

## VERTICAL DISTRIBUTION OF MOLLUSCS IN THE INTERTIDAL AREA IN AND AROUND MUMBAI, INDIA.

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### ABSTRACT

Vertical distribution of intertidal molluscs in and around Mumbai had been studied. Each species has an upper and lower limit of distribution along the vertical intertidal gradient and are concentrated at particular levels or zones where they find optimum living conditions. Zonation of the intertidal area with reference to molluscs at rocky shores of TIFR, Bandstand and NCPA have similarities. However, there is no similarity in zonation among rocky, sandy and muddy shores. Rocky intertidal zones are more diverse and dense in terms of molluscs. The mid and lower littoral zones have rich molluscan diversity. The upper littoral zone at some sites, especially Girgaon chowpatty is totally devoid of molluscs due to anthropogenic activities. *Gafrarium divaricatum*, *Nerita oryzae*, *N. polita* and *Neritina crepidularia* have established themselves in all three marked zones, indicating their power to adjust with the wide fluctuations in surrounding environmental conditions.

**Keywords :** Intertidal, molluscs, zonation, pollution, dominance.

### INTRODUCTION

The intertidal region, a zone of interaction between sea, land and atmosphere, is one of the most interesting divisions of marine ecosystem, as it is daily covered and uncovered by flooding and ebbing tides. The width of intertidal belt exposed depends on the level of high and low tides and gradient of the shore. The inhabitants of this zone are known to be hardy and highly diverse as the result of diel changes in exposure, dessication and submergence. This area ranks next only to the sub-tidal region in terms of richness and variety of the life it supports (Colman,

1933). Species at high shore levels have appropriate morphology, physiology and behaviour to allow them to survive for longer periods without being submerged in sea water, whereas species of lower level are essentially marine and can cope only for brief period of exposure. Each species has an upper and lower limit of distribution along the vertical intertidal gradient of shore and are concentrated at particular levels or zones where they find optimum living conditions. These zones are usually named after their dominance. The most outstanding contribution in the field of zonation is that of Prof. and Mrs. Stephenson, who, after 30 years of research

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in the field, put forward an universal system of intertidal zonation in 1949 (Stephenson and Stephenson, 1949). Zonation of species in intertidal area has been studied by many workers in different countries (Evans, 1948-Great Britain; Stephenson and Stephenson, 1949-Australia; Chapman and Traverthen, 1953-New Zealand; Southward and Oston, 1954-Australia; Arudpragasum, 1970-Srilanka; Lubchenco, 1980. England and Rakocinski *et al.*, 1993-USA)

Though India is surrounded by sea from three sides, with a long coast line of 8129 km, very limited studies have been done on intertidal zonation, such as those of Bhatt (1959), Parulekar (1973), Balani (1975) and Sriramamurthy (1980).

One of the most dominant group of animals occupying the intertidal zone are molluscs. The molluscs are not only rich protein source for the people, but also play a very important role in small scale industries as molluscan shells are used in preparation of washing soda, cement, lime, jewellerys, decorative items and various medicines. The economic importance of the molluscs compelled us for recording the vertical distribution of molluscan species inhabiting in the intertidal zone in and around Mumbai.

