Chapter 10

Conclusions & Future Scope

10.1 CONCLUSIONS:
The present work describes the surface and subsurface distribution of benthic foraminifera based on 214 sediment samples (126 surface- and 88 sub-surface-) from the regions off Myanmar. An attempt has been made to assess the modern benthic environments in the study area apart from making estimates of the sea level fluctuations and drawing high resolution palaeo-climatic interpretations. The results of the present work are summed-up under different subheadings as follows:

10.1.1 Foraminiferal taxonomy-
126 surface sediments collected from a depth range of 10-1080 m off Myanmar were analyzed for their foraminiferal content.
- 737 species belonging to 235 genera are reported of which 24 species belonging to 13 genera are planktonic.
- Out of the 737 species identified, 132 species have been reported from the study area by earlier workers. Thus, including the 57 species which have been identified only up till the generic level, 605 species are reported for the first time from the study area, off Myanmar.
- This is the first comprehensive report on foraminiferal taxonomy from the region off Myanmar that is accompanied by illustrations.

10.1.2 Distribution of Relict foraminifera-
- Apart from the normal Recent benthic foraminifera, relict fauna comprising larger foraminiferal assemblage, soft coral sclerites and coral caryophyllids, and coralline algae are found along the west coast of Myanmar.
- This fauna in combination with echo-sounding records and $^{14}$C AMS dates provide numerous evidences for the existence of Late Pleistocene-Holocene soft coral patches, along the west coast of Myanmar which have been destructed due to sea level rise.
A regional sea level curve for the west coast of Myanmar is proposed which illustrates the sea level history of the past 16,000 years.

A comparison of this curve with other published global and regional sea level curves, suggests that the vertical tectonic component of displacement, especially during the Late Pleistocene-Holocene, has a direct bearing on the local sea levels of Myanmar.

10.1.3 Surface distribution of foraminifera and ecological implications-

- Of those reported here, 150 species have been reported from the Arabian Sea before and 230 species are common between the Bay of Bengal and the study area. 35 of these species reported here have been reported from the South China Sea before.
- The study area has greater number of species (230) that are common to the Bay of Bengal and only 150 species common to the Arabian Sea. At the same time the study area has 154 species common to the Bay of Bengal, South China Sea and eastern Kalimantan which have not been reported from the Arabian Sea before.
- The faunal assemblage suggests that the region has a strong affinity towards the 'mixed zone' proposed by Bhalla (1970) and/or Indo-Pacific foramogeographic province of Cushman (1948).
- The station-wise data subjected to cluster analysis revealed the existence of different microenvironments within the study area in the form of clusters viz.:
  2. Cluster B- representing extremely low salinity regimes in regions close to the mouths of the Ayeyarwady and the Gulf of Martaban.
  3. Cluster C- represents the shelf environments with higher salinity regimes. This environment is further broadly clustered into 3 major sub-clusters, to reveal microenvironments within the shelf.

However, the major observations establish that the benthic foraminiferal assemblages are governed by the strong salinity gradient prevalent in the study area.

10.1.4 Development of a site specific proxy for palaeo-monsoons-

During the species distribution studies, it was noticed that *Asterorotalia trispinosa* was not reported from the Arabian Sea whereas is reported all along the east coast. In
order to estimate its ecological preferences, this specific species was studied in detail for its spatial distribution in the study area w.r.t. prevalent environmental parameters. The studies revealed that:

- *A. trispinosa* prefers low salinities (<32 psu), silty-clay substrates and a depth zone of 18-40 m.
- It is characteristic of the Indo-pacific realm, occurring in deltaic and high sedimentation regions.
- Its sensitivity to salinity makes it a promising proxy for indicating past monsoons in subsurface records.

10.1.5 Subsurface distribution of foraminifera and palaeoclimatic implications-

- The highlight of this study is that this data set offers high resolution records for the past 489 years; a resolution of ~4 years since 1513 to 1676 AD and since then 8 years resolution unto present.
- Downcore distribution of foraminifera, benthic-planktonic percentage abundances, abundances and MPS of *Asterorotalia trispinosa*, additional microfossil abundances and geochemical data generated on foraminiferal species, all indicate a major climatic boundary at ~1650-1675 AD.
- Downcore variations in the abundance and MPS of *A. trispinosa* indicate:
  1. Two significant climatic conditions in the study area since 1513 AD; a dry climate prior to 1650 AD and warm and wet climate since 1650 to present.
  2. Since 1650, 3 major freshwater pulses are recorded in the core at 1675, 1750 and 1850 AD.
- Mg/Ca and Sr/CA ratios show signs of significant fluctuations post ~1675 AD. Highest Mg/Ca ratios and corresponding lowest Sr/Ca ratios seem to indicate a significant warming resulting in heavy fresh water discharge causing significant drop in salinities.
- Significant drop in the δ¹⁸O values is seen at ~1675, 1765 and 1875 AD, reinforcing the major fresh water pulses implied in the *A. trispinosa* abundances.
- The support data reinforce the results for three major fresh water pulses in the study area, there by proving the efficiency and reliability of *A. trispinosa* as a proxy for palaeo-monsoons.
• MPS data shows a 93.86 year cyclicity in climatic events in the study area which falls into the scope of the Gleissberg Cycle (viz. 80 ±10 years).

• Sunspot minimas recorded at ~1650, 1770 and 1850 AD responsible for the Little Ice Age in Europe seem to have signatures during the same period in the monsoons over the Indian sub-continent, in the form of 3 major fresh water pulses recorded in the study area.

• Oval shaped, siliceous testate amoebae made up of star-shaped platelets are encountered in the study area. Their high abundances in the core coincide with dry climates of the past. However, its identification and ecology could neither be ascertained through literature review nor through correspondence with other workers.

10.1.6 Pteropod assemblages in the study area-
• Pteropods are the second most abundant microfossil group in the sediment samples under study.

• A total of 18 species of pteropods exist in the study area.

• Only two species, namely *Creseis acicula* and *C. constricta* are tolerant to low salinities, while all the others do not occur in the low salinity regimes at the mouths of the Ayeyarwady.

• Absence of Limacinids from the core suggest that no major bathymetric changes have occurred in the region over the past 500 years.

• Sporadic occurrences of *C. acicula* in the core indicate periods of comparatively higher salinity in the study area.

10.2 Future Scope:
• As stated before approximately 57 species have been identified only unto the generic level. There is good scope for establishing new species after separating sufficient numbers of such specimens for detailed observation and description. Such species need to be compared with the types specimens deposited with well known centers of taxonomy, such as the British Museum of Natural History or the American Museum of Natural History, to avoid redefining a pre-existing species.
• Dredge samples need to be collected and studied in order to strengthen the sea level postulations made in the study area and refine them.

• All radiocarbon dates are calibrated using a reservoir age generated in the Andaman Islands. Generation of reservoir age for the study area which is characterized by very high rates of sedimentation is a very crucial need of the hour.

• More cores, especially in the outer delta need to be studied to obtain high resolution palaeoclimatic signatures for longer time scales.

• Testate amoebae have proved to be highly reliable palaeo-climatic indicators. Thus testate amoebae found in the study area need to be identified in order to establish their ecology to develop them as reliable proxies in this salinity driven region. The samples collected in the deeper regions of the study area contain a lot of Radiolarians. Similarly most of the shelf sediments contain ostracods in significant numbers. Their distributions too need to be studied in order to develop them as a proxy.