

## Quantitative Distribution of Planktonic Foraminifera in the South-West Coast of India

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Twenty-six species of planktonic Foraminifera have been identified from plankton and sediment samples, collected during the *Blue-Fin* cruise-4 in March 1971, from the south-eastern Arabian Sea. Shelf waters are dominated by species belonging to the genera *Globigerinoides*, *Globoquadrina* and *Globigerinita* while the bathyal regions are represented by species of the genera *Globorotalia* and *Sphaeroidinella*. Some species such as *Globigerinoides conglobatus*, *G. sacculifer*, *Globorotalia menardii*, *G. tumida*, *Pulleniatina obliquiloculata* and *Sphaeroidinella dehiscens* which are characteristic of low-latitude regions of the world oceans are encountered in the south-west coast of India. As compared with the Bay of Bengal, in the Arabian Sea fauna there is a great diversity of species which can be attributed to increased salinity of the Arabian Sea waters. The quantitative distribution of this group shows that very high concentrations of these Foraminifera are present in the offshore regions of Alleppey and Quilon.

IN view of the importance of planktonic Foraminifera as sediment producers and indicators of oceanographic conditions of the sea besides being useful in dating sediments, increased interest has been laid on studies related to taxonomy, ecology and distribution of this group in the world oceans. In comparison with the Indian Ocean, the Pacific and Atlantic Oceans have been studied in greater detail with respect to planktonic Foraminifera. Although earlier expeditions, *Challenger* (1872-76) and John Murray (1939), have made significant contributions on the presence and distribution of planktonic Foraminifera, information on ecology and geochronology of this group in the Indian Ocean could be obtained only after the beginning of International Indian Ocean Expedition (1962-65).

Research cruises of INS *Darshak* conducted by the Institute during 1966-69 have given a considerable account of planktonic Foraminifera present in the north-west coast of India<sup>1-4</sup>. No detailed study has been made on quantitative distribution of the species apart from reports<sup>5-7</sup> on some common forms in the south-eastern Arabian Sea. The present study has been taken up to determine the species composition of planktonic Foraminifera and distribution in the investigated area, based on plankton and sediment samples collected on board *Blue-Fin*, a fishing trawler belonging to Central Institute of Fisheries Operatives, Cochin. Fifteen plankton samples have been collected towards the sea perpendicular to the coast off Cochin, Alleppey and Quilon and also 3 sediment samples have been obtained from the coast off Cochin. Locations from which these samples were collected are given in Fig. 1.

### Materials and Methods

Plankton and sediment samples were examined for the specimens of planktonic Foraminifera. Vertical hauls of plankton were made at all the stations 1 to 15 using the Heron-Tranter net (mouth area, 0.25 m<sup>2</sup>; net length, 2.50 m; aperture size,

0.2 mm). For the determination of the amount of water passed through meshes of the net, a Rigosha flow meter was used at the centre of the net. Three sediment samples at stations 3 to 5 were collected with a Lafond-Dietz snapper.

### Oceanographic Conditions

Two distinct water masses have been identified along the south-west coast of India: (i) Arabian Sea Water and (ii) Equatorial Surface Water. The salinity of Arabian Sea Water has a value ranging

