

MARINE FAUNA OF MALVAN, CENTRAL WEST COAST OF INDIA

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ABSTRACT

Marine fauna of the rocky, sandy and muddy shores of Malvan (Lat. 16°05' N; Long 73°03' E) comprises of 208 species belonging to 172 genera, 97 families, 16 classes and 9 phyla. Forty major animal types including corals and pearl oysters, were identified.

Rock pool environment was most interesting, as it not only had the maximum number of species but also a high order of faunal diversity. Eight zones indicating the vertical distribution of fauna in relation to tidal range were demarcated. Mid-littoral zone in the rock pools and mud flat mangrove ecosystem and lower littoral zone on the rocky and sandy shores, harbour maximum number of species. Three critical levels, limiting the vertical distribution of intertidal fauna were identified. The findings are discussed in relation to environmental conditions. The need for the conservation of marine fauna in these areas is also highlighted.

INTRODUCTION

The intertidal region—a zone of interaction between the sea, land and air, is one of the most interesting regions of the marine biota. The inhabitants of this region, due to diel changes in exposure, desiccation and submergence, are known to be hardy and diverse.

In recent years, a number of reports on occurrence and taxonomy of intertidal fauna from different parts of the Indian coasts have appeared, but only few give a comprehensive account of the fauna of different niches of the intertidal region.

The present communication, based on observations undertaken since 1966, gives an account of distribution, habit, habitat, zonation and critical levels of vertical distribution of intertidal fauna of rocky, sandy and muddy shores of Malvan. Earlier reports on the marine fauna of Malvan pertain to sea anemones (Parulekar, 1966, 1969 & 1971 a & b); molluscs (Joshi, 1969); polychaetes (Parulekar, 1973); island fauna (Panikkar, Parulekar and Untawale, 1973); pearl oysters (Ranade, 1977) and corals (Qasim and Wafar, 1979).

DESCRIPTION OF THE STUDY AREA

Topography: Malvan, a 'taluk' headquarter in Ratnagiri district of Maharashtra State, is located (Lat. 16°05' N, Long. 73°30' E) along the central west coast of India. The northern and the southern limits of Malvan are marked by Kalavali creek and Karli river respectively. On the east, the ranges of the western Ghats form a back drop.

The coastline (Fig. 1) is marked by islands (*Sindhudurg, Padamgad* and *Kavdebakal*), oyster rocks (*Mandel* and *Don Tarra*), rocky promontories (*Rajkot* and *Sarjekot*), sandy beaches (*Chiwallychi vel, Kond vel, Malwan Chowpatty* and *Dandi*), and mud plat-mangroves (in the environs of *Kalarali* and *Kolamb creek*). The rock formations are mainly granites and gneisses and in a few gneissic interruptions, the rocks are covered by laterite beds.

Climatology and Hydrography: Malvan has typical monsoon type tropical climate. The annual average rainfall is about 3000 mm with maximum precipitation during the summer monsoon extending from June to September. The atmospheric temperature ranges from 28° to 33°C with minimum and maximum values recorded in December and May, respectively. The relative humidity varies between 70% (April) and 90% (July-August). The winds are variable, with higher speed upto 30 km/hour or more in June-August as against 13-17 km/hour in the remaining months of the year. The currents are clockwise or shoreward during February-September; anticlockwise during November-January and transitional in October. The sea off Malvan is generally calm, except in the rainy season when, at times, it becomes choppy. Due to the presence of a number of vertical or near vertical rocky surfaces, the surf is moderately high with an appreciable quantum of spray.

Dehadrai and Bhargava (1972) have reported that the surface water temperature, salinity and dissolved oxygen values in Malvan Bay range between 25°C (September) and 32°C (April); 18.6‰ (September) to 36‰ (April); 4 ml/l (November) to 5.8 ml/l (February) respectively, during the major part of the annual cycle, excepting the monsoon season (June-August).

