab.2.- KUMAR and SRINIVASAN, 2004, pp.299-312.

Nonionoides grateloupi (d'Orbigny) LOBELICH and TAPPAN, 1988, p.618, pl.692, figs.7-14.- HENRIQUES, 1993, pp.146-147, pl.21, fig.5a-c.- MAYENKAR, 1994, p.155, pl.19, figs.7-14.- CHATURVEDI, 2001, p.184, pl.13, fig.12.- KATHAL, 2002, p.446, pl.4, figs.9a-b.- MAZUMDER *et al.*, 2003, p.8, tab.1.

Hypotype: Length=0.35 mm; width=0.24 mm; thickness=0.14 mm.

Repository: GOD NIO Cat No.GOA-389

Subfamily PULLENIINAE Schwager, 1877

Genus MELONIS Montfort, 1808

Melonis barleeanum **(Williamson)**

Plate 20, Figure 15

Nonionina barleeana WILLIAMSON, 1858, p.32, pl.3, figs.68-69.

Melonis barleeanum (Williamson) HERMELIN and SHIMMIELD, 1990, pp.8-11, pl.3, figs.12,16, tab.4.- GUPTA, 1992, p.483, pl.2, fig.6.- MAYENKAR, 1994, p.156, pl.20, figs.2a-b.- MAZUMDER *et al.*, 2003, p.8, tab.1.- RAI and SINGH, 2004, pp.415-429, tab.1.- NAGENDRA *et al.*, 2004, pp.51-60, pl.2, fig.4, tab.1.

Hypotype: Length=0.47 mm; width=0.39 mm; thickness=0.21 mm.

Repository: GOD NIO Cat No.GOA-390

Melonis pompiloides **(Fichtel and Moll)**

Plate 20, Figure 16

Nautilus pompiloides FICHTEL and MOLL, 1798, p.31, pl.2, figs.a-c.

Nonionina pompiloides (Fichtel and Moll) D'ORBIGNY, 1826, p.294.- BRADY, 1884, p.727, pl.109, figs.10-11.

Nonion pompiloides (Fichtel and Moll) CUSHMAN, 1929, p.89, pl.13, figs.25a-b.- GANAPATI and SATYAVATI, 1958, p.108, pl.111, fig.84.- RAO, 1970b, p.263, pl.4, fig.43.

Melonis pompiloides (Fitchel and Moll) KHARE, 1992, p.171, pl.16, fig.1. RAI and SINGH, 2004, pp.415-429, tab.1.

Remarks: The specimens under consideration are similar to *Nonion pompililoides*, described by Cushman (1939a). Later, Khare (1992) used *Melonis* instead of *Nonion* for the same species due to its higher degree of resemblance with the genus *Melonis*. So these specimens have been named *Melonis pompiloides*.

Hypotype: Length=0.29 mm; width=0.23 mm; thickness=0.19 mm.
Repository: GOD NIO Cat No.GOA-391

***Melonis soldani* (d'Orbigny)**
Plate 20, Figure 17

Nonionina soldanii D'ORBIGNY, 1846, p.109, pl.5, figs.15-16.

Nonion soldanii (d'Orbigny) CUSHMAN, 1939a, p.13, pl.3, figs.10-11; pl.4, fig.23.

Remarks: The identification of these specimens has refernce to Cushman's (1939a) *Nonion soldanii* (pl.3, fig.10). Depending upon the generic characters (mainly deep and open umbilici), it has been placed under the genus *Melonis*.

Hypotype: Maximum diameter=0.32 mm; thickness=0.19 mm.
Repository: GOD NIO Cat No.GOA-392

Genus PULLENIA Parker and Jones, 1862

***Pullenia bulloides* (d'Orbigny)**
Plate 20, Figure 18

Nonionina bulloides D'ORBIGNY, 1846, p.107, pl.5, fig.9-10.
Pullenia bulloides (d'Orbigny) PARKER and JONES, 1862, p.184.- RAI and SINGH, 2004, pp.415-429, tab.1.- NAGENDRA *et al.*, 2004, pp.51-60, pl.2, fig.6, tab.1.

Hypotype: Maximum diameter=0.17 mm; thickness=0.13 mm.
Repository: GOD NIO Cat No.GOA-393

***Pullenia quinqueloba* (Reuss)**
Plate 21, Figure 1

Nonionina quinqueloba REUSS, 1851, p.71, pl.5, fig.31.
Pullenia quinqueloba (Reuss) BRADY, 1884, pl.84, figs.14-15.- RAI and SINGH, 2004, pp.415-429, tab.1.

Hypotype: Maximum diameter=0.35 mm; thickness=0.20 mm.
Repository: GOD NIO Cat No.GOA-394

Superfamily CHILOSTOMELLACEA Brady, 1881

4.5.1.66 Family CHILOSTOMELLIDAE Brady, 1881
Subfamily CHILOSTOMELLINAE Brady, 1881
Genus CHILOSTOMELLA Reuss, 1849

***Chilostomella oolina* Schwager**
Plate 21, Figure 2

Chilostomella oolina SCHWAGER, 1878, p.527, pl.1, fig.16.- ZOBEL, 1973, p.19, pl.2, figs.36-37.- HERMELIN and SHIMMIELD, 1990, pp.8-11, tab.4.- MAYENKAR, 1994, p.156, pl.19, fig.7.- MAZUMDER *et al.*, 2003, p.8, tab.1.- RAI and SINGH, 2004, pp.415-429, tab.1.

Hypotype: Length=0.32 mm; maximum diameter =0.14 mm.
Repository: GOD NIO Cat No.GOA-395

4.5.1.67 Family OSANGULARIIDAE Loeblich and Tapan, 1964
Genus OSANGULARIA Brotzen, 1940

Osangularia bengalensis **(Schwager)**
Plate 21, Figure 3

Anomalina bengalensis SCHWAGER, 1866, p.259, pl.7, fig.111.
Parrella bengalensis (Schwager) FINLEY, 1939, p.523.
Osangularia bengalensis (Schwager) CUSHMAN, 1954, p.360, pl.89, fig.21.- ROCHA and UBALDO, 1964c, p.117, pl.XI, figs.13-14.

Hypotype: Maximum diameter=0.47 mm; thickness=0.27 mm.
Repository: GOD NIO Cat No.GOA-396

4.5.1.68 Family ORIDORSALIDAE Loeblich and Tappan, 1984
Genus ORIDORSALIS Andersen, 1961

Oridorsalis **sp.**
Plate 21, Figure 4

Remarks: The specimens from off Goa region are quite similar to *Oridorsalis umbonatus* (Reuss), described by Yassini and Jones (1995) and Hayward *et al.* (1999). Due to lesser convexity and porosity of these specimens, its nomenclature remains open under the genus *Oridorsalis*.

Hypotype: Maximum diameter=0.68 mm; thickness=0.40 mm.
Repository: GOD NIO Cat No.GOA-397

4.5.1.69 Family HETEROLEPIDAE Gonzáles-Donoso, 1969
Genus HETEROLEPA Franzenau, 1884

Heterolepa subhaidingerii **(Parr)**
Plate 21, Figure 5

Truncatulina haidingerii (d'Orbigny) BRADY, 1884, p.663, pl.95, figs.7a-c.- ANTONY, 1968, p.116, pl.8, figs.13a-b.

Cibicides subhaidingerii PARR, 1950, v.5, pt.6, p.364, pl.15, figs.7a-c.- HENRIQUES, 1993, p.136, pl.20, fig.2.- MAYENKAR, 1994, p.147, pl.18, fig.3.- KATHAL, 2002, p.445, pl.4, fig.5a-c.- MAZUMDER *et al.*, 2003, p.8, tab.1.
Heterolepa subhaidingerii (Parr) HOTTINGER *et al.*, 1993, p.139, pl.197, figs.1-4.- RAO, 1998, p.215, pl.54, figs.4-5.

Hypotype: Maximum diameter=0.66 mm; thickness=0.15 mm.
Repository: GOD NIO Cat No.GOA-398

4.5.1.70 Family GAVELINELLIDAE Hofker, 1956
Subfamily GYROIDINOIDINAE Saidova, 1881
Genus GYROIDINOIDES Brotzen, 1942

***Gyroidinoides orbicularis* (d'Orbigny)**
Plate 21, Figure 6

Gyroidina orbicularis D'ORBIGNY, 1826, p.278.- FRERICHS, 1970, pp.146-147.- MATHUR and GUPTA, 1989, pp.120-126, tab.1.- HENRIQUES, 1993, p.148, pl.22, figs.4a-b.- MAYENKAR, 1994, p.157, pl.20, fig.4a-b.

Gyroidinoides orbicularis (d'Orbigny) CORLISS, 1979, p.124, tab.1- CORLISS, 1983, p.102, tab.2.

Hypotype: Maximum diameter=0.29 mm; thickness=0.13 mm.
Repository: GOD NIO Cat No.GOA-399

***Gyroidinoides soldanii* (d'Orbigny)**
Plate 21, Figure 7

Gyroidina soldanii D'ORBIGNY, 1826, p.112, no.5.
Rotalia soldanii (d'Orbigny) D'ORBIGNY, 1846, p.155, pl.8, figs.10-12.
Gyroidinoides soldanii (d'Orbigny) CORLISS, 1979, p.124, tab.1- NIGAM and SETTY, 1980, p.277, fig.3.- RAO, 1998, p.215, pl.54, figs.6-7.

Hypotype: Maximum diameter=0.32 mm; thickness=0.23 mm.
Repository: GOD NIO Cat No.GOA-400

Subfamily GAVELINELLINAE Hofker, 1956

Genus GYROIDINA d'Orbigny, 1826

***Gyroidina bradyi* (Trauth)**

Plate 21, Figure 8

Truncatulina bradyi TRAUTH, 1918.

Cibicides bradyi (Truath) THALMANN, 1942.- RAI and SINGH, 2004, pp.415-429, tab.1.

Gyroidina bradyi (Truath) JONES, 1994, p.99, pl.95, fig.5.

Hypotype: Maximum diameter=0.23 mm; thickness=0.12 mm.

Repository: GOD NIO Cat No.GOA-401

***Gyroidina* cf. *G. pulisukensis* (Saidova)**

Plate 21, Figure 9

Gyroidinus pulisukensis SAIDOVA, 1975, p.237.

Gyroidina pulisukensis (Saidova) LOEBLICH and TAPPAN, 1988, p.638, pl.716, figs.14-18.

Hypotype: Maximum diameter=0.44 mm; thickness=0.30 mm.

Repository: GOD NIO Cat No.GOA-402

***Gyroidina* sp. A**

Plate 21, Figure 10

Remarks: These specimens have some similarity with *Gyroidinoides soldanii*, but are more flattened with an umbilicus less prominent.

Hypotype: Maximum diameter=0.39 mm; thickness=0.22 mm.

Repository: GOD NIO Cat No.GOA-403

***Gyroidina* sp. B**

Plate 21, Figure 11

Remarks: These dorsal sides of these specimens have a more pronounced convexity and bear numerous pores.

Hypotype: Maximum diameter=0.43 mm; thickness=0.28 mm.
Repository: GOD NIO Cat No.GOA-404

Superfamily ROTALIACEA Ehrenberg, 1839

4.5.1.71 Family ROTALIIDAE Ehrenberg, 1839
Subfamily PARAROTALIINAE Reiss, 1963
Genus PARAROTALIA Calvez, 1949

***Pararotalia* cf. *P. calcar* (d'Orbigny)**
Plate 21, Figure 12

Calcarina calcar D'ORBIGNY, 1826, p.276, model no.34.- BARKER, 1960, p.222, pl.108, figs.3a-c.- RAO, 1971b, p.161.- SETTY, 1976, p.229.- RAO *et al.*, 1987, tab.1, pl.VI, fig.1-2.- KYAW and SAING, 2001, p.13, pl.III, fig.64.
Rotalia calcar (d'Orbigny) - BRADY, 1884, p.709, pl.108, figs.3-4. - KURIAN, 1953, p.756.- GANAPATI and SATYAVATI, 1958, p.110, pl.5, figs.118-119.- SETHULEKSHMI AMMA, 1958, pp.73-74, pl.3, figs.113a-b.- ANTONY, 1968, pp.94-495, pl.6, figs.11a-b.- RAO, 1970b, p.273, pl.6, fig.68.- VEDANTAM and RAO, 1970, p.329, table 3.
Pararotalia calcar (d'Orbigny) NIGAM, 1982, p.152, pl.5, fig.10.- KHARE, 1992, p.174, pl.16, figs.8a-b.- JAYARAJU, 1993, p.117, pl.4, figs.7-8.- JAYARAJU and REDDI, 1996, p.315, table 1.- RAO, 1998, p.217, pl.55, figs.1-2.- GANDHI, 1999, p.99, pl.8, figs.11-12.- NIGAM and KHARE, 1999, p.303, pl.6, figs.17a-b.- NIGAM and CHATURVEDI, 2000, p.134.- CHATURVEDI, 2001, p.186, pl.14, fig.2.- GANDHI and RAJAMANICKAM, 2004, p.293-304, tab.1,2.

Hypotype: Maximum diameter=0.26 mm; thickness=0.14 mm.
Repository: GOD NIO Cat No.GOA-405

Subfamily AMMONIINAE Saidova, 1981
Genus AMMONIA Brünnich, 1772

***Ammonia* aff. *A. globosa* (Millett)**

Plate 22, Figure 1

Discorbina imperatoria (d'Orbigny) var. *globosa* MILLETT, 1903, p.701, pl.7, figs.23-26.
Rotalia erinacea HERON-ALLEN and EARLAND, 1915, p.720, pl.53, figs.26-29.
"Eponides" globosus (Millett) UJIIÉ, 1963, p.233, pl.1, figs.26-29.
Pararotalia murrayi (Heron-Allen and Earland) UJIIÉ, 1963, p.239, pl.3, figs.3-9.
Pararotalia? globosa (Millett) MATOBA, 1970, p.57, pl.6, figs.8a-c.
Ammonia globosa (Millett) SHOUYI *et al.*, 1978, p.49, pl.V, figs.7-11.

Hypotype: Maximum diameter=0.28 mm; thickness=0.15 mm.
Repository: GOD NIO Cat No.GOA-406

***Ammonia ketienziensis angulata* (Kuwano)**

Plate 22, Figure 2

Rotalia ketienziensis angulata KUWANO, 1950, p.312, fig.1.
Ammonia ketienziensis angulata (Kuwano) HUANG, 1964, p.53, pl.1, fig.6.

Hypotype: Maximum diameter=0.47 mm; thickness=0.27 mm.
Repository: GOD NIO Cat No.GOA-407

***Ammonia sobrina* (Shupack)**

Plate 22, Figure 3

Rotalia beccarii var. *sobrina* SHUPACK, 1934, p.6, pl.6, figs.a-c.- RAMANATHAN, 1970, p.130.
Ammonia beccarii ROCHA and UBALDO, 1964 b, p.647, pl.2, figs.17-18.
Ammonia sobrina (Shupack) SEIBOLD, 1971, p. 46, pl.6, figs.4-6, pl.7, figs.1-2 text fig.2; 1972, p.452, pl.1, fig.a ; 1975, p.191.- SEIBOLD and SEIBOLD, 1981, p.40, pl.17, fig.10.- NIGAM, 1982, p.142, pl.4, fig.22.- SETTY and NIGAM, 1984, p.432, pl.32, figs.9-10; 1985, p.286.- SETTY *et al.*, 1984, p.50, table 1.- NIGAM, 1986, p.424, table 1.- NIGAM *et al.*, 1992b, p.536, table 1.- KHARE, 1992, pp.176-177, pl.16, figs.10a-c.- HENRIQUES, 1993, pp.149-150, pl.22, fig.6. MAYENKAR, 1994, pp158-159, pl.20, figs.6a-c.- DAS, 1996, p.49, table1.- NIGAM and KHARE, 1999, p.303, pl.6, figs.19a-b.- NIGAM and

CHATURVEDI, 2000, p.134.- CHATURVEDI, 2001, p.189, pl.15, fig.5.- KATHAL, 2002, p.448, pl.5, figs.8a-b.- MAZUMDER *et al.*, 2003, p.8, tab.1.
Ammonia beccarii (Linne') *sobrina* RAO *et al.*, 1985, p.76, table 1.

Hypotype: Maximum diameter=0.13 mm; thickness=0.07 mm.
Repository: GOD NIO Cat No.GOA-408

***Ammonia tepida* (Cushman)**
Plate 22, Figure 4

Rotalia beccarri var. *tepida* CUSHMAN, 1926, p.79, pl.1, fig.9.- VEDANTAM and RAO, 1970, p.329, table 3.- RAO, 1974, p.64, pl.2, figs.33a-b.- REDDY *et al.*, 1983, p.107.- KYAW and SAING, 2001, p.13, pl.III, fig.59.
Discorbis rosacea (d'Orbigny) ANTONY, 1968, p.91, pl.5, figs.23a- b.
Discorbis tepida (Cushman) SEIBOLD, 1971, p.44, text fig.1, pl.5, figs.4-6, pl.6, figs.1-3; 1972, p.452, pl.1, fig.b.
Ammonia beccarri ver tepida (Cushman) - RAMANATHAN, 1970, p.130.- RAO, 1974, p.64, fig.33.- REDDY *et al.*, 1974, p.15.- RAO *et al.*, 1979, p.360, table.3.- REDDY and RAO, 1980, p.168, pl.5, figs.5-6.- RAGOTHAMAN and KUMAR, 1985, p.109, pl.2, figs.15-16.- RAO *et al.*, 1985, p.76, table 1; PAL,1989, p.109, table 1.
Ammonia tepida (Cushman) RAO and RAO, 1974, p.416, pl.2, figs.10a-b; 1976a, p.300, table 7; 1970b, p.220.- SEIBOLD, 1975, pp.191-192.- BHATIA and KUMAR, 1976, p.249, table 1.- SETTY, 1976a, p.229.- BHALLA and RAGHAV, 1980, p.289, table 1.- SEIBOLD and SEIBOLD, 1981, p.42, table 3a.- VENKATACHALAPATHY and SHAREEF, 1981, p.44.- NIGAM, 1982, pp.143-145, pl.4, fig.23.- SETTY and NIGAM, 1984, p.432, pl.32, fig.15; 1985, p.286.- SETTY *et al.*, 1984, p.50, table 1.- NAIDU *et al.*, 1985, p.95, pl.2, figs.5-6.- SHAREEF and VENKATACHALAPATHY, 1987b, p.189; 1988, p.435, pl.4, figs.5a-b.- KUMAR, 1988, p.111, pl.10, figs.9-10.- KALADHAR *et al.*, 1990, p.72, table 1.- KUMAR *et al.*, 1990, p.55, table 1.- KHARE, 1992, p.177, pl.17, figs.2a-b.- HENRIQUES, 1993, pp.150-151, pl.22, fig.7.- MAYENKAR, 1994, p.159-160, pl.20, figs.7a-b.- DAS, 1996, p.49, pl.1 fig.2.- RAO, 1998, pp.220-221, pl.56, figs.3-4.- GANDHI, 1999, pp.94-95, pl.8, figs.4-5.- NIGAM and KHARE, 1999, p.303, pl.6, figs.21a-b.- NIGAM and CHATURVEDI, 2000, p.134.- CHATURVEDI, 2001, p.190, pl.14, fig.6.- KATHAL, 2002, p.449, pl.6, figs.1a-c.- MAZUMDER *et al.*, 2003, p.8, tab.1.- GANDHI and RAJAMANICKAM, 2004, p.293-304, tab.1,2.- KUMAR and SRINIVASAN, 2004, pp.299-312.

Hypotype: Maximum diameter=0.21 mm; thickness=0.10 mm.

Repository: GOD NIO Cat No.GOA-409

Genus ASTEROROTALIA Hofker, 1950

Asterorotalia dentata **(Parker and Jones)**

Plate 22, Figure 5

Rotalia beccarri (Linne) var. *dentata* - PARKER and JONES, 1865, pp.387-388, 422, pl.19, figs.18a-c.

Streblus dentatus (Parker and Jones) BHATIA, 1956, p.22, pl.3, figs.3a-c.- BHATIA and BHALLA, 1959, p.80, pl.2, figs.2a-c.- ROCHA and UBALDO, 1964a, p.416, figs.6a-c; 1964b, p.647, pl.2, figs.19-20.

Ammonia dentata (Parker and Jones) BHALLA, 1968, p.383, pl.1, figs.8a-b.- BHATIA and KUMAR, 1976, p.242.- RAO and RAO, 1976a, p.416, pl.2, fig.9.- NIGAM *et al.*, 1979, p.245.- REDDY and RAO, 1980, p.168, pl.4, figs.3-5.- SETTY and NIGAM, 1980b, p.421.- NIGAM and SARUPRIA, 1981, p.179, appendix 1. - NARAPPA *et al.*, 1982, p.221.- NIGAM and THIEDE, 1983, p.126, table 3.- BHALLA and GAUR, 1987, p.124, pl.2, figs.5a-c.- JAYARAJU, 1993, p.116, pl.4, figs.5-6.- KATHAL, 2002, p.448, pl.5, figs.7a-c.- RAO, 1998, p.219, pl.55, figs.7-10.- KUMAR and SRINIVASAN, 2004, pp.299-312.

Ammonia dentatus RAO and RAO, 1976a, p.300; 1976b, p.220.- RAO and RAO, 1978, p.426.- RAO *et al.*, 1979, p.360, table 3.- VENKATACHALAPATHY and SHAREEF, 1981, p.44.- REDDY *et al.*, 1983, p.107.- SHAREEF and VENKATACHALAPATHY, 1987a, p.194, table 1; 1987b, p.189; 1988, p.435, pl.4, figs.6a-b.

Asterorotalia dentata (Parker and Jones) HOFKER, 1971, s.28, abb.33, t71/10-13, t51/1-4.- LUTZE, 1974, p.32, pl.7, figs.117-118.- SEIBOLD, 1975, pp.192-193, figs.6a-c, pl.6, fig.2.- BHALLA and NIGAM, 1979, p:239; 1988, p.518, table 1.- BHALLA and RAGHAV, 1980, p.289, table 1.- SEIBOLD and SEIBOLD, 1981, p.13, table 3a & 5.- RAO *et al.*, 1982, p.215, table 3.- REDDY and REDDY, 1982, p.250, table 2.- NIGAM, 1984, p.423.- SETTY *et al.*, 1984, p.50, table 1.- NAIDU *et al.*, 1985, p.95, pl.2, figs.11-12.- RAO *et al.*, 1985, p.76, table 1. SETTY and NIGAM, 1985, p.286.- KUMAR, 1988, p.110, pl.10, figs.6-8.- KALADHAR *et al.*, 1990, p.72, table 1.- KHARE, 1992, p.178, pl.17, figs.3a-b.- NIGAM *et al.*, 1992b, p.536, pl.1, fig.e.- HENRIQUES, 1993, pp.151-152, pl.22, fig.8.- MAYENKAR, 1994, pp.160-161, pl.21, figs.1a-b.- JAYARAJU and REDDI, 1996, p.315, table 1.- NIGAM and KHARE, 1999, p.303, pl.6 fig.22a-b.- JAYARAJU *et al.*, 2000, p.335, table 2.- NIGAM and

CHATURVEDI, 2000, p.134.- CHATURVEDI, 2001, p.191, pl.14, fig.8.- MAZUMDER *et al.*, 2003, p.8, tab.1.- GANDHI and RAJAMANICKAM, 2004, p.293-304, tab.1,2.

Hypotype: Maximum diameter=0.80 mm; thickness=0.39 mm.
Repository: GOD NIO Cat No.GOA-410

***Asterorotalia inflata* (Millett)**
Plate 22, Figure 6

Rotalia schroeteriana PARKER and JONES var *inflata* MILLETT, 1904, p.504, pl.10, figs.5a-c.
Asterorotalia inflata (Millett) HOFKER, 1951, p.501, figs.342a-b.- SEIBOLD, 1975, pp.193-194, pl.3, figs.7a-b.- VENKATACHALAPATHY and SHAREEF, 1976, pp.373-375, pl.1, figs.3a-c.- BHALLA and NIGAM, 1979, p.239.- VENKATACHALAPATHY and SHAREEF, 1981, p.44.- SEIBOLD and SEIBOLD, 1981, p.12, table 3a.- NIGAM, 1982, p.150, pl.5, fig.5.- NARAPPA *et al.*, 1982, p.221, pl.2, fig.1.- SETTY *et al.*, 1984, p.50, table 1.- NAIDU *et al.*, 1985, p.95, pl.2, fig.13.- RAO *et al.*, 1985, p.75, table 1.- NIGAM, 1986, p.424, table 1.- SHAREEF and VENKATACHALAPATHY, 1987b, p.189; 1988, p.435,- KUMAR, 1988, p.113, pl.10. figs.11-12.- PAL, 1989, p.109, table 1.- KALADHAR *et al.*, 1990, p.72, table 1.- KHARE, 1992, p.180, pl.7, figs.4a-c.- HENRIQUES, 1993, pp.152-153, pl.22, fig.9.- MAYENKAR, 1994, pp.161-162, pl.20, figs.8a-c.- RAO, 1998, pp.221-222, pl.56, figs.5-7.- GANDHI, 1999, p.97, pl.8, fig.8.- NIGAM and KHARE, 1999, p.303, pl.6, fig.23a-c.- NIGAM and CHATURVEDI, 2000, p.134.- CHATURVEDI, 2001, p.192, pl.15, fig.1.- MAZUMDER *et al.*, 2003, p.8, tab.1.- GANDHI and RAJAMANICKAM, 2004, p.293-304, tab.1,2.- KUMAR and SRINIVASAN, 2004, pp.299-312.

Hypotype: Maximum diameter=0.25 mm; thickness=0.12 mm.
Repository: GOD NIO Cat No.GOA-411

Genus ROTALIDIUM Asano, 1936

***Rotalidium annectens* (Parker and Jones)**
Plate 22, Figure 7-8

Rotalia beccarii (Linnaeus) var. *annectens* PARKER and JONES, 1865, pp.387,422, pl.19, figs. 11a-c.

Streblus annectens (Parker and Jones) ISHIZAKI 1940, p.58, pl.3, figs.12-13.- BHATIA, 1956, p.22, pl.3, fig.1-2.- BHATIA and BHALLA, 1959, p.79, pl.2, figs.1a-c.- ROCHA and UBALDO, 1964a, p.417, pl.4, figs.3a-c; 1964b, p.647, pl.2, figs.13-14.- KYAW and SAING, 2001, p.13, pl.III, fig.57.

Ammonia annectens (Parker and Jones) HUANG, 1964, pp.50-52, pl.2, fig.3 ; pl.3, figs.1-2, text fig.3.- BHALLA, 1970, p.158, pl.20, figs.a-c.- RAO and RAO, 1974, p.416, pl.2, fig.7; 1976a, p.298; 1976b, p.217.- BHATIA and KUMAR, 1976, p.249 (table).- RAO and RAO, 1978, p.426.- BHALLA and NIGAM, 1979, p.239, NIGAM *et al.*, 1979, p.245.- RAO *et al.*, 1979, p.360, table 3.- BHALLA and RAGHAV, 1980, p.289, table 1.- SETTY and NIGAM, 1980, p.421; 1984, p.423, appendix1.- SETTY and NIGAM, 1985, p.286.- NIGAM and SARUPRIA, 1981, p.179, appendix 1.- NARAPPA *et al.*, 1982, p.221.- NIGAM and THIEDE, 1983, p.126, table 3.- NIGAM, 1984, p.423, appendix 1; 1986, p.424, table 1.- SETTY *et al.*, 1984, p.50, table 1.- SRIVASTAVA *et al.*, 1984, p.37, pl.1, fig.4.

Cavarotalia annectens (Parker and Jones) MULLER-MERZ, 1980, p.36.- NIGAM and RAO, 1987.- BHALLA and GAUR, 1987, p.124, pl.2, figs.6a-c.- BHALLA and NIGAM, 1988, p.518, table 1.- NIGAM *et al.*, 1992b, p.536, pl.1 fig.d, table 1.- TALIB and FAROOQUI, 1994, p91, table 1.

Rotalidium annectens (Parker and Jones) KHARE, 1992, P.181-182, pl.17, fig.5a-c.- HENRIQUES, 1993, pp.153-154, pl.22, figs.10a-b.- MAYENKAR, 1994, pp.162-163, pl.21, figs.2a-c.- NIGAM and KHARE, 1995, p.45.- NIGAM and KHARE, 1999, p.303, pl.7, fig.1.- NIGAM and CHATURVEDI, 2000, p.134.- CHATURVEDI, 2001, p.193, pl.15, fig.2.- KATHAL, 2002, p.448, pl.5, figs.5a-b.- MAZUMDER *et al.*, 2003, p.8, tab.1.

Hypotype: (Megalospheric) Maximum diameter=0.44 mm; thickness=0.21 mm.
(Microspheric) Maximum diameter=0.67 mm; thickness=0.30 mm.

Repository: GOD NIO Cat No.GOA-412

Genus ROTALINOIDES Saidova, 1975

Rotalinoides papillosus **(Brady)**

Plate 22, Figure 9

Rotalia papillosa BRADY, 1884, p.708, pl.106, fig.9.- GANAPATI and SATYAVATI, 1958, p.116, pl.5, figs.124-125.- ANTONY, 1968, p.93-94, pl.6, fig.9a-b.- VEDANTAM and RAO, 1970, p.329, table 3.

Streblus papillosus (Brady) BHATIA, 1956, p.23, pl.4, figs.1-2.- ROCHA and UBALDO, 1964a, p.418, pl.4, fig.7a-c; 1964b, pl.2, figs.21-23.
Ammonia papillosa (Brady) RAO *et al.*, 1979, p.357, table 3.
Ammonia papillosus (Brady) BHALLA and NIGAM, 1979, p.23 ; 1988, p.518, table 1.- NIGAM *et al.*, 1979, p.245, BHALLA and RAGHAV, 1980, p.289, table 1.- SETTY and NIGAM, 1980b, p.421; 1985, p.286.-NIGAM and SARUPRIA, 1981, p.179, appendix 1.- NIGAM and THIEDE, 1983, p.126, table 3.- NIGAM, 1984, p.423, appendix 1; 1986, p.424, table 1.- BHALLA and GAUR, 1987, p.124, pl.2, figs.7a-c.
Rotalinoides papillosus (Brady) SAIDOVA, 1975, p.220.- KHARE, 1992, pp.183-184, pl.17, figs.6a-c.- RAO, 1998, pp.224-225, pl.57, figs.8-10.- CHATURVEDI, 2001, p.194, pl.15, fig.3.

Hypotype: Maximum diameter=0.80 mm; thickness=0.52 mm.
Repository: GOD NIO Cat No.GOA-413

4.5.1.72 Family ELPHIDIIDAE Galloway, 1933
Subfamily ELPHIDIINAE Galloway, 1933
Genus CRIBRONONION Thalmann, 1947

***Cribrononion simplex* (Cushman)**
Plate 22, Figure 10

Elphidium simplex CUSHMAN, 1933b, pt.2, p.52, pl.12, figs.8-9.- KURIAN, 1953, p.755.- BHATIA, 1956, p.20, pl.5, fig.13.- BHATIA and BHALLA, 1959, p.79, pl.1, figs.7a-b.- ROCHA and UBALDO, 1964a, p.417, pl.3, figs.10a-b.- BHALLA, 1968, p.386, pl.2, figs.3a-b.- RAO, 1971b, p.159, fig.38.- RAO and RAO, 1974, p.418, pl.3, fig.5; 1976a, p.3000, tab.7.- REDDY *et al.*, 1974, p.19, BHATIA and KUMAR, 1976, p.248, tab.- NIGAM *et al.*, 1979, p.245.- REDDY and RAO, 1980, p.169, pl.6, fig.6.- SETTY and NIGAM, 1980, p.421.- NARAPPA *et al.*, 1982, p.221.- NIGAM and THIEDE, 1983, p.126, tab.3.- SETTY and NIGAM, 1984, p.434, pl.33, fig.9.- RAO *et al.*, 1987, p.169, pl.6, fig.11.- BHALLA and NIGAM, 1988, p.518, tab.1.- KALADHAR *et al.*, 1990, p.72, tab.1.- KHARE, 1992, p.193, pl.19, figs.2a-b.
Cribrononion simplex (Cushman) DEBENAY and BASOV, 1993.- RAO, 1998, p.225, pl.58, figs.1-2.- KUMAR and SRINIVASAN, 2004, pp.299-312.

Hypotype: Maximum diameter=0.23 mm; thickness=0.11 mm.
Repository: GOD NIO Cat No.GOA-414

Genus ELPHIDIUM Montfort, 1808

Elphidium advenum **(Cushman)**

Plate 23, Figure 1

Polystomella subnodosa BRADY, 1884, p.734, pl.10, figs.1a-b.

Polystomella advena CUSHMAN, 1922, p.56, pl.9, figs.11-12.

Elphidium advena (Cushman) BHATIA, 1956, p.20, pl.5, figs.9a-b.- RAO, 1971b, p.159, fig.35.- RAO and RAO, 1974, p.418, pl.3, fig.2.- SETTY and NIGAM, 1980b, p.421; 1985, p.286. - NIGAM, 1986, p.424, table 1.- BHALLA and NIGAM, 1988, p.518, table 1.- PAL, 1989, p.109, table 1.- KYAW and SAING, 2001, p.16, pl.III, fig.90.

Elphidium advenum CUSHMAN, 1930, p.25, pl.10, figs.1-2.- SETHULEKSHMI AMMA, 1958, p.22, pl.1, fig.34.- BHATIA and BHALLA, 1959, p.79, pl.1, figs.9a-b.- ROCHA and UBALDO, 1964a, p.416, pl.3, fig.5; 1964b, p.647, pl.1, fig.4.- ANTONY, 1968, p.61, pl.4, fig.4.- BHALLA, 1968, pp.384-385, pl.2, figs.5a-b.- REDDY *et al.*, 1974, p.19.- SEIBOLD, 1975, p.195, pl.2, fig.4.- RAO and RAO, 1978, p.426.- BHALLA and NIGAM, 1979, p.239.- NIGAM *et al.*, 1979, p.246.- REDDY and RAO, 1980, p.169, pl.4, figs.13-14.- SEIBOLD and SEIBOLD, 1981, p.44, table 3b.- NIGAM, 1982, p.158-161, pl.6, fig.14.- RAO *et al.*, 1982, p.215, table 3.- REDDY and REDDY, 1982, p.250, table 2.- REDDY *et al.*, 1983, p.107.- SETTY and NIGAM, 1984, p.434, pl.33, fig.10.- SETTY *et al.*, 1984, p.50, table 1.- SRIVASTAVA *et al.*, 1984, p.37, pl.1, fig.7.- RAO *et al.*, 1985, p.76, table 1.- BHALLA and GAUR, 1987, p.124, pl.1, fig.10.- NAIDU, 1987, p.27, table 7.- KUMAR, 1988, p.120, pl.11, fig.8.- KALADHAR *et al.*, 1990, p.72, table 1.- KHARE, 1992, pp.185-186, pl.18, figs.1a-b.- HENRIQUES, 1993, pp.154-155, pl.22, figs.11a-b.- JAYARAJU, 1993, p.120, pl.5, fig.1.- MAYENKAR, 1994, pp.163-164, pl.21, figs.3a-b.- DAS, 1996, p.49, table1.- RAO, 1998, p.226, pl.58, figs.5-6.- NIGAM and KHARE, 1999, p.303, pl.7, fig.4a-b.- NIGAM and CHATURVEDI, 2000, p.134.- CHATURVEDI, 2001, p.195, pl.15, fig.5.- KATHAL, 2002, p.449, pl.6, figs.6a-c.- MAZUMDER *et al.*, 2003, p.8, tab.1.- RAJSHEKHAR and REDDY, 2003, p.36.- GANDHI and RAJAMANICKAM, 2004, p.293-304, tab.1,2.

Hypotype: Maximum diameter=0.41 mm; thickness=0.21 mm.
Repository: GOD NIO Cat No.GOA-415

Elphidium crispum **(Linne)**

Plate 23, Figure 2

Nautilus crispum LINNE, 1758, p.709.

Elphidium crispum (Linne) CUSHMAN and GRANT, 1927, p.73, pl.7, figs.3a-b.- BHATIA, 1956, p.20, pl.5 figs.11a-b.- SETHULEKSHMI AMMA, 1958, p.22, pl.1, fig.33.- ROCHA and UBALDO, 1964a, p.416, pl.3, figs.8, 12.- ANTONY, 1968, p.60, pl.3, fig.27.- BHALLA, 1968, pp.385-386, pl.2, figs.4a-b; 1970, pp.158-159, pl.21, figs.1a-b.- RAO, 1970b, p.264, pl.4, fig.46; 1974, p.67, fig.28.- VEDANTAM and RAO, 1970, p.329, table 3.- REDDY *et al.*, 1974, p.19.- SEIBOLD, 1975, p.195.- BHATIA and KUMAR, 1976, p.249.- RAO and RAO, 1976b, p.217.- RAO and RAO, 1978, p.426.- BHALLA and NIGAM, 1979, p.239.- NIGAM *et al.*, 1979, p.246.- RAO *et al.*, 1979, p.357, table 3.- BHALLA and RAGHAV, 1980, p.289, table 1.- REDDY and RAO, 1980, p.169, pl.6, figs.1-2.- SETTY and NIGAM, 1980b, p.421.- SEIBOLD and SEIBOLD, 1981, p.44, table 3b.- VENKATACHALAPATHY and SHAREEF, 1981, p.44 - NARAPPA *et al.*, 1982, p.221.- RAO *et al.*, 1982, p.215, table 3.- NIGAM, 1982, pp.164-166, pl.6, fig.2.- REDDY and REDDY, 1982, p.250, table 2.- REDDY *et al.*, 1983, p.107.- SETTY and NIGAM, 1984, p.434, pl.33, fig.12.- BHALLA and LAL, 1985, p.430.- RAGOTHAMAN and KUMAR, 1985, p.109, pl.2, figs.24-25.- RAO *et al.*, 1985, p.76, table 1; 1987, p.169, pl.6, fig.5.- SHAREEF and VENKATACHALAPATHY, 1987b, p.189; 1988, p.436, pl.4, fig.8.- BHALLA and NIGAM, 1988, p.518, table 1.- KUMAR, 1988, p.121, pl.12, fig.6.- KALADHAR, *et al.*, 1990, p.72, table 1.- KHARE, 1992, pp.187-189, pl.18, figs.3a-b.- HENRIQUES, 1993, pp.156-157, pl.23, figs.1a-b.- JAYARAJU, 1993, p.121, pl.5, fig.2.- MAYENKAR, 1994, pp.165-166, pl.21, figs.4a-b.- TALIB AND FAROOQUI, 1994, p.91, table 1. – JAYARAJU and REDDI, 1995, p.570, table 3; 1996, p.315, table 1.- RAO, 1998, p.227-228, pl.58, figs.9-10.- NIGAM and KHARE, 1999, p.303, pl.7, fig.6a-b.- NIGAM and CHATURVEDI, 2000, p.134.- CHATURVEDI, 2001, p.196, pl.16, fig.2.- KATHAL, 2002, p.449, pl.6, figs.10a-c.- MAZUMDER *et al.*, 2003, p.8, tab.1.- RAJSHEKHAR and REDDY, 2003, p.36.- GANDHI and RAJAMANICKAM, 2004, p.293-304, tab.1,2.- KUMAR and SRINIVASAN, 2004, pp.299-312.

Hypotype: Maximum diameter=0.58 mm; thickness=0.30 mm.

Repository: GOD NIO Cat No.GOA-416

***Elphidium discoidale* (d'Orbigny)**

Plate 23, Figure 3

Polystomella discoidale D'ORBIGNY, 1840, p.46, pl.6, figs.23-24.

Elphidium discoidale (d'Orbigny) CUSHMAN, 1930, p.22, pl.8, figs.8-9.- RAMANATHAN, 1970, p.130.- VEDANTAM and RAO, 1970, p.329, table 3.- RAO and RAO, 1974, p.418, pl.3, fig.2.- SEIBOLD, 1975, p.195, pl.2, figs.8a-b.- RAO and RAO, 1976a, p.300, table 7; 1976b, p.217.- RAO *et al.*, 1979, p.360, table 3.- BHALLA and RAGHAV, 1980, p.289, table 1.- SEIBOLD and SEIBOLD, 1981, p.12, table 3a.- VENKATACHALAPATHY and SHAREEF, 1981, p.44 - NARAPPA *et al.*, 1982, p.221.- RAO *et al.*, 1982, p.215, table 3.- SETTY *et al.*, 1984, p.50, table 1.- RAO *et al.*, 1985, p.76, table 1.- SHAREEF and VENKATACHALAPATHY, 1987a, p.194, table 1; 1987b, p.189; 1988, p.436, pl.4, fig.7.- KUMAR, 1988, p.123, pl.12, fig.4.- KALADHAR, *et al.*, 1990, p.72, table 1.- KHARE, 1992, pp.189-190, pl.18, figs.4a-b.- HENRIQUES, 1993, p.157, pl.23, figs.2a-b.- JAYARAJU, 1993, p.123, pl.5, fig.3.- MAYENKAR, 1994, p.166, pl.21, figs.5a-b.- DAS, 1996, p.49, table1.- RAO, 1998, p.230, pl.59, fig.8.- GANDHI, 1999, pp.103-104, pl.9, fig.5-6.- NIGAM and KHARE, 1999, p. 303, pl.7, fig.7a-b.- JAYARAJU *et al.*, 2000, p.335, table 2.- NIGAM and CHATURVEDI, 2000, p.134.- CHATURVEDI, 2001, p.197, pl.16, fig.3.- KYAW and SAING, 2001, p.16, pl.III, fig.91.- KATHAL, 2002, p.450, pl.6, figs.4a-b.- MAZUMDER *et al.*, 2003, p.8, tab.1.- GANDHI and RAJAMANICKAM, 2004, p.293-304, tab.1,2.

Hypotype: Maximum diameter=0.30 mm; thickness=0.16 mm.
Repository: GOD NIO Cat No.GOA-417

***Elphidium macellum* (Fichtel and Moll)**
Plate 23, Figure 4

Nautilus macellus var. beta FICHTEL and MOLL, 1798, p.66, pl.10, figs.h-k.

Elphidium macellum (Fichtel and Moll) CUSHMAN, 1939a, p.31, pl.14, figs.1-3; pl.15, figs.9-10.- ANTONY, 1968, p.63, pl.3, fig.28.- GANDHI and RAJAMANICKAM, 2004, p.293-304, tab.1,2.

Hypotype: Maximum diameter=0.47 mm; thickness=0.23 mm.
Repository: GOD NIO Cat No.GOA-418

***Elphidium minutum* (Reuss)**
Plate 23, Figure 5

Polystomella minuta REUSS, 1864, p.478, pl.4, figs.6a-b.

Elphidium minutum (Reuss) CUSHMAN, 1939a, p.40, pl.10, figs.22-25.- BHALLA, 1968, p.386, pl.2, fig.6a-b; 1970, p.159, pl.21, figs.2a-b.- NIGAM *et al.*, 1979, p.245.- NIGAM, 1982, p.171, pl.6, fig.6.- DAS, 1996, p.49, table1.- CHATURVEDI, 2001, p.200, pl.16, fig.7.

Hypotype: Maximum diameter=0.39 mm; thickness=0.19 mm.
Repository: GOD NIO Cat No.GOA-419

***Elphidium reticulosum* Cushman**
Plate 23, Figure 6

Elphidium reticulosum CUSHMAN, 1933a, p.51, pl.12, figs.5a-b.- CUSHMAN, 1939a, p.59, pl.16, fig.24.

Hypotype: Maximum diameter=0.30 mm; thickness=0.15 mm.
Repository: GOD NIO Cat No.GOA-420

Superfamily NUMMULITACEA Blainville, 1827

4.5.1.73 Family NUMMULITIDAE Blainville, 1827
Genus HETEROSTEGINA d'Orbigny, 1826

***Heterostegina* sp.**
Plate 23, Figure 7

Remarks: A centrally thickened test, calcareous walls and an anastomosing bundle of the canals in the peripheral band characterize these. However in the study area, this species is very rare and its surfaces are abraded. Hence its nomenclature was kept open under the genus *Heterostegina*.

Hypotype: Maximum diameter=0.38 mm; thickness=0.10 mm.
Repository: GOD NIO Cat No.GOA-421

Genus OPERCULINA d'Orbigny, 1826

***Operculina complanata* (Defrance)**

Plate 23, Figure 8

Lenticulites complanatus DEFRANCE, 1822, p.453.

Operculina complanata (Defrance) BRADY, 1884, p.743, pl.112, figs.3,5,8.- GANAPATI and SATYAVATI, 1958, p.115, pl.4, fig.91.- ANTONY, 1968, p.65, pl.4, fig.9.- SAING, 1972, p.371, pl.5, fig.18.- KYAW and SAING, 2001, p.16, pl.IV, fig.103.

Hypotype: Maximum diameter=0.49 mm; thickness=0.10 mm.

Repository: GOD NIO Cat No.GOA-422

***Operculina granulosa* Leymerie**

Plate 23, Figure 9

Operculina granulosa LEYMERIE, 1846, pp.337-373.- GANAPATI and SATYAVATI, 1958, p.108, pl.4, fig.92.- SETHULEKSHMI AMMA, 1958, p.19, pl.1, figs.29a-c.- ANTONY, 1968, p.64, pl.4, figs.7a-b.- RAO, 1970b, p.264, pl.5, fig.48.- VEDANTAM and RAO, 1970, p.329, tab.3.- KHARE, 1992, p.197, pl.9, figs.7a-c.- MAYENKAR, 1994, p.167, pl.21, fig.8.- RAO, 1998, p.233, pl.60, fig.9.- MAZUMDER *et al.*, 2003, p.8, tab.1.

Hypotype: Maximum diameter=0.56 mm; thickness=0.13 mm.

Repository: GOD NIO Cat No.GOA-423

4.6 FIRST REPORT

From the taxonomic studies we were able to list out the species that are being reported for the first time from the entire Indian Ocean and the Arabian Sea.

4.6.1 INDIAN OCEAN

Of all the 423 species described above, the following species are being reported for the first time from the Indian Ocean:

Ammobaculites filiformis Earland, *Ammolagena clavata* (Parker and Jones), *Ammonia* aff. *A. globosa* (Millett), *Ammonia ketienziensis angulata* (Kuwano), *Bifarilaminella advena* (Cushman), *Bolivina* cf. *B. inflata* Heron-Allen and Earland, *Bolivina* cf. *B. oceanica* Cushman, *Bolivina spinata* Cushman, *Bolivinella elegans* Parr, *Botuloides pauciloculus* Zheng, *Brizalina difformis* (Williamson), *Bulimina mexicana* Cushman, *Buliminella* cf. *B. milletti* Cushman, *Cassidulina sicula* Seguenza, *Cassidulina subcarinata* Uchio, *Cassidulina tortuosa* Cushman and Hughes, *Cassidulinoides bradyi* (Norman), *Ceratobulimina jonesiana* (Brady), *Cibicides* cf. *C. fletcheri* Cushman and McCulloch, *Cibicides pachyderma* (Rzehak), *Cibicidina walli* Bandy, *Cibicidoides bradii* (Tolmachoff), *Cibicidoides globulosus* (Chapman and Parr), *Cribrostomoides* cf. *C. bradyi* Cushman, *Cushmanina plumigera* (Brady), *Cystammina pauciloculata* (Brady), *Dentalina ariena* Patterson and Pettis, *Dentalina bradyensis* (Dervieux), *Dentalina cf. D. albatrossi* (Cushman), *Dentalina inflexa* (Reuss), *Dentalina turgoidea* Kristan-Tollmann, *Elphidium reticulosum* Cushman, *Epistominella minuta* (Olsson), *Eratidus* cf. *E. foliaceus* (Brady), *Fissurina* aff. *F. duplicata* (Sidebottom), *Fissurina* aff. *F. pulchella* (Brady), *Fissurina* aff. *F. striolata* (Sidebottom), *Fissurina bradyiformata* (McCulloch), *Fissurina earlandi* Parr, *Fissurina fissicarinata* Parr, *Fissurina imporcata* McCulloch, *Fissurina milletti* Todd, *Fissurina seguenziana* (Fornasini), *Fissurina semimarginata* (Reuss), *Fissurina staphyllearia* Schwager, *Fissurina submarginata* Boomgaart, *Francuscia extensa* (Cushman), *Fursenkoina bradyi* (Cushman), *Fursenkoina complanata* (Egger), *Glandulina ovula* d'Orbigny, *Globocassidulina oriangulata* Belford, *Gyroidina* cf. *G. pulisukensis* (Saidova), *Haplophragmoides* cf. *H. tenuis* Cushman, *Hormosina globulifera* Brady, *Hormosina spiculifera* Hofker, *Karreriella* cf. *K. chilostoma* (Reuss), *Karrerulina erigona* (Saidova), *Lagena* aff. *L. undulata* Sidebottom, *Lagena alticostata* Cushman, *Lagena caudata* (d'Orbigny), *Lagena* cf. *L. multilatera chathamensis* McCulloch, *Lagena favosiformis proba* McCulloch, *Lagena flatulenta* Loeblich and Tappan, *Lagena gibbera* Buchner, *Lagena multilatera* McCulloch, *Lagena substriata elegantula* Jones, *Lenticulina angulata* (Reuss), *Lenticulina crassa* (d'Orbigny), *Lenticulina cultrata* (Montfort), *Lenticulina limbosus chiriguanoi* (Boltovskoy), *Lenticulina pliocaena* (Silvestri), *Lenticulina subcarinata* (Cushman), *Mesosigmoilina minuta* (Collins), *Miliolinella* cf. *M.oceanica* (Cushman), *Miliolinella warreni* Andersen, *Murrayinella* cf. *M. murrayi* (Heron-Allen and Earland), *Neoconorbina parkerae* (Natland), *Nodosaria lamnulifera* Thalmann, *Nonionella auricula* Heron-Allen and Earland, *Nonionella* cf. *N. limbato-striata* Cushman, *Oolina apiopleura* (Loeblich and Tappan), *Oolina felsinea* (Fornasini), *Oolina setosa* (Earland), *Oolina truncata* (Brady), *Orectostomina camposi* (Brönnimann and Beurlen), *Orthomorphina* aff. *O. parvula* (Todd), *Parafissurina* aff. *P. arctica* Green, *Parafissurina fusiformis* (Wiesner), *Parafissurina himatiostoma* Loeblich and Tappan, *Parafissurina lateralis* (Cushman), *Parafissurina subcarinata* Parr, *Patellinella inconspicua* (Brady), *Planularia australis* Chapman, *Procerolagena ingens* (Buchner), *Proxifrons advena* (Cushman), *Pygmaeoseistron nebulosum* (Cushman), *Pyramidulina cancellata* (d'Orbigny), *Pyramidulina* cf. *P. eptagona* Costa, *Pyrgo elongata* (d'Orbigny), *Pyrgo striolata* (Brady), *Quinqueloculina* cf. Q. *inaequalis* d'Orbigny, *Quinqueloculina distorqueata* Cushman, *Quinqueloculina quadrilateralis* (d'Orbigny), *Quinqueloculina subpolygona* Parr, *Reophanus ovicula* (Brady), *Reophax mortenseni* Hofker, *Reophax nodulosus* Brady, *Reussella laevigata* Cushman, *Saccorhiza ramosa* (Brady), *Saracenaria latifrons* (Brady), *Siphotextularia* cf. *S. concava* (Karrer), *Spiroloculina* aff. S. *caduca* Cushman, *Spiroloculina angulosa* d'Orbigny, *Spiroloculina venusta* Cushman and Todd, *Tritaxis challengeri* (Hedley, Hurdle and Burdett), *Trochammina* cf. *T. nana* (Brady), *Usbekistania charoides* (Jones and Parker), *Uvigerina brunnensis* Karrer, *Uvigerina hollicki* Thalmann, *Uvigerina vadescens* Cushman, *Vaginulina* aff. *V. badenensis* d'Orbigny, *Vaginulina* cf. *V. hemitemna* Kristan-Tollmann and *Verneuilinulla propinqua* (Brady).

4.6.2 ARABIAN SEA

Similarly, the following species are being reported from the Arabian Sea for the first time:

Ammodiscus incertus (d'Orbigny), *Baggina indica* (Cushman), *Bolivina silvestrina* Cushman, *Bombulina spinata* (Cushman), *Cibicides lucida* (Reuss), *Cycloforina semiplicata* (McCulloch), *Fursenkoina* cf. *F. schreibersiana* (Czjzek), *Laevidentalina filiformis* (d'Orbigny), *Lagena* cf. *L. oceanica* Albani, *Lagena hispida* Reuss, *Lagena lyellii* (Seguenza), *Lagena pecularis* Cushman and McCulloch, *Lagena spiratiformis* McCulloch, *Lenticulina* cf. *L. gibba* (d'Orbigny), *Lenticulina limbosa* (Reuss), *Marginopora vertebralis* Quoy and Gaimard, *Miliolinella lamellidens* (Reuss), *Miliolinella lutea* (d'Orbigny), *Neoconorbina terquemi* (Rzehak), *Nonion pacificum* (Cushman), *Nonion sloanii* (d'Orbigny), *Nonionella* cf. *N. japonica* (Asano), *Oolina lineata* (Williamson), *Pyrgo* cf. *P. denticulata* (Brady), *Pyrgo* cf. *P. nasutus* Cushman, *Sagrinella convallaria* (Millett), *Triloculina striatotrigonula* Parker and Jones, *Uvigerina aculeata* d'Orbigny, *Uvigerina bassensis* Parr. and *Uvigerina bifurcata* d'Orbigny.

4.7 SUMMARY

(i) A total of 423 species are reported within the depth range of 15 to 3300 m off Goa region.

(ii) A large number of species are reported for the first time from the Indian Ocean and/or Arabian Sea. This is due to the fact that no attempt was made to catalogue the foraminifera from the deeper part of the Arabian Sea. As shown in Figure 1.2 (Chapter 1), most of the earlier reports are based on shelf sediments only.

(iii) The study also reports a number of species identified up to generic level. Due to limited time available, only taxonomic notes have been added but naming "New Species" has been avoided. In future, their remains a scope to decide upon their taxonomic status (new or not) by using additional material, and comparison with collections of type species in well-known centres within India and abroad, like British Museum of Natural History, American Museum of Natural History etc. This decision is in agreement with the policy of the Micropaleotology lab, National Institute of Oceanography, Goa so as not to simply enlarge data by naming more "New Species" without taking proper care to countercheck with the already available extensive list of species of foraminifera.

CHAPTER 5

RELICT BENTHIC FORAMINIFERA: PALEOCLIMATIC IMPLICATIONS

5.1 INTRODUCTION

As discussed in Chapter 4 (pages 73-74), a considerable number of specimens encountered in surface sediments cannot be placed under the category of Recent foraminifera. Such specimens are identified by their earthy colour, dull luster, abraded or polished surfaces and broken tests with deposition of secondary material. The term 'relict' is used for such foraminiferal specimens that remained on the seafloor for thousands of years without any major transportation (Murray, 1991).

Such specimens once identified with reference to their ecology, distribution and time of deposition can be helpful to derive inference about paleoclimatic conditions of the area in which they occur. In view of the above, such specimens encountered from the study area are identified (list of the all species identified is in Chapter 4, page 74) and their distribution pattern along with their ecology and significance are discussed in this chapter. In order to understand the comprehensive distribution of relict foraminifera off central west coast of India, 51 additional samples (Table 3.3) within the depth zone of 46 to 1330 m (Henriques, 1993) were also used along with data from 52 core top samples of the present study.

5.2 DISTRIBUTION PATTERN OF RELICT BENTHIC FORAMINIFERA

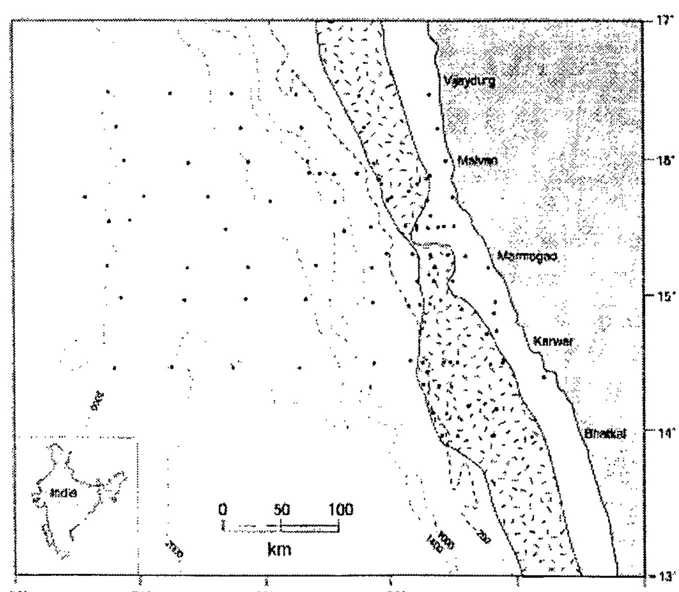


Figure 5.1: 'Relict zone' encountered off central west coast of India

In study area, within 50-135 m water depth, the abundance of relict benthic foraminifera varies from 5.35% (at station SC-51) to 18.18% (at station SC-30) of total benthic foraminifera. The fauna comprise of 32 species belonging to 14 genera and 9 families. This zone of relict fauna is referred to as a 'relict zone', for this study and illustrated as a shaded area in the figure 5.1.

Relict benthic foraminiferal genera encountered in this study include *Alveolinella*, *Ammonia*, *Amphistegina*, *Elphidium*, *Eponides*, *Operculina*, *Quinqueloculina*, *Rotalinoides*, *Sahulia*, *Siphonaperta*, *Spiroloculina*, *Spiroplectinella*, *Textularia* and *Triloculina*. Table 5.1 lists the species under major genera encountered off central west coast of India.

Table 5.1: Relict benthic foraminiferal species under major genera encountered off central west coast of India

Sr.No.	Genus	Species
1.	*Alveolinella*	*A. quoii*
2.	*Ammonia*	*A. tepida*
3.	*Amphistegina*	*A. lessonii*, *Amphistegina* sp.
4.	*Elphidium*	*E. advenum*, *E. craticulatum*, *E. crispum*, *E. discoidale*, *E. macellum*
5.	*Eponides*	*Eponides* sp.
6.	*Operculina*	*O. complanata*, *Operculina* sp.
7.	*Quinqueloculina*	*Q. bicarinata*, *Q. intricata*, *Q. kerimbatica*, *Q. ludwigi*, *Q. seminulum*, *Q. vulgaris*, *Quinqueloculina* sp.
8.	*Rotalinoides*	*R. papillosa*
9.	*Sahulia*	*S. conica*
10.	*Siphonaperta*	*S. agglutinans*, *S. horrida*
11.	*Spiroloculina*	*S. exilis*, *S. indica*
12.	*Spiroplectinella*	*S. sagittula*
13.	*Textularia*	*T. agglutinans*, *T. bulbosa*, *Textularia* cf. *T. pseudogramen*, *Textularia* sp.
14.	*Triloculina*	*T. terqemiana*, *T. tricarinata*, *Triloculina* sp.

Depending upon the major assemblages of relict foraminifera, two distinct subzones can be delineated:

1. Agglutinated subzone – This subzone is represented by six species of agglutinated genera *Textularia*, *Sahulia* and *Spiroplectinella*. The representative species of these genera are *Textularia agglutinans*, *T. bulbosa*, *T.* cf. *pseudogramen*, *Textularia* sp., *Sahulia conica*, and *Spiroplectinella sagittula*. This group is predominant in relatively shallower part of the relict benthic foraminiferal zone and comprises ~45–50% of total relict fauna at ~50 to ~75 m water depth.
2. *Alveolinella–Amphistegina–Operculina* subzone – This subzone is represented by three robust genera *Alveolinella*, *Amphistegina* and *Operculina* with five species; namely, *Alveolinella quoii*, *Amphistegina lessonii*, *Amphistegina* sp., *Operculina complanata* and *Operculina* sp. This assemblage is predominant at relatively deeper part of the relict zone and constitutes ~13–40% of total relict fauna at ~85-135 m water depth.

The region between agglutinated and *Alveolinella–Amphistegina–Operculina* subzone is marked by the presence of a transitional zone characterized by relict foraminifera fouled by barnacles (sessile cirripedes; Figure 3.3), and this subzone partially overlaps the agglutinated and *Alveolinella–Amphistegina–Operculina* subzones. This barnacle fouled relict foraminifera subzone extends from a water depth of 60 m to 90 m. Figure 5.2 shows the schematic depth zonation of two different relict benthic foraminiferal assemblages along with the overlapping barnacle zone.

In order to assess the paleoclimatic significance of relict assemblage, the chronology to the relict assemblage was assigned on the basis of radiocarbon dating of surface sediments associated with relict foraminifera from the depth of ~100 m, which gives an age of 12,000-10,000yr BP (Nigam *et al.*, 1993).

5.3 DISCUSSION

Relict foraminifera have been encountered from numerous parts of world oceans and have been applied to solve diverse geological problems. Here we show how relict foraminifera can help indicate the presence of ancient coral reef and its destruction with reference to sea level changes and associated phenomena.

Figure 5.2 Schematic representations of three relict zones. The elongated conical tests represent the agglutinated subzone; deformed polygonal tests show the barnacle subzone while rounded tests represent *Amphistegina-Alveolinella-Operculina* subzone.

Amphistegina, Alveolinella, Operculina, Quinqueloculina, Spiroloculina, Triloculina, Elphidium and *Textularia* dominating the relict assemblage in the deeper part of the relict zone from the study area are amongst the important benthic foraminiferal genera reported from world's famous reef systems, with first three genera being considered as the index fauna for coral reef (Venne-Peyre, 1985; Hart and Kaesler, 1986; Martin and Right, 1988; Hallock, 1995; Hohenegger, 1998; Yordanova and Hohengger, 1998; Langer and Lipps, 2003).

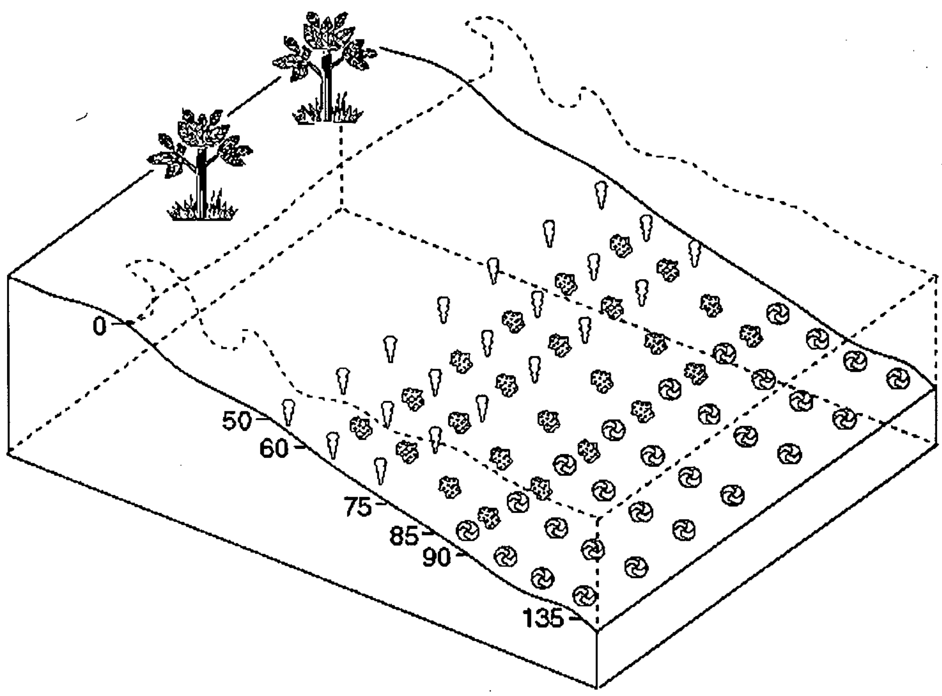


Figure 5.2: Schematic representation of three relict zones. The elongated conical tests represent the Agglutinated subzone; deformed polygonal tests show the Barnacle subzone while rounded tests represent *Amphistegina-Alveolinella-Operculina* subzone.

Based on the high abundance of relict *Amphistegina, Alveolinella* and *Operculina,* the presence of a paleo-reef environment is postulated within the depth range of 85-135 m in the study area. Similar conditions have also been reported from other parts of the world and have been used to understand past sea level variations (Stoddart, 1971; MacIntyre, 1972).

To infer the paleoenvironmental significance of paleo-reef, it is necessary to understand physico-chemical preferences of modern day reefs. Modern coral reefs are restricted within the tropical region with temperature and salinity range of 17-34°C and 30-38‰ respectively; normally marine water with considerably low turbidity with the maximum water depth of

30m is most congenial for a coral reef to flourish (Guilcher, 1988). As the paleo-reef environment in the study area is inferred at a depth range of 85 to 135 m, the paleo-sea level (at 12,000-10,000 yr BP) can approximately be fixed at a water depth ~80 m lower than present.

The conclusion regarding the presence of a paleo-reef and thus the lowered sea level are in agreement with the geomorphological/geophysical and bathymetric studies (Fig. 5.3, 5.4 and 5.5) carried out in this region (Vora and Almeida, 1990; Vora *et al.*, 1996; Wagle *et al.*, 2002; Rao *et al.*, 2003). These studies indicated the existence of a 1300 km long shelf edge barrier reef system of 9,200 to 11,330 yr BP age at a water depth of 85-136 m. Figure 5.3 shows the presence of early Holocene reef system postulated by the aforesaid authors.

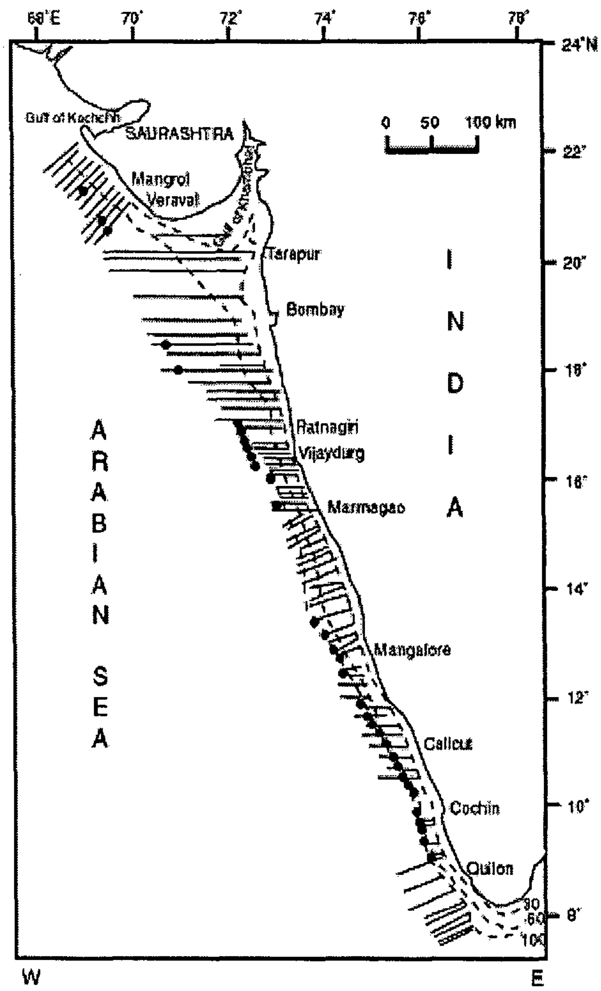


Figure 5.3: Postulated early Holocene reef system along west coast (modified after Vora *et al.*, 1996); straight lines represent the line of echo sounding and side scan sonar data, while black dots represent the presence of past reef.

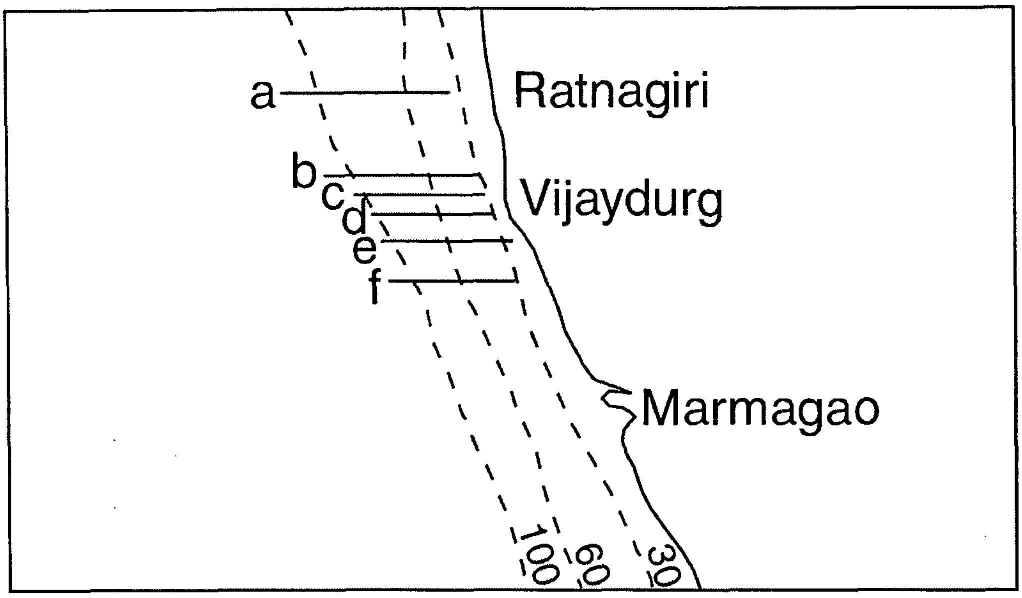


Figure 5.4: Close view of present study area (modified after Vora *et al.*, 1996) Lines a, b, c, d, e and f are the lines of echo sounding and side scan sonar data

The inference regarding lowered sea level, based on the presence of a paleo-reef also gets credence from the abundance of relict barnacle at a water depth of 60 m to 90 m (Figure 5.6). Nigam *et al.* (1993) and Henriques (1993) reported the abundance of relict barnacle, *Tetraclita squamosa*, attached to the relict foraminifera, at a depth of 60-90 m in the study area. Ecologically *T. squamosa* represents high salinity and high-energy intertidal depth zone environment (Ekman, 1967). *T. squamosa rufotincta* (Pilsbury) has been reported within tidemarks on rock (Daniel, 1972). However, this species is totally absent in the modern environment of the west coast of India (Wagh, 1972). The relict presence of *T. squamosa* can be explained by the fact that it resided in this area and got encrusted on foraminiferal tests when the sea level was lower ~10,000 yr BP, thus indicating that at ~10,000 yr BP, the shore line was ~80 m lower than that at present.

A third zone dominated by agglutinated foraminifera, mainly Textularia towards the shallower depths, follows the zone of 'barnacle encrusted relict foraminifera'. *Textularia*, agglutinated rectilinear biserial benthic foraminifer is a well-known genus indicating "shallow water low salinity condition" (Kaminski *et al.*, 2002). Presence of six relict species of *Textularia* and other agglutinated genera at the water depth of 50-75 m with an abundance of ~55.0% of total relict benthic foraminifera, indicate the decline of salinity, most probably due to high influx of fresh water.

The fresh water influx probably resulted in increased turbidity as well as sea level rise, which eventually destroyed the coral reef. The barnacle species *Tetraclita squamosa* (now relict) could not keep pace with the sudden fall in salinity below its tolerant limit due to freshwater influx, and subsequent sea level rise, and hence disappeared in the course of time from this area.

The findings of the present study can also be discussed with reference to the Holocene sea level fluctuation curve (Figure 5.7) from the western Indian continental margin (Hashimi *et al.*, 1995). The figure 5.7 places the paleo-shoreline at 80-90 m depth around 12,000 yr BP, followed by a stand-still for about 2000 years and then a rapid sea level rise up to 7000 yr BP (Hashimi *et al.*, 1995). During 12,000-10,000 yr BP, when the paleo-shoreline was at a standstill at 80 m depth or was on a very slow rise, the reef formed and flourished at the water depth of 85 m to 135 m under conditions favorable for its growth. The rapid sea level rise between ~10,000 to ~7,000 yr BP probably caused the extinction of the barnacle and increase in the abundance of *Textularia.*

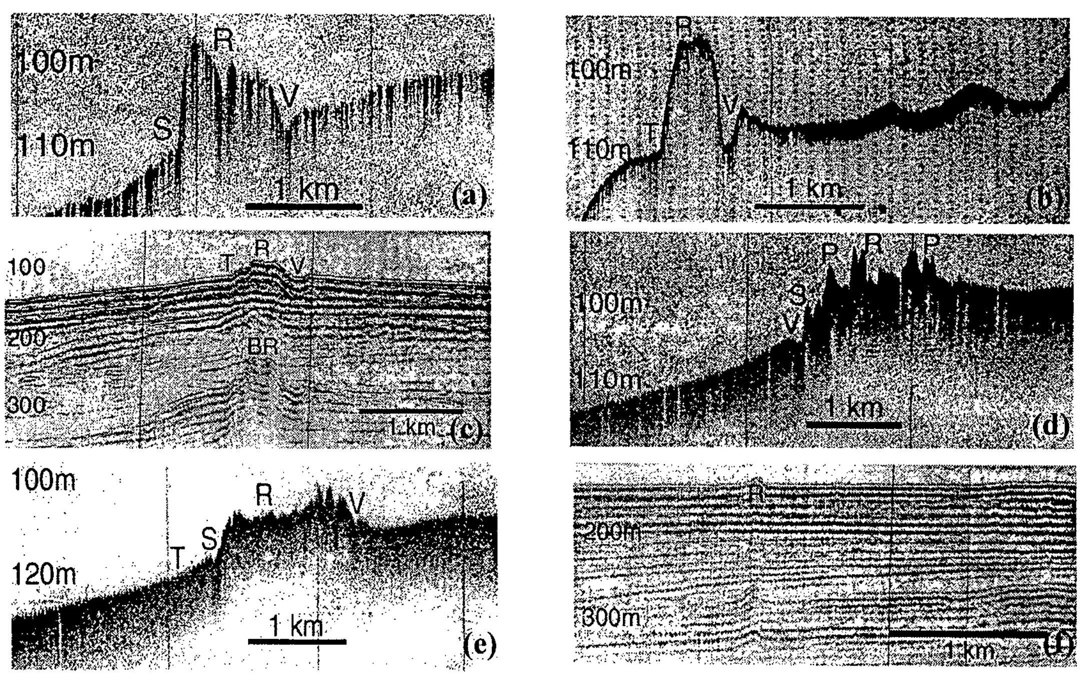


Figure 5.5: Echo sounding and side scan sonar profile for the lines a to f respectively of figures 5.3 (modified after Vora *et al.*, 1996); R = reef; BR = buried reef; T = terrace; V= valley/depression; S= scarp; P= pinnacle.

