PREFACE
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Ocean covers 71% of the earth's surface (Perkin, 1977). It covers an area of 56 million square kilometers. It consists about 1420 quadrillion cubic meters of water (Mellanby, 1980). Man has been attracted to the oceans for a variety of reasons, which includes adventure, food, commerce, trade, industry and recreation. Thus man has put the oceans to multiple uses and he is expected to do so in future even at a larger scale.

India is endowed with a long and varied coastline of nearly 7500 km, under 53 coastal districts of 10 maritime states and 6 union territories including the Andaman, Nicobar and Lakshadweep islands. Nearly 50% (420 million according to 1991 census) of the country's population resides in these areas. About 340 communities are primarily occupied in marine and coastal fisheries. Its Exclusive Economic Zone (EEZ) stands over 2 million km².

Estuaries have been the focal point of the maritime studies and activities. As they are semi-enclosed they provide natural harbour for trade and commerce. Most of the great cities like New York, Tokyo, London, Shanghai, Buenos Aires, Osaka and Los Angeles have developed around the estuaries. In India, the coastal population has been quite high since many centuries and the metropolitan cities like Mumbai, Kolkata and Chennai are also developed around the estuaries. Besides, the biodiversity in this ecosystem is very impressive. They are the best settling places for clams and oysters.
The plants called mangroves in these estuaries also act as nursery ground for a variety of shrimps and finfishes. (ENVIS, 2002).

Indian mangrove areas are excellent nursery grounds for a variety of commercially important prawns, crabs, finfishes and shell fishes, as they provide abundant food, shelter for these organisms. These ecosystems provide food, roosting and nesting site and shelter to a large variety of birds. The mangroves support many trophic levels of aquatic and terrestrial organisms, by enriching the fertility of estuarine waters for production. Mangrove contributing for the formation of excellent habitat for variety of fishes, prawns, molluscs, crabs, reptiles, birds etc. Many deep sea fishes, freshwater prawns and estuarine molluscs are known to use the habitat for breeding and rearing the juveniles in the food rich and safe shelters of mangroves.

The term mangrove refers to an ecological group of halophytic plant species as well as to a variety of complex plant communities dominated by these species, found along sheltered tropical and subtropical shores. Globally, the mangroves are estimated to include 16 – 24 families and 54 – 75 species. These ecosystems harbour 193 plant species, 397 fishes, 259 crabs, 256 molluscs, 450 insects and more than 250 other associated species. (Banerjee and Ghosh, 1998).

In the recent, due to very high density of human settlements, industrial and navigational needs and also by pollution, major development projects (for ports and industries), land reclamation and over-exploitation of living and non living coastal resources, there is
erosion of the coastal, marine biodiversity. Hence, coastal and marine protected areas are important not only for nature protection, but also for conservation of critical and economic resources of the coastal states. Along the west coast alone, about 40% of the mangrove area has been converted into agriculture and urban development. Our understanding of the natural processes in this vulnerable and fragile ecosystem is far from adequate. (Upadhyay et al., 2002).

One of the most successful patterns of animal construction is the molluscan plan. There are more than twice as many species of molluscs as there are vertebrates and only the arthropods are clearly a more numbers and more successful group (Russel-Hunter, 1979, 1982). Molluscs are largely marine and no marine habitat lacks molluscs and many marine communities are dominant organisms of the second trophic level are molluscs.

**Clams:** The Bivalvia is more uniform group of oysters, clams and mussels (about 31,000 species). The clams are with the shell in the form of two calcareous valves united by an elastic hinge ligament. Extension of the mantle and its shell has occurred, followed by its lateral compression, so that all parts of the body (including visceral mass and foot) lie within the mantle cavity and the head is lost (Russel-Hunter, 1983).

**Life history:** Alike most bivalve, clams discharge eggs and sperm through the exhalant opening of siphon and fertilization takes place in open water. Mass spawning occurs to ensure fertilization.
Immediately after fertilization the eggs divide rapidly and develop into spawning larvae which in essence are simply tiny clams.

**Growth:** The growth rate of most clams is relatively slow and decrease with age. Growth is rapid when abundant food is present and water temperature and salinity are at optimum requirements, but decreases and virtually stops in monsoon at the time of too much lowering of salinity.

In India, the development of molluscan fisheries is very important especially on west coast of Maharashtra. During southwest monsoon when fishing in the open sea is suspended due to inclement weather, the clams, oysters and mussels substitute the marine fishes. Clams in particular land themselves well to myriad of habitat and broad environmental ranges. Generally, they are more abundant on the west coast than the east coast of India (Algarswami and Meiyappan, 1989). They are indiscriminately harvested for human consumption, particularly during the monsoon season. Recent studies suggests that due to overexploitation and other anthropogenic changes, abundance of commercially exploited clam resources especially those in the backwaters and estuaries have been reduced considerably (Anon, 2002). Mining activities, sand extraction and industrial pollution are the main reasons affecting the clam resources (Ingole et al., 2006).