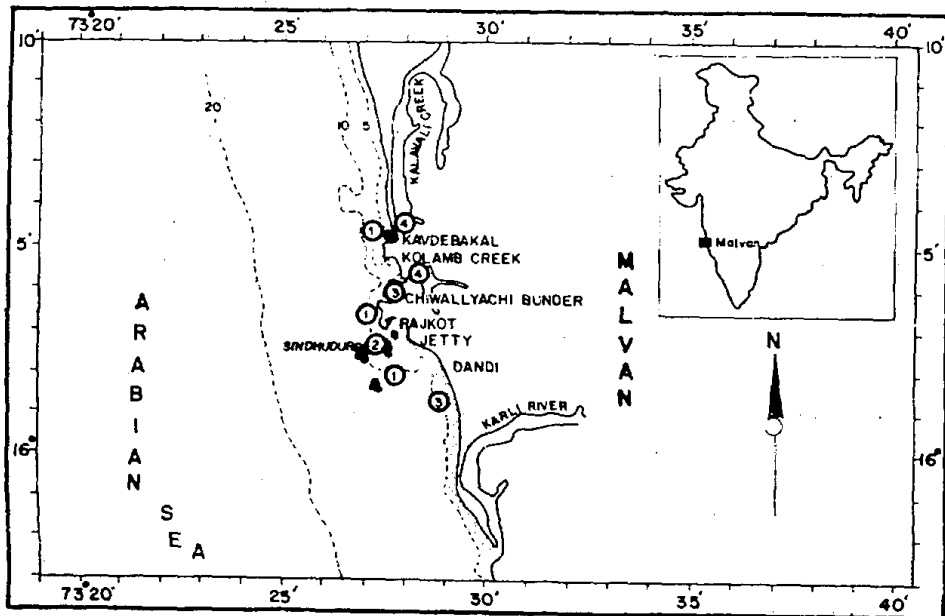


Fig. 1. Map of Malvan coast, showing the topographic features. Sites for collection, shown by serial numbers: (1) Rocky Shore (2) Rock Pool-Gravel Bed (3) Sandy Shore (4) Mud Plat-Mangroves. Solid dots indicate island and oyster rocks.

Tides and Tidal Levels: The tides are of semi-diurnal mixed type with an amplitude of about 2.25 m and the different tidal levels are as follows:

		(Height m)
EHWS (Extreme High Water of Spring)	..	4.60
MHWS (Mean High Water of Spring)	..	4.12
MHW (Mean High Water)	..	3.50
MHWN (Mean High Water of Neap)	..	3.20
MTL (Mean Tide Level)	..	2.60
MLWN (Mean Low Water of Neap)	..	1.94
MLW (Mean Low Water)	..	1.54
MLWS (Mean Low Water of Spring)	..	1.05
ELWS (Extreme Low Water of Spring)	..	0.00

MATERIAL AND METHODS

Four different types of ecosystems, namely, rocky shore, rock pool-gravel bed, sandy shore and mud plat-mangrove vegetation, as indicated (Fig. 1) by serial numbers 1 to 4, respectively, were studied. Collections were made at low tide and the generalized method of Evans (1948) was followed to determine the vertical distribution of animals. All practicable devices were employed to explore the maximum of niches, yet only the ecologically significant organisms have been considered. The relative abundance of each species was estimated subjectively and no quantitative estimates attempted. Sand dwelling meiofaunal forms have not been considered. Results represent the collections made over a number of years, since 1966, and cover different months and seasons in an annual cycle. However, seasonal changes in the faunal abundance have not been discussed.

RESULTS AND DISCUSSION

Habitat and Faunal Distribution: The intertidal (including 15 species which are also found in subtidal region) fauna of Malvan (Table I) is represented by 208 species, belonging to 9 phyla, 16 classes, 97 families, 172 genera and 7 varieties.

Forty major animal types were identified and their distribution in rocky shore, rock pool-gravel bed, sandy shore and mud plat-mangrove vegetation indicated (Table II) that rock pool environment, in having thirtytwo animal types and 92 species, was the richest. While sandy shore had more number of species (57) than in the rocky shore (56), the latter had more number of animal types (20) than in the former (15). The mud plat-mangrove ecosystem in having 29 species representing 16 animal types, was relatively impoverished. In an overall assessment, it may be said that the ecosystems characterized by hard bottom deposits were faunistically richer than those with the soft substratum.