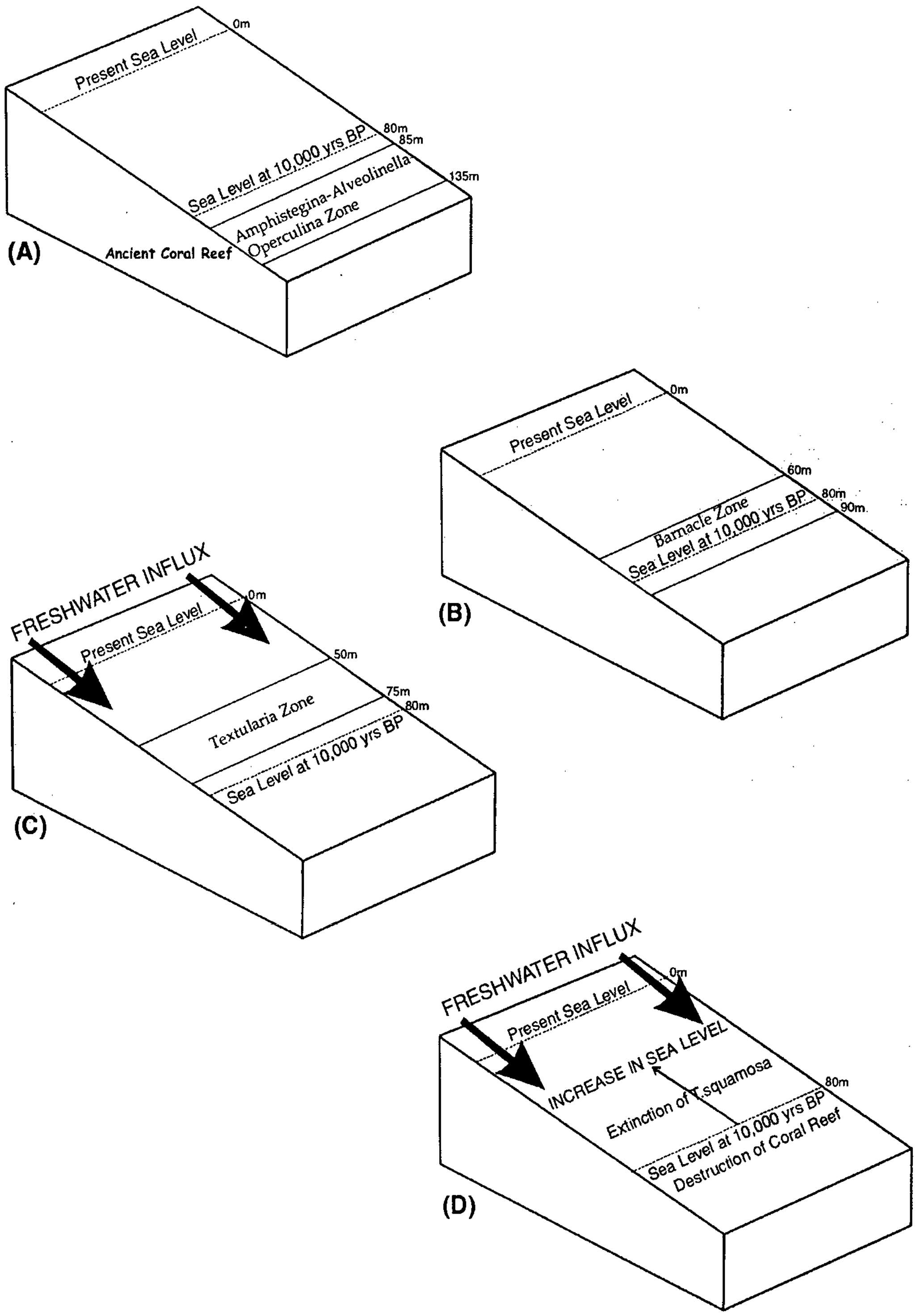


Figure 5.6: Schematic representation of paleoclimatic scenario at ~10,000 BP; (A) Ancient coral reef at early Holocene based on the coral reef indicator fauna; (B) Barnacle zone, supporting the paleo-sea level at 80m; (C) Agglutinated zone, representing the freshwater influx; (D) Freshwater influx, sea level rise, destruction of coral reef, extinction of *T. squamosa*

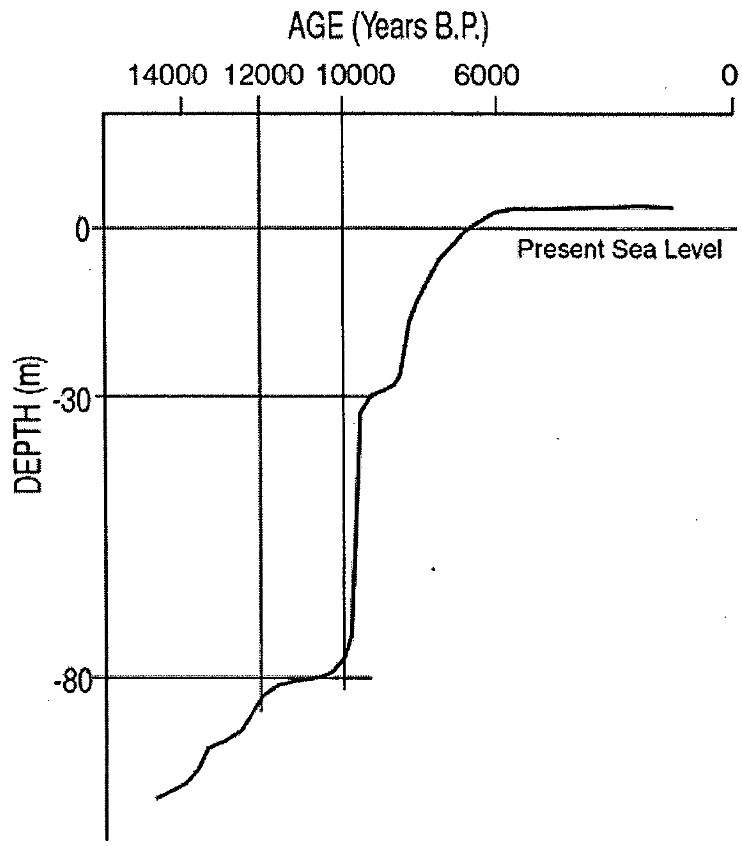


Figure 5.7: Sea level variation curve for the west coast of India (modified after Hashimi *et al.*, 1995)

5.4 CONCLUSIONS

After summarizing the distribution of relict benthic foraminifers off central west coast of India and the ecological preferences of the modern day counterparts of the relict benthic foraminiferal species, we conclude that (*vide* Figure 5.6):

1. The presence of the coral reef indicators *Amphistegina-Alveolinella-Operculina* assemblage proves the presence of a coral reef prior to Holocene, within the depth zone of 85m to 135m (Figure 5.6A). Depending upon the present day coral ecology the paleo-sea level is fixed at ~80 m water depth at ~12,000 to 10,000 yr BP.
2. The presence of relict barnacle zone within the depth of 60-90 m supports the postulation of 80 m lowered sea level (Figure 5.6B) and decline of salinity probably because of fresh water influx and resultant increased sea level.
3. The presence of agglutinated (mostly represented by *Textularia*) zone at 50-75 m water depth indicates freshwater influx (probably from landward side) (Figure 5.6C).

4. Freshwater influx increased the sea level from 80 m to the present day level (Figure 5.6D). This affected both, the barnacle and the coral reef. Increased fresh water influx lowered the salinity in the present area, thus adversely affecting *T. squamosa*, which eventually got extinct. Coral reef also, could not cope up with the rapid sea level rise and was destroyed just after ~10,000 yr BP.

5.5 IMPLICATIONS

This study documents the presence of a late Pleistocene-Holocene reef system along with the then shoreline at 80 m lower than present on the basis of presence of relict coral-reef foraminiferal assemblage at the present day water depth of 50-135m. The reason for destruction of the reef is suggested to be the rise of sea level during early Holocene due to rise in global temperature, as it is reported that with the onset of Holocene the global temperature rose by ~4°C (Coughan and Neyenzi, 1991). Increased temperature resulted in thermal expansion of seawater and melting of the glacial ice. This eventually increased the sea level rapidly, so much so that the reef could not cope up with the sudden rise of sea level. Thus, this study shows how rapid sea level change associated with early Holocene warming adversely affected the flourishing reef system in the region off west coast of India. The present study has made a pioneering but modest beginning in this direction. Trust this will pave the way for more such studies from the Indian waters.

CHAPTER 6
DISTRIBUTION OF RECENT FORAMINIFERA IN SURFACE SAMPLES

6.1 INTRODUCTION

"The past history of our globe must be explained by what can be seen to be happening today."

James Hutton (1726-97)

Understanding the geologic past requires employment of indirect methods called 'proxies'. Such proxies are developed based on the relationship that exists between the typical characteristics of different species / assemblages of microorganisms and their ambient bio-physico-chemical conditions, during their lifetime. Especially organisms like Foraminifers bearing hard exoskeletons, once dead, their hard parts (which record signatures of the past environment) get buried and preserved in sediments for ages and later serve as 'proxies' to decipher past climate. The study of the surface distribution of foraminifers as discussed in this chapter was carried out with the objective of understanding the effect of various physico-chemical parameters on the distribution of benthic foraminifers, and to develop benthic foraminiferal proxy for paleoclimatic reconstruction in this region.

6.2 DISTRIBUTION OF RECENT FORAMINIFERA IN SURFACE SAMPLES

In order to understand the relative abundance of foraminifera in the study area, the total benthic foraminiferal number (TBFN) in one gram of sand (>63 μm) as well as in one gram of dry sediment were calculated. The TBFN in sand fraction in the study area varies between 1000 (SC-14, water depth=18 m) and 1,36,053 (SC-04, water depth=1000 m) specimens and the TBFN in dry sediment ranges between 32 (SC-14, water depth=18 m) and 44,840 (SC-51, water depth=80 m).

Significant number of benthic foraminifers belonging to agglutinated, calcareous as well as porcellaneous forms are reported throughout the study area. The relative abundance of agglutinated forms, (*Pilulina*, *Saccorhiza*, *Ammodiscus*, *Ammolagena*, *Usbekistania*, *Reophax*, *Scherochorella*, *Subreophax*, *Hormosina*, *Reophanus*, *Cribrostomoides*, *Haplophragmoides*, *Veleroninoides*, *Ammobaculites*, *Eratidus*, *Cystammina*, *Alveolophragmium*, *Cyclammina*, *Orectostomina*, *Spiroplectinella*, *Ammoglobigerina*, *Tritaxis*, *Trochammina*, *Karrerulina*, *Verneuilinulla*, *Eggerella*, *Karreriella, Sahulia, Textularia, Karrerotextularia* and *Siphotextularia*) varied from 0 to 20.73%. The maximum abundance of agglutinated forms is reported from the station SC-44 at a water depth of 325 m (Fig. 6.1). In general, more number of agglutinated foraminifers is reported from the northern part of the study area. One species of agglutinated foraminifera *Ammolagena clavata* is discussed (see page 277-281) in detail due to its special significance.

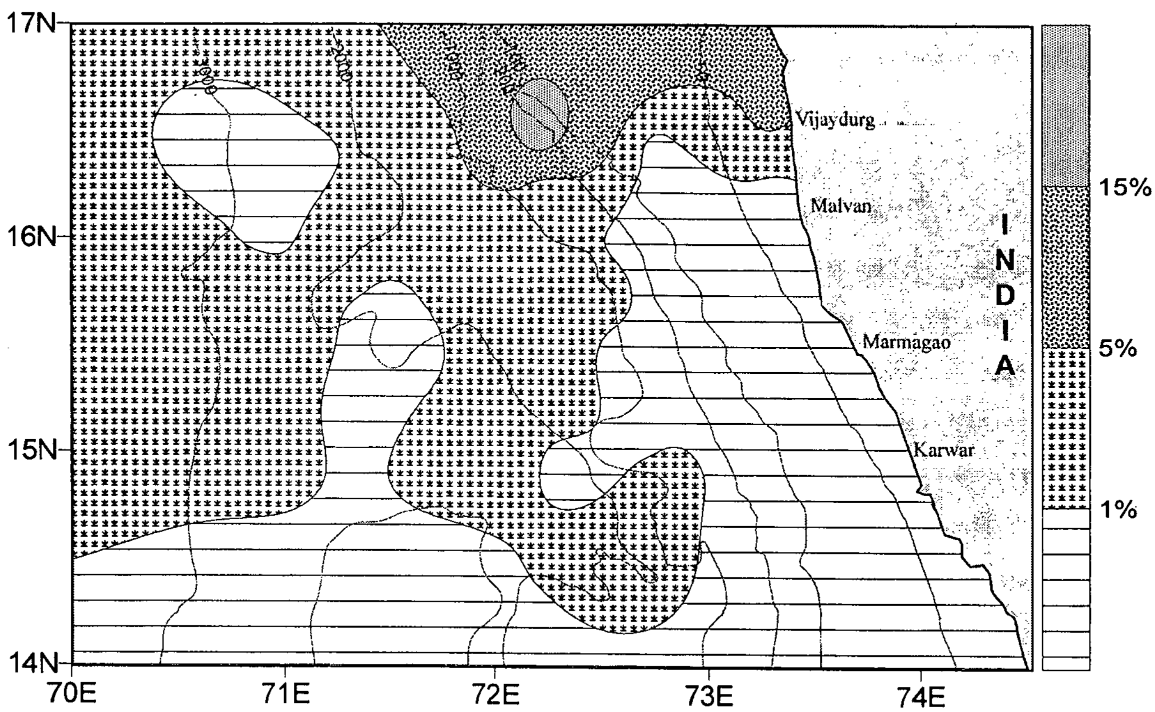


Figure 6.1: Distribution of agglutinated benthic foraminifera in the study area

Similarly among miliolid group (*Cornuspira, Planispirinella, Vertebralina, Edentostomina, Ophthalmidium, Spirophthalmidium, Adelosina, Paleomiliolina, Spiroloculina, Siphonaperta, Cycloforina, Hauerina, Quinqueloculina, Cribromiliolinella, Miliolinella, Pyrgo, Triloculina, Triloculinalla, Mesosigmoilina, Spirosigmoilina, Pseudohauerina, Borelis, Parasorites* and *Marginopora*), maximum abundance (31.71%) is recorded at station SC-44 whereas, it is almost absent at many other stations (Fig. 6.2). Surface abundance of miliolids peaks in the northern part of the study area.

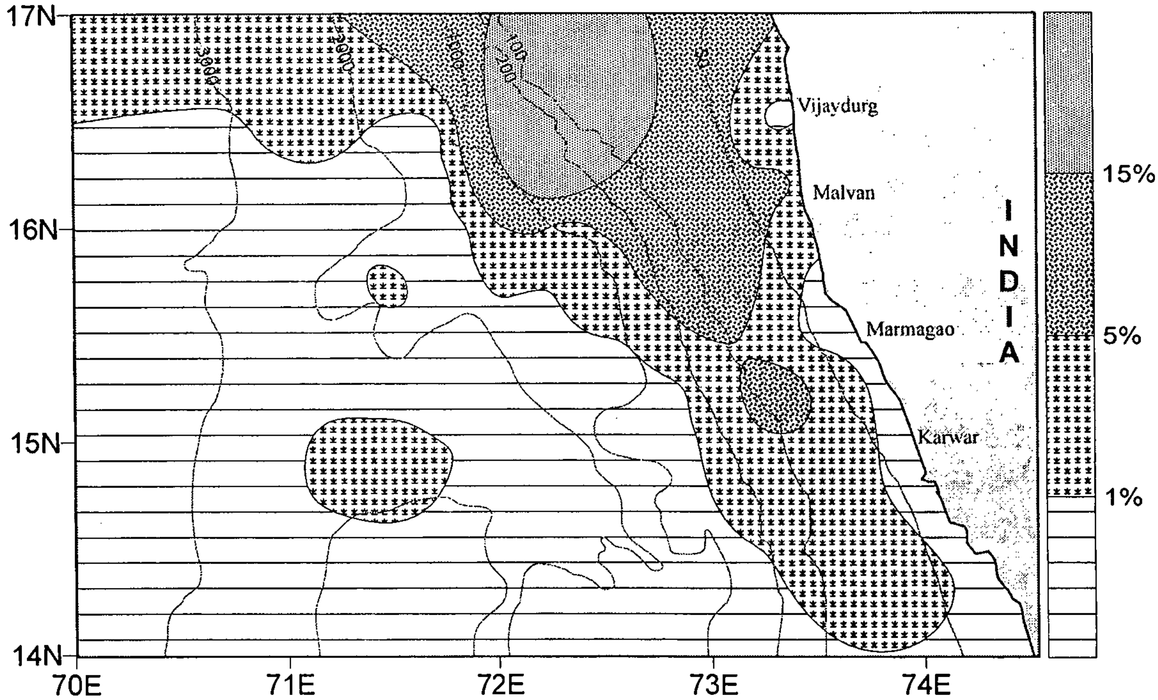


Figure 6.2: Distribution of miliolids in the study area

Planktic foraminifera (belonging to genera *Beella*, *Gallitellia*, *Globorotalia*, *Neogloboquadrina*, *Pulleniatina*, *Globigerinita*, *Globoquadrina*, *Globigerina*, *Globigerinella*, *Globigerinoides*, *Globoturborotalita* and *Orbulina*) are also present but are very rare in the shallow water regions, whereas in the deep waters they are abundant (Fig. 6.3A). Maximum abundance of planktonic foraminifers roughly follows the deep Oxygen Minima Zone, probably reflecting the excellent preservation of tests in the oxygen-depleted environment. In general the abundance of planktic foraminifers increases away from the coast. Since a lot of research papers have already discussed (see Table 1.1, 1.2, 1.3 in Chapter 1) the distribution and ecology of planktic foraminifera, they are not discussed in detail in present study. Abundance of benthic foraminifers is comparatively more in the shallow water regions (Fig. 6.3B).

6.2.1 SPATIAL DISTRIBUTION

Of the total 383 benthic foraminiferal species being reported from the surface sediments, the spatial distribution of 21 abundant genera (>5% at two stations) along the central west coast of India is discussed in detail. The ecology of these genera is discussed in the background of global ecological summary compiled by Murray (1991).

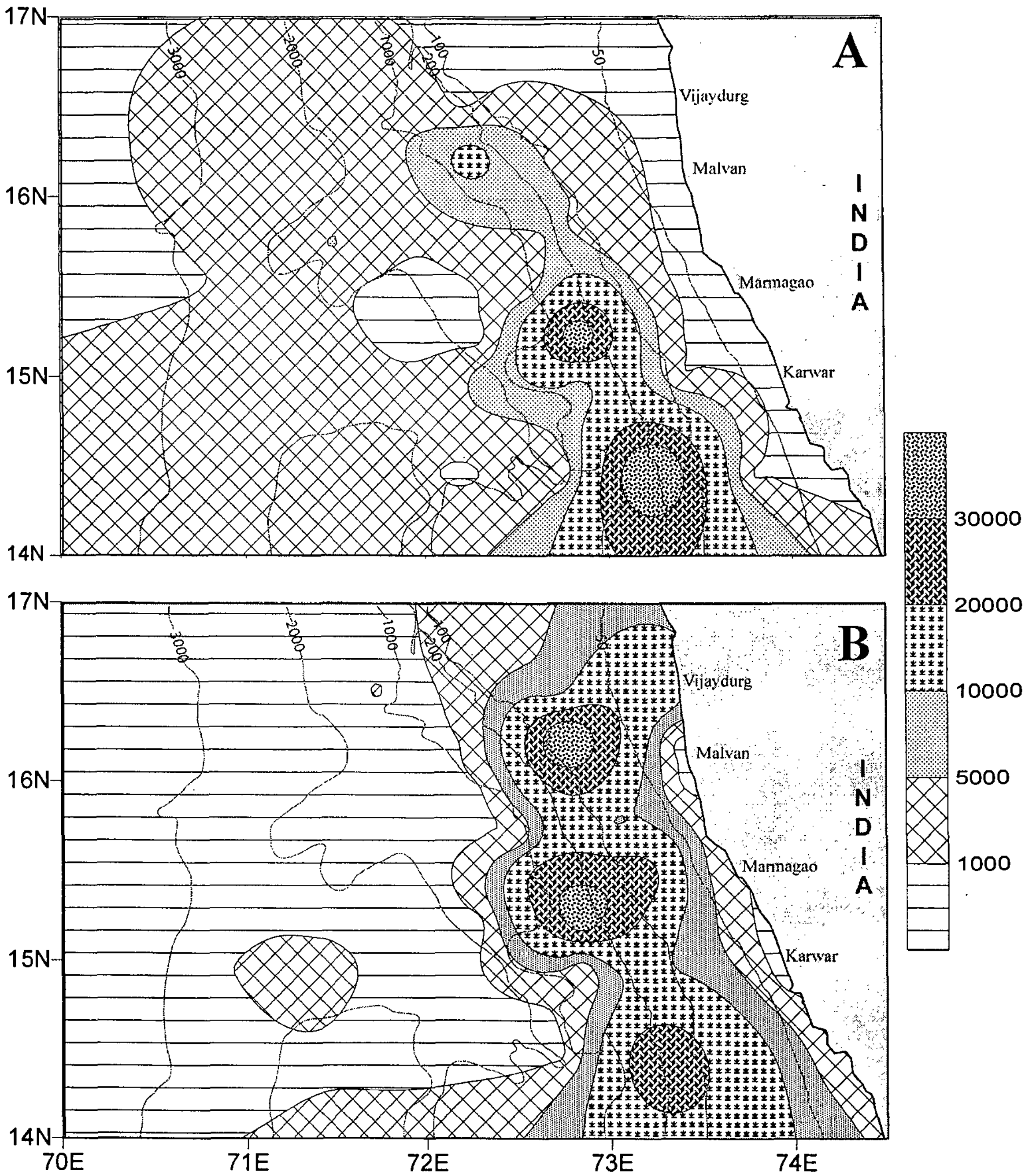


Figure 6.3: Surface distribution of (A) planktic and (B) benthic foraminifera

A) *Ammonia*

Genus *Ammonia* has been reported from a water depth of 0-50 m globally (Murray, 1991). In this region off central west coast of India, *Ammonia* abundance >5% is confined to shallow water stations (<28 m water depth) (Figure 6.4). Comparatively reduced abundance (1-5%) of *Ammonia* is noticed in northern and southern extremes of the study area, whereas throughout most of the study area it shows a nearly absent to rare presence (<1%).

Table 6.1: Maximum abundance of major genera (abundance >5% at atleast two stations), reported in the study area.

Sr.No.	Genus	Maximum Abundance (%)	Station	Water depth (m)	Figure
1.	*Fursenkoina*	63.93	SC-06	56	6.12
2.	*Bolivina*	46.82	SC-26	240	6.6
3.	*Ammonia*	46.27	SC-29	18	6.4
4.	*Bulimina*	40.52	SC-04	1000	6.8
5.	*Epistominella*	36.67	SC-36	2850	6.11
6.	*Nonion*	34.10	SC-28	15	6.17
7.	*Amphistegina*	28.42	SC-27	62	6.5
8.	*Cibicides*	25.96	SC-27	62	6.24
9.	*Globocassidulina*	24.23	SC-31	1130	6.13
10.	*Rotalidium*	23.47	SC-13	21	6.22
11.	*Osangularia*	22.65	SC-37	2420	6.19
12.	*Gyroidina*	21.72	SC-01	3140	6.14
13.	*Pullenia*	16.25	SC-36	2850	6.20
14.	*Cassidulina*	14.67	SC-40	100	6.10
15.	*Melonis*	14.29	SC-02	2775	6.16
16	*Brizalina*	11.45	SC-06	56	6.7
17.	*Quinqueloculina*	11.28	SC-44	325	6.21
18.	*Nonionoides*	11.17	SC-28	15	6.18
19.	*Uvigerina*	09.26	SC-40	100	6.23
20.	*Gyroidinoides*	09.29	SC-04	1000	6.15
21.	*Cancris*	09.26	SC-05	86	7.9

B) *Amphistegina*

Murray (1991) while summarising the ecology of various genera, reported genus *Amphistegina* from a water depth of 0-130 m. In the present study area also, genus *Amphistegina* is abundant at ~20 to ~150 m water depth with the maximum abundance being reported between 20-100 m depth zone (Fig. 6.5).

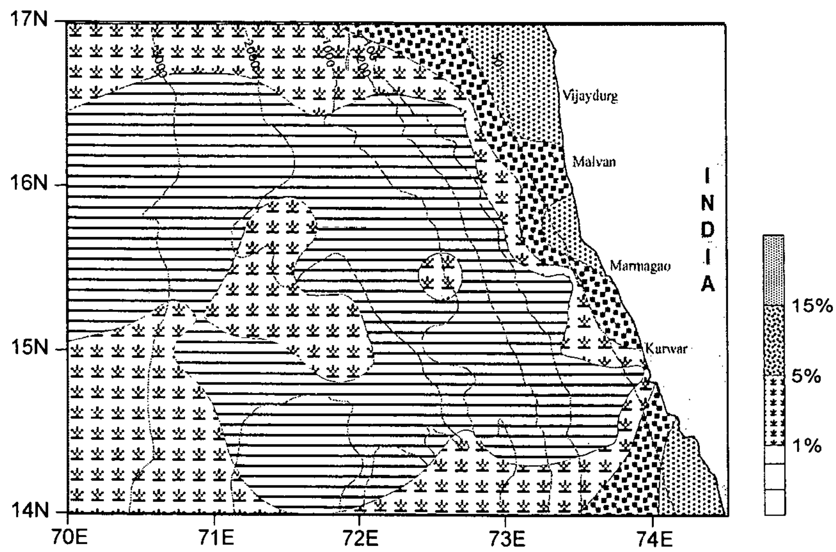


Figure 6.4: Surface distribution of genus *Ammonia* in the study area

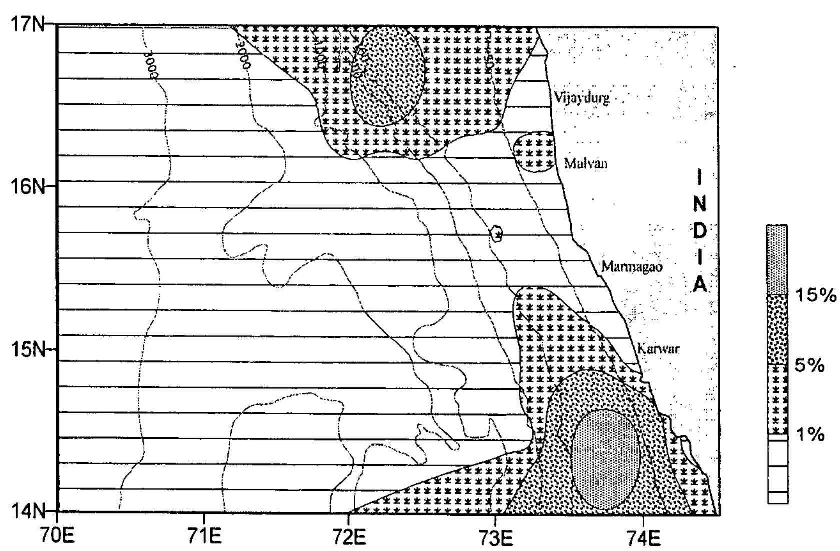


Figure 6.5: Surface distribution of genus *Amphistegina* in the study area.

C) *Bolivina*

Surface abundance of genus *Bolivina* extends from shallow (19 m) to deep stations (2350 m) (Figure 6.6). Its maximum abundance (46.82%) is recorded at the depth of 240 m (SC-26) and the maximum abundance (>15%) zone corresponds with the OMZ in the western Arabian Sea. The presence of *Bolivina* generally beyond ~100 m in the study area suggests that the genus is resistant to oxygen-depleted environment (Boltovskoy *et al.*, 1991). The general distribution of genus *Bolivina* in the study area confirms the inner shelf to bathyal zone of occurrence of *Bolivina*, as reported by Murray (1991).

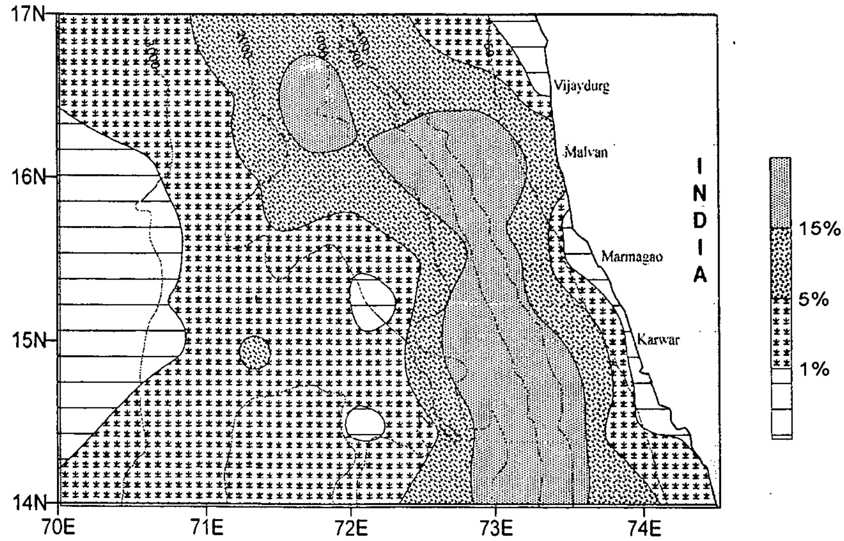


Figure 6.6: Surface distribution of genus *Bolivina* in the study area

D) *Brizalina*

Genus *Brizalina* has previously been reported to be abundant in marginal marine to bathyal waters (Murray, 1991). In the present study area also, the surface distribution of genus *Brizalina* shows that it is abundant in shallow water marginal marine region (Figure 6.7). The relative abundance of *Brizalina* off central west coast of India is comparatively very low being rare throughout most of the study area. The significant presence of *Brizalina* is confined to <1000 m water depth.

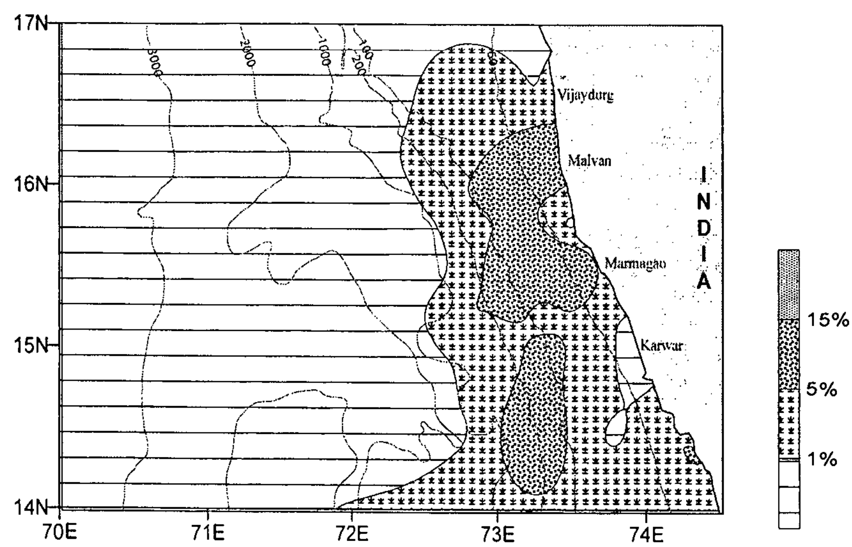


Figure 6.7: Surface distribution of genus *Brizalina* in the study area

E) *Bulimina*

Genus *Bulimina* shows a maximum abundance in the intermediate (780 m) to deep-water (2420 m) zone in the present study area, being highest in the central part of the study area (Fig. 6.8). A similar depth zone of occurrence of genus *Bulimina* has also been suggested by Murray (1991), after compiling the ecological preference of *Bulimina* from different parts of the world oceans.

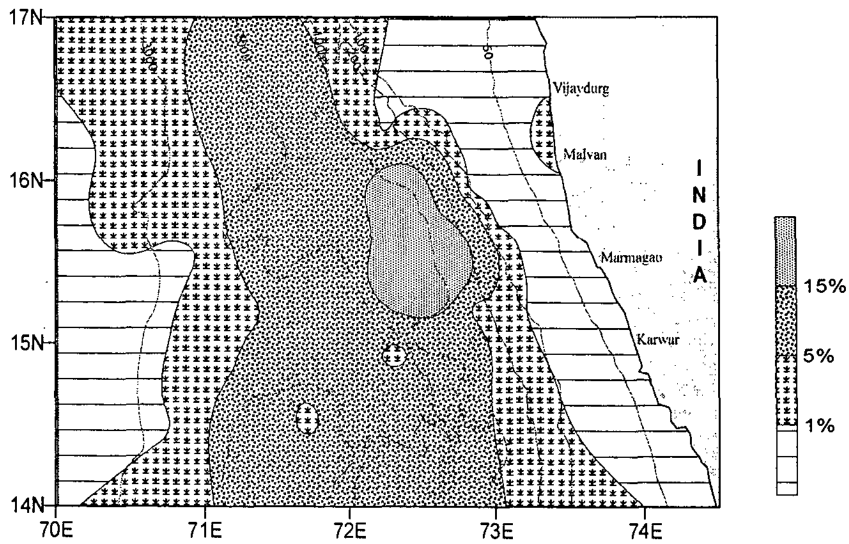


Figure 6.8: Surface distribution of genus *Bulimina* in the study area.

F) *Cancris*

The genus *Cancris* shows abundant (>5%) presence within the depth zone of ~50 m to ~200m in the present study area and is rare to absent throughout rest of region (Fig. 6.9). The distribution of genus *Cancris* off central west coast of India approximately corresponds with the depth zone (50-150 m) for abundance of *Cancris* given by Murray (1991).

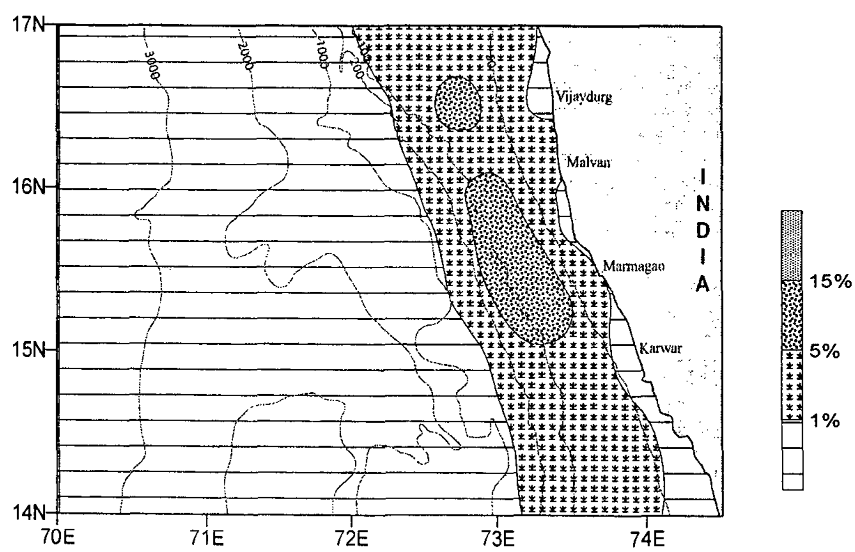


Figure 6.9: Surface distribution of genus *Cancris* in the study area.

G) *Cassidulina*

Cassidulina occurs in the intermediate water depth (62 m to ~150 m) and is rare to absent in both shallower and deeper stations (Fig. 6.10). Its maximum abundance (14.67%) is noticed at the water depth of 90 m (SC-30). Ecologically *Cassidulina* has been reported to be infaunal and abundant in shelf to bathyal zone (Corliss and Fois, 1990; Murray, 1991).

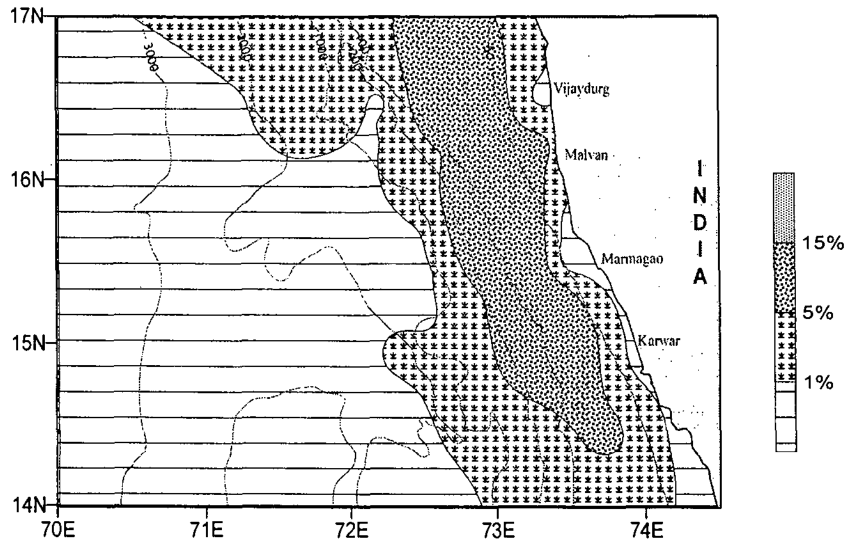


Figure 6.10: Surface distribution of genus *Cassidulina* in the study area.

H) *Epistominella*

This genus is abundant in the deeper stations (>780 m) (Figure 6.11). *Epistominella* is rare or absent in shallower region. Its maximum abundance (36.67%) is noticed at the water depth of 2850 m (SC-26). Murray (1991) reported that genus *Epistominella* is widely distributed in shelf to bathyal zone.

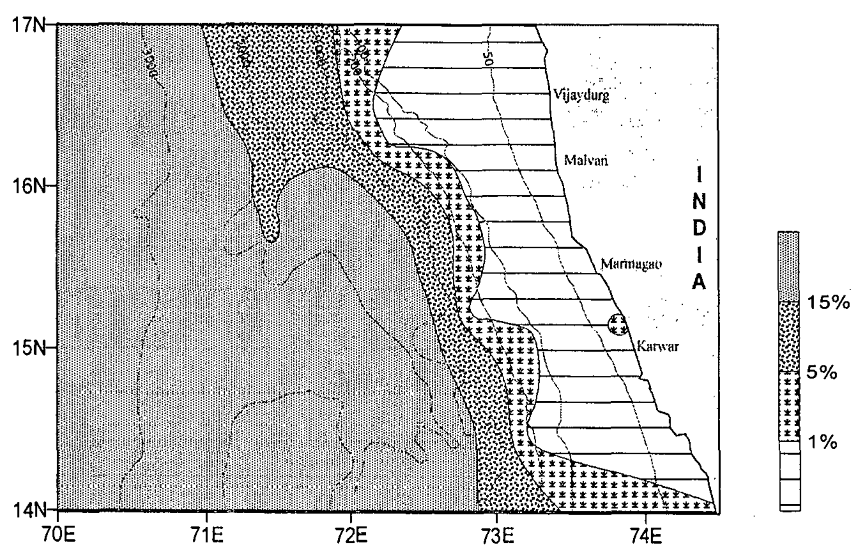


Figure 6.11: Surface distribution of genus *Epistominella* in the study area.

I) *Fursenkoina*

Fursenkoina shows maximum abundance in the shallow to intermediate water depth zone in the central part of the study area (15 to 294 m) (Figure 6.12). *Fursenkoina* is either very low (1-5%) or rare (<1%) in abundance through most of the study area, especially the deeper region.

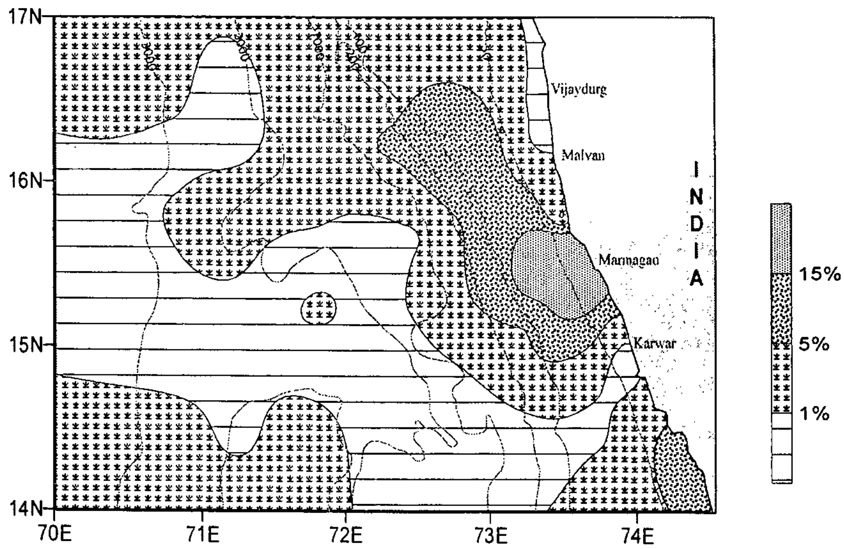


Figure 6.12: Surface distribution of genus *Fursenkoina* in the study area.

J) *Globocassidulina*

Genus *Globocassidulina* shows maximum abundance in the central part of the study area, while it is comparatively low or rare in both shallow as well as deeper regions (Figure 6.13). The surface distribution of genus *Globocassidulina* in the region off central west coast of India corresponds with the reported presence of *Globocassidulina* from different parts of the world oceans as summarised by Murray (1991).

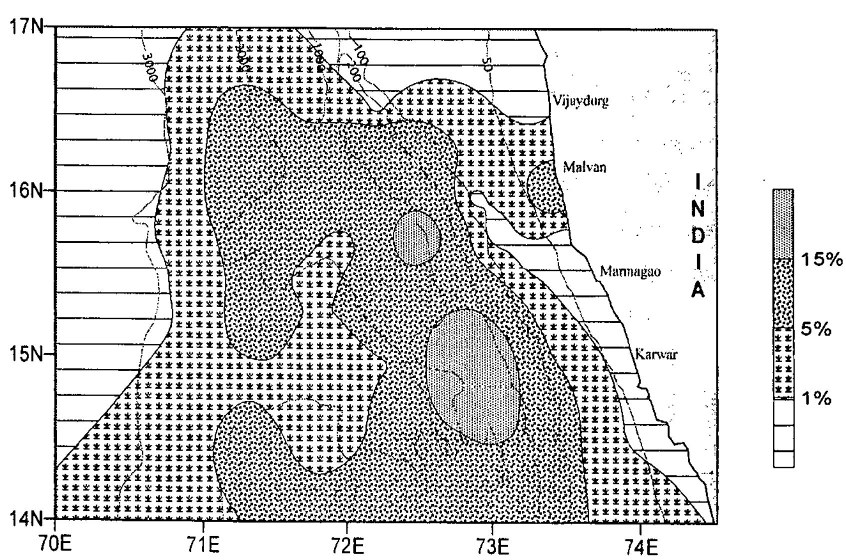


Figure 6.13: Surface distribution of genus *Globocassidulina* in the study area.

K) *Gyroidina*

The surface distribution of genus *Gyroidina* is a typical intermediate to deep-water genus being abundant in deeper water stations. In shallower region (<80 m) it is rare or absent (Figure 6.14). *Gyroidina* has globally been reported from the shelf-bathyal region of the world oceans (Murray, 1991), as in the present study.

L) *Gyroidinoides*

Like the genus *Gyroidina*, *Gyroidinoides* is also a deep-water genus. Comparatively lesser presence (1-5%) is reported beyond the water depth of 780 m. Patches of high abundance (as high as 09.23% at SC-04, water depth=1000 m) are noted in the deeper region. Genus *Gyroidinoides* is rare or absent in shallower stations (Figure 6.15).

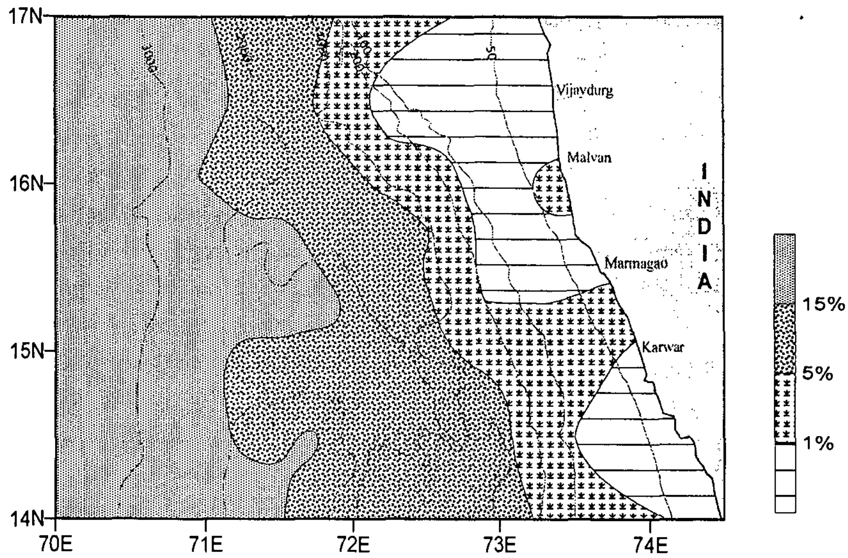


Figure 6.14: Surface distribution of genus *Gyroidina* in the study area.

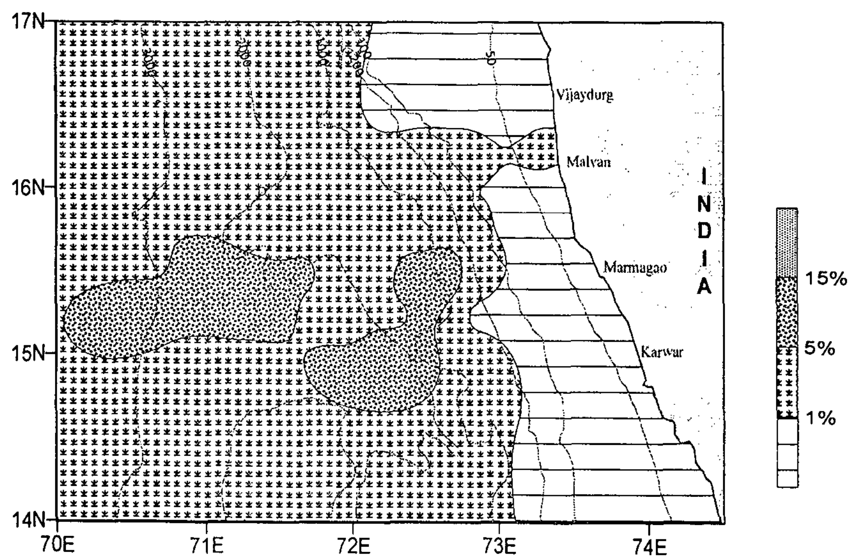


Figure 6.15: Surface distribution of genus *Gyroidinoides* in the study area.

M) *Melonis*

Melonis is also a deep-water genus being reported from the shelf to bathyal water depth from world oceans (Murray, 1991). In the present study area it is rare or absent in shallower region. *Melonis* abundance increases towards the deeper ocean and reaches to as high as 16.73% at water depth 1650m (Fig. 6.16).

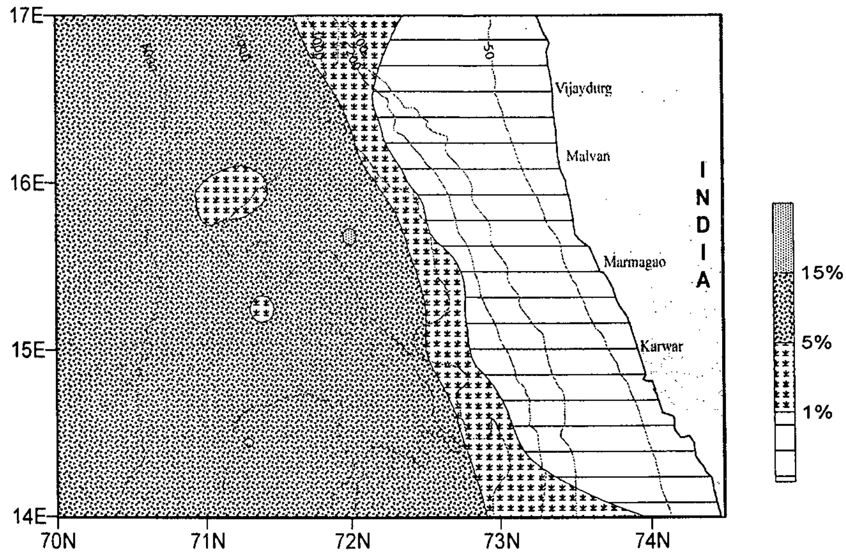


Figure 6.16: Surface distribution of genus *Melonis* in the study area.

K) *Nonion*

Global distribution of genus *Nonion* shows its abundance in shallow water (0-180 m) shelf region (Murray, 1991). In the present study area also, genus *Nonion* is confined to shallow water zone (water depth <56 m) (Figure 6.17), being rare to absent from most of the deeper water region. Maximum abundance of *Nonion* is reported from very near shore region.

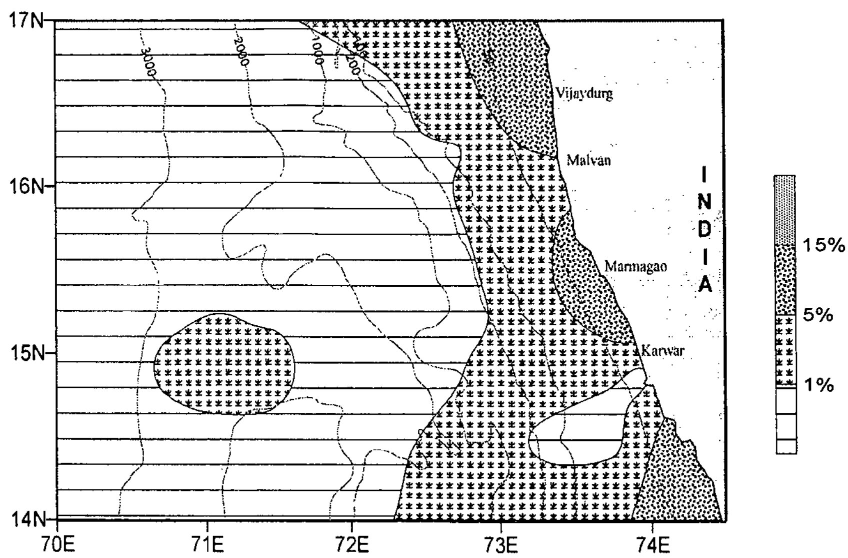


Figure 6.17: Surface distribution of genus *Nonion* in the study area.

L) *Nonionoides*

Like *Nonion*, genus *Nonionoides* is also being reported to be abundant in the shelf region of the world oceans (Murray, 1991). In the region off central west coast of India also, genus *Nonionoides* is confined to the region shallower than ~50 m water depth (Figure 6.18) thus confirming the global distribution summarised by Murray (1991). Genus *Nonionoides,* like *Nonion,* is either absent or rare in the deeper region of the study area.

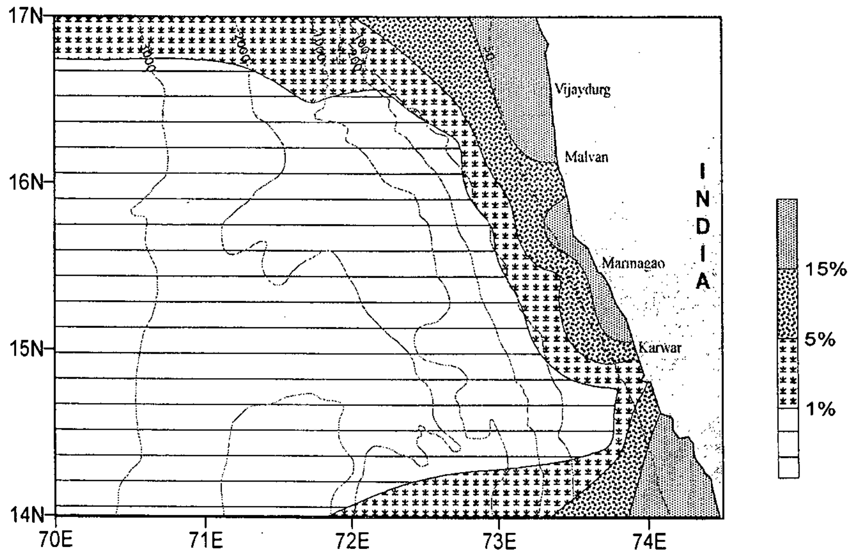


Figure 6.18: Surface distribution of genus *Nonionoides* in the study area.

M) *Osangularia*

Genus *Osangularia* is rare or absent in the shallow water region while its abundance increases towards the deeper region of the study area (Fig. 6.19). The abundant presence (>5%) of *Osangularia* is reported in the region beyond ~1000 m water depth. The high abundance of *Osangularia* is observed in patches in the deeper water region.

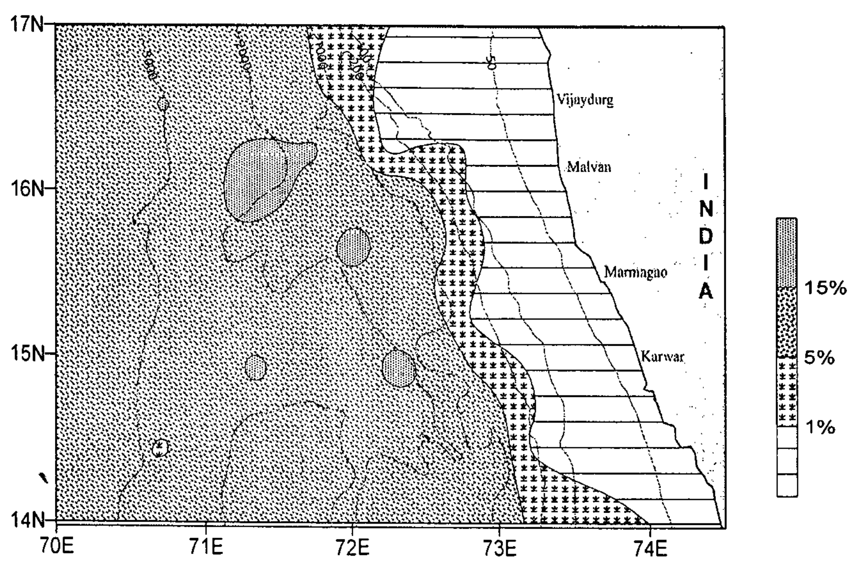


Figure 6.19: Surface distribution of genus *Osangularia* in the study area.

N) *Pullenia*

Surface distribution of *Pullenia* in the present study area shows that it occurs mainly in the deep-water region. Its abundance crosses 1% beyond ~1000 m and reaches a maximum (16.25%) at 1850 m water depth (SC-36). In shallower region it is rare or absent (Figure 6.20). The present day distribution of *Pullenia* in the region off central west coast of India corresponds with the distribution summarized by Murray (1991).

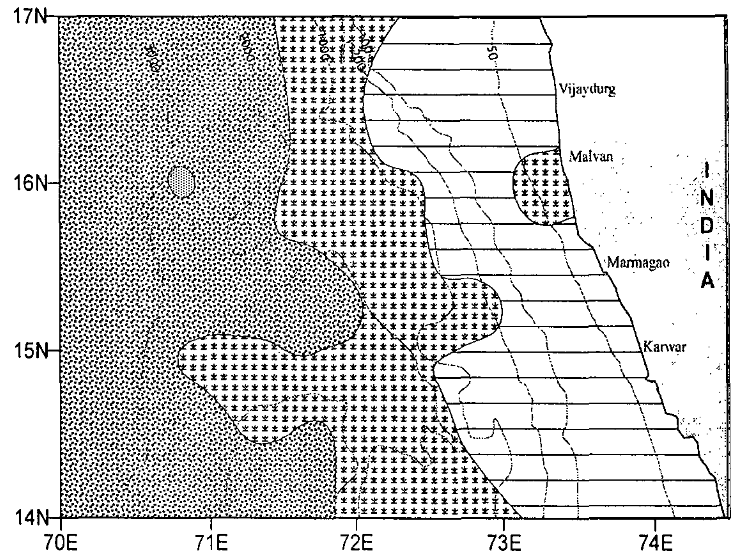


Figure 6.20: Surface distribution of genus *Pullenia* in the study area.

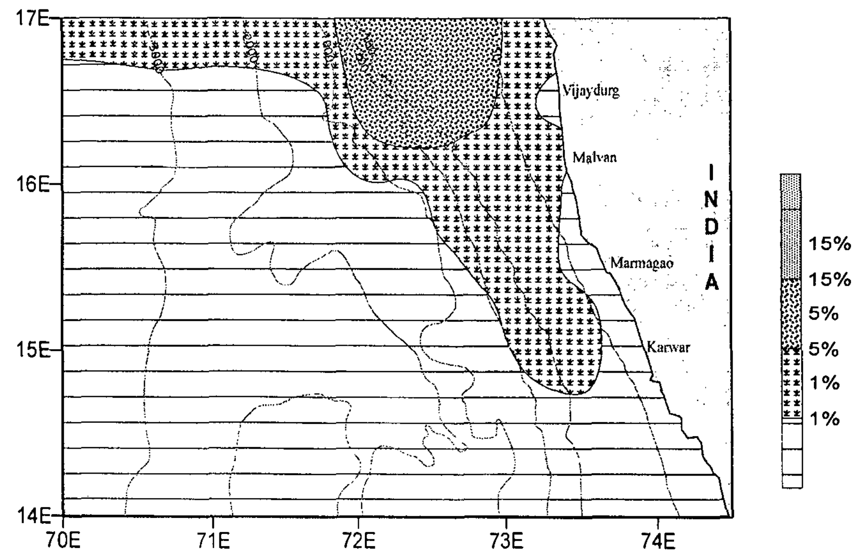


Figure 6.21: Surface distribution of genus *Quinqueloculina* in the study area.

O) *Quinqueloculina*

Surface distribution of genus *Quinqueloculina* from different world oceans shows that it confined to the shelf region of the oceans. In the region off central west coast of India also, abundant presence of *Quinqueloculina* is reported in samples within 19 to 325 m, mostly in northern portion. The maximum abundance (11.28%) is noticed at 325 m water depth (SC-44). It is rare or absent both, in very shallow and deep water region (Figure 6.21).

P) *Rotalidium*

Genus *Rotalidium* is rare to absent almost throughout the deeper part of the study area. Significant abundance of genus *Rotalidium* is reported from the near shore regions with maximum abundance confined below ~100 m water depth (Figure 6.22).

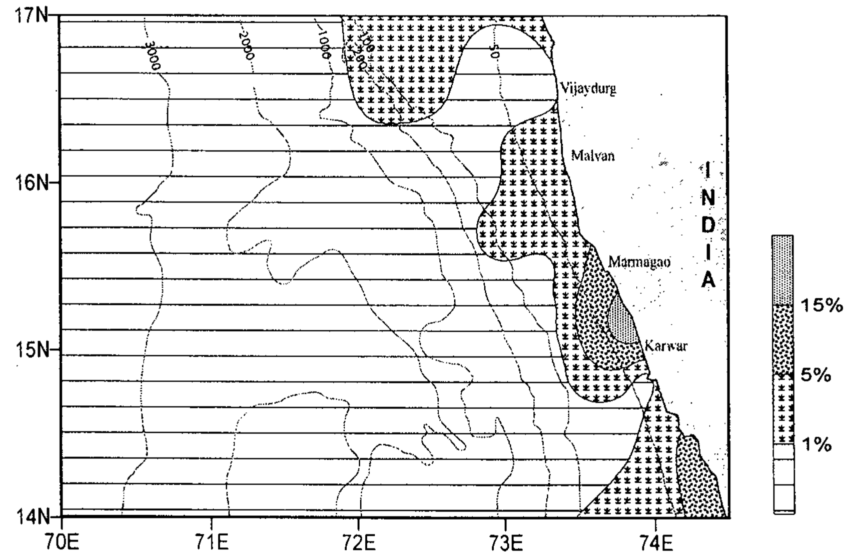


Figure 6.22: Surface distribution of genus *Rotalidium* in the study area.

Q) *Uvigerina*

Previously *Uvigerina* has been suggested as a shelf to bathyal genera. In the region off Goa, this genus is reported (1-5%) from the intermediate stations (between 19 to 1650 m) and reaches its maximum (15.97%) at the water depth of 380 m (SC-11). It is rare or absent (<1%) in both shallow and deep water stations (Figure 6.23). According to Boltovskoy *et al.* (1991), *Uvigerina* prefers low oxygen. The results support the observation that large stocks of benthic foraminifera are found in low oxygen concentration zone (where predators are minimum and food supply is maximum) dominated by species such as *Uvigerina* (Lutze and Coulbourn, 1984).

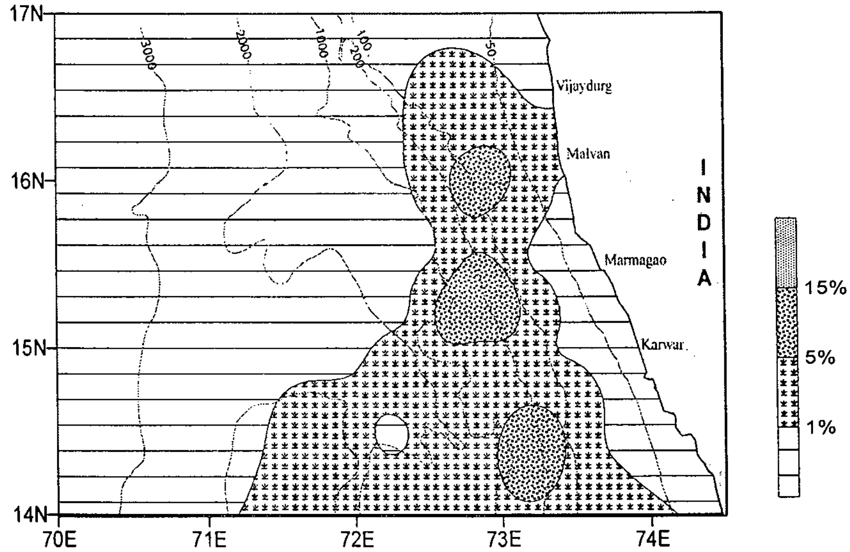


Figure 6.23: Surface distribution of genus *Uvigerina* in the study area.

R) *Cibicides*

Genus *Cibicides* is present throughout the study area. Comparatively higher abundance of *Cibicides* is noted from the intermediate water depth while its abundance decreases towards the deeper region (Fig. 6.24). Murray (1991) also summarised that *Cibicides* is shelf to bathyal genus with occurrence reported from waters ranging in depth from 0m to >2000 m.

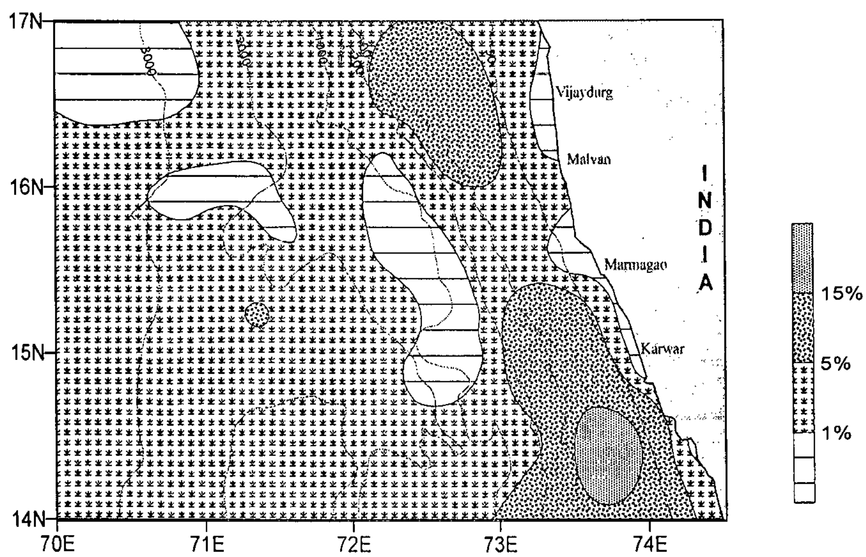


Figure 6.24: Surface distribution of genus *Cibicides* in the study area.

6.2.2 DEPTH DISTRIBUTION

Relative abundances of major genera (with abundance >5% atleast at two stations) when plotted on kite diagrams (Fig. 6.25A, B and C) show that a few genera are abundant in the shallow water regions, with a few being present throughout the study area, irrespective of the depth of water column. *Ammonia, Nonion, Nonionoides* and *Rotalidium* appear to be the typical shallow water genera inhabiting the inner shelf. *Amphistegina, Cassidulina, Quinqueloculina, Uvigerina, Brizalina, Cancris* and *Cibicides* characterize the shallow water, outer shelf assemblage. *Epistominella, Melonis, Gyroidina, Gyroidinoides* and *Osangularia* represent deeper water fauna. The distribution of *Bulimina*, *Bolivina*, *Fursenkoina*, *Globocassidulina* and *Pullenia* does not seem to be controlled by depth. In general, the surface distribution of major genera in the region off central west coast of India corresponds with the depth zone of surface distribution of these genera compiled by Murray (1991) on the basis of distribution of these genera from different parts of the world oceans. In order to better understand and draw meaningful conclusions from the assemblages out of the surface distribution of major genera in the study area, cluster analysis was performed as discussed in the next section.

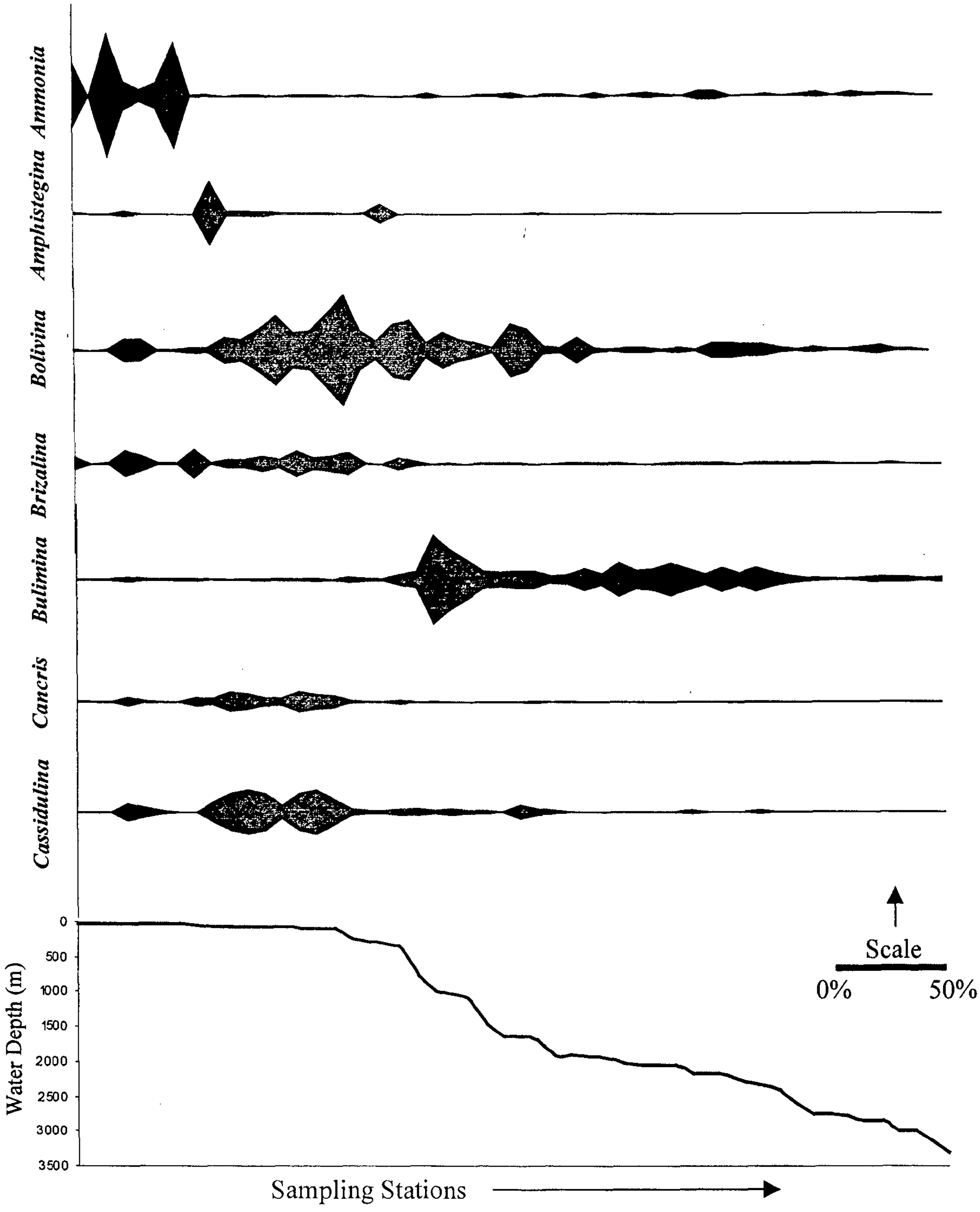


Figure 6.25a: Relative abundance of *Ammonia, Amphistegina, Bolivina, Brizalina, Bulimina, Cancris, Cassidulina* in surface sediments in the region off central west coast of India

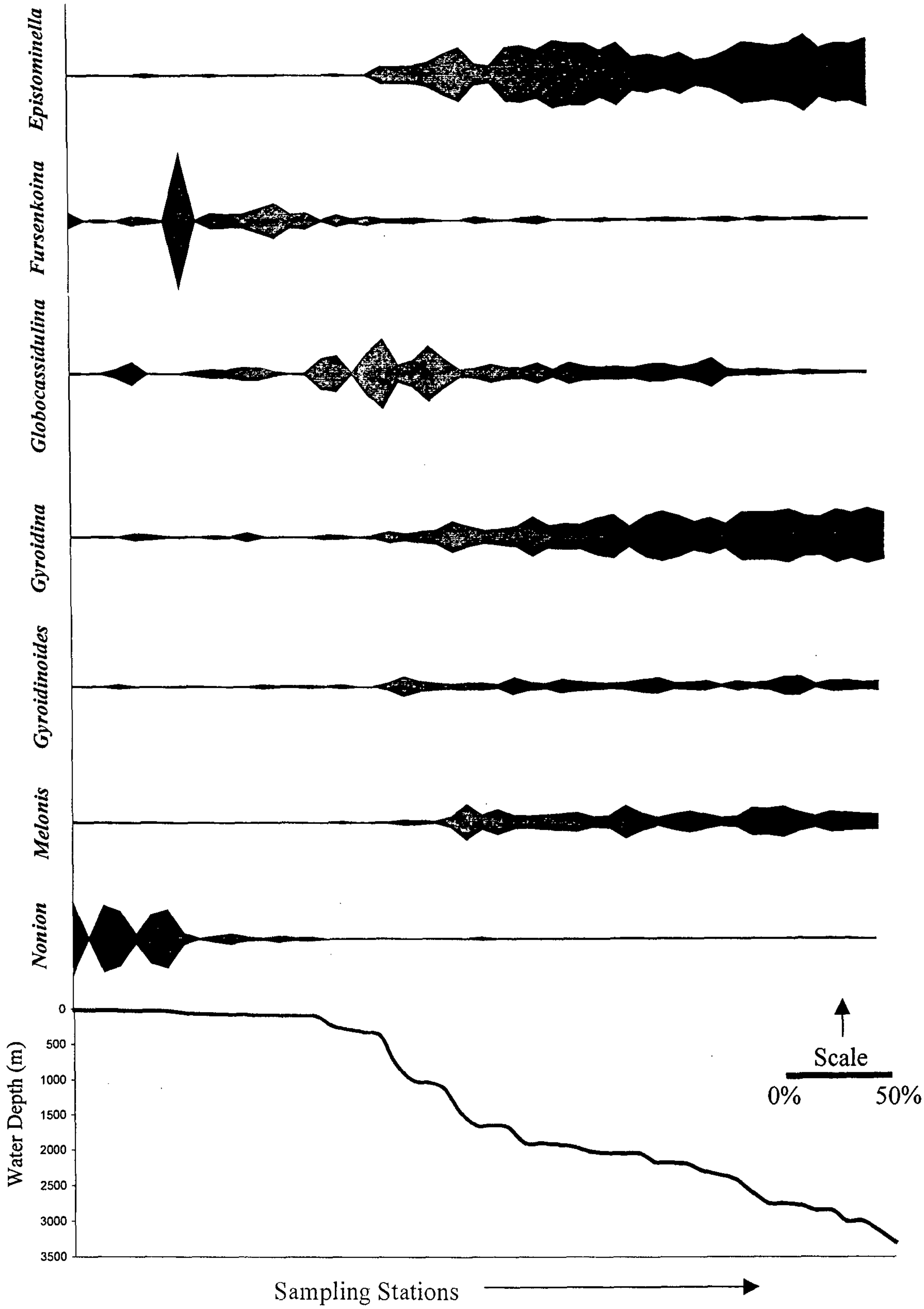


Figure 6.25b: Relative abundance of *Epistominella, Fursenkoina, Globocassidulina, Gyroidina, Gyroidinoides, Melonis, Nonion* in surface sediments in the region off central west coast of India

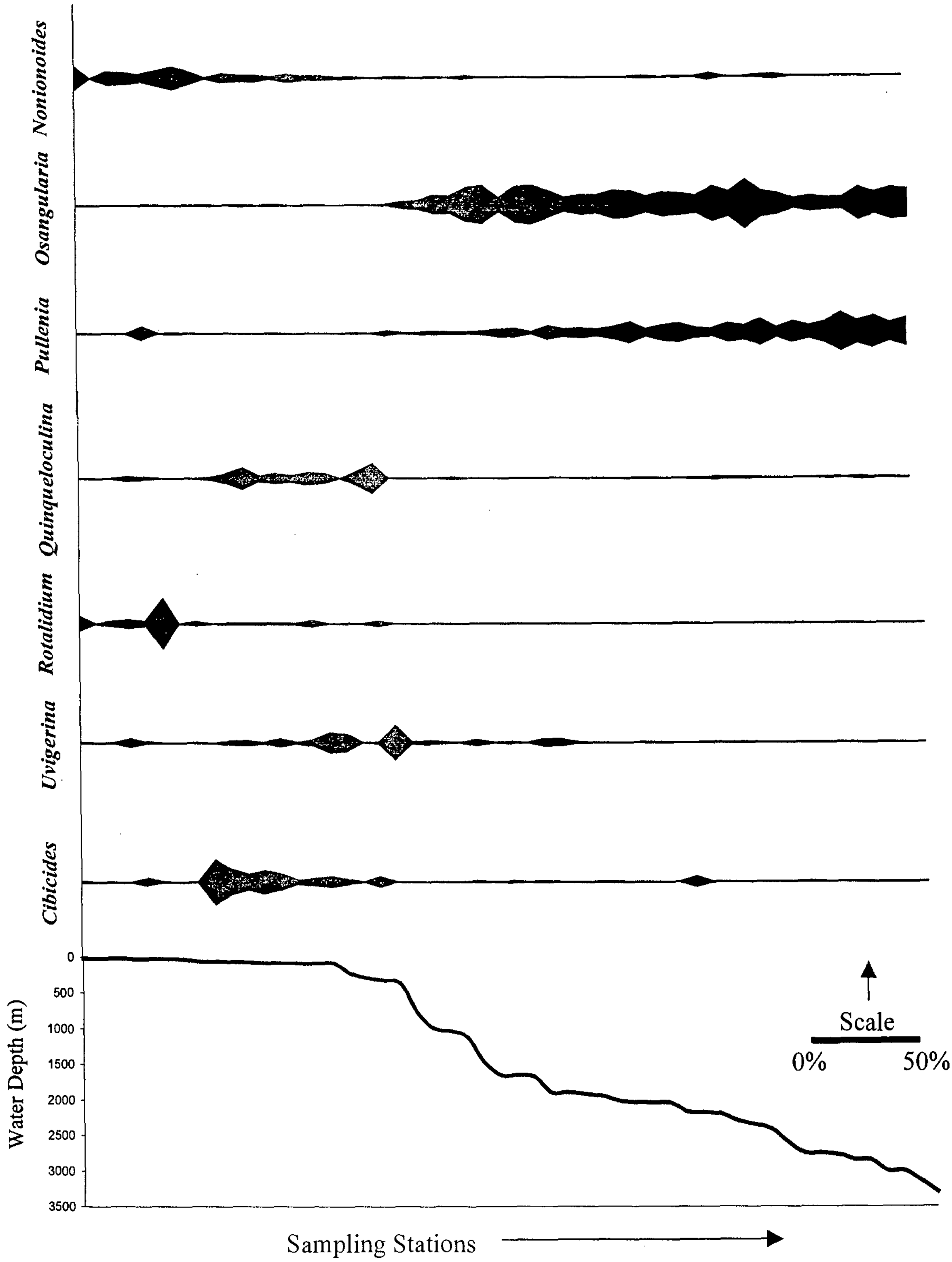


Figure 6.25c: Relative abundance of *Nonionoides, Osangularia, Pullenia, Quinqueloculina, Rotalidium, Uvigerina, Cibicides* in surface sediments in the region off central west coast of India.