## MATERIAL AND METHODS

### TOPOGRAPHY OF SELECTED SITES :

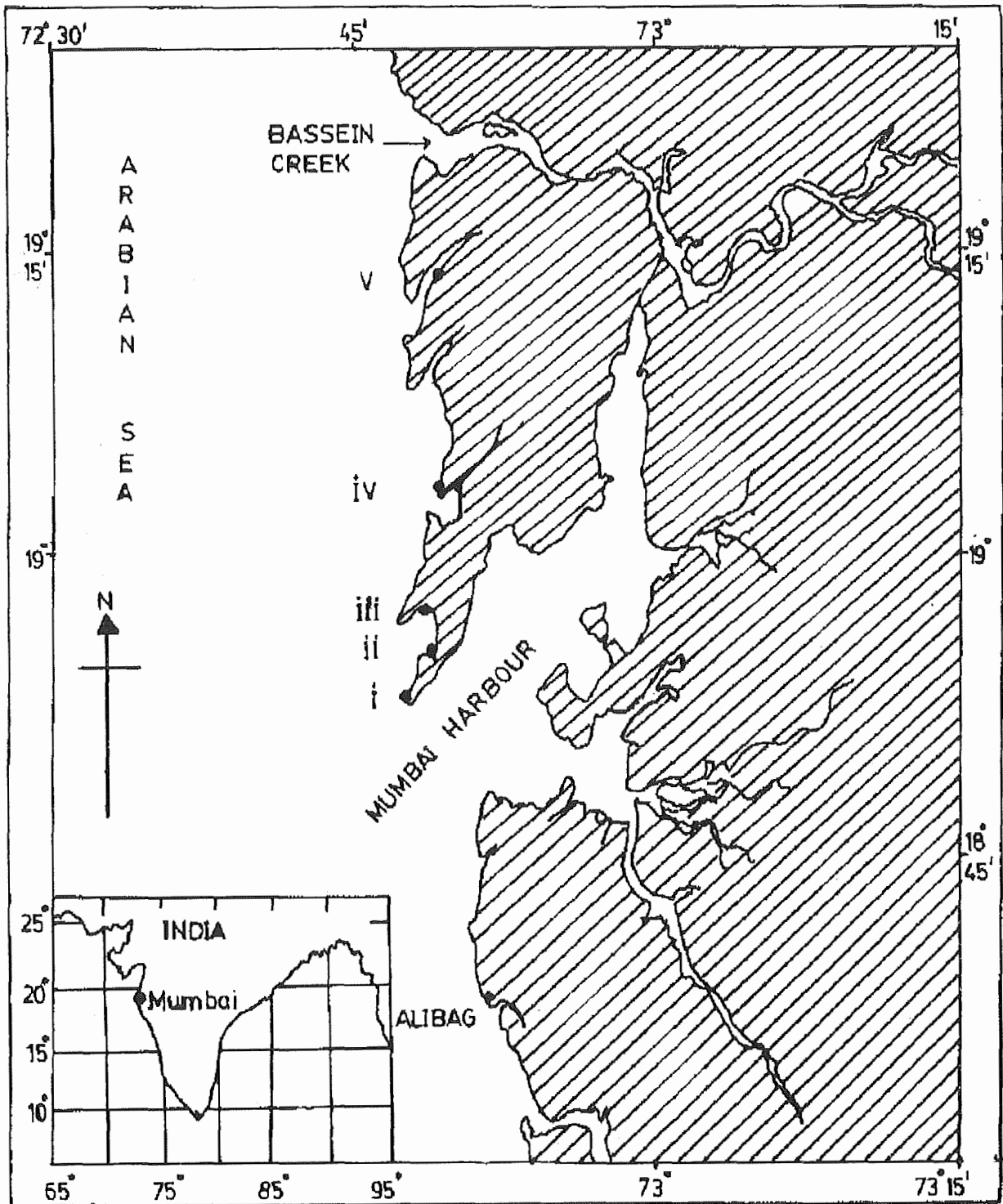
After a preliminary survey of entire coastline around Mumbai, the following sites (Fig. 1) were selected for the present study.

**i) TIFR Shore :** The coastal stretch

near TIFR (Tata Institute of Fundamental Research) at Colaba represents, the southern most end of Mumbai Island. The shore is an open type and hence subjected to direct wave action throughout the year. In order to protect the shore line from erosion due to wave action cement boulders are arranged along the upper most zone of the shore. Remaining intertidal area is formed of rocks and boulders of varying dimensions. Maximum width of intertidal belt recorded during spring low tides (0.03m) is 315 m and shore exhibits very uneven profile. This shore is protected and prohibited therefore, it is free from human activities. As a result, it is cleaner than other stretches of Mumbai shore.