A high order of niche specificity was observed in the marine fauna of Malvan. Most of the species were observed to be single-habitat dwellers. As shown in Table III, 186 species out of the total 208, were restricted to a particular habitat, whereas 22 species were found on more than one habitat and that too in such

Table I. A check list of intertidal fauna of Malvan.

I. Phylum: Porifera	III. Phylum : Annelida
Family: Tetillidae	Family : Aphroditidae
1. <i>Tetilla dactyloides</i> , (Carter)	33. <i>Lepidonotus carinulatus</i> , Grube
Family: Tethyidae	34. <i>Gattyana deludens</i> , Fauvel
2. <i>Tethys lynnerium</i> , Linn.	35. <i>Harmothoe ampullifera</i> , (Grube)
II. Phylum Coelenterata	36. <i>Sthenelais boa</i> , (Johnston)
Family: Veretillidae	37. <i>Leanira japonica</i> , McIntosh
3. <i>Cavernularia orientalis</i> , Thompson & Simpson	38. <i>Polyodontes melanonotus</i> , (Grube)
Family: Virgulariidae	39. <i>Panthalis oerstedii</i> , Kinberg
4. <i>Virgularia rumphii</i> , Kolliker	Family : Chrysopetalidae
Family: Edwardsiidae	40. <i>Bhawania cryptocephala</i> , Gravier
5. <i>Edwardsia tinctoria</i> , Annandale	Family : Amphinomidae
Family: Haloclavidae	41. <i>Eurythoe complanata</i> , (Pallas)
6. <i>Metapeachia tropica</i> , (Panikkar)	42. <i>Chloeia rosea</i> , Potta
Family: Haliactiidae	Family : Hesionidae
7. <i>Pelocoetes exul</i> , Annandale	43. <i>Hesione pantherina</i> , Risso
8. <i>Phytocoetes gangeticus</i> , Annandale	44. <i>Leocrates claparedii</i> , (Costa)
Family: Actiniidae	45. <i>Leocratides ehlersi</i> , (Horst)
9. <i>Anemonia indicus</i> , Parulekar	46. <i>Podarke angustifrons</i> , (Grube)
10. <i>Bunddosoma granulifera</i> , (Leseur)	Family : Syllidae
11. <i>Anthopleusa midori</i> , Uchida	47. <i>Syllis (Haplosyllis) spongicola</i> , Grube
12. <i>Anthopleura asiatica</i> , Uchida	48. <i>Syllis (Sylli) gracilis</i> , Grube
13. <i>Anthopleura panikkarii</i> , Parulekar	49. <i>Syllis (Typosyllis) closterobranchia</i> , Schmarde
15. <i>Paracondylactis indicus</i> Dave	50. <i>Syllis (Typosyllis) variegata</i> , Grube
16. <i>Actinogeton sultana</i> , (Carlgren)	Family : Nereidae
17. <i>Cribrinopsis robertii</i> , Parulekar	51. <i>Nereis (Nereis) chingrighattensis</i> , Fauvel
18. <i>Acontiophorum bombayensis</i> , Parulekar	52. <i>Nereis (Nereis) chilkaensis</i> , Southern
Family: Metridiidae	53. <i>Nereis (Ceratoneis) costae</i> , Grube
19. <i>Metridium senile</i> var. <i>fimbriatum</i> , (Stoliczka)	54. <i>Nereis (Ceratoneis) mirabilis</i> , Kinberg
20. <i>Neoaiptasia commensali</i> , Parulekar	55. <i>Perinereis vancaurica</i> (Ehlers) var. <i>typica</i> (Fauvel)
Family: Aiptasiomorphidae	56. <i>Perinereis vancaurica</i> (Ehlers) var. <i>indica</i> (Bhatt)
21. <i>Aiptasiomorpha luciae</i> , (Verrill)	57. <i>Perinereis cultrifera</i> , Grube var. <i>typica</i> , Grube
Family : Didumenidae	58. <i>Perinereis aibuhitensis</i> , Grube
22. <i>Didumene schilleriana</i> (Stoliczka)	59. <i>Perinereis nigro-punctata</i> , Horst.
Family : Epizoantidae	60. <i>Perinereis nuntia</i> (Savigny) var. <i>typica</i> (Savigny)
23. <i>Epizoanthus elongatum</i> , (Verrill)	61. <i>Perinereis nuntia</i> (Savigny) var. <i>brevicirris</i> , (Grube)
Family : Siderastreaidae	Family: Eunicidae
24. <i>Siderastrea savignyana</i> , (Milne-Edwards and Haime)	62. <i>Eunice tentaculata</i> , Quatrefages
25. <i>Coscianarea monile</i> , (Forskal)	63. <i>Eunice antennata</i> , Savignyi
Family : Poritidae	64. <i>Marphysa sanguinea</i> , Montagu
26. <i>Porites lutea</i> , Milne Edwards and Haime	65. <i>Diopatra neapolitana</i> , Delle chiaje
27. <i>Porites lichen</i> , Dana	66. <i>Onuphis</i> sp.
Family: Faviidae	67. <i>Lumbriconereis heteropoda</i> , Marenzeller
28. <i>Favites halicora</i> (Ehrenberg)	68. <i>Arabella iricolor</i> , (Montagu)
29. <i>Goniastrea retiormis</i> , (Lamarck)	
30. <i>Cyphastrea</i> Sp.	
Family: Mussidae	
31. <i>Cynaria lacrymalis</i> , (Milne-Edwards and Haime)	
Family : Dendrophyllidae	
32. <i>Turbiniaria crater</i> , (Pallas)	