6.2.3 Q-MODE CLUSTER ANALYSIS

In order to study the inter-station relationship amongst the benthic foraminiferal population, Q-mode cluster analysis technique was employed.

Different criteria can be used to choose the variables for the Q-mode cluster analysis; *viz.* total species, total genus or even clubbed genus number. To increase the precision for the analysis, we have chosen the total number of species as the variables. Therefore, the final matrix of 383 variables from 52 stations has been subjected to Q-mode clustering techniques. The results of cluster analysis are plotted in the form of a two-dimensional binary dendrogram (Fig. 6.26).

At 28.0 level of rescaled distance cluster combine, a majority of stations can be classified into two clusters marked as cluster A and B in figure 6.26.

Cluster A

Cluster A is composed of 5 stations and all of them are concentrated within the water depth 28 m. This cluster is representative of shallow water (15-28 m) assemblage. The dominant species of this cluster are *Ammonia tepida*, *Asterorotalia dentata*, *Brizalina spathulata*, *B. striatula*, *Haplophragmoides* sp. B, *Nonion* cf. *N. asterizens*, *N. incisum*, *N. scaphum*, *Nonionoides boueanum*, *N. elongatum*, *Rotalidium annectens* and *Rotalinoides papillosus*.

Cluster B

Cluster B is composed of 45 stations and this cluster is representative of intermediate to deepwater (>70 m) assemblage. At level 21.0, cluster B is further classified into three heads namely B1, B2 and B3. Cluster B1 is composed of 2 stations, namely SC-04 (1000 m) and SC-39 (1040 m). The dominant species of this cluster are *Bolivina seminuda, Bulimina alazanensis, Epistominella exigua, Globocassidulina oriangulata, G. subglobosa*, and *Osangularia bengalensis*. Cluster B2 is composed of 10 stations and represents the intermediate water assemblage (70-380 m), with most of the stations above OMZ. The dominant species of this cluster are *Bolivina lowmani*, *Bolivina marginata*, *Bolovina ordinaria*, *Bolivina robusta*, *Bolivina seminuda*, *Brizalina spathulata*, *Cassidulina* cf. *C. crassa*, *Eponides* sp., *Fursenkoina bradyi*, *Fursenkoina complanata*, *Globocassidulina subglobosa*, *Neoeponides praecinctus*, and others. Cluster B3 is composed of 30 stations and this cluster represents the deep-water assemblage (>380 m).

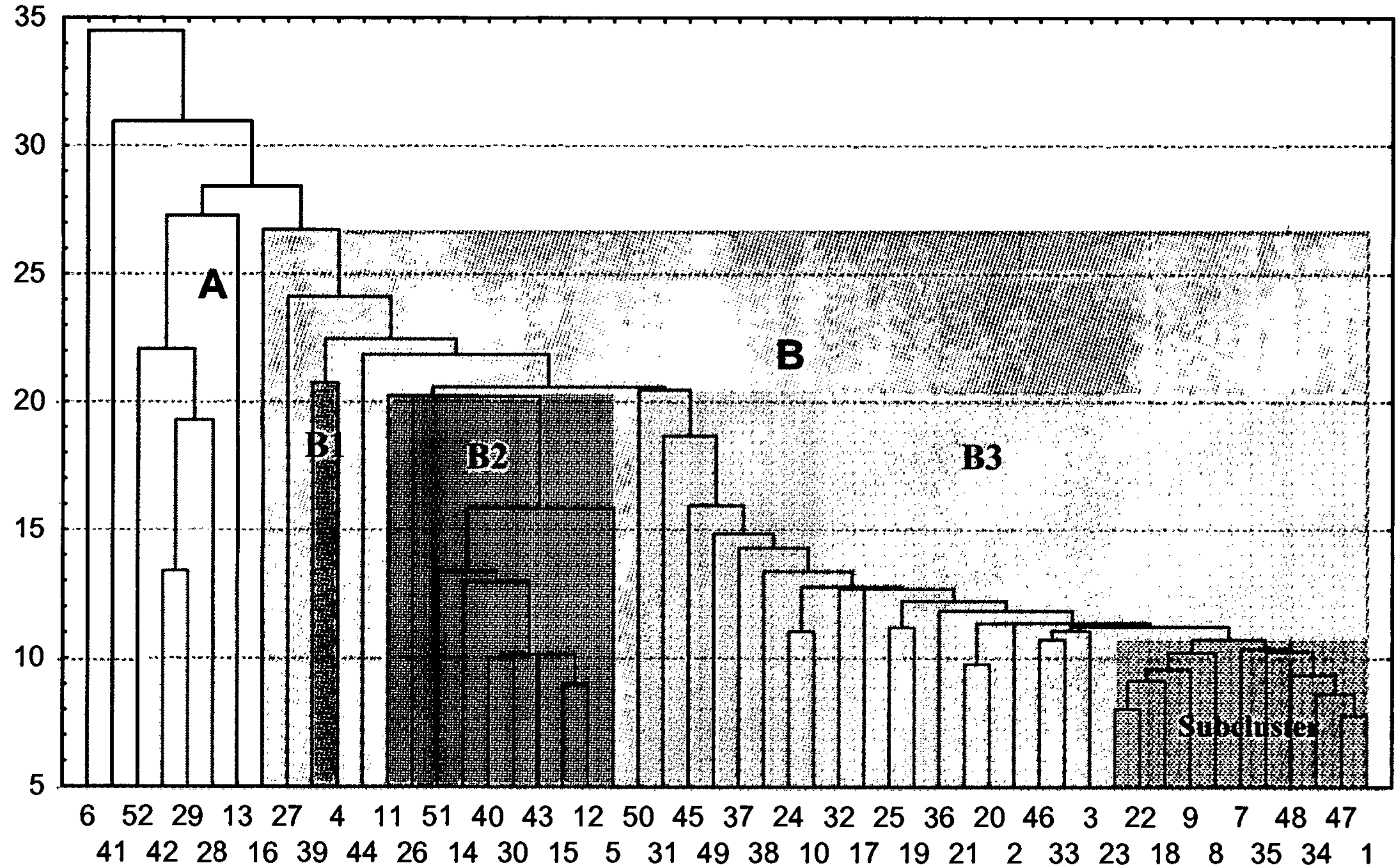


Figure 6.26: Result of Q-mode cluster analysis in form of two-dimensional binary dendrogram showing the main clusters; A and B with three subclusters B1, B2 and B3. The station numbers are placed along X-axis and Linkage distances are placed along Y-axis

The dominant species of this cluster are *Bolivina seminuda*, *B. silvestrina*, *Bulimina aculeata*, *Bulimina marginata*, *Epistominella minuta*, *E. exigua*, *Globocassidulina oriangulata*, *G. subglobosa*, *Gyroidina* sp. A, *Gyroidina* sp. B, *Gyroidinoides soldanii*, *Melonis barleeunum*, *M. pompilioides*, *Osangularia bengalensis*, *Pullenia buloides* and *P. subcarinata*. Within the cluster B3, another subcluster noticed. This subcluster is composed of 11 stations and represents the deeper water assemblage (>1900 m), below the typical OMZ. The dominant species of this cluster are *Epistominella exigua*, *E. minuta*, *Gyroidina* sp. A, *Gyroidina* sp. B, *Gyroidinoides soldanii*, *Melonis barleeanum*, *Osangularia bengalensis*, *Pullenia bulloides* and *P. subcarinata*.

6.3 AMMOLAGENA CLAVATA: INDICATOR OF WATERMASS

6.3.1 INTRODUCTION

Sometimes the distribution of a single genus/species also provides useful information about the climate/paleoclimate, water masses etc. One such example is noticed in the study area as discussed below.

Ammolagena clavata (Jones and Parker, 1860), an agglutinated foraminiferal species, has been reported from Recent and older sediments in different parts of world oceans (Table 6.2 and 6.3), except from the Recent sediments of the Indian Ocean. Thus, the absence of *A.clavata* in Recent sediments of the Indian Ocean has suggested that the Indian Ocean has adverse conditions for this particular species, and also that it has a restricted geographic distribution. However, the present study reports the first ever presence of this species in the Arabian Sea, and provides new information on its geographic distribution.

Table 6.2: Previous record of geographic occurrence of *Ammolagena clavata*

Major Ocean/Sea Depth	Distribution and Ecology	Reference
Arctic (Not Mentioned)	(Not Mentioned)	Wollenburg and Mackensen 1998
Atlantic	392-3270 m (196-1635 fm)	Cushman, 1918
	1008 m, continental margin of northwest Africa	Lutze and Coulbourn, 1984
	700 m (350 fm) and 3800 m (1900 fm)	Barker, 1960

Table 6.2 (Contd.)

	(Not Mentioned)	Braga and Galhano, 1965
	3312-3975 m, within his "*Cassidulina crassa* association"	Herb, 1971
	2500-3000 m, attached on small pebbles and large sand grains	Cole, 1981
	2750-4925 m	Schröder, 1986
	(Not Mentioned)	Mackensen *et al.*, 1993
	2600-4500 m, temperature 1.0°C, salinity 34.8‰	Harloff and Mackensen, 1997
	(Not Mentioned)	Schmiedl *et al.*, 1997
	1500-1800 m ("Boundary Layer Association"), southern Portuguese continental margin, showed impact of the Mediterranean Outflow Water (MOW)	Schönfeld, 1997
	1205-1209 m, total oxygen range 4.82– 3.10ml/l	Schönfeld, 2001
	553 m, percentage out of the total fauna 0.4%	Fontanier *et al.*, 2002
	Atlantic 396-1917 m	Schönfeld, 2002
Pacific	820 m (410 fm)	Barker, 1960
	780-5070 m	Lukina, 1980
	(Not Mentioned)	Milam and Anderson, 1981
	865 m	Hughes, 1988
	(Not Mentioned)	Neinstedt and Arnold, 1988
	684-2119 m	Van Marle, 1988
	114-548 m, attached to fish otoliths, smooth tests of foraminifera, other shell fragments, pebbles, debris and coralline sand	Burch and Burch, 1995
	2503 m, temperature 3.3°C	Hess and Kuhnt, 1996

Table 6.3: Previous record of stratigraphic occurrence of *Ammolagena clavata*

Major Ocean/Sea	Age (ecology)	Reference
Arctic	Pliocene (<1% abundance, water depth 951m)	Mullen and McNeil, 1995
	Miocene (water depth 290.3 m)	Kaminski *et al.*, 1989
	Middle Oligocene	McNeil, 1985
	Oligocene (attached to large quartz grains, grouped as belonging to "Coarsely Agglutinated Assemblage")	Kaminski and Austin, 1999
Mediterranean	Eocene	Morlotti and Kuhnt, 1992
Atlantic	Maasrichtian to Lower Eocene (water depth lower bathyal to upper abyssal, pseudoattached to benthic foraminifera)	Kaminski *et al.*, 1988
Indian	Lower Cretaceous (attached to shell fragments or to other foraminiferal tests)	Holbourn and Kaminski, 1997

6.3.2 DISTRIBUTION AND ECOLOGY OF AMMOLAGENA CLAVATA

Ammolagena clavata was found in six surface samples out of 52 samples. The depth zone of the occurrence is 1650-2050 m, wherein the temperature is 4.5°C and salinity of 34.9‰. This zone is below the OMZ in this area (Stackelberg, 1972). This species was found as rare (1 to 5 specimens) in each sample having a sand-size fraction ranging from 6.25 to 21.94% and planktonic foraminifera from 49.34 to 86.68%. These samples include all the often reported planktic foraminiferal species of the Arabian Sea with abundant benthic species including, *viz. Bolivina seminuda*, *Bulimina gibba*, *Epistominella exigua*, *E. minuta*, *Globocassidulina subglobosa*, *Gyroidina* sp. A, *Gyroidina* sp. B, *Melonis barleeanum*, *M. pompilioides*, *Osangularia bengalensis*.

A. clavata specimens are 1.0 to 1.3 mm in length with a large and ovoid proloculus of 0.4 to 0.5 mm diameter and a narrow tubular rectilinear second chamber of variable length but of nearly uniform diameter. The test was found attached to both planktonic (*Globorotalia menardii*) and benthic (*Ammodiscus tenuis*) foraminifera. Its wall is finely granulated, reddish-brown in colour, smoothly finished and glossy. Aperture of the test is terminal and rounded (Plate 1, Figure 4).

6.3.3 DISCUSSION

According to previous reports, this species was found at water depths of 553-4500 m in the Atlantic and 684-2503 m in the Pacific Ocean. Jones and Charnock (1985) referred this species to be of upper bathyal to abyssal environments (200-6000 m) (Table 7.2), but in the present study it has been reported only at the depth of 1650-2050 m.

The occurrence of this species as attached to planktonic foraminifera *Globorotalia menardii* has not been reported before from any region in the world. Previously this species was reported to be found attached either to sediment grains, particularly large quartz grains (Kaminski *et al.*, 1990; Kaminski and Austin, 1999) and small pebbles (Cole, 1981), or on benthic foraminiferal species, such as *Ammodiscus* sp. (Neinstedt and Arnold, 1988) and *Ammobaculites jarvisi* (Cushman and Renz, 1946). In the present area also, *A. clavata* was found attached to the benthic foraminifera *Ammodiscus tenuis*.

In the geological past, this species has been reported from Eocene, Oligocene, Miocene and Pliocene from the Arctic and Mediterranean areas (Table 6.3). So far, there is only one report mentioning its presence from Lower Cretaceous of Indian Ocean region (Holbourn and Kaminski, 1997). The present study reveals its occurrence in the Recent sediments of the Indian Ocean. Therefore, in Indian Ocean region, there is a noticeable hiatus in the geologic distribution of this species spanning almost 135 m.y. The absence of this species during this period may be due either to lack of data or paleoceanographic/paleoclimatic changes in the Indian Ocean region.

6.3.4 CONCLUSION

The discovery of the agglutinated benthic foraminiferal species *Ammolagena clavata* in Recent sediments of the Arabian Sea, Indian Ocean region, results in its reclassification from exclusively Pacific-Atlantic to cosmopolitan. In this study this species was designated as deep-water benthic attached to the planktonic foraminiferal species *Globorotalia menardii*, which association has not been reported from any other region so far.

6.4 RECTILINEAR BENTHIC FORAMINIFERA: INDICATOR OF OXYGEN MINIMA ZONE

6.4.1 INTRODUCTION

The important physico-chemical factors that affect the distribution of marine organisms include, depth of the water column, temperature, salinity, turbidity, nutrients and dissolved oxygen. Out of these, the peculiar variation in concentration of dissolved oxygen with depth, results in low oxygen concentration zone or Oxygen Minima Zone (OMZ) in some parts of the world oceans (Fig. 6.27). The bio-geochemical processes within the OMZ produce a restricted ecosystem for biota thus, making it important to discover the presence and extent of such regions as this information is useful for a variety of disciplines, most notably economic geology, environmental geology, ecology, and cell biology (Bernhard and Sen Gupta, 1999). Studies have revealed that low oxygen availability has a dramatic impact on benthic community (Levin and Gage, 1998). Many taxa, especially those with calcified exoskeletons, tend to be absent in OMZ (Rosenberg *et al.,* 1983; Levin *et al.,* 2000). Some calcareous taxa do occur in OMZ, such as foraminifers, but they are generally the exceptional specialists of such environments (Levin *et al.*, 2000; Gooday *et al.,* 2000). The "life styles" exhibited by species inhabiting OMZ tend to be different from those living above or below the reduced oxygen concentration depths.

Foraminifers has so far been used in various fields of oceanography, such as indicator of paleomonsoonal variation, sediment movement, pollution effect, sea level changes, etc. by virtue of their extreme sensitivity to the variations in the physico-chemical characteristics of their ambient environment. A slight change in any of the parameters of marine environment modifies the foraminiferal assemblages. Thus, specific assemblage from specific set of ecological conditions provides clues for paleoecological or paleoceanographic studies. A number of efforts have been made to document characteristic foraminiferal distribution in surface sediments of OMZ from the world oceans (Fig. 6.27). However, except for a brief mention in reports by Zobel (1973) and abundance of *Bulimina costata* in OMZ (Mazumder *et al.*, 2003), no significant attempts were made to document the benthic foraminiferal response to oxygen concentration in the eastern Arabian Sea, west coast of India.

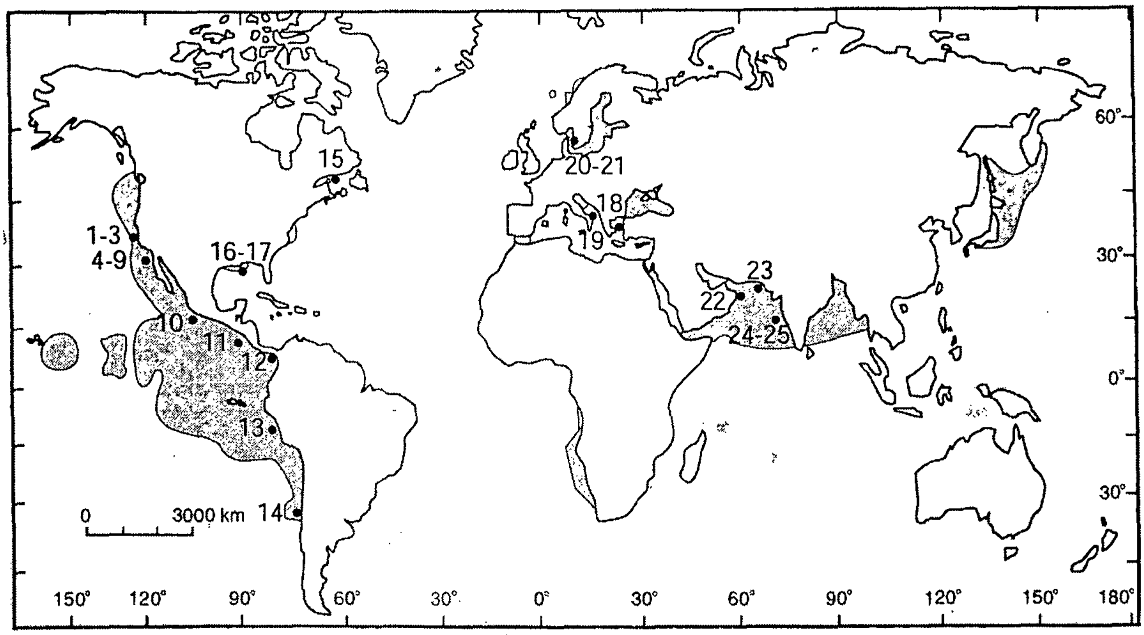


Figure 6.27: The world locations where the relationship between foraminifera and Oxygen Minima Zone has been studied on the basis of a minimum of 5 surface sediment samples (modified after Bernhard and Sen Gupta, 1999). [Santa Barbara Basin: 1. Harman (1964), 2. Phlegar and Soutar (1973), 3. Bernhard *et al.* (1997); Off California: 4. Streeter (1972), 5. Phlegar and Soutar (1973), 6. Blake (1976), 7. Douglas and Heitman (1979), 8. Quinterno and Gardner (1987), 9. Bernhard (1992); Off Mexico: 10. Perez-Cruz and Machain-Castillo (1990); Off El Salvador: 11. Smith (1964); Gulf of Panama: 12. Golik and Phlegar (1977); Off Peru: 13. Resig (1981); Peru-Chile Trench: 14. Ingle *et al.* (1980); Nova Scotia: 15. Corliss and Emerson (1990); Gulf of Mexico: 16. Sen Gupta *et al.* (1997), 17. Osterman (2003); Aegean Sea: 18. Katz and Thunell (1984); Adriatic Sea: 19. Jorissen *et al.* (1992); Drammensfjord, Norway: 20. Alve (1995), 21. Bernhard and Alve (1996); Off Oman: 22. Gooday *et al.* (2000); Off Pakistan: 23. Jannink *et al.* (1998); Off Goa, India: 24. Mazumder *et al.* (2003), 25. Present Study. (Modified after, Bernhard and Sen Gupta, 1999).

Further, though a number of authors have reported the invariable abundance of rectilinear forms in OMZ (Kaiho, 1994; Bernhard and Sen Gupta, 1999), the collective response on the rectilinear forms has not been investigated so far. Hence, the objective of the present study is to emphasize on the spatial distribution of benthic foraminifers, with a special reference to rectilinear forms, from the Arabian Sea, off central west coast of India, a region marked by well-developed OMZ.

6.4.2 OXYGEN MINIMA ZONE

The solubility of oxygen decreases with decreasing salinity and increases with rise in temperature. The amount of dissolved oxygen in seawater (including values of supersaturation) varies between 0 and 8.5 ml/l, the usual range being 1-6 ml/l (Tait, 1981). According to the classification of aquatic environments and corresponding biofacies (Tyson and Pearson, 1991), there are four zones in the oceans depending on dissolved oxygen concentration: (a) oxic (aerobic biofacies, with 8.0-2.0 ml/l O_2), (b) dysoxic (dysaerobic, 2.0-0.2 ml/l O_2), (c) suboxic (quasi anaerobic, 0.2-0.0 ml/l O_2), and (d) anoxic (anaerobic, 0.0 ml/l O_2). The more general physiological or ecological term "hypoxia" indicated a degree of oxygen depletion that would induce a severe stress on marine organisms, without necessarily implying a specific threshold value (Tyson and Pearson, 1991). The zone in the oceans, where concentration of dissolved oxygen is least, due to excessive use of available oxygen by organisms (for respiration) and organic matter (to degrade itself) but lesser supply, resulting from reduced circulation of water, is referred as Oxygen Minima Zone or OMZ (Sen Gupta and Machain-Castillo, 1993). The OMZ is caused by biochemical processes wherein oxygen is consumed, whereas its position and distribution is determined by circulation (Wyrtki, 1962). The OMZ has a geographical importance because of the formation of organic-rich sediments under reduced oxidation condition (Kennett, 1982). Although bottom water oxygenation is not directly influenced by organic input, the oxygenation of interstitial waters and the primary redox fronts do change in response to variations in the organic matter flux (Fontanier *et al.*, 2002).

The major regions exhibiting hypoxia irrespective of sampling depth are the Baltic Sea, Black Sea, Gulf of Aden, Arabian Sea, Bay of Bengal, Philippine region, northwest Pacific margin, eastern Pacific, Norwegian region and southwest African region (Kamykowski and Zentara, 1990). The majority of the marine records of hypoxia from world oceans are from depths above 1500 m.

In case of northern Indian Ocean, the surrounding landmass in the north, east, and west cause a sluggish renewal of subsurface waters thus giving rise to acute oxygen depletion at intermediate depths (Wyrtki, 1973; Sen Gupta and Naqvi, 1984). In the Arabian Sea region, the low oxygenated waters (<0.5 ml/l) extend from 150 m to a depth of approximately 1500 m (Stackelberg, 1972; Sen Gupta *et al.*, 1976; Sen Gupta *et al.*, 1980; Naqvi, 1994). The combination of high primary production and moderate ventilation (You and Tomczak, 1993) leads to an intense OMZ at water depths between 200 and 1000 m (Wyrtki, 1973; Olson et al., 1993). The persistence of OMZ in the Arabian Sea region results from the slow advection of water (Severdrup *et al.*, 1942), higher respiration rates (Ryther and Menzel, 1965), and influx of low oxygenated waters from the South Indian Ocean (Swallow, 1984).

6.4.3 RESULT

Within 405 benthic foraminiferal species identified, 68 species belong to 22 genus of rectilinear bi- and tri-serial benthic foraminifers, namely *Bolivina* (18 species), *Uvigerina* (14 species), *Bulimina* (7 species), *Fursenkoina* (5 species), *Brizalina* (3 species), Neouvigerina (2 species), *Reussella* (2 species), *Sagrinella* (2 species), *Trifarina* (2 species), *Bolivinella* (1 species), *Bolivinita* (1 species), *Buliminella* (1 species), Euuvigerina (1 species), *Hopkinsinella* (1 species), *Loxostomina* (1 species), *Pleurostomella* (1 species), *Rectobolivina* (1 species), *Sigmavirgulina* (1 species), *Siphogenerina* (1 species), *Siphouvigerina* (1 species), *Stainforthia* (1 species) and *Virgulinella* (1 species) shows its importance for the study detecting the index group for OMZ.

The list of rectilinear bi- and tri-serial benthic foraminifera is given below.

1. *Bolivina dilatata* Reuss
2. *B. doniezi* Cushman and Wickenden
3. *B.* cf. *B. inflata* Heron-Allen and Earland
4. *B. kuriani* Seibold
5. *B. lowmani* Phleger and Parker
6. *B. marginata* Cushman
7. *B.* cf. *B. oceanica* Cushman
8. *B. ordinaria* Phleger and Parker
9. *B.* cf. *B. pacifica* Cushman and McCulloch
10. *B. persiensis* Lutze
11. *B. pseudoplicata* Heron-Allen and Earland
12. *B. robusta* Brady
13. *B. seminuda* Cushman
14. *B. silvestrina* Cushman
15. *B. spinata* (Cushman)
16. *B. spinescens* Cushman
17. *B. variabilis* (Williamson)
18. *Bolivina* sp.
19. *Brizalina difformis* (Williamson)
20. *B. spathulata* (Williamson)
21. *B. striatula* (Cushman)

22. *Bolivinella elegans* Parr
23. *Bolivinita quadrilatera* (Schwager)
24. *Stainforthia concava* (Hoglund)
25. *Hopkinsinella glabra* (Millett)
26. *Loxostomina limbata* (Brady)
27. *Rectobolivina* sp.
28. *Sagrinella convallaria* (Millett)
29. *S.* cf. *S. guinai* Saidova
30. *Siphogenerina* aff. *S. virgula* (Brady)
31. *Bulimina aculeata* d'Ordigny
32. *B. alazanensis* Cushman
33. *B. biserialis* Millett
34. *B. exilis* Brady
35. *B. gibba* Fornasini
36. *B. marginata* d'Orbigny
37. *B. mexicana* (Cushman)
38. *Buliminella* cf. *B. milletti* Cushman
39. *Euuvigerina aculeata* (d'Orbigny)
40. *Neouvigerina ampullacea* (Brady)
41. *N. interrupta* (Brady)
42. *Siphouvigerina porrecta* (Brady)
43. *Uvigerina asperula* Czjzek
44. *U.* cf. *U.auberiana* d'Orbigny
45. *U. bassensis* Parr
46. *U. bifurcata* d'Orbigny
47. *U. brunensis* Karrer
48. *U. canariensis* d'Orbigny
49. *U. hollicki* Thalmann
50. *U. mediterranea* Hofker
51. *U. peregrina* Cushman
52. *U. proboscidea* Schwager
53. *U. vadescens* Cushman
54. *U. schwageri* Brady
55. *Uvigerina* sp.A
56. *Uvigerina* sp.B
57. *Trifarina carinata* (Cushman)
58. *Trifarina* sp.

59. *Reussella laevigata* (Cushman)
60. *R. spinulosa* (Reuss)
61. *Fursenkoina bradyi* (Cushman)
62. *F.complanata* (Egger)
63. *F. pontoni* (Cushman)
64. *F.* cf. *F. schreibersiana* (Czjzek)
65. *F. texturata* (Brady)
66. *Sigmavirgulina tortuosa* (Brady)
67. *Virgulinella pertusa* (Reuss)
68. *Pleurostomella* sp.

6.4.4 GRAPHICAL REPRESENTATION OF DATA

The percentage of rectilinear bi- and tri-serial benthic foraminifera has been considered for the study of the interrelationship between OMZ and benthic foraminifera. The three-point moving average of the percentage of rectilinear benthic forminifera (black line in Fig. 6.28) and total benthic foraminiferal number in 1 gm of sand fraction (blue line in Fig. 6.28) were plotted against the depth.

Figure 6.28 shows two prominent peaks in both the rectilinear benthic foraminifera percentage and total benthic foraminiferal number. Recalculated data from previous work (Henriques, 1993) (see Table 3.3 in Chapter 3 for details of samples) have also been incorporated to verify the prominence of shallow water peak. Figure 6.29 represents the five-point moving average of rectilinear benthic foraminifera after incorporating the recalculated data from previous work. The curve shows two major peaks, >50% of rectilinear foraminifera at ~60 m water depth and >65% of rectilinear foraminifera at ~150 m water depth.

The broader region of high abundance crosses 40% of rectilinear form among the total benthic foraminifera within the water depth of 90-1000 m, which matches with the well documented OMZ of the Arabian Sea reported before on the basis of the study of chemistry of water and sediment, and within the depth range the percentage is always >40%. Hence, considering >40% of rectilinear benthic foraminiferal abundance as cut-off, one more major high-abundance region is noticed besides the above-mentioned zone. This region is restricted within the depth range of ~50 to ~60 m.

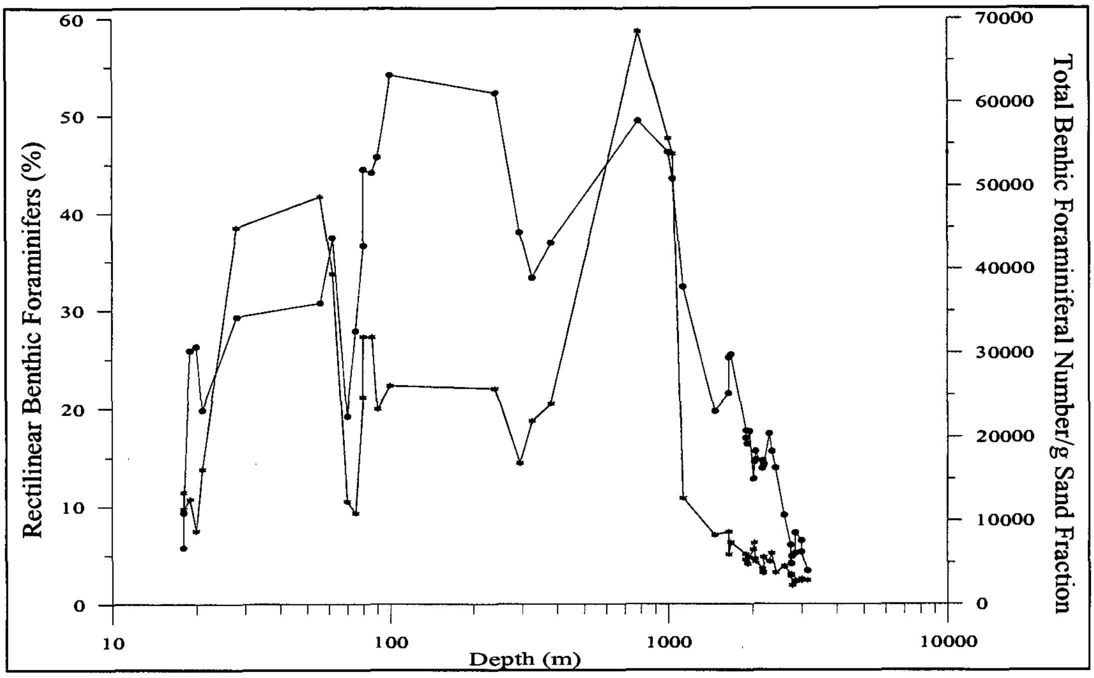


Figure 6.28: Relation between depth and percentage of rectilinear (black lines) and total benthic foraminiferal number in sand fraction (blue lines)

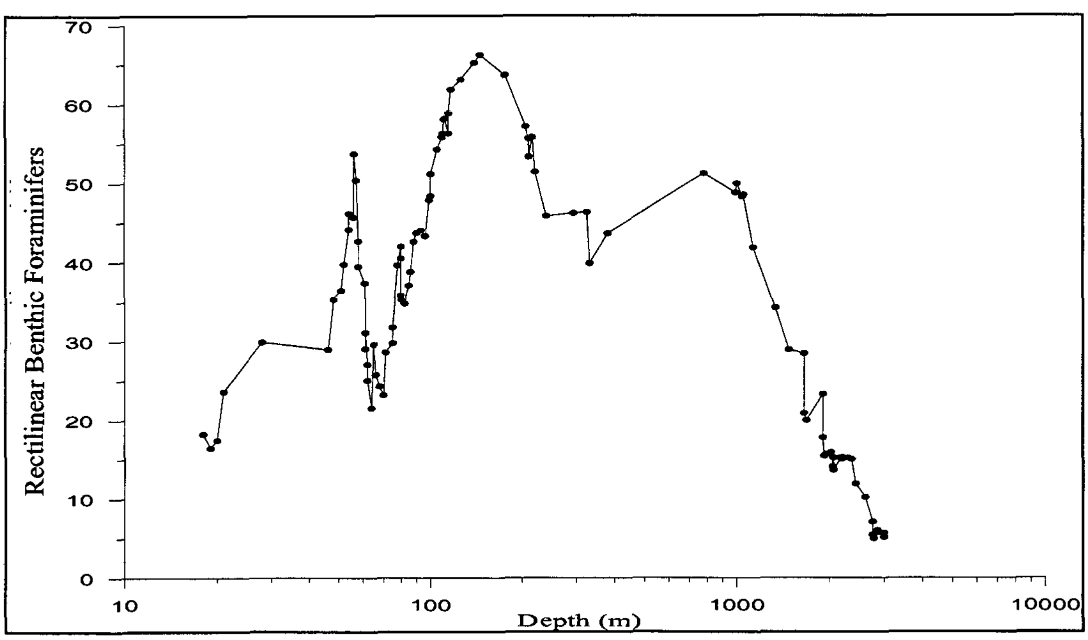


Figure 6.29: Curve representative of the relation between depth and percentage of rectilinear foraminifera of recalculated data from the present study and previous work

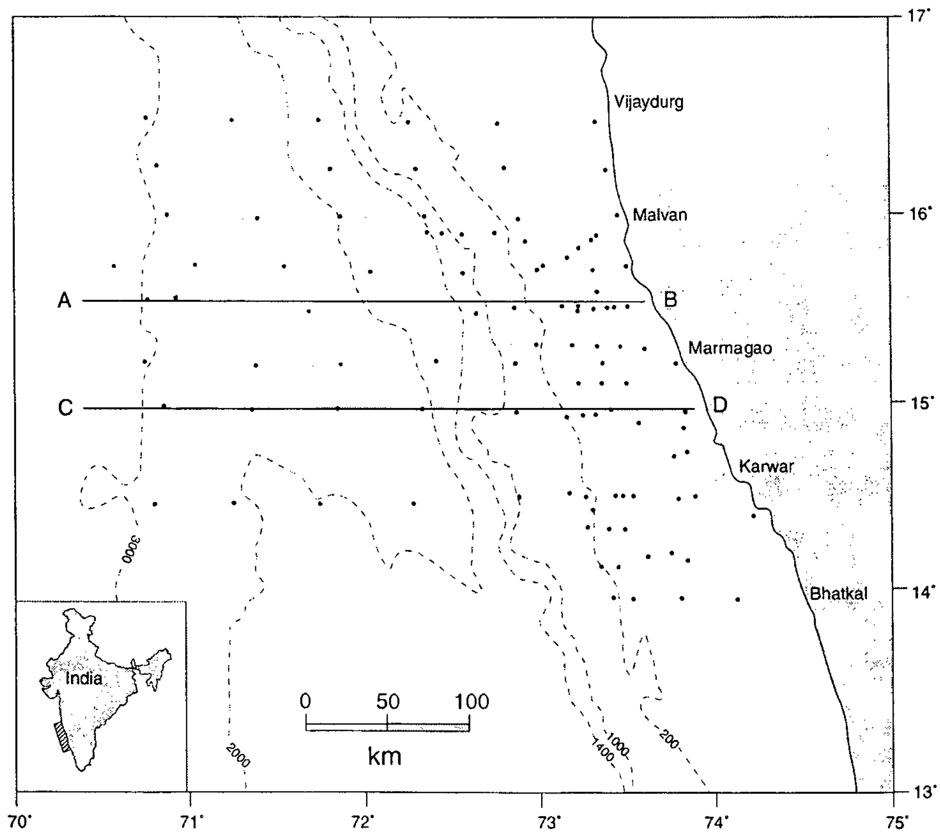


Figure 6.30: Transects along which the rectilinear benthic foraminifera and dissolved oxygen concentration were compared. Black dots are the samples used for counting the percentage of rectilinear benthic foraminifera

The rectilinear benthic foraminiferal percentage and dissolved oxygen concentration against water depth was compared graphically along two cross sections (15°23'N and 14°55'N) (Fig. 6.30). The dissolved oxygen concentration along these two lines is available in Sen Gupta *et al.* (1980).

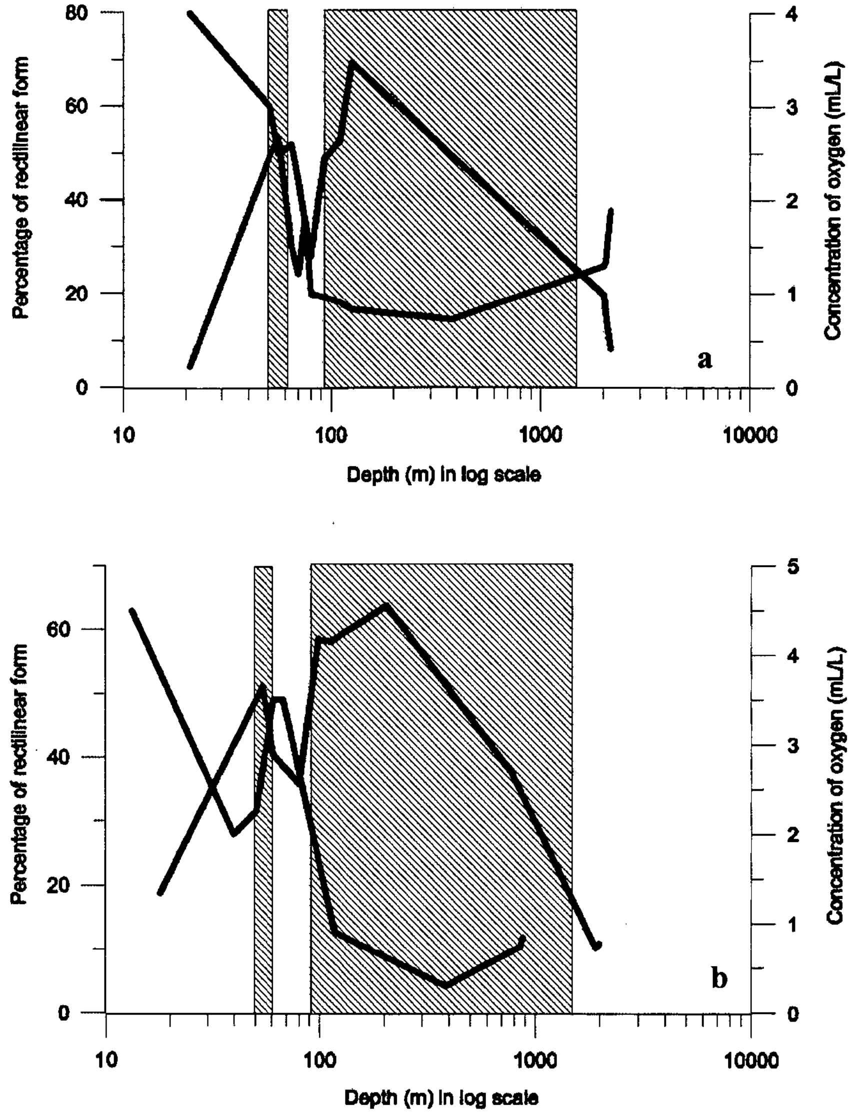


Figure 6.31: Comparison between rectilinear benthic percentage (blue line) and oxygen concentration (black line) along two transects (a) AB and (b) CD as in figure 6.30. Shaded area represents OMZ (both shallow and deep water)

Figure 6.31 shows the graphic representation between the rectilinear benthic foraminiferal percentage (blue lines) and dissolved oxygen concentration (black lines) against water depth along 15°23 N and 14°55 N. The graphs show a distinct negative correlation, with the decrease of oxygen concentration coinciding with the increase of rectilinear foraminifera. The shaded area represents the depths with low oxygen concentration.

6.4.5 DISCUSSION

Figure 6.27 shows the areas of the world oceans where a relationship between foraminifers in surface sediments (only those papers are included wherein minimum a 5 of surface samples has been analyzed; details given in caption to Fig. 6.27) and OMZ has been studied. It indicates that not much attention has been paid to the foraminiferal distribution in the OMZ of Arabian Sea.

Benthic foraminifers have been widely reported to get affected by the presence of oxygen minima conditions that lead to variation in abundance of foraminiferal assemblages (see, Bernhard and SenGupta, 1999, for review). So far it has been reported that the foraminiferal abundance is negatively correlated with the bottom-water oxygen concentration (Bernhard, 1992). On the contrary, Phlegar and Soutar (1973) reported that oxygen is not a limiting ecological factor for benthic foraminifers in the low-oxygen environments of Baja California. This view is also supported by a number of experimental studies (Moodley and Hess, 1992; Bernhard and Alve, 1996; Moodley et al., 1998). The consistent presence of infaunal taxa within the sediments demonstrates that these taxa are tolerant to a wide range of low-oxygen conditions as determined by pore-water manganese profiles (Corliss and Emerson, 1990). Douglas *et al.* (1980) and Thompson (1982) noted high standing stocks of benthic foraminifers in the anoxic environment of Santa Barbara and Santa Monica basins due to the lack of macrobenthic predators. The high density of benthic foraminiferal stocks in the OMZ is probably the combined effect of organic flux and absence of predation (Jannink *et al.*, 1998).

In the present study area, the presence of similar benthic foraminiferal characteristics along a shallow and deeper water depth zones, that has earlier been reported to have a low oxygen concentration based on other biogeochemical analysis, indicates that the OMZ in the Arabian Sea off central west coast of India is also marked by a peculiar benthic foraminiferal assemblage. A comparison of the benthic foraminiferal assemblage of the present study area with that from OMZ of the world oceans reveals presence of numerous common features. Interestingly, the physico-chemical characteristics of OMZ in the Arabian Sea, off central west coast of India, seem to be distinct as compared to others, as evident from the presence of a few species not reported from other OMZ and absence of a few others, which have been reported from other OMZ.

As far as foraminiferal characteristics from the OMZ of Arabian Sea are concerned, very limited studies have been conducted. Though studies have been undertaken to the north and northwestern part of the Arabian Sea, the present study is the first for the eastern Arabian Sea. Though in all these reports rectilinear foraminifers constitute one of the abundant foraminiferal assemblages in the OMZ of the world oceans including the OMZ of northern and northwestern Arabian Sea, but according to Sen Gupta and Machain-Castillo (1993), "data on oxygen levels and species distributions do not support the hypothesis that a particular shape or some other test morphology is a characteristic of most dysoxic-suboxic benthic foraminifers, regardless of their phylogeny". But the significant abundance of rectilinear foraminifers (upto 70%) within the depth of 90 m to 1500 m, a well-established OMZ (oxygen concentration <1.0 mL/L), west coast of India clearly indicates the potential application of the same as an index fauna for the OMZ in the Arabian Sea.

In addition to the above, similar abundance of rectilinear benthic foraminifers is also reported from the depth of 50-60 m of the present area, indicating OMZ (oxygen concentration ~2.0 mL/L) in coastal area. This finding is significant in view of the report of Naqvi *et al.* (2000) who suggested that the presence of coastal hypoxic zone off west coast of India could be linked to increased production of N_2O caused by the addition of anthropogenic nitrate and its subsequent denitrification. Similar hypoxic conditions in coastal areas have also been reported from different parts of the world (Turner and Rabalais, 1994; Diaz and Rosenberg, 1995; Malakoff, 1998; Rabalais, 2000). A strong spring and summer oxygen depletion is reported in nearshore bottom waters of the Louisiana continental shelf based on benthic foraminifers (Sen Gupta *et al.*, 1996), probably due to an increase in organic flux from surface to bottom waters near the outflow of Mississippi River (Turner and Rabalais, 1994). Foraminiferal characteristics from coastal hypoxic conditions were also recorded from the Gulf of Mexico (Osterman, 2003) wherein it was proposed that the 5-30 m thick hypoxic zone was formed seasonally due to spring runoff (Rabalais *et al.*, 1999; Rabalais and Turner, 2001). The similar change in benthic foraminiferal colonisation pattern has also been revealed with the change of anoxic to oxic condition of Drammensfjord, southern Norway and proposed to be due to seasonal variation (Alve, 1995). All these reports thus, support the presence of characteristic foraminiferal assemblage from OMZ in the present study. River inputs of fine-grained sediments rich in organic matter may also lead to the periodic development of low-oxygen or anoxic conditions on continental shelves (Murrell and Fleeger, 1989), although the distribution of these regions is strongly influenced by hydrographic and other conditions (Van der Zwaan and Jorissen, 1991). In the present area, the aforesaid hypoxia in coastal waters might be the result of either anthropogenic activities or due to natural seasonal influx of west-flowing rivers of Indian coast. These possibilities need to be checked by an intensive study especially through the temporal variation in the characteristics of benthic foraminifers.

In view of the findings of the surface distribution of rectilinear benthic foraminifers corresponding with the OMZ, an attempt has been made to study the variation, if any, in the intensity and extent of OMZ, through study of rectilinear benthic foraminifers in sub-surface sediments (short-cores) collected from both shallow and deep water areas.

6.4.6 CONCLUSION

Based on the foraminiferal analysis of surface sediment samples, we report that the presence of OMZ in the Arabian Sea off the central west coast of India affects the benthic foraminifers resulting in a characteristic assemblage. The significant abundance of rectilinear foraminifers (upto 70%) within a well-established OMZ, ~90 to ~1500 m water depth of central west coast of India clearly indicates the potential application of the same as an index fauna for the OMZ in the Arabian Sea. We further conclude that the higher abundance of rectilinear form also indicates a distinct oxygen minima condition in a comparatively shallower depth ranging from ~50 to ~60 m.

CHAPTER 7
DISTRIBUTION OF FORAMINIFERA IN SUBSURFACE SEDIMENTS AND PALEOCLIMATIC IMPLICATIONS

7.1 INTRODUCTION

Understanding the 'cause and effect' relationship between various climatic parameters that recurred during the geologic past is important in order to understand paleoclimatic variations. Ocean bottoms carpeted with a thick pile of unconsolidated sediments accumulated over millions of years are excellent source of information about the past that can be deciphered using various means including abundance and morphologic variation of foraminifers. The selection of the ideal site from where sediments for such studies are collected is very important. The region along the west coast of India is unique due to the presence of a widely reported oxygen minima zone (OMZ). Such regions with extremely low dissolved oxygen concentration support very low biological activity on the sea floor, thus, considerably reducing the bioturbation of sediments and in turn a better preservation of information within the sediments.

The intensity and extent of OMZ is regulated by various biological and physico-chemical parameters, mainly the rate of production of organic matter and replenishment of dissolved oxygen. The rate of production of organic matter and replenishment of dissolved oxygen are in turn regulated by ocean water circulation, supply of nutrients, sea surface temperature, wind pattern etc. Therefore, any change in these bio-physico-chemical parameters will result in variation in intensity and extent of OMZ or independently reconstructed variations in OMZ will provide clues about changes in bio-physico-chemical parameters during the geologic past.

Typical benthic foraminiferal assemblages characterise OMZs from rest of the ecosystems in world oceans. In the present study also a clear relationship has been established between rectilinear benthic foraminiferal abundance and OMZ, based on surface sediments, as discussed in the previous chapter. Making use of these characteristic benthic foraminiferal assemblages from OMZ, Cannariato and Kennett (1999) reported changes in OMZ over the past 60 k yr from Santa Lucia slope, California margin. In a similar study, Hendy *et al.* (2003) stated that during the last glacial, pore water oxygen concentration changed largely along the North American margin, which suggests that the fluctuation of OMZ is in accordance with the rapid climate change. Ohkushi *et al.* (2003) documented a high sensitivity of benthic foraminifera with changing oxygenation states and concluded that the

California basin was well oxygenated during cool episodes and poorly oxygenated during warm episodes. Bubenshchikova *et al.* (2003) also applied benthic foraminiferal assemblage to reconstruct past OMZ variation from Sakhalin and Kamchatka slope region, over the last glacial-interglacial period.

But no such attempt has still been made from the OMZ off west coast of India. The well-documented OMZ off west coast of India provides an ideal setting to test the potential application of benthic foraminiferal characteristics in deciphering the past variations in the extent and intensity of OMZ.

In the present chapter an attempt has been made to document the temporal variations in the intensity and extent of OMZ off the central eastern Arabian Sea, with the help of variation in benthic foraminiferal assemblage, and to correlate it with variation in biological and physico-chemical parameters during the geologic past as reported previously.

7.2 CONCEPTUAL FRAMEWORK FOR PALEOCLIMATIC RECONSTRUCTION

As discussed in Chapter 6, based on surface distribution of benthic foraminifers, it was inferred that rectilinear benthic foraminifera respond to deeper (150-1200 m) as well as shallow zone of reduced oxygen concentration. Increased abundance of rectilinear benthic foraminifera under depleted oxygen conditions in surface sediment samples indicates that time-series distribution of relative abundance of rectilinear benthic foraminifera can be used to infer past variations in dissolved oxygen concentrations. Relatively uniform down-core abundance of rectilinear foraminifera will indicate no change in the intensity and extent of OMZ while significant variation in percentage of rectilinear forms may indicate variation in dissolved oxygen concentration. In order to test this concept a set of ten cores was selected from the present study area as discussed below.

7.3 SELECTION OF CORES

A set of ten cores (Fig. 7.1) along 3 East-West transects covering the present day shallow and deep OMZ off central west coast of India, were carefully selected to study the temporal variations in extent and intensity of OMZ off central west coast of India.

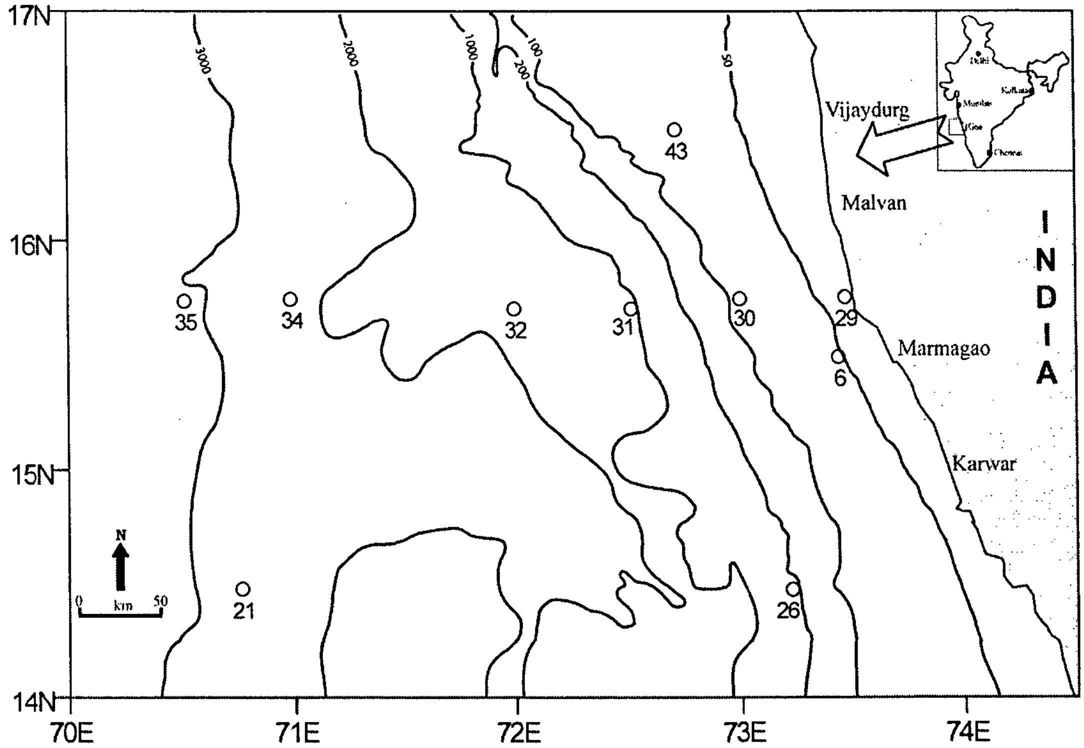


Figure 7.1: Locations of the cores selected for a detailed study

For convenience of a comparative study, down-core variation of 22 common benthic foraminiferal genera (>5% in at least one station) in all these cores was plotted as discussed in the next section. The large benthic foraminiferal distribution data set of ten cores was further subjected to Q-mode cluster analysis in order to draw meaningful assemblages. Finally, based on significant down-core variation of relative abundance of rectilinear benthic foraminifera, a few cores were selected for detailed study and the results are discussed subsequently.

7.4 RESULTS AND DISCUSSION

All of the selected cores have rich benthic foraminiferal content (Fig. 7.2). A total of 420 species of foraminifera have been identified in the subsurface sediments. In the following sections temporal distribution of foraminiferal components and different genera in each core, is described in detail.

7.4.1 GENERIC FORAMINIFERAL VARIATION

The foraminiferal study shows a total of 423 species in 10 cores. A generic foraminiferal comparison revealed 22 common genera (>5% in at least one station). These common genera are *Ammonia, Asterorotalia, Bolivina, Brizalina, Bulimina, Cancris, Cassidulina, Elphidium, Epistominella, Fursenkoina, Globocassidulina, Gyroidina, Gyroidinoides,* *Melonis*, *Nonion*, *Nonionoides*, *Osangularia*, *Pullenia*, *Quinqueloculina*, *Rotalidium*, *Trifarina* and *Uvigerina*. All other genera are rare in abundance. The following table (Table 7.1) shows the total number of species and major species (>5% in at least one station) under each genus mentioned above. Temporal variation of major genera and morpho-groups are presented below. Table 7.2 shows a comparative generic distribution of foraminifera in ten different cores. The down core variations of genera abundant in all the ten cores are presented in Figures 7.3 to 7.24.

Table 7.1: Total and major species (>5% in at least one station) under each genus in ten Cores

Sr. No.	Genus	No. of Species	Major Species (>5% in at least one station)
1	*Ammonia*	4	*Ammonia tepida*
2	*Asterorotalia*	2	*Asterorotalia dentata*
3	*Bolivina*	18	*Bolivina lowmani, B. marginata, B. ordinaria, B. persiensis, B. pseudoplicata, B. robusta, B. seminuda*
4	*Brizalina*	3	*Brizalina spathulata, B. striatula*
5	*Bulimina*	7	*Bulimina aculeate, B. gibba*
6	*Cancris*	4	*Cancris sp.*
7	*Cassidulina*	7	*Cassidulina aff. C. algida, Cassidulina cf. C. crassa, C. sicula, C. teretis*
8	*Elphidium*	6	Nil
9	*Epistominella*	3	*Epistominella exigua, E. minuta*
10	*Fursenkoina*	5	*Fursenkoina bradyi, F. complanata, F. texturata*
11	*Globocassidulina*	2	*Globocassidulina oriangulata, G. subglobosa*
12	*Gyroidina*	4	*Gyroidina bradyi, Gyroidina* sp. A, *Gyroidina* sp. B
13	*Gyroidinoides*	2	*Gyroidinoides orbicularis, G. soldanii*
14	*Melonis*	3	*Melonis barleeanum, M. pompilioides*
15	*Nonion*	5	*Nonion* cf. *N. asterizens, Nonion aff. N. depressulum, N. incisum, N. scaphum, N. sloanii*
16	*Nonionoides*	3	*Nonionoides elongatum*
17	*Osangularia*	1	*Osangularia bengalensis*
18	*Pullenia*	2	*Pullenia bulloides, P. subcarinata*
19	*Quinqueloculina*	21	Nil
20	*Rotalidium*	1	*Rotalidium annectens*
21	*Trifarina*	2	*Trifarina carinata*
22	*Uvigerina*	15	*Uvigerina* cf. *U. auberiana, U. canariensis*

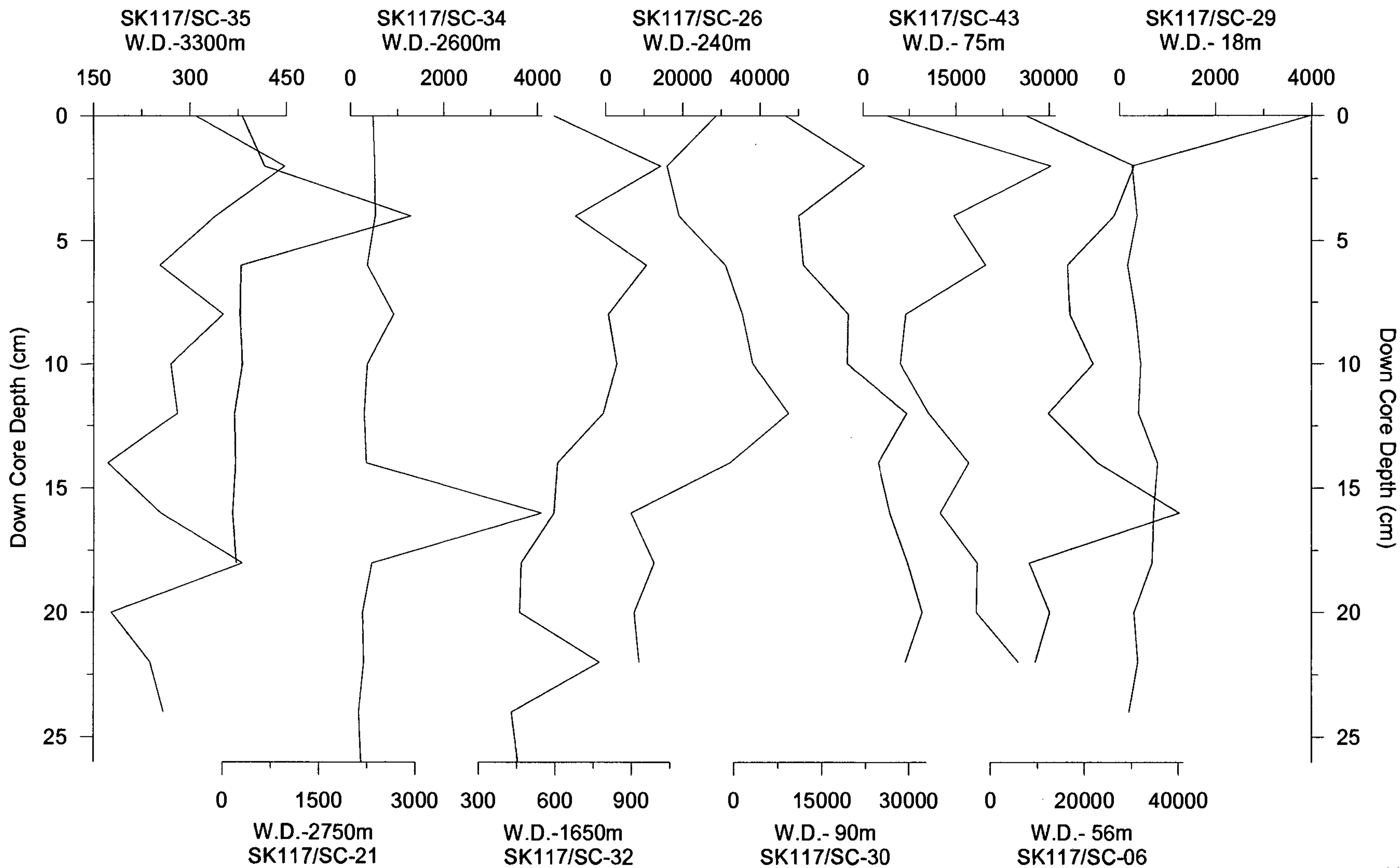


Figure 7.2: Down-core distribution of total benthic foraminiferal number (TBFN)/g dry sediment in cores selected for detailed study. The x-axis represents the TBFN/g dry sediment.

Table 7.2: Maximum and minimum abundances of major (greater than 5% at minimum one station) genera. The bold numbers indicate the cores in which the abundance of respective genera is equal to or greater than 5%

Genus	SC-29 (18 m)		SC-06 (56 m)		SC-43 (75 m)		SC-30 (90 m)		SC-26 (240 m)		SC-31 (1130 m)		SC-32 (1650 m)		SC-34 (2600 m)		SC-21 (2750 m)		SC-35 (3300 m)	
	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
1. *Ammonia*	**49.8**	10.1	**5.7**	0.2	**5.3**	0.8	1.3	0.0	1.4	0.0	1.7	0.0	2.0	0.0	1.5	0.0	2.5	0.0	2.0	0.0
2. *Asterorotalia*	**8.0**	1.1	1.4	0.0	1.7	0.0	4.7	0.0	0.7	0.0	1.5	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0
3. *Bolivina*	1.5	0.0	**11.5**	1.5	**23.1**	9.2	**30.1**	16.0	**46.8**	22.3	**14.1**	0.0	**12.7**	2.2	**5.5**	1.4	1.9	0.0	3.3	0.0
4. *Brizalina*	2.0	0.3	**12.5**	4.8	3.8	0.9	**5.1**	0.7	**13.7**	1.0	1.5	0.0	2.5	0.0	1.4	0.0	0.3	0.0	0.0	0.0
5. *Bulimina*	1.4	0.0	**5.1**	1.0	3.8	0.3	3.3	0.0	**10.7**	1.7	**18.5**	0.0	**6.9**	1.6	4.9	0.5	0.7	3.7	**6.1**	1.0
6. *Cancris*	0.0	0.0	**5.2**	2.3	**11.1**	2.8	**6.9**	0.0	1.4	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7. *Cassidulina*	0.3	0.0	1.9	0.0	**17.8**	12.4	**19.4**	12.2	**16.0**	1.8	**21.6**	1.3	4.8	0.0	3.7	0.0	1.2	0.0	2.0	0.0
8. *Elphidium*	**5.8**	0.0	0.7	0.0	1.0	0.0	1.8	0.0	1.4	0.0	1.9	0.0	0.7	0.0	0.3	0.0	4.9	0.0	0.5	0.0
9. *Epistominella*	0.3	0.0	0.3	0.0	0.6	0.0	0.7	0.0	0.7	0.0	**16.4**	8.9	**31.6**	17.3	**21.0**	5.9	**32.3**	13.9	**31.9**	12.7
10. *Fursenkoina*	4.2	0.4	**63.9**	39.0	**25.0**	6.5	**6.7**	1.2	0.5	0.0	0.9	0.0	1.6	0.0	2.3	0.0	2.0	0.0	2.6	0.0
11. *Globocassidulina*	0.4	0.0	2.1	0.0	3.8	0.0	**9.9**	0.0	**13.6**	1.7	**28.3**	12.5	**12.6**	2.8	**5.8**	1.3	**5.4**	0.0	**5.6**	0.7
12. *Gyroidina*	1.5	0.0	0.5	0.0	1.1	0.0	**5.0**	0.0	2.5	0.3	**18.3**	3.4	**13.5**	5.7	**24.0**	9.3	**23.3**	13.2	**22.4**	6.7
13. *Gyroidinoides*	1.1	0.0	0.4	0.0	1.9	0.0	3.5	0.6	3.9	0.5	3.7	1.0	**6.9**	2.6	**11.1**	4.1	**11.6**	3.9	**9.9**	3.9
14. *Melonis*	0.7	0.0	0.0	0.0	0.6	0.0	0.5	0.0	1.7	0.0	3.6	0.0	**16.7**	1.4	**8.2**	3.2	**17.0**	2.8	**9.6**	2.0
15. *Nonion*	**44.6**	22.8	**14.4**	5.3	4.9	0.3	3.3	0.0	2.1	0.0	0.9	0.0	0.4	0.0	0.4	0.0	0.0	0.0	0.0	0.0
16. *Nonionoides*	**11.2**	2.5	**6.1**	1.7	3.5	0.7	3.6	1.0	1.1	0.3	1.7	0.0	0.8	0.0	0.8	0.0	0.3	0.0	0.6	0.0
17. *Osangularia*	0.4	0.0	0.0	0.0	0.3	0.0	0.3	0.0	1.8	0.0	**10.4**	6.5	**21.7**	13.5	**26.2**	12.4	**9.5**	1.4	**27.6**	6.4
18. *Pullenia*	0.4	0.0	0.0	0.0	0.7	0.0	0.3	0.0	0.3	0.0	2.4	0.4	**6.9**	0.6	**14.9**	5.8	**10.9**	5.1	**11.4**	5.2
19. *Quinqueloculina*	4.3	0.0	1.0	0.0	**8.4**	1.6	4.5	1.8	3.0	0.0	0.9	0.0	3.2	0.0	**5.0**	0.0	3.2	0.0	4.3	0.0
20. *Rotalidium*	**27.4**	2.4	3.1	0.0	3.3	0.0	**6.1**	1.0	2.5	0.3	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21. *Trifarina*	0.0	0.0	0.0	0.0	3.3	0.6	**6.6**	1.6	6.0	1.1	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22. *Uvigerina*	0.0	0.0	1.0	0.0	**7.4**	1.5	**8.7**	2.7	**20.2**	6.1	1.5	0.0	0.8	0.0	0.0	0.0	0.0	0.0	1.0	0.0

Genus *Ammonia* (Fig. 7.3) in subsurface sediments is represented by four species, viz. *Ammonia* aff. *A. globosa*, *A. ketienziensis angulata*, *A. sobrina* and *A. tepida*. Their maximum abundance (49.8% of the total benthic foraminiferal number) has been observed at the depth of 2-4 cm in core SK117 SC-29. Among the four species of this genus, *A. tepida* is most abundant (reaches up to 43.6% at a depth of 2-4 cm in core SK117 SC-29). Down-core distribution of *Ammonia* shows that it is a typical shallow water genus with the maximum abundance in the cores collected from the shallow water regions (<75 m).

Genus *Asterorotalia* (Fig. 7.4) is represented by two species namely *Asterorotalia dentata* and *A. inflata*. Their maximum abundance (8.0% of total benthic foraminiferal number) has been observed at a core depth of 6-8 cm in SK117 SC-29. Between two species of this genus, *A. dentata* is more abundant (reaches up to 6.2% at core depth of 24-27 cm in core SK117 SC-29). Genus *Astrorotalia* is also a shallow water genus being abundant in shallow water cores (<90 m).

Genus *Bolivina* (Fig. 7.5) is represented by 18 species namely *Bolivina dilatata*, *B. doniezi*, *B. inflata*, *B. kuriani*, *B. lowmani*, *B. marginata*, *Bolivina* cf. *B. oceanica*, *B. ordinaria*, *Bolivina* cf. *B. pacifica*, *B. persiensis*, *B. pseudoplicata*, *B. robusta*, *B. seminuda*, *B. silvestrina*, *B. spinata*, *B. spinescens*, *B. variabilis*, *Bolivina* sp. A. Their maximum abundance (46.8% of total benthic foraminiferal number) has been observed at a core depth of 0-2 cm in core SK117 SC-26. Out of the total of 18 species of this genus reported from the subsurface sediments in the present study, *B. pseudoplicata* is most abundant (reaches up to 24.3% at core depth of 20-22 cm in core SK117 SC-26). The distribution of genus *Bolivina* shows that *Bolivina* is abundant in intermediate depth cores (75-240 m).

Genus *Brizalina* (Fig. 7.6) is represented by three species namely *Brizalina difformis*, *B. spathulata* and *B. striatula* out of which *B. spathulata* is most abundant (reaches up to 13.4% at the depth of 2-4 cm in core SK117 SC-26). Their maximum abundance (13.7% of total benthic foraminiferal number) has been observed at core depth of 2-4 cm in core SK117 SC-26 (Fig. 7.6). Genus *Brizalina* doesn't show any preferred depth distribution.