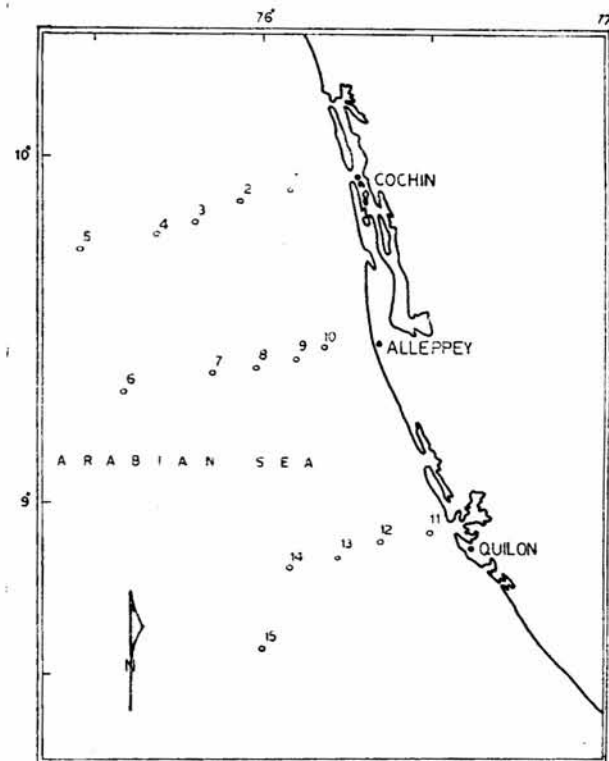


Fig. 1 — Location of stations

from 35 to 35.5‰ during postmonsoon season and it decreases with depth. Sinking of this water mass takes place during winter and is replaced by Equatorial Surface Water which moves northwards along the coast. In this water salinity increases from the surface downwards. It has been found that a salinity maxima layer of water exists between the two water masses. During premonsoon months, relatively stable hydrographic conditions exist in the waters of south-eastern Arabian Sea. Collections of samples have been made in March 1971 from the above region during the *Blue-Fin* cruise-4 and hydrographic observations during this cruise are confined to the measurements of salinity and temperature of surface water. In the coast off Cochin salinity varies from 33.2 to 33.45‰ and temperature from 29° to 29.7°C; in the Alleppey coast, salinity varies from 33.45 to 33.65‰ and temperature from 28.5° to 29.1°C; and in the Quilon cruise track, salinity varies from 33.7 to 34.05‰ and temperature from 28.7° to 29.9°C.

#### Systematics

Twenty-six species of planktonic Foraminifera have been identified from the plankton and sediment samples collected and the classification adopted agrees with that of Parker<sup>8</sup>.

### Order FORAMINIFERIDA

#### Family GLOBIGERINIDAE Carpenter, Parker & Jones, 1862

##### Genus *Globigerina* d'Orbigny, 1826

##### *Globigerina bulloides* d'Orbigny

*Globigerina bulloides*, d'Orbigny<sup>9</sup>; Parker<sup>8</sup>; Be' and Hamlin<sup>10</sup>; Bhatt<sup>11</sup>

This species is characterized by a strongly arched umbilical aperture with no lip.

It has been observed in the plankton samples from the sites where depth of water is more than 50 m and also in the sediment samples from sites 3, 4 and 5. The greatest abundance 1710 specimens/1000 m<sup>3</sup> of water is found at station 6 off Alleppey.

##### *Globigerina calida* Parker

*Globigerina calida*, Parker<sup>8</sup>; Bhatt<sup>11</sup>

Specimens of this species have a trochospiral test with radially elongated final chamber with an umbilical extraumbilical aperture having a distinct lip. It is found in the plankton samples at stations 4 and 6 and in the sediment samples collected off Cochin.

##### *Globigerina falconensis* Blow

*Globigerina falconensis*, Blow<sup>12</sup>; Parker<sup>8</sup>

This species resembles *Globigerina bulloides*, but it can be readily distinguished from the latter by its low arched umbilical aperture with a lip. It is not encountered in the plankton samples. In the sediment samples at stations 3 and 5 off Cochin it formed slightly more than 5% of the total fauna.

##### *Globigerina pachyderma* (Ehrenberg)

*Aristerospira pachyderma*, Ehrenberg<sup>13</sup>; *Globigerina pachyderma*, Parker<sup>8</sup>; Be' and Hamlin<sup>10</sup>; Bhatt<sup>11</sup>

Specimens typical of tropical warm waters having shells coiled towards right side have been found in the sediment sample at station 5 forming only 1% of the total fauna. This species has not been observed in the plankton samples.

##### *Globigerina quinqueloba* Natland

*Globigerina quinqueloba*, Natland<sup>14</sup>; Parker<sup>8</sup>; Be' and Hamlin<sup>10</sup>; Bhatt<sup>11</sup>

This form can be distinguished by its 5-6 chambers in the final whorl with a final chamber extending over the umbilicus.

It has been found in the sediment samples from sites 2 and 3 off Cochin.

##### *Globigerina rubescens* Hofker

*Globigerina rubescens*, Hofker<sup>15</sup>; Parker<sup>8</sup>; Be' and Hamlin<sup>10</sup>

This small species which is characteristic of tropical waters has been observed in the plankton samples at stations 7, 14 and 15. It formed less than 5% of the total fauna in the sediments collected from stations 4 and 5 off Cochin.

