Chapter I

Introduction
1.1. Seagrass ecosystem-General Account

Seagrass ecosystem forms one of the important coastal ecosystems of tropical and temperate regions. This ecosystem is conspicuous and often dominant habitats in shallow water coastal areas (den Hartog, 1970). This ecosystem is well known for its high primary and secondary productivity, ability to stabilize sediments, production of vast quantities of detritus and support of diverse faunal and floral communities (Phillips and Mc Roy, 1980).

Seagrasses are the marine monocots, which constitute about 0.01% of flowering plants and have adapted to the submerged marine habitat. There is a pronounced latitudinal gradient in structural complexity and spatial heterogeneity of seagrass environments. Seagrass ecosystem is associated with several faunal and floral assemblages such as algae, sponges, corals, crustaceans, molluscs and fishes.

Seagrass meadows may include mono-specific or multi-species communities. They exhibit a variety of leaf shapes, shoot densities and rhizome characteristics (Fig.1.1). Many meadows are not uniform in appearance, due to biological and physical disturbances. Seagrasses grow in soft sediments, from the low water mark to the depths of about 3-5 m and are inhabited by a rich associated biota. At the deeper end of the seagrass meadows, light becomes a limiting factor, strongly affecting photosynthesis.
and the lower limit is usually related to light irradiance. As the rhizome system grows and extends laterally, shoots may be sent up. A well-developed seagrass bed may extend laterally into bare sediments by means of the rhizome system. Dissolved nutrients are taken up by the rhizomes and roots mainly from the pore water present in sediments.

Seagrasses are flowering plants and the pollens are transported through the water currents. They produce seeds and are borne by water currents. Seagrasses appear to reproduce more by asexual method, through the rhizome system. Colonization of new areas by seedlings is difficult unless the sediment is already physically stable and rich in dissolved nutrients. This can be accomplished by the presence of other plants such as seaweeds, which stabilize the sediments and add nutrients. Thus, through succession a patch of bare sand may change to a bed of seagrass.

The complex ecology and multiple roles (Fig.1.2) that seagrass communities carry out thrust the need for maintaining and improving these communities. Like mangrove and salt marsh communities, seagrasses are important primary producers. They stabilize substrata, serve as habitats and nurseries, and are direct and indirect food source for a diverse fauna. The abundance and diversity of ichthyo-fauna in seagrass meadows is well known. The roles of benthic algae are less understood, although drift species are known to serve as habitats and food source for gammaridean amphipods. Further, these submerged flowering plants can be used to monitor the health of coastal ecosystems. So the need for conservation and management of seagrass meadows is evident when their extensive ecological roles are considered.
Fig. 1.1. Key morphological features of seagrass (adapted from Hemminga and Duarte, 2000)

Fig. 1.2. Summary of seagrass ecosystem (adapted from Fortes, 1990)
Introduction

In tropics, seagrasses are often associated with coral reefs. Coral reefs are constructional wave resistant features, which are built by a variety of species and are often cemented together. Coral reefs and seagrasses interact physically in a number of ways. Reefs are active producers of carbonate skeletal material. The upward growth of these skeletal materials is an effective barrier, which dissipates wave energy and creates a low energy environment in their lee. The reefs also reduce the action of currents on shorelines. Biological and physical processes breakdown these calcareous materials, resulting in the formation of gravel, sand and silt. The accumulation of these sediments by the action of waves and currents create a favorable condition for the colonization of seagrasses. Seagrasses trap and stabilize sediments, which is important for adjacent coral reefs, because it prevents abrasion or burial of reefs during storm conditions.