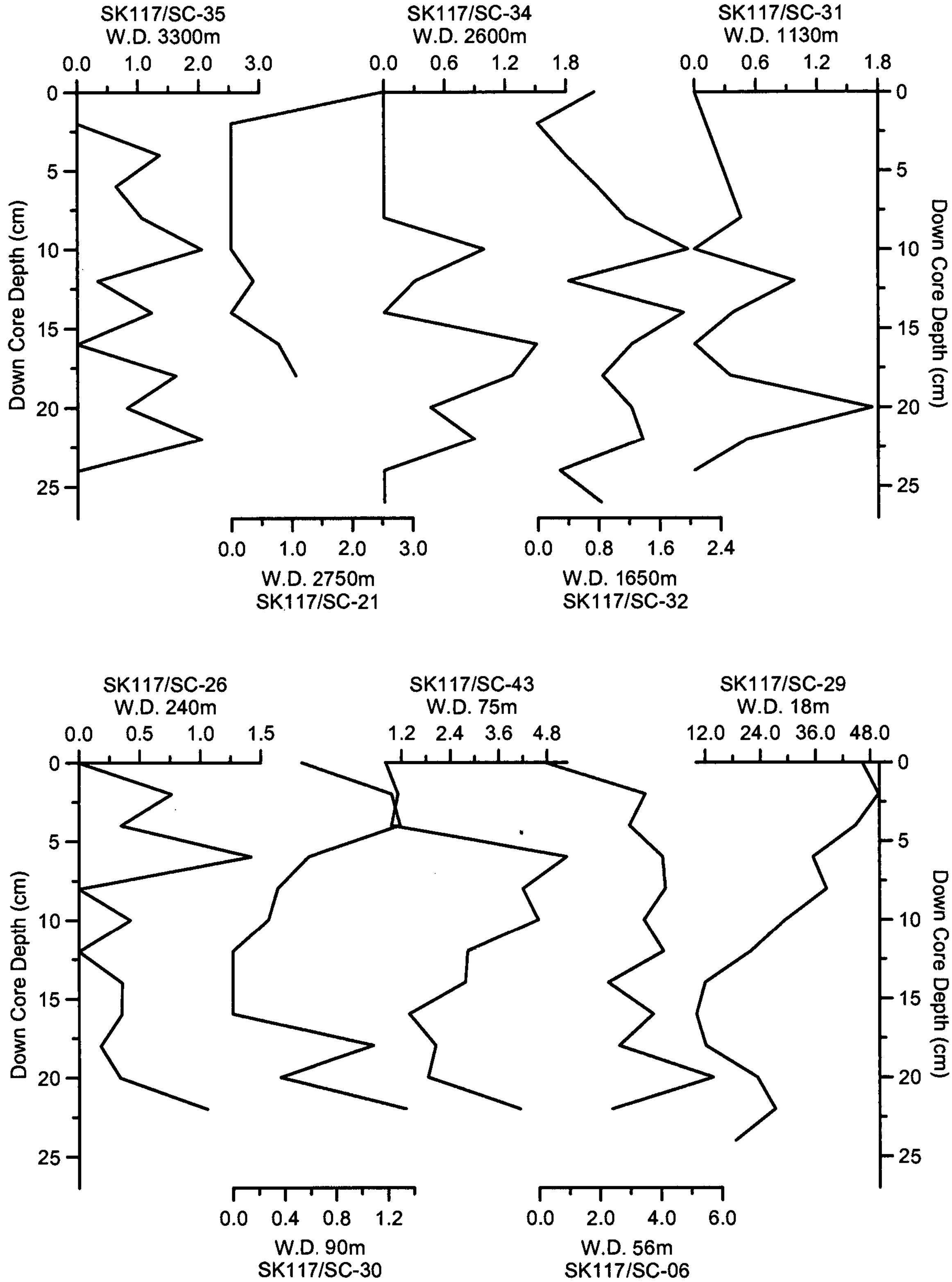
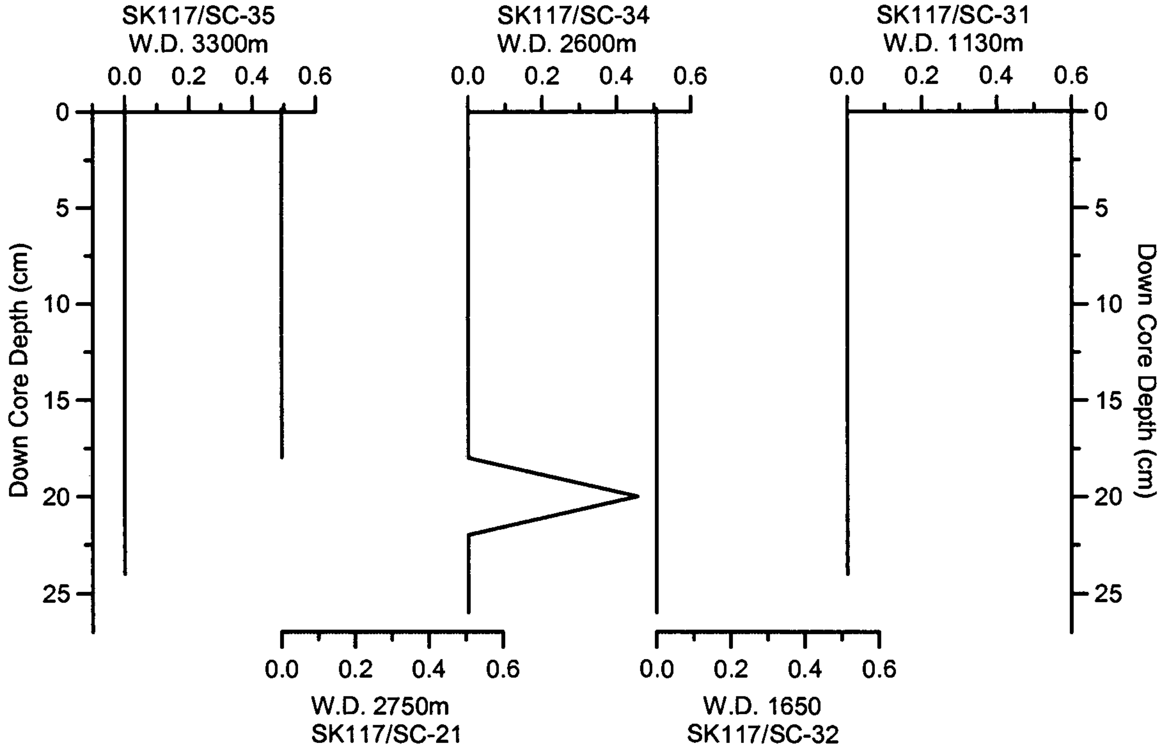


Figure 7.3: Down-core variation of *Ammonia* indicates that this genus is typical of shallow water



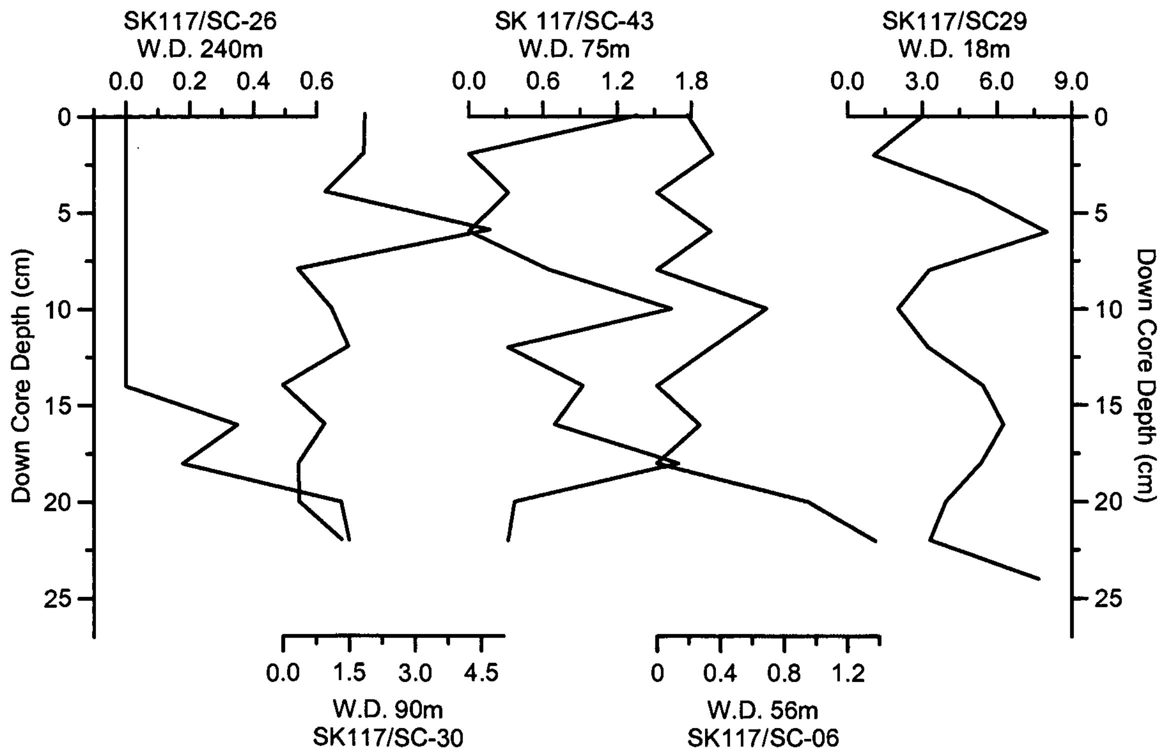


Figure 7.4: Down-core variation of *Asterorotalia* indicates that this genus is typical of shallow water

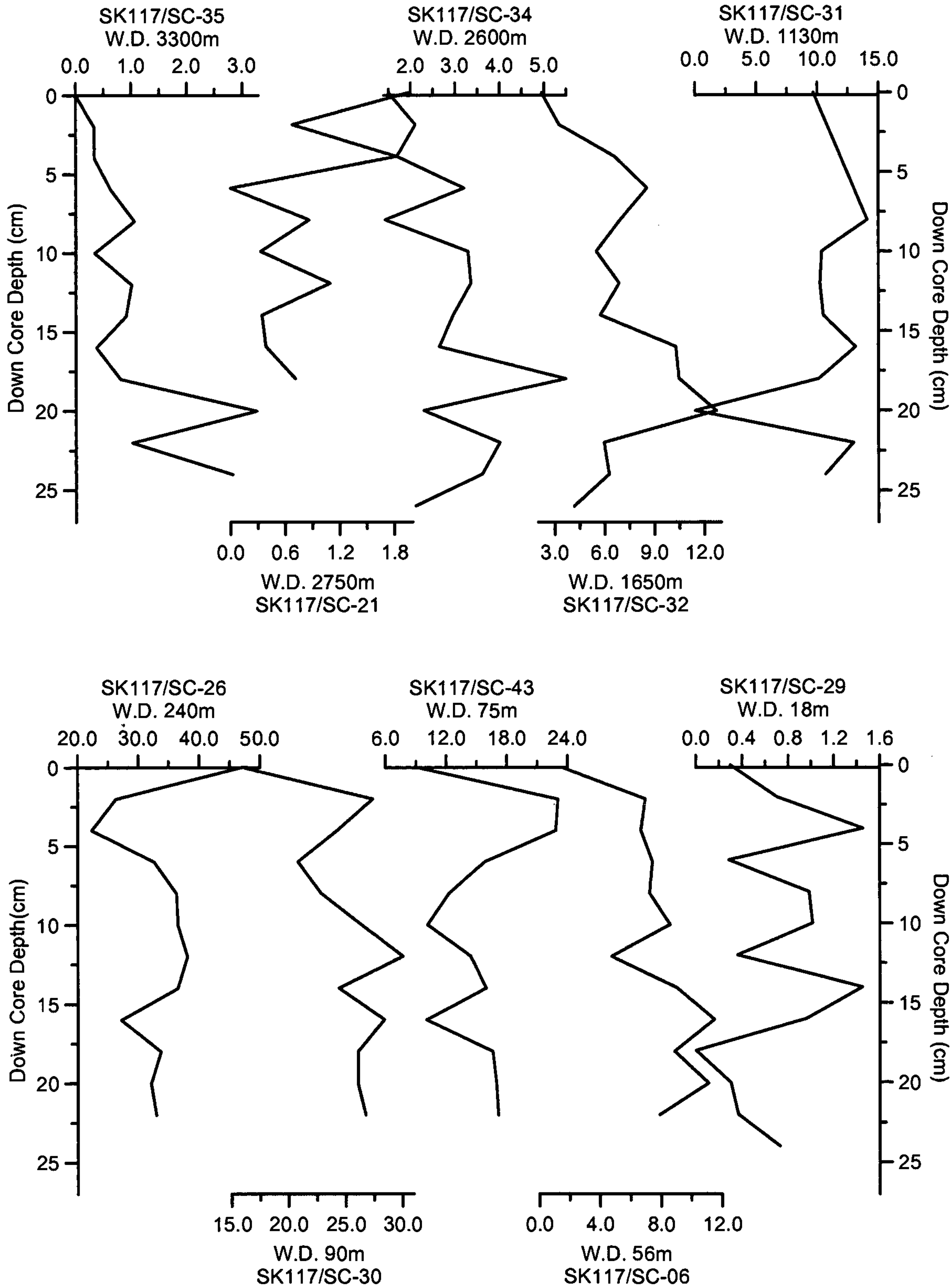


Figure 7.5: Down-core variation of *Bolivina* indicates that this genus is abundant in intermediate depth zone

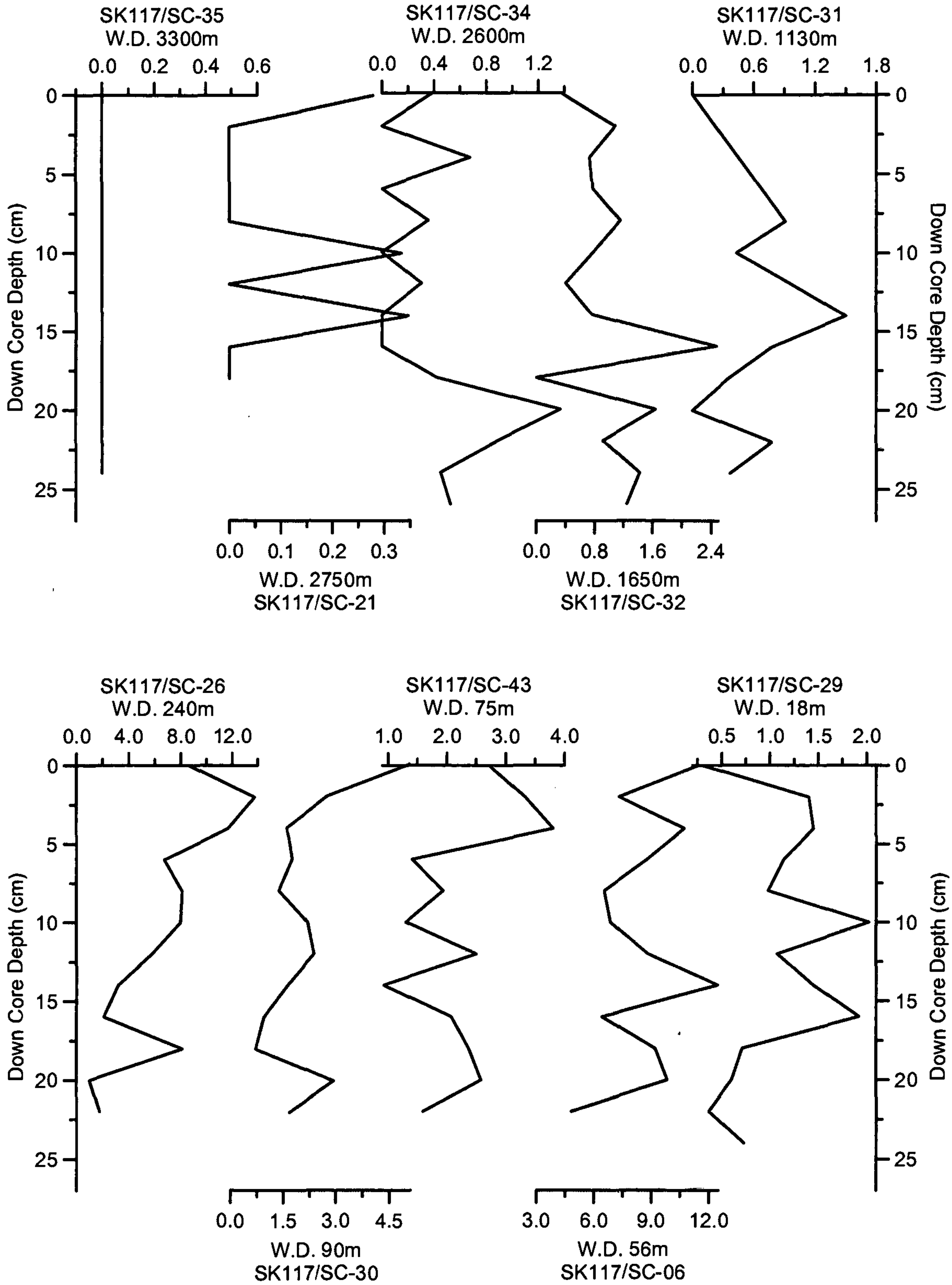


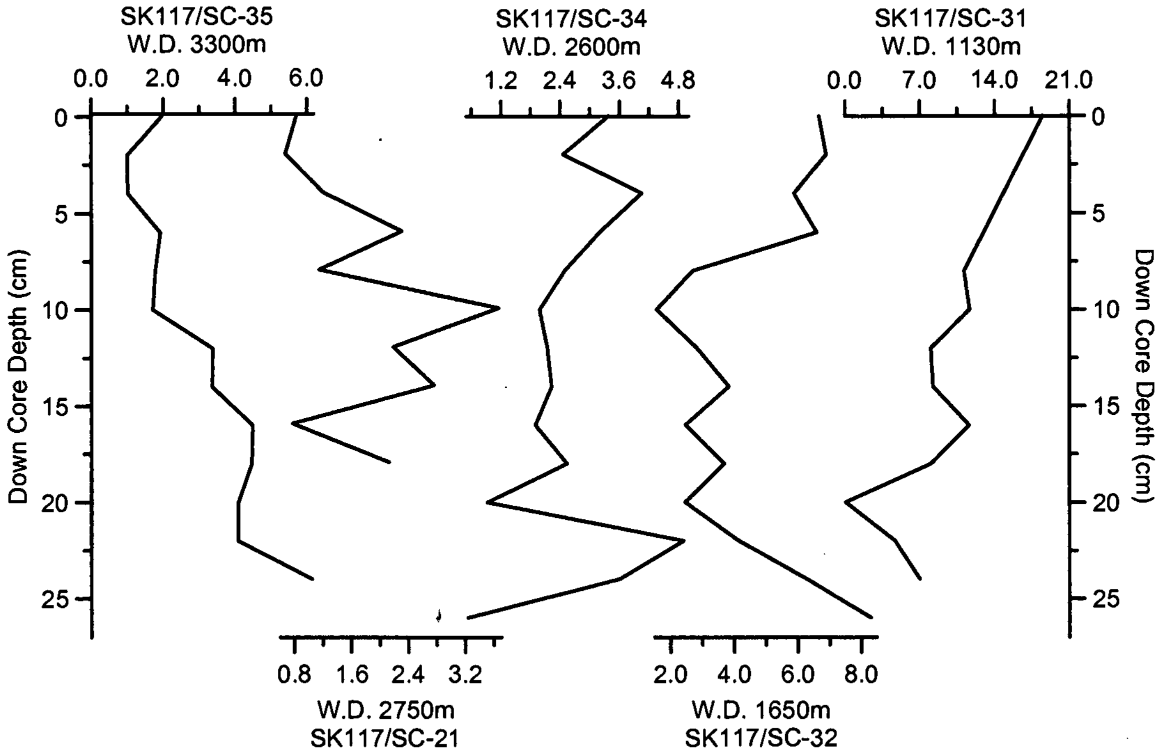
Figure 7.6: Down-core variation of *Brizalina* indicates that this genus occurs irrespective of depth

Genus *Bulimina* (Fig. 7.7) is represented by 7 species namely *Bulimina alazanensis*, *B. aculeata*, *B. biserialis*, *B. exilis*, *B. gibba*, *B. marginata* and *B. mexicana*. Their maximum abundance, 18.5% of total benthic foraminiferal number, has been observed at core depth of 0-8 cm in core SK117 SC-31. Out of the total of 7 species reported from this genus, *B. biserialis* is most abundant (reaches up to 6.5% at core depth of 4-6 cm in core SK117 SC-26). The down-core distribution of genus *Bulimina* appears to be unaffected by the water depth as *Bulimina* is abundant in both shallow as well as deeper water cores.

Genus *Cancris* (Fig. 7.8) is represented by 4 species namely *Cancris auriculus*, *C. oblongus*, *C. sagra* and *Cancris* sp. Their maximum abundance (6.9% of total benthic foraminiferal number) has been observed at core depth of 0-2 cm in core SK117 SC-30. Out of 4 species of this genus reported in the present study, *Cancris* sp. is most abundant (reaches up to 5.2% at core depth of 8-10 cm in core SK117 SC-43). Genus *Cancris* is abundant in shallow water cores (56-90 m).

Genus *Cassidulina* (Fig. 7.9) is represented by 7 species namely *Cassidulina* aff. *C. algida*, *Cassidulina* cf. *C. crassa*, *C. laevigata*, *C. sicula*, *C. subcarinata*, *C. teretis* and *C. tortuosa* out of which *Cassidulina* cf. *C. crassa* is most abundant (reaches up to 8.9% at core depth of 8-10 cm in core SK117 SC-31). Their maximum abundance (21.6% of total benthic foraminiferal number) has been observed at core depth of 10-12 cm in core SK117 SC-31. Genus *Cassidulina* is abundant in intermediate water depth (75-1130 m).

Genus *Elphidium* (Fig. 7.10) is represented by 6 species namely *Elphidium advenum*, *E. crispum*, *E. discoidale*, *E. macellum*, *E. minutum* and *E. reticulosum*, with the maximum abundance, (5.8% of total benthic foraminiferal number) observed at the core depth of 14-16 cm in core SK117 SC-29 (Fig. 7.10). Among 6 species of this genus reported in the subsurface sediments in the present study, *Elphidium minutum* is most abundant (reaches up to 4.9% at core depth of 4-6 cm in core SK117 SC-21). *Elphidium* is abundant only in the core reported from shallow water (18 m).



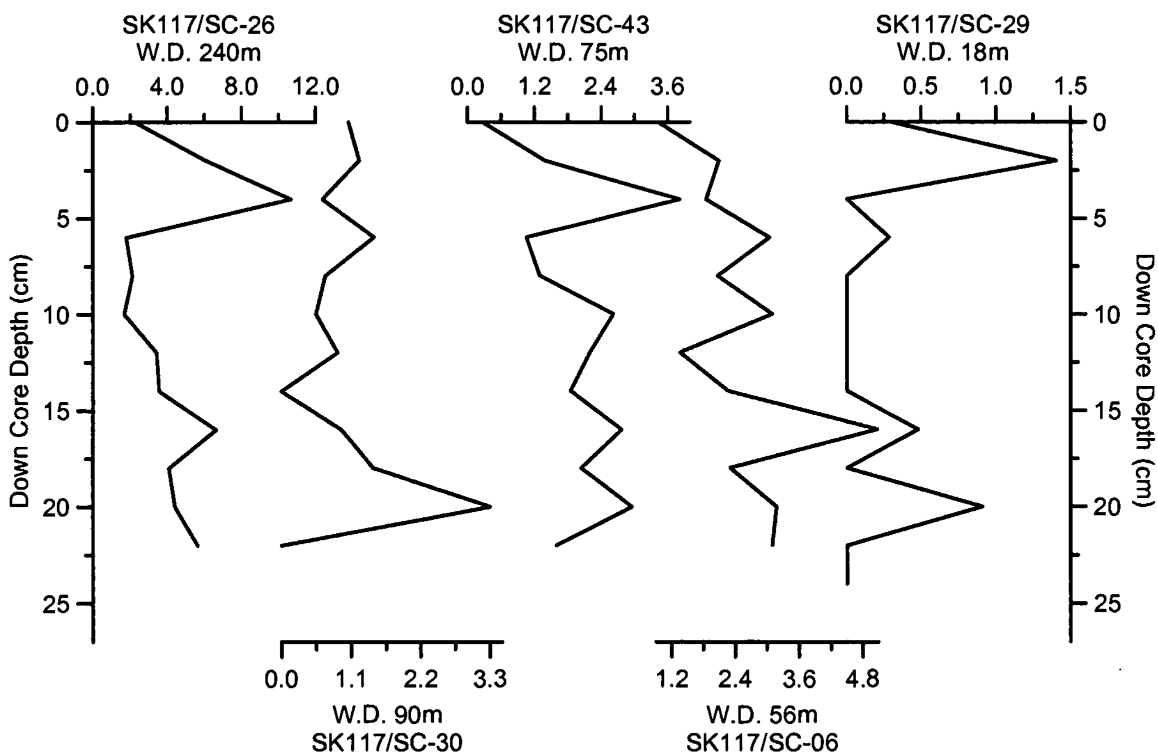


Figure 7.7: Down-core variation of *Bulimina* indicates that this genus is abundant in the intermediate depth zone

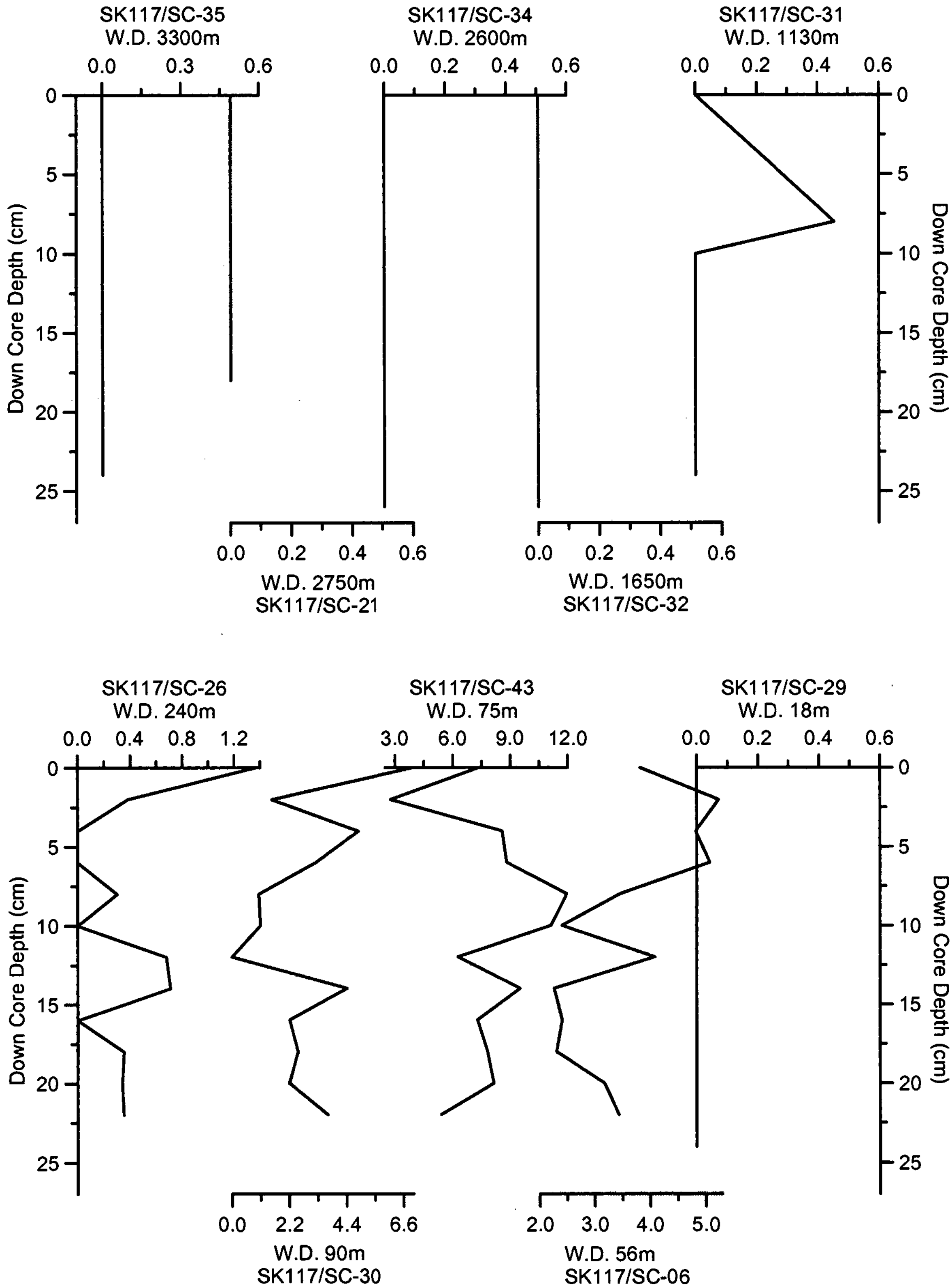


Figure 7.8: Down-core variation of *Cancris* indicates that this genus is abundant in shallow depth zone

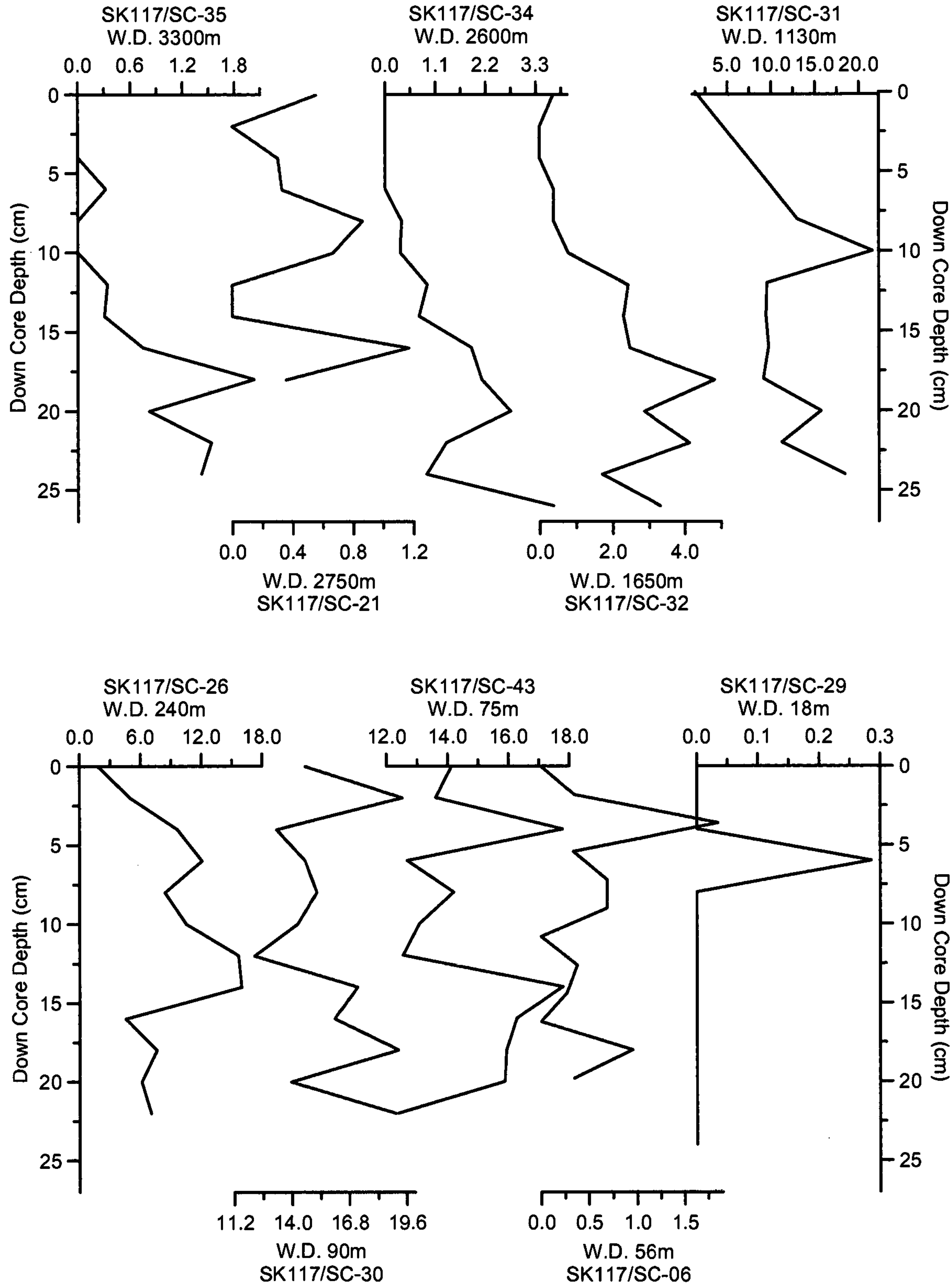


Figure 7.9: Down-core variation of *Cassidulina* indicates that this genus is abundant in the intermediate depth zone.

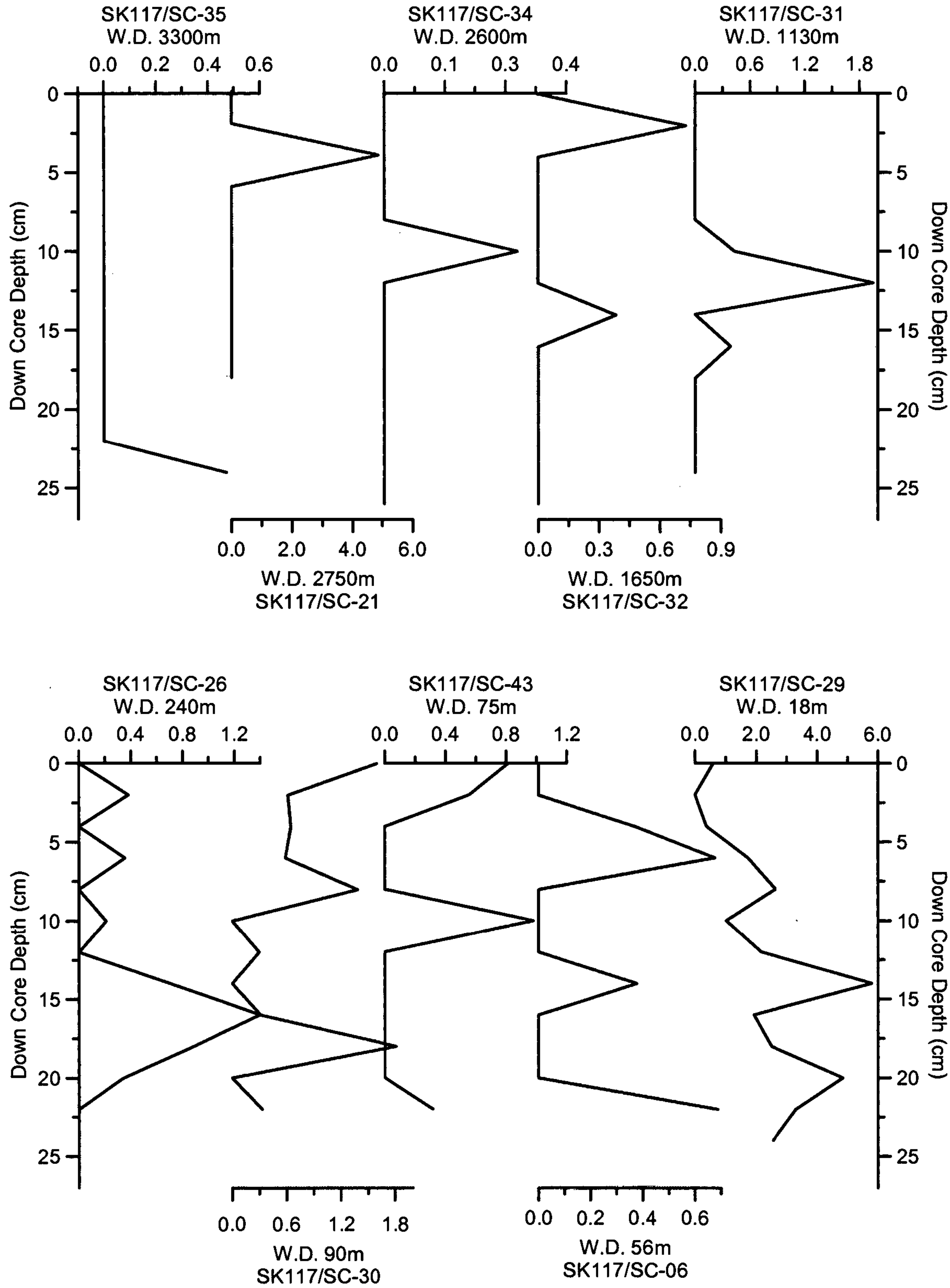


Figure 7.10: Down-core variation of *Elphidium* indicates that this genus is abundant in shallow depth zone

Genus *Epistominella* (Fig. 7.11) is represented by 3 species namely *Epistominella decorata*, *E. exigua* and *E. minuta*. The maximum abundance of genus *Epistominella* (32.3% of total benthic foraminiferal number) has been observed at core depth of 10-12 cm in core SK117 SC-21. Among the 3 species of this genus, *Epistominella exigua* is most abundant (reaches up to 29.5% at core depth of 4-6 cm in core SK117 SC-35). Maximum abundance of *Epistominella* shows that the percentage of *Epistominella* is comparatively higher in deeper water cores (>1130 m).

Genus *Fursenkoina* (Fig. 7.12) is represented by 5 species namely *Fursenkoina bradyi*, *F. complanata*, *F. pontoni*, *Fursenkoina* cf. *F. schreiberiana* and *F. texturata*. Their maximum abundance (63.9% of total benthic foraminiferal number) has been observed at core depth of 0-2 cm in core SK117 SC-06. Among the 5 species of this genus, *Fursenkoina bradyi* is most abundant (reaches up to 33.0% at core depth of 0-2 cm in core SK117 SC-06). *Fusenkoina* is more abundant in shallow water cores (56-90 m).

Genus *Globocassidulina* (Fig. 7.13) is represented by two species namely *Globocassidulina oriangulata* and *G. subglobosa*, with maximum abundance (28.3% of total benthic foraminiferal number) at core depth of 20-22 cm in core SK117 SC-31 (Fig. 7.13). Between the two species of this genus, *G. subglobosa* is most abundant (reaches up to 20.3% at core depth of 0-8 cm in core SK117 SC-31). Down-core abundance of genus *Globocassidulina* shows that abundance of this genus is not solely affected by depth of water column.

Genus *Gyroidina* (Fig. 7.14) is represented by 4 species namely *Gyroidina bradyi*, *Gyroidina* cf. *G. pulisukensis*, *Gyroidina* sp. A and *Gyroidina* sp. B. Genus *Gyroidina* reaches to a maximum abundance of 24.0% of total benthic foraminiferal number, at a core depth of 10-12 cm in core SK117 SC-34. Out of 4 species of this genus reported in the present study, *Gyroidina* sp. B is most abundant (reaches up to 20.7% at core depth of 10-12 cm in core SK117 SC-34). Genus *Gyroidina* is more abundant in deeper water cores (>1130 m).

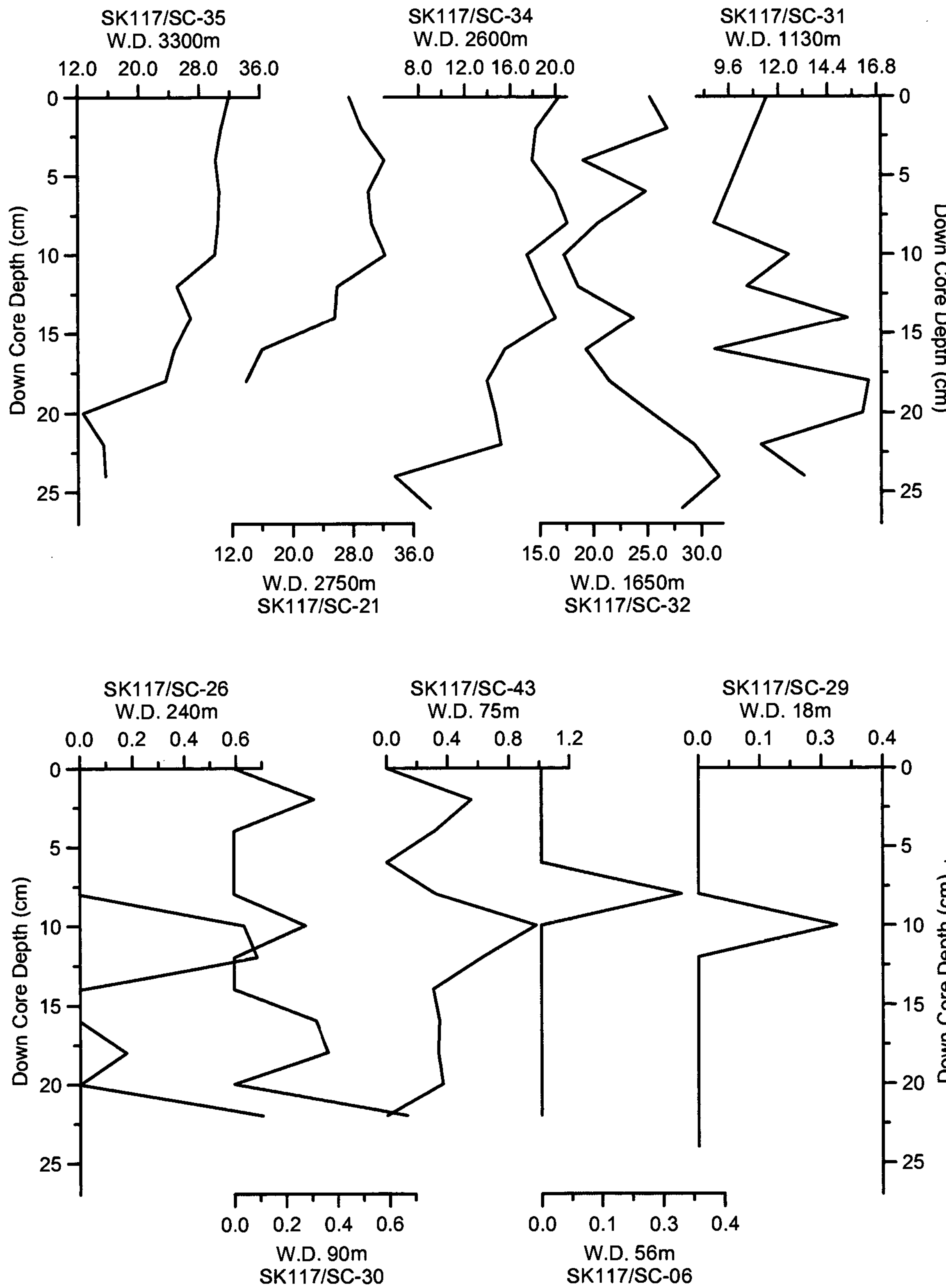


Figure 7.11: Down-core variation of *Epistominella* indicates that this genus is abundant in deeper depth zone

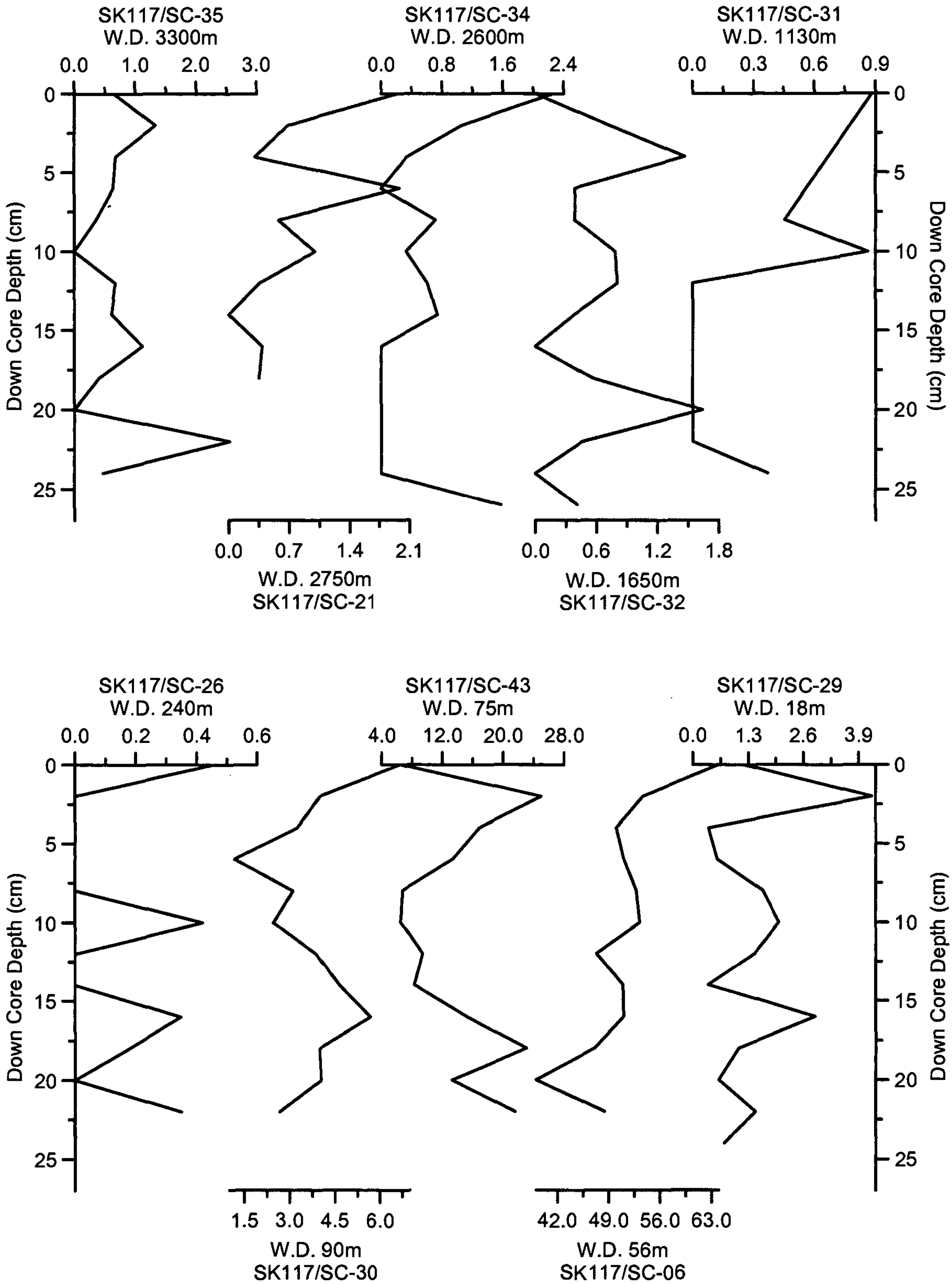


Figure 7.12: Down-core variation of *Fursenkoina* indicates that this genus is abundant in shallow depth zone

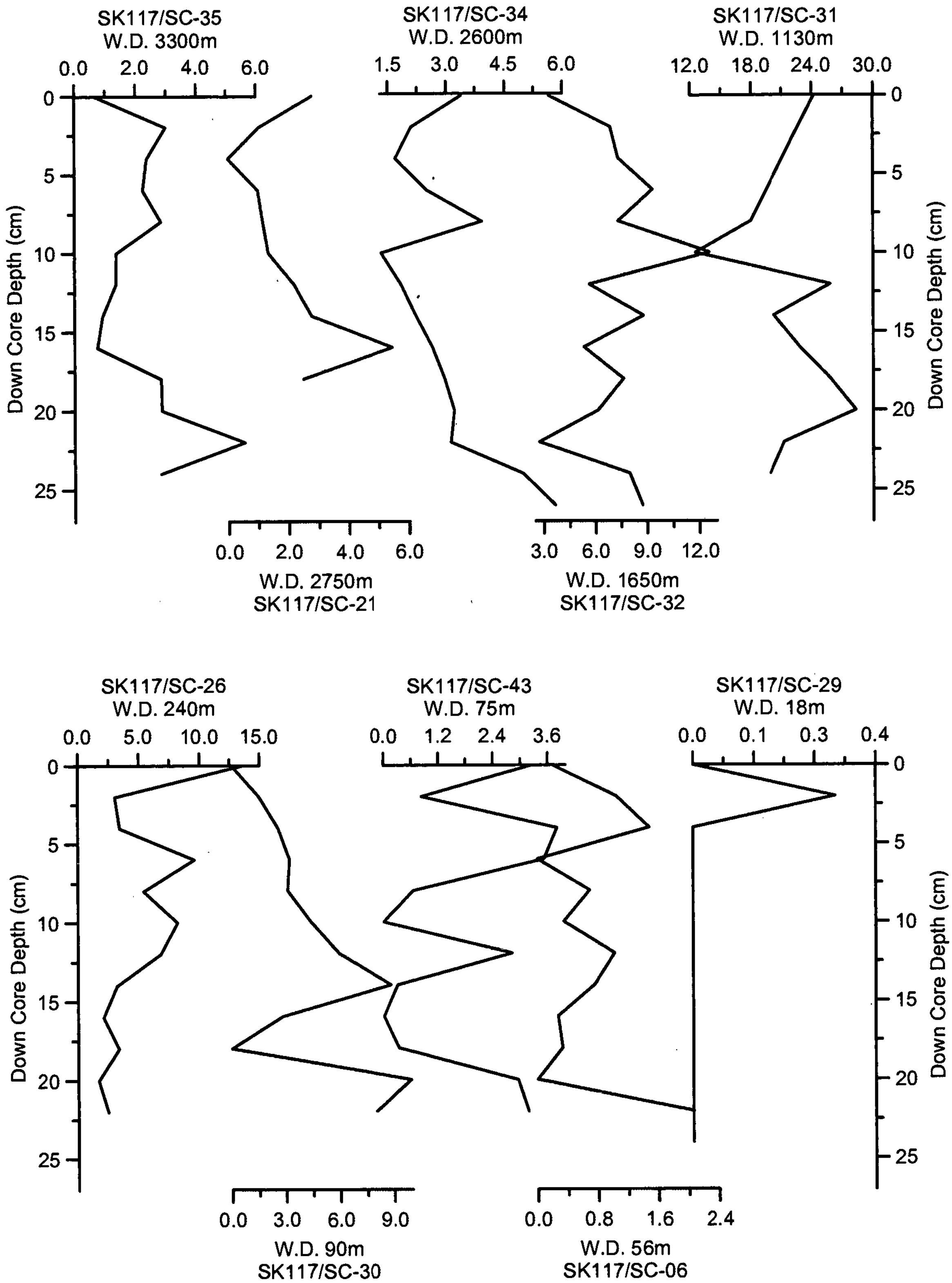
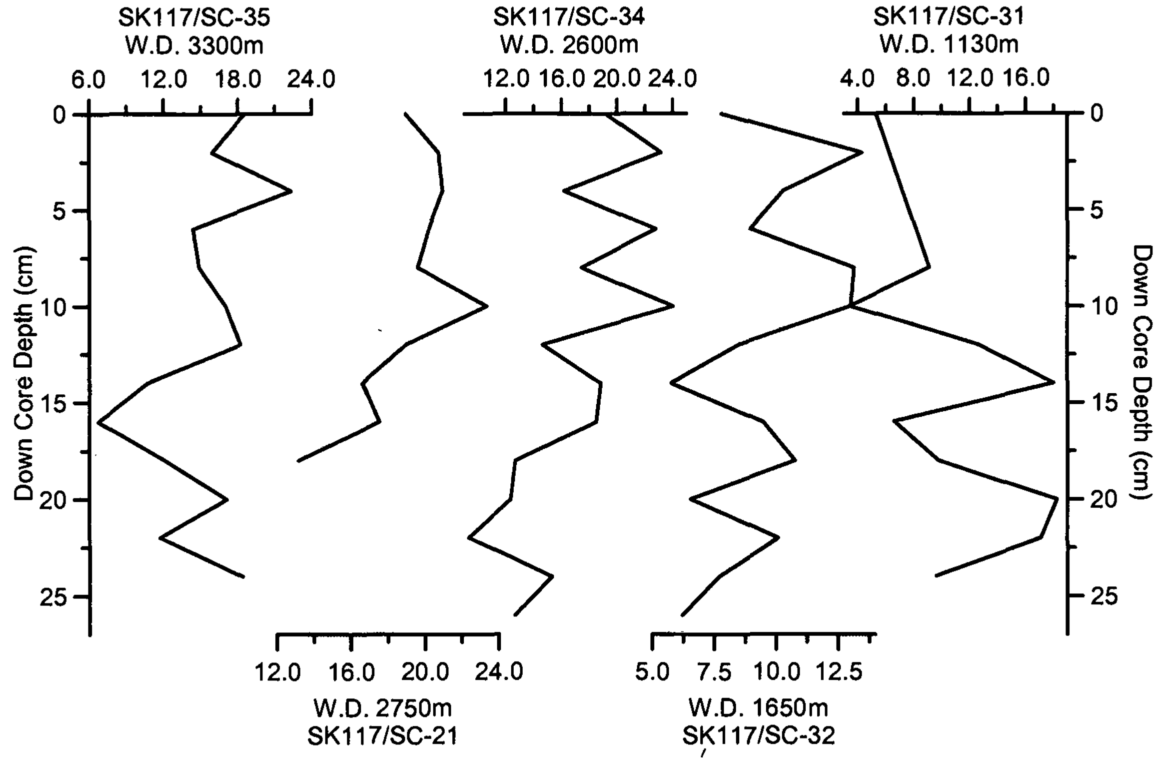


Figure 7.13: Down-core variation of *Globocassidulina* indicates that abundance of this genus is not solely affected by depth of water column in the study area



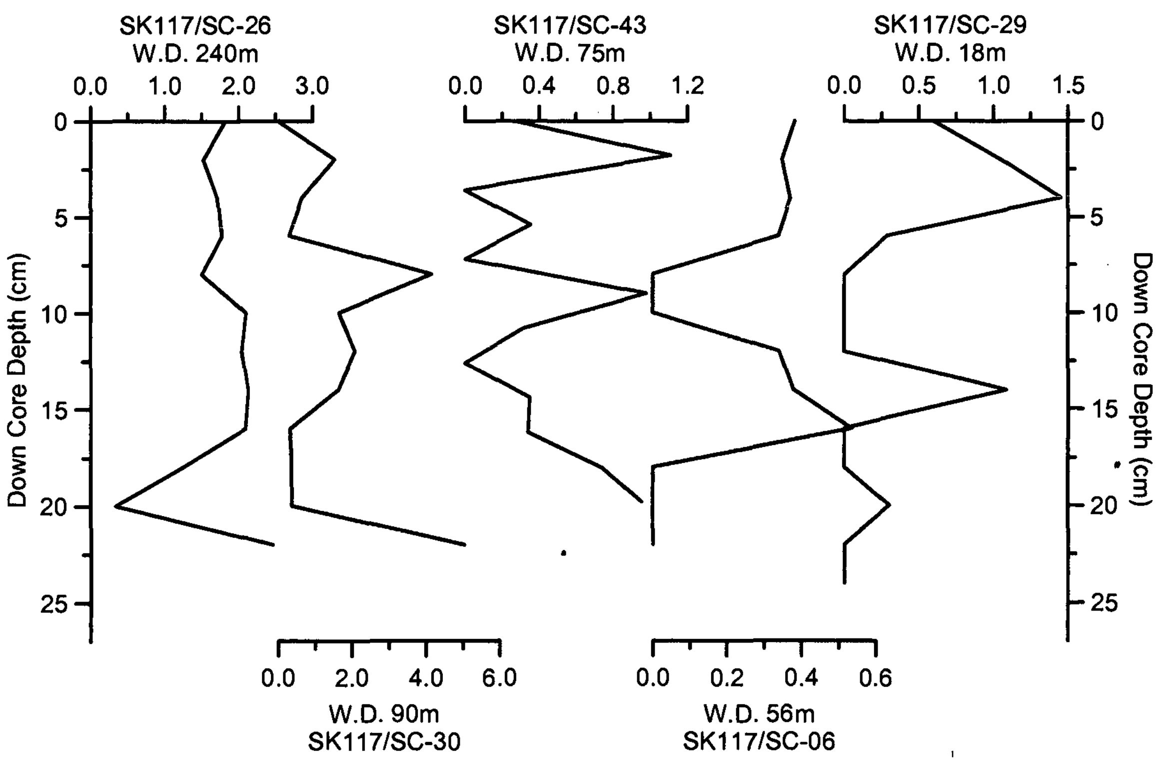


Figure 7.14: Down-core variation of *Gyroidina* indicates that it is more abundant in deeper water zone

Genus *Gyroidinoides* (Fig. 7.15) is represented by two species namely *Gyroidinoides orbicularis* and *G. soldanii*. Their maximum abundance, 11.6% of total benthic foraminiferal number, has been observed at core depth of 4-6 cm in core SK117 SC-21. Between the two species of this genus, *G. soldanii* is most abundant (reaches up to 7.5% at core depth of 2-4 cm in core SK117 SC-21). Genus *Gyroidinoides* is more abundant in deeper water zone (>1650 m).

Genus *Melonis* (Fig. 7.16) is represented by three species namely *Melonis barleeanum*, *M. pompilioides* and *M. soldani*. Their maximum abundance, 17.0% of total benthic foraminiferal number, has been observed at core depth of 2-4 cm in core SK117 SC-21. Out of three species of this genus reported in the present study, *M. barleeanum* is most abundant (reaches up to 9.9% at core depth of 2-4 cm in core SK117 SC-21). Genus *Melonis* is also more abundant in deeper water zone (>1650 m).

Genus *Nonion* (Fig. 7.17) is represented by 5 species namely *Nonion* cf. *N. asterizens*, *Nonion* aff. *N. depressulum*, *N. incisum*, *N. scaphum* and *N. sloanii*. Their maximum abundance (44.6% of total benthic foraminiferal number) has been observed at core depth of 18-20 cm in core SC-29 (Fig. 7.17). Among the 5 species of this genus, *N. scaphum* is most abundant (reaches up to 21.1% at core depth of 2-4 cm in core SK117 SC-29). *Nonion* is comparatively more abundant in shallow water zone in the study area (<75 m).

Genus *Nonionoides* (Fig. 7.18) is represented by three species namely *Nonionoides boueanum*, *N. elongatum* and *N. grateloupi*. Their maximum abundance, 11.2% of total benthic foraminiferal number, has been observed at a depth of 12-14 cm in core SK117 SC-29. Among the three species of this genus, *N. elongatum* is most abundant (reaches up to 7.9% at core depth of 12-14 cm in core SK117 SC-29). Genus *Nonionoides* is comparatively more abundant in shallow water zone in the study area (<56 m).

Genus *Osangularia* (Fig. 7.19) is represented by only one species namely *Osangularia bengalensis* with maximum abundance (27.6% of total benthic foraminiferal number) at core depth of 16-18 cm in core SK117 SC-35 and is abundant in deeper water cores (>1130 m).

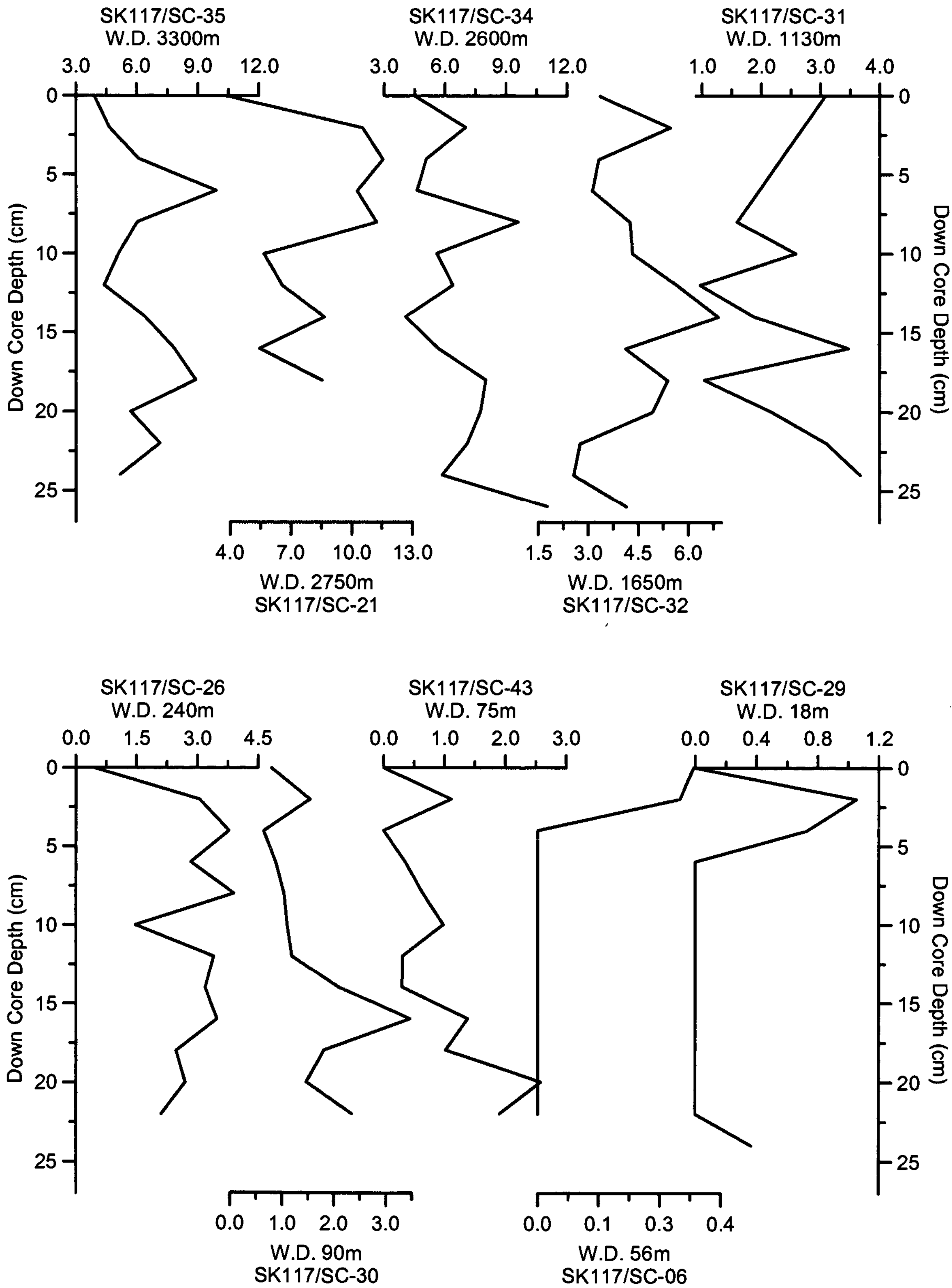


Figure 7.15: Down-core variation of *Gyroidinoides* indicates that it is more abundant in deeper

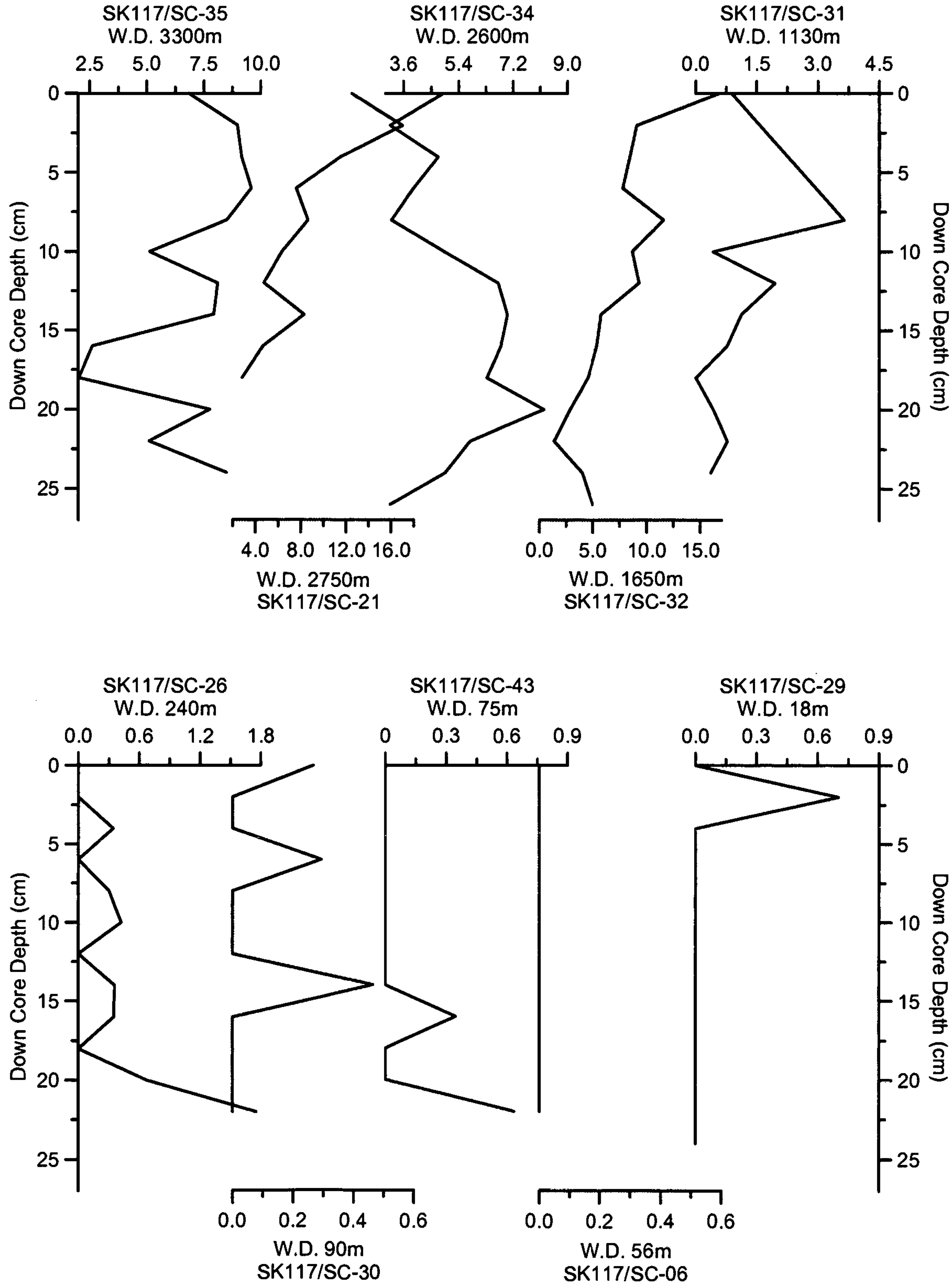


Figure 7.16: Down-core variation of *Melonis* shows that it is more abundant in deeper water zone

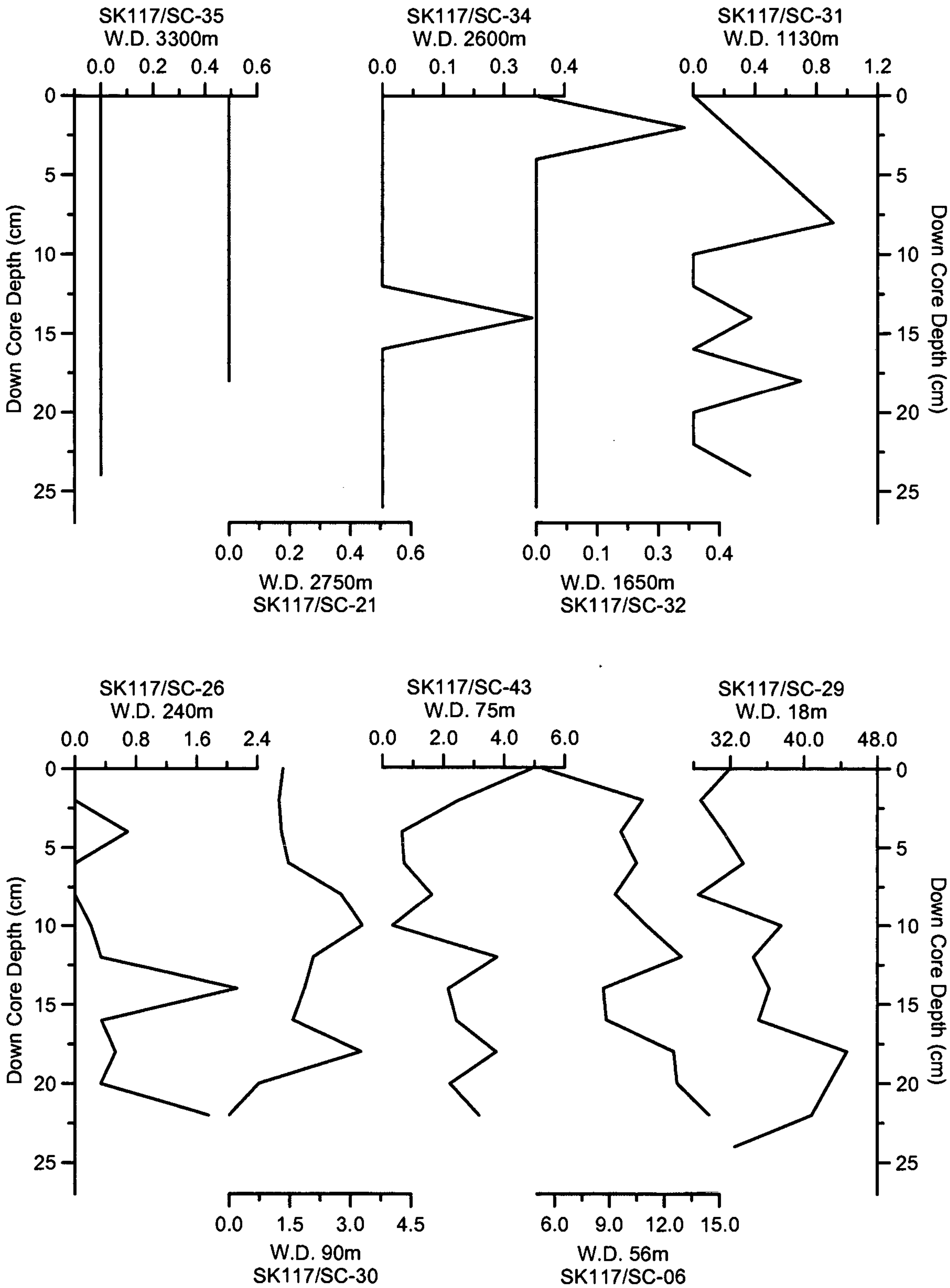


Figure 7.17: Down-core variation of *Nonion* shows that it is more abundant in shallow water zone

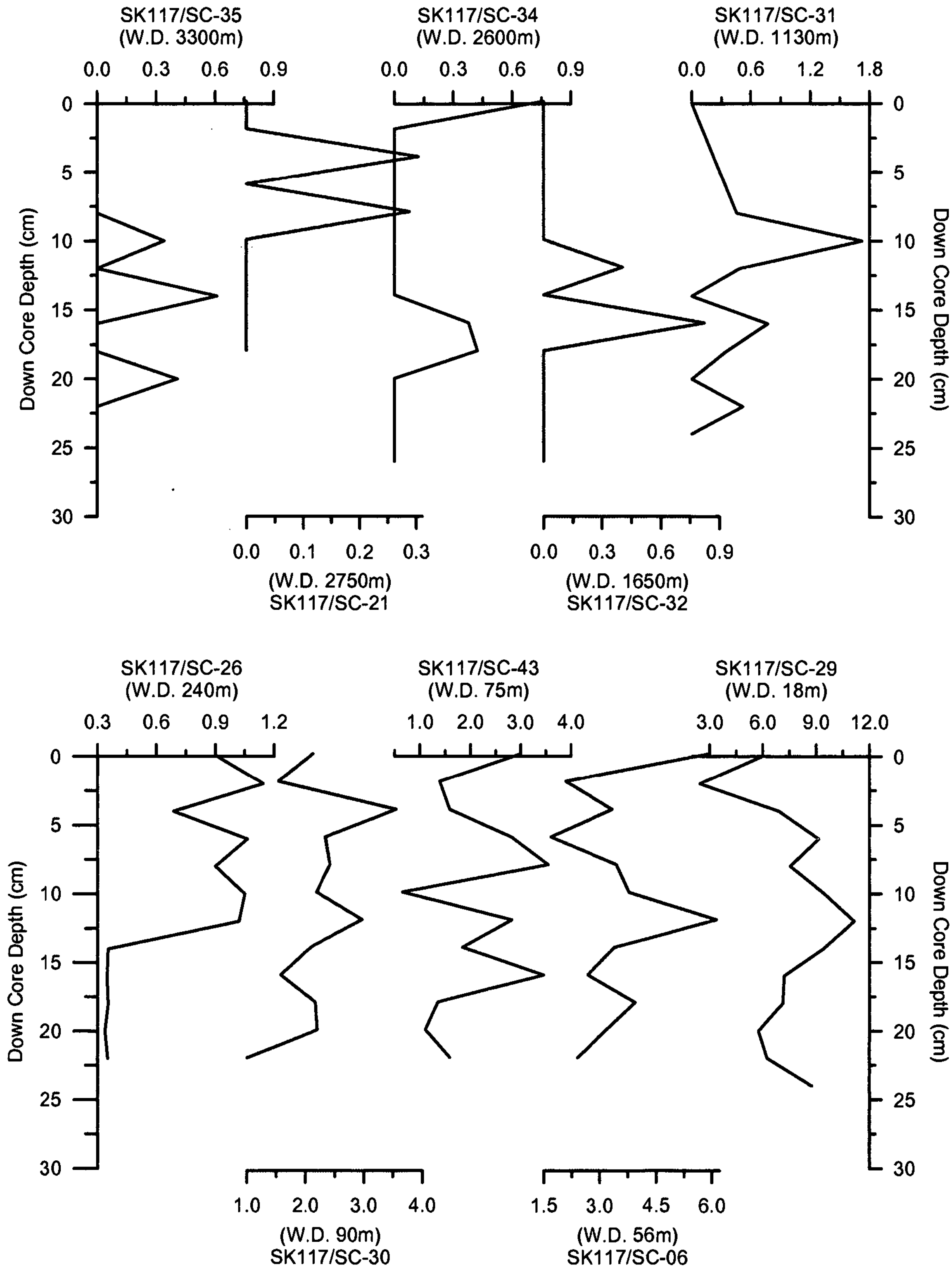


Figure 7.18: Down-core variation of *Nonionoides* shows that it is more abundant in shallow water zone

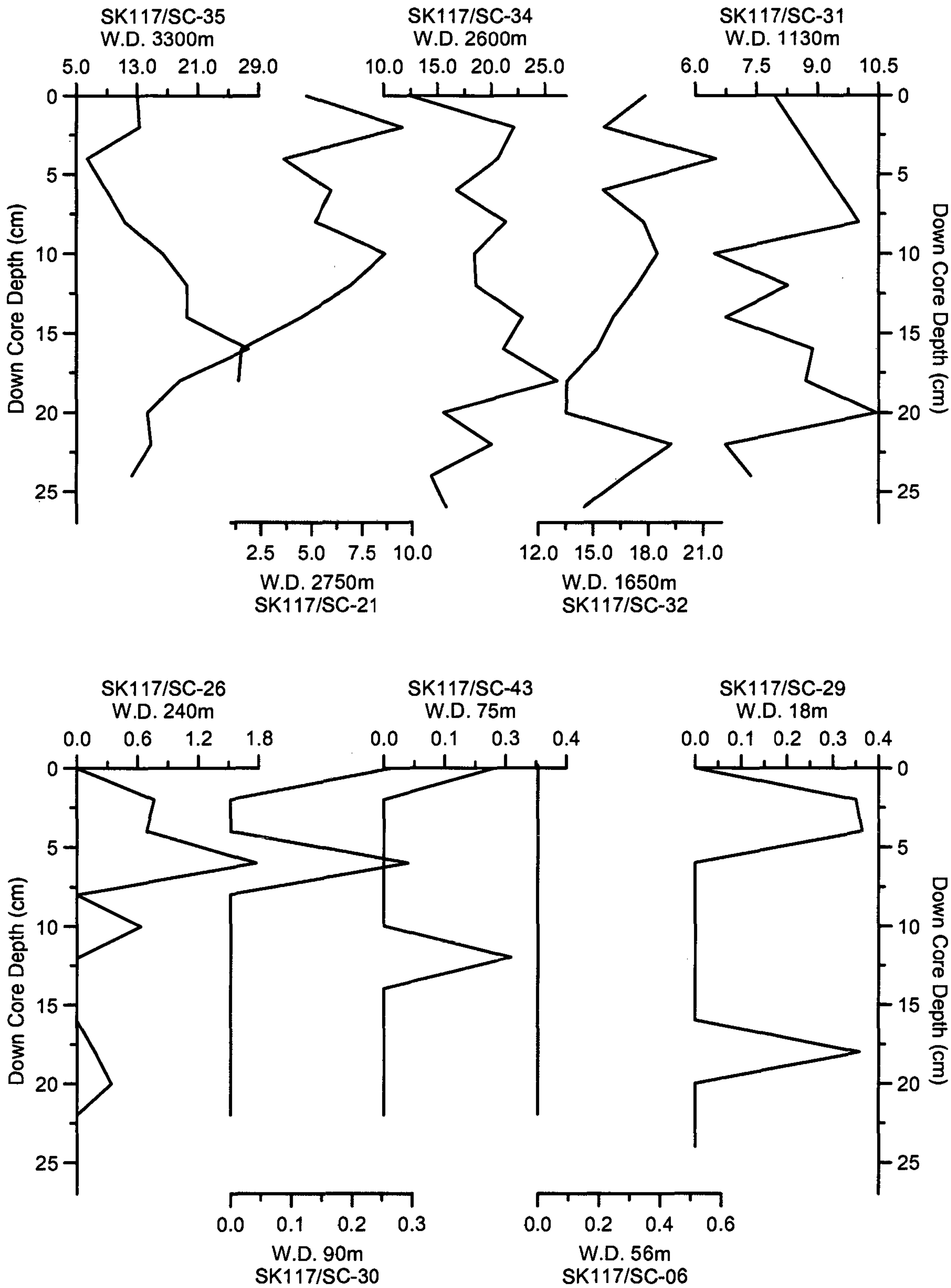


Figure 7.19: Down-core variation of *Osangularia.* Genus *Osangularia* is more abundant in deeper water zone

Genus *Pullenia* (Fig. 7.20) is represented by two species namely *Pullenia bulloides* and *P. subcarinata.* The maximum abundance of genus *Pullenia* (14.9% of total benthic foraminiferal number) has been observed at 4-6 cm depth in core SK117 SC-34 (Fig. 7.20). Out of two species of *Pullenia* reported in the present study, *P. subcarinata* is more abundant (reaches up to 7.9% at core depth of 0-2 cm in core SK117 SC-34). Genus *Pullenia* is more abundant in deeper water cores (>2600 m).