Family Glyceridae

69. *Glycera alba*, Rathke

Family : Spionidae

70. *Polydora (Polydora) coeca*, Oersted71. *Cirriformia limnoricola*, Kirkegaard & Santhakumaran72. *Phyllochaetopterus socialis*, Clapareda73. *Sabellaria* sp.

Family : Terebellidae

74. *Pista* sp.75. *Spirographis spallanzanii*, Viviani76. *Dasychone cingulatus*, Grube77. *Dasychone serratibranchis*, Grube78. *Potamilla leptochaeta*, Southern

Family : Serpulidae

79. *Vemiliopsis glandigerus*, Gravier

IV. Phylum : Sipunculoidea

Family : Dendrostomiidae

80. *Dendrostoma signifer*, Selenka and de Man

V. Phylum : Echiuroidea

Family : Echiuridae

81. *Ochetosoma bombayensis*, Bhatt

VI. Phylum : Arthropoda

Family : Squillidae

82. *Squilla raphidea* Fabricius83. *Squilla nepa*, Latreille84. *Squilla scorpio*, Latreille85. *Squilla interrupta*, Wood. Mason86. *Gonadactylus chiracra*, (Fabricius)

Family : Euridicidae

87. *Cirolana* sp.88. *Limnoria (Limnoria) bombayensis*, Pillay

Family : Sphaeromidae

89. *Sphaeroma walkeri*, Stebbing

Family : Idoteidae

90. *Synidotea variegata*, Collinge

Family : Ligyidae

91. *Ligia exotica*, Roux

Family : Calappidae

92. *Matuta victor*, De maan93. *Matuta planipes*, Fabricius

Family : Leucosiinae

94. *Philyra globosa*, (Fabricius)

Family : Dorippidae

95. *Dorippe astuta*, Fabricius

Family : Hymenosomatidae

96. *Elamena cristatipes*, Gravely97. *Schizophrys aspera*, (Milne-Edwards)

Family : Portunidae

98. *Portunus pelagicus* (Linnaeus)99. *Portunus sanguinolentus*, (Herbst)100. *Charybdis annulata*, (Fabricius)101. *Thalamita arenata*, Milne-Edwards

Family : Xanthidae

102. *Leptodius arassimanus*, Milne-Edwards103. *Ozius rugulosus*, Stimpson
Family : Pinnotheridae104. *Pinnotheres* sp.