#### Genus *Globigerinella* Cushman, 1927

##### *Globigerinella aequilateralis* (Brady)

*Globigerinella siphonifera* (d'Orbigny), Parker<sup>8</sup>; Bhatt<sup>11</sup>; *Globigerinella aequilateralis*, Be' and Hamlin<sup>10</sup>

It has a test with planispirally arranged chambers in the adult with an equatorial aperture which is interiomarginal.

This species has been observed in plankton samples from the offshore regions 4, 6 and 15 off Cochin, Alleppey and Quilon respectively. Also, in the sediment samples collected from the offshore region of Cochin.

##### *Globigerinella adamsi* (Banner and Blow)

*Hastigerina (Bolliella) adamsi*, Banner and Blow<sup>16</sup>; *Globigerinella adamsi*, Parker<sup>8</sup>

Test planispiral with radially elongated final chambers as in *Globigerina calida* and *G. digitata*. It has an umbilical equatorial aperture which is interiomarginal.

This is a rare species found at stations 6 and 7 (in plankton samples) and 5 (in the sediment).

#### Genus *Hastigerina* Thomson, 1876

##### *Hastigerina pelagica* (d'Orbigny)

*Hastigerina pelagica*, Brady<sup>17</sup>; Parker<sup>8</sup>; Be' and Hamlin<sup>10</sup>

Test planispiral with triradiate spines, aperture equatorial. This species is common in tropical waters.

In the samples collected it has been observed in two plankton tows (stations 7 and 15) and in the sediment (station 5). In both sample types it constitutes less than 5% of the total fauna.

#### Genus *Globigerinoides* Cushman, 1927

*Globigerinoides conglobatus* (Brady)

*Globigerina conglobata*, Brady<sup>18</sup>; *Globigerinoides conglobatus*, Parker<sup>8</sup>

Test trochospiral with four chambers in the final whorl with an umbilical aperture on the ventral side and two secondary apertures for each chamber on the dorsal side.

It is observed in plankton tows from the sites 6, 7 and 14 and in all sediment samples collected from the coast off Cochin. In both types of samples, it forms less than 5% of the total fauna.

*Globigerinoides ruber* (d'Orbigny)

*Globigerina rubra*, d'Orbigny<sup>19</sup>; *Globigerinoides ruber*, Parker<sup>8</sup>; Be' and Hamlin<sup>10</sup>; Bhatt<sup>11</sup>

This species is common in the south-west coast of India and observed at most of the stations studied.

*Globigerinoides sacculifer* (Brady)

*Globigerina sacculifera*, Brady<sup>20</sup>; *Globigerinoides quadrilobatus sacculifer*, Parker<sup>8</sup>; *Globigerinoides sacculifer*, Be' and Hamlin<sup>10</sup>

This species can be identified easily by its sac-like final chamber with a secondary aperture for each chamber on the dorsal side.

It is found in most plankton samples collected from the areas where the depth of water is less than 200 m and forms more than 5% of the total fauna whereas in the sediments collected from the coast off Cochin it never exceeded 5% of the fauna.

#### Genus *Orbulina* d'Orbigny, 1839

*Orbulina universa* d'Orbigny

*Orbulina universa*, d'Orbigny<sup>19</sup>; Parker<sup>8</sup>; Be' and Hamlin<sup>10</sup>

Adult specimens with a spherical test have been observed. This species is widely distributed in Atlantic, Pacific and Indian Oceans.

It is observed in plankton tows at stations 5, 6, 14 and 15 and forms more than 10% of the total fauna in the offshore areas of Alleppey and Quilon and less than 10% in the sediments collected from the coast off Cochin.

#### Genus *Pulleniatina* Cushman, 1927

*Pulleniatina obliquiloculata* (Parker & Jones)

*Pulleniatina obliquiloculata*, Carpenter, Parker & Jones<sup>21</sup>; Be' and Hamlin<sup>10</sup>

Test with 3½ chambers in the final whorl of the test, aperture extraumbilical and wall smooth.

It is found in plankton samples at stations 7 and 14 forming more than 5% of the total fauna and is common in the offshore region of Cochin.

#### Genus *Sphaeroidinella* Cushman, 1927

*Sphaeroidinella dehiscens* (Parker & Jones)

*Sphaeroidina bulloides* d'Orbigny var. *dehiscens*, Parker & Jones<sup>22</sup>; *Sphaeroidinella dehiscens*, Parker<sup>8</sup>

It is a typical low-latitude species observed in the plankton samples at stations 5, 14 and 15 off Cochin and Quilon and also in the sediment sample from station 5.