Genus *Quinqueloculina* (Fig. 7.21) is represented by 21 species namely *Quinqueloculina annectens*, *Q. berthelotiana*, *Q. bicarinata*, *Q. distorqueata*, *Q. echinata*, *Q. elegans*, *Quinqueloculina* cf. *Q. inaequelis*, *Q. kerimbatica*, *Q. lamarckiana*, *Q. mosharrafai*, *Q. multimarginata*, *Q. parkeri*, *Q. pseudoreticulata*, *Q. schlumbergeri*, *Q. seminulum*, *Q. sulcata*, *Q. trigunola*, *Q. undulose-costata*, *Q. venusta*, *Q. vulgaris* and *Quinqueloculina* sp.nov. Their maximum abundance, 8.4% of total benthic foraminiferal number, has been observed at a depth of 0-2 cm in core SK117 SC-43 (Fig. 8.21). Among 21 species of *Quinqueloculina* reported in the present study, *Q. seminulum* is most abundant (reaches up to 3.2% at core depth of 26-28 cm in core SK117 SC-34). The comparative abundance of *Quinqueloculina* is very low throughout all the cores, except SK117 SC-34 recovered from a water depth of 75m.

Genus *Rotalidium* (Fig. 7.22) represented by only one species namely *Rotalidium annectens* reaches to a maximum abundance of 27.4% of total benthic foraminiferal number at a depth of 16-18 cm in core SK117 SC-29 (Fig. 7.22). The down-core variation of genus *Rotalidium* shows that it is abundant only in shallow water core (≤90 m), being almost absent from the deeper water cores.

Genus *Trifarina* (Fig. 7.23) is represented by two species namely *Trifarina carinata* and *Trifarina* sp. Their maximum abundance, 6.6% of total benthic foraminiferal number, has been observed at core depth of 8-10 cm in core SK117 SC-30. Between the two species of *Trifarina*, *Trifarina carinata* is more abundant (reaches up to 6.6% at core depth of 8-10 cm in core SK117 SC-30). The abundance of genus *Trifarina* is very low in all but two cores, viz. SK117 SC-30 and SK117 SC-26.

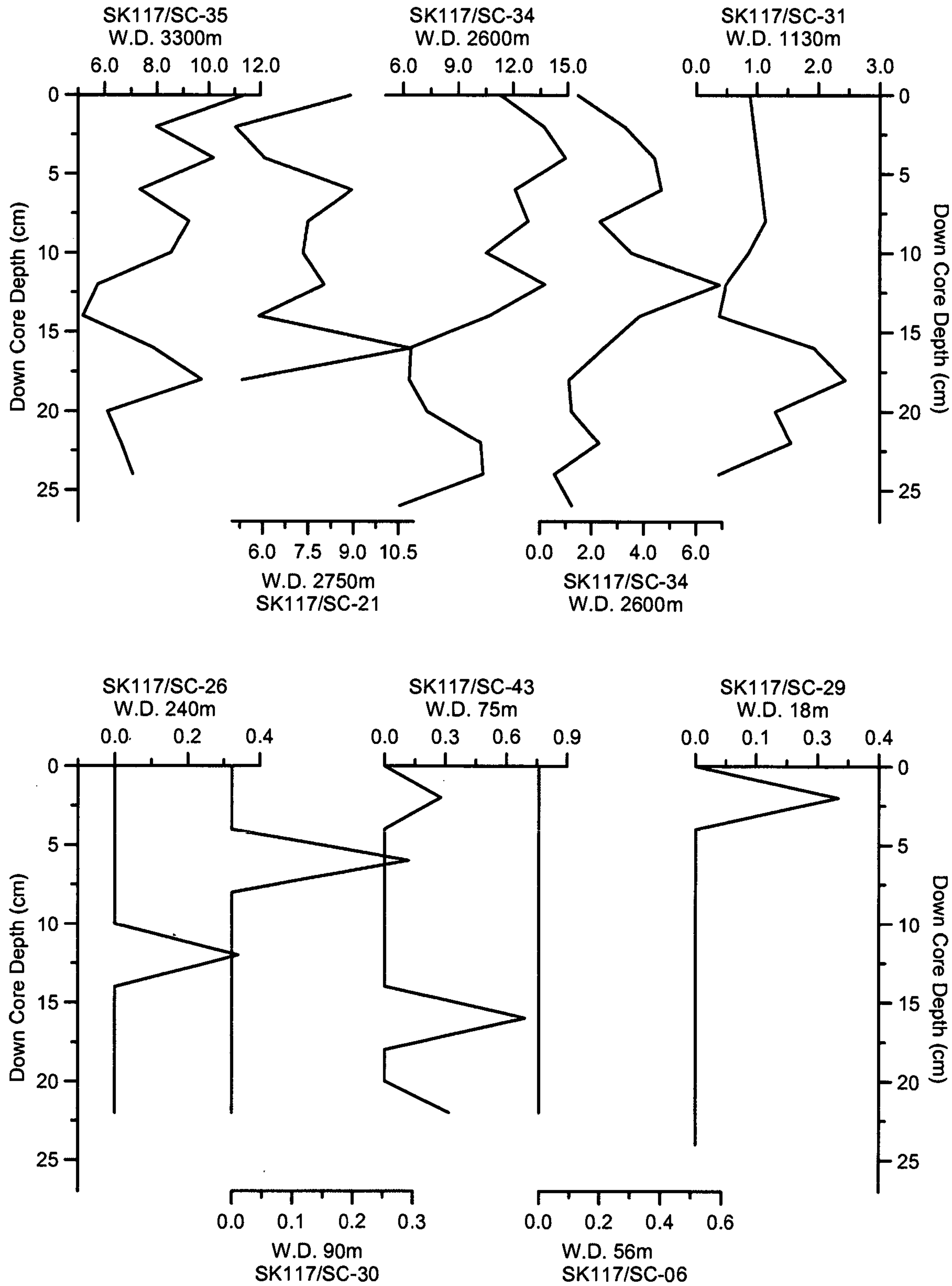


Figure 7.20: Down-core variation of *Pullenia* shows that it is a typical deep-water genus in the present study area

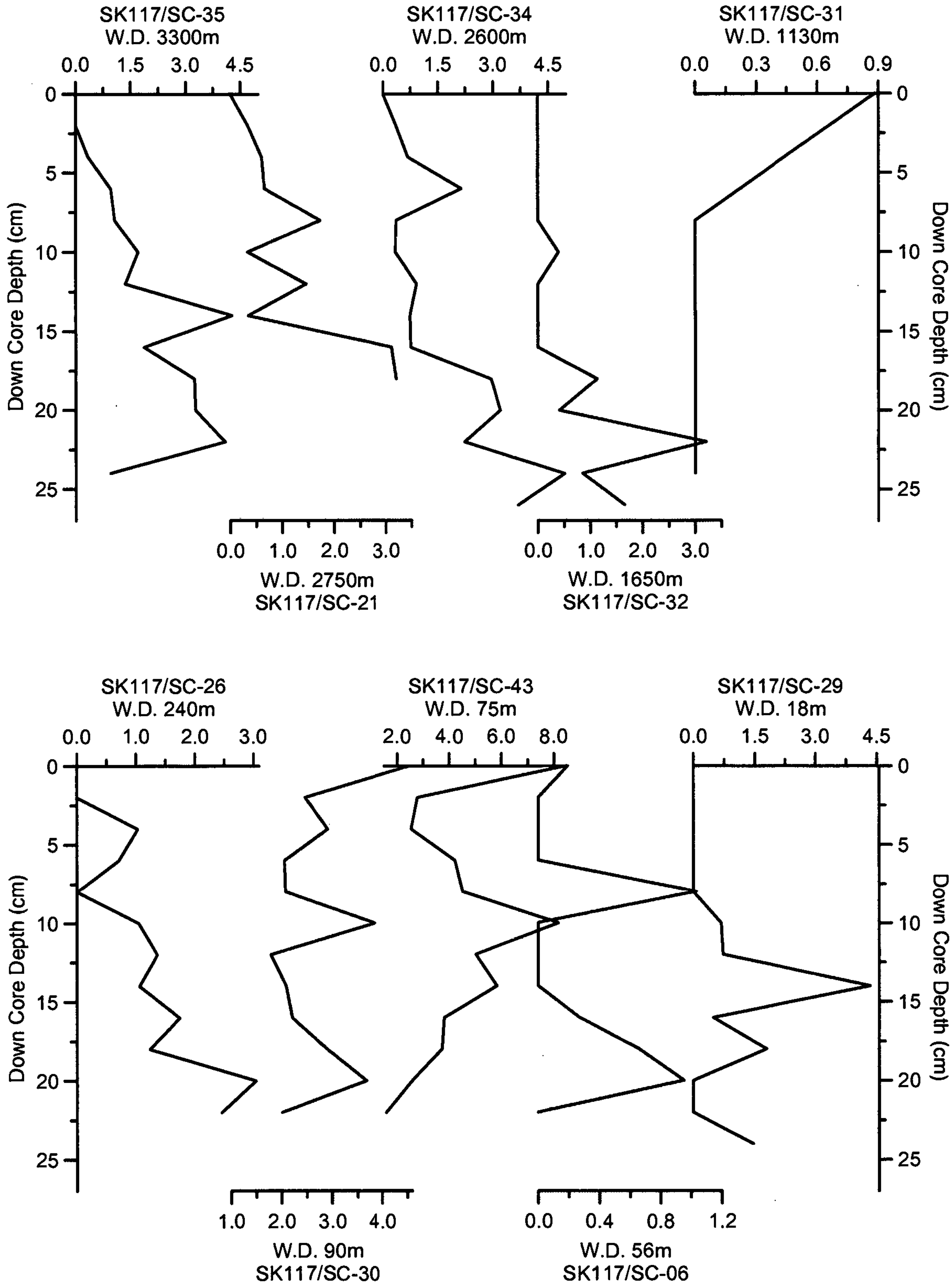


Figure 7.21: Down-core variation of *Quinqueloculina* shows that in general, the abundance of *Quinqueloculina* is very low in all the cores in the present study area

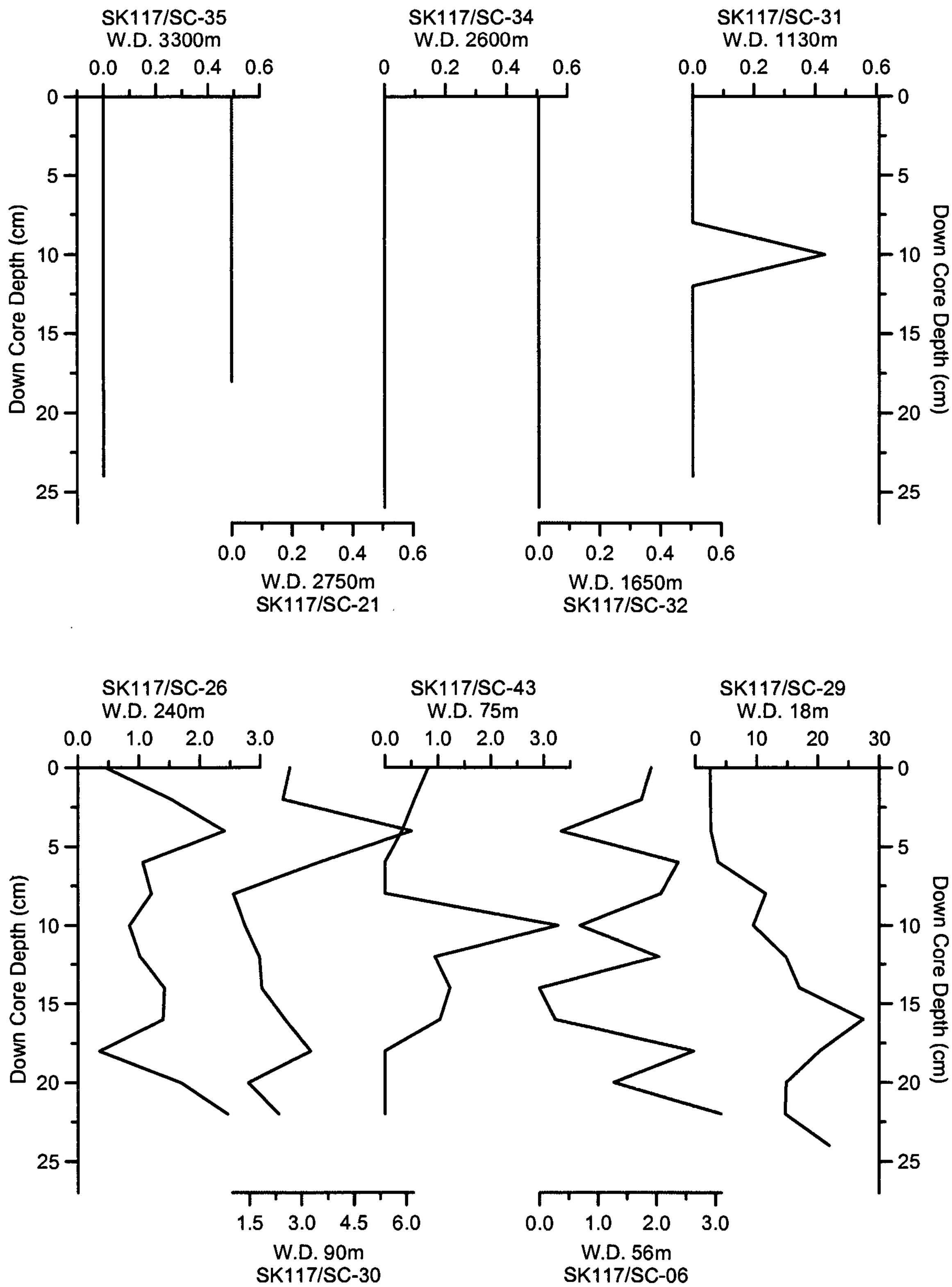


Figure 7.22: Down-core variation of *Rotalidium*. Significant abundance of genus *Rotalidium* is reported only in shallow water cores

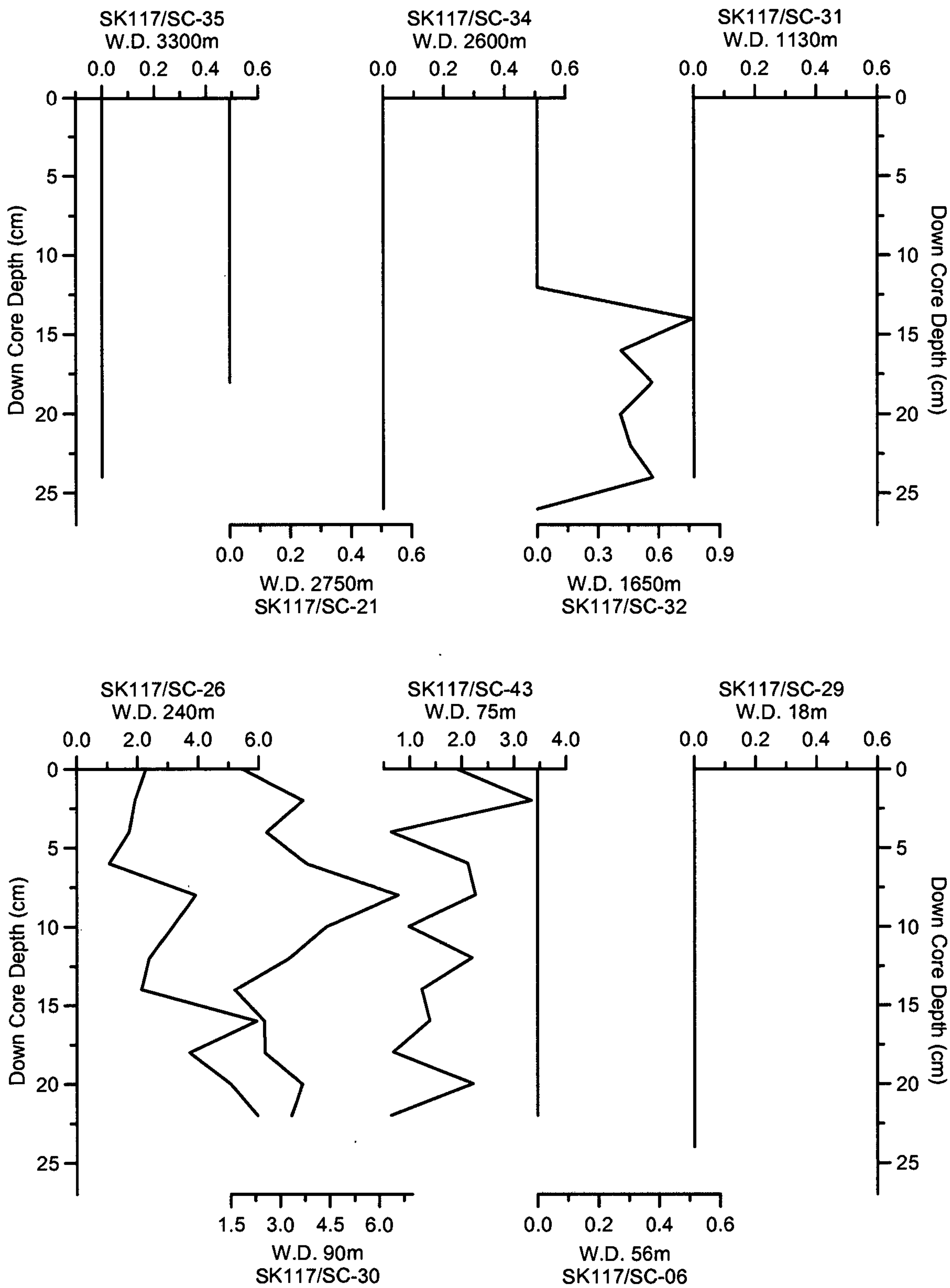


Figure 7.23: Down-core variation of *Trifarina*. Abundance of genus *Trifarina* is low throughout all the cores except SK 117 SC-30 and SK 117 SC-26

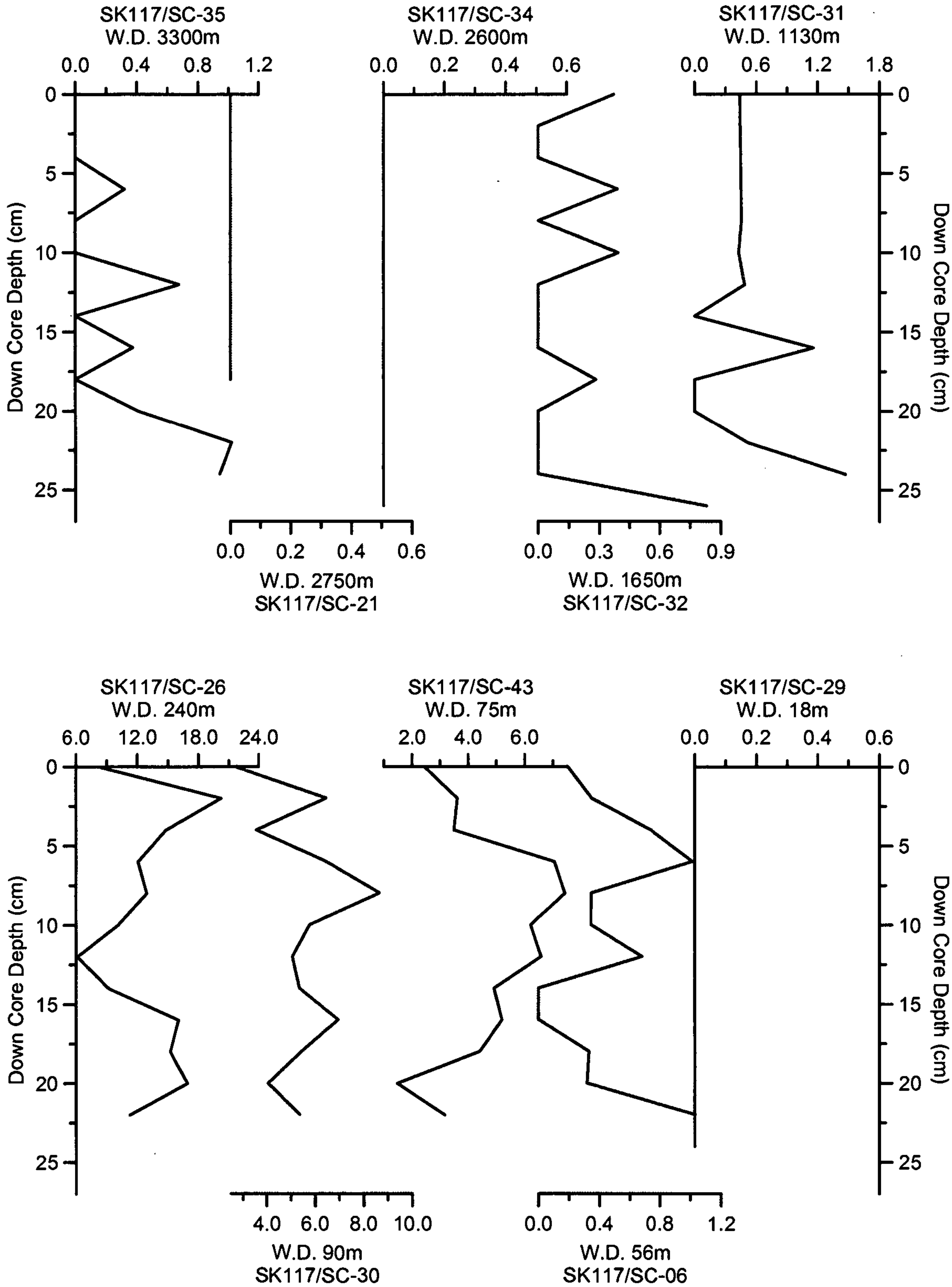


Figure 7.24: Down-core variation of *Uvigerina*. Genus *Uvigerina* is more abundant in intermediate water depth cores

Genus *Uvigerina* (Fig. 7.24) is represented by 15 species namely *Uvigerina aculeate*, *U. asperula*, *Uvigerina* cf. *U. auberiana*, *U. bassensis*, *U. bifurcata*, *U. brunensis*, *U. canariensis*, *U. hollicki*, *U. mediterranea*, *U. peregrina*, *U. proboscidea*, *U. proboscidea var. vadenscens*, *U. schlumbergeri*, *Uvigerina* sp. A and *Uvigerina* sp. B. Their maximum abundance, 20.2% of total benthic foraminiferal number, has been observed at a depth of 2-4 cm in core SK117 SC-26. Among the 15 species of this genus, *Uvigerina canariensis* is most abundant (reaches up to 13.0% at core depth of 2-4 cm in core SK117 SC-26). Genus *Uvigerina* is more abundant in intermediate water depth cores (75-240 m).

In order to draw meaningful inferences from this large set of foraminiferal data (122 sub samples of 10 cores including their top layers), Q-mode cluster analysis, which provides a better grouping of stations depending upon faunal similarities, was performed.

7.5 Q-MODE CLUSTERING

The percentage distribution of 297 species of 10 cores is taken as the initial database for Q-mode cluster analysis. Statistica version 5.0 (computer software for the q-mode clustering) was used on the matrix of total 122 samples of all 10 cores to sort the station data into clusters.

The results of cluster analysis are presented in the form of two-dimensional hierarchy dendrograms in which stations are presented along horizontal axis and rescaled distance cluster combine along vertical axis. At 21.0 level of rescaled distance cluster combine, a majority of stations can be classified into three clusters marked as cluster A, B and C in figure 7.25.

Cluster A

Cluster A comprises of 13 stations (samples) and all of them concentrated within the core SK117 SC-29 (water depth 18 m). This cluster is represents the shallow water (~18 m) assemblage. The dominant species of this cluster are *Ammonia sobrina*, *A. tepida*, *Asterorotalia dentata*, *Nonion* cf. *N. asterizens*, *Nonion* aff. *N. depressulum*, *N. incisum*, *N. scaphum*, *N. sloanii*, *Nonionoides elongatum*, *Rotalidium annectens* and *Rotalinoides papillosus*. This core stands out from the rest being the only core located outside the oxygen-depleted zone and towards the shallower side.

Cluster B

Cluster B includes 60 stations (samples) of the cores SK117 SC-21 (water depth 2750 m), SK117 SC-31 (1130 m), SK117 SC-32 (1650 m), SK117 SC-34 (2600 m) and SK117 SC-35 (3300 m). This cluster represents the deep-water (>1130 m) assemblage. The dominant species of this cluster are *Cassidulina* aff. *C. algida*, *Cassidulina* cf. *C. crassa*, *C. sicula*, *C. teretis*, *Epistominella exigua*, *E. minuta*, *Globocassidulina oriangulata*, *G. subglobosa*, *Gyroidina bradyi*, *Gyroidina* sp. A, *Gyroidina* sp. B, *Gyroidinoides orbicularis*, *G. soldanii*, *Melonis baleeanum*, *M. pompilioides*, *Osangularia bengalensis*, *Pullenia bulloides* and *P. subcarinata*.

Cluster C

Cluster C consists of 48 stations (samples) of the cores SK117 SC-06 (water depth 56 m), SK117 SC-26 (240 m), SK117 SC-30 (90 m) and SK117 SC-43 (75 m). This cluster represents the intermediate water (56-240 m) assemblage. At level 13.0, cluster C is further classified into three heads namely C1, C2 and C3. Cluster C1 comprises of 24 stations of SK117 SC-30 (90 m) and SK117 SC-43 (75 m) cores. This cluster represents the assemblage existing within the 'gap' between the shallow and deep OMZ. The dominant species of this cluster are *Bolivina dilatata*, *B. lowmani*, *B. marginata*, *B. pseudoplicata*, *Cassidulina* cf. *C. crassa*, *Fursenkoina bradyi*, *F. complanata*, *Globocassidulina subglobosa*, *Rotalidium annectens*, *Trifarina carinata*, *Uvigerina canariensis* and unidentified sp. 30. Cluster C2 consists of 11 stations of the single core SK117 SC-26 (240 m). This cluster represents the relatively shallower stations within the deep water OMZ. The dominant species of this cluster are *Bolivina dilatata*, *B. lowmani*, *B. marginata*, *B. ordinaria*, *B. persiensis*, *B. pseudoplicata*, *B. robusta*, *B. seminuda*, *Brizalina spathulata*, *Cassidulina* cf. *C. crassa*, *Globocassidulina subglobosa*, *Trifarina carinata*, *Uvigerina* cf. *U. auberiana*, *Uvigerina canariensis* and unidentified sp. 30. Cluster C3 is composed of 12 stations of the single core SK117 SC-06 (56 m). This cluster is represents the shallow water OMZ assemblage. The dominant species of this cluster are *Bolivina pseudoplicata*, *Brizalina spathulata*, *B. striatula*, *Fursenkina bradyi*, *F. complanata*, *F. texturata* and *Nonion* cf. *N. asterizens*.

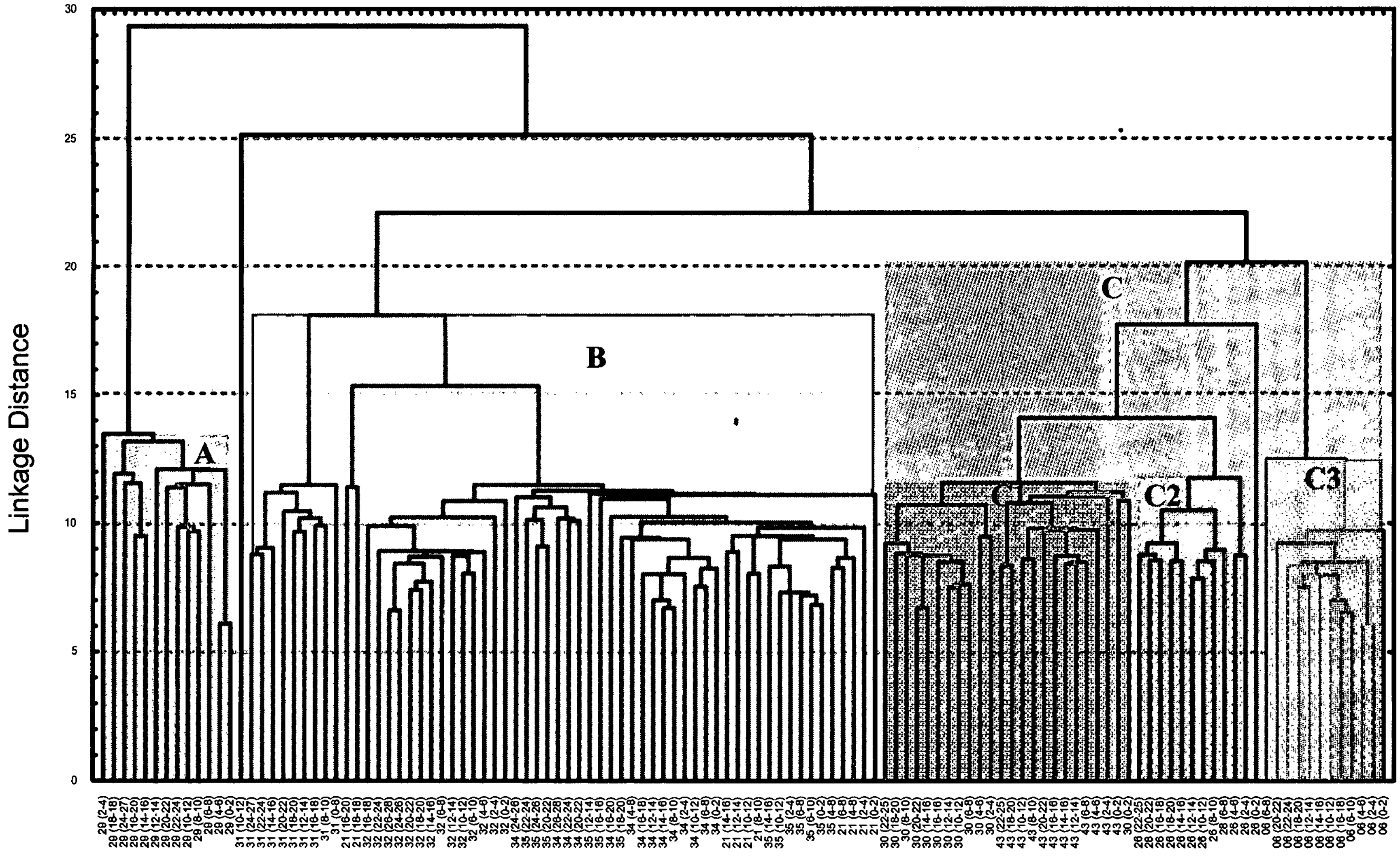


Figure 7.25: Result of Q-mode cluster analysis in the form of two-dimensional binary dendrogram, showing the main clusters; A, B and C with three subclusters C1, C2 and C3. The station numbers are placed along X-axis and Linkage distances are placed along Y-axis.

Cluster analysis of down-core benthic foraminiferal distribution clearly shows a control of depth and dissolved oxygen concentration over benthic foraminiferal assemblages in the study area. Thus, the results of cluster analysis support the findings of the study carried out to document the effect of varying dissolved oxygen concentration on the distribution of benthic foraminifers in surface samples. The results further lend credence to the potential application of benthic foraminiferal characteristics to reconstruct past variations of dissolved oxygen concentration in the study area.

7.6 TEMPORAL VARIATION IN INTENSITY AND EXTENT OF OMZ

Various foraminiferal characteristics including the variation in abundance, test composition and morphology of individual species have been used as indicators for paleoclimatic studies by several workers (Sejrup *et al.*, 1981; Patterson and Lohman, 1982; Kalia and Chowdhury, 1983; Kartz and Thunnell, 1984; Malmgren, 1984; Boyle and Keigwin, 1985; Delaney and Boyle, 1986; Nigam, 1986; Nigam and Rao, 1987; Curry *et al.*, 1988; Izuka, 1988; Loubere *et al.*, 1988; Nigam, 1988b; Pederson *et al.*, 1988; Collins, 1989; Gary *et al.*, 1989). However, of late, it has been emphasized that efforts should be made to recognize indexing assemblages to draw paleoclimatic inferences (Van der Zwaan *et al.* 1999). Alve and Nagy (1990) also stated that it is reasonable to assume that the distribution pattern of major faunal parameters (as super generic groups, species diversity and genera) in different environments is more persistent through time than species occurrences, and could be a more efficient approach in paleoclimatic studies. Nigam and Khare (1999) also used a similar approach for reconstructing paleoclimatic variations off Karwar region, India.

The down-core variation in abundance of rectilinear benthic foraminifers (rectilinear benthic foraminifers are as mentioned in Chapter 6, page no. 284-286) (Fig. 7.26) in ten cores selected for the present study shows a marked difference in the magnitude of variation in the cores within or near to the present day OMZ and those outside the present day OMZ. Table 7.3 shows the maximum and minimum percentage of rectilinear benthic foraminifers in each core along with the total variation. The magnitude as well as the maximum abundance of rectilinear forms is comparatively low (marked with bold face) in four (SK117 SC-21, SK117 SC-32, SK117 SC-34 and SK117 SC-35) out of the five deeper water cores along with the core collected from the shallowest region (SK117 SC-29). In view of the limited variation, as well as considerably low maximum abundance of rectilinear benthic foraminifers, these cores have not been considered to study the temporal variation of OMZ.

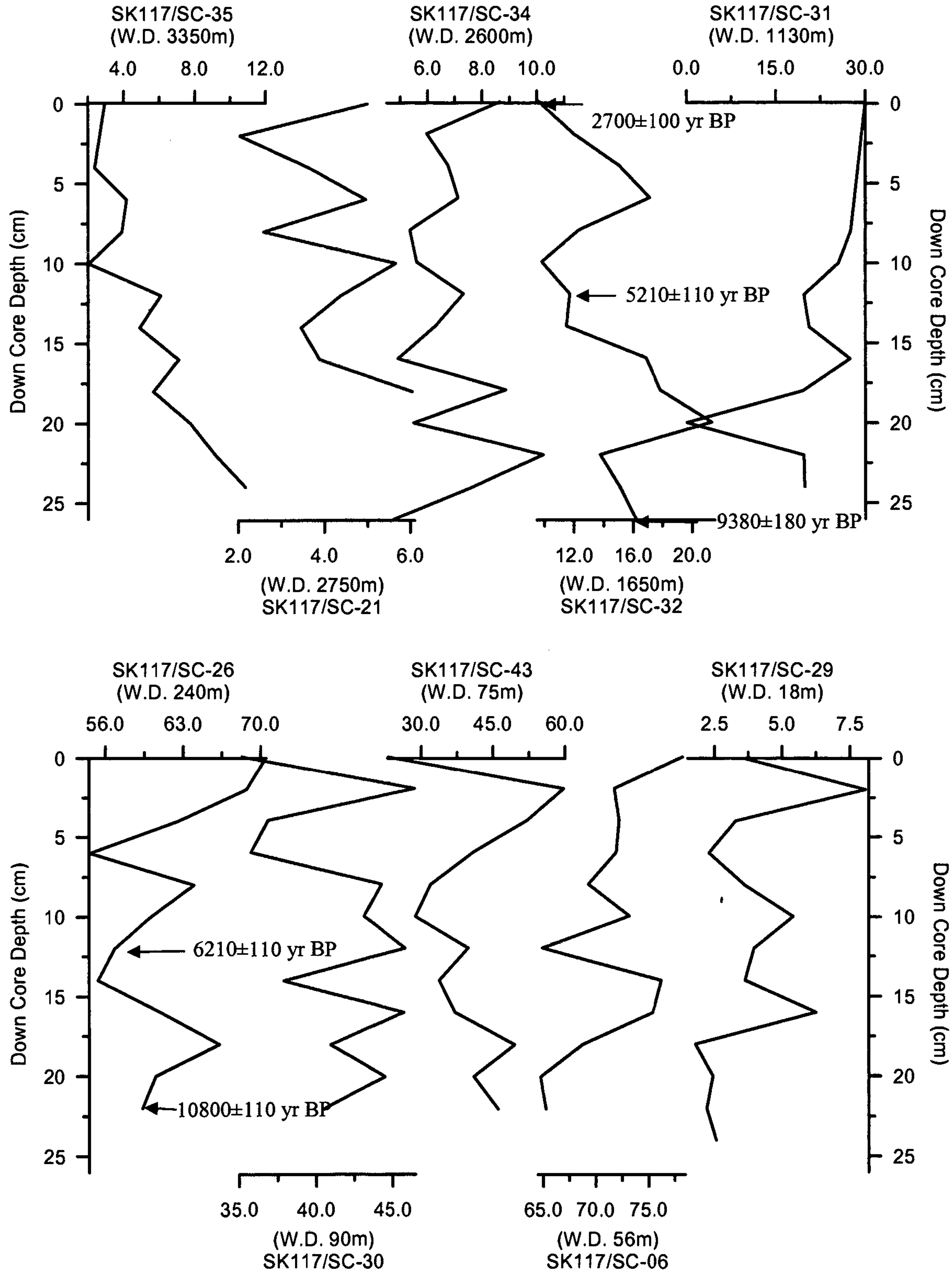


Figure 7.26: Down-core variation of rectilinear benthic foraminifer (RBF). Figure clearly shows that the abundance of RBF is very low in all deeper water cores as well as the core recovered from the shallowest water depth

The remaining cores lying within or near the present day OMZ, show a significant variation (>11.0%) in rectilinear benthic foraminiferal percentage throughout the core. The down-core variation in the percentage of rectilinear benthic foraminifera in these cores is discussed in detail in the next section.

Table 7.3: Maximum and minimum percentage of rectilinear benthic foraminifers in each core along with the total variation. Only those cores with maximum rectilinear benthic foraminiferal percentage higher than 40% and down-core variation more than 10% (values highlighted in bold) have been selected for detailed study.

Core No.	Depth (m)	Rectilinear Benthic Foraminifera (%)		Variation
		Maximum	Minimum	
SK 117 SC-29	18	**08.07**	01.79	**06.28**
SK 117 SC-06	56	78.24	64.76	13.48
SK 117 SC-43	75	59.72	23.10	36.62
SK 117 SC-30	90	46.46	35.20	11.26
SK 117 SC-26	240	70.45	54.61	15.84
SK 117 SC-31	1130	**29.96**	00.00	29.96
SK 117 SC-32	1650	**21.31**	09.67	11.64
SK 117 SC-34	2600	**10.22**	04.74	**05.48**
SK 117 SC-21	2750	**06.05**	02.04	**04.01**
SK 117 SC-35	3300	**10.85**	02.05	**08.80**

7.6.1. CORES UNDER THE INFLUENCE OF OMZ

Based on the strong correlation between the present day abundance of rectilinear forms and the OMZ and significant variation in the down-core distribution of the rectilinear benthic foraminifers (RBF) it is inferred that the intensity of OMZ has considerably varied during the past. Since, in surface sediments the abundance of rectilinear benthic foraminifera in the OMZ remains higher than 40%, the consistently higher than 40% down-core abundance of rectilinear benthic foraminifera in cores SK 117 SC-06 and SK 117 SC-26 shows that region around the cores SK 117 SC-06 and SK 117 SC-26 has always remained within the OMZ, throughout the time span covered by the cores. Down-core variation of rectilinear benthic foraminifera in both of these cores shows that atleast at two more occasions the abundance of RBF was as high as that at present. This indicates that the OMZ was much intense atleast at two occasions during the time span covered by the cores, the intensity of which is comparable to what prevails at present. In between these time spans, the abundance of RBF was significantly low, thus suggesting that OMZ at these times was much less intense than that at present.

Since the surface sediments associated with the cores SK 117 SC-30 and SK 117 SC-43 have been dated to be ~10,000-12,000 yr B.P., owing to lack of sedimentation in this zone after ~10,000-12,000 yr B.P., the significant downward trend in the abundance of RBF towards the top of the cores SK 117 SC-30 and SK 117 SC-43 shows that at ~10,000-12,000 yr B.P., either the OMZ was less intense or the region around this core was away from the influence of the OMZ. The down-core abundance of RBF in the core SK 117 SC-30 exceeds the 40% mark at three more occasions, thus indicating that at these three occasions the region around this core was under the influence of intense OMZ. Similar variations are also observed in the core SK 117 SC-43, but the topmost event in this core is much more prominent than the previous two, thus suggesting that the region around the core SK 117 SC-43, was under the influence of intense OMZ for a longer time effecting the topmost higher abundance of RBF. Incidentally, the down-core variation of RBF is comparable in cores SK 117 SC-30 and SK 117 SC-43, thus suggesting that the similar factors influenced the down-core variations of RBF in the region around these two cores. Comparable observations are also made in case of cores SK 117 SC-06 and SK 117 SC-26, encountered in the present day OMZ, as discussed in the previous section.

7.6.2. POSSIBLE CAUSES AND INFERENCE FROM DOWN-CORE OMZ VARIATION

The down-core variation of RBF in the present study area shows considerable fluctuations in cores collected from both, shallow as well deep OMZ of the present day, thus suggesting their existence as well as significant changes in their intensity over the past.

The presence of OMZ has previously been correlated with the organic matter flux and the rate of freshening of seawater, regulating the concentration of dissolved oxygen. Increased organic matter flux coupled with reduced renewal of seawater, has been suggested to result in utilization of available oxygen to recycle the organic matter, by the macro-fauna and thus resulting in depleted oxygen levels (Wyrtki, 1962; Kamykowski and Zentara, 1990). Such hypoxic zones have widely been reported from the eastern Pacific, southeast Atlantic off west Africa and northern Indian Ocean.

Such hypoxic zones off shelf and slope regions of the world oceans have been suggested to exist through thousands of years (Reichart *et al.*, 1998) due to natural factors. However, recently such hypoxic zones have also been reported from shallow depths and anthropogenic eutrophication has been suggested as the possible cause for the origin of oxygen minima condition in shallow water, as in Gulf of Mexico, Baltic Sea and parts of the Black Sea (Turner and Rabalais, 1994; Diaz and Rosenberg, 1995; Malakoff, 1998; Rabalais, 2000; Rabalais and Turner, 2001; Mee, 2001). Sen Gupta *et al.* (1996) reported a strong spring and summer oxygen depletion in near shore bottom waters of the Louisiana continental shelf based on benthic foraminifers. Turner and Rabalais (1994) suggested increased organic matter flux from surface to bottom waters near the outflow of Mississippi River as the probable cause for shallow hypoxic condition. Osterman (2003) reported the foraminiferal characteristics from 5-30 m thick coastal hypoxic conditions from the Gulf of Mexico. Naqvi *et al.* (2000) reported that the presence of coastal hypoxic zone off west coast of India could be linked to an increased production of N_2O caused by the addition of anthropogenic nitrate and its subsequent denitrification.

Previously attempts have been made to reconstruct past variations in intensity and extent of OMZ from the Pakistan and Oman margin of the Arabian Sea (Altabet *et al.*, 1995; Reichart *et al.*, 1997, 1998; Dulk *et al.*, 1998; Schulz *et al.*, 1998; Rad *et al.*, 1999). Most of these studies attributed the past variations in the intensity or extent of OMZ to the changes in monsoon strength. The Arabian Sea in general records biannual primary productivity maxima associated with the southwest and northeast monsoons (Wiggert *et al.*, 2005). During southwest monsoon upwelling leads to increased availability of nutrients thus supporting high productivity, whereas strong wind forced deepening of mixed layer results in higher productivity during northeast monsoon season (Banse, 1987). Increased surface water productivity leads to increased organic matter flux to the sea bottom and thus increased utilization of available bottom water oxygen for decomposition of organic matter and finally depleted oxygen levels.

In order to ascertain the possible causes for the past variation of dissolved oxygen concentration in the study area, the down-core variation in abundance of various dominant genera was studied in detail (Fig. 7.3-7.24) because the specific ecological preference of different genera as well as the assemblage provide a better idea of the bottom water conditions.

The increased down-core abundance of RBF is closely associated with increased abundance of mainly *Bolivina, Fursenkoina, Uvigerina* (Fig. 7.5, 7.12 and 7.24). These genera have previously been reported to be abundant in oxygen depleted and organic matter rich environment (Murray, 1991; Van der Zwaan *et al.*, 1999; Bernhard and Sen Gupta, 1999). Kitazato *et al.* (2000) also, based on increased abundance of juvenile specimens during higher phytodetritus flux, concluded that the increased supply of organic matter results in increased reproduction, thus higher abundance of *Bolivina*. Therefore the past OMZ variations as inferred in the present study through the down-core variation of RBF abundance, can also be attributed to changing organic matter flux probably resulting from the changing monsoon strength.

7.6.3 PAST VARIATION IN SHALLOW OMZ: NATURAL OR ANTHROPOGENIC?

As stated earlier, the factors leading to the development of shallow OMZ are highly debated and most often anthropogenic eutrophication is cited as one of the possible reason. One possible way to settle this controversy is to decipher the down-core extent of such hypoxic zones. If the hypoxic zones persist through the geologic past even before possible anthropogenic intervention, then factors other than anthropogenic effects are responsible for the development of coastal hypoxic zones.

The core SK 117-SC-06 collected from 56 m water depth, lying in the shallow water OMZ off central west coast of India (established based on surface distribution of RBF), provides an opportunity to test this hypothesis. Since, radiocarbon dating is not available for this core, chronology has been established by extrapolating the ages and rate of sedimentation from the nearby cores. Based on ~53 cm/kyr sedimentation rate at 22 m water depth (Nigam and Khare, 1992a) and ~2 cm/kyr at 240 m water depth (present study), the estimated rate of sedimentation of the present core is calculated to be ~13 cm/kyr. Based on the sedimentation rate of ~13 cm/kyr, the core SK 117-SC-06 (24 cm long) is presumed to cover a time-span of ~1800 years B.P.

The consistent >60% abundance of RBF throughout the core SK 117-SC-06, shows that OMZ conditions prevailed throughout the time-span covered by the core. This rules out the possibility of the coastal OMZ off central west coast off India being anthropogenic in origin. This is because, in that case the signatures of hypoxic conditions in the form of higher percentage of RBF would have been restricted to the top few centimeter only. Therefore the present study shows that shallow water hypoxic conditions off central west coast of India are possibly because of natural phenomena. However, it is possible that anthropogenic cause might have intensified the shallow hypoxic condition. Study of additional well-dated cores from shallow water area will help in solving this problem.

7.6.4 SEA-LEVEL CHANGES AND OMZ

An important factor responsible for development and variation of OMZ is the changing sea level, especially for the extent of OMZ towards the shallower side. This leads to change in bottom water circulation as well as the dissolved oxygen concentration. Sea level fluctuations also change the location of sedimentary basins within the sea where the terrestrial sediments and organic debris get deposited. The possible influence of changing sea level on the variation in extent and intensity of OMZ has previously been documented by Keller and Pardo (2004), Luning *et al.* (2004). Whatley *et al.* (2003) while studying the Upper Cretaceous of East Anglia, also concluded that the landward extent of OMZ was regulated by the changing sea-level.

The present study based on down-core variation of foraminiferal characteristics in a transect of cores covering both shallow as well as deep water depths, provides an opportunity to decipher possible effects of sea level variation on the extent and intensity of OMZ along central west coast of India. Hashimi *et al.* (1995) published sea level variation curve along west coast of India during Holocene. The sea level variations as documented by Nigam *et al.* (1992a) and Hashimi *et al.* (1995) show that during the Holocene, sea level changed significantly at ~8,800, ~5,500 and ~2,200 years B.P. A comparison of down-core variation of RBF in a well-dated core (SK 117 SC-06) with the sea level variation during the Holocene shows that the increased abundance of RBF in core SK 117 SC-06 (Fig. 7.26) roughly corresponds with three episodes of significant sea level change. Another core, SK 117 SC-32 (Fig. 7.26), for which radiocarbon dates are available, also shows two well-developed peaks of RBF approximately at the same time as the sea level variations. Therefore, based on this coherent variation of RBF percentage associated with sea-level variations, it is postulated that the oxygen minima conditions responded to sea level fluctuation during the Holocene. Additional cores from present day shallower margin of OMZ, along with well established chronology will help in further understanding the role of sea-level variation in regulating the extent and intensity of OMZ.

7.7 CONCLUSION

Based on the temporal variation of RBF in ten cores collected from the central west coast of India, it is concluded that the extent and intensity of both shallow and deep OMZ have varied considerably during the geologic past. The down-core abundance of RBF coincides with the abundance of *Bolivina, Fursenkoina* and *Uvigerina,* genera previously reported from high organic matter flux environments, associated with high surface productivity regions. Therefore, it is inferred that the past variation in the intensity and extent of OMZ off central west coast of India, resulted from the changing surface productivity.

Based on the down-core variation of RBF in cores collected from the present day shallow water OMZ, it is concluded that the shallow water OMZ along the central west coast of India existed throughout the last ~1800 yr B.P., thus ruling out the anthropogenic intervention as a possible cause for the generation of shallow water OMZ. However, the possible intensification of shallow water hypoxia after the human intervention cannot be addressed due to the limitation of the present work.

A comparison of sea level changes during the Holocene with the variation in RBF percentage in two well dated cores shows that the significant sea level change during the Holocene is coupled with a corresponding change in percentage of RBF, thus indicating the effect of sea-level change in regulating the extent and intensity of OMZ along central west coast of India.

CHAPTER 8
SUMMARY, CONCLUSIONS AND FUTURE SCOPE

A total of 164 sediment samples (52 surface and 112 subsurface from 10 cores) off Central west coast of India (Vijaydurg-Karwar sector) were used to study the fundamental and applied aspects of foraminifera and their paleoclimatic significance. The major findings are summarized below:

1. A total of 100,358 specimens belonging to 423 foraminiferal species (405 benthic and 18 planktic) comprising 163 genera, 73 families, 38 superfamilies and 6 suborders are being reported.

2. Out of the 405-benthic species the following species are being reported for the first time from the Recent sediments of the Indian Ocean:

   Ammobaculites filiformis Earland, *Ammolagena clavata* (Parker and Jones), *Ammonia* aff. *A. globosa* (Millett), *Ammonia ketienziensis angulata* (Kuwano), *Bifarilaminella advena* (Cushman), *Bolivina* cf. *B. inflata* Heron-Allen and Earland, *Bolivina* cf. *B. oceanica* Cushman, *Bolivina spinata* Cushman, *Bolivinella elegans* Parr, *Botuloides pauciloculus* Zheng, *Brizalina difformis* (Williamson), *Bulimina mexicana* Cushman, *Buliminella* cf. *B. milletti* Cushman, *Cassidulina sicula* Seguenza, *Cassidulina subcarinata* Uchio, *Cassidulina tortuosa* Cushman and Hughes, *Cassidulinoides bradyi* (Norman), *Ceratobulimina jonesiana* (Brady), *Cibicides* cf. *C. fletcheri* Cushman and McCulloch, *Cibicides pachyderma* (Rzehak), *Cibicidina walli* Bandy, *Cibicidoides bradii* (Tolmachoff), *Cibicidoides globulosus* (Chapman and Parr), *Cribrostomoides* cf. *C. bradyi* Cushman, *Cushmanina plumigera* (Brady), *Cystammina pauciloculata* (Brady), *Dentalina ariena* Patterson and Pettis, *Dentalina bradyensis* (Dervieux), *Dentalina cf. D. albatrossi* (Cushman), *Dentalina inflexa* (Reuss), *Dentalina turgoidea* Kristan-Tollmann, *Elphidium reticulosum* Cushman, *Epistominella minuta* (Olsson), *Eratidus* cf. *E. foliaceus* (Brady), *Fissurina* aff. *F. duplicata* (Sidebottom), *Fissurina* aff. *F. pulchella* (Brady), *Fissurina* aff. *F. striolata* (Sidebottom), *Fissurina bradyiformata* (McCulloch), *Fissurina earlandi* Parr, *Fissurina fissicarinata* Parr, *Fissurina imporcata* McCulloch, *Fissurina milletti* Todd, *Fissurina seguenziana* (Fornasini), *Fissurina semimarginata* (Reuss), *Fissurina staphyllearia* Schwager, *Fissurina submarginata* Boomgaart, *Francuscia extensa* (Cushman), *Fursenkoina bradyi* (Cushman), *Fursenkoina complanata* (Egger), *Glandulina ovula* d'Orbigny, *Globocassidulina oriangulata* Belford, *Gyroidina* cf. *G. pulisukensis* (Saidova), *Haplophragmoides* cf. *H. tenuis* Cushman, *Hormosina globulifera* Brady, *Hormosina spiculifera* Hofker, *Karreriella* cf. *K. chilostoma* (Reuss), *Karrerulina erigona* (Saidova), *Lagena* aff. *L. undulata* Sidebottom, *Lagena alticostata* Cushman, *Lagena caudata* (d'Orbigny), *Lagena* cf. *L. multilatera chathamensis* McCulloch, *Lagena favosiformis proba* McCulloch, *Lagena flatulenta* Loeblich and Tappan, *Lagena gibbera* Buchner, *Lagena multilatera* McCulloch, *Lagena substriata elegantula* Jones, *Lenticulina angulata* (Reuss), *Lenticulina crassa* (d'Orbigny), *Lenticulina cultrata* (Montfort), *Lenticulina limbosus chiriguanoi* (Boltovskoy), *Lenticulina pliocaena* (Silvestri), *Lenticulina subcarinata* (Cushman), *Mesosigmoilina minuta* (Collins), *Miliolinella* cf. *M.oceanica* (Cushman), *Miliolinella warreni* Andersen, *Murrayinella* cf. *M. murrayi* (Heron-Allen and Earland), *Neoconorbina parkerae* (Natland), *Nodosaria lamnulifera* Thalmann, *Nonionella auricula* Heron-Allen and Earland, *Nonionella* cf. *N. limbato-striata* Cushman, *Nonionella* cf. *N. limbato-striata* Cushman, *Oolina apiopleura* (Loeblich and Tappan), *Oolina felsinea* (Fornasini), *Oolina setosa* (Earland), *Oolina truncata* (Brady), *Orectostomina camposi* (Brönnimann and Beurlen), *Orthomorphina* aff. *O. parvula* (Todd), *Parafissurina* aff. *P. arctica* Green, *Parafissurina fusiformis* (Wiesner), *Parafissurina himatiostoma* Loeblich and Tappan, *Parafissurina lateralis* (Cushman), *Parafissurina subcarinata* Parr, *Patellinella inconspicua* (Brady), *Planularia australis* Chapman, *Procerolagena ingens* (Buchner), *Proxifrons advena* (Cushman), *Pygmaeoseistron nebulosum* (Cushman), *Pyramidulina cancellata* (d'Orbigny), *Pyramidulina* cf. *P. eptagona* Costa, *Pyrgo elongata* (d'Orbigny), *Pyrgo striolata* (Brady), *Quinqueloculina* cf. Q. *inaequalis* d'Orbigny, *Quinqueloculina distorqueata* Cushman, *Quinqueloculina quadrilateralis* (d'Orbigny), *Quinqueloculina subpolygona* Parr, *Reophanus ovicula* (Brady), *Reophax mortenseni* Hofker, *Reophax nodulosus* Brady, *Reussella laevigata* Cushman, *Saccorhiza ramosa* (Brady), *Saracenaria latifrons* (Brady), *Siphotextularia* cf. *S. concava* (Karrer), *Spiroloculina* aff. S. *caduca* Cushman, *Spiroloculina angulosa* d'Orbigny, *Spiroloculina venusta* Cushman and Todd, *Tritaxis challengeri* (Hedley, Hurdle and Burdett), *Trochammina* cf. *T. nana* (Brady), *Usbekistania charoides* (Jones and Parker), *Uvigerina bifurcata* d'Orbigny, *Uvigerina brunnensis* Karrer, *Uvigerina hollicki* Thalmann, *Uvigerina vadescens* Cushman, *Vaginulina* aff. *V. badenensis* d'Orbigny, *Vaginulina* cf. *V. hemitemna* Kristan-Tollmann and *Verneuilinulla propinqua* (Brady).

3. The following species have been reported for the first time from the Recent sediments of the Arabian Sea:

   Ammodiscus incertus (d'Orbigny), *Baggina indica* (Cushman), *Bolivina silvestrina* Cushman, *Bombulina spinata* (Cushman), *Cibicides lucida* (Reuss), *Cycloforina semiplicata* (McCulloch), *Fursenkoina* cf. *F. schreibersiana* (Czjzek), *Laevidentalina filiformis* (d'Orbigny), *Lagena* cf. *L. oceanica* Albani, *Lagena hispida* Reuss, *Lagena lyellii* (Seguenza), *Lagena pecularis* Cushman and McCulloch, *Lagena spiratiformis* McCulloch, *Lenticulina* cf. *L. gibba* (d'Orbigny), *Marginopora vertebralis* Quoy and Gaimard, *Miliolinella lamellidens* (Reuss), *Miliolinella lutea* (d'Orbigny), *Neoconorbina terquemi* (Rzehak), *Nonion pacificum* (Cushman), *Nonion sloanii* (d'Orbigny), *Nonionella* cf. *N. japonica* (Asano), *Oolina lineata* (Williamson), *Pyrgo* cf. *P. denticulata* (Brady), *Pyrgo* cf. *P. nasutus* Cushman, *Sagrinella convallaria* (Millett), *Triloculina striatotrigonula* Parker and Jones, *Uvigerina aculeata* d'Orbigny and *Uvigerina bassensis* Parr. All specimens are systematically catalogued and illustrated.

4. Within the water depth of 50 to 135 m, a distinct relict benthic foraminiferal assemblage was reported.

   In order to explore the applied aspects of the present study and to highlight the environmental significance, conclusions have been drawn separately on the basis of relict benthic foraminifera, Recent benthic foraminifera in surface samples and benthic foraminifera in subsurface samples.

5. Relict Benthic Foraminifera:

   a. Coral reef indicating assemblage: Depending upon the present-day coral reef morphology, *Amphistegina-Operculina-Alveolinella* assemblage has been used as the indicator of ancient (early Holocene) coral reef at the present-day water depth of 85-135 m, and the paleoshoreline (of early Holocene) is marked at the present-day water depth of 80 m.

   b. Barnacle fouling of relict foraminifera: Abundant relict foraminiferal specimens encrusted with intertidal sessile cirripedes (barnacles) are reported from a depth zone of 60-90 m. The encrustation of barnacles on the relict foraminiferal specimens provides supporting evidence to demarcate paleoshoreline.

c. Presence of the genus *Textularia*: Abundance of *Textularia* at the depth of 50-75 m indicates the decline of salinity, most probably due to high influx of fresh water into the sea. The consequences of fresh water influx were increase in the turbidity and sea level rise, which eventually destroyed the coral reef.

This study indicates that due to the rapid rise in temperature, the sea level and fresh water runoff increased during early Holocene, that destroyed the then prevailing coral reef environment. This event in the past could be taken as an example to estimate what is in store for us in the future with reference to the looming danger of global warming associated with green house effect.

6. Recent Benthic Foraminifera in surface samples:

a. Different foraminiferal genera characterise the different water depths as follows:
   - Shallow water inner shelf assemblage: *Ammonia, Nonion, Nonionoides* and *Rotalidium.*
   - Shallow water outer shelf assemblage: *Amphistegina, Cassidulina Quinqueloculina, Uvigerina, Brizalina, Cancris* and *Cibicides.*
   - Deeper water assemblage: *Epistominella, Melonis, Gyroidina, Gyroidinoides* and *Osangularia.*

However the distribution of some species seems to be independent of depth, such as *Bolivina, Fursenkoina, Globocassidulina* and *Pullenia.*

b. The Q- mode cluster analysis revealed 2 distinct clusters. Cluster A comprises 5 stations distributed between the water depth of 15 and 28 m and is composed of *Ammonia tepida, Asterorotalia dentata, Brizalina spathulata, B. striatula, Haplophragmoides* sp. B, *Nonion* cf. *N. asterigens, N. incisum, N. scaphum, Nonionoides boueanum, N. elongatum, Rotalidium annectens* and *Rotalinoides papillosus.* Cluster B comprises 45 stations located at a water depth greater than 70 m. Within this cluster, three distinct sub-clusters can be identified, which clearly demarcate the assemblages characterizing the water depths of < 70 m, 70-380 m and >380 m.

c. Based on the inverse relationship between abundance of rectilinear benthic foraminifera and dissolved oxygen concentration, it is established that the significant abundance (up to 70%) of rectilinear benthic foraminifera can be used as an indicator of the well-established oxygen minima zone (90 to 1500 m water depth) in the Arabian Sea off the central west coast of India.

d. The similar higher abundance of rectilinear forms at a comparatively shallower depth ranging from 50 to 60 m indicates the presence of distinct shallow water oxygen minima condition, in addition to OMZ in deeper water (please see 'c' above).

7. Benthic Foraminifera in subsurface samples:

a. The variation in the distribution and abundance of rectilinear forms of foraminifera in the ten cores indicates that the extent and intensity of both shallow and deep water OMZ has considerably fluctuated in the geologic past. These variations can be attributed to changing organic matter flux probably resulting from the fluctuating monsoon strength.

b. The down-core variation of rectilinear forms of foraminifera in cores from the present day shallow water (50-60 m) OMZ, indicates that the shallow water OMZ along the central west coast of India has continuously existed for the last ~1800 yr B.P. This signature rules out the possibility of anthropogenic changes as the cause for the formation of shallow water OMZ. However it is possible that the anthropogenic effect might have intensified the shallow hypoxic condition.

c. The variation in the abundance of rectilinear forms of foraminifera in two well-dated cores corresponds to the significant sea level changes during the Holocene. Thus, it can be concluded that the extent and intensity of OMZ along central west coast of India during the Holocene have possibly been regulated by the sea level changes.

FUTURE SCOPE:

In the present study a number of specimens have remained unidentified up to the species level. These specimens have not been assigned any existing valid name or new name due to the limited time available for the present work. In the future, it thus retains a good scope to compare these specimens with the collection of type specimens from well-known centers, *viz.* British Museum of Natural History, American Museum of Natural History, etc, and hence to assign new name for those specimens. This will restrict unnecessary expansion of literature by adding more name as "New Species" without proper care taken to refer to the already available extensive list of species of foraminifera.

The present study reports the presence of deep-water oxygen minima zone (150-1500 m) along with shallow water oxygen deficient condition (50-60 m). Analyzing more closely spaced samples within the suggested depth range can further strengthen this study. Particularly, the shallow water zone has to be studied by using more closely spaced samples in order to understand the relationship between benthic foraminifera and oxygen concentrations.

A study of the variation in behaviour of benthic foraminifera (collected live from intense OMZ) through oxygen manipulation experiments in the laboratory is also recommended. This will strengthen the postulation that benthic foraminifera can be reliably used as keys to indicate the OMZ conditions in the past. Such studies will help to solve controversies, which set up natural phenomenon against anthropogenic contributions to be responsible for global environmental change.

Collection of few long gravity or piston cores from OMZ (both shallow and deep water) for foraminiferal investigations, estimation of other parameters, *viz.* organic matter, isotope studies and closely spaced radiocarbon dates is the need of the hour. Such study will bring out the true picture of the varying oxygen conditions over the geological past.

