Phytoplankton communities include several algal groups, of which cyanobacteria is the most abundant and diatoms the most diverse (Armbrust 2009). There are over 250 genera of extant diatoms with perhaps as many as 200,000 species (Mann et al. 1999) ranging across three orders of magnitude in size (5 µm to 2mm). Their high species diversity implies the existence of very different communities exposed to various environmental conditions. They may constitute the phytoplankton or phytobenthos either as free floating or sessile communities respectively. This study addressed the diatoms in the different habitats. First, the phytoplankton community was analysed to elucidate the spatial and temporal distribution of the dominant phytoplankton groups over a period of four years along three shipping routes in the Bay of Bengal (Chennai–Singapore, southern Bay of Bengal; Chennai–Port Blair, Central Bay of Bengal and Port Blair–Kolkata, Northern Bay of Bengal). The Bay of Bengal is known for its unique hydrographical features such as low salinity resulting from the influx of fresh water from rivers. The average annual discharges of fresh water is high in the Northern Bay ($10^{12}$ m$^3$ from Ganges and Brahmaputra), medium in the Central Bay ($8.5 \times 10^{10}$ m$^3$, Krishna and Godavari), and low in the Southern Bay (Cauvery and Pennar) (UNESCO, 1988). This results in highly stratified surface waters (Shetye et al. 1991). The seasonal changes in the two major groups of the phytoplankton (diatom and Trichodesmium) were probed. The phytoplankton community showed a clear seasonal succession in the appearance and dominance of these two groups. The abundance of diatoms and the appearance of Trichodesmium
were influenced by the monsoon patterns and the stratification of the surface water. The observations revealed that diatoms dominated the phytoplankton community for the larger part of the year. But during certain months (February and October) *Trichodesmium* replaced diatoms in dominance. The average diatom abundance was highest in the northern bay whereas the species diversity was the highest in the central bay. Although the Bay of Bengal supported a diverse diatom community, few species tended to be dominant during the different seasons in the three sectors. These included *Proboscia alata*, *Climacodium frauenfeldianum*, *Leptocylindrus minimus* and *Thalassionema nitzschioides*.

The dominant species of the Bay of Bengal exhibited characteristic features that enable growth in the generally low nutrient and highly stratified surface waters of the bay, such as, nitrogen fixing (*Trichodesmium*) and the ability to sequester trace amounts of ammonium (*Proboscia alata*) indicating a probable syntrophic relationship between these two groups, symbiosis with endocellular cyanobacteria (*Climacodium frauenfeldianum*) and opportunism during periods of nutrient enrichments (*Leptocylindrus minimus* and *Thalassionema nitzschioides*).

The occurrence of *Trichodesmium* was predominant in the Bay especially during the winter months. During summer *Trichodesmium* was observed closer to the coast of India. Remote sensing techniques were used to map the occurrence of *Trichodesmium* on a larger scale to elaborate on the spatial and temporal variability of this species in the Bay of Bengal. Temperature,
shallow mixed layer depth, stratification of the water column, nutrient availability and currents were the main factors controlling the distribution of *Trichodesmium* in the bay.

The next aspect addressed was, the diatoms from the benthic environments and their response to nutrients. For this, sediment samples were collected from three diverse coastal habitats: sandflat, mangrove flat and port site situated in Goa, along the west coast of India. Sampling was carried out over an annual cycle: monsoon, post-monsoon and pre-monsoon. This study focused on the effect of nutrient enrichment on the resident diatom community in the three different habitats, wherein, the nutrient concentrations were increased without altering the nutrient ratios.

The response to nutrient enrichment by the diatom community from the sandflat and port area was positive and showed an increase in diversity. The reverse was observed in the mangrove flat, where mostly a decrease in diversity was recorded in response to the increasing nutrient levels. These variations in the emergence of diatoms in the different enrichment level across the sites could be due to the initial diatom abundance present, which depends on the habitat characteristics of the sites.

Sandflats are generally more oligotrophic than silt-rich sediments (Heip et al. 1995), characteristic of the mangrove flat and therefore inputs of nutrients are generally welcome. The mangrove flat is made up of silt and has a high specific surface area, thus diatoms have greater access to the organic-rich layer surrounding the individual silt particles. These factors are responsible
for the high growth rate of diatoms in silt-rich sediments compared to sandy sediments (van de Koppel et al. 2001).