#### Genus *Globorotalia* Cushman, 1927

*Globorotalia crassaformis* (Galloway & Wissler)

*Pulvinulina crassa* (d'Orbigny), Brady<sup>17</sup>; *Globorotalia crassaformis*, Parker<sup>8</sup>; Be' and Hamlin<sup>10</sup>

This is a rare species observed in the sediment sample at station 5 off Cochin.

*Globorotalia inflata* (d'Orbigny)

*Globigerina inflata*, d'Orbigny<sup>23</sup>; *Globorotalia inflata*, Parker<sup>8</sup>; Be' and Hamlin<sup>10</sup>

Test with 4-5 chambers in the final whorl having coiled to the left side are encountered; wall non-spinose.

It has been observed in a single plankton sample at station 6 off Alleppey.

*Globorotalia hirsuta* d'Orbigny

*Rotalina hirsuta*, d'Orbigny<sup>23</sup>; *Globorotalia hirsuta*, Parker<sup>8</sup>; Be' and Hamlin<sup>10</sup>

Test trochospiral compressed and surface covered with very fine spine like structures. Aperture extending from the umbilicus to the periphery with a distinct lip.

It has been observed in the plankton sample (station 6) off Alleppey and in the sediment samples (stations 4 and 5) off Cochin forming less than 2% of the total fauna.

*Globorotalia truncatulinoides* d'Orbigny

*Rotalia truncatulinoides*, d'Orbigny<sup>23</sup>; *Globorotalia truncatulinoides*, Parker<sup>8</sup>; Be' and Hamlin<sup>10</sup>

This species is rare in the area studied. In the plankton sample (station 6) and sediment samples (stations 4 and 5), it forms 1% of the total fauna.

*Globorotalia menardii* (d'Orbigny)

*Rotalia (Rotalie) menardii*, d'Orbigny<sup>9</sup>; *Globorotalia cultrata*, Parker<sup>8</sup>; *Globorotalia menardii*, Be' and Hamlin<sup>10</sup>; Bhatt<sup>11</sup>

This species is common in the south-west coast of India and forms less than 10% of the total fauna in the plankton samples at stations 5-7, 14 and 15. It is also found in the sediment samples collected from the coast off Cochin forming more than 5% of the fauna.

*Globorotalia menardii flexuosa* (Koch)

*Globorotalia menardii flexuosa*, Be' and McIntyre<sup>1</sup>

Be' and McIntyre<sup>1</sup> discovered for the first time this species in living condition from the Indian



Ocean but not recorded so far from the recent deposits of Atlantic and Pacific Oceans.

In the present study it has been taken from plankton and sediment samples collected from station 5 off Cochin.

*Globorotalia tumida* (Brady)

*Pulvinulina menardii* (d'Orbigny) var. *tumida*, Brady<sup>20</sup>; *Globorotalia tumida*, Parker<sup>8</sup>

Test with 5-6 chambers in the final whorl and is elongated towards the final chamber.

This species is observed at 7 stations (3 to 7, 14 and 15) in the plankton samples. Like *G. menardii*, this species also forms 5% of the total population of planktonic Foraminifera in the sediment samples collected.

**Genus *Globoquadrina* Finlay, 1947**

*Globoquadrina conglomerata* Schwager

*Globigerina conglomerata*, Schwager<sup>24</sup>; Banner and Blow<sup>25</sup>; *Globoquadrina conglomerata*, Parker<sup>8</sup>

Adult specimens have four chambers in the final whorl, surface pitted and aperture umbilical. It is known so far only from the Indo-Pacific region and has been observed in the sediment samples collected from the coast off Cochin.

*Globoquadrina dutertrei* (d'Orbigny)

*Globigerina dutertrei*, d'Orbigny<sup>19</sup>; *Globoquadrina dutertrei*, Parker<sup>8</sup>; Be' and Hamlin<sup>10</sup>; Bhatt<sup>11</sup>

It can be readily distinguished by the presence of umbilical teeth, test wall pitted and nonspinose. It is common in the nearshore waters of south-eastern Arabian Sea and forms more than 5% of the fauna in the sediment sample at station 4.