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Plate 1

Plate 1

(Scale bar equals 100 μm unless specified)

Figure 1	*Pilulina* sp.; Apertural View
Figure 2	*Saccorhiza ramosa* (Brady); Side View [Scale bar = 200 μm]
Figure 3	*Ammodiscus incertus* (d'Orbigny); Side View [Scale bar = 300 μm]
Figure 4	*Ammolagena clavata* (Parker and Jones);
	(a) Side View, attached with *Ammodiscus tenuis*;
	(b) Side View, attached with *Globorotalia menardii* (SEM Photographs)
Figure 5	*Usbekistania charoides* (Jones and Parker);
	(a) Top View; (b) Bottom View; (c) Side View [Scale bar = 200 μm]
Figure 6	*Reophax mortenseni* Hofker; Side View [Scale bar = 300 μm]
Figure 7	*Reophax nodulosus* Brady; Side View [Scale bar = 300 μm]
Figure 8	*Scherochorella* sp.; Side View [Scale bar = 200 μm]
Figure 9	*Subreophax* cf. *S. monile* (Brady); Side View [Scale bar = 200 μm]
Figure 10	*Hormosina globulifera* Brady; Side View [Scale bar = 200 μm]
Figure 11	*Hormosina spiculifera* Hofker; Side View [Scale bar = 200 μm]
Figure 12	*Reophax nodulosus* Brady; Side View [Scale bar = 300 μm]
Figure 13	*Reophanus ovicula* (Brady); Side View [Scale bar = 300 μm]
Figure 14	*Cribrostomoides* cf. *C. bradyi* Cushman;
	(a) Side View; (b) Apertural View [Scale bar = 200 μm]
Figure 15	*Haplophragmoides* cf. *H. tenuis* Cushman;
	(a) Side View; (b) Apertural View
Figure 16	*Haplophragmoides* sp. A;
	(a) Side View; (b) Apertural View
Figure 17	*Haplophragmoides* sp. B;
	(a) Side View; (b) Apertural View
Figure 18	*Veleroninoides* sp.;
	(a) Dorsal View; (b) Ventral View; (c) Apertural View [Scale bar = 200 μm]
Figure 19	*Ammobaculites filiformis* Earland; Side View
Figure 20	*Eratidus* cf. *E. foliaceus* (Brady); Side View [Scale bar = 200 μm]
Figure 21	*Cystammina pauciloculata* (Brady);
	(a) Side View; (b) Opposite Side View [Scale bar = 200 μm]
Figure 22	*Alveolophragmium orbiculatum* Shchedrina;
	(a) Side View; (b) Apertural View [Scale bar = 200 μm]
Figure 23	*Cyclammina cancellata* Brady;
	(a) Side View; (b) Apertural View [Scale bar = 300 μm]

PLATE 1

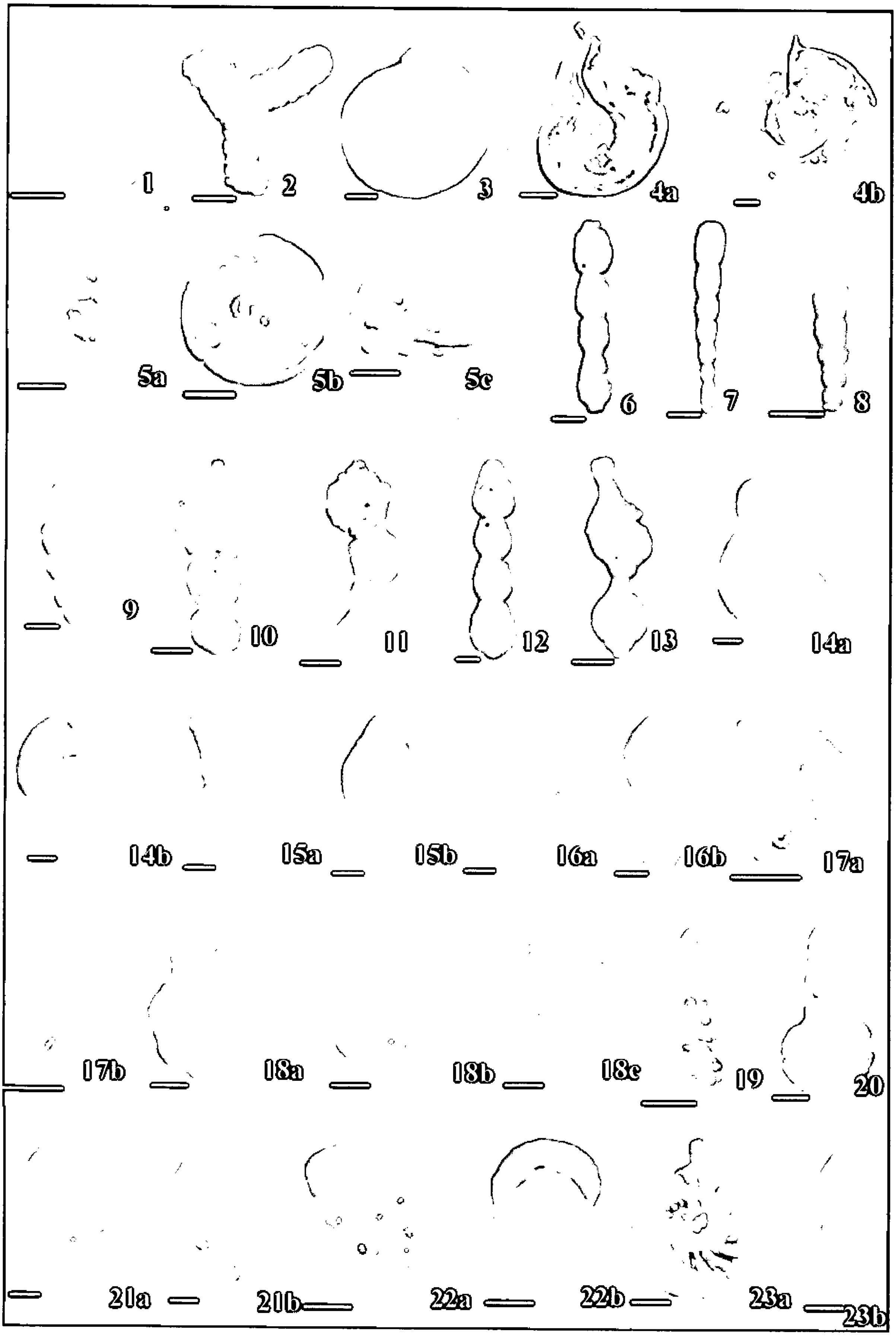
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Plate 2

Plate 2

(Scale bar equals 100 µm unless specified)

Figure 1	*Orectostomina camposi* (Brönnimann and Beurlen); Side View [Scale bar = 200 µm]
Figure 2	*Spiroplectinella sagittula* (d'Orbigny); Side View
Figure 3	*Ammoglobigerina globigeriniformis* (Parker and Jones); (a) Dorsal View; (b) Ventral/Apertural View
Figure 4	*Tritaxis challengeri* (Hedley, Hurdle and Burdett); (a) Dorsal View; (b) Ventral View; (c) Apertural View
Figure 5	*Trochammina* cf. *T. nana* (Brady); (a) Dorsal View; (b) Ventral/Apertural View [Scale bar = 300 µm]
Figure 6	*Trochammina hadai* Uchio; (a) Dorsal View; (b) Ventral View; (c) Apertural View
Figure 7	*Trochammina inflata* (Montagu); (a) Dorsal View; (b) Ventral View; (c) Apertural View
Figure 8	*Karrerulina erigona* (Saidova); Side View [Scale bar = 200 µm]
Figure 9	*Verneuilinulla propinqua* (Brady); (a) Side View; (b) Apertural View [Scale bar = 200 µm]
Figure 10	*Eggerella bradyi* (Cushman); (a) Side View; (b) Apertural View
Figure 11	*Karreriella* cf. *K. chilostoma* (Reuss); (a) Side View; (b) Apertural View
Figure 12	*Sahulia conica* (d'Orbigny); Side View
Figure 13	*Textularia agglutinans* d'Orbigny; Side View
Figure 14	*Textularia foliacea* (Heron-Allen and Earland); Side View
Figure 15	*Textularia* aff. *T. milleti* Cushman; Side View
Figure 16	*Textularia pseudogramen* Chapman and Parr; Side View
Figure 17	*Karrerotextularia* sp.; Side View
Figure 18	*Siphotextularia* cf. *S. concava* (Karrer); Side View
Figure 19	*Cornuspira involvens* (Reuss); (a) Side View; (b) Apertural View
Figure 20	*Planispirinella exigua* (Brady); Side View
Figure 21	*Vertebralina* sp.; (a) Side View; (b) Opposite Side/Apertural View

PLATE 2

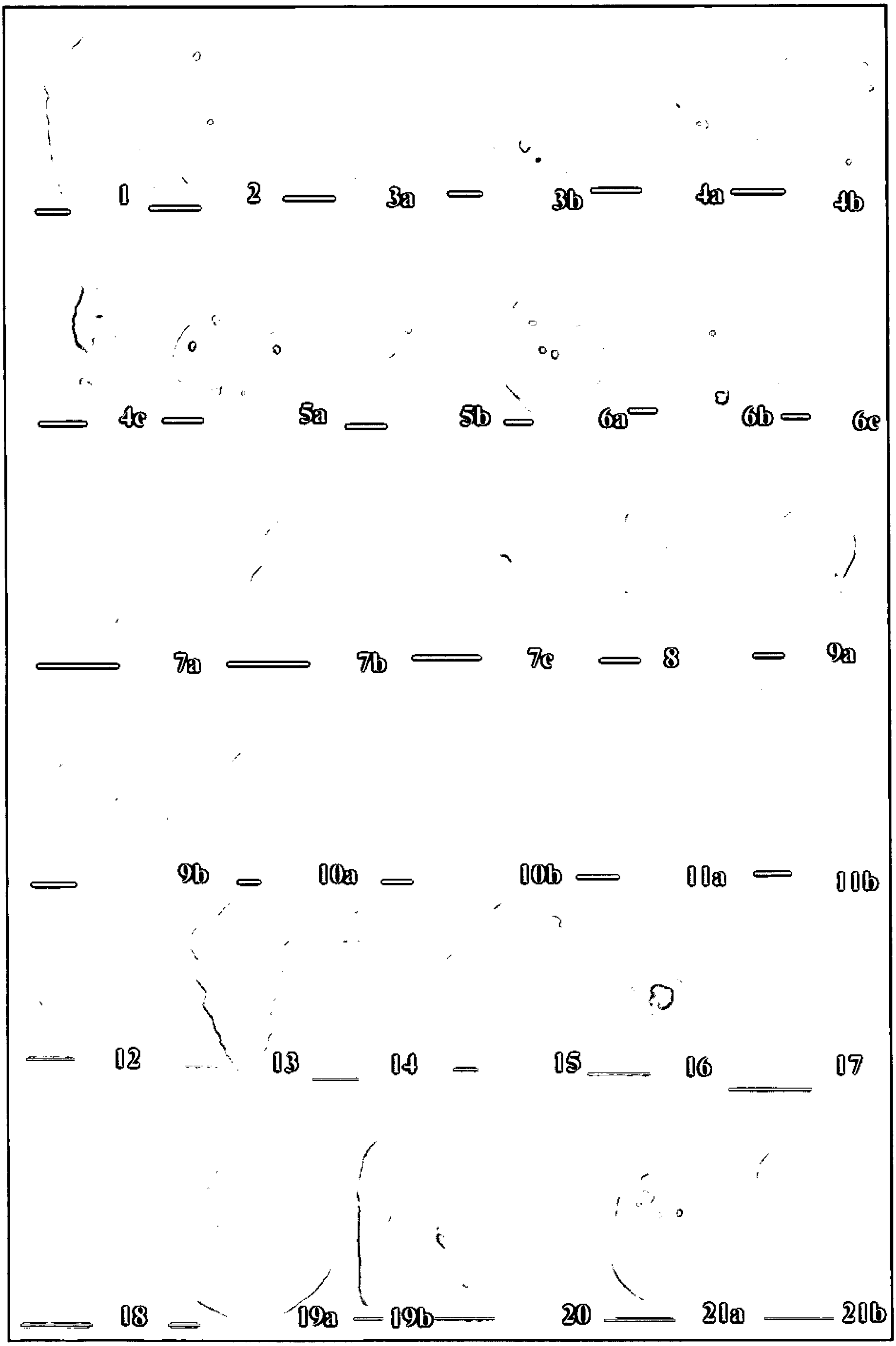
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Plate 3

Plate 3

(Scale bar equals 100 μm unless specified)

Figure 1	*Edentostomina cultrata* (Brady); (a) Side View; (b) Apertural View
Figure 2	*Edentostomina rupertiana* (Brady); [Scale bar = 200 μm] (a) Side View; (b) Apertural View
Figure 3	*Ophthalmidium* sp.; [Scale bar = 200 μm] (a) Side View; (b) Apertural View
Figure 4	*Spirophthalmidium acutimargo* (Brady); Side View
Figure 5	*Spirophthalmidium* sp.; Side View
Figure 6	*Adelosina laevigata* d'Orbigny; (a) Front View; (b) Back View; (c) Apertural View
Figure 7	*Paleomiliolina* sp.; Side View
Figure 8	*Spiroloculina angulata* (Cushman); (a) Side View; (b) Apertural View
Figure 9	*Spiroloculina angulosa* d'Orbigny; (a) Side View; (b) Apertural View
Figure 10	*Spiroloculina antillarium* d'Orbigny; [Scale bar = 300 μm] (a) Side View; (b) Apertural View
Figure 11	*Spiroloculina aperta* Cushman and Todd; (a) Side View; (b) Apertural View
Figure 12	*Spiroloculina* aff. S. *caduca* Cushman; (a) Side View; (b) Apertural View
Figure 13	*Spiroloculina communis* Cushman and Todd; (a) Side View; (b) Apertural View
Figure 14	*Spiroloculina depressa* d'Orbigny; [Scale bar = 200 μm] (a) Side View; (b) Apertural View
Figure 15	*Spiroloculina excavata* d'Orbigny; (a) Side View; (b) Apertural View
Figure 16	*Spiroloculina indica* Cushman and Todd; (a) Side View; (b) Apertural View
Figure 17	*Spiroloculina planissima* Wiesner; [Scale bar = 200 μm] (a) Side View; (b) Apertural View
Figure 18	*Spiroloculina rotunda* d'Orbigny; (a) Side View; (b) Apertural View
Figure 19	*Spiroloculina tricarinata* Terquem; [Scale bar = 300 μm] (a) Side View; (b) Apertural View
Figure 20	*Spiroloculina venusta* Cushman and Todd; (a) Side View; (b) Apertural View

PLATE 3

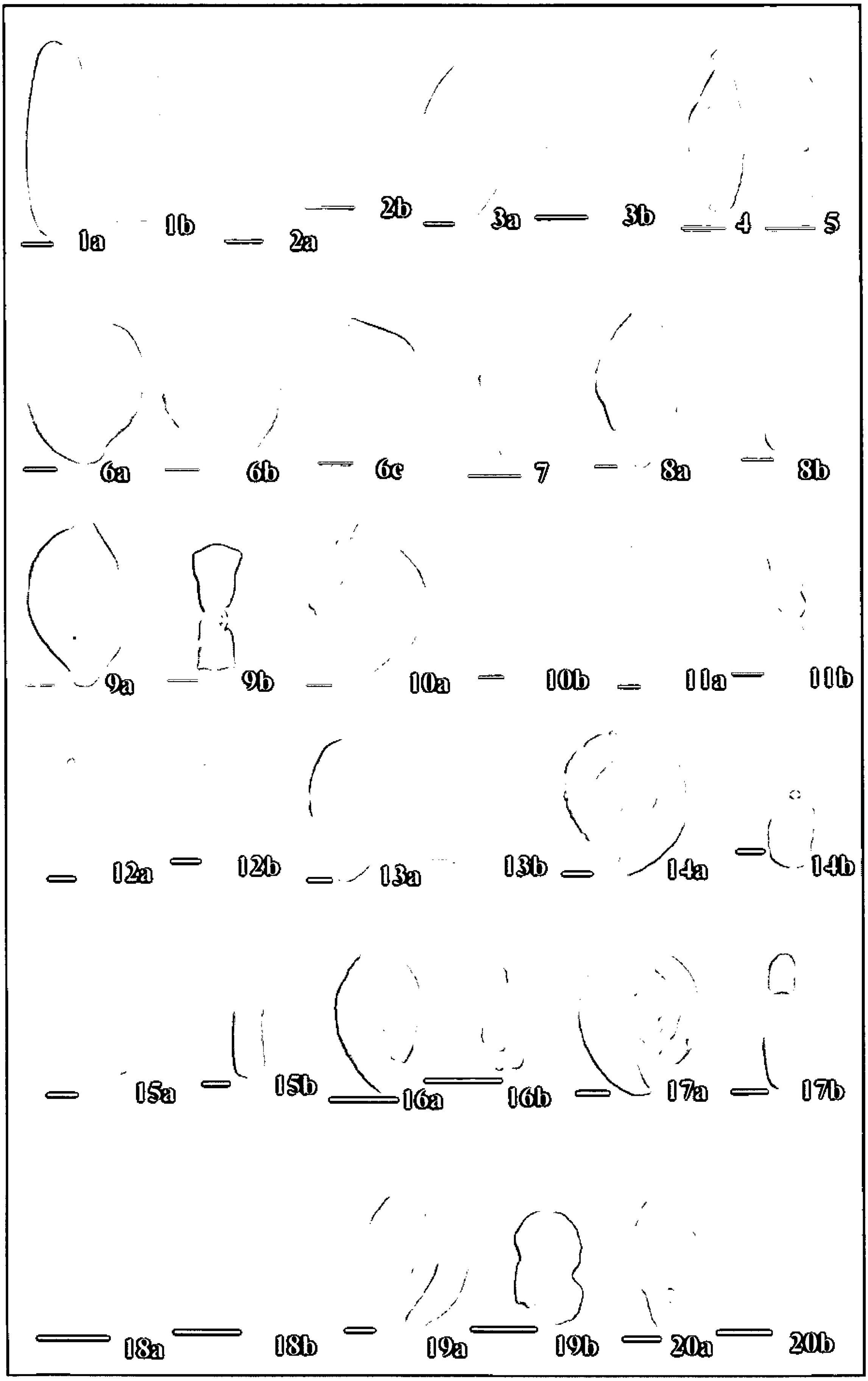
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Plate 4

Plate 4

(Scale bar equals 100 μm unless specified)

Figure 1	*Spiroloculina* sp.;
	(a) Side View; (b) Apertural View
Figure 2	*Siphonaperta* cf. *S. agglutinans* (d'Orbigny); [Scale bar = 200 μm]
	(a) Four-chamber View; (b) Three-chamber View; (c) Apertural View
Figure 3	*Siphonaperta horrida* (Cushman);
	(a) Side View; (b) Apertural View
Figure 4	*Cycloforina semiplicata* (McCulloch); [Scale bar = 300 μm]
	(a) Four-chamber View; (b) Three-chamber View; (c) Apertural View
Figure 5	*Hauerina fragilissima* (Brady);
	(a) Side View; (b) Apertural View
Figure 6	*Quinqueloculina* cf. *Q.annectens* (Schlumberger); Scale bar = [200 μm]
	(a) Four-chamber View; (b) Three-chamber View; (c) Apertural View
Figure 7	*Quinqueloculina berthelotiana* d'Orbigny; [Scale bar = 200 μm]
	(a) Four-chamber View; (b) Three-chamber View; (c) Apertural View
Figure 8	*Quinqueloculina bicarinata* d'Orbigny; [Scale bar = 200 μm]
	(a) Four-chamber View; (b) Three-chamber View; (c) Apertural View
Figure 9	*Quinqueloculina distorqueata* Cushman;
	(a) Four-chamber View; (b) Three-chamber View; (c) Apertural View
Figure 10	*Quinqueloculina echinata* (d'Orbigny); [Scale bar = 200 μm]
	(a) Four-chamber View; (b) Three-chamber View; (c) Apertural View
Figure 11	*Quinqueloculina elegens* d'Orbigny;
	(a) Four-chamber View; (b) Three-chamber View; (c) Apertural View
Figure 12	*Quinqueloculina* cf. Q. *inaequelis* d'Orbigny;
	(a) Four-chamber View; (b) Three-chamber View; (c) Apertural View
Figure 13	*Quinqueloculina kerimbatica* (Heron-Allen and Earland);
	(a) Four-chamber View; (b) Three-chamber View; (c) Apertural View

PLATE 4

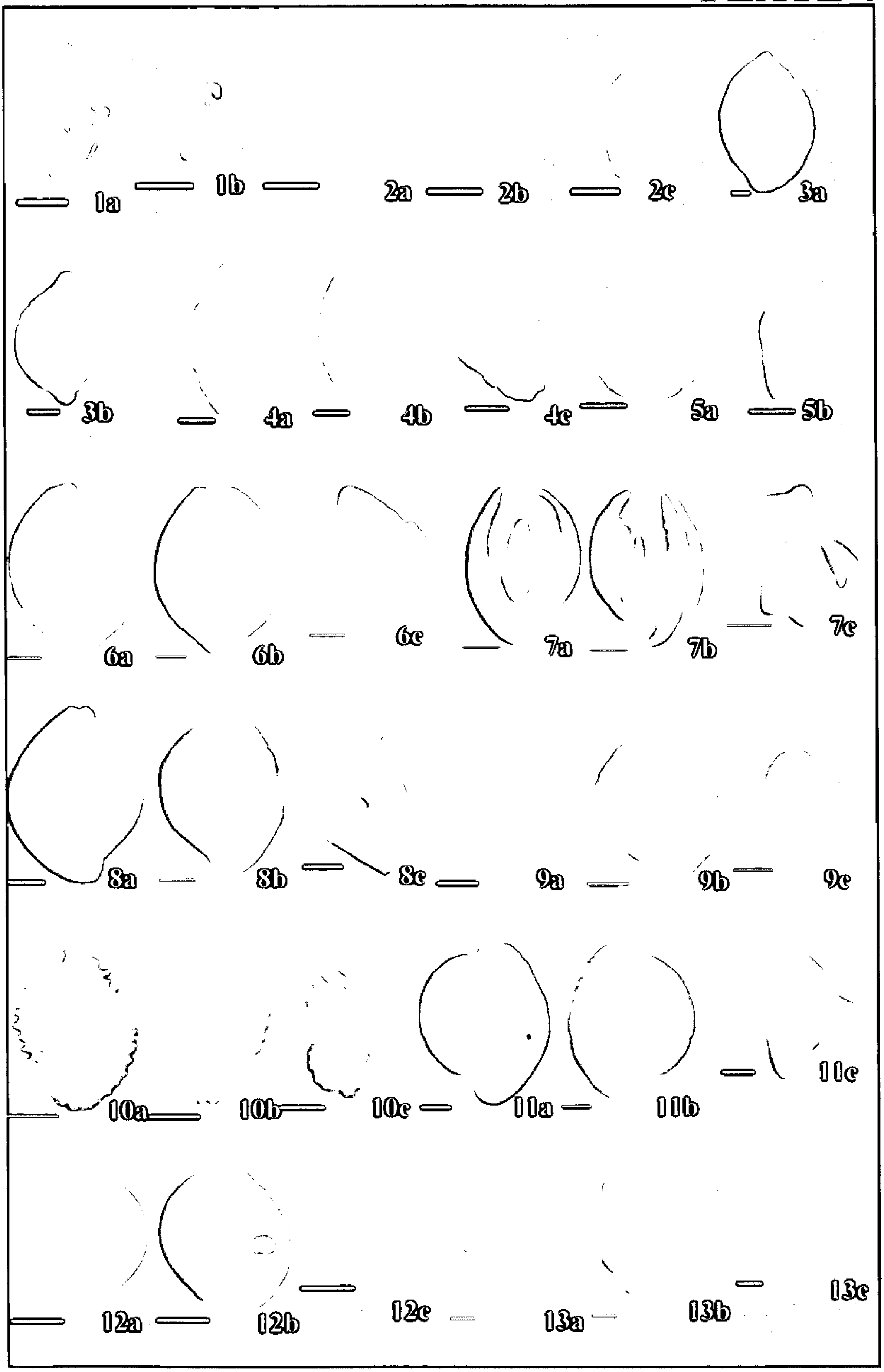

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Plate 5

Plate 5

(Scale bar equals 100 µm unless specified)

Figure 1	*Quinqueloculina lamarckiana* d'Orbigny; (a) Four-chamber View; (b) Three-chamber View; (c) Apertural View [Scale bar = 200 µm]
Figure 2	*Quinqueloculina mosharrafai* Said; (a) Four-chamber View; (b) Three-chamber View; (c) Apertural View
Figure 3	*Quinqueloculina multimarginata* Said; (a) Four-chamber View; (b) Three-chamber View; (c) Apertural View
Figure 4	*Quinqueloculina parkeri* (Brady); (a) Four-chamber View; (b) Three-chamber View; (c) Apertural View
Figure 5	*Quinqueloculina polygona* d'Orbigny; (a) Four-chamber View; (b) Three-chamber View; (c) Apertural View
Figure 6	*Quinqueloculina pseudoreticulata* Parr; (a) Four-chamber View; (b) Three-chamber View; (c) Apertural View [Scale bar = 200 µm]
Figure 7	*Quinqueloculina quadrilateralis* (d'Orbigny); (a) Four-chamber View; (b) Three-chamber View; (c) Apertural View
Figure 8	*Quinqueloculina rhodiensis* Parker; (a) Four-chamber View; (b) Three-chamber View; (c) Apertural View
Figure 9	*Quinqueloculina schlumbergeri* (Wiesner); (a) Four-chamber View; (b) Three-chamber View; (c) Apertural View
Figure 10	*Quinqueloculina subpolygona* Parr; (a) Four-chamber View; (b) Three-chamber View; (c) Apertural View
Figure 11	*Quinqueloculina sulcata* d'Orbigny; (a) Four-chamber View; (b) Three-chamber View; (c) Apertural View
Figure 12	*Quinqueloculina trigonula* Terquem; (a) Four-chamber View; (b) Three-chamber View; (c) Apertural View

PLATE 5

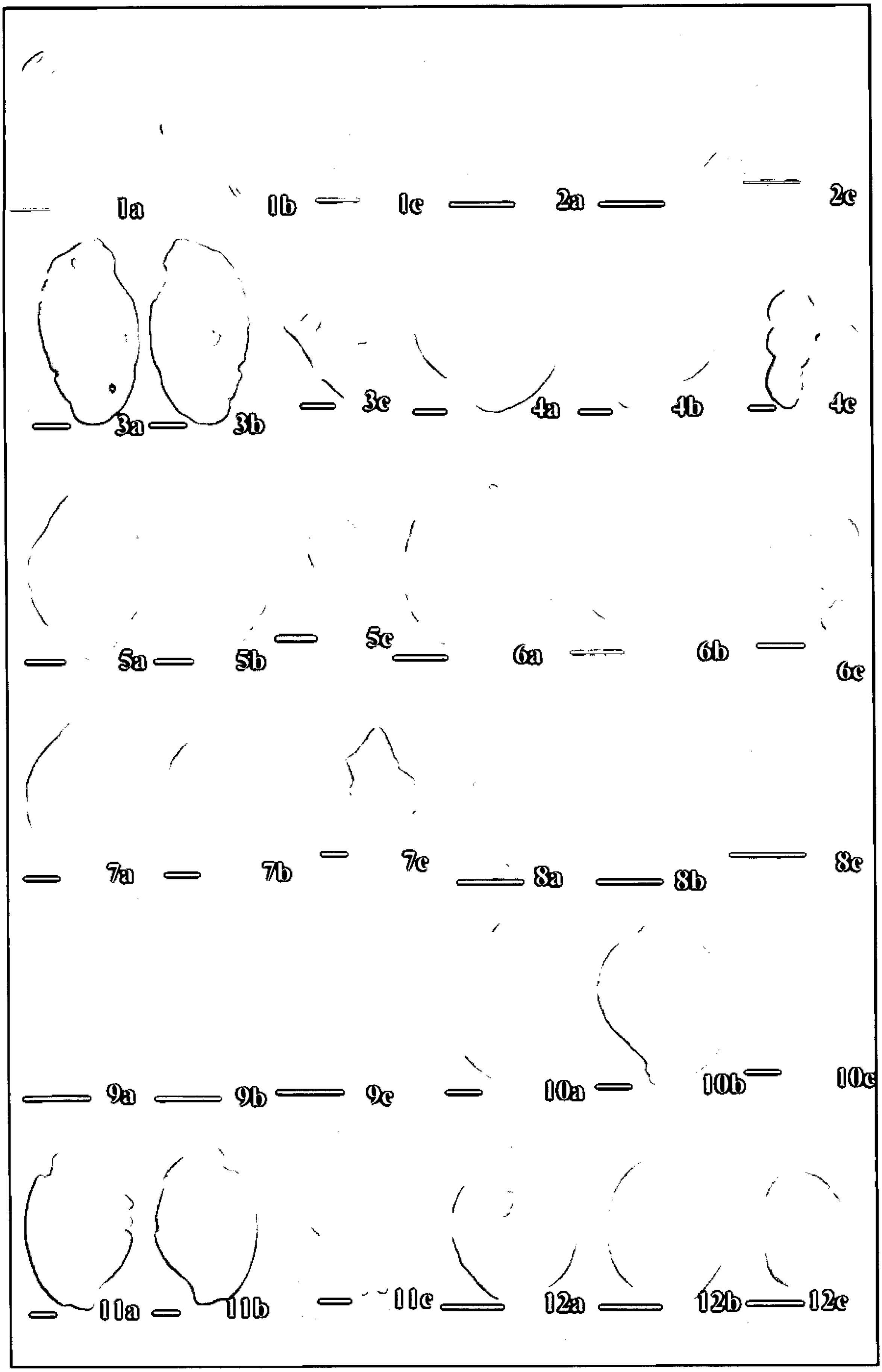
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Plate 6

Plate 6

(Scale bar equals 100 μm unless specified)

Figure 1	*Quinqueloculina undulosecostata* Terquem; [Scale bar = 200 μm]
	(a) Four-chamber View; (b) Three-Chamber View; (c) Apertural View
Figure 2	*Quinqueloculina venusta* Karrer; [Scale bar = 200 μm]
	(a) Four-chamber View; (b) Three-Chamber View; (c) Apertural View
Figure 3	*Quinqueloculina seminulum* (Linne);
	(a) Four-chamber View; (b) Three-Chamber View; (c) Apertural View
Figure 4	*Quinqueloculina vulgaris* d'Orbigny;
	(a) Four-chamber View; (b) Three-Chamber View; (c) Apertural View
Figure 5	*Quinqueloculina* sp.,
	(a) Four-chamber View; (b) Three-Chamber View; (c) Apertural View
Figure 6	*Cribromiliolinella* sp.;
	(a) Four-chamber View; (b) Three-Chamber View; (c) Apertural View
Figure 7	*Miliolinella australis* (Parr);
	(a) Four-chamber View; (b) Three-Chamber View; (c) Apertural View
Figure 8	*Miliolinella circularis* (Bornemann);
	(a) Four-chamber View; (b) Three-Chamber View; (c) Apertural View
Figure 9	*Miliolinella labiosa* (d'Orbigny);
	(a) Four-chamber View; (b) Three-Chamber View; (c) Apertural View
Figure 10	*Miliolinella lamellidens* (Reuss);
	(a) Four-chamber View; (b) Three-Chamber View; (c) Apertural View
Figure 11	*Miliolinella lutea* (d'Orbigny);
	(a) Four-chamber View; (b) Three-Chamber View; (c) Apertural View
Figure 12	*Miliolinella oblonga* (Montagu);
	(a) Four-chamber View; (b) Three-chamber View; (c) Apertural View

PLATE 6

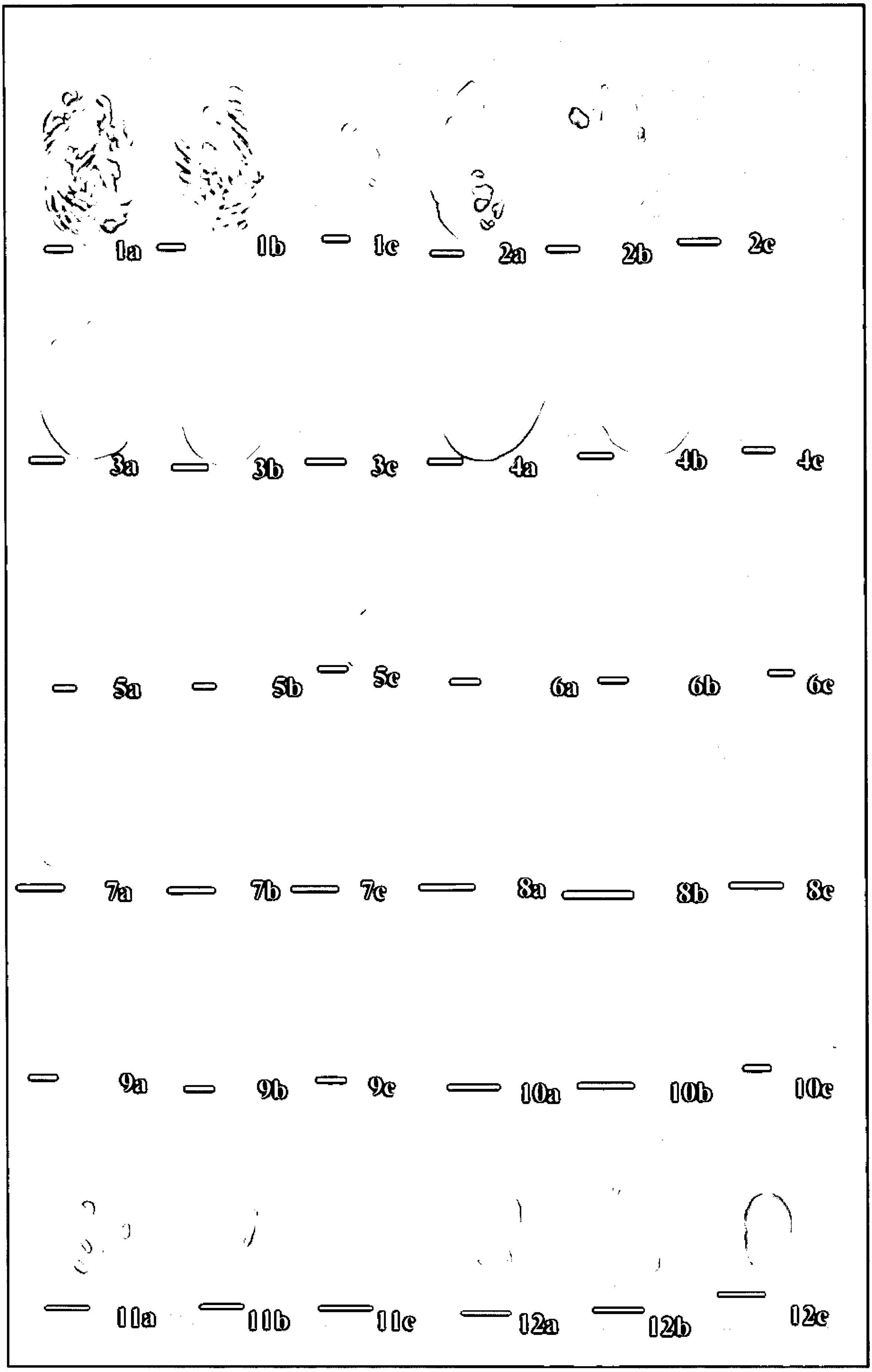

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Plate 7

Plate 7

(Scale bar equals 100 μm unless specified)

Figure 1	*Miliolinella* cf. *M. oceanica* (Cushman);
	(a) Four-chamber View; (b) Three-chamber View; (c) Apertural View
Figure 2	*Miliolinella subrotunda* (Montagu);
	(a) Four-chamber View; (b) Three-chamber View; (c) Apertural View
Figure 3	*Miliolinella warreni* Anderson;
	(a) Four-chamber View; (b) Three-chamber View; (c) Apertural View
Figure	4 *Miliolinella* sp.;
	(a) Four-chamber View; (b) Three-chamber View; (c) Apertural View
Figure 5	*Pyrgo* cf. *P. denticulata* (Brady);
	(a) Front View; (b) Back View; (c) Apertural View
Figure 6	*Pyrgo elongata* (d'Orbigny);
	(a) Front View; (b) Back View; (c) Apertural View
Figure 7	*Pyrgo laevis* Defrance;
	(a) Front View; (b) Back View; (c) Apertural View
Figure 8	*Pyrgo* cf. *P. nasutus* Cushman;
	(a) Front View; (b) Back View; (c) Apertural View
Figure 9	*Pyrgo striolata* (Brady);
	(a) Front View; (b) Back View; (c) Apertural View
Figure 10	*Pyrgo* sp. A;
	(a) Front View; (b) Back View; (c) Apertural View

PLATE 7

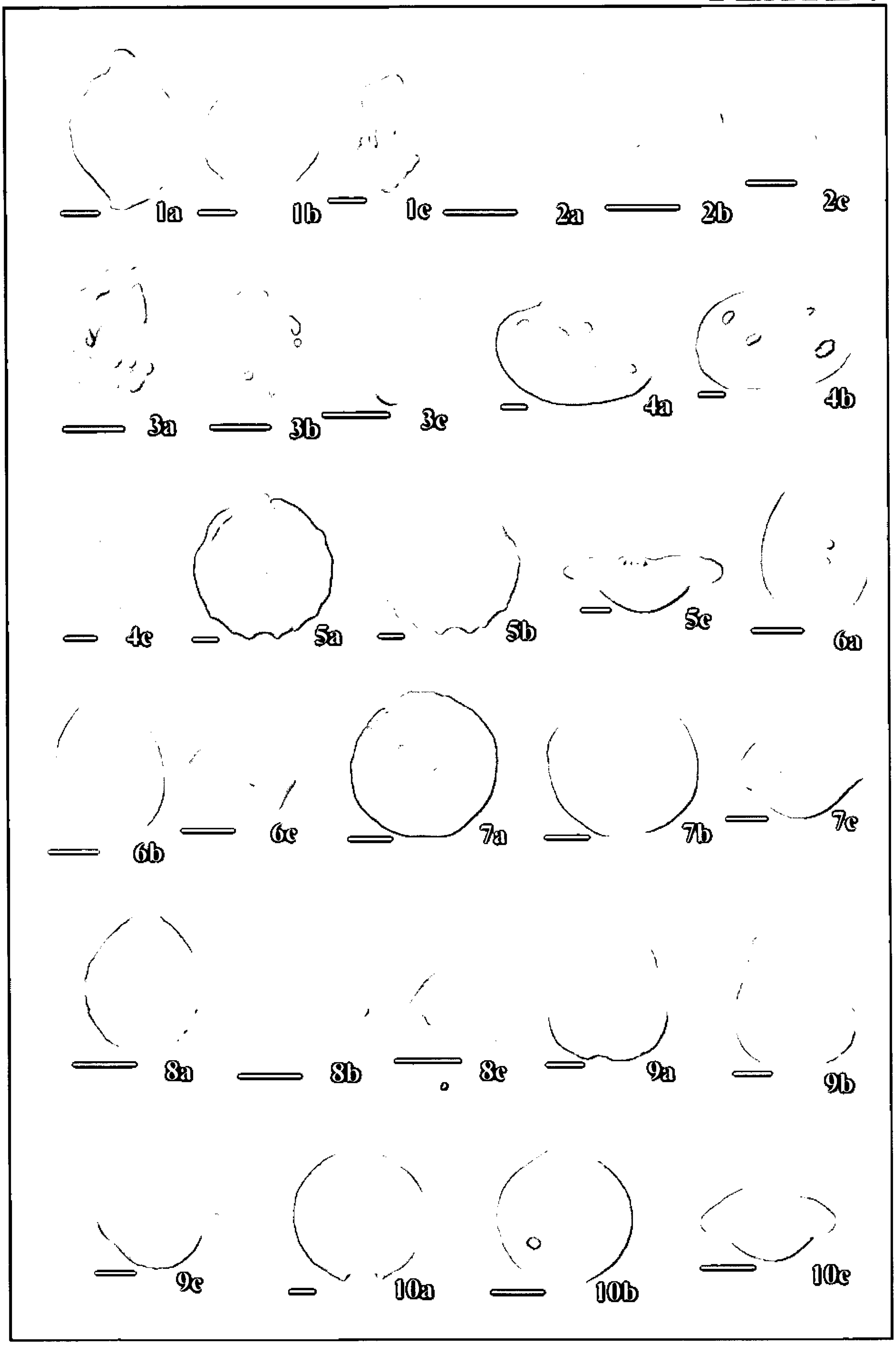

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Plate 8

Plate 8

(Scale bar equals 100 μm unless specified)

Figure 1	*Pyrgo* sp. B;
	(a) Front View; (b) Back View; (c) Apertural View
Figure 2	*Pyrgo* sp. C;
	(a) Front View; (b) Back View; (c) Apertural View
Figure 3	*Pyrgo* sp. D;
	(a) Front View; (b) Back View; (c) Apertural View
Figure 4	*Pyrgo* sp. E;
	(a) Front View; (b) Back View; (c) Apertural View
Figure 5	*Triloculina insignis* (Brady);
	(a) Three-chamber View; (b) Two-chamber View; (c) Apertural View
Figure 6	*Triloculina striatotrigonula* Parker and Jones;
	(a) Three-chamber View; (b) Two-chamber View; (c) Apertural View
Figure 7	*Triloculina terquemiana* (Brady);
	(a) Three-chamber View; (b) Two-chamber View; (c) Apertural View
Figure 8	*Triloculina tricarinata* d'Orbigny;
	(a) Three-chamber View; (b) Two-chamber View; (c) Apertural View
Figure 9	*Triloculina trigonula* (Lamarck);
	(a) Three-chamber View; (b) Two-chamber View; (c) Apertural View
Figure 10	*Triloculinalla* sp.;
	(a) Three-chamber View; (b) Two-chamber View; (c) Apertural View
Figure 11	*Mesosigmoilina minuta* (Collins); Side View
Figure 12	*Spirosigmoilina tenuis* (Cžjžek); Side View
Figure 13	*Pseudohauerina orientalis* (Cushman);
	(a) Front View; (b) Back View; (c) Apertural View
Figure 14	*Borelis* sp.; Side View

PLATE 8

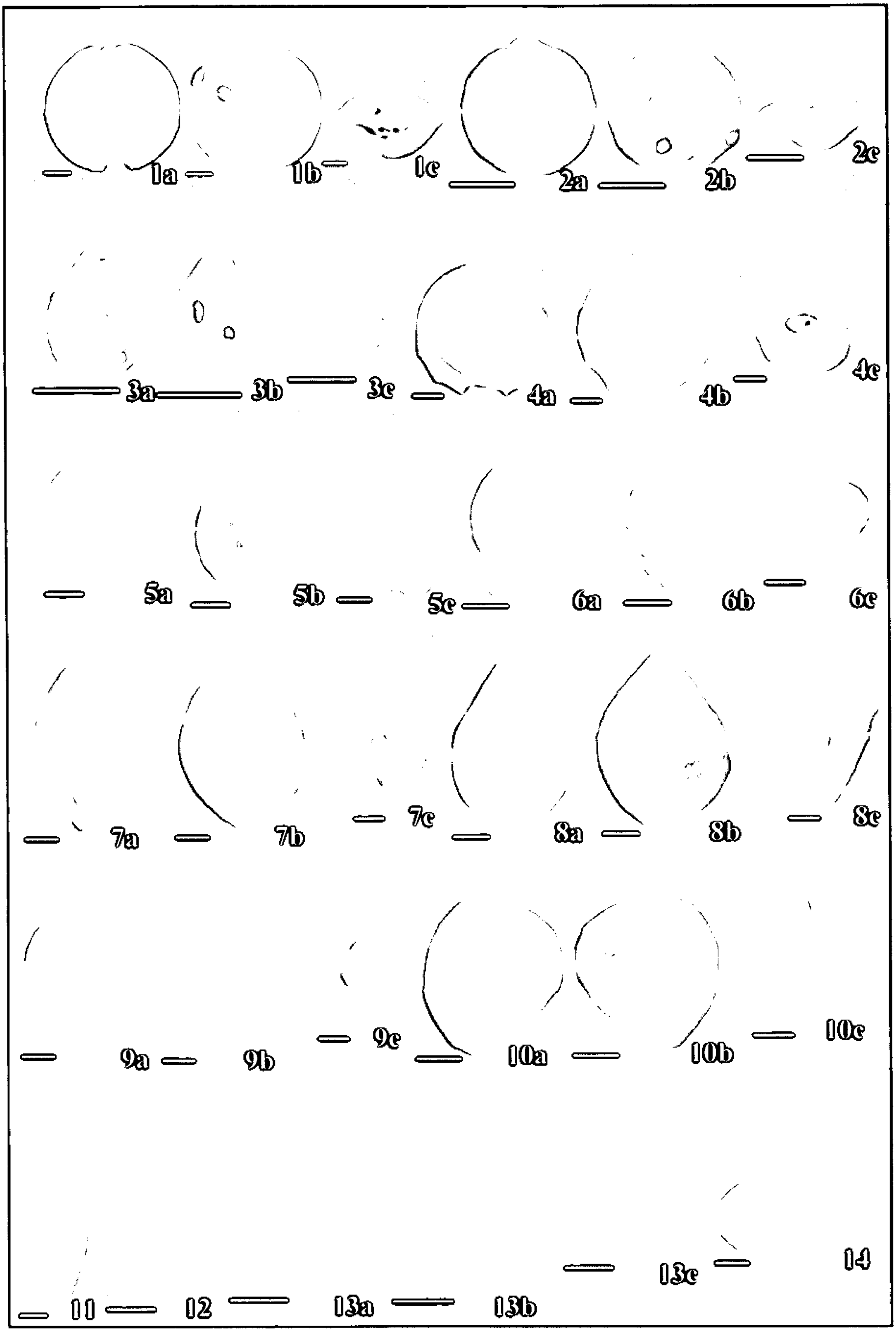
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Plate 9

Plate 9

(Scale bar equals 100 μm unless specified)

Figure 1	*Parasorites marginalis* (Lamarck); Side View [Scale bar = 300 μm]
Figure 2	*Marginopora vertebralis* Quoy and Gaimard; Side View
Figure 3	*Botuloides pauciloculus* Zheng; Side View
Figure 4	*Dentalina cf. D. albatrossi* (Cushman); Side View [Scale bar = 300 μm]
Figure 5	*Dentalina inflexa* (Reuss); Side View
Figure 6	*Dentalina turgoidea* Kristan-Tollmann; Side View
Figure 7	*Nodosaria vertebralis* (Batsch); Side View [Scale bar = 200 μm]
Figure 8	*Dentalina* sp. A; Side View [Scale bar = 200μm]
Figure 9	*Dentalina* sp. B; Side View
Figure 10	*Dentalina* sp. C; Side View [Scale bar = 200μm]
Figure 11	*Dentalina* sp. D; Side View
Figure 12	*Dentalina* sp. E; Side View [Scale bar = 200μm]
Figure 13	*Dentalina* sp. F; Side View [Scale bar = 200μm]
Figure 14	*Laevidentalina aphelis* Loeblich and Tappan; Side View [Scale bar = 300μm]
Figure 15	*Dentalina ariena* Patterson and Pettis; Side View
Figure 16	*Dentalina bradyensis* (Dervieux); Side View [Scale bar = 300μm]
Figure 17	*Laevidentalina filiformis* (d'Orbigny); Side View [Scale bar = 300μm]
Figure 18	*Nodosaria catesbyi* d'Orbigny; Side View
Figure 19	*Nodosaria lamnulifera* Thalmann; Side View [Scale bar = 200μm]
Figure 20	*Nodosaria pausiloculata* Cushman; Side View [Scale bar = 200μm]
Figure 21	*Nodosaria* sp.; Side View
Figure 22	*Pyramidulina cancellata* (d'Orbigny); (a) Side View; (b) Apertural View
Figure 23	*Pyramidulina* cf. *P. eptagona* Costa; [Scale bar = 200μm] (a) Side View; (b) Apertural View
Figure 24	*Proxifrons advena* (Cushman); Side View
Figure 25	*Lenticulina angulata* (Reuss); (a) Side View; (b) Apertural View
Figure 26	*Lenticulina calcar* (Linnaeus); (a) Side View; (b) Apertural View
Figure 27	*Lenticulina crassa* (d'Orbigny)(megalospheric form); (a) Side View; (b) Apertural View
Figure 28	*Lenticulina crassa* (d'Orbigny)(microspheric form); (a) Side View; (b) Apertural View
Figure 29	*Lenticulina cultrata* (Montfort); (a) Side View; (b) Apertural View
Figure 30	*Lenticulina* cf. *L. gibba* (d'Orbigny); (a) Side View; (b) Apertural View
Figure 31	*Lenticulina limbosa* (Reuss); (a) Side View; (b) Apertural View [Scale bar = 200μm]
Figure 32	*Lenticulina limbosus chiriguanoi* (Boltovskoy); (a) Side View; (b) Apertural View

PLATE 9

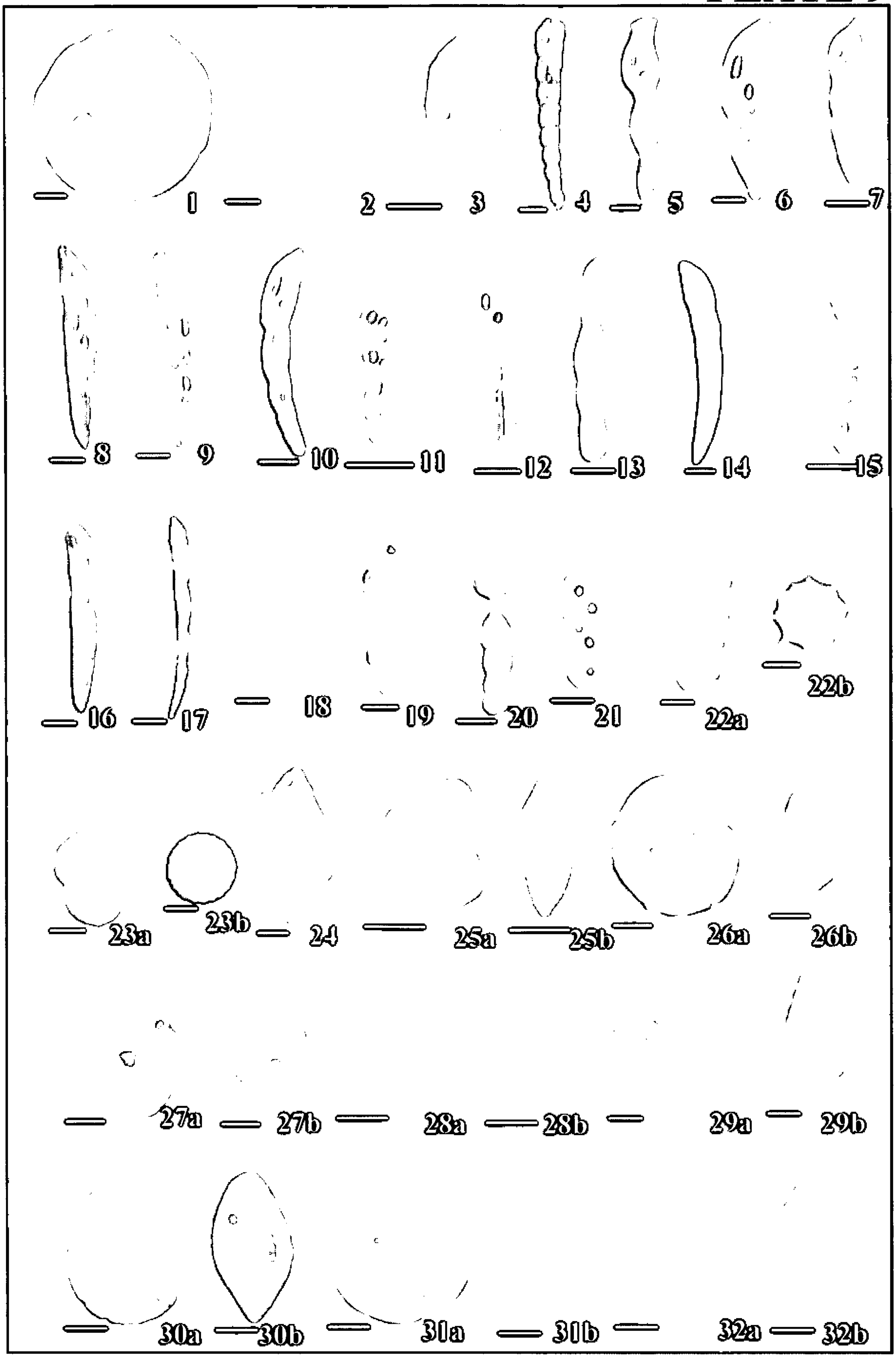
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Plate 10

Plate 10

(Scale bar equals 100 μm unless specified)

Figure 1	*Lenticulina macrodiscus* Cushman; (a) Side View; (b) Apertural View
Figure 2	*Lenticulina subcarinata* (Cushman); (a) Side View; (b) Apertural View
Figure 3	*Lenticulina pliocaena* (Silvestri); Side View [Scale bar = 200μm]
Figure 4	*Lenticulina thalmanni* (Hessland); (a) Side View; (b) Apertural View [Scale bar = 200μm]
Figure 5	*Lenticulina* sp.; (a) Side View; (b) Apertural View
Figure 6	*Saracenaria latifrons* (Brady); (a) Side View; (b) Apertural View
Figure 7	*Amphicoryna intercellularis* (Brady) Type A (specimen with two transparent globular chambers with slender long neck) Side View
Figure 8	*Amphicoryna intercellularis* (Brady) Type B (specimen showing four opaque chambers with depressed sutures and short stout neck) Side View
Figure 9	*Astacolus crepidulus* (Fichtel and Moll); Side View
Figure 10	*Planularia Australia* Chapman; Side View
Figure 11	*Vaginulina* aff. *V. badenensis* d'Orbigny; Side View [Scale bar = 200μm]
Figure 12	*Vaginulina* cf. *V. hemitemna* Kristan-Tollmann; Side View [Scale bar = 200μm]
Figure 13	*Lagena caudata* (d'Orbigny); Side View
Figure 14	*Lagena doveyensis* Haynes; Side View
Figure 15	*Lagena elongata* (Ehrenberg); Side View
Figure 16	*Lagena favosiformis proba* McCulloch; Side View
Figure 17	*Lagena flatulenta* Loeblich and Tappan; Side View
Figure 18	*Lagena gibbera* Buchner; Side View
Figure 19	*Lagena* aff. *L. undulata* Sidebottom; Side View
Figure 20	*Lagena hispida* Reuss; Side View
Figure 21	*Lagena laevis* (Montagu); Side View
Figure 22	*Lagena multilatera* McCulloch; Side View
Figure 23	*Lagena* cf. *L. multilatera chathamensis* McCulloch; Side View
Figure 24	*Lagena* cf. *L. oceanica* Albani; Side View
Figure 25	*Lagena paradoxa* (Sidebottom); Side View
Figure 26	*Lagena spiratiformis* McCulloch; Side View
Figure 27	*Lagena striata* (d'Orbigny); Side View
Figure 28	*Lagena substriata elegantula* Jones; Side View
Figure 29	*Lagena sulcata* (Walker and Jacob); Side View
Figure 30	*Lagena alticostata* Cushman; Side View
Figure 31	*Lagena lyellii* (Seguenza); Side View
Figure 32	*Lagena pecularis* Cushman and McCulloch; Side View
Figure 33	*Procerolagena distoma* (Parker and Jones); Side View
Figure 34	*Procerolagena ingens* Buchner; Side View
Figure 35	*Procerolagena gracilis* (Williamson); Side View

PLATE 10

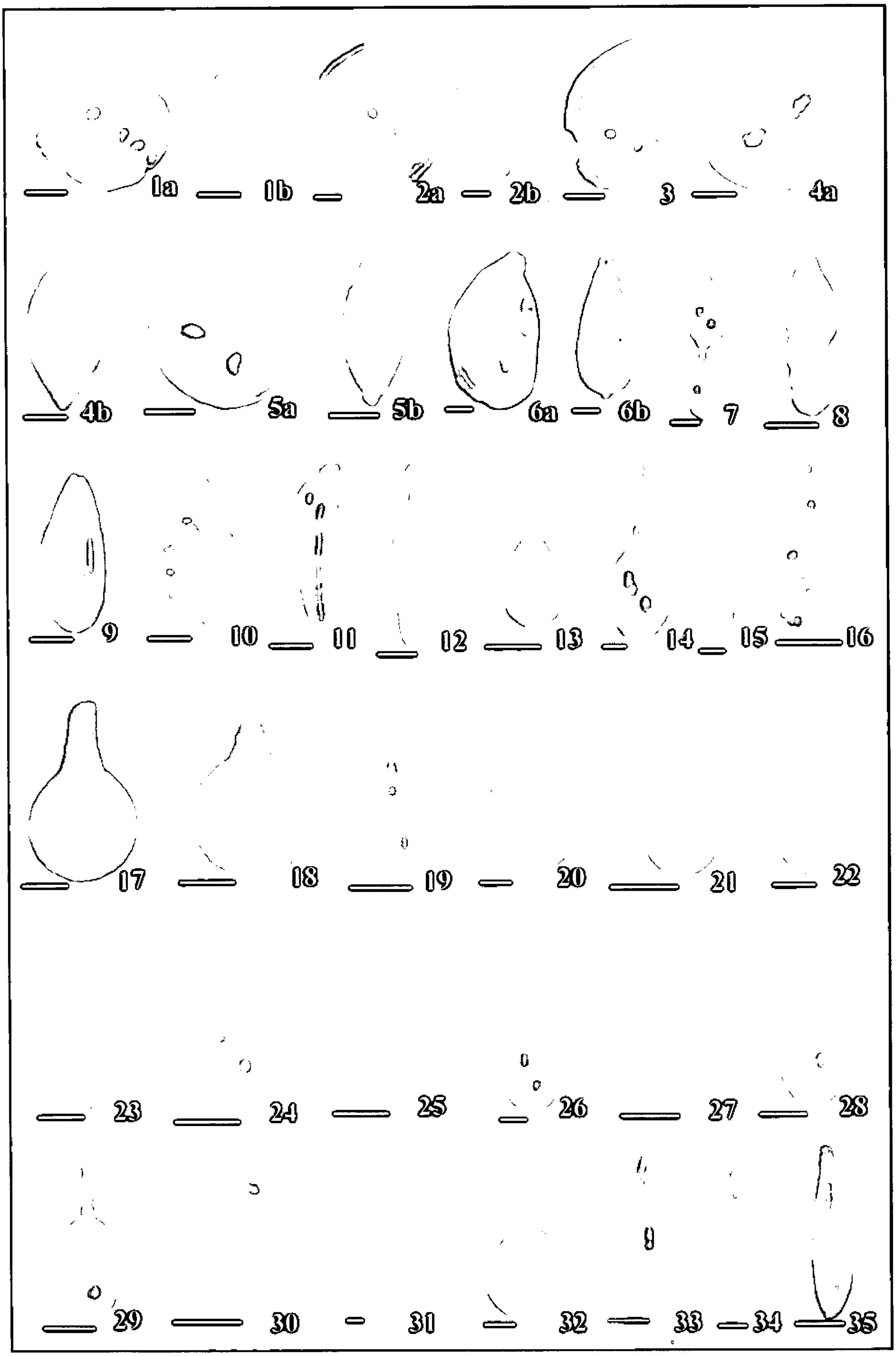

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Plate 11

Plate 11

(Scale bar equals 100 μm unless specified)

Figure 1	*Pygmaeoseistron hispidulum* (Cushman); Side View
Figure 2	*Pygmaeoseistron nebulosum* (Cushman); Side View
Figure 3	*Francuscia extensa* (Cushman); Side View
Figure 4	*Metapolymorphina* sp.; (a) Side View; (b) Opposite Side View
Figure 5	*Pyrulina gutta* (d'Orbigny); Side View
Figure 6	*Cushmanina plumigera* (Brady); Side View
Figure 7	*Heteromorphina* sp.; Side View
Figure 8	*Oolina apiopleura* (Loeblich and Tapan); Side View
Figure 9	*Oolina felsinea* (Fornasini); Side View
Figure 10	*Oolina globosa* (Montagu); Side View
Figure 11	*Oolina setosa* (Earland); Side View
Figure 12	*Oolina lineata* (Williamson); Side View
Figure 13	*Oolina truncata* (Brady); Side View
Figure 14	*Fissurina annectens* (Burrows and Holland); Front View
Figure 15	*Fissurina* aff. *F. duplicata* (Sidebottom); Front View
Figure 16	*Fissurina bradyiformata* (McCulloch); Front View
Figure 17	*Fissurina cucullata* Silvestri; Front View
Figure 18	*Fissurina earlandi* Parr; Front View
Figure 19	*Fissurina fissicarinata* Parr; (a) Front View; (b) Side View
Figure 20	*Fissurina imporcata* McCulloch; (a) Front View; (b) Side View
Figure 21	*Fissurina lagenoides* (Williamson); Front View
Figure 22	*Fissurina milletti* Todd; Front View
Figure 23	*Fissurina orbignyana* Seguenza; Front View
Figure 24	*Fissurina* aff. *F. pulchella* (Brady); Front View
Figure 25	*Fissurina seguenziana* (Fornasini); Front View
Figure 26	*Fissurina semimarginata* (Reuss); Front View
Figure 27	*Fissurina staphyllearia* Schwager; Front View
Figure 28	*Fissurina* aff. *F. striolata* (Sidebottom); Front View
Figure 29	*Fissurina submarginata* Boomgaart; Front View
Figure 30	*Fissurina wrightiana* (Brady); Front View
Figure 31	*Fissurina* sp.; Front View
Figure 32	*Parafissurina* aff. *P. arctica* Green; Front View
Figure 33	*Parafissurina fusiformis* (Wiesner); Front View

PLATE 11

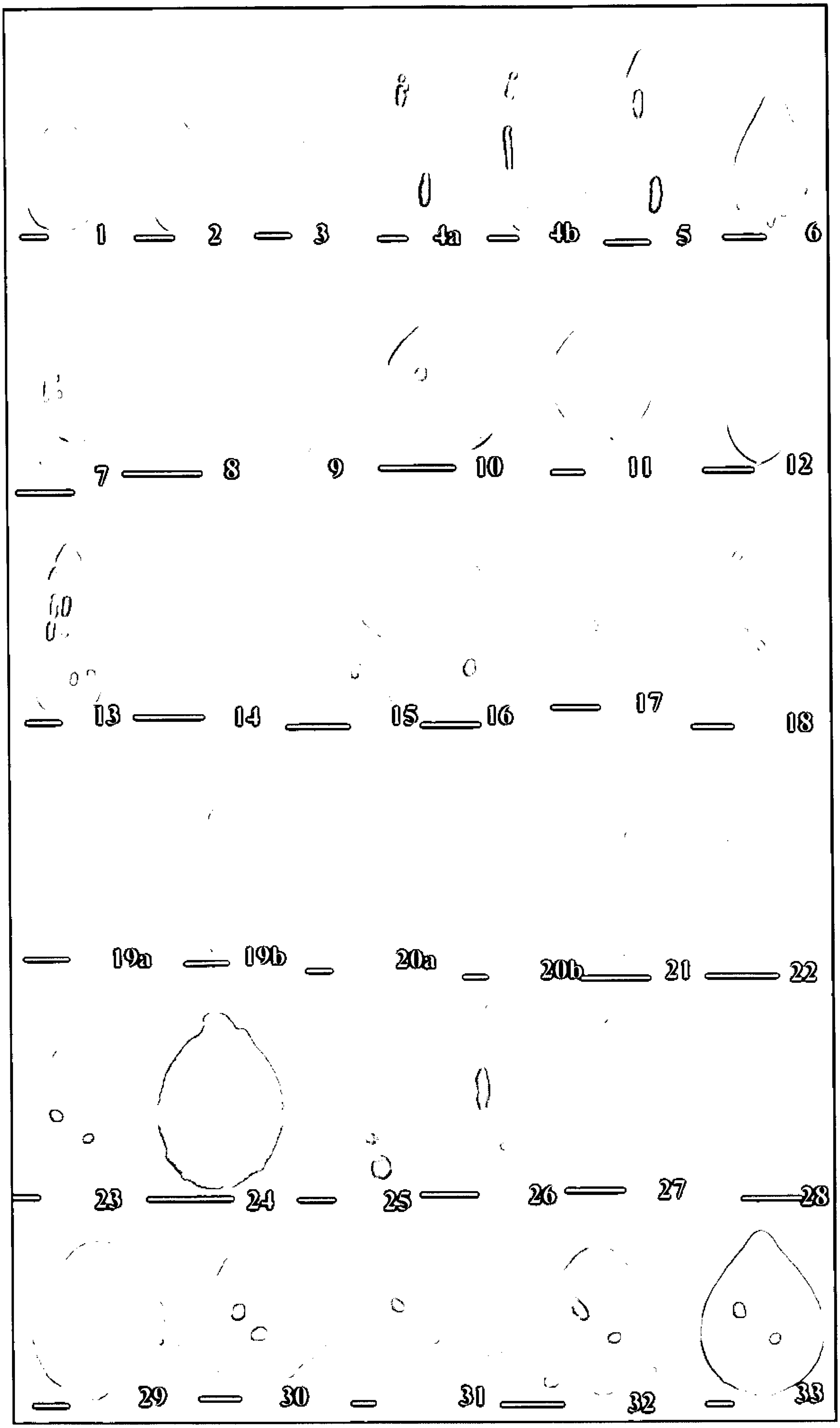

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Plate 12

Plate 12

(Scale bar equals 100 μm unless specified)

Figure 1	*Parafissurina himatiostoma* Loeblich and Tappan; Front View
Figure 2	*Parafissurina lateralis* (Cushman); Front View
Figure 3	*Parafissurina subcarinata* Parr; Front View
Figure 4	*Pseudofissurina* sp.; Front View
Figure 5	*Bifarilaminella advena* (Cushman); Side View
Figure 6	*Glandulina ovula* d'Orbigny; Side View
Figure 7	*Globulotuba* sp.; Side View
Figure 8	*Bombulina spinata* (Cushman); Side View
Figure 9	*Ceratobulimina jonesiana* (Brady); [Scale bar = 200μm]
	(a) Side View; (b) Apertural View
Figure 10	*Hoeglundina* cf. *H. elegans* (d'Orbigny); [Scale bar = 300μm]
	(a) Dorsal View; (b) Ventral View; (c) Apertural View
Figure 11	*Gallitellia vivans* (Cushman); Side View [Scale bar = 50μm]
Figure 12	*Globorotalia menardii* (d'Orbigny); [Scale bar = 200μm]
	(a) Dorsal View; (b) Ventral View; (c) Apertural View
Figure 13	*Neogloboquadrina dutertrei* (d'Orbigny);
	(a) Dorsal View; (b) Ventral View
Figure 14	*Neogloboquadrina pachyderma* (Ehrenberg);
	(a) Dorsal View; (b) Apertural/Ventral View
Figure 15	*Pulleniatina obliquiloculata* Parker and Jones;
	(a) Dorsal View; (b) Apertural/Ventral View
Figure 16	*Globigerinita glutinata* (Egger);
	(a) Dorsal View; (b) Apertural/Ventral View
Figure 17	*Globoquadrina conglomerata* (Schwager); [Scale bar = 200μm]
	(a) Dorsal View; (b) Apertural/Ventral View
Figure 18	*Neogloboquadrina hexagona* (Natland);
	(a) Dorsal View; (b) Apertural/Ventral View
Figure 19	*Globigerina bulloides* d'Orbigny;
	(a) Dorsal View; (b) Apertural/Ventral View
Figure 20	*Globigerina falconensis* Blow;
	(a) Dorsal View; (b) Apertural/Ventral View
Figure 21	*Globigerinella aequilateralis* (Brady); [Scale bar = 200μm]
	(a) Dorsal View; (b) Apertural/Ventral View

PLATE 12

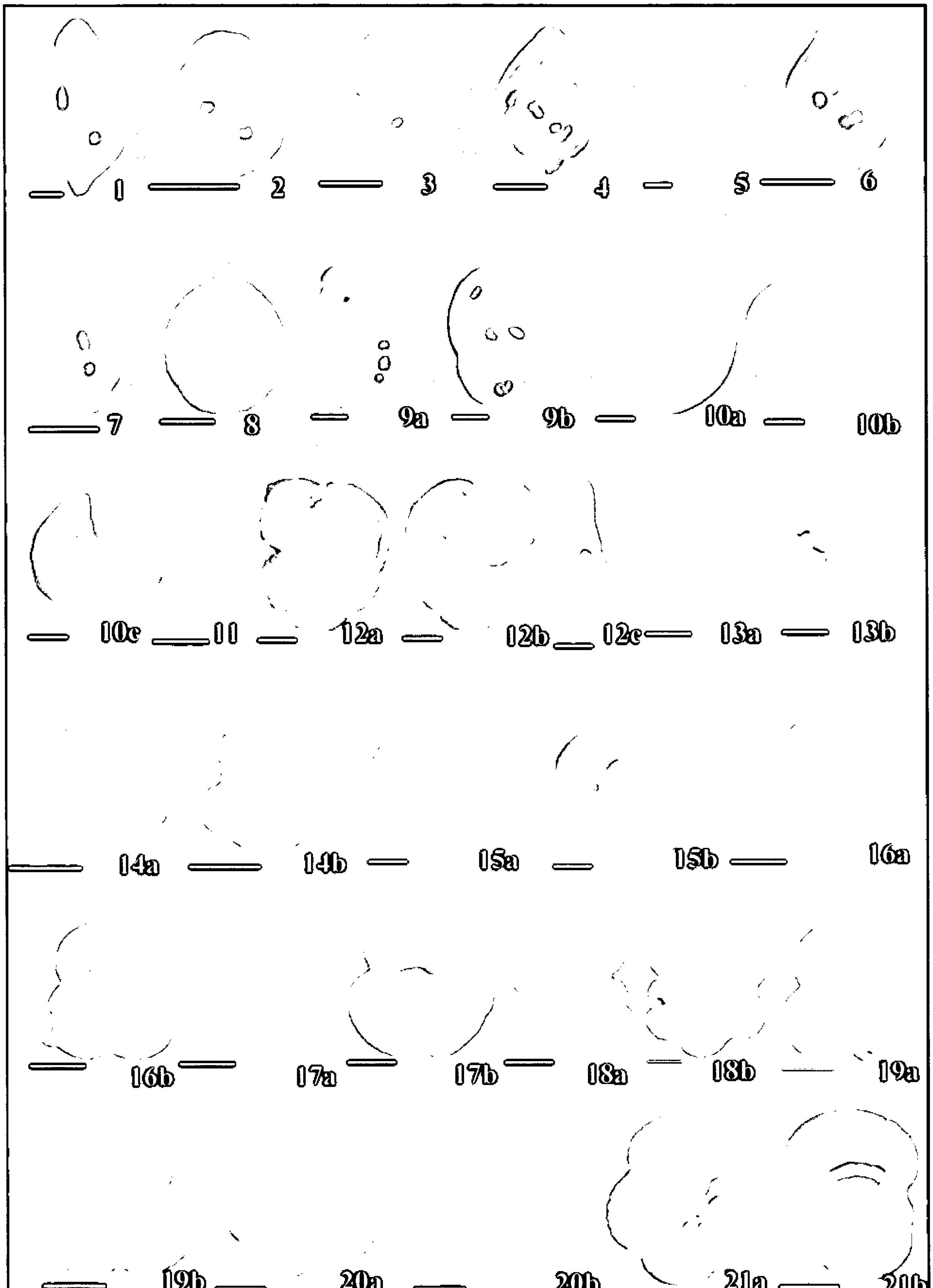

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Plate 13

(Scale bar equals 100 μm unless specified)

Figure 1	*Globigerinella calida* (Parker); (a) Dorsal View; (b) Ventral View; (c) Apertural View
Figure 2	*Beella digitata* (Brady); (a) Dorsal View; (b) Apertural/Ventral View
Figure 3	*Globigerinoides conglobatus* (Brady); (a) Dorsal View; (b) Apertural/Ventral View
Figure 4	*Globigerinoides rubber* (d'Orbigny); (a) Dorsal View; (b) Apertural/Ventral View
Figure 5	*Globigerinoides sacculifer* (Brady) (without sack); (a) Dorsal View; (b) Apertural/Ventral View
Figure 6	*Globigerinoides sacculifer* (Brady) (with sack); [Scale bar = 200μm] (a) Dorsal View; (b) Apertural/Ventral View
Figure 7	*Globoturborotalita rubescens* (Hofker); (a) Dorsal View; (b)Ventral/Apertural View
Figure 8	*Orbulina universa* d'Orbigny; Side View [Scale bar = 200μm]
Figure 9	*Bolivina dilatata* Reuss; Side View
Figure 10	*Bolivina doniezi* Cushman and Wickenden; Side View
Figure 11	*Bolivina* cf. *B. inflata* Heron-Allen and Earland; Side View
Figure 12	*Bolivina kuriani* Seibold; Side View
Figure 13	*Bolivina lowmani* Phleger and Parker; Side View
Figure 14	*Bolivina marginata* Cushman; Side View
Figure 15	*Bolivina* cf. *B. oceanica* Cushman; Side View
Figure 16	*Bolivina ordinaria* Phleger and Parker; Side View
Figure 17	*Bolivina* cf. *B. pacifica* Cushman and McCulloch; Side View
Figure 18	*Bolivina persiensis* Lutze; Side View
Figure 19	*Bolivina pseudoplicata* Herron-Allen and Earland; Side View
Figure 20	*Bolivina robusta* Brady; Side View
Figure 21	*Bolivina seminuda* Cushman; Side View
Figure 22	*Bolivina silvestrina* Cushman; Side View
Figure 23	*Bolivina spinata* Cushman; Side View
Figure 24	*Bolivina spinescens* Cushman; Side View
Figure 25	*Bolivina variabilis* (Williamson); Side View
Figure 26	*Bolivina* sp.; Side View
Figure 27	*Brizalina difformis* (Williamson); Side View
Figure 28	*Brizalina spathulata* (Williamson); Side View
Figure 29	*Brizalina striatula* (Cushman); Side View

PLATE 13

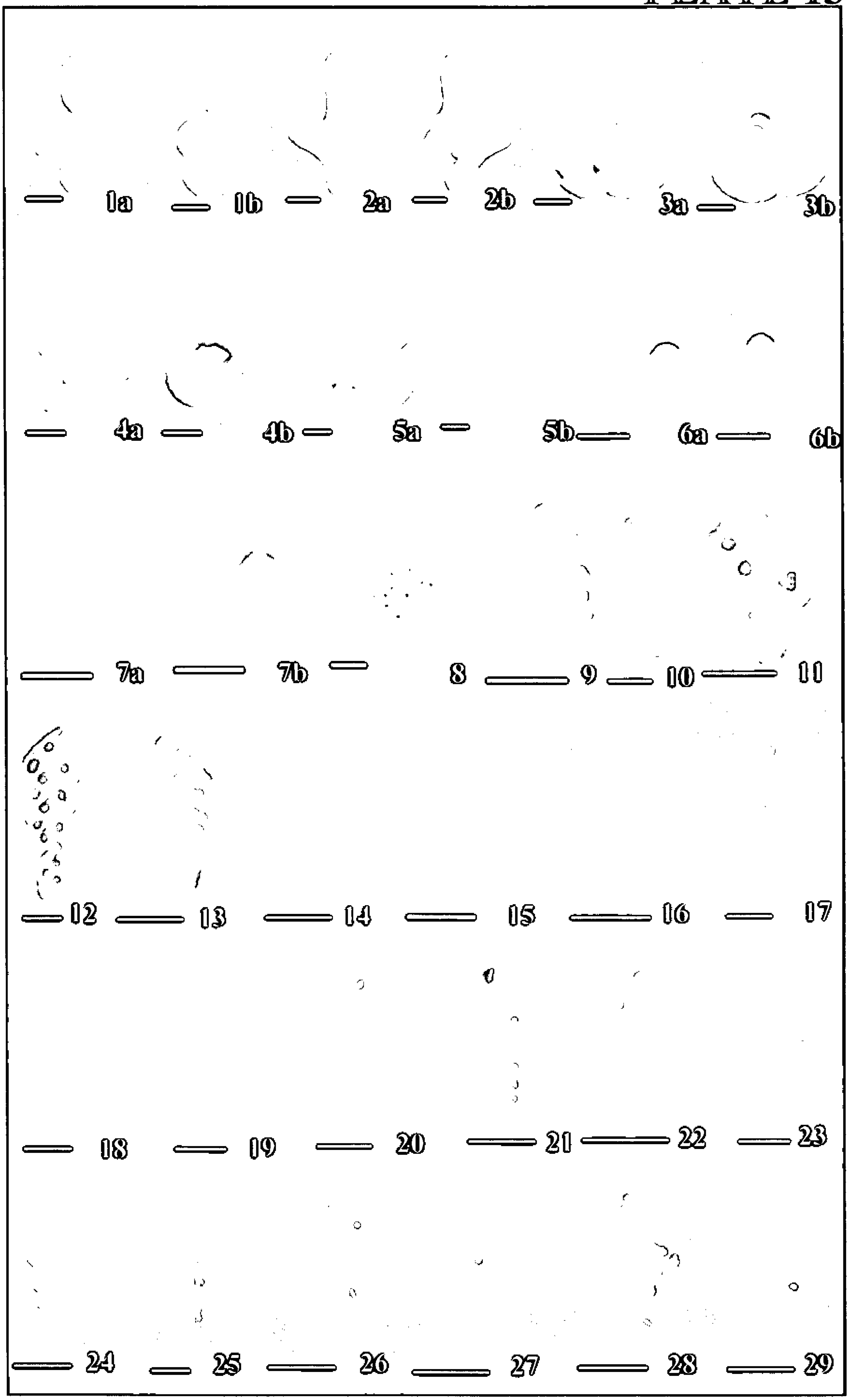

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Plate 14

Plate 14

(Scale bar equals 100 μm unless specified)

Figure 1	*Bolivinella elegans* Parr; Side View
Figure 2	*Bolivinita quadrilatera* (Schwager); Side View
Figure 3	*Cassidulina* aff. *C. algida* Cushman;
	(a) Dorsal View; (b) Ventral View; (c) Apertural View
Figure 4	*Cassidulina* cf. *C. crassa* d'Orbigny;
	(a) Dorsal View; (b) Ventral View; (c) Apertural View
Figure 5	*Cassidulina laevigata* d'Orbigny;
	(a) Dorsal View; (b) Ventral View; (c) Apertural View
Figure 6	*Cassidulina sicula* Seguenza;
	(a) Dorsal View; (b) Ventral View; (c) Apertural View
Figure 7	*Cassidulina subcarinata* Uchio;
	(a) Dorsal View; (b) Ventral View; (c) Apertural View
Figure 8	*Cassidulina teretis* Tappan;
	(a) Dorsal View; (b) Ventral View; (c) Apertural View
Figure 9	*Cassidulina tortuosa* Cushman and Hughes;
	(a) Dorsal View; (b) Ventral View; (c) Apertural View
Figure 10	*Cassidulinoides bradyi* (Norman); Side View
Figure 11	*Globocassidulina oriangulata* Belford;
	(a) Dorsal View; (b) Ventral/Apertural View
Figure 12	*Globocassidulina subglobosa* (Brady); [Scale bar = 50μm]
	(a) Dorsal View; (b) Ventral View; (c) Apertural View
Figure 13	*Islandiella* sp.;
	(a) Dorsal View; (b) Ventral View; (c) Apertural View
Figure 14	*Stainforthia concava* (Hoglund); Side View
Figure 15	*Hopkinsinella glabra* (Millett); Side View
Figure 16	*Loxostomina limbata* (Brady); Side View

PLATE 14

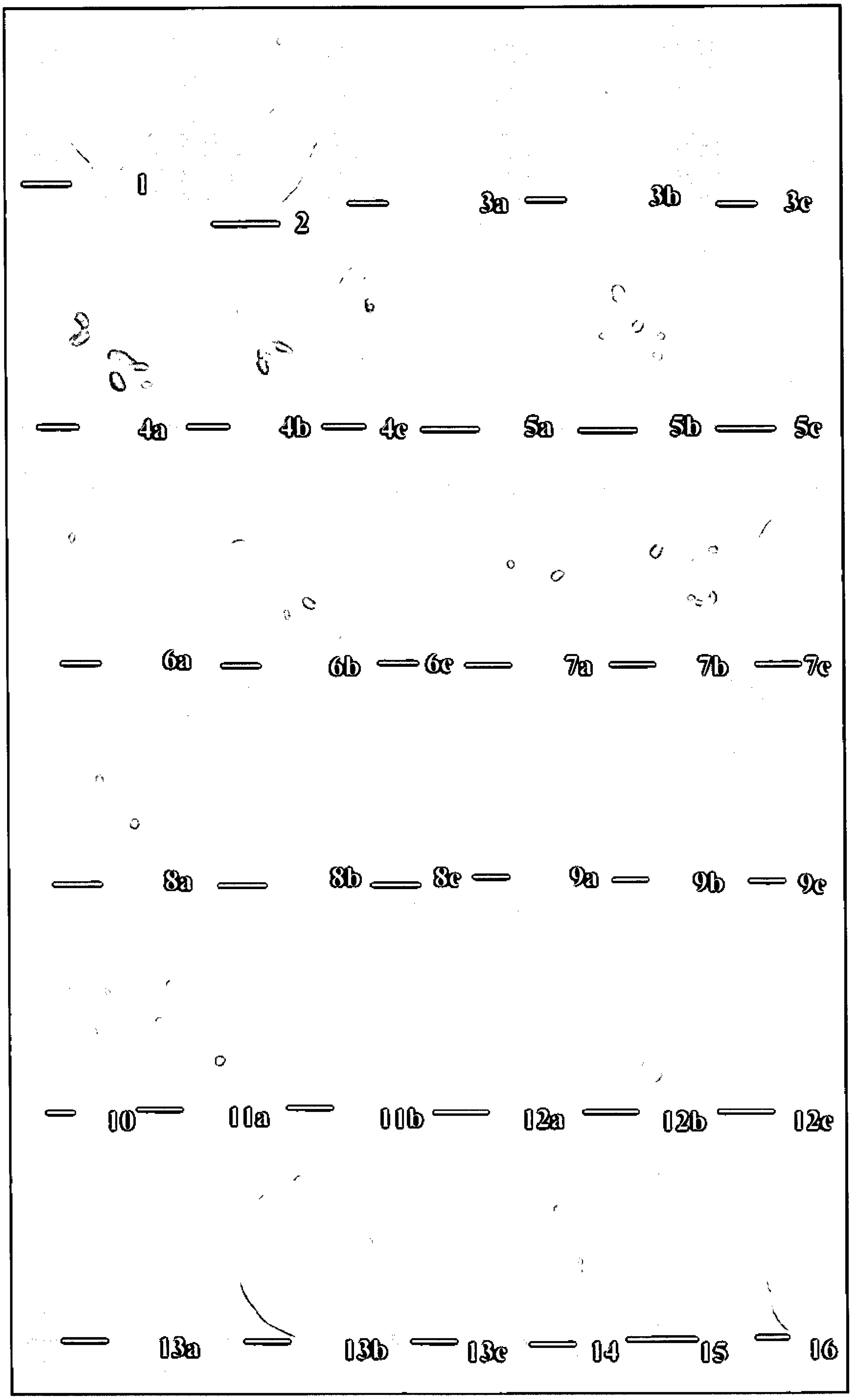

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Plate 15

(Scale bar equals 100 μm unless specified)