The seas around Lakshadweep and the reef lagoons are of great ecological significance as they influence the fauna and flora associated with the coral reefs and seagrass beds, to a great extent. Coral reefs of Lakshadweep consist of a wide variety of plants and animals and show high rates of productivity in nutrient poor oceanic waters. Each island except Androth has a lagoon on the western side with a sandy beach. The lagoons and reefs provide suitable coral habitat, for innumerable varieties of animals and plants. About 112.38 hectares of seagrass areas have been identified in the lagoons of Lakshadweep, which covers an area of about 4200 km². Minicoy, the southern most island of Lakshadweep Archipelago has the largest lagoon among the group and has a rich vegetation of seagrasses in the intertidal zone of the lagoon.
1.2. Geomorphology of Lakshadweep islands- the Study Area

Lakshadweep group of islands consists of 36 islands, including 12 atolls, 3 reefs and 5 submerged banks, lying scattered in the Arabian sea, west cost of India and lies in between 8°N and 12°N latitudes and 71°E and 74°E longitudes (Fig.1.3). According to Survey of India, the geographical area of Lakshadweep is 32 km², 20000 km² of territorial waters and 400000 km² of Exclusive Economic Zone (EEZ). There are 36 islands of which Agatti, Amini, Androth, Bitra, Chetlat, Kadamat, Kalpeni, Kavaratti, Kiltan and Minicoy are inhabited. Among the uninhabited islands, Bangaram is a tourist resort and Suheli, a coconut growing and fishing centre. Pitti, the bird island is a small reef with sand bank covering an area of 1.2 hectares, lying northwest of Kavaratti, where terns in thousands visit for nesting. The entire Lakshadweep group of islands lie on the northern edge of 2500 km long north – south aligned submarine Laccadive –Chagos ridge. The ridge is separated from the Malabar ridge by the Lakshadweep Sea and merges with the shelf at some places between 11°N and 14°N. The ridge rises from a depth of 4000 m in the Arabian Sea. The height of the land above the sea level in the islands is generally 1 to 2 m without any major topographical features. The reefs of all the atolls are widest on the southwest side. The atoll consists of islands and lagoons, which are in various stages of development. Lagoons vary considerably in size, bottom topography, and geomorphology. The central part of the lagoon is usually deep with numerous coral knolls. According to Glenny’s Gravity data, this represents a continuation of the Aravalli Mountains.
Fig. 1.3. Location of Lakshadweep group of Islands

Fig. 1.4. General Profile of Minicoy Atoll
There is a chain of shoals or banks between 16°N - 17°N and between 18°N - 19°N and 72°E, which are supposed to be the continuation of Lakshadweep ridge with the Aravalli. According to geologists, there was a submergence of land during late Miocene and Pliocene in the west of Malabar Coast. Lakshadweep islands are low coralline islands. Except Androth, all of them extend in north-south direction in the form of crescent shaped banks (Ahmed, 1972). The coral reefs have a steeper shore on the eastern side and there is a lagoon on the west (Fig. 1.4), so that the crescent shaped reefs is developed on the leeward side of the southwest monsoon.

1.3. Climate

The island experiences a tropical humid climate, with an average rainfall of about 1600 mm, from May to October. Since there are no streams in any of the islands, the only natural water source is ground water. Due to its location, the region experiences the overlapping of both the southwest and northeast monsoon. The temperatures are almost uniform with a slight increase from south to north.

Oceanic islands of coral origin in the deep sea are very important from the viewpoint of oceanography. The islands normally lead to the development of stable eddy systems in the middle of the ocean, which in turn make the atolls very productive and rich in fauna and flora.

1.4. Marine Research in Lakshadweep Islands — A Review

Recognition of the scientific importance of island ecosystems dates back well over a century to the observations of Charles Darwin in the Galapagos Islands in 1835. The marine biological and fisheries research in Lakshadweep area dates back to the later half of the nineteenth century, when attempts were made by some British naturalists to study the flora and
fauna of the Lakshadweep and Maldives Archipelagoes. The Cambridge University expedition under the leadership of Prof. J. Stanley Gardiner was a significant event in the marine biological and oceanographic research and the results were published in two volumes of *Fauna and Geography of the Maldives and Laccadive Archipelagoes*. The atoll of Minicoy has been described by Gardiner (1903). Information in detail about Lakshadweep, relating to geographical features, land flora, fauna, history, etc. is well documented by Ellis (1924) and Mannadiar (1977). The Central Marine Fisheries Research Institute undertook a comprehensive and indicative survey of the marine living resources of Lakshadweep Sea, under the leadership of Dr. P. S. B. R. James, in 1987 and published the details of the survey in 1989.