Among the molluscan shell fishes clams have long been used for food and were also important to the early settlers. Although it is of
minor importance when compared to the total landed weight and value of fishery products it does form a part of the economy of many local communities along the coast.

The clams are abundant along the coast of Ratnagiri (Maharashtra) and are important with reference to the food value. Shells are mainly used as a raw material for lime factories along the coast. Indiscriminate exploitation of the living resources and pollution of the coast in many regions of Maharashtra are causing major threats to these molluscs. Therefore major challenge is for conservation, sustainable utilization and maintenance and enhancement of the molluscan biodiversity of the regions in the state. Inspite of the above fact, very less attention has been paid by researchers with regard to effect of pollution on estuarine clams from Ratnagiri coast of Maharashtra (Kumbhar, 2001). The variable ecological characteristics of estuarine water influence the biochemical and physiological condition of animals inhabiting the same area. According to Suryawanshi (2002), the animals are acclimatizing the prevailing conditions and their activities like growth and reproduction are controlled by the internal as well as external factors.

An estuary achieves a good balance between physical and biotic components and thereby high biological productivity. The initial responses to environmental changes are usually behavioral. Clams are very sensitive to a changing environment particularly in salinity and turbidity. These species can tolerate gradual transfer from normal
to lower salinity of water and get acclimatized; they die within short period when directly transferred to lower salinities. Several bivalve species have been shown to exhibit various levels of acclimation in the face of altered environmental conditions (Prosser and Brown, 1961; Kennedy and Mihursky, 1972; Bayne, 1973; Ansell and Sivadas, 1974).

Tides are water movements, which are caused by some astronomical factors. They represent a rhythmic rise and fall of water and often waves of long wavelengths characterize the process. The chief astronomic force behind the tidal rhythm is the attraction of the moon and the sun, which depends on the movements of earth in relation to the moon and the sun. Tides influence the seashore fauna variously, as low tides exposed the shore and high tides flood the substratum.

There have been many studies of the growth of the bivalves with an emphasize on changing rates of growth with age and the effects of changes in environmental factor such as temperature, salinity and the concentration of food. In this contribution Bayne and Hawkins (1991) studied growth of bivalve mollusc, relation between protein and energy metabolism. They observed that the energetic cost of growth and the extent to which bivalves may change physiological expression in order to maintain rates of growth under variable environmental conditions. The synthesis of macromolecules incurs energetic costs which are part of complex "Heat increment" of feeding
and growth. Nevertheless, several workers described the role of temperature as one of the most important exogenous factors for reproduction of a species (Ingole, 1987, Grant and Creese, 1995).

The changes in biochemical components produced by environmental variations may reflect energetic requirement for osmotic work, changes in water content of the tissues and even hormonal or enzymatic interactions within cells (Vernberg and Vernberg, 1972). Many estuarine bivalves are sensitive to lowered salinities and valve opening is progressively delayed with increasing dilutions; as the lethal limit approaches, the animal's behavior become erratic and death occurs (Milne, 1940; Motwani, 1955; Mane, 1974; Dogson, 1982). The animals could not get food from water, due to which animals might be utilized the stored food material, and hence the animals showed fall in the biochemical components like protein, lipid and glycogen.

According to Yadava, (2003) the fisheries sector occupies a very important place in the socio-economic development of India. This sector has been recognized as a powerful income and employment generator, as it stimulates growth of a number of subsidiary industries and is a source of cheap and nutritious food. At the same time it is an instrument of livelihood for a large section of economically backward population of the country. More than 6.0 million fishermen and fish farmers in the country depend on fisheries and aquaculture for their
livelihood. The fisheries sector has also been one of the major contributors of foreign exchange earnings through export.

The main objectives of fisheries and aquaculture development programs of the Government of India during the Tenth Five-Year Plan (2002-2007) have been towards optimization of production and productivity, increase of marine products, generation of employment and welfare of fisher-folk communities and their socio-economic status.

Practically no adequate attention has so far been given to the biodiversity of mangrove associated bivalve and gastropod molluscs, physicochemical parameters of the clam habitat and its relation to the biochemical changes and reproductive cycle of these clam species from the Ratnagiri District coast of Maharashtra State; hence, the present study was undertaken.

The results obtained on the above aspects are presented under six different chapters 1. Introduction, 2. Material and Methods, 3. Results, 4. Discussion, 5. General Summary and conclusion, and 6. Bibliography.