Figure 1	*Rectobolivina* sp.; Side View
Figure 2	*Sagrinella* cf. *S. guinai* Saidova; Side View [Scale bar = 50μm]
Figure 3	*Sagrinella convallaria* (Millett); Side View
Figure 4	*Bulimina aculeata* d'Orbigny; Side View [Scale bar = 300μm]
Figure 5	*Bulimina alazanensis* Cushman; Side View
Figure 6	*Bulimina biserialis* Millett; Side View
Figure 7	*Bulimina exilis* Brady; Side View [Scale bar = 50μm]
Figure 8	*Bulimina gibba* Fornasini; Side View
Figure 9	*Bulimina marginata* d'Orbigny; Side View
Figure 10	*Bulimina mexicana* (Cushman); Side View
Figure 11	*Globobulimina* cf. *G. pacifica* Cushman; Side View [Scale bar = 200μm]
Figure 12	*Praeglobobulimina ovata* (d'Orbigny); Side View [Scale bar = 300μm]
Figure 13	*Praeglobobulimina pupoides* (d'Orbigny); Side View [Scale bar = 300μm]
Figure 14	*Buliminella* cf. *B. milletti* Cushman; Side View [Scale bar = 50μm]
Figure 15	*Uvigerina aculeata* d'Orbigny; Side View
Figure 16	*Neouvigerina ampullacea* (Brady); Side View
Figure 17	*Neouvigerina interrupta* Brady; Side View
Figure 18	*Siphouvigerina porrecta* (Brady); Side View
Figure 19	*Uvigerina asperula* Cžjžek; Side View
Figure 20	*Uvigerina* cf. *U. auberiana* d'Orbigny; Side View
Figure 21	*Uvigerina bassensis* Parr; Side View
Figure 22	*Uvigerina bifurcata* d'Orbigny; Side View [Scale bar = 200μm]
Figure 23	*Uvigerina brunnensis* Karrer; Side View
Figure 24	*Uvigerina canariensis* d'Orbigny; Side View
Figure 25	*Uvigerina hollicki* Thalmann; Side View
Figure 26	*Uvigerina mediterranea* Hofker; Side View
Figure 27	*Uvigerina peregrina* Cushman; Side View
Figure 28	*Uvigerina proboscidea* Schwager; Side View [Scale bar = 200μm]
Figure 29	*Uvigerina vadescens* Cushman; Side View
Figure 30	*Uvigerina schwageri* Brady; Side View
Figure 31	*Uvigerina* sp. A; Side View
Figure 32	*Uvigerina* sp. B; Side View
Figure 33	*Trifarina carinata* (Cushman); Side View
Figure 34	*Trifarina* sp.; Side View
Figure 35	*Reussella laevigata* Cushman; Side View

PLATE 15

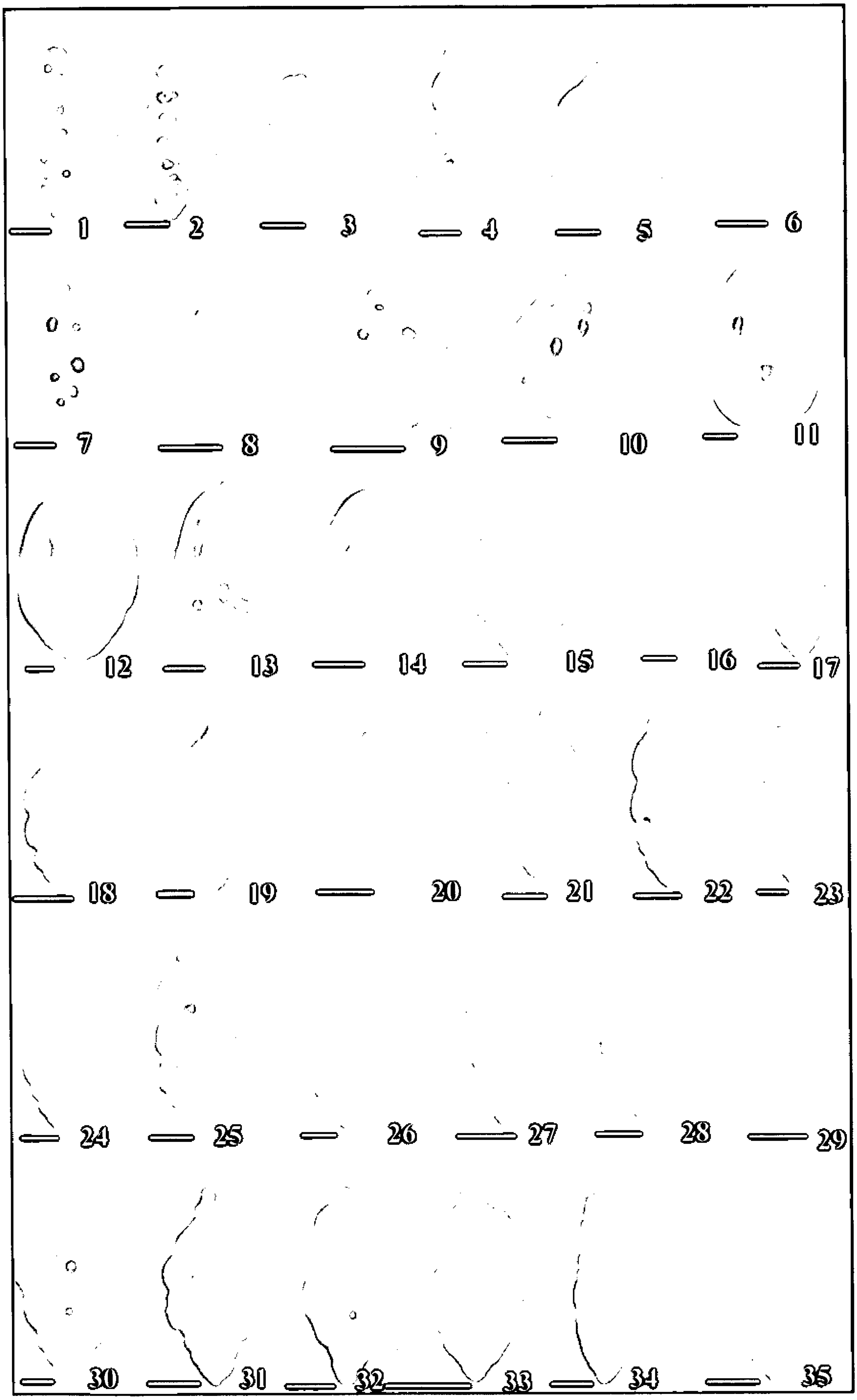
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Plate 16

(Scale bar equals 100 μm unless specified)

Figure 1	*Reussella spinulosa* (Reuss);
	(a) Front View; (b) Opposite Side View; (c) Apertural View
Figure 2	*Fursenkoina bradyi* (Cushman); Side View
Figure 3	*Fursenkoina complanata* (Egger); Side View
Figure 4	*Fursenkoina pontoni* (Cushman); Side View
Figure 5	*Fursenkoina* cf. *F. schreibersiana* (Cžjžek); Side View
Figure 6	*Fursenkoina texturata* (Brady); Side View
Figure 7	*Sigmavirgulina tortuosa* (Brady); Side View
Figure 8	*Virgulinella pertusa* (Reuss); Side View
Figure 9	*Pleurostomella* sp.; Side View [Scale bar = 200μm]
Figure 10	*Orthomorphina* aff. *O. parvula* (Todd); Side View
Figure 11	*Patellinella inconspicua* (Brady); [Scale bar = 200μm]
	(a) Side View; (b) Apertural View
Figure 12	*Patellinella* sp.;
	(a) Side View; (b) Top View; (c) Bottom/Apertural View
Figure 13	*Baggina indica* (Cushman);
	(a) Dorsal View; (b) Ventral View; (c) Apertural View
Figure 14	*Baggina philippiensis* (Cushman);
	(a) Dorsal View; (b) Ventral View; (c) Apertural View
Figure 15	*Cancris auriculus* (Fichtel and Moll);
	(a) Dorsal View; (b) Ventral View; (c) Apertural View
Figure 16	*Cancris oblonga* (Williamson);
	(a) Dorsal View; (b) Ventral View; (c) Apertural View
Figure 17	*Cancris sagra* (d'Orbigny);
	(a) Dorsal View; (b) Ventral View; (c) Apertural View
Figure 18	*Cancris* sp.;
	(a) Dorsal View; (b) Ventral View; (c) Apertural View

PLATE 16

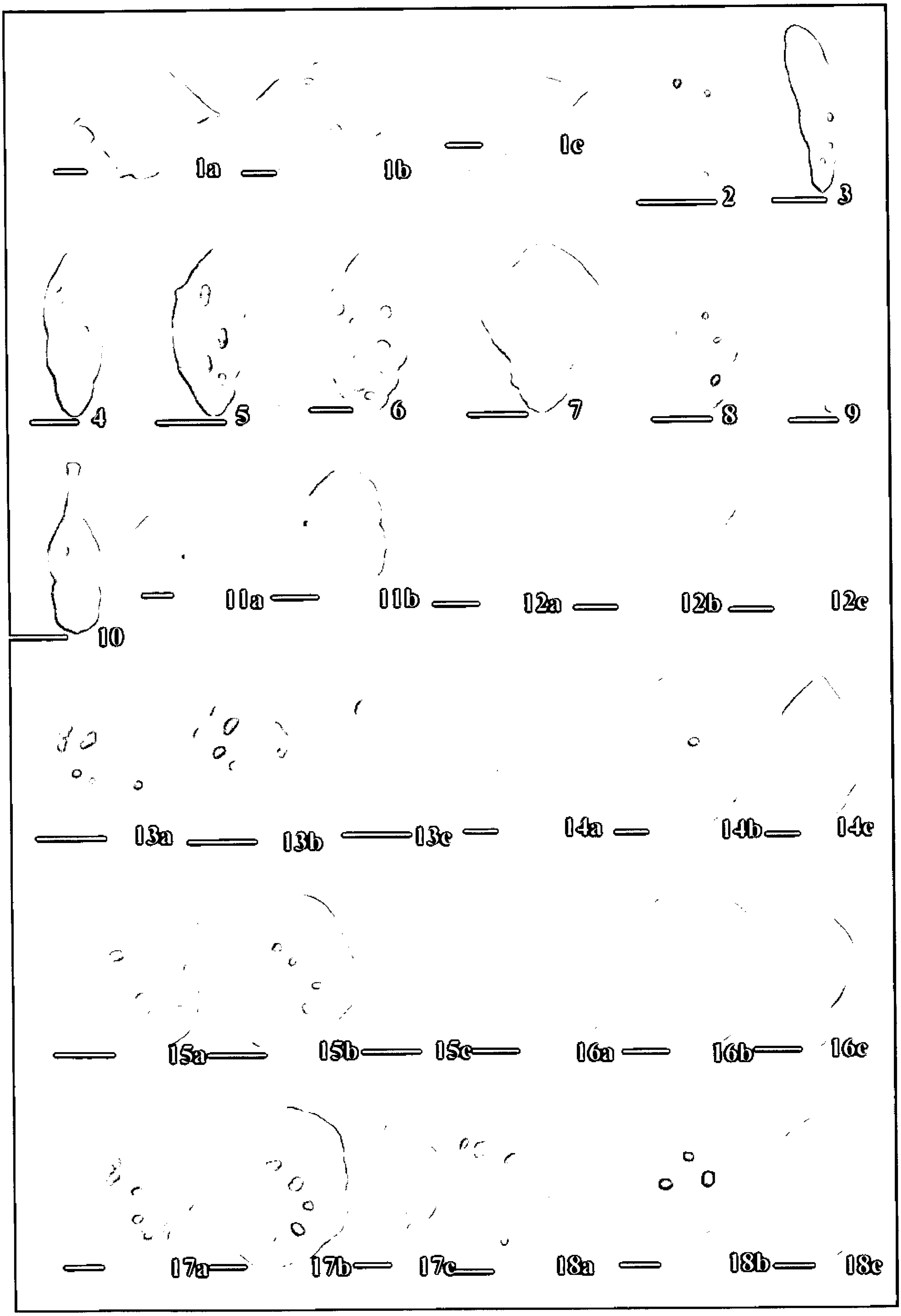

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Plate 17

Plate 17

(Scale bar equals 100 μm unless specified)

Figure 1	*Eponides repandus* (Fichtel and Moll);
	(a) Dorsal View; (b) Ventral View; (c) Apertural View
Figure 2	*Eponides* sp.; [Scale bar = 50μm]
	(a) Dorsal View; (b) Ventral View; (c) Apertural View
Figure 3	*Neoeponides praecinctus* (Karrer);
	(a) Dorsal View; (b) Ventral View; (c) Apertural View
Figure 4	*Neoconorbina parkerae* (Natland);
	(a) Dorsal View; (b) Ventral View; (c) Apertural View
Figure 5	*Neoconorbina terquemi* (Rzehak);
	(a) Dorsal View; (b) Ventral View; (c) Apertural View
Figure 6	*Rosalina globularis* d'Orbigny;
	(a) Dorsal View; (b) Ventral View; (c) Apertural View
Figure 7	*Rosalina* sp.;
	(a) Dorsal View; (b) Ventral View; (c) Apertural View
Figure 8	*Murrayinella* cf. *M. murrayi* (Heron-Allen and Earland);
	(a) Dorsal View; (b) Ventral View; (c) Apertural View
Figure 9	*Cibicidoides bradii* (Tolmachoff);
	(a) Dorsal View; (b) Ventral View; (c) Apertural View
Figure 10	*Cibicidoides cicatricosus* (Schwager);
	(a) Dorsal View; (b) Ventral View; (c) Apertural View
Figure 11	*Cibicidoides globulosus* (Chapman and Parr);
	(a) Dorsal View; (b) Ventral View; (c) Apertural View

PLATE 17

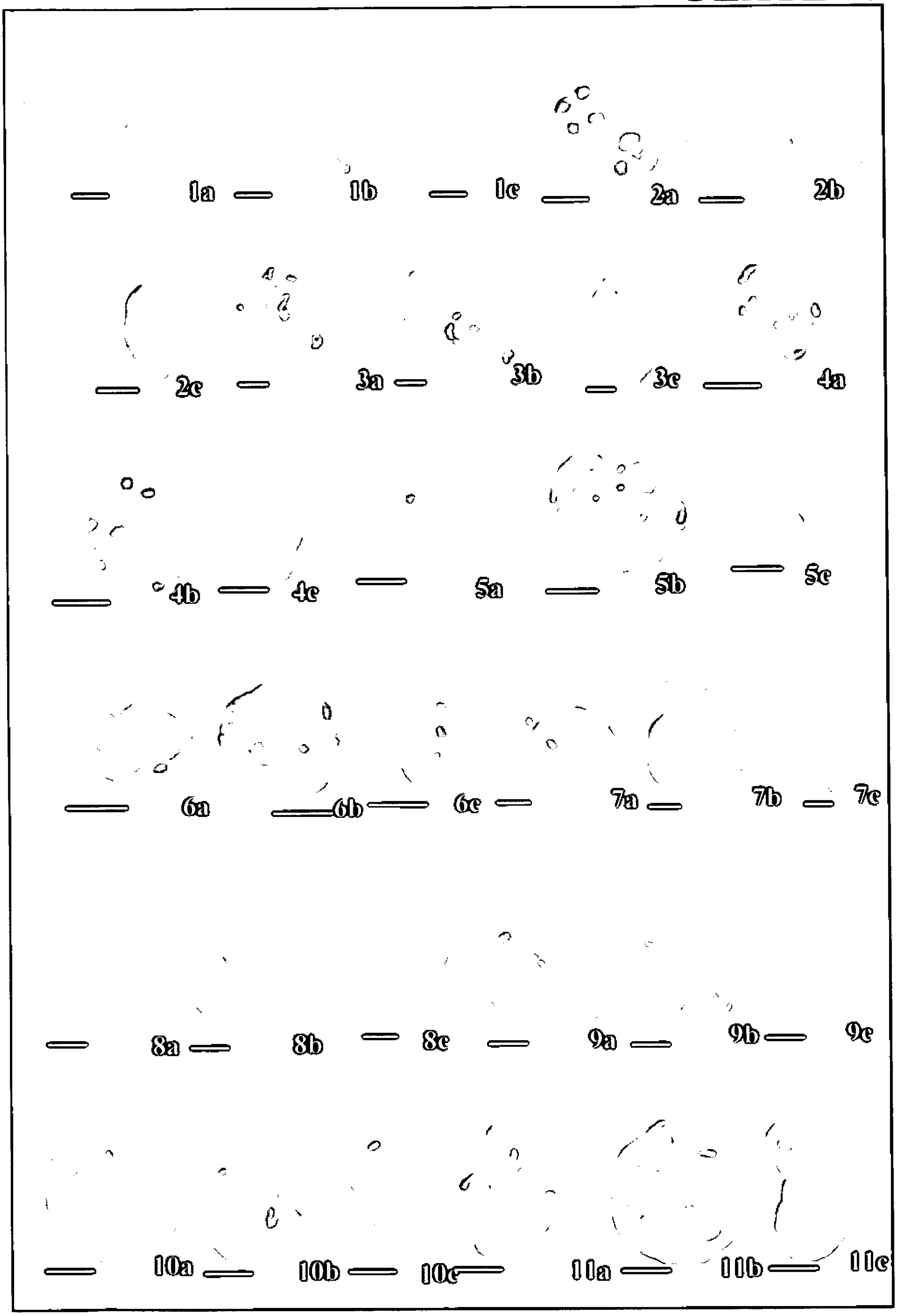
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Plate 18

(Scale bar equals 100 μm unless specified)

Figure 1	*Cibicidoides* cf. *C. kullenbergi* (Parker);
	(a) Dorsal View; (b) Ventral View; (c) Apertural View
Figure 2	*Cibicides lucida* (Reuss); [Scale bar = 200μm]
	(a) Dorsal View; (b) Ventral View; (c) Apertural View
Figure 3	*Cibicidoides wuellerstorfi* (Schwager); [Scale bar = 200μm]
	(a) Dorsal View; (b) Ventral View; (c) Apertural View
Figure 4	*Epistominella decorata* (Phleger and Parker);
	(a) Dorsal View; (b) Ventral View; (c) Apertural View
Figure 5	*Epistominella exigua* (Brady);
	(a) Dorsal View; (b) Ventral View; (c) Apertural View
Figure 6	*Epistominella minuta* (Olsson);
	(a) Dorsal View; (b) Ventral View; (c) Apertural View
Figure 7	*Planulinoides* sp.;
	(a) Dorsal View; (b) Ventral View; (c) Apertural View
Figure 8	*Laticarinina pauperata* (Parker and Jones) [Scale bar = 300μm]
	Type A (specimen showing smooth periphery, bulging chambers, opaque and large test);
	(a) Side View; (b) Opposite View
Figure 9	*Laticarinina pauperata* (Parker and Jones) [Scale bar = 200μm]
	Type B (specimen showing smooth periphery, less bulging chambers, semitransparent and more elongated test);
	(a) Side View; (b) Opposite View
Figure 10	*Laticarinina pauperata* (Parker and Jones) [Scale bar = 300μm]
	Type C (specimen showing smooth periphery, less bulging chambers, transparent and more elongated test);
	(a) Side View; (b) Opposite View
Figure 11	*Laticarinina pauperata* (Parker and Jones) [Scale bar = 300μm]
	Type D (specimen showing rough periphery, irregularly bulging chambers and opaque test);
	(a) Side View; (b) Opposite View
Figure 12	*Hyalinea balthica* (Schroter);
	(a) Dorsal View; (b) Ventral View; (c) Apertural View
Figure 13	*Cibicides* cf. *C. fletcheri* Cushman and McCulloch;
	(a) Dorsal View; (b) Ventral View; (c) Apertural View

PLATE 18

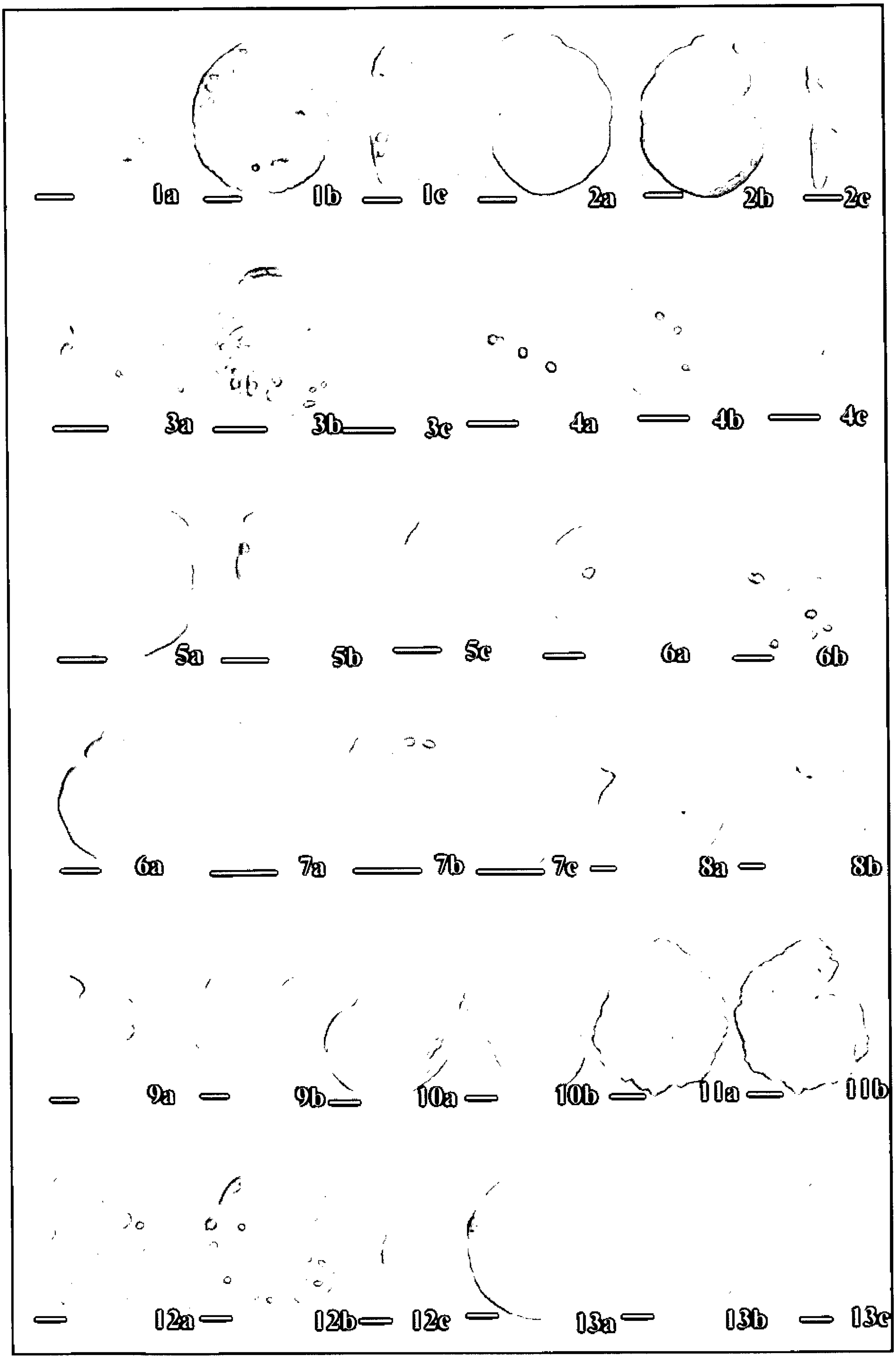

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Plate 19

Plate 19

(Scale bar equals 100 µm unless specified)

Figure 1	*Cibicides* cf. *C. labatulus* (Walker and Jacob); (a) Dorsal View; (b) Ventral View; (c) Apertural View
Figure 2	*Cibicides pachyderma* (Rzchak); (a) Dorsal View; (b) Ventral View; (c) Apertural View
Figure 3	*Cibicides refulgens* Montfort; (a) Dorsal View; (b) Ventral View; (c) Apertural View
Figure 4	*Cibicidina walli* Bandy; (a) Dorsal View; (b) Ventral View; (c) Apertural View
Figure 5	*Cibicides* sp. A; (a) Dorsal View; (b) Ventral View; (c) Apertural View
Figure 6	*Cibicides* sp. B; (a) Dorsal View; (b) Ventral View; (c) Apertural View
Figure 7	*Planorbulina mediteranensis* d'Orbigny; Side View [Scale bar = 200µm]
Figure 8	*Pseudoeponides pauciloculata* (Phleger and Parker); (a) Dorsal View; (b) Ventral View; (c) Apertural View
Figure 9	*Asterigerinata* sp.; [Scale bar = 50µm] (a) Dorsal View; (b) Ventral/Apertural View
Figure 10	*Amphistegina lessonii* d'Orbigny; (a) Side View; (b) Apertural View
Figure 11	*Amphistegina radiata* (Fichtel and Moll); (a) Side View; (b) Apertural View
Figure 12	*Nonion* cf. *N. asterizans* (Fichtel and Moll); (a) Side View; (b) Apertural View
Figure 13	*Nonion* aff. *N. depressulum* (Walker and Jacob); (a) Side View; (b) Apertural View
Figure 14	*Nonion incisum* (Cushman); (a) Side View; (b) Apertural View

PLATE 19

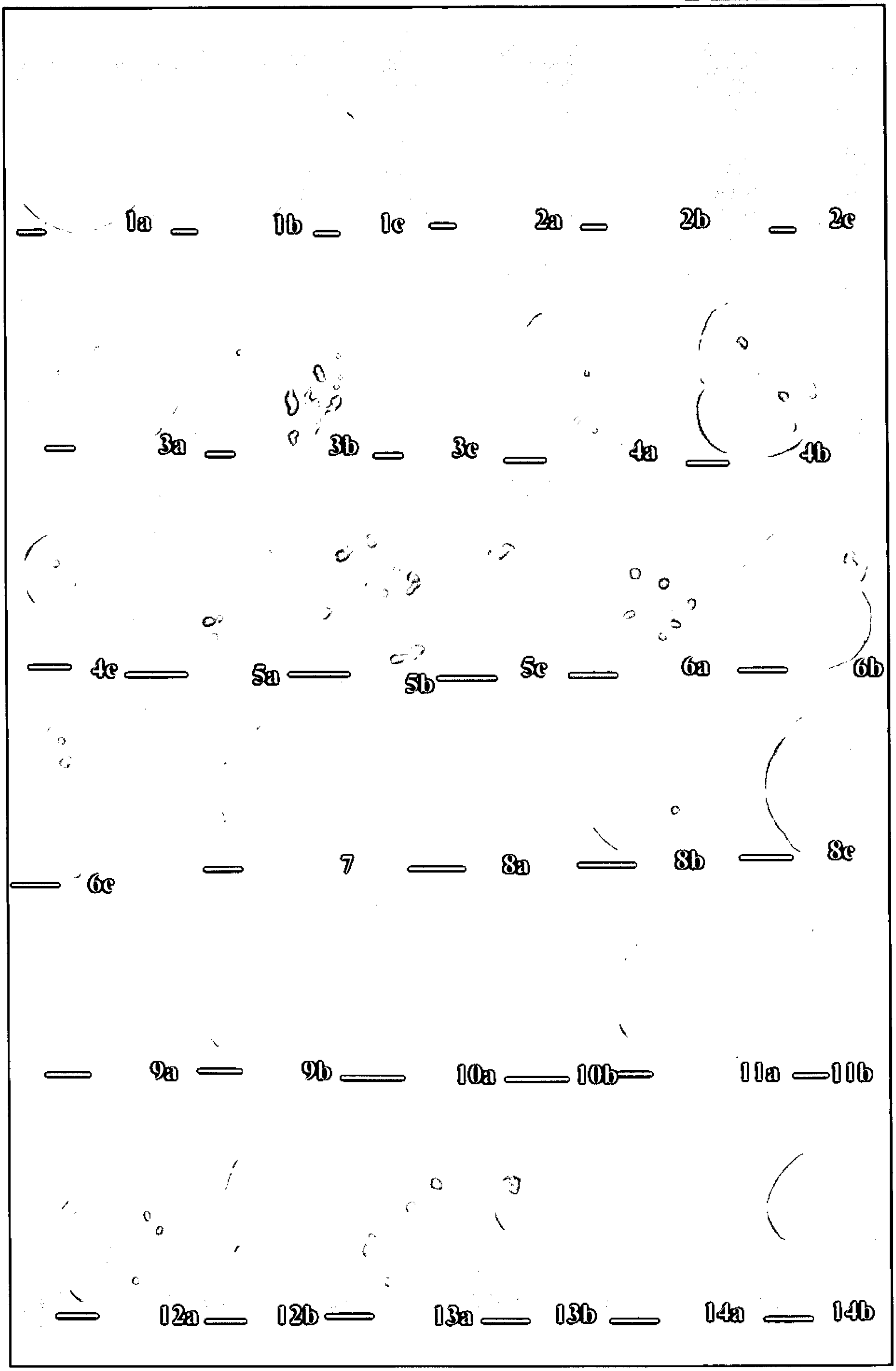

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Plate 20

(Scale bar equals 100 μm unless specified)

Figure 1	*Nonion pacificum* (Cushman);
	(a) Side View; (b) Apertural View
Figure 2	*Nonion scaphum* (Fichtel and Moll);
	(a) Side View; (b) Apertural View
Figure 3	*Nonion sloanii* (d'Orbigny);
	(a) Side View; (b) Apertural View
Figure 4	*Nonionella auricula* Heron-Allen and Earland;
	(a) Side View; (b) Apertural View
Figure 5	*Nonionella auris* (d'Orbigny);
	(a) Side View; (b) Apertural View
Figure 6	*Nonionella basispinata* (Cushman and Moyer);
	(a) Side View; (b) Apertural View
Figure 7	*Nonionella* cf. *N. japonica* (Asano);
	(a) Side View; (b) Apertural View
Figure 8	*Nonionella* cf. *N. limbato-striata* Cushman;
	(a) Side View; (b) Apertural View
Figure 9	*Nonionella hantkeni* (Cushman and Applin);
	(a) Side View; (b) Apertural View
Figure 10	*Nonionella opima* Cushman;
	(a) Side View; (b) Apertural View
Figure 11	*Nonionella turgida* (Williamson);
	(a) Side View; (b) Apertural View
Figure 12	*Nonionoides boueanum* (d'Orbigny);
	(a) Side View; (b) Apertural View
Figure 13	*Nonionoides elongatum* (d'Orbigny);
	(a) Side View; (b) Apertural View
Figure 14	*Nonionoides grateloupi* (d'Orbigny);
	(a) Side View; (b) Apertural View
Figure 15	*Melonis barleeanum* (Williamson);
	(a) Side View; (b) Apertural View
Figure 16	*Melonis pompilioides* (Fichtel and Moll);
	(a) Side View; (b) Apertural View
Figure 17	*Melonis soldani* (d'Orbigny);
	(a) Side View; (b) Apertural View
Figure 18	*Pullenia bulloides* (d'Orbigny); [Scale bar = 50μm]
	(a) Side View; (b) Apertural View

PLATE 20

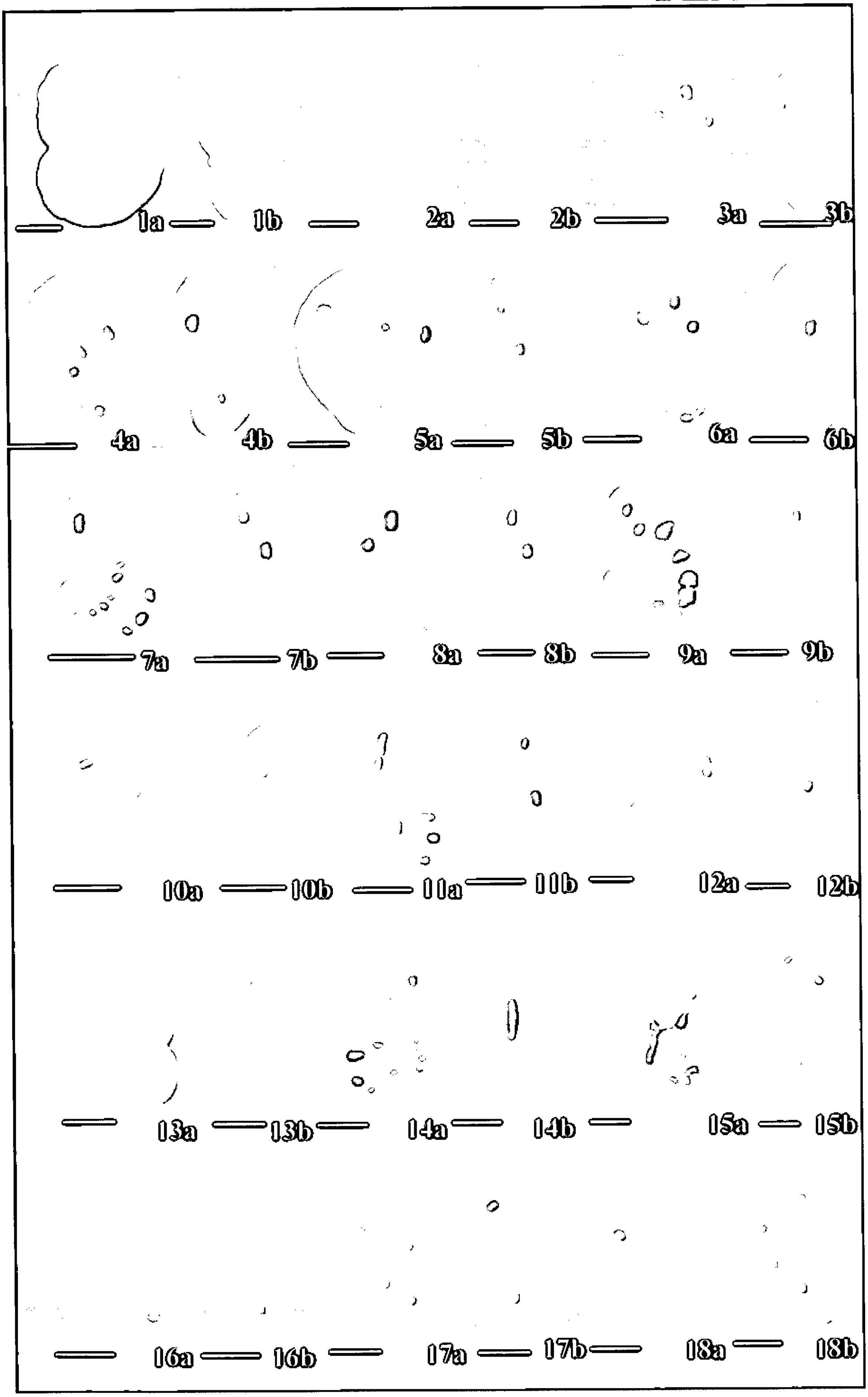
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Plate 21

Plate 21

(Scale bar equals 100 μm unless specified)

Figure 1	*Pullenia quinqueloba* (Reuss); (a) Side View; (b) Apertural View
Figure 2	*Chilostomella oolina* Schwager; Side View
Figure 3	*Osangularia bengalensis* (Schwager); (a) Dorsal View; (b) Ventral View; (c) Apertural View
Figure 4	*Oridorsalis* sp.; [Scale bar = 200μm] (a) Dorsal View; (b) Ventral View; (c) Apertural View
Figure 5	*Heterolepa subhaidingerii* (Parr); [Scale bar = 200μm] (a) Dorsal View; (b) Ventral View; (c) Apertural View
Figure 6	*Gyroidinoides orbicularis* d'Orbigny; (a) Dorsal View; (b) Ventral View; (c) Apertural View
Figure 7	*Gyroidinoides soldanii* (d'Orbigny); (a) Dorsal View; (b) Ventral View; (c) Apertural View
Figure 8	*Gyroidina bradyi* (Trauth); (a) Dorsal View; (b) Ventral View; (c) Apertural View
Figure 9	*Gyroidina* cf. *G. pulisukensis* (Saidova); (a) Dorsal View; (b) Ventral View; (c) Apertural View
Figure 10	*Gyroidina* sp. A; (a) Dorsal View; (b) Ventral View; (c) Apertural View
Figure 11	*Gyroidina* sp. B; (a) Dorsal View; (b) Ventral View; (c) Apertural View
Figure 12	*Pararotalia* cf. *P. calcar* (d'Orbigny); (a) Dorsal View; (b) Ventral View; (c) Apertural View

PLATE 21

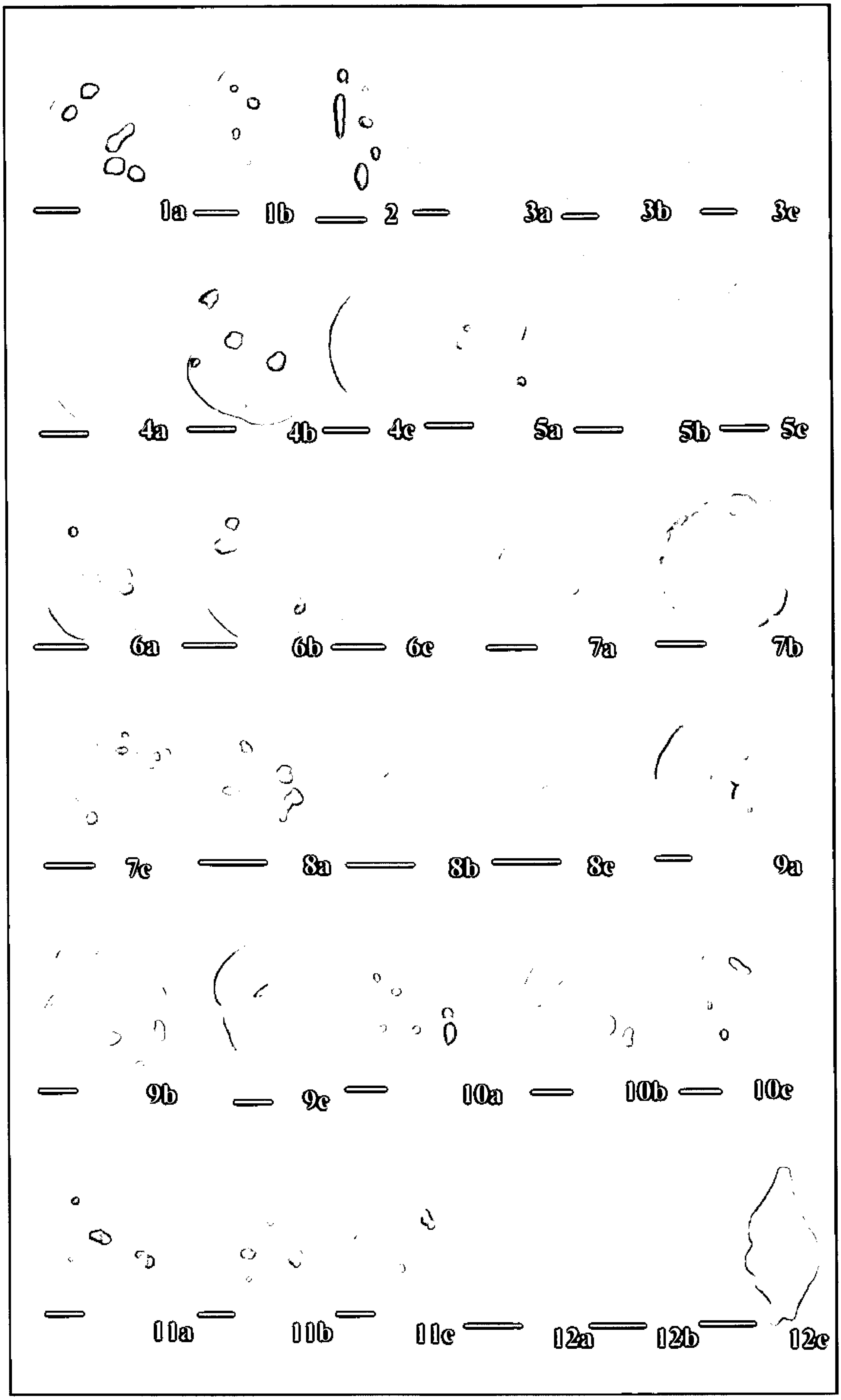

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Plate 22

Plate 22

(Scale bar equals 100 μm unless specified)

Figure 1	*Ammonia* aff. *A. globosa* (Millett); (a) Dorsal View; (b) Ventral View; (c) Apertural View
Figure 2	*Ammonia ketienziensis angulata* (Kuwano); (a) Dorsal View; (b) Ventral View; (c) Apertural View
Figure 3	*Ammonia sobrina* (Shupack); [Scale bar = 50μm] (a) Dorsal View; (b) Ventral View; (c) Apertural View
Figure 4	*Ammonia tepida* (Cushman); [Scale bar = 50μm] (a) Dorsal View; (b) Ventral View; (c) Apertural View
Figure 5	*Asterorotalia dentata* (Parker and Jones); [Scale bar = 200μm] (a) Dorsal View; (b) Ventral View; (c) Apertural View
Figure 6	*Asterorotalia inflata* (Millett); (a) Dorsal View; (b) Ventral View; (c) Apertural View
Figure 7	*Rotalidium annectens* (Parker and Jones) (Megalospheric Form); (a) Dorsal View; (b) Ventral View; (c) Apertural View
Figure 8	*Rotalidium annectens* (Parker and Jones) [Scale bar = 200μm] (Microspheric Form); (a) Dorsal View; (b) Ventral View; (c) Apertural View
Figure 9	*Rotalinoides papillosus* (Brady); [Scale bar = 200μm] (a) Dorsal View; (b) Ventral View; (c) Apertural View
Figure 10	*Cribrononion simplex* (Cushman); (a) Side View; (b) Apertural View

PLATE 22

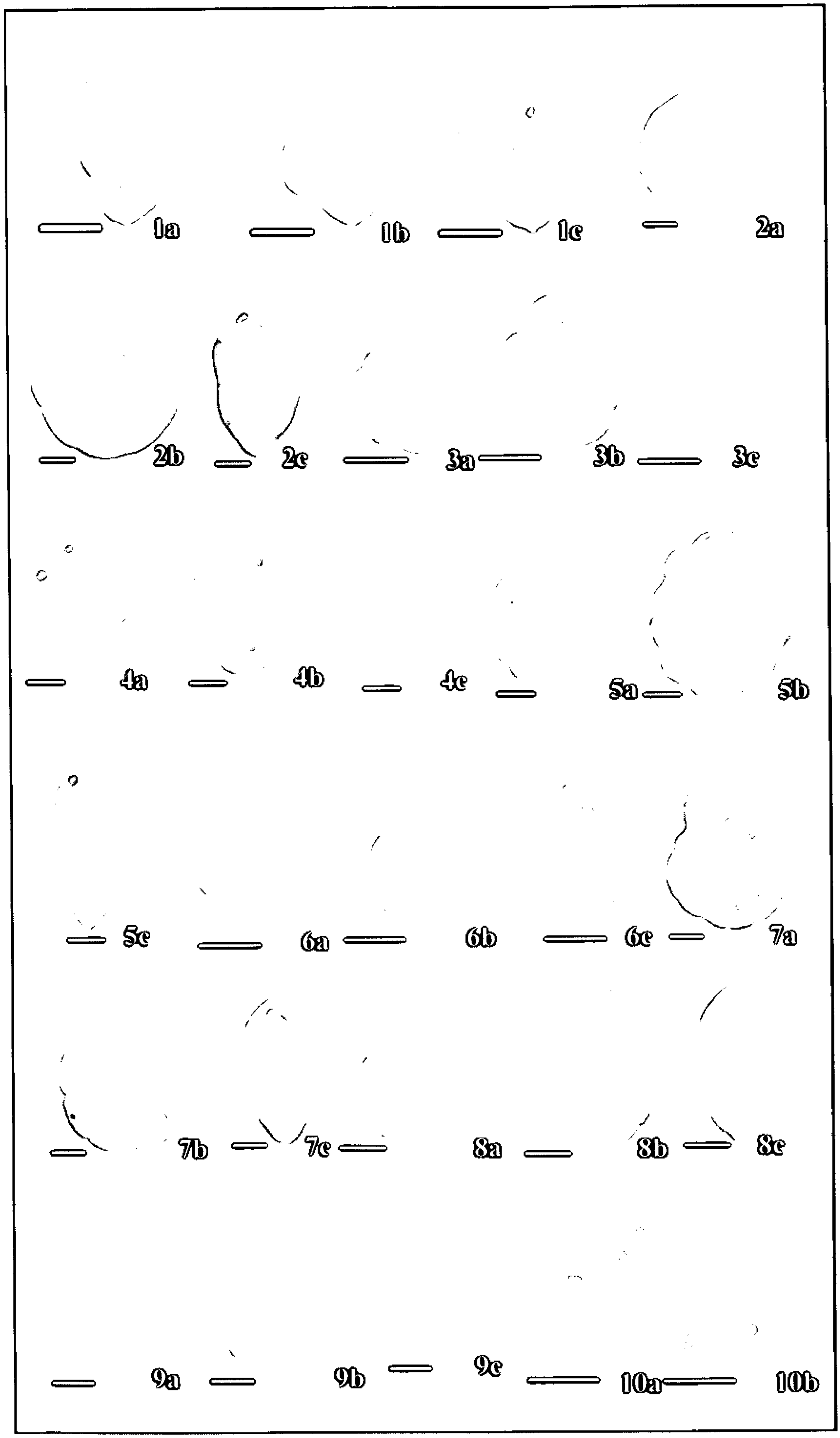
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Plate 23

Plate 23

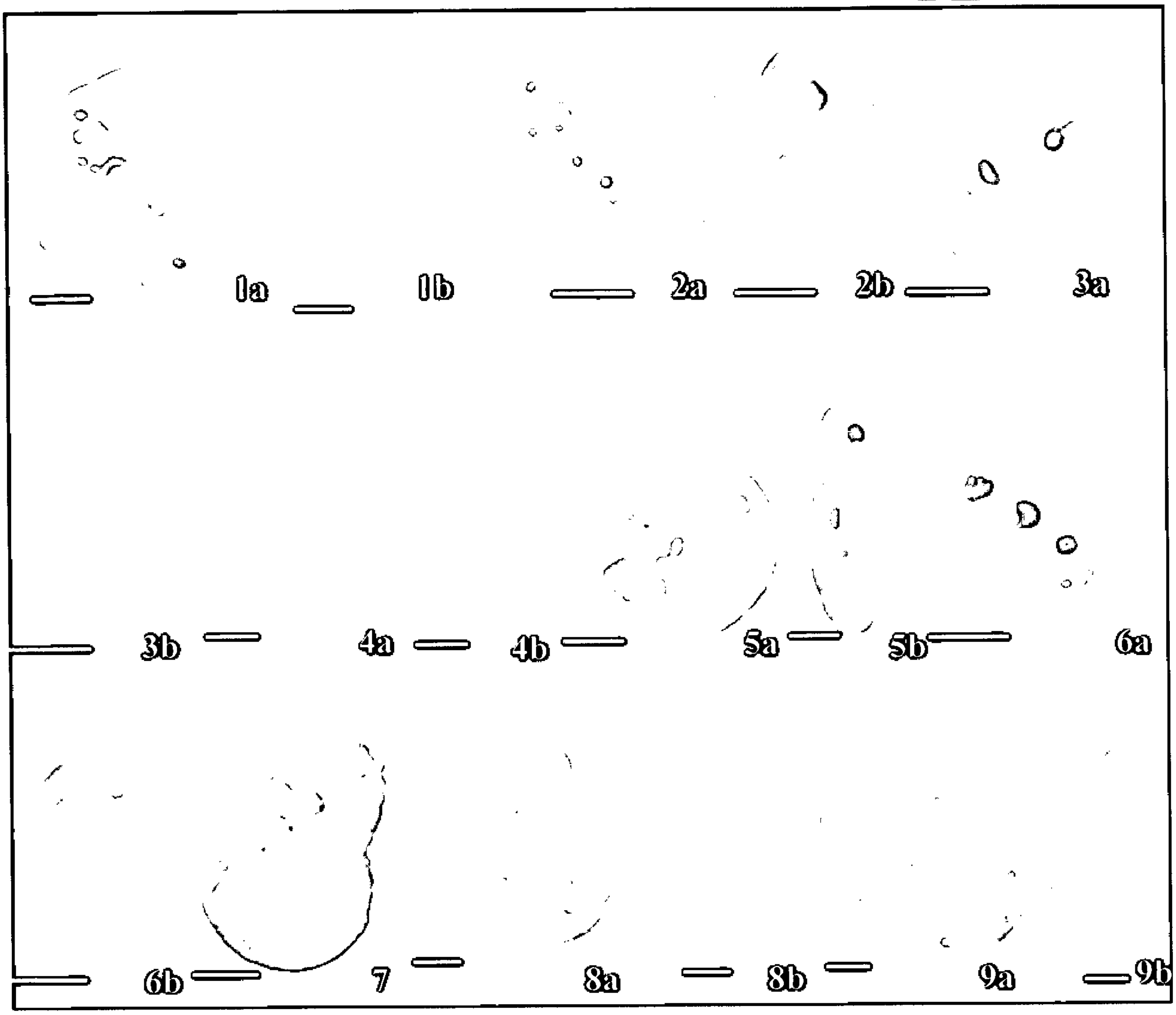
(Scale bar equals 100 µm unless specified)

Figure 1	*Elphidium advenum* (Cushman);
	(a) Side View; (b) Apertural View
Figure 2	*Elphidium crispum* (Linne); [Scale bar = 200µm]
	(a) Side View; (b) Apertural View
Figure 3	*Elphidium discoidale* (d'Orbigny);
	(a) Side View; (b) Apertural View
Figure 4	*Elphidium macellum* (Fichtel and Moll);
	(a) Side View; (b) Apertural View
Figure 5	*Elphidium minutum* (Reuss);
	(a) Side View; (b) Apertural View
Figure 6	*Elphidium reticulosum* Cushman;
	(a) Side View; (b) Apertural View
Figure 7	*Heterostegina* sp.; Side View [Scale bar = 200µm]
Figure 8	*Operculina complanata* (Defrance);
	(a) Side View; (b) Apertural View
Figure 9	*Operculina granulosa* Leymerie;
	(a) Side View; (b) Apertural View

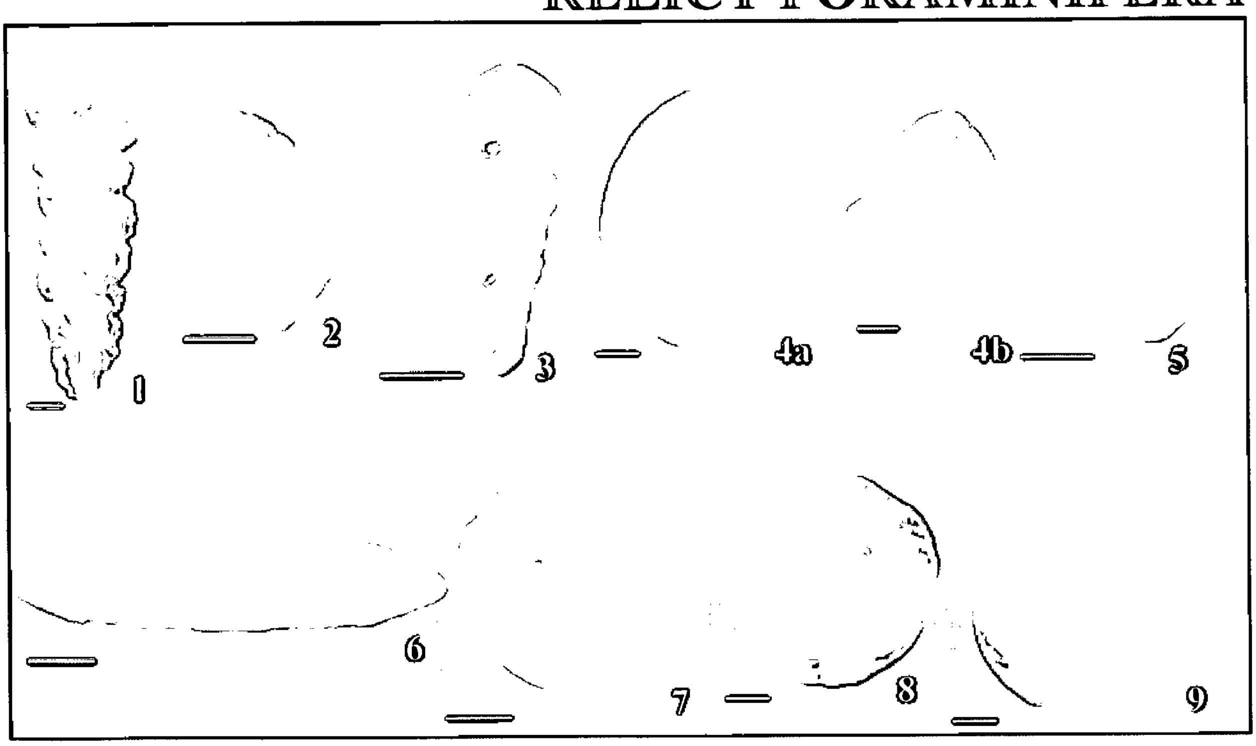
Relict Foraminifera

Figure 1	*Textularia agglutinans*; [Scale bar = 300µm]
Figure 2	*Sahulia conica*
Figure 3	*Spiroplectinella sagittula*
Figure 4	*Quinqueloculina vulgaris*; (a) Side View; (b) Apertural View
Figure 5	*Triloculina tricarinata*; [Scale bar = 300µm]
Figure 6	*Alveolinella quoyi*; [Scale bar = 300µm]
Figure 7	*Amphistegina lessonii*; [Scale bar = 300µm]
Figure 8	*Elphidium craticulatum*; [Scale bar = 300µm]
Figure 9	*Operculina complanata*; [Scale bar = 300µm]

PLATE 23



RELICT FORAMINIFERA



ANNEXURES

Annexure 1

DISTRIBUTION OF BENTHIC FORAMINIFERA IN THE SURFACE SEDIMENTS OFF THE CENTRAL WEST COAST OF GOA

Name of Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
Adelosina laevigata	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Alveopgragmium orbiculatum	0.3	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ammobaculites filiformis	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ammodiscus incertus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ammoglobigerina globigereniformis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ammolagena clavata	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ammonia aff. *A. globosa*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ammonia ketienziensis angulata	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.3	0.0	0.3	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.4	0.8	0.0
Ammonia sobrina	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ammonia tepida	0.0	0.0	0.0	2.2	0.5	0.2	1.3	2.7	1.7	0.0	0.0	0.0	7.7	0.0	0.8	0.0	1.0	0.6	0.0	0.7	2.5	0.3	0.3	0.0	0.4	0.0
Amphicoryna intercellularis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.7	0.0	0.3	0.0	0.8	0.0	1.4
Amphistegina lessonii	0.0	0.0	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Amphistegina radiata	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Astacolus crepidulus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Asterigerinata sp.	0.0	0.8	0.4	0.0	0.0	0.0	1.0	0.4	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Asterorotalia dentata	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.8	7.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Asterorotalia inflata	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.3	4.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Baggina indica	0.0	0.0	0.4	0.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.3	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0
Baggina philippiensis	0.0	0.0	0.0	0.0	0.3	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.3	0.0	0.0	0.9
Bifarilaminella advena	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Bolivina dilatata	0.0	0.0	0.0	0.0	4.6	0.2	0.0	0.0	0.0	0.0	2.8	2.6	0.3	0.0	3.6	0.4	0.0	0.0	0.0	0.0	0.3	0.0	0.3	0.0	0.4	10.0
Bolivina doniezi	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	2.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
Bolivina inflata	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Bolivina kuriani	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Bolivina lowmani	0.0	0.0	0.0	0.4	3.0	0.0	0.0	0.0	0.7	0.0	0.3	0.5	0.0	0.0	1.6	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Bolivina marginata	0.0	0.0	0.0	0.4	4.1	0.2	0.0	0.0	0.3	0.0	4.5	3.6	0.0	0.0	2.2	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.8	6.4
Bolivina cf. *B. oceanica*	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	2.1	0.0	0.6	0.0	0.8	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
Bolivina ordinaria	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.3	0.5	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.5
Bolivina cf. *B. pacifica*	0.0	0.4	0.4	0.0	0.0	0.6	0.3	0.4	0.3	0.0	1.4	0.3	0.0	0.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Bolivina persiensis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Bolivina pseudoplicata	0.0	0.0	0.0	1.1	1.4	0.2	0.0	0.0	0.0	0.0	1.0	0.3	0.0	0.0	1.1	10.7	0.0	0.0	0.0	0.0	0.3	1.2	0.0	0.0	1.2	3.6
Bolivina robusta	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	3.8	0.5	0.0	0.0	2.2	1.2	0.5	0.3	0.0	0.0	0.0	0.3	0.3	0.0	1.6	6.4
Bolivina seminuda	0.7	0.0	0.4	1.9	0.5	0.0	0.3	0.0	0.3	0.4	4.5	0.3	0.0	0.0	1.6	6.2	0.5	0.3	1.6	0.0	0.3	0.3	0.0	0.4	0.8	9.5
Bolivina silvestrina	0.0	0.4	0.0	2.2	0.5	0.4	0.0	0.0	0.0	0.0	1.4	0.0	0.0	0.0	0.0	2.9	1.0	0.0	0.0	0.0	0.3	0.0	0.3	0.0	1.2	0.9
Bolivina spinata	0.0	0.0	1.1	0.0	0.3	0.0	0.0	0.4	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.6	1.6	0.0	0.6	0.6	0.0	0.4	0.0	0.0
Bolivina spinescens	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.1	1.6	0.3	1.6	0.0	0.0	0.0	0.0	0.0	0.4	0.0
Bolivina variabilis	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.7	1.8	0.0	0.0	2.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Bolivina sp.	0.0	0.4	1.1	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.7	0.3	0.3	0.3	0.0	0.0	0.0
Bolivinella elegens	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Bombulina spinata	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0
Borelis sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Botuloides pauciloculus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Brizalina difformis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.3	0.0	0.4	0.0
Brizalina spathulata	0.0	0.0	0.0	0.0	9.3	1.3	0.0	0.0	0.0	0.0	4.9	3.6	0.3	0.0	5.5	1.6	0.0	0.0	0.0	0.0	0.3	0.0	0.3	0.0	0.0	8.6
Brizalina striatula	0.0	0.0	0.4	0.0	0.0	10.1	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.5	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.3	0.4	0.0	0.0
Bulimina aculeata	0.0	0.0	6.0	0.0	0.0	0.0	0.0	1.9	4.3	8.8	0.0	0.0	0.0	0.0	0.0	0.0	1.0	2.5	2.4	0.0	0.0	4.6	3.0	12.6	4.0	0.0
Bulimina alazanensis	0.3	0.0	0.4	37.5	0.0	0.0	0.0	0.8	1.0	1.5	0.0	0.0	0.0	0.0	0.0	0.8	1.0	1.3	1.6	1.4	0.6	3.4	0.9	0.4	0.4	0.0
Bulimina biserialis	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9
Bulimina exilis	0.3	0.4	0.4	0.0	0.5	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Bulimina gibba	0.0	0.0	0.7	1.9	0.3	0.0	0.0	0.4	1.0	0.0	4.9	0.0	0.3	0.0	0.3	1.2	1.0	0.3	0.8	0.0	0.3	0.3	0.0	0.4	0.4	0.5

Name of Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
Bulimina marginata	0.0	0.0	2.5	0.7	0.0	0.6	0.0	1.5	3.3	5.1	0.0	0.0	0.0	0.0	0.3	4.5	0.0	1.3	0.8	0.0	0.0	0.0	0.3	1.1	2.8	0.9
Bulimina mexicana	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Buliminella cf. *B. milletti*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cancris auriculus	0.0	0.0	0.0	0.0	3.0	0.4	0.0	0.0	0.0	0.0	0.3	1.3	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cancris oblongus	0.0	0.0	0.0	0.0	3.0	0.6	0.0	0.0	0.0	0.0	0.0	2.3	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	1.4
Cancris sagra	0.0	0.0	0.0	0.0	3.0	2.1	0.0	0.0	0.0	0.0	1.4	1.0	0.0	0.0	1.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cancris sp.	0.0	0.0	0.0	0.4	0.3	0.8	0.0	0.0	0.0	0.0	0.0	4.1	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cassidulina aff. *C. algida*	0.0	0.0	0.0	0.0	4.9	0.0	0.0	0.0	0.0	0.0	0.3	3.1	0.0	0.0	3.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cassidulina cf. *C. crassa*	0.0	0.0	0.0	0.0	1.6	0.0	0.0	0.0	0.0	0.4	1.4	2.8	0.6	0.0	3.6	1.6	1.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.0	1.4
Cassidulina laevigata	0.0	0.0	0.4	0.4	1.1	0.0	0.0	0.0	0.0	0.0	0.0	2.6	0.0	0.0	1.9	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cassidulina sicula	0.0	0.0	0.0	1.1	0.5	0.0	0.0	0.0	0.0	0.0	0.0	1.8	0.3	0.0	0.8	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.6	0.0
Cassidulina subcarinata	0.0	0.0	0.4	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cassidulina teretis	0.0	0.0	0.0	0.0	1.4	0.0	0.0	0.0	0.0	0.0	0.3	0.5	0.0	0.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5
Cassidulina tortuosa	0.0	0.0	0.0	0.0	2.2	0.0	0.0	0.0	0.0	0.0	0.3	1.8	0.0	0.0	1.4	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cassidulinoides bradyi	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0
Ceratobulimina jonesiana	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Chilostomella oolina	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cibicides cf. *C. fletcheri*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cibicides cf. *C. labatulus*	0.0	0.0	0.0	0.0	0.5	0.0	0.3	0.0	0.0	0.4	0.0	2.6	0.0	0.0	2.7	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.4	0.0
Cibicides lucida	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0
Cibicides pachyderma	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.3	0.0	0.0	0.4	0.0
Cibicides refulgens	0.3	0.0	0.4	0.0	0.0	0.0	0.7	0.0	0.3	1.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	1.7	0.6	0.6	1.1	0.4	0.0
Cibicides sp. A	0.0	0.0	0.0	0.0	1.6	0.2	0.0	4.6	0.0	0.4	0.0	11.9	0.3	0.0	10.7	0.0	0.5	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.8	2.3
Cibicides sp. B	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cibicidina walli	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.7	1.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cibicidoides bradii	2.8	1.1	0.7	0.0	0.0	0.0	0.3	1.2	1.0	0.0	0.3	0.0	0.0	0.0	0.3	0.0	0.5	2.2	1.6	1.4	0.8	0.6	1.2	0.4	0.4	0.0
Cibicidoides cicatricosus	0.7	0.0	0.7	0.0	0.0	0.0	0.0	0.0	1.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.7	0.0	0.0	0.0	0.0	0.4	0.0
Cibicidoides globulosus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cibicidoides cf. *C. kullenbergi*	0.0	0.0	0.4	0.0	0.0	0.0	0.7	0.4	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.3	0.0	0.0	0.0	0.0	0.0	0.4	0.4	0.0
Cibicidoides wullerstofi	0.3	0.4	0.0	0.0	0.0	0.0	0.3	0.8	0.7	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.6	0.0	0.0	0.3	1.5	1.2	0.0	0.0	0.0
Conuspira involvens	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cribromiliolinella sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cribrononion simplex	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cribrostomoides cf. *C. bradyi*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cushmanina plumigera	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.0	0.3	0.0	0.0	0.0	0.0	0.0
Cyclammina canceliata	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cycloforina semiplicata	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cystammina pauciloculata	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Dentalina ariena	0.0	0.4	0.0	0.4	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.7	0.0	0.0	0.3	0.4	0.0	0.0
Dentalina bradyensis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0
Dentalina inflexa	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0
Dentalina turgoidea	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Edentostomina cultrata	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Edentostomina rupertiana	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Eggerella bradyi	0.3	0.0	0.0	0.7	0.0	0.2	1.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.5	0.3	0.0	0.7	1.4	0.0	1.2	0.0	0.4	0.0
Elphidium advenum	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Elphidium crispum	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Elphidium discoidale	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Elphidium macellum	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Elphidium minutum	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Name of Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
Elphidium reticulosum	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Epistominella decorata	0.7	0.0	0.4	0.0	0.0	0.0	0.7	2.7	2.3	0.4	0.0	0.0	0.0	0.0	0.3	3.3	0.5	1.0	0.8	1.4	3.3	1.9	0.3	0.8	1.2	0.0
Epistominella exigua	18.3	20.3	11.3	6.3	0.0	0.0	22.9	13.1	17.5	24.5	0.3	0.5	1.0	0.0	0.0	1.6	19.3	21.7	10.5	17.1	16.4	18.6	20.1	21.1	9.5	0.0
Epistominella minuta	8.3	5.3	4.2	1.9	0.5	0.0	4.7	1.9	2.6	4.7	0.0	0.5	0.3	0.0	0.3	2.9	5.7	9.6	8.1	10.3	7.8	9.3	6.4	7.7	8.7	0.0
Eponides sp.	0.0	0.0	0.0	1.1	0.5	0.6	0.7	0.4	0.0	0.0	9.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	1.2	1.1	0.4	0.0
Eratidus cf. *E. foliaceus*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fissurina annectens	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9	0.0	0.0	0.0	0.0
Fissurina bradyiformata	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0
Fissurina cucullata	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0
Fissurina earlandi	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fissurina fissicarinata	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0
Fissurina imporcata	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fissurina lagenoides	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.7	0.6	0.0	0.0	0.0	0.0	0.0
Fissurina milletti	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fissurina orbignyana	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fissurina aff. *F. pulchella*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fissurina aff. *F. seguenziana*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fissurina semimarginata	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fissurina staphyllearia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fissurina aff. *F. striolata*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0
Fissurina submarginata	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0
Fissurina wrightiana	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0
Fissurina sp.	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Francuscia extensa	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fursenkoina bradyi	0.0	0.0	0.0	0.0	12.5	33.0	0.0	0.0	0.0	0.0	1.0	3.6	1.9	0.0	3.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0
Fursenkoina complanata	0.3	1.1	0.0	0.4	3.0	23.5	0.3	0.0	1.0	0.4	1.4	2.6	0.3	0.0	1.1	0.0	0.0	0.0	0.0	0.0	1.4	0.6	1.5	0.4	0.0	0.0
Fursenkoina pontoni	0.0	0.0	0.0	1.1	0.0	0.4	0.0	0.0	0.0	0.0	1.4	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.8	0.0	0.6	0.0	0.0	0.0	0.0	0.0
Fursenkoina cf. *F. schreibersiana*	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.3	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fursenkoina texturata	0.0	0.0	0.0	0.7	1.1	6.5	0.0	0.8	0.7	0.4	0.0	0.8	0.3	0.0	1.9	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5
Glandulina ovula	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0
Globobulimina cf. *G. pacifica*	0.3	0.4	1.8	0.4	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Globocassidulina oriangulata	0.3	0.0	2.8	2.2	0.3	0.0	0.0	5.4	3.0	7.7	1.4	0.0	0.0	0.0	2.2	23.0	3.6	2.2	3.2	1.4	1.7	3.7	4.0	4.6	5.6	1.8
Globocassidulina subglobosa	0.3	1.9	1.8	5.2	1.4	0.2	0.3	1.9	2.0	1.5	16.7	3.6	0.0	0.0	3.6	7.4	1.6	1.0	1.6	0.7	1.1	2.5	0.6	1.1	7.5	11.8
Globulotuba sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Gyroidina bradyi	0.0	0.8	1.8	0.7	0.0	0.2	0.7	1.2	0.7	0.0	0.0	0.8	0.0	0.0	0.5	0.0	4.7	0.3	0.0	0.0	1.1	0.6	0.6	0.8	1.2	0.0
Gyroidina cf. *G. pulisukensis*	1.7	1.5	2.1	0.4	0.0	0.0	0.7	3.5	2.6	1.1	0.0	0.0	0.0	0.0	0.0	2.5	0.0	1.6	2.4	0.0	0.8	0.9	4.0	2.7	3.2	0.9
Gyroidina sp. A	8.3	3.4	4.9	0.4	0.0	0.2	3.3	6.6	7.9	3.3	0.3	0.0	0.0	0.0	0.0	0.0	1.0	3.2	0.8	3.4	1.7	3.7	4.0	2.3	2.0	0.0
Gyriodina sp. B	11.7	15.4	7.8	1.1	0.3	0.0	11.3	8.5	5.9	5.5	1.0	0.5	1.6	0.0	2.7	1.6	2.1	5.1	8.1	15.8	15.3	9.3	7.0	2.3	6.0	0.9
Gyroidinoides orbicularis	1.7	6.0	3.5	3.0	0.5	0.0	1.3	4.2	1.3	2.9	0.0	0.0	0.0	0.0	0.0	0.4	3.6	4.8	3.2	1.4	2.8	1.5	1.8	1.1	2.4	0.0
Gyroidinoides soldanii	1.7	2.3	2.5	6.3	0.0	0.4	7.6	3.1	1.0	1.5	0.0	0.0	0.0	0.0	0.0	2.9	4.2	1.3	0.0	0.7	1.1	1.9	1.8	2.3	0.0	0.5
Haplopphragmoides cf. *H. tenuis*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0
Haplophragmoides sp. A	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0
Haplophragmoides sp. B	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Haurina fragilissima	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Heterolopa subhaidigerii	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0
Heteromorphina sp.	0.0	0.0	0.7	0.4	0.0	0.0	0.0	0.4	0.3	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.4	0.0
Heterostegina sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Hoeglundina cf. *H. elegens*	1.4	0.8	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0	2.6	1.3	0.0	0.7	0.0	0.0	0.0	0.8	0.4	0.0
Hopkinsinella glabra	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.3	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	1.8
Hormosina globulifera	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Name of Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
Hormosina spiculifera	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Hyalinea balthica	0.0	0.0	0.4	1.1	1.9	0.2	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9
Islandiella sp.	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0
Karreriella cf. *K. chilostoma*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Karrerotextularia sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Karrerulina origona	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.8	0.0
Laevidentalina aphelis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Laevidentalina filiformis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lagena alticostata	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lagena caudata	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lagena doveyensis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lagena elongata	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lagena flatulenta	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lagena gibbera	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lagena hispida	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lagena laevis	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lagena cf. *L. lyellii*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lagena multilatera	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lagena cf. *L. multilatera chathamensis*	0.0	0.4	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0
Lagena cf. *L. oceanica*	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0
Lagena paradoxa	0.7	0.0	0.0	0.4	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lagena pecularis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lagena spiratiformis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lagena striata	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lagena substriata elegantula	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lagena sulcata	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lagena aff. *L. undulata*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Laticarinina pauperata	0.3	0.4	0.0	0.0	0.0	0.0	0.7	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lenticulina angulata	0.0	0.4	0.4	0.7	0.0	0.0	0.0	0.4	0.3	0.0	0.0	0.0	0.0	0.0	0.5	0.8	0.0	0.0	1.6	0.7	0.3	0.6	0.0	0.0	0.0	0.0
Lenticulina calcar	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lenticulina crassa	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0
Lenticulina cultrata	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lenticulina cf. *L. gibba*	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.3	0.0	0.0	0.0
Lenticulina limbosa	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lenticulina limbosus chiriguanoi	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.3	0.0	0.8	0.0	0.0	0.0	0.8	0.0	0.0	0.3	0.0	0.4	0.8	0.0
Lenticulina macrodiscus	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0
Lenticulina pliocaena	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lenticulina subcarinata	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lenticulina thalmanni	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lenticulina sp.	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5
Loxostomina limbata	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.3	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Marginopora vertebralis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Melonis barleeanum	4.1	12.4	6.4	1.5	0.3	0.0	6.0	1.2	3.0	6.9	0.0	0.0	0.3	0.0	0.0	0.4	2.1	2.9	3.2	8.2	6.7	1.2	3.0	8.0	2.4	0.0
Melonis pompilioides	2.8	1.9	1.1	0.4	0.0	0.0	2.7	1.9	2.6	1.8	0.3	0.0	0.0	0.0	0.0	0.0	2.1	3.8	6.5	4.8	5.8	3.1	2.7	6.1	2.0	0.0
Melonis soldani	0.3	0.0	0.7	0.4	0.0	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.1	1.0	0.0	0.0	0.0	0.3	0.0	1.1	0.4	0.0
Mesosigmoilina minuta	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Metapolymorphina sp.	0.0	0.0	1.1	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.0	0.3	0.0	0.3	0.0	0.0	0.0
Miliolinella australis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Miliolinella circularis	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Miliolinella labiosa	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Annexure 1 (Contd.)