**ii) NCPA shore :** NCPA (National Center for Performing Art) sea shore is a semi-sheltered shore. Big cement boulders and stones are arranged in the high water zone in order to avoid erosion of the shore. The remaining part of the shore is comprised of stones and debris like bricks and concrete structures. Initially, it was a sandy shore but today it is neither a rocky nor a sandy shore. However, it is much similar to rocky shore. The shore has a very steep slope, therefore, shore are exposed during spring low tide (0.06m) is limited to 31m only.

**iii) Girgaon shore :** This shore is located in south Mumbai and popularly known as Girgaon Chowpatty. It is a sandy shore and one of the most famous recreational points for people living in Mumbai. Thus thousands of people visit the shore every day, as a result of which the ecological conditions of the shore are deteriorated. It is a very gently sloping shore and therefore, a large width (581m)



*Fig. 1 : Map showing sites of investigation i) TIFR shore ii) NCPA shore  
iii) Girgaon shore iv) Bandstand shore v) Gorai creek*

of shore is exposed during spring low tide (0.06m).

**iv) Bandstand shore :** It is situated at Bandra, the mid point of western coast line of Mumbai. It is an open type of natural rocky shore composed of rock beds and stones of various dimension. It is also subjected to direct wave action throughout the year. Maximum exposure was recorded 198 m during spring low tide (0.03m). Shore profile is very uneven.

**v) Gorai Creek :** Gorai creek is situated at the northern end of Mumbai, which has a narrow link with Arabian Sea. Many narrow and wide drainage channels discharge their effluents into it. The creek encloses a large area of mud flat infested with dense mangrove on both sides, which gets completely exposed during low tide measuring 96m in width (0.03m).

Total width of tidal belt exposed during spring low tide, and shore profile at the selected sites were measured following Bhatt (1959) and Holme and McIntyre (1971). Following Bhatt, (1959) and Parulekar (1973) three tidal zones were adapted for regular study.

1. Upper littoral zone (High water zone - HWZ) - area between highest high water (spring tide) mark and lowest high water (neap high tide) mark.

2. Mid littoral zone (Mid water zone - MWZ) - area between lowest high water mark and highest low water (neap low tide) mark.

3. Lower littoral zone (Low water zone - LWZ) - area between highest low water mark and lowest low water (spring low tide) mark.

The distribution pattern of molluscs in these zones at each station was studied on fortnightly basis between September 1996 and August 1998. Molluscs were identified following Hormell (1949); Subramaniam et al., (1949, 1951, 1952); Bhatt (1959); Rao (1982) and Apte (1996). Identities of some of the specimen were confirmed by ZSI, Kolkata.

## RESULTS AND DISCUSSION

### Zonation of molluscan species at NCPA shore:

The upper littoral zone measuring 11.5m, was dominated by *Littorina intermedia*, *L. ventricosa* and *Tectarius malaccanus*, hence this zone is known as the littorinid zone. Of the three littorinids *T. malaccanus* was most dominant species found crawling up to 1m above the mark of spring high tide (splash zone). *L. ventricosa* was not found in certain months of the year. In the lower level of upper littoral zone sporadic distribution of gastropods *Drupa contracta*, *D. subnodulosa*, *Thais tissoti*, *Nerita oryzae* and *N. polita* were recorded.