Family : Ocypodidae

105. *Uca annulipes*, Latreille106. *Dotilla myctiroides* (Milne-Edwards)107. *Macrophthalmus sulcatus*, Milne-Edwards108. *Ocypod ceratophthalma* Milne-Edwards109. *Emerita holthuisi* (Sankoli)

Family : Grapsidae

110. *Metagrapsus messor* (Forsk.)111. *Sesarme oceanica*, De Maan

Family : Porcellanidae

112. *Petrolisthes boscii*, (Audouin)

Family : Paguridae

113. *Clibanarius intraspinus*, Hilgendorf114. *Clibanarius padavensis*, de Man115. *Diogenesustus*, (Fabricius)116. *Diogenes miles*, (Herbst)

Family : Sergestidae

117. *Acetes indicus* Milne-Edwards

Sub-Family : Paenidae

118. *Penaeus japonicus*, Bate119. *Metapenaeus monoceros*, Fabricius120. *Parapeneopsis styliifera*, Milne Edward

Family : Hippolytidae

121. *Hippolysmata ensiostris*, Kemp

Family : Iblidae

122. *Ibla cumingi*, Darwin123. *Lepas* sp.

Family : Balanidae

124. *Balanus tintinnabulum tintinnabulum* (Linn)125. *Balanus (Balanus) amphitrite* var. *communis*, Darwin126. *Tetraclita (Tetraclitella) purpurascens*, (Wood)127. *Cthamalus withersi*, Pilsbry

Family : Hydrometridae

128. *Halobates* sp.

VII. Phylum : Mollusca

Family : Ischnochitonidae

129. *Ischnochiton computus*, (Gould)

Family : Fissurellidae

130. *Diodora bombayana*, (Sowerby)131. *Scutus unguis*, (Linn)

Family : Patellidae

132. *Cellana radiata*, (Born)

Family : Trochidae

133. *Euchelus asper*, (Gmelin)134. *Euchelus tricarinatus*, Lamarck135. *Calliostoma scobinatum* (A.Ad.)

136. *Gibbula swainsonii*, A. Ad.
 137. *Clanculus depictus*, A. Ad.
 138. *Trochus radiatus*, Gmelin
 139. *Umbonium vestiarum*, (Linn).

Family : Turbinidae

140. *Turbo intercostalis*, Menke
 141. *Astrea stellata*, Gmelin

Family : Neritidae

142. *Nerita oryzarum*, Reelus
 143. *Nerita polita*, Linn.

Family : Littorinidae

144. *Littorina subgranosa* Dunker
 145. *Littorina intermedia*, Phil
 146. *Littorina ventricosa*, Phil
 147. *Tectarius malaccanus*, Phil

Family : Vermetidae

148. *Vermetus* sp.

Family : Planaxidae

149. *Planaxis sulcatus*, Born

Family : Potamididae

150. *Cerithidea fluviatilis*, Potiez & Michaud

151. *Telescopium telescopium* (Linn)

Family : Cerithiidae

152. *Alaba rectangulata*, Craven
 153. *Cerithium morus*, Lamarck
 154. *Cerithium rubus*, Deshayes

Family : Calyptraeidae

155. *Ergoëa walshii*, Hermann

Family : Strombidae

156. *Tibia curta*, Lamarck

Family : Naticidae

157. *Natica lineata*, Lamarck
 158. *Natica maculosa*, Lamarck

Family : Cypræidae

159. *Cyprea pallida*, Gray

Family : Bursidae

160. *Bursa tuberculata*, Brod.

Family : Muricidae

161. *Murex adustus*, Lamarck
 162. *Drupa kankanensis*, Melvill
 163. *Thais carinifera*, (Lam)
 164. *Thais rudoplhi*, (Lam)
 165. *Thais tissoti*, Petit

Family : Pyrenidae

166. *Pyrene terpsichore*, Sowerby

Family : Buccinidae

167. *Babylonia spirata*, Linn.

Family : Nassidae

168. *Bullia lineolata*, Wood
 169. *Nassarius ornatus*, Kinner

Family : Turridae

170. *Surcula javana*, Linn

Family : Aplysiidae

171. *Aplysia cornifera*, Sowerby
 172. *Bursatella leachii*, de Blainville

Family : Onchidiidae

173. *Onchidium verraculatum*, Cuvier

Family : Arcidae

174. *Arca bistrigata*, Dunker

175. *Arca symmetrica*, Reeve

176. *Anadara granosa*, Lam.

Family : Mytilidae

177. *Mytilus viridis*, Linn.

178. *Modiolus striatulus*, Linn.