*Globoquadrina hexagona* (Natland)

*Globigerina hexagona*, Natland<sup>14</sup>; *Globoquadrina hexagona*, Parker<sup>8</sup>

Test compressed with 5 to 6 chambers in the final whorl of the adult, wall pitted and non-spinose. Aperture umbilical and in some cases it is extraumbilical with teeth. This species is restricted to Indo-Pacific region. In the present investigation it is found in the sediment sample from station 3 constituting only 1% of the total fauna.

**Incertae Familiae**

**Genus *Globigerinita* Bronnimann, 1951**

*Globigerinita glutinata* (Egger)

*Globigerina glutinata*, Egger<sup>26</sup>; *Globigerinita glutinata*, Parker<sup>8</sup>; Be' and Hamlin<sup>10</sup>; Bhatt<sup>11</sup>

Typical specimens with a bulla covering the umbilical region have been encountered. In the plankton samples at stations 5, 6, 8, 14 and 15 and in the sediment sample at station 3, it forms more than 10% of the total fauna.

**Results and Discussion**

The planktonic foraminiferal assemblage of the south-eastern Arabian Sea is a mixed one consisting of low-latitude, mid-latitude and high-latitude faunal elements. In general, the fauna is dominated by species characteristic of low-latitude waters of the world oceans and they are represented by *Globigerinoides conglobatus*, *G. sacculifer*, *Globorotalia menardii*, *G. tumida*, *Pulleniatina obliquiloculata* and *Sphaeroidinella dehiscens*. Yet another species which is found to be more abundant in the south-west coast of India is *Orbulina universa*. Kustanowich<sup>27</sup> also has observed that it occurs in greater frequencies in the lower latitudes. Mid-latitude types are composed of *Globorotalia crassaformis*, *G. hirsuta*, *G. inflata*, *G. truncatulinoides* and *Globigerina bulloides* while the high-latitude form *Globigerina pachyderma* also has been found in the fauna. Both mid-latitude (with the exception of *Globigerina bulloides*) and high-latitude forms are rare in the area studied. Their presence in the low-latitude waters of the Kerala coast can be attributed to the action of water currents. Cifelli<sup>28</sup> ascribed this overlapping of different faunal elements to temperature tolerance or adaptability of different planktonic foraminiferal species as seen in the case of cold water species living over a wide range of sea water temperatures. From the information available on range of temperature tolerance of planktonic foraminiferal species, it is obvious that the grouping of species with reference to different ranges of temperatures of sea water<sup>29,30</sup> seems to be satisfactory when compared with the classification of species according to latitude as suggested by Phleger *et al.*<sup>31</sup>. Three forms, *Globoquadrina conglomerata*, *G. hexagona* and *Globigerinella adamsi*, which are found only in Indo-Pacific region have also been encountered in the area studied. A striking feature of low-latitude fauna especially in the Indo-Pacific region is its greater diversity in species composition.

Distribution of planktonic species in this investigation shows that the shelf waters of the coast are dominated by the following forms: *Globigerinoides ruber*, *G. sacculifer*, *Globoquadrina dutertrei* and *Globigerinita glutinata* while the waters of the bathyal regions by species of *Globorotalia* and *Sphaeroidinella dehiscens*. Thus based on the extent of abundance of planktonic foraminiferal populations in waters and sediments, it is possible that they can serve as indicators in differentiating the shelf and bathyal zones of the marine environment (Table 1 and Figs. 2-4).

Table 2 shows the presence of different planktonic foraminiferal species in the regions studied along the Indian coasts. Species which show a wide range of distribution along the Indian coasts are: (1) *Globigerina bulloides*, (2) *Globigerinella aequilateralis*, (3) *Globigerinoides ruber*, (4) *G. sacculifer*, (5) *Orbulina universa*, (6) *Globorotalia menardii* and (7) *Globoquadrina dutertrei*. Species found in the Arabian Sea but not recorded so far from the Bay of Bengal are: *Globorotalia inflata*, *G. pumilio*, *Globigerinita iota* and *G. uvula*. The above tabulation of the species also shows that in the Arabian Sea fauna there is a great diversity of species when compared with that of the Bay of Bengal. This can be attributed to relatively increased salinity of the Arabian Sea waters. On average, the salinity range of Bay of Bengal is

30-33‰ whereas it is 34-37‰ for the Arabian Sea<sup>39</sup>. Further species which seem to be characteristic of Bay of Bengal are: *Globigerina helicinae*, *G. parabolloides* and *G. immaturus* and these forms have not hitherto been reported from the Arabian Sea.