This was reflected in the high abundance and generic number of the microphytobenthic diatom community at the mangrove flat. The port site has a rocky-sandy texture, and is prone to regular dredging, resulting in the absence of a stable benthic community. This site showed highest nutrient levels during monsoon which resulted in higher diatom abundance in the monsoon as compared to the other seasons. The sediment diatom composition is generally composed of pennate diatoms. The port site, unlike the other two sites, was dominated by centric diatoms. The absence of an stable substratum could be the reason for the occurrence of pennates in low numbers, and the resulting dominance by transient, tychopelagic centric diatoms. The diatoms, *Skeletonema*, *Thalassiosira* and *Chaetoceros* were the most dominant diatoms observed in the port site. Species like *Asterionellopsis* and *Chaetoceros* were recorded only in the port site and clearly showed preference for higher nutrient levels. All three sites recorded the presence of *Thalassionema nitzschioides* mostly in the presence of nutrients.

The spatio-temporal variability of diatoms was assessed up to a depth of 15 cm in the sandflat and the mangrove flat. This revealed the presence of diatoms up to a depth of 15 cm in the two sites. Their appearance indicated that their viability was not affected by the condition at this depth. However, the two sites varied in terms of distribution of diatoms with depth. It was observed that the sandflat supported a higher abundance of viable benthic
diatoms with depth as compared to the mangrove flat. This distribution was mainly influenced by the interstitial space and the re-suspension in the area, which was least in the mangrove flat.

The third aspect addressed was, how species interact with one-another to emerge dominant in an assemblage. Experimental work was carried out to elaborate on the interactions between diatom species. The role of the different mechanisms adopted by a species to gain an exclusive edge and dominate other species is discussed. Nine benthic diatoms were selected to explore the succession of species in different nutrient conditions wherein the biovolume contribution of each species were kept equal at the beginning of the experiment. Each microcosm was inoculated such that the cell abundances varied according to their biovolumes. Their growth was monitored in nutrient enriched and un-enriched media for a period of 30 days. One set of the enriched and un-enriched microcosms were renewed every second day, while another set was kept stagnant throughout the experimental period. Observations revealed that *Amphiprora* fared well in the un-enriched microcosms and outcompeted the other species due to its ability to sequester nutrients quickly. While *Achnanthes* had the advantage of stalks that helped it to combat space limitations and as a result nutrient limitations since it could procure nutrients from above the biofilm. A third strategy was adopted by *Odontella*. This species underwent spore formation and avoided competition. These observations highlight the advantages of physical traits such as larger
size and stalk formation and physiological adaptations like dormancy in the structuring of a community and the evolution of a climax species.

It was observed in the various parts of this study that *Thalassionema nitzschioides* was very variable in its occurrence. This species occurred in the plankton as well as in the benthos and indicated preference to elevated nutrients (as observed by its dominance in the Bay of Bengal during the nutrient replete season [chapter 2] and its emergence in higher levels of nutrients [chapter 3]). However, in the experimental conditions this species could survive up to 12 days in the un-enriched conditions and not in the enriched conditions. *T. nitzschioides* has been reported from high productive regions (Schrader and Sorknes 1990), and also from low nutrient regimes (Kobayashi and Takahashi 2002) similar to the observations in the present study. These contrasting results indicate a very complex interaction between the biological and physicochemical factors that determine the community structure.

Finally, the life-cycle of a centric diatom, *Odontella regia*, has been described. *Odontella regia*, a planktonic diatom, was followed through the vegetative and the sexual cycle. The vegetative cycle was recorded from before cytokinesis until the separation of two daughter cells. In the sexual cycle, the sequence of events of spermatogenesis and oogenesis was followed. It was observed that this species underwent the hologenous type of spermatogenesis (wherein the entire protoplast of the mother cell is distributed between the spermatozoids) and type I oogenesis (wherein two eggs are...
produced per oogonium). Spermatogenesis occurred with six special (depauperating) mitosis resulting in 64 sperm cells per cell. *O. regia* is one of the taxon of the seemingly closely-related planktonic *Odontella* species (*O. sinensis*, *O. regia* and *O. mobiliensis*; Drebes 1974). The interesting thing is that the three diatom taxa of similar habit and morphology have three different sperm cell counts (128 in *O. sinensis*, 64 in *O. regia* and 32 in *O. mobiliensis*). This study highlighted the fact that the course of gametogenesis not only varies at the intergeneric level but also at the interspecific level.