Although the narrowest (9.0m) of the three zones, the mid littoral zone of NCPA shore had a rich molluscan diversity. Gastropod species *Nerita oryzae*, *N. polita*, *Drupa contracta*, *D. subnodulosa*, *D. konkanensia*, *Planaxis sulcatus*, *Bursa tuberculata*, *B. granularis*, *Thais carinifera*, *T. tissoti*, *Pyrene terpsichore*, *Cypraea arabica*, *Hemifusus pugilinus*, *Cellana radiata* and bivalve species *Arca symmetrica*, *Gafrarium divaricatum*, *Anomia achaeus*, *Crassostrea gryphoides*

and *C. lugubris* were found in this zone. *A. acheus* and *Crassostrea gryphoides* were very common, but *C. lugabris* was recorded only twice. Gastropods *Cypraea arabica*, and *Drupa kokanensis* were recorded only twice during the study. *H. pugilinus* was recorded occasionally, however, *P. sulcatus* and *Drupa contracta* were most dominant.

Lower littoral zone covers a width of 12.5m of the shore thereby representing the widest part of this shore. The trochids *Euchelus indicus*, *E. asper*, *Trochus radiatus*, *Clanculus depictus*, *C. ceylanicus* and *C. scombinatum* were dominating in this zone, therefore, this zone is named as trochid zone. The lower part of this zone is completely dominated by *E. indicus*; sometimes, entire rocks were found covered by this species. *Drilla atkinsonii*, *Clavatula virginia*, *Diodora bombayana*, *Scutus unquis* and *N. oryzarum* were also recorded in the area. *N. oryzarum* was present throughout the shore having maximum density in mid littoral zone. The bivalves *G. divaricatum* and *Cardium latum* also occurred with the former being dominant.

**Zonation at TIFR and Bandstand Shore :** A tidal belt of 315m and 198m were recorded at TIFR and Bandstand sea shores during low tide. The upper littoral zone at both shores was limited in the tidal height of 1.3m. The upper most part of the upper littoral zone at both shores was littorinid zone, where, *Littorina intermedia* and *Tectarius malaccanus* were detected abundantly. These littorinids were also present in splash zone up to 2m height at TIFR. *L. undulata* was rare at Bandstand shore.

Gastropods *Nerita polita*, *N. oryzarum*, *N. albicilla*, *Planaxis sulcatus*, *P. similis*, *Cerithium morus*, *Ergaea walshi*, *Thais blanfordi*, *T. tissoti*, *T. carinifera*, *Cypraea arabica*, *Bursa tuberculata*, *Drupa contracta*, *D. tuberculata* and *D. knokanensis* were collected in the mid littoral zone at both shores, However *Conus textile*, *C. piperatus*, *Murex adustus*, *Aplysia benedicti* were noticed at TIFR and *T. rudolphi*, *T. hippocastanum*, *Pyrene terpsichore*, *P. atrata* were found exclusively at Bandstand shore. Highest density of *P. sulcatus* and *P. atrata* were recorded throughout the mid littoral at TIFR shore. *Murex adustus*, *Nerita chamaeleon* were rare in this zone at TIFR. At Bandstand *P. sulcatus* and *C. morus* were abundant in upper part of mid littoral zone while, *N. oryzarum* was abundant in lower part. Bivalves *Gafrarium divaricatum*, *G. pectinatum* and *Semele cordiformis* and a continuous bed of *Saccostrea cucullata* were recorded at both shores.

Gastropods *Nerita oryzarum*, *N. albicilla*, *Turbo brunneus*, *Trochus radiatus*, *Cellana radiata*, *Euchelus indicus*, *E. asper*, *Clanculus ceylanicus*, *Bursa tuberculata* and bivalve *G. pectinatum*, *Modiolus emarginatus*, *Gastrana polygona* and Oyster *Crassostrea lugubris* were detected only at Bandstand shore.

The results, specially pertaining to occurrence of *Aplysia benedicti* along with the colony of corals in the mid littoral zone of TIFR contradicts the common belief that these species occur in pollution free oceanic waters. The rich coral ground recorded in

the intertidal zone at TIFR indicates that this region is still free from adverse effects of environmental pollution. *Gafrarium divaricatum* was distributed at all levels at NCPA, TIFR and Bandstand shores which indicates its tolerance to wide fluctuations in the surrounding environment. Some variations recorded in distribution and zonation of molluscs between TIFR and Bandstand would be attributed to the variations in the ecological conditions of the two shores.