Fertility of the sea with the help of planktonic Foraminifera has been studied by some workers<sup>40,41</sup> while Phleger<sup>42</sup> has carried out this investigation with benthic Foraminifera. Thus Foraminifera are useful in locating productive areas in the sea. High concentrations of planktonic Foraminifera are usually found in the regions of high organic production. In the present study, planktonic Foraminifera are found to be abundant in the offshore areas of the south-west coast of India. The greatest abundance (8040 specimens/1000 m<sup>3</sup> of water) is observed at station 6 off Alleppey. This is followed by 7916

specimens/1000 m<sup>3</sup> of water at station 15 off Quilon and 5240 specimens/1000 m<sup>3</sup> of water at station 5 off Cochin. Seaward from the shore to 40 m depth along the south-west coast of India, the nearshore waters are barren of planktonic Foraminifera. Relatively high concentrations of planktonic Foraminifera in the offshore regions of Alleppey and Quilon suggest high organic production in these waters since there is a direct zooplankton-phytoplankton-nutrient relationship. Also, these high concentrations agree in general with the tendency of the zooplankton to increase in abundance towards the equator. Such high concentrations of planktonic Foraminifera have also been noticed in the equatorial waters of Pacific, Atlantic and Indian Oceans. On the basis of above observations Be' and Hamlin<sup>10</sup> have concluded that the waters of equatorial regions of the world oceans are very productive.

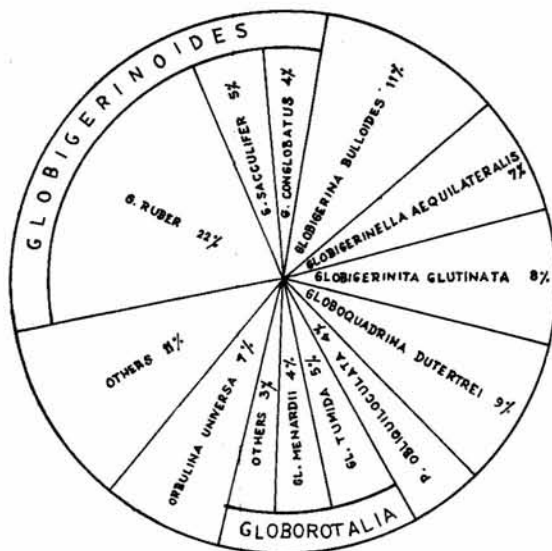


FIG. 2  
STATION NO. 4

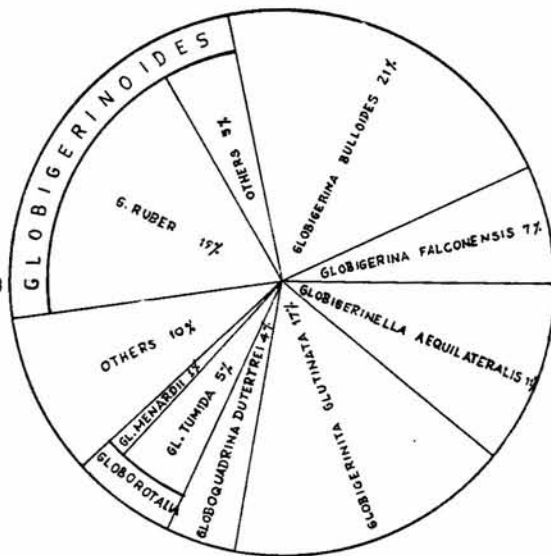
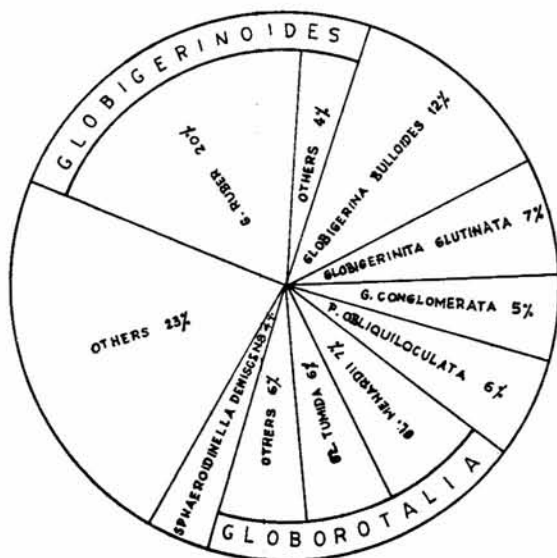