Name of Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
Miliolinella lamellidens	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Miliolinella lutea	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Miliolinella oblonga	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Miliolinella cf. *M. oceanica*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Miliolinella subrotunda	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Miliolinella warreni	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Miliolinella sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Murrayinella cf. *M. murrayi*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.1	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0
Neocorbina parkerae	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Neocorbina terquemi	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Neoeponides praecinctus	0.0	0.0	0.0	0.0	1.9	0.0	0.0	0.0	0.0	0.0	0.0	5.7	0.0	0.0	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Neouvigerina ampullacea	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Neouvigerina interrupta	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nodosaria catesbyi	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nodosaria lamnulifera	0.0	0.0	0.0	0.0	1.4	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nodosaria pausiloculata	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nodosaria vertebralis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nodosaria sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nonion cf. *N. asterizens*	0.0	0.0	0.0	0.0	0.3	0.6	0.0	0.0	0.0	0.0	0.3	0.5	3.5	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nonion aff. *N. depressulum*	0.0	0.0	0.0	0.0	0.8	0.8	0.0	0.0	0.0	0.0	0.0	1.6	0.6	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0
Nonion incisum	0.0	0.0	0.0	0.0	0.8	0.4	0.0	0.0	0.0	0.0	0.0	0.5	2.3´	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nonion pacificum	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nonion scaphum	0.0	0.0	0.0	0.0	0.5	2.7	0.3	0.0	0.0	0.0	0.0	0.0	15,4	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nonion sloanii	0.0	0.0	0.4	0.0	0.5	1.0	0.0	0.0	0.0	0.0	0.0	0.3	1.3	0.0	0.3	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0
Nonionella auricula	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0
Nonionella auris	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nonionella basispinata	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.3	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0
Nonionella hantkeni	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.7	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nonionella cf. *N. japonica*	0.0	0.0	0.0	0.0	0.5	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nonionella cf. *N. limbato-striata*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nonionella opima	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nonionella turgida	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.5
Nonionoides boueanum	0.0	0.0	0.0	0.0	1.1	3.2	0.0	0.0	0.0	0.0	0.3	2.1	1.6	0.0	0.5	0.4	0.0	0.0	1.6	0.7	0.0	0.0	0.0	0.0	0.4	0.0
Nonionoides elongatum	0.0	0.0	0.0	0.0	2.2	2.7	0.0	0.4	0.0	0.0	0.0	1.6	4.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nonionoides grateloupi	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	1.3	0.0	2.5	0.8	0.0	0.0	1.6	1.4	0.0	0.0	0.0	0.8	1.2	0.9
Oolina apiopleura	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Oolina felsinea	0.0	0.4	0.4	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.1	0.3	0.3	0.0	0.4	0.0
Oolina globosa	0.0	0.8	0.4	0.4	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.3	0.0	0.0	0.0	0.5	0.0	0.8	0.0	0.3	0.6	0.0	0.8	0.4	0.0
Oolina lineata	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Oolina setosa	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Oolina truncata	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Operculina complanata	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Operculina granulosa	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ophthalmidium sp.	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Oridorsalis sp.	1.4	1.1	1.8	0.0	0.0	0.0	1.3	1.2	0.3	1.1	0.0	0.0	0.0	0.0	0.3	0.0	2.1	1.3	0.8	4.1	0.0	0.6	0.9	0.4	0.4	0.0
Orthomorphina aff. *O. parvula*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Osangularia bengalensis	14.5	7.1	11.0	4.1	0.0	0.0	5.6	10.0	12.2	8.4	0.3	0.0	0.0	0.0	0.0	3.3	18.2	8.9	16.1	9.6	4.7	13.0	12.8	7.7	15.5	0.0
Paleomiliolina sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Parafissurina aff. *P. arctica*	0.3	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.8	0.0	0.0	0.0	0.3	0.0	0.0	0.0
Parafissurina fusiformis	0.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0

Name of Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
Parafissurina himatiostoma	0.3	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0
Parafissurina lateralis	0.0	0.0	0.0	0.7	0.0	0.2	0.3	0.8	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.0	0.8	0.0	0.3	0.4	0.0	0.0
Parafissurina subcarinata	0.0	0.4	0.0	0.0	0.0	0.0	1.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.5
Pararotalia cf. *P. calcar*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Parasorites marginalis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Patellinella inconspicua	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Patellinella sp.	0.3	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pilulina sp.	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Planispirinella exigua	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Planorbulina mediterranensis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Planularia australia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Planulinoides sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.3	0.0	0.0	0.0	0.0
Pleurostomella sp.	0.7	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Praeglobobulimina ovata	0.3	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Praeglobobulimina pupoides	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Procerolagena distoma	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Procerolagena gracilis	0.0	0.4	0.0	0.0	0.0	0.0	0.3	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.9	0.0	0.0	0.0	0.0
Procerolagena ingens	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Proxifrons advena	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pseudoeponides pauciloculata	0.0	0.0	1.4	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pseudofissurina sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pseudohauerina orientalis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pullenia bulloides	2.8	1.9	5.7	0.7	0.0	0.0	3.7	4.2	3.6	0.7	1.4	0.0	0.0	0.0	0.0	0.0	0.0	2.2	3.2	2.1	5.0	3.1	3.4	3.4	0.4	0.0
Pullenia quinqueloba	5.2	3.8	1.1	0.0	0.0	0.0	5.3	3.5	5.0	2.2	0.7	0.0	0.0	0.0	0.0	0.4	1.0	1.9	0.0	2.1	3.9	1.9	2.1	0.0	0.4	0.0
Pygmaeoseistron hispidulum	0.0	0.0	0.4	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.8	0.7	0.0	0.0	0.0	0.0	0.0	0.0
Pygmaeoseistron nebulosum	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pyrimidulina cancellata	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pyrimidulina cf. *P. eptagona*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pyrgo cf. *P. denticulata*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0
Pyrgo elongata	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pyrgo laevis	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pyrgo cf. *P. nasutus*	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0
Pyrgo striolata	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Quinqueloculina annectens	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Quinqueloculina berthelotiana	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Quinqueloculina bicarinata	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Quinqueloculina distorqueata	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Quinqueloculina echinata	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Quinqueloculina elegans	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Quinqueloculina cf. *Q. inaequelis*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Quinqueloculina kerimbatica	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Quinqueloculina lamarckiana	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Quinqueloculina mosharrafai	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Quinqueloculina multimarginata	0.0	0.0	0.0	0.0	0.0	0.2	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Quinqueloculina parkeri	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Quinqueloculina polygona	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Quinqueloculina pseudoreticulata	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Quinqueloculina quadrilatelaris	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Quinqueloculina rhodiensis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Quinqueloculina schlumbergeri	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.3	0.0	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Name of Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
Quinqueloculina seminulum	0.0	0.0	0.0	0.0	1.6	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Quinqueloculina subpolygona	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Quinqueloculina sulcata	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Quinqueloculina trigunola	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Quinqueloculina undulose-costata	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Quinqueloculina venusta	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Quinqueloculina vulgaris	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Quinqueloculina sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Reophanus ovicula	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Reophax mortenseni	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Reophax nodulosus	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0
Reusella laevigata	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Reusella spinulosa	0.0	0.0	0.0	0.0	0.0	0.0	3.7	1.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Rosalina globularis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Rosalina sp.	0.0	0.0	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.7	0.8	0.0	0.0	0.0	0.0	0.5	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Rotalidium annectens	0.0	0.0	0.0	0.0	0.5	1.9	0.0	0.0	0.0	0.0	0.0	0.5	23.5	1.7	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5
Rotalinoides papollosius	0.0	0.0	0.0	0.0	0.3	0.4	0.0	0.0	0.0	0.0	0.0	0.0	9.6	1.7	0.3	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Saccorhiza ramosa	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0
Sagrinella convallaria	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0
Sagrinella cf. *S. guinai*	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Saracenaria latifrons	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.5
Scherochorella sp.	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sigmavirgulina tortuosa	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Siphonaperta aff. *S. agglutinans*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Siphonaperta horrida	0.0	0.0	0.7	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.8	0.0	0.0	0.3	0.3	0.0	0.0	0.0
Siphotextularia aff. *S. concava*	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5	0.0	0.3	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.8	0.8	0.0
Siphouvigerina porrecta	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Spiroloculina angulata	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Spiroloculina angulosa	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Spiroloculina antillarium	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Spiroloculina asperta	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Spiroloculina aff. *S. caduca*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Spiroloculina communis	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Spiroloculina depressa	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Spiroloculina excavata	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Spiroloculina indica	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Spiroloculina planissima	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Spiroloculina rotunda	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Spiroloculina tricarinata	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Spiroloculina venusta	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Spiroloculina sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Spirophthalmidium acutimargo	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Spirophthalmidium sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0
Spirosigmoilina tenuis	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9
Stainforthia concava	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subreophax cf. *S. monile*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.3	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0
Textularia agglutinans	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Textularia aff. *T. milletti*	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Textularia pseudogramen	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Trifarina carinata	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.5	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	1.8

Name of Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
Trifarina sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5
Triloculina insignis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Triloculina striatotrigonula	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Triloculina terquemiana	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Triloculina tricarinata	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Triloculina trigonula	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Triloculinella sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Tritaxis challengeri	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Trochammina hadai	0.3	0.8	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Trochammina inflata	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Trochammina cf. *T. nana*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Usbekistania charoides	0.7	1.5	0.0	0.0	0.0	0.0	0.0	0.4	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.8	0.7	0.0	0.3	0.0	0.0	0.0	0.0
Uvigerina aculeata	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.6	0.0
Uvigerina asperula	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Uvigerina cf. *U. auberiana*	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	1.6	0.0	0.0	0.0	0.0	0.0	3.0	0.4	0.4	0.0
Uvigerina bassensis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
Uvigerina bifurcata	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0
Uvigerina brunensis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Uvigerina canariensis	0.0	0.0	0.0	0.0	0.5	0.2	0.0	0.0	0.0	0.0	0.3	0.3	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.8
Uvigerina hollicki	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9
Uvigerina mediterranea	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	12.5	0.3	0.0	0.0	0.0	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.7
Uvigerina peregrina	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Uvigerina proboscidea	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0
Uvigerina schlumbergeri	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5
Uvigerina schwageri	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Uvigerina vadenscens	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0
Uvigerina sp. A	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Uvigerina sp. B	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Vaginulina aff. *V. badenensis*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Vaginulina cf. *V. hemitemna*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Veleroninoides sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.3	0.0	0.0	0.0
Verneulinulla propinqua	0.0	0.0	0.4	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Vertebralina sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Virgulinella pertusa	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Annexure 1 (Contd.)

Name of Species	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52
Adelosina laevigata	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0
Alveopgragmium orbiculatum	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0
Ammobaculites filiformis	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ammodiscus incertus	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.3	0.0	0.0	0.0
Ammoglobigerina globigereniformis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ammolagena clavata	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.3	0.0	0.0	0.0
Ammonia aff. *A. globosa*	0.0	0.9	1.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.9	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ammonia ketienziensis angulata	0.7	0.3	0.6	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.4	0.3	0.0	0.0	0.0	0.4	0.4	0.0	0.0	0.0	0.0
Ammonia sobrina	0.4	0.0	0.3	0.3	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.7	2.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.9
Ammonia tepida	0.0	23.0	44	0.3	0.0	0.4	2.3	0.0	0.0	0.8	0.4	0.0	0.0	0.0	3.3	35	0.3	0.0	1.4	0.0	0.0	0.0	0.0	0.2	0.0	9.4
Amphicoryna intercellularis	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.4	0.0	0.0	0.0	0.0	0.0
Amphistegina lessonii	14.0	0.3	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	4.0	0.0	0.0	0.0	0.0	0.3	0.5	0.0	0.0
Amphistegina radiata	15.0	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.2	4.6	0.0	0.0	0.0	0.0	0.0	0.0	0.3	1.9
Astacolus crepidulus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Asterigerinata sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.0	0.0	0.9	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.0
Asterorotalia dentata	0.0	0.9	2.4	1.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.0	0.5	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Asterorotalia inflata	0.4	0.0	0.6	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Baggina indica	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Baggina philippiensis	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0
Bifarilaminella advena	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Bolivina dilatata	0.4	0.0	0.0	2.9	0.0	0.0	0.7	0.0	0.0	0.0	0.4	0.0	1.3	4.0	1.7	0.0	2.7	0.9	0.0	0.0	0.0	0.0	0.6	0.2	3.7	0.0
Bolivina doniezi	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.1	0.0
Bolivina inflata	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0
Bolivina kuriani	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Bolivina lowmani	1.4	0.0	0.0	0.5	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	1.0	2.0	2.5	0.0	0.0	1.2	2.5	0.3	0.0	0.4	2.3	0.5	10	1.9
Bolivina marginata	0.4	0.0	0.0	5.1	0.4	0.4	0.3	0.0	0.0	0.0	0.0	0.5	0.3	6.0	1.7	0.0	1.9	0.0	0.7	0.0	0.4	0.0	0.0	0.2	3.4	0.0
Bolivina cf. *B. oceanica*	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.8	0.0	0.5	0.0	0.0	0.3	0.0	0.4	0.0	0.0	0.3	0.0
Bolivina ordinaria	0.0	0.0	0.0	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	0.8	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.3	3.8
Bolivina cf. *B. pacifica*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Bolivina persiensis	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.6	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.4	0.0	0.0	0.0	0.0	0.0
Bolivina pseudoplicata	0.4	1.1	0.3	1.1	0.4	0.4	0.0	0.4	0.0	0.4	1.3	2.0	1.6	3.0	0.0	0.2	1.9	0.0	1.4	0.3	0.0	0.0	2.0	1.7	1.1	0.0
Bolivina robusta	0.0	0.0	0.0	1.6	0.4	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.6	6.0	0.8	0.2	0.8	0.0	0.4	0.0	0.0	0.0	0.6	0.5	2.0	1.9
Bolivina seminuda	0.0	0.0	0.0	0.0	4.8	1.1	2.7	0.8	0.0	1.3	1.3	4.4	5.1	1.0	0.8	0.0	0.5	4.6	10	2.4	2.1	0.7	9.3	8.8	1.4	0.0
Bolivina silvestrina	0.4	0.0	0.0	1.1	1.3	0.4	1.3	0.0	0.0	0.0	1.3	2.5	3.8	1.0	0.0	0.7	0.0	0.9	6.8	1.0	0.4	0.0	2.9	3.2	2.6	1.9
Bolivina spinata	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0
Bolivina spinescens	0.0	0.0	0.0	0.0	1.3	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0
Bolivina variabilis	0.0	0.0	0.0	2.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.0	0.0	0.0	0.5	0.0	0.4	0.0	0.0	0.0	0.0	0.0	2.9	0.0
Bolivina sp.	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0
Bolivinella elegens	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0
Bombulina spinata	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.4	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0
Borelis sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Botuloides pauciloculus	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0
Brizalina difformis	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.4	0.0	0.0	0.5	0.3	0.0
Brizalina spathulata	0.4	0.0	0.0	4.5	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.5	0.6	5.0	5.8	0.0	2.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.9	5.7
Brizalina striatula	0.0	5.2	0.3	0.5	0.0	0.0	0.3	0.4	0.0	0.0	0.4	0.0	0.0	0.0	0.0	1.1	0.3	0.0	0.0	0.7	0.0	0.0	0.0	0.2	0.3	3.8
Bulimina aculeata	0.0	0.0	0.0	0.0	6.2	2.6	5.6	0.8	0.0	0.0	2.1	3.4	1.3	0.0	0.0	0.0	0.0	0.0	0.4	4.5	0.0	0.0	2.0	0.2	0.0	0.0
Bulimina alazanensis	0.0	0.0	0.0	0.0	2.2	0.0	1.0	1.5	0.7	2.1	1.7	0.0	20	0.0	0.0	0.0	0.0	0.0	0.0	1.4	1.4	0.0	0.0	0.0	0.0	0.0
Bulimina biserialis	0.0	0.0	0.3	0.5	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.3	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0

Annexure 1 (Contd.)

Name of Species	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52
Bulimina exilis	0.0	0.0	0.0	0.3	2.2	1.5	0.7	0.4	0.3	0.0	0.4	2.0	1.3	0.0	0.0	0.0	0.0	0.0	1.8	1.4	0.7	0.4	0.3	0.7	0.6	0.0
Bulimina gibba	0.0	0.0	0.0	0.3	3.1	1.1	2.7	0.8	1.0	0.4	2.1	4.4	4.5	0.0	0.0	0.0	0.0	0.6	5.0	2.4	0.4	1.4	5.5	0.5	0.0	0.0
Bulimina marginata	0.4	0.0	0.0	0.0	4.0	0.7	0.7	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.8	0.7	0.0	0.0	0.4	0.3	0.0	0.0	0.0	0.0	0.0	1.9
Bulimina mexicana	0.0	0.0	0.0	0.0	0.0	0.7	0.3	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0
Buliminella cf. *B. milletti*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cancris auriculus	0.7	0.3	0.0	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	0.0	0.0	2.2	0.0	0.0	0.0	0.0	0.0	0.3	0.0	1.1	0.0
Cancris oblongus	1.8	0.0	0.0	2.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	0.8	0.0	1.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	1.9
Cancris sagra	0.4	0.0	0.0	2.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.9	0.0
Cancris sp.	0.0	0.0	0.0	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	2.4	0.3	0.0	0.0	0.0	0.0	0.3	0.0	0.9	1.9
Cassidulina aff. *C. algida*	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.6	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0
Cassidulina cf. *C. crassa*	4.6	0.0	0.0	7.5	0.9	0.4	0.3	0.0	0.0	0.0	0.0	0.0	1.3	6.0	0.8	0.2	7.6	0.3	4.0	0.3	0.4	0.0	1.2	0.7	3.4	1.9
Cassidulina laevigata	0.0	0.0	0.0	2.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.8	0.0	1.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.9
Cassidulina sicula	0.0	0.0	0.0	2.4	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	2.0	1.7	0.0	3.3	0.0	0.4	0.3	0.0	0.0	0.3	0.5	0.3	0.0
Cassidulina subcarinata	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cassidulina teretis	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cassidulina tortuosa	0.7	0.0	0.0	2.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.6	1.9
Cassidulinoides bradyi	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.2	0.0	0.0
Ceratobulimina jonesiana	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Chilostomella oolina	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.5	1.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.4	0.4	0.9	0.0	0.0	0.0
Cibicides cf. *C. fletcheri*	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0
Cibicides cf. *C. labatulus*	3.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.1	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cibicides lucida	0.0	0.0	0.0	0.0	0.0	1.1	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cibicides pachyderma	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0
Cibicides refulgens	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.4	0.7	0.0	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.4	0.4	0.3	0.0	0.0	0.0
Cibicides sp. A	21	0.9	0.0	3.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.0	3.3	0.0	7.3	4.6	0.7	0.0	0.0	0.0	0.0	0.0	7.1	0.0
Cibicides sp. B	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9	0.0	0.0	0.0	0.4	0.0	0.2	2.0	0.0
Cibicidina walli	0.0	0.0	0.0	1.6	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0
Cibicidoides bradii	0.4	0.0	0.0	0.3	0.0	1.5	0.3	1.1	0.3	0.0	0.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0	1.1	0.3	0.0	1.8	0.6	0.7	0.0	0.0
Cibicidoides cicatricosus	1.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cibicidoides globulosus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.1	0.0	1.1	0.0	0.0	0.0	0.0	3.7	0.0	0.0
Cibicidoides cf. *C. kullenbergi*	1.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0
Cibicidoides wullerstofi	0.0	0.0	0.0	0.0	0.0	1.5	1.0	0.0	0.0	0.0	0.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.0	1.7	0.0	0.0	0.0
Conuspira involvens	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	0.0	0.0
Cribromiliolinella sp.	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cribrononion simplex	0.0	1.4	0.0	0.3	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.3	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cribrostomoides cf. *C. bradyi*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0
Cushmanina plumigera	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cyclammina cancellata	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.8	0.4	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0
Cycloforina semiplicata	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0
Cystammina pauciloculata	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Dentalina ariena	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.3	0.0	0.9	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.3	0.0	0.0	0.0
Dentalina bradyensis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Dentalina inflexa	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Dentalina turgoidea	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Edentostomina cultrata	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0
Edentostomina rupertiana	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0
Eggerella bradyi	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	1.3	0.4	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.4	0.4	0.3	0.0	0.0	0.0
Elphidium advenum	0.4	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.4	0.0	0.0	0.0	0.0	0.2	0.0	0.0
Elphidium crispum	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Elphidium discoidale	0.4	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Annexure 1 (Contd.)

Name of Species	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52
Elphidium macellum	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Elphidium minutum	0.4	0.0	0.3	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.1	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.0
Elphidium reticulosum	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Epistominella decorata	0.0	0.0	0.0	0.0	1.3	1.5	0.3	0.4	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0
Epistominella exigua	0.0	0.0	0.0	0.0	4.4	17.0	9.6	14.0	26.0	30.0	12.0	21.0	5.8	0.0	0.0	0.0	0.0	0.0	7.6	7.9	17.0	21.0	6.4	1.0	0.0	0.0
Epistominella minuta	0.0	0.0	0.0	0.0	5.7	7.1	4.7	5.6	4.9	6.7	2.6	2.5	2.9	0.0	0.0	0.2	0.0	0.0	2.5	4.1	6.4	6.4	1.2	0.2	0.3	0.0
Eponides sp.	0.0	0.0	0.0	0.3	0.0	0.0	0.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.0	0.0	0.0	1.8	0.7	0.4	0.4	0.0	0.0	0.3	0.0
Eratidus cf. *E. foliaceus*	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fissurina annectens	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fissurina bradyiformata	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fissurina cucullata	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fissurina earlandi	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fissurina fissicarinata	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0
Fissurina imporcata	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0
Fissurina lagenoides	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.4	0.0	0.0	0.0	0.0
Fissurina milletti	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0
Fissurina orbignyana	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fissurina aff. *F. pulchella*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fissurina aff. *F. seguenziana*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fissurina semimarginata	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.2	0.0	0.0
Fissurina staphyllearia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fissurina aff. *F. striolata*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fissurina submarginata	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fissurina wrightiana	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fissurina sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fronenscia extensa	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0
Fursenkoina bradyi	0.4	2.9	0.6	1.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.3	3.0	4.1	0.7	2.7	0.3	0.7	0.0	0.0	0.0	0.0	2.0	4.6	0.0
Fursenkoina complanata	0.4	3.2	0.3	3.5	0.4	0.0	1.0	1.1	0.7	0.4	0.4	1.5	0.6	4.0	0.0	0.0	3.8	1.5	1.8	0.0	1.1	0.4	0.6	3.7	7.1	0.0
Fursenkoina pontoni	0.0	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.6	0.0	0.0	0.0
Fursenkoina cf. *F. schreibersina*	0.0	0.6	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fursenkoina texturata	0.0	0.3	0.0	0.5	0.4	0.0	0.3	1.1	0.0	0.4	0.9	2.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0
Glandulina ovula	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0
Globobulimina cf. *G. pacifica*	0.0	0.0	0.0	1.3	0.0	0.0	2.3	0.0	0.0	0.0	0.0	0.0	0.0	2.0	0.0	0.0	0.0	0.0	5.8	0.0	0.0	0.0	0.3	0.0	0.0	0.0
Globocassidulina oriangulata	0.4	0.0	0.0	0.0	4.0	0.0	7.6	3.4	0.7	2.1	2.1	6.4	5.8	1.0	1.7	0.0	0.5	0.6	4.0	2.4	0.7	0.7	2.0	1.2	0.3	0.0
Globocassidulina subglobosa	1.4	0.6	0.0	0.0	20	3.3	0.0	0.0	0.0	0.0	10.0	2.5	5.8	0.0	8.3	0.0	2.7	0.0	0.0	4.8	0.0	0.0	5.8	15	5.1	3.8
Globulotuba sp.	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Gyroidina bradyi	0.0	0.0	0.0	0.0	0.4	0.7	1.7	0.8	1.0	0.4	0.0	0.5	0.0	0.0	0.8	0.0	0.3	0.0	0.4	1.7	0.7	1.1	0.0	0.0	0.0	0.0
Gyroidina cf. *G. pulisukensis*	0.0	0.0	0.0	0.0	1.8	2.2	2.7	2.3	2.3	0.8	0.0	1.0	1.0	0.0	0.0	0.0	0.0	0.0	2.2	1.4	1.4	2.5	0.9	0.7	0.0	0.0
Gyroidina sp. A	0.0	0.0	0.0	0.0	0.4	4.5	6.3	3.8	6.2	4.2	1.7	2.5	1.3	0.0	0.0	0.0	0.0	0.0	0.4	4.8	4.6	4.3	2.0	0.0	0.0	0.0
Gyriodina sp. B	0.0	0.0	0.6	0.0	2.6	0.4	6.0	12.0	9.1	9.6	8.1	4.9	1.9	0.0	1.7	0.5	0.0	0.0	2.2	6.2	14.0	10.0	3.2	0.5	0.6	0.0
Gyroidinoides orbicularis	0.4	0.0	0.0	0.0	2.2	1.1	1.7	1.5	0.3	0.0	0.4	1.0	3.8	0.0	0.0	0.0	0.0	0.0	2.2	2.1	2.9	2.5	0.9	1.2	0.6	0.0
Gyroidinoides soldanii	0.0	0.0	0.0	0.8	0.9	2.2	1.0	3.0	3.6	1.7	0.4	1.5	1.0	1.0	0.0	0.0	0.0	0.0	1.1	2.1	2.1	2.1	0.9	0.5	1.4	1.9
Haplopphragmoides cf. *H. tenuis*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Haplophragmoides sp. A	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Haplophragmoides sp. B	0.0	0.3	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Haurina fragilissima	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0
Heterolopa subhaidigerii	0.4	0.0	0.0	0.0	0.0	0.4	0.3	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Heteromorphina sp.	0.0	0.0	0.0	0.0	0.0	0.4	0.7	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0
Heterostegina sp.	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.3	0.0
Hoeglundina cf. *H. elegens*	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.4	0.3	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0

Name of Species	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52
Hopkinsinella glabra	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.6	0.0	0.8	0.0	0.0	0.0	0.4	0.3	0.4	0.0	0.9	0	0.3	0.0
Hormosina globulifera	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Hormosina spiculifera	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Hyalinea balthica	2.5	0.0	0.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.2	0.6	0.0
Islandiella sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Karreriella cf. *K. chilostoma*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.3	13	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Karrerotextularia sp.	0.0	0.0	0.0	0.0	1.8	0.0	0.0	0.0	0.0	0.0	0.4	2.0	1.0	0.0	0.0	0.0	0.0	0.0	1.8	0.3	0.0	0.0	2.6	1.5	0.0	0.0
Karrerulina origona	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Laevidentalina aphelis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Laevidentalina filiformis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lagena alticostata	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0
Lagena caudata	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lagena doveyensis	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0
Lagena elongata	0.0	0.0	0.0	0.0	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lagena flatulenta	0.0	0.0	0.0	0.0	0.4	0.4	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0
Lagena gibbera	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lagena hispida	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0
Lagena laevis	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lagena cf. *L. lyellii*	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lagena multilatera	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lagena cf. *L. multilatera chathamensis*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lagena cf. *L. oceanica*	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0
Lagena paradoxa	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lagena pecularis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0
Lagena spiratiformis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lagena striata	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lagena substriata elegantula	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lagena sulcata	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lagena aff. *L. undulata*	0.0	0.0	0.0	0.0	0.0	0.4	0.3	0.8	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Laticarinina pauperata	0.0	0.0	0.0	0.0	0.0	0.7	0.7	0.4	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.7	0.0	0.4	0.6	0.0	0.0	0.0
Lenticulina angulata	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.2	0.0	0.0	0.7	0.0	0.4	0.4	0.3	0.2	0.0	0.0
Lenticulina calcar	0.0	0.0	0.0	0.5	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lenticulina crassa	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lenticulina cultrata	0.4	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9	0.0
Lenticulina cf. *L. gibba*	0.0	0.0	0.0	0.5	0.4	0.0	0.0	0.4	0.3	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lenticulina limbosa	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.9
Lenticulina limbosus chiriguanoi	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0
Lenticulina macrodiscus	0.0	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lenticulina pliocaena	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lenticulina subcarinata	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.6	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lenticulina thalmanni	0.0	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lenticulina sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Loxostomina limbata	3.2	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Marginopora vertebralis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Melonis barleeanum	0.0	0.3	0.0	0.0	0.0	6.7	2.0	1.5	3.9	1.7	0.4	3.4	1.3	0.0	0.0	0.0	0.0	0.0	4.7	2.1	6.4	5.7	9.0	0.5	0.0	0.0
Melonis pompilioides	0.0	0.0	0.0	0.3	0.9	7.4	5.3	3.4	2.9	3.3	3.4	3.4	0.3	0.0	0.0	0.0	0.0	0.0	2.2	3.8	2.9	2.5	2.6	0.2	0.3	0.0
Melonis soldani	0.0	0.0	0.0	0.0	0.0	2.6	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.3	0.0	0.0	0.0
Mesosigmoilina minuta	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Metapolymorphina sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.4	0.7	0.0	0.0	0.0	0.0	0.0
Miliolinella australis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0

Annexure 1 (Contd.)

Name of Species	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52
Miliolinella circularis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0
Miliolinella labiosa	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5	0.0	0.0
Miliolinella lamellidens	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0
Miliolinella lutea	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.7	0.6	0.0
Miliolinella oblonga	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.4	0.0	0.0	0.4	0.0	0.0	0.0	1.7	0.0	0.5	0.6	0.0	0.0	0.0	0.4	0.0	4.6	0.3	0.0
Miliolinella cf. M. oceanica	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Miliolinella subrotunda	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.7	0.0	0.0
Miliolinella warreni	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.0
Miliolinella sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0
Murrayinella cf. M. murrayi	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Neocorbina parkerae	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Neocorbina terquemi	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0
Neoeponides praecinctus	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	4.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0
Neouvigerina ampullacea	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Neouvigerina interrupta	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nodosaria catesbyi	0.7	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0
Nodosaria lamnulifera	0.4	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nodosaria pausiloculata	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nodosaria vertebralis	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nodosaria sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nonion cf. N. asterizens	0.0	8.3	6.6	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	4.1	7.6	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.9
Nonion aff. N. depressulum	0.4	1.4	2.4	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	1.6	3.8	0.3	0.7	0.0	0.0	0.0	0.0	0.0	0.6	0.0
Nonion incisum	0.0	5.4	5.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nonion pacificum	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nonion scaphum	0.0	17.0	14.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.2	0.3	0.0	0.0	0.0	0.4	0.4	0.0	0.0	0.3	23
Nonion sloanii	0.0	2.3	3.6	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.9
Nonionella auricula	0.0	0.6	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0
Nonionella auris	0.0	0.3	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nonionella basispinata	0.4	0.0	0.0	0.5	0.9	0.0	0.7	0.4	0.0	0.0	0.0	0.0	0.0	1.0	0.8	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.6	0.0	3.7	0.0
Nonionella hantkeni	0.0	0.3	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.3	0
Nonionella cf. N. japonica	0.4	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nonionella cf. N. limbato-striata	0.0	0.0	1.5	0.3	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.9
Nonionella opima	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nonionella turgida	0.0	0.0	0.3	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0
Nonionoides boueanum	0.0	5.7	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	1.4	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nonionoides elongatum	0.0	5.2	4.2	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	2.5	8.5	2.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.7
Nonionoides grateloupi	0.4	0.3	0.6	1.1	0.0	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.6	1.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.9	0.0
Oolina apiopleura	0.0	0.0	0.0	0.0	0.0	0.0	0.3	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.2	0.0	0.0
Oolina felsinea	0.0	0.0	0.0	0.0	0.0	0.0	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.4	0.0	0.0	0.0	0.0
Oolina globosa	0.0	0.0	0.0	0.3	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0
Oolina lineata	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0
Oolina setosa	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.4	0.0	0.4	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Oolina truncata	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Operculina complanata	3.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Operculina granulosa	6.0	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ophthalmidium sp.	0.0	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.9
Oridorsalis sp.	0.0	0.0	0.0	0.0	0.4	1.1	1.0	0.0	0.0	0.0	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.7	0.0	0.0	0.0	1.9
Orthomorphina aff. O. parvula	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Osangularia bengalensis	0.4	0.0	0.0	0.3	7.9	18.0	8.3	12	13	5.8	23.0	6.4	8.7	0.0	0.0	0.0	0.3	0.0	6.5	12.0	15.0	10.0	17.0	0.2	1.1	0.0
Paleomiliolina sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Name of Species	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52
Parafissurina aff. *P. arctica*	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.3	0.0	0.0	0.0
Parafissurina fusiformis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Parafissurina himatiostoma	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.3	0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.4	1.4	0.3	0.0	0.0	0.0
Parafissurina lateralis	0.0	0.6	0.0	0.3	0.0	0.4	0.3	1.9	0.7	0.8	1.3	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.4	0.0	0.0	0.0	0.0	0.0
Parafissurina subcarinata	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.8	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.4	0.0	0.0	0.0	0.0
Pararotalia cf. *P. calcar*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.2	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0
Parasorites marginalis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Patellinella inconspicua	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Patellinella sp.	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.2	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0
Pilulina sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Planispirinella exigua	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0
Planorbulina mediterranensis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Planularia australis	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Planulinoides sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0
Pleurostomella sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.4	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Praeglobobulimina ovata	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.2	0.0	0.0
Praeglobobulimina pupoides	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0
Procerolagena distoma	0.0	0.0	0.0	0.0	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Procerolagena gracilis	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.4	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.4	0.0	0.0	0.0	0.0	0.0
Procerolagena ingens	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Proxifrons advena	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pseudoeponides pauciloculata	0.0	1.4	2.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.8	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pseudofissurina sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0
Pseudohauerina orientalis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.2	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0
Pullenia bulloides	0.0	0.0	0.0	0.0	0.4	0.4	2.3	3.4	7.8	6.7	2.1	0.0	1.0	0.0	4.1	0.4	0.0	0.0	1.8	2.4	2.5	4.6	0.6	0.0	0.3	0.0
Pullenia quinqueloba	0.0	0.0	0.0	0.0	0.4	1.1	2.0	7.9	3.6	9.6	3.8	3.4	0.6	0.0	1.7	0.0	0.0	0.0	1.4	5.5	7.1	8.9	2.9	0.2	0.0	0.0
Pygmaeoseistron hispidulum	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.4	0.0	0.0	0.0	0.5	0.3	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.7	0.0	0.0	0.0	0.0
Pygmaeoseistron nebulosum	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pyrimidulina cancellata	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pyrimidulina cf. *P. eptogona*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pyrgo cf. *P. denticulata*	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pyrgo elongata	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pyrgo laevis	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pyrgo cf. *P. nasutus*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.4	0.0	0.0	0.3	0.0
Pyrgo striolata	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Quinqueloculina annectens	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Quinqueloculina berthelotiana	0.0	0.0	0.0	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0
Quinqueloculina bicarinata	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.1	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0
Quinqueloculina distorqueata	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.6	0.0	0.0	0.0	0.0	0.0	2.4	0.3	0.0
Quinqueloculina echinata	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Quinqueloculina elegans	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Quinqueloculina cf. *Q. inaequelis*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0
Quinqueloculina kerimbatica	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Quinqueloculina lamarckiana	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.9
Quinqueloculina mosharrafai	0.0	0.0	0.0	0.3	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Quinqueloculina multimarginata	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.5	0.3	0.0	0.3	0.4	0.0	0.0	0.5	0.6	0.0
Quinqueloculina parkeri	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0
Quinqueloculina polygona	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0
Quinqueloculina pseudoreticulata	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Quinqueloculina quadrilatelaris	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Annexure 1 (Contd.)

Name of Species	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52
Quinqueloculina rhodiensis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Quinqueloculina schlumbergeri	0.4	0.0	0.0	0.3	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0
Quinqueloculina seminulum	0.0	0.0	0.0	0.3	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.0	1.1	1.5	0.0	0.0	0.4	0.0	0.0	0.5	0.9	0.0
Quinqueloculina subpolygona	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.2	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0
Quinqueloculina sulcata	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Quinqueloculina trigunola	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.3	0.0
Quinqueloculina undulose-costata	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Quinqueloculina venusta	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Quinqueloculina vulgaris	0.7	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.6	1.5	0.0	0.0	0.0	0.0	0.0	0.2	0.6	0.0
Quinqueloculina sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Reophanus ovicula	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Reophax mortenseni	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Reophax nodulosus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Reusella laevigata	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.2	0.0	0.0	0.0	0.0	0.0	1.5	0.3	0.0
Reusella spinulosa	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Rosalina globularis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0
Rosalina sp.	2.8	0.0	0.0	2.4	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.8	0.0	2.7	1.5	0.0	0.3	0.0	0.0	0.3	10	0.9	0.0
Rotalidium annectens	0.0	6.9	2.4	2.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.5	0.0	0.8	2.1	0.0	0.0	0.0	0.0	0.0	0.0	0.9	3.8
Rotalinoides papollosius	0.0	0.6	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.5	0.0	0.0	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Saccorhiza ramosa	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sagrinella convallaria	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sagrinella cf. *S. guinai*	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0
Saracenaria latifrons	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Scherochorella sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sigmavirgulina tortuosa	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0
Siphonaperta aff. *S. agglutinans*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Siphonaperta horrida	0.4	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.4	0.0	0.0	0.0	0.0	0.0	0.0
Siphotextularia aff. *S. concava*	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	2.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0
Siphouvigerina porrecta	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0
Spiroloculina angulata	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0
Spiroloculina angulosa	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Spiroloculina antillarium	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Spiroloculina asperta	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Spiroloculina aff. *S. caduca*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.3	0.0
Spiroloculina communis	0.0	0.0	0.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.6	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.9	0.0
Spiroloculina depressa	0.0	0.0	0.0	0.0	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Spiroloculina excavata	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Spiroloculina indica	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0
Spiroloculina planissima	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Spiroloculina rotunda	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Spiroloculina tricarinata	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0
Spiroloculina venusta	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.3	0.0
Spiroloculina sp.	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Spirophthalmidium acutimargo	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0
Spirophthalmidium sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0
Spirosigmoilina tenuis	0.0	0.9	0.3	0.0	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.6	1.9
Stainforthia concava	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subreophax cf. *S. monile*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Textularia agglutinans	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Textularia aff. *T. milletti*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Name of Species	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52
Textularia pseudogramen	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Trifarina carinata	0.0	0.0	0.0	1.9	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	3.0	0.0	0.0	1.9	0.0	0.0	0.0	0.0	0.0	0.6	0.0	1.7	0.0
Trifarina sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Triloculina insignis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	1.8	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0
Triloculina striatotrigonula	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0
Triloculina terquemiana	0.4	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0
Triloculina tricarinata	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.3	0.3	0.0	0.0	0.0	0.0	0.0	0.2	0.3	0.0
Triloculina trigonula	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	2.7	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0
Triloculinella sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0
Tritaxis challengeri	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Trochammina hadai	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Trochammina inflata	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Trochammina cf. *T. nana*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Usbekistania charoides	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.7	0.4	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.4	0.0	0.0	0.0	0.0
Uvigerina aculeata	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Uvigerina asperula	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Uvigerina cf. *U. auberiana*	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.3	0.0	0.0	0.0	0.0	0.0	0.0
Uvigerina bassensis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.3	0.0
Uvigerina bifurcata	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Uvigerina brunensis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Uvigerina canariensis	0.0	0.3	0.0	1.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.0	0.8	0.0	2.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.9	3.8
Uvigerina hollicki	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Uvigerina mediterranea	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Uvigerina peregrina	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Uvigerina proboscidea	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Uvigerina schlumbergeri	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Uvigerina schwageri	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Uvigerina vadenscens	0.0	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0
Uvigerina sp. A	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Uvigerina sp. B	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Vaginulina aff. *V. badenensis*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Vaginulina cf. *V. hemitemma*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Veleroninoides sp.	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Verneulinulla propinqua	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Vertebralina sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0
Virgulinella pertusa	0.0	0.0	1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	27.0	1.3	0.0	0.0	0.7	0.0	0.0	0.0	0.3	0.0	0.0	0.0

Annexure 1 (Contd.)

Annexure 2
COMPLETE LIST OF PUBLICATIONS

FULL PAPERS

1. Sumana Dasgupta, Jyotisankar Ray, **Abhijit Mazumder**, Niroj K. Sarkar, Sumita Das and Chandrani Dasgupta (2000). Correlation Characteristics among Minerological Parameters in Porphyritic Granite Bodies around Raghunathpur, Purulia District, West Bengal. *Journal Geological Society of India*, v.56, pp.263-270.
2. **Abhijit Mazumder**, Pravin J. Henriques and R. Nigam (2003). Distribution of benthic foraminifera within oxygen minima zone, off central West Coast of India. *Gondwana Geological Magazine*, special volume no.6, pp.5-12.
3. R. Saraswat, **A. Mazumder**, S. Kurtarkar, R. Nigam, and A. Ganguly (2003). Role of 12S mitochondrial gene on dimorphism and coiling direction in benthic foraminiferal species *Pararotalia nipponica*. *Gondwana Geological Magazine*, special volume no.6, pp.23-27.
4. Rajiv Nigam, Rajeev Saraswat and **Abhijit Mazumder** (2003). Life Spans of Planktonic Foraminifers: New Insight through Sediment Traps. *Journal of the Paleontological Society of India*, v.48, pp.129-133.
5. R. Saraswat, Sujata R. Kurtarkar, **A. Mazumder** and R. Nigam (2004). Foraminifers as indicators of Marine Pollution: A Culture Experiment with *Rosalina leei*. *Marine Pollution Bulletin*, v.48/1-2, pp.91-96.
6. Rajiv Nigam, **Abhijit Mazumder** and Rajeev Saraswat (2004). *Ammolagena clavata* (Jones and Parker) 1860, An Agglutinated Benthic Foraminiferal Species – First Report from the Indian Ocean Region. *Journal of Foraminiferal Research*, pp.74-78.
7. **Abhijit Mazumder** (2004). Benthic Foraminiferal Testimony to Late Pleistocene-Holocene Coral Reef and Sea Level Rise along Central West Coast of India, *in Synopsis of the Presentations of Young Scientists' Award Programme, Indian Science Congress Association*, pp.28-32.

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1. Rajiv Nigam, Pravin J. Henriques and **Abhijit Mazumder** (2002). Benthic Foraminifera within Oxygen Minima Zone – Are They Different in the Indian Ocean .from Other Regions? *in* XVIII Indian Colloquium on Micropaleontology and Stratigraphy, Nagpur, India.

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2. Rajiv Nigam, Subodh K. Chaturvedi and **Abhijit Mazumder** (2002). Coiling Direction in *Rotalidium annectens* – An Additional Tool in Deciphering the Paleostorms, *in* XVIII Indian Colloquium on Micropaleontology and Stratigraphy, Nagpur, India.
3. R. Nigam, A. Ganguly, **A. Mazumder**, R. Saraswat and S. Kurtarkar (2002). An attempt to Study Genetic Control on Dimorphism and Coiling Direction in Benthic Foraminiferal Species *Pararotalia nipponica*, *in* XVIII Indian Colloquium on Micropaleontology and Stratigraphy, Nagpur, India.
4. Rajiv Nigam, **Abhijit Mazumder** and Pravin J. Henriques (2002). Foraminiferal Evidences for Ancient Reef and Paleo-Shoreline along Central West Coast of India, *in* 39th Annual Convention and Meeting, Indian Geophysical Union, Nagpur, India.
5. R. Nigam, R. Saraswat, P. D. Naidu, **A. Mazumder**, V. Raiker and A. Y. Volvaiker (2002). Signatures of Global and Regional Climatic Events During Holocene in Northern Indian Ocean: Preliminary Clues from Mean Diameter Variation in *Orbulina universa*, *in* 39th Annual Convention and Meeting, Indian Geophysical Union, Nagpur, India.
6. Rajiv Nigam, Rajeev Saraswat and **Abhijit Mazumder** (2003). Sediment Traps: A Potential Technique to Determine life Spans of Planktonic Foraminifera, *in* International Workshop on Biogeochemical Processes in the Northern Indian Ocean, Goa, India.
7. R. Nigam, **A. Mazumder**, Sujata R. Kurtarkar and R. Saraswat (2003). Culture Studies: A Viable Tool to Evaluate Potentiality of Benthic Foraminifers for Pollution Monitoring in Near Shore Areas, *in* XIX Indian Colloquium on Micropaleontology and Stratigraphy, Banaras, India.
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9. **Abhijit Mazumder** (2004). A note on benthic foraminiferal testimony to Late Pleistocene-Holocene coral reef and sea level rise along central west coast of India, *in* Young Scientists' Award Programme, 91st Indian Science Congress, Chandigarh, India.

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10. Rajeev Saraswat, Rajiv Nigam, Sujata R. Kurtarkar and **Abhijit Mazumder** (2004). Response of Benthic Foraminiferal Species *Pararotalia nipponica* (Asano) to Salinity Variations in Laboratory Culture: Implications for Paleoclimatic Reconstruction, *in* National Symposium on Application of Marine Geosciences, National Institute of Oceanography, Goa, India.

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1. Rajiv Nigam, **Abhijit Mazumder** and Pravin Henriques (2000). Ghatata Badhta Samudra: Foraminifera Dwara Shodh ki Sambhavanayen. ONGC Bulletin, v.37, no.2, pp.1-6.
2. Subodh K. Chaturvedi, **Abhijit Mazumder**, Ranjay Sinha, Neloy Khare and Rajiv Nigam (2000). Vatavaran Pradushan se Utpanna Samasyawon ke nirakaran mein Foraminifera (Shukhma Jivashmo) Adharit Purajalvayu Adhyayan ki Mahatwapurna Bhumika. Bharat mein Vigyan ke Badhate Charan, pp.162-166.
3. Rajiv Nigam, Pravin Henriques, **Abhijit Mazumder** and C.V.Subbarao (2003). Bharat ke Durvarti Kendriya Pashchimi Tat ke Alpatama Oxygen Pradeshon men Nitalastha Chhidradhar Vitaran par Ek Tippani. Sager Bodh, pp.70-77.
4. Rajiv Saraswat, Rajiv Nigam and **Abhijit Mazumder** (2004). Avasad Trap: Kya, Kaise aur Kiyun? Samudrika, Samudri Skandha, Bharatiya Bhuvaigyanik Sarvekshan, v.11, pp.62-68.

Annexure 3
INDIAN SCIENCE CONGRESS ASSOCIATION "YOUNG SCIENTIST AWARD"

Indian Science Congress Association

INDIAN SCIENCE CONGRESS ASSOCIATION

ISCA YOUNG SCIENTIST AWARD

This is to certify that Abhijit Mazumder

participated in the 91st Indian Science Congress

held at Chandigarh during January 3-7, 2004

He/She is a recipient of

ISCA Young Scientist Award

by The Indian Science Congress Association

in the Section of Earth System Sciences

Asis Datta

January 7, 2004

Prof. Asis Datta

(General President)

Annexure 4

ALPHABETICAL LIST OF FORAMINIFERAL SPECIES RECORDED IN THE SURFACE AND SUBSURFACE SEDIMENTS, PAGE, PLATE AND FIG. NO.

Sr. No.	Species	Surface	Subsurface	Plate & Fig. No.	Page. No.
1.	*Adelosina laevigata*	√	√	3/6	95
2.	*Alveolophragmium orbiculatum*	√		1/22	83
3.	*Ammobaculites filiformis*	√		1/19	82
4.	*Ammodiscus incertus*	√		1/3	76
5.	*Ammoglobigerina globigeriniformis*	√		2/3	85
6.	*Ammolagena clavata*	√		1/4	76
7.	*Ammonia* aff. *A. globosa*	√	√	22/1	229
8.	*Ammonia ketienziensis angulata*	√	√	22/2	229
9.	*Ammonia sobrina*	√	√	22/3	229
10.	*Ammonia tepida*	√	√	22/4	230
11.	*Amphicoryna intercellularis*	√		10/7	136
12.	*Amphistegina lessonii*	√	√	19/10	214
13.	*Amphistegina radiata*	√	√	19/11	214
14.	*Astacolus crepidulus*	√		10/9	136
15.	*Asterigerinata* sp.	√	√	19/9	213
16.	*Asterorotalia dentata*	√	√	22/5	231
17.	*Asterorotalia inflata*	√	√	22/6	232
18.	*Baggina indica*	√	√	16/13	199
19.	*Baggina philippiensis*	√	√	16/14	199
20.	*Beella digitata*	√	√	13/2	163
21.	*Bifarilaminella advena*	√		12/5	156
22.	*Bolivina dilatata*	√		13/9	169
23.	*Bolivina doniezi*	√	√	13/10	169
24.	*Bolivina* cf. *B. inflata*	√		13/11	170
25.	*Bolivina kuriani*	√	√	13/12	170
26.	*Bolivina lowmani*	√	√	13/13	170
27.	*Bolivina marginata*	√	√	13/14	171
28.	*Bolivina* cf. *B. oceanica*	√	√	13/15	171
29.	*Bolivina ordinaria*	√	√	13/16	171
30.	*Bolivina* cf. *B. pacifica*	√	√	13/17	172
31.	*Bolivina persiensis*	√	√	13/18	172
32.	*Bolivina pseudoplicata*	√	√	13/19	172
33.	*Bolivina robusta*	√	√	13/20	173
34.	*Bolivina seminuda*	√	√	13/21	173
35.	*Bolivina silvestrina*	√	√	13/22	173
36.	*Bolivina spinata*	√	√	13/23	173
37.	*Bolivina spinescens*	√	√	13/24	174
38.	*Bolivina variabilis*	√	√	13/25	174
39.	*Bolivina* sp.	√	√	13/26	174
40.	*Bolivinella elegans*	√		14/1	177
41.	*Bombulina spinata*	√	√	12/8	157
42.	*Bolivinita quadrilatera*		√	14/2	177
43.	*Borelis* sp.	√		8/14	124
44.	*Botuloides pauciloculus*	√		9/3	125
45.	*Brizalina difformis*	√	√	13/27	175
46.	*Brizalina spathulata*	√	√	13/28	175
47.	*Brizalina striatula*	√	√	13/29	176
48.	*Bulimina aculeata*	√	√	15/4	184

Annexure 4 (Contd.)

49.	*Bulimina alazanensis*	√	√	15/5	184
50.	*Bulimina biserialis*	√	√	15/6	184
51.	*Bulimina exilis*	√	√	15/7	185
52.	*Bulimina gibba*	√	√	15/8	185
53.	*Bulimina marginata*	√	√	15/9	185
54.	*Bulimina mexicana*	√	√	15/10	186
55.	*Buliminella* cf. *B. milletti*	√	√	15/14	187
56.	*Cancris auricula*	√	√	16/15	199
57.	*Cancris oblonga*	√	√	16/16	200
58.	*Cancris sagra*	√	√	16/17	200
59.	*Cancris* sp.	√	√	16/18	201
60.	*Cassidulina* aff. *C. algida*	√	√	14/3	177
61.	*Cassidulina* cf. *C. crassa*	√	√	14/4	178
62.	*Cassidulina laevigata*	√	√	14/5	178
63.	*Cassidulina sicula*	√	√	14/6	178
64.	*Cassidulina subcarinata*	√	√	14/7	179
65.	*Cassidulina teretis*	√	√	14/8	179
66.	*Cassidulina tortuosa*	√	√	14/9	179
67.	*Cassidulinoides bradyi*	√	√	14/10	179
68.	*Ceratobulimina jonesiana*	√	√	12/9	158
69.	*Chilostomella oolina*	√	√	21/2	224
70.	*Cibicides* cf. *C. fletcheri*	√		18/13	209
71.	*Cibicides* cf. *C. labatulus*	√	√	19/1	209
72.	*Cibicides lucida*	√	√	18/2	210
73.	*Cibicides pachyderma*	√	√	19/2	210
74.	*Cibicides refulgens*	√	√	19/3	211
75.	*Cibicides* sp. A	√	√	19/5	211
76.	*Cibicides* sp. B	√	√	19/6	211
77.	*Cibicidina walli*	√	√	19/4	212
78.	*Cibicidoides bradii*	√	√	17/9	205
79.	*Cibicidoides cicatricosus*	√	√	17/10	205
80.	*Cibicidoides globulosus*	√	√	17/11	205
81.	*Cibicidoides* cf. *C. kullenbergi*	√	√	18/1	205
82.	*Cibicidoides wuellerstorfi*	√	√	18/3	206
83.	*Cornuspira involvens*	√		2/19	91
84.	*Cribromiliolinella* sp.	√		6/6	112
85.	*Cribrononion simplex*	√	√	22/10	234
86.	*Cribrostomoides* cf. *C. bradyi*	√	√	1/14	80
87.	*Cushmanina plumigera*	√		11/6	146
88.	*Cyclammina cancellata*	√	√	1/23	83
89.	*Cycloforina semiplicata*	√		4/4	102
90.	*Cystammina pauciloculata*	√		1/21	83
91.	*Dentalina cf. D. albatrossi*		√	9/4	125
92.	*Dentalina ariena*	√	√	9/15	125
93.	*Dentalina bradyensis*	√		9/16	126
94.	*Dentalina inflexa*	√		9/5	126
95.	*Dentalina turgoidea*	√	√	9/6	126
96.	*Dentalina* sp. A		√	9/8	126
97.	*Dentalina* sp. B		√	9/9	127
98.	*Dentalina* sp. C		√	9/10	127
99.	*Dentalina* sp. D		√	9/11	127
100.	*Dentalina* sp. E		√	9/12	127
101.	*Dentalina* sp. F		√	9/13	128
102.	*Edentostomina cultrata*	√		3/1	93

Annexure 4 (Contd.)

103.	*Edentostomina rupertiana*	√		3/2	93
104.	*Eggerella bradyi*	√	√	2/10	87
105.	*Elphidium advenum*	√	√	23/1	235
106.	*Elphidium crispum*	√	√	23/2	235
107.	*Elphidium discoidale*	√	√	23/3	236
108.	*Elphidium macellum*	√	√	23/4	237
109.	*Elphidium minutum*	√	√	23/5	237
110.	*Elphidium reticulosum*	√	√	23/6	238
111.	*Epistominella decorata*	√	√	18/4	206
112.	*Epistominella exigua*	√	√	18/5	207
113.	*Epistominella minuta*	√	√	18/6	207
114.	*Eponides repandus*		√	17/1	201
115.	*Eponides* sp.	√	√	17/2	202
116.	*Eratidus* cf. *E. foliaceus*	√		1/20	82
117.	*Fissurina annectens*	√	√	11/14	149
118.	*Fissurina bradyiformata*	√	√	11/16	149
119.	*Fissurina cucullata*	√	√	11/17	150
120.	*Fissurina* aff. *F. duplicata*		√	11/15	150
121.	*Fissurina earlandi*	√	√	11/18	150
122.	*Fissurina fissicarinata*	√	√	11/19	151
123.	*Fissurina imporcata*	√	√	11/20	151
124.	*Fissurina lagenoides*	√	√	11/21	151
125.	*Fissurina milletti*	√	√	11/22	151
126.	*Fissurina orbignyana*	√	√	11/23	152
127.	*Fissurina* aff. *F. pulchella*	√		11/24	152
128.	*Fissurina seguenziana*	√		11/25	152
129.	*Fissurina semimarginata*	√	√	11/26	152
130.	*Fissurina staphyllearia*	√		11/27	153
131.	*Fissurina* aff. *F. striolata*	√		11/28	153
132.	*Fissurina submarginata*	√	√	11/29	153
133.	*Fissurina wrightiana*	√	√	11/30	153
134.	*Fissurina* sp.	√	√	11/31	154
135.	*Francuscia extensa*	√	√	11/3	145
136.	*Fursenkoina bradyi*	√	√	16/2	195
137.	*Fursenkoina complanata*	√	√	16/3	195
138.	*Fursenkoina pontoni*	√	√	16/4	195
139.	*Fursenkoina* cf. *F. schreibersiana*	√	√	16/5	196
140.	*Fursenkoina texturata*	√	√	16/6	196
141.	*Gallitellia vivans*	√	√	12/11	159
142.	*Glandulina ovula*	√	√	12/6	156
143.	*Globigerina bulloides*	√	√	12/19	163
144.	*Globigerina falconensis*	√	√	12/20	164
145.	*Globigerinella aequilateralis*	√	√	12/21	165
146.	*Globigerinella calida*	√	√	13/1	165
147.	*Globigerinita glutinata*	√	√	12/16	162
148.	*Globigerinoides conglobatus*	√	√	13/3	166
149.	*Globigerinoides ruber*	√	√	13/4	166
150.	*Globigerinoides sacculifer*	√	√	13/5	167
151.	*Globobulimina* cf. *G. pacifica*	√	√	15/11	186
152.	*Globocassidulina oriangulata*	√	√	14/11	180
153.	*Globocassidulina subglobosa*	√	√	14/12	180
154.	*Globoquadrina conglomerata*	√	√	12/17	162
155.	*Globorotalia menardii*	√	√	12/12	159
156.	*Globoturborotalita rubescens*	√	√	13/7	168

Annexure 4 (Contd.)

157.	*Globulotuba* sp.	√	√	12/7	156
158.	*Gyroidina bradyi*	√	√	21/8	227
159.	*Gyroidina* cf. *G. pulisukensis*	√	√	21/9	227
160.	*Gyroidina* sp. A	√	√	21/10	227
161.	*Gyroidina* sp. B	√	√	21/11	227
162.	*Gyroidinoides orbicularis*	√	√	21/6	226
163.	*Gyroidinoides soldanii*	√	√	21/7	226
164.	*Haplophragmoides* cf. *H. tenuis*	√		1/15	80
165.	*Haplophragmoides* sp. A	√		1/16	81
166.	*Haplophragmoides* sp. B	√	√	1/17	81
167.	*Hauerina fragilissima*	√		4/5	102
168.	*Heterolepa subhaidingerii*	√	√	21/5	225
169.	*Heteromorphina* sp.	√	√	11/7	147
170.	*Heterostegina* sp.	√		23/7	238
171.	*Hoeglundina* cf. *H. elegans*	√	√	12/10	158
172.	*Hopkinsinella glabra*	√	√	14/15	181
173.	*Hormosina globulifera*	√		1/10	79
174.	*Hormosina spiculifera*	√		1/11	79
175.	*Hyalinea balthica*	√	√	18/12	208
176.	*Islandiella* sp.	√	√	14/13	180
177.	*Karreriella* cf. *K. chilostoma*	√	√	2/11	88
178.	*Karrerotextularia* sp.	√	√	2/17	91
179.	*Karrerulina erigona*	√	√	2/8	87
180.	*Laevidentalina aphelis*	√		9/14	128
181.	*Laevidentalina filiformis*	√	√	9/17	128
182.	*Lagena alticostata*	√	√	10/30	137
183.	*Lagena caudata*	√	√	10/13	138
184.	*Lagena doveyensis*	√	√	10/14	138
185.	*Lagena elongata*	√		10/15	138
186.	*Lagena favosiformis proba*		√	10/16	138
187.	*Lagena flatulenta*	√	√	10/17	139
188.	*Lagena gibbera*	√	√	10/18	139
189.	*Lagena hispida*	√	√	10/20	139
190.	*Lagena laevis*	√	√	10/21	139
191.	*Lagena lyellii*	√	√	10/31	140
192.	*Lagena multilatera*	√	√	10/22	140
193.	*Lagena* cf. *L. multilatera chathamensis*	√	√	10/23	140
194.	*Lagena* cf. *L. oceanica*	√	√	10/24	141
195.	*Lagena paradoxa*	√	√	10/25	141
196.	*Lagena pecularis*	√	√	10/32	141
197.	*Lagena spiratiformis*	√		10/26	142
198.	*Lagena striata*	√	√	10/27	142
199.	*Lagena substriata elegantula*	√		10/28	142
200.	*Lagena sulcata*	√	√	10/29	143
201.	*Lagena* aff. *L. undulata*	√	√	10/19	143
202.	*Laticarinina pauperata*	√	√	18/8	208
203.	*Lenticulina angulata*	√	√	9/25	131
204.	*Lenticulina calcar*	√	√	9/26	132
205.	*Lenticulina crassa*	√	√	9/27	132
206.	*Lenticulina cultrata*	√	√	9/29	132
207.	*Lenticulina* cf. *L. gibba*	√		9/30	133
208.	*Lenticulina limbosa*	√		9/31	133
209.	*Lenticulina limbosus chiriguanoi*	√	√	9/32	133
210.	*Lenticulina macrodiscus*	√	√	10/1	134

Annexure 4 (Contd.)

211.	*Lenticulina pliocaena*	√	√	10/3	134
212.	*Lenticulina subcarinata*	√	√	10/2	134
213.	*Lenticulina thalmanni*	√	√	10/4	135
214.	*Lenticulina* sp.	√	√	10/5	135
215.	*Loxostomina limbata*	√	√	14/16	182
216.	*Marginopora vertebralis*	√	√	9/2	124
217.	*Melonis barleeanum*	√	√	20/15	222
218.	*Melonis pompiloides*	√	√	20/16	222
219.	*Melonis soldani*	√	√	20/17	223
220.	*Mesosigmoilina minuta*	√	√	8/11	122
221.	*Metapolymorphina* sp.	√	√	11/4	146
222.	*Miliolinella australis*	√		6/7	113
223.	*Miliolinella circularis*	√		6/8	113
224.	*Miliolinella labiosa*	√	√	6/9	114
225.	*Miliolinella lamellidens*	√		6/10	114
226.	*Miliolinella lutea*	√	√	6/11	114
227.	*Miliolinella oblonga*	√	√	6/12	114
228.	*Miliolinella* cf. *M. oceanica*	√		7/1	115
229.	*Miliolinella subrotunda*	√	√	7/2	115
230.	*Miliolinella warreni*	√		7/3	115
231.	*Miliolinella* sp.	√		7/4	116
232.	*Murrayinella* cf. *M. murrayi*	√		17/8	204
233.	*Neoconorbina parkerae*	√		17/4	203
234.	*Neoconorbina terquemi*	√	√	17/5	203
235.	*Neoeponides praecinctus*	√	√	17/3	202
236.	*Neogloboquadrina dutertrei*	√	√	12/13	160
237.	*Neogloboquadrina hexagona*	√	√	12/18	160
238.	*Neogloboquadrina pachyderma*	√	√	12/14	161
239.	*Neouvigerina ampullacea*	√	√	15/16	187
240.	*Neouvigerina interrupta*	√	√	15/17	188
241.	*Nodosaria catesbyi*	√	√	9/18	129
242.	*Nodosaria lamnulifera*	√		9/19	129
243.	*Nodosaria pausiloculata*	√		9/20	129
244.	*Nodosaria vertebralis*	√		9/7	130
245.	*Nodosaria* sp.	√	√	9/21	130
246.	*Nonion* cf. *N. asterizans*	√	√	19/12	215
247.	*Nonion* aff. *N. depressulum*	√	√	19/13	215
248.	*Nonion incisum*	√	√	19/14	215
249.	*Nonion pacificum*	√		20/1	216
250.	*Nonion scaphum*	√	√	20/2	216
251.	*Nonion sloanii*	√	√	20/3	217
252.	*Nonionella auricula*	√	√	20/4	217
253.	*Nonionella auris*	√	√	20/5	218
254.	*Nonionella basispinata*	√	√	20/6	218
255.	*Nonionella hantkeni*	√	√	20/9	218
256.	*Nonionella* cf. *N. japonica*	√	√	20/7	219
257.	*Nonionella* cf. *N. limbato-striata*	√	√	20/8	219
258.	*Nonionella opima*	√	√	20/10	219
259.	*Nonionella turgida*	√	√	20/11	220
260.	*Nonionoides boueanum*	√	√	20/12	220
261.	*Nonionoides elongatum*	√	√	20/13	221
262.	*Nonionoides grateloupi*	√	√	20/14	222
263.	*Oolina apiopleura*	√	√	11/8	147
264.	*Oolina felsinea*	√	√	11/9	147

Annexure 4 (Contd.)

265.	*Oolina globosa*	√	√	11/10	148
266.	*Oolina lineata*	√		11/12	148
267.	*Oolina setosa*	√		11/11	148
268.	*Oolina truncata*	√	√	11/13	149
269.	*Operculina complanata*	√	√	23/8	239
270.	*Operculina granulosa*	√	√	23/9	239
271.	*Ophthalmidium* sp.	√	√	3/3	93
272.	*Orbulina universa*	√	√	13/8	168
273.	*Orectostomina camposi*		√	2/1	84
274.	*Oridorsalis* sp.	√	√	21/4	225
275.	*Orthomorphina* aff. *O. parvula*	√		16/10	198
276.	*Osangularia bengalensis*	√	√	21/3	225
277.	*Paleomiliolina* sp.	√		3/7	95
278.	*Parafissurina* aff. *P. arctica*	√	√	11/32	154
279.	*Parafissurina fusiformis*	√	√	11/33	154
280.	*Parafissurina himatiostoma*	√	√	12/1	155
281.	*Parafissurina lateralis*	√	√	12/2	155
282.	*Parafissurina subcarinata*	√	√	12/3	155
283.	*Pararotalia* cf. *P. calcar*	√	√	21/12	228
284.	*Parasorites marginalis*	√		9/1	124
285.	*Patellinella inconspicua*	√		16/11	198
286.	*Patellinella* sp.	√	√	16/12	198
287.	*Pilulina* sp.	√		1/1	75
288.	*Planispirinella exigua*	√		2/20	92
289.	*Planorbulina mediterranensis*	√		19/7	212
290.	*Planularia australis*	√		10/10	127
291.	*Planulinoides* sp.	√	√	18/7	207
292.	*Pleurostomella* sp.	√	√	16/9	197
293.	*Praeglobobulimina ovata*	√	√	15/12	186
294.	*Praeglobobulimina pupoides*	√	√	15/13	187
295.	*Procerolagena distoma*	√		10/33	143
296.	*Procerolagena gracilis*	√	√	10/35	144
297.	*Procerolagena ingens*	√	√	10/34	144
298.	*Proxifrons advena*	√	√	9/24	131
299.	*Pseudoeponides pauciloculata*	√	√	19/8	213
300.	*Pseudofissurina* sp.	√	√	12/4	155
301.	*Pseudohauerina orientalis*	√		8/13	123
302.	*Pullenia bulloides*	√	√	20/18	223
303.	*Pullenia quinqueloba*	√	√	21/1	224
304.	*Pulleniatina obliquiloculata*	√	√	12/15	161
305.	*Pygmaeoseistron hispidulum*	√	√	11/1	145
306.	*Pygmaeoseistron nebulosum*	√	√	11/2	145
307.	*Pyramidulina cancellata*	√		9/22	130
308.	*Pyramidulina* cf. *P. eptagona*	√		9/23	131
309.	*Pyrgo* cf. *P. denticulata*	√	√	7/5	116
310.	*Pyrgo elongata*	√		7/6	116
311.	*Pyrgo laevis*	√	√	7/7	117
312.	*Pyrgo* cf. *P. nasutus*	√	√	7/8	117
313.	*Pyrgo striolata*	√		7/9	117
314.	*Pyrgo* sp. A		√	7/10	117
315.	*Pyrgo* sp. B		√	8/1	118
316.	*Pyrgo* sp. C		√	8/2	118
317.	*Pyrgo* sp. D		√	8/3	118
318.	*Pyrgo* sp. E		√	8/4	118

Annexure 4 (Contd.)

319.	*Pyrulina gutta*		√	11/5	146
320.	*Quinqueloculina* cf. *Q. annectens*	√		4/6	102
321.	*Quinqueloculina berthelotiana*	√	√	4/7	103
322.	*Quinqueloculina bicarinata*	√		4/8	103
323.	*Quinqueloculina distorqueata*	√		4/9	104
324.	*Quinqueloculina echinata*	√		4/10	104
325.	*Quinqueloculina elegens*	√	√	4/11	104
326.	*Quinqueloculina* cf. Q. *inaequalis*	√	√	4/12	105
327.	*Quinqueloculina kerimbatica*	√		4/13	105
328.	*Quinqueloculina lamarckiana*	√	√	5/1	105
329.	*Quinqueloculina mosharrafai*	√		5/2	106
330.	*Quinqueloculina multimarginata*	√	√	5/3	106
331.	*Quinqueloculina parkeri*	√	√	5/4	107
332.	*Quinqueloculina polygona*	√		5/5	107
333.	*Quinqueloculina pseudoreticulata*	√		5/6	107
334.	*Quinqueloculina quadrilateralis*	√		5/7	108
335.	*Quinqueloculina rhodiensis*	√		5/8	108
336.	*Quinqueloculina schlumbergeri*	√	√	5/9	108
337.	*Quinqueloculina seminulum*	√	√	6/3	109
338.	*Quinqueloculina subpolygona*	√		5/10	110
339.	*Quinqueloculina sulcata*	√	√	5/11	110
340.	*Quinqueloculina trigonula*	√	√	5/12	110
341.	*Quinqueloculina undulose costata*	√		6/1	111
342.	*Quinqueloculina venusta*	√	√	6/2	111
343.	*Quinqueloculina vulgaris*	√	√	6/4	111
344.	*Quinqueloculina* sp.	√		6/5	112
345.	*Rectobolivina* sp.		√	15/1	182
346.	*Reophanus ovicula*	√		1/13	79
347.	*Reophax mortenseni*	√	√	1/6	77
348.	*Reophax nodulosus*	√		1/7	78
349.	*Reussella laevigata*	√	√	15/35	194
350.	*Reussella spinulosa*	√	√	16/1	194
351.	*Rosalina globularis*	√	√	17/6	203
352.	*Rosalina* sp.	√	√	17/7	204
353.	*Rotalidium annectens*	√	√	22/7	232
354.	*Rotalinoides papillosus*	√	√	22/9	233
355.	*Saccorhiza ramosa*	√		1/2	75
356.	*Sagrinella convallaria*	√	√	15/3	183
357.	*Sagrinella* cf. *S. guinai*	√	√	15/2	183
358.	*Sahulia conica*		√	2/12	88
359.	*Saracenaria latifrons*	√		10/6	135
360.	*Scherochorella* sp.	√		1/8	78
361.	*Sigmavirgulina tortuosa*	√	√	16/7	196
362.	*Siphonaperta* cf. *agglutinans*	√		4/2	101
363.	*Siphonaperta horrida*	√	√	4/3	101
364.	*Siphotextularia* cf. *S. concava*	√	√	2/18	91
365.	*Siphouvigerina porrecta*	√	√	15/18	188
366.	*Spiroloculina angulata*	√		3/8	95
367.	*Spiroloculina angulosa*	√	√	3/9	96
368.	*Spiroloculina antillarium*	√		3/10	96
369.	*Spiroloculina aperta*	√		3/11	97
370.	*Spiroloculina* aff. S. *caduca*	√	√	3/12	97
371.	*Spiroloculina communis*	√	√	3/13	97
372.	*Spiroloculina depressa*	√	√	3/14	98

Annexure 4 (Contd.)

373.	*Spiroloculina excavata*	√		3/15	98
374.	*Spiroloculina indica*	√	√	3/16	99
375.	*Spiroloculina planissima*	√		3/17	99
376.	*Spiroloculina rotunda*	√	√	3/18	99
377.	*Spiroloculina tricarinata*	√	√	3/19	100
378.	*Spiroloculina venusta*	√		3/20	100
379.	*Spiroloculina* sp.	√	√	4/1	100
380.	*Spirophthalmidium acutimargo*	√	√	3/4	94
381.	*Spirophthalmidium* sp.	√	√	3/5	94
382.	*Spiroplectinella sagittula*		√	2/2	84
383.	*Spirosigmoilina tenuis*	√	√	8/12	123
384.	*Stainforthia concava*	√		14/14	181
385.	*Subreophax* cf. *S. monile*	√		1/9	78
386.	*Textularia agglutinans*	√	√	2/13	89
387.	*Textularia foliacea*		√	2/14	90
388.	*Textularia* aff. *T. milletti*	√	√	2/15	90
389.	*Textularia pseudogramen*	√	√	2/16	90
390.	*Trifarina carinata*	√	√	15/33	193
391.	*Trifarina* sp.	√	√	1/534	193
392.	*Triloculina insignis*	√		8/5	119
393.	*Triloculina striatotrigonula*	√		8/6	119
394.	*Triloculina terquemiana*	√	√	8/7	120
395.	*Triloculina tricarinata*	√	√	8/8	120
396.	*Triloculina trigonula*	√	√	8/9	121
397.	*Triloculinella* sp.	√		8/10	122
398.	*Tritaxis challengeri*	√		2/4	85
399.	*Trochammina hadai*	√		2/6	85
400.	*Trochammina* cf. *T. nana*	√		2/5	86
401.	*Trochammina inflata*	√		2/7	86
402.	*Usbekistania charoides*	√		1/5	77
403.	*Uvigerina aculeata*	√		15/15	189
404.	*Uvigerina asperula*	√		15/19	189
405.	*Uvigerina* cf. *U. auberiana*	√	√	15/20	189
406.	*Uvigerina bassensis*	√	√	15/21	190
407.	*Uvigerina bifurcata*	√	√	15/22	190
408.	*Uvigerina brunnensis*	√	√	15/23	190
409.	*Uvigerina canariensis*	√	√	15/24	190
410.	*Uvigerina hollicki*	√	√	15/25	191
411.	*Uvigerina mediterranea*	√	√	15/26	191
412.	*Uvigerina peregrina*	√	√	15/27	191
413.	*Uvigerina proboscidea*	√	√	15/28	191
414.	*Uvigerina schwageri*	√		15/30	192
415.	*Uvigerina vadescens*	√	√	15/29	192
416.	*Uvigerina* sp. A	√	√	15/31	192
417.	*Uvigerina* sp. B	√	√	15/32	193
418.	*Vaginulina* aff. *V. badenensis*	√		10/11	137
419.	*Vaginulina* cf. *V. hemitemna*	√		10/12	137
420.	*Veleroninoides* sp.	√		1/18	81
421.	*Verneuilinulla propinqua*	√		2/9	87
422.	*Vertebralina* sp.	√		2/21	92
423.	*Virgulinella pertusa*	√	√	16/8	197