#### **Zonation at Girgaon chowpatty :**

The upper littoral zone, measuring 18m in width, is devoid of molluscan fauna, as an impact of anthropogenic activities. Plenty of garbage including plastic bags, flowers, waste papers and many other waste materials are dumped on the shore every day leading to increased stress on the intertidal biota. Despite such a condition, the lower part of the shore possesses a variety of fauna.

In the mid littoral zone, which measures 75.5m in width, Gastropods *Nassarius ornatus*, *Babylonia spirata* and *H. pugilinus* were found plentiful along with considerable number of bivalves *Donax scortum* and *Cardita antiquata* which occur superficially or fully buried in the sediment. Gastropod *Ergaea walshi* and bivalve *Solen truncatus* reported by Bhatt (1959) in this area were not detected during present investigation. The loss is due to increased pollution in the surrounding area.

Lower littoral zone is broader (487.5m width) among all the three zones. Gastropods *Babylonia spirata*, *Hemifusus pugilinus* and bivalves *Donax scortum*, *D. incarnatus*, *Cardium asiaticum*, *Cardita*

*antiquata*, *Placenta placenta*, *Mactra cornea*, *Paphia textile*, *P. malabarica* and *Arca granosa* were recorded in this zone. An overlapping of *B. spirata* and *H. pugilinus* were observed in mid and lower littoral zone, which is the *Cardita* zone. *C. antiquata* was found overlapping in mid and lower littoral zone; however, their population was found to decrease from upper to lower level of lower littoral zone. The lower level of this zone had a thin population of mollusca. The gastropod *Tibia curta* and bivalve *Chione imbricata* recorded by Bhatt (1959) were found to be absent from this area due to many fold increase in pollution.

**Zonation at Gorai creek:** The upper and mid littoral zones of the creek is densely covered by mangroves on both the sides. Gastropods *Littorina scabra*, *Neritina crepidularia*, *Potamides cingulatus* and *Telescopium telescopium* were distributed among these mangroves. In the lower littoral zone only *Katelsia opima* was recorded. Normally the intertidal estuarine areas are characterized by fine sediments inhabited by relatively few species in comparison with marine intertidal areas. These few species may however be very abundant and the overall biomass may be high in comparison with other aquatic system. (Mc Lusky *et al.*, 1993)

At all the sites, the mid littoral zone was found to harbour maximum number of species and individuals owing to the presence of optimum living conditions. Presence of very few molluscan species in the upper littoral zone indicates unsuitability of environment due to maximum percent exposure, minimum submergence and high degree of dessication (Parulekar, 1973).

More number of species recorded at rocky shore of NCPA, TIFR, Bandstand followed by sandy shore of Girgaon chawpatty and muddy shore of Gorai creek is an confirmation with findings of Parulekar (1981) from Konkan shore. Pattern of zonation at rocky (TIFR, Band stand and NCPA), sandy (Girgaon chowpatty) and muddy shore (Gorai creek) was also found to differ due to fundamental differences in the physical environment of different types of substrata. Any common universal system can not be employed to explain the zonation of intertidal organisms by adopting a common system for rocky, sandy and muddy shores (Chapman and Traverthen, 1953).

Occurrence of larger number of molluscs at low tide levels may be due to greater environmental stability, lesser dessication, lower temperature range and increased time for feeding (McLachlan, 1990). Such distribution pattern has been discribed as a typical pattern by Eltringham (1971).

Overlapping of molluscs like *Nerita oryzarum*, *N. polita* and *G. divaricatum* was noticed in all the zones of rocky shores. *Neritina crepidularia* from Gorai creek was also present in upper and mid littoral zones. The ability these molluscs to survive in wide range of environmental conditions is certainly due to the euryhaline and eurythermal characteristics of these animals.

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