FIG. 3  
STATION NO. 5  
NEARSHORE REGION



OFFSHORE REGION

Figs. 2 to 4 — Composition of planktonic Foraminifera in the sediments from the coast off Cochin

KAMESWARA RAO: FORAMINIFERA IN THE SOUTH-WEST COAST OF INDIA

TABLE 1 — QUANTITATIVE DISTRIBUTION OF PLANKTONIC FORAMINIFERAL SPECIES

Station No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
Date (1971)	16/3	16/3	16/3	16/3	16/3	16/3	17/3	17/3	17/3	17/3	17/3	17/3	17/3	17/3	17/3	
Time (hrs)	0841	1025	1200	1350	1710	2240	0325	0535	0625	0810	1345	1503	1655	1835	2200	
Water depth (m)	29	41	67	192	1450	930	183	66	54	29	27	53	62	187	960	
Depth of tow (m)	0-15	0-34	0-59	0-177	0-188	0-197	0-148	0-49	0-39	0-20	0-19	0-44	0-50	0-149	0-181	
Vol. of water filtered (m <sup>3</sup> )	3	10	16	20	33	47	35	10	35	6	6	13	10	38	60	
Latitude (N)	09°56'	09°53'	09°51'	09°48'	09°46'	09°19'	09°23'	09°25'	09°26'	09°28'	08°55'	08°53'	08°51'	08°49'	08°34'	
Longitude (E)	76°04'	75°55'	75°47'	75°39'	75°28'	75°33'	75°50'	75°58'	75°05'	76°11'	76°29'	76°21'	76°13'	76°05'	76°00'	
No. of specimens/1000 m <sup>3</sup> of water	—	312	578	4584	5240	8040	4570	1950	623	—	—	890	862	4560	7916	
PLANKTONIC SPECIES																
<i>Globigerina bulloides</i>	—	—	64	764	1348	1710	1142	488	104	—	—	—	235	781	1333	
<i>Globigerina calida</i>	—	—	—	254	—	—	—	—	—	—	—	—	—	—	—	
<i>Globigerinella aequilateralis</i>	—	—	—	509	—	107	—	—	—	—	—	—	—	—	333	
<i>Globigerinella adamsi</i>	—	—	—	—	—	—	—	—	—	—	—	—	—	—	167	
<i>Hastigerina pelagica</i>	—	—	—	—	—	—	142	—	—	—	—	—	—	—	166	
<i>Globigerinoides conglobatus</i>	—	—	—	—	—	320	143	—	—	—	—	—	—	130	—	
<i>Globigerinoides ruber</i>	—	104	193	1274	1647	1716	1428	975	312	—	—	180	392	1042	1583	
<i>Globigerinoides sacculifer</i>	—	208	257	1018	—	—	571	—	207	—	—	710	78	—	—	
<i>Orbulina universa</i>	—	—	—	—	150	965	—	—	—	—	—	—	—	651	833	
<i>Pulleniatina obliquiloculata</i>	—	—	—	—	—	—	429	—	—	—	—	—	—	390	—	
<i>Sphaeroidinella dehiszens</i>	—	—	—	—	299	—	—	—	—	—	—	—	—	130	250	
<i>Globorotalia hirsuta</i>	—	—	—	—	—	107	—	—	—	—	—	—	—	—	—	
<i>Globorotalia inflata</i>	—	—	—	—	—	107	—	—	—	—	—	—	—	—	—	
<i>Globorotalia menardii</i>	—	—	—	—	450	536	286	—	—	—	—	—	—	260	750	
<i>Globorotalia menardii flexuosa</i>	—	—	—	—	149	—	—	—	—	—	—	—	—	—	—	
<i>Globorotalia truncatulinoides</i>	—	—	—	—	—	107	—	—	—	—	—	—	—	—	—	
<i>Globorotalia tumida</i>	—	—	—	255	449	965	429	—	—	—	—	—	—	390	1000	
<i>Globotrifarina dutertrei</i>	—	—	64	510	—	320	—	—	—	—	—	—	157	261	417	
<i>Globigerinita glutinata</i>	—	—	—	—	748	1072	—	487	—	—	—	—	—	521	1083	