179. *Brachydontes karachiensis*,
Melville

Family : Pectinidae

180. *Chlamys tranquebaricus*, (Cmelin)

Family : Limidae

181. *Lima lima* (Linn)

Family : Anomiidae

182. *Anomis achaeus*, Gray

Family : Ostreidae

183. *Crassostrea cucullata*, Born

184. *Crassostrea bicolor*, Hanley

185. *Crassostrea lacerata*, Hanley

Family : Trapeziidae

186. *Trapezium vellicatum*, Reeve

Family : Cardiidae

187. *Cardium asiaticum*, Brug

Family : Veneridae

188. *Gafrarium divaricatum*, Chemnitz

189. *Sunetta solandri*, Gray

190. *Meretrix meretrix*, Linn

191. *Meretrix casta* (Chemnitz)

192. *Paphia textile*, Gmelin

Family : Mactridae

193. *Coecella transversalis*, Deshayes

Family : Donacidae

194. *Donax incarnatus*, Chemnitz

195. *Donax scortum*, Chemnitz

Family : Soleniidae

196. *Solen truncatus*, Sowerby

Family : Pteriidae

197. *Pinctada chemnitzii*, (Philippi)

Family : Pholadidae

198. *Mariesia striata*, Linn.

VIII. Phylum : Echinodermata

Family : Asterinidae

199. *Astropecten indica*, Smith

Family : Ophiactidae

200. *Ophiactis savignyii*, Muller and
Troschel

Family : Temnopleuridae

201. *Temnopleurus torreumaticus*, Klein

Family : Phyllophoridae

202. *Holothura scabra*, Linn

203. *Synapta* sp.

IX. Phylum : Chordata

Class : Pisces

Family : Ophichthyidae
204. *Pisodonophis boro*, (Hamilton
Buchanan)

Family : Theraponidae
205. *Therapon jarbua*, Forskal

Family : Blenniidae
206. *Petroscirtes punctatus*, (Cu, & Val.)

Family : Gobiidae
207. *Callogobius* sp.
208. *Batrachus* sp.

Table II. Distribution of animal types in the marine environment of Malvan.

Sl. No.	Animal Type	Total No. of species	Habitat			
			Rocky shore	Rock pools & Gravel bed	Sandy shore	Mud plat & Mangroves
1	Sponges	2	-	1	1	-
2	Sea fan, sea pen, etc.	2	-	2	-	-
3	Sea mat (zoantharia)	1	-	1	-	-
4	Sea anemones	18	4	10	8	3
5	Corals	9	9	6	-	-
6	Worms	49	8	19	15	8
7	Stomatopods	5	1	-	4	-
8	Isopods	5	2	2	-	1
9	Crabs	21	1	9	8	3
10	Hermit crab	4	-	2	4	1
11	Shrimp and prawn	5	-	3	-	2
12	Stalked & Goose barnacle	2	-	1	1	-
13	Sessile barnacle	4	2	2	-	1
14	Insects	1	-	1	-	-
15	Limpets	4	3	2	-	-
16	Top shell	10	6	3	1	-
17	Button shell	1	-	-	1	-
18	Periwinkle	4	4	2	-	1
19	Worm shell	1	1	-	-	-
20	Whelk	8	1	3	2	2
21	Shell drill	2	-	-	2	-
22	Cowries	1	-	1	-	-
23	Spire shells	11	5	2	3	1
24	Sea hare	3	3	-	-	1
25	Cockles	3	1	1	-	1
26	Mussels	3	1	2	-	-
27	Pane shell	3	1	2	-	-
28	Edible oyster	3	1	2	-	1
29	Pearl oyster	1	1	1	-	-
30	Clams	8	-	3	4	1
31	Bean clam	2	-	-	2	-
32	Razor clam	1	-	-	-	1
33	Rock drill	1	-	1	-	-
34	Star fish	1	-	-	1	-
35	Brittle star	1	1	1	-	-
36	Sea urchin	1	-	1	-	-
37	Sea cucumber	2	-	2	-	-
38	Perches	2	-	2	-	-
39	Rock skipper	1	-	1	-	-
40	Mud skipper	2	-	1	-	-

niches, having similar physical characters. Accordingly, out of 9 species of hard corals inhabiting the rocky shore, only 6 species were found in the rock pools, thus indicating high adaptability towards colonization in a comparable substrate. In con-

trast, sipunculid and echiurid worms, which were collected from rocky shore and mud plat-mangrove ecosystem, respectively, showed 100% niche specificity followed by annelids (95%), molluscs (94%) and arthropods (93%). An estimation of faunal similarity index indicated (Table III) that fauna of rocky shore-rock pool was more alike (8.10%) than the rock pool-sandy shore (1.36%). In possessing graded per cent similarity from 2.35 to 3.48% with the fauna of other niches, the mud plat mangrove fauna display a high degree of adaptability.