The hydrobiological parameters of marine environment of Lakshadweep islands have been studied by different groups of scientists, based on the data collected during the survey of these islands and during oceanographic cruises. Sankaranarayanan (1973) studied the chemical characteristics of waters around Kavaratti Atoll (Lakshadweep). Other studies include Naqvi and Reddy (1979); Jagtap and Untawale (1984) and Gopinath (2002). The primary production of seagrass beds of Kavaratti Atoll has been determined by Qasim and Bhattathiri (1971). Other major investigations on primary production in Lakshadweep waters were, those of Bhattathiri and Devassy (1979); Kaladharan, (1998); Kaladharan *et al.*, (1998); Kaladharan and David Raj (1989); Mohammed *et al.*, (1999); Koya *et al.*, (1999) and Dhargalkar *et al.*, (2000). Kannan *et al.*, (1999) reported the distribution and the present status of seagrasses from Lakshadweep area.

Results of the detailed ecological survey of the macro fauna of Minicoy Atoll have been presented by Nagabhushanam and Rao (1972). The studies carried out on marine fauna are mainly from Minicoy (Gardiner, 1903; 1906); Pillai, (1986); Jones and Kumaran, (1980) and Suresh and Mathew, (1998). Anzari (1984) described seagrass habitat complexity and macro invertebrate abundance in Lakshadweep coral reef lagoon. Inspite of a plethora of information, there has been no concerted attempt to study the seagrass ecosystem of Minicoy lagoon. Hence a pioneering attempt in this regard has
been made to study the seagrass habitat structure and function in Lakshadweep islands.

1.5. Objectives and scope of the Study

The main objectives of the study are-

1. To study the temporal and spatial variations in hydrographic parameters prevailing in the Minicoy lagoon,
2. To study the interactions of hydrographic parameters in the lagoon,
3. To study the species composition, distribution, abundance, biomass and community structure of seagrasses.
4. To study the species composition, distribution, abundance and biomass of macro-algae present in the seagrass meadow,
5. To investigate the species composition, distribution, abundance and community structure of macro-invertebrate fauna found in seagrass meadow,
6. To examine the species composition, distribution, abundance and community structure of ichthyofauna community structure of seagrass meadow,
7. To delineate the ecological relationships between flora and fauna with the hydrographic parameters.
8. To study the interactions between flora and fauna and,
9. To highlight the importance of seagrass ecosystem for the existence of an oceanic coral island.

Seagrass ecology have evolved as most other research programmes within aquatic ecology, from a descriptive stage, focused on the distribution and biology of the plants, to a quantitative, process oriented stage. In this transition stage, research topics have diversified and new approaches and
tools have appeared. Research efforts over past four decades have generated widespread awareness of the importance of seagrass meadows as marine ecosystems, thereby placing seagrass ecosystems as primary targets of marine conservation and restoration programmes. These achievements have resulted from the efforts of a growing community of seagrass ecologists.

On the other hand, the scientific studies on seagrass ecology are still limited compared to many other marine ecosystems. Moreover, the increase of knowledge on the ecology of seagrass meadows does not appear to be conferring a better basis to sustainably manage these ecosystems, for seagrass meadows are still being lost from the world's coastal ocean at alarming rates. This situation suggests a lack of awareness and dearth of relevant information being generated. The development of seagrass ecology has either been insufficient or has left important gaps leading to negligence on the subject.

Studies on seagrass ecosystems have demonstrated the importance of seagrass meadows in various parts of the world. Current research is also showing how susceptible these systems are to human perturbations. The changes were related to reduce water quality conditions, specifically, excessive nutrients and sediment input. The loss of seagrass habitats has resulted in faunal changes, decline in some commercial stocks and increased shoreline erosion. Under the above backdrop it is imperative that proper assessment of Indian seagrass meadows be undertaken and understanding gained of their importance to fishery resources of India's coastal waters. The seagrass ecosystem of Lakshadweep Archipelago was the least studied part of the Indian Coastal waters. In this study, the current status of seagrass ecology in Minicoy lagoon was evaluated to provide a baseline diagnose of its
strengths and weaknesses with the aim to develop a solid basis for the
management and conservation of seagrass meadows.

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