TABLE 2 — PLANKTONIC FORAMINIFERAL SPECIES RECORDED IN THE SEAS AROUND INDIA

Planktonic species	Areas scanned															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
<i>Globigerina bulloides</i>	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
<i>Globigerina calida</i>				X	X	X	X	X	X	X	X	X	X	X	X	
<i>Globigerina digitata</i>	X			X	X	X	X	X	X	X	X	X	X	X	X	
<i>Globigerina falconensis</i>				X	X	X	X	X	X	X	X	X	X	X	X	
<i>Globigerina helicinae</i>				X	X	X	X	X	X	X	X	X	X	X	X	
<i>Globigerina pachyderma</i>				X	X	X	X	X	X	X	X	X	X	X	X	
<i>Globigerina</i> cf. <i>G. parabulloides</i>				X	X	X	X	X	X	X	X	X	X	X	X	
<i>Globigerina quinqueloba</i>				X	X	X	X	X	X	X	X	X	X	X	X	
<i>Globigerina rubescens</i>				X	X	X	X	X	X	X	X	X	X	X	X	
<i>Globigerinella aequilateralis</i>	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
<i>Globigerinella adamsi</i>				X	X	X	X	X	X	X	X	X	X	X	X	
<i>Hastigerina pelagica</i>	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
<i>Globigerinoides conglobatus</i>	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
<i>Globigerinoides immaturus</i>	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
<i>Globigerinoides ruber</i>	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
<i>Globigerinoides sacculifer</i>	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
<i>Globigerinoides tenellus</i>	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
<i>Orbulina universa</i>	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
<i>Pulleniatina obliquiloculata</i>	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
<i>Sphaeroidinella dehiszens</i>	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
<i>Globorotalia crassaformis</i>				X	X	X	X	X	X	X	X	X	X	X	X	
<i>Globorotalia hirsuta</i>				X	X	X	X	X	X	X	X	X	X	X	X	
<i>Globorotalia inflata</i>				X	X	X	X	X	X	X	X	X	X	X	X	
<i>Globorotalia menardii</i>				X	X	X	X	X	X	X	X	X	X	X	X	
<i>Globorotalia menardii flexuosa</i>				X	X	X	X	X	X	X	X	X	X	X	X	X
<i>Globorotalia pumilio</i>				X	X	X	X	X	X	X	X	X	X	X	X	
<i>Globorotalia scitula</i>				X	X	X	X	X	X	X	X	X	X	X	X	
<i>Globorotalia truncatulinoides</i>				X	X	X	X	X	X	X	X	X	X	X	X	
<i>Globorotalia tumida</i>				X	X	X	X	X	X	X	X	X	X	X	X	
<i>Globoquadrina conglomerata</i>				X	X	X	X	X	X	X	X	X	X	X	X	
<i>Globoquadrina dutertrei</i>	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
<i>Globoquadrina hexagona</i>				X	X	X	X	X	X	X	X	X	X	X	X	
<i>Globigerinita glutinata</i>				X	X	X	X	X	X	X	X	X	X	X	X	
<i>Globigerinita humilis</i>				X	X	X	X	X	X	X	X	X	X	X	X	
<i>Globigerinita iota</i>				X	X	X	X	X	X	X	X	X	X	X	X	
<i>Globigerinita uvula</i>				X	X	X	X	X	X	X	X	X	X	X	X	
<i>Candeina nitida</i>	X															X

Areas: 1, Laccadive region<sup>32</sup>; 2, Arabian Sea<sup>33</sup>; 3, Travancore coast<sup>5</sup>; 4, Kerala coast<sup>6</sup>; 5, Alleppey coast<sup>7</sup>; 6, Gulf of Cambay<sup>2</sup>; 7, North-west coast of India<sup>8</sup>; 8, Eastern Arabian Sea<sup>9</sup>; 9, South-west coast of India (Author)<sup>10</sup>; 10, Gulf of Mannar<sup>34</sup>; 11, Krusadi areas<sup>11</sup>; 12, Bay of Bengal<sup>36</sup>; 13, Vishakhapatnam coast<sup>11</sup>; 14, Bay of Bengal<sup>37</sup>; 15, Andaman Sea<sup>38</sup>; and 16, Northern Indian Ocean<sup>1</sup>.

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