CHAPTER VII
SUMMARY AND CONCLUSION

The present work deals with ecology and distribution of Recent benthic foraminifera, from the inner shelf sediments of Gulf of Mannar, off Tuticorin. The area under investigation is located in the southeast coast of India, forming a part of Survey of India’s topo sheets numbering 58 L/1 and 5. The area extends from off Thermal plant near Tuticorin harbor in the South to Van island in the north, confining to the Gulf of Mannar. It is geographically situated between the latitudes N 8°45’ to N 8°50’ and longitudes E 78°10’ to E 78°15’.

Sediment and bottom water samples were collected from 21 sampling stations, once in three months, for a period of one year - representing summer, pre monsoon, post monsoon and winter. Thus the collections amounted to a total of 84 samples.

A review of previous researches on Recent benthonic foraminifera from the east and west coasts of India, as well as on the hydrological, sedimentological and pollution studies has been made.

The widely employed system of classification proposed by A.R. Loeblich Jr. and H. Tappan 1988 has been followed in the present study.

In the present study, 117 foraminiferal species belonging to 54 genera, 38 families, 18 super families of 5 suborders (Chart 1) are described and illustrated. Out of the total 117 species, 17 species come under suborder TEXTULARIINA; only one species under suborder SPIRILLINA; 39 under suborder MILIOLINA; 11 under order LEGENINA and remaining 49 under suborder ROTALIINA. Variations and abnormalities noticed in some of the
above foraminiferal species have been identified and discussed. For a clear illustration, different views of all the 117 foraminiferal species have been provided through a series of SEM photomicrographs.

The population size both living and total (living + dead) in each of the stations during different seasons have been found out. It is observed that –

a. the maximum living population size is found only in stations between 16 and 21 during all the collections.

b. the fauna are found to be in living condition in all the stations of all the collections.

c. the living population is found to be maximum in summer (April) and is closely followed by the pre monsoon (July).

The living/total population ratios of the present study, is high and almost with constant values (except for shore stations) and this may be attributed to higher sedimentation rate.

The various sedimentological and bottom water parameters have been evaluated. In the study area, organic matter content shows a positive relation with the sediment fines of the substrate. Spatially, the organic matter content shows an appreciable variation while there is only a limited variation between seasons. Spatially, the percentage of calcium carbonate is higher in stations between 14 and 21 where the population is more and it is found to be positively correlated with population abundance. Temporal variation of CaCO₃ content also shows a similar behaviour. The substrate of the study area is found to be made up of silty-sand, followed by silty-clay-sand, sand and clay-sand.

The spatial distribution of heavy metal concentration reveals that they are more concentrated in stations 5 and 11. There are two geochemical associations of trace metals in the study area. Cd and Pb constitute an
association showing an affinity with calcium carbonate and grain size (coarse sediment) of the substrate. The other geochemical association consists of Fe, Cr, Mn, Co, Ni and Zn. This association has an affinity with the organic matter and grain size (fine sediment) of the substrate.

The spatial distribution of abnormal foraminifera also indicates that they are more concentrated either near the station 5 or near 11. Deformities in *Helinina perlucida*, *Nonionoides boueanaum*, *N. grateleoupi*, *Pararotalia nipponica*, *Peneroplis planatus*, *Poroeponoides lateralis*, *Quinqueloculina seminulum* and *Spiroloculina costifera* are attributed to the concentration of the heavy metals in the sediments.

Spatially, the bottom water parameters show only a little variation while there is an appreciable variation between seasons.

A comparison of the mean temperature of July, October, January and April with that of the mean living and total population reveal that the higher temperature that prevails during April favours higher reproduction and abundance of foraminiferal population both as living and as total. In the present area, dissolved oxygen content of the bottom water is one of the main controlling factors, and has shown a positive correlation with foraminiferal population both as living and total. Higher salinity values favours higher reproduction and abundance of foraminiferal population in April and is followed in July in the present area.

The pH of the bottom water has only very little variation both spatially and temporally and hence a convincing correlation between foraminiferal population and pH values cannot be achieved.

Among these living species, the following species are considered widespread and abundantly occurring since they are found as living in more than 90% samples collected and studied. They are *Ammonia beccarii*, *A.
tepida, Asterorotalia inflata, Nonionoides boueunum, Quinqueloculina seminulum and Spiroloculina communis.

The rest 111 species are considered to be either rarely (<25 samples as living), moderately (26-45 samples as living), commonly (46-65 samples as living) or most commonly (> 65 samples as living) occurring species since they are found in living condition in less than 90% samples collected and studied.

Ecological and distribution study of the abundant and wide spread foraminiferal species reveals the following:

- Among the six abundant and wide spread fauna viz. Ammonia beccarii, A. tepida, Asterorotalia inflata, Nonionoides boueunum, Quinqueloculina seminulum and Spiroloculina communis except for Asterorotalia inflata other species prefer the environmental conditions that prevail during April (summer) that favours higher reproduction and abundance of population, in the present area.

- In the present area, the population of A. inflata seems to be higher during July and closely followed by April.

- In the study area, wherever the environmental conditions are uncongenial where the substrate is sandy (stations 1-4) or highly polluted with higher fines (station 5), the population are less and the species diversity is also less and hence, predominance of abundant species.

- The less population encountered during October and January is mainly because of the bay depression in the adjoining bay and monsoon rain (which is more between October – December) and the resultant modifications of the sediment and bottom water parameters.
The accommodative substrates that favour the population abundance are silty sand (deeper part of the collection) and siltyclaysand (middle segment of the collection).

In general, the increase in temperature, salinity and dissolved oxygen content of the bottom water and the higher calcium carbonate content along with moderate organic matter of the bottom sediments are suggested for an abundance of living population. The most accommodative substrate is silty-sand followed by siltyclaysand.

The distribution of foraminifera is studied through a statistical technique - cluster analysis. The cluster analysis using the percentage frequencies of 117 species for 4 seasons, which were then reduced to to 54 variables (Genera), by the average linkage method resulted in dendrograms that have been interpreted for statistical application.

The cluster analysis, taking fifty four genera as variables, gave rive to different dendrograms for different collections. The grouping of different clusters reveal that the distribution of clusters for a seasonal collection is mainly controlled by sediment characters. Some of the assemblages (clusters) prefer substrate with high sediment fines and organic matter content (middle segment of the traverses) while the other group prefer substrate with moderate sediment fines and organic matter content.

A comparative study of the foraminiferal assemblage of the present area, with those from the Bay of Bengal, off Porto-Novo (Ragothaman, 1974), from the Palk Bay, off Rameswaram (Kumar, 1988) and those from the Bay of Bengal, off Chennai (Sivakumar, 2002) reveals that

- the two species *Ammonia beccarii* and *Quinqueloculina seminulum* are found to be abundant and wide spread species of all the areas of comparison.
the following two species *Ammonia tepida* and *Noionoides boueanum* are found to occur as widespread and abundant in any three areas of comparison while *Asterorotalia inflata* and *Spiroloculina communis* have been noticed as abundant fauna of any two areas of comparison.

In the Bay of Bengal off Porto-Novo, Palk Bay off Rameswaram and Bay of Bengal off Chennai, foraminiferal population has been found to be higher during summer (April) as reported by Ragothaman (1974), Kumar (1988) and Sivakumar (2002) respectively.

In the present study area too, the living population is found to be higher in summer collection (April).