Zonation: The vertical distribution of intertidal organisms on rocky, sandy and muddy substrate is a direct consequence of the amplitude and height of the tide on the shore (Doty, 1946). Due to fundamental differences in the physical environment of the different type of substratum it is doubtful whether any common universal system could be employed to explain the zonation of intertidal organisms by adopting a common system for rocky, sandy and muddy shores (Chapman and Traverthen, 1953). However, as suggested by Morton and Challies (1969), "on tropical beaches these shore types intergrade so closely towards the centre that a line of demarcation is virtually unable to be drawn" and accordingly, a generalized system, as given below which appropriately explains the zonation of intertidal fauna of rocky, sandy and muddy shore of Malvan, was devised and used.

Zone	Height (m)	
Spray (Rocky shore)	EHWS + 1.12	
Spill (Rock pool-gravel bed)	EHWS - 0.8	
Supra Littoral (Sandy shore)	EHWS + 0.9	
Tree Top Line (Mud plat-mangrove)	EHWS + 1.0	
Upper Littoral	Upward of MHWS to EHWS \pm 0.48	
Mid Littoral	} Common for Rocky, Sandy & muddy shores	
Lower littoral		Between MLW & MHWS \pm 0.3
Sub-tidal		Between ELWS & MLW $0 \pm .2$ ELWS $0 \pm .3$

Table III. Habitat preference and faunal similarity in the intertidal fauna of Malvan.

Sl. No.	Taxa	Total No. of species	Occurrence		Faunal similarity %
			Single habitat	Double habitat	
1.	Porifera	2	2	-	i) Rocky shore and rock pool-gravel bed - 8.10
2.	Coelenterata	30	19	11	
3.	Annelida	47	45	2	ii) Rocky shore and mud plat-mangrove - 2.35
4.	Sipunculoidea	1	1	-	
5.	Echiuroidea	1	1	-	iii) Rock pool and sandy shore - 1.36
6.	Arthropoda	47	44	3	
7.	Molluscs	70	66	4	iv) Rock pool and mud plat-mangrove - 2.47
8.	Echinodermata	5	4	1	
9.	Pisces	5	4	1	v) Sandy shore and mud plat-mangrove - 3.48

Fig. 2 shows the zonation of species in different niches, in relation to tide levels and per cent exposure. Of all the zones, mid littoral was found to be most expansive but not essentially harbouring maximum number of species. Accordingly the mid-littoral zone in rock pool and mud plat-mangrove ecosystem had more number of species, whereas on rocky and sandy shores, more number of species prefer lower littoral zone (Fig. 2). Similarly, the sub-tidal species, especially on rocky shore are reportedly transitional (Stephenson and Stephenson, 1949) and with a small upper limit of 0.3 m available for habitation, were more prevalent (18%) in rocky shore environment and showed low preference (3%) for soft substrate habitat, like mud plat-mangrove.

The uppermost zone (Fig. 2) in either rocky, sandy or muddy shore having maximum per cent exposure, minimum submergence and high degree of desiccation was very thinly populated, except possibly by 4 species of littorinid gastropod and a species of isopod, *Ligia exotica*. This observation is in conformity with the earlier report (Parulekar, 1973) that higher up on the shore, the number of species decreases as the conditions for survival become more and more rigorous.

In the present investigation, it was observed that the number of species in the littoral region, which extends upward from ELWS to EHWS ± 0.48 m, was maximum (93.5%) in the rock pool environment, followed by 89% in sandy and muddy shores and the minimum (75%) on the rocky shore. Such a difference in the population in the same zone but in different substrate of the same locality, is due to the presence of certain levels on the shore which are critical in the sense that more species attain their upper or lower limits at these levels than at the other (Colman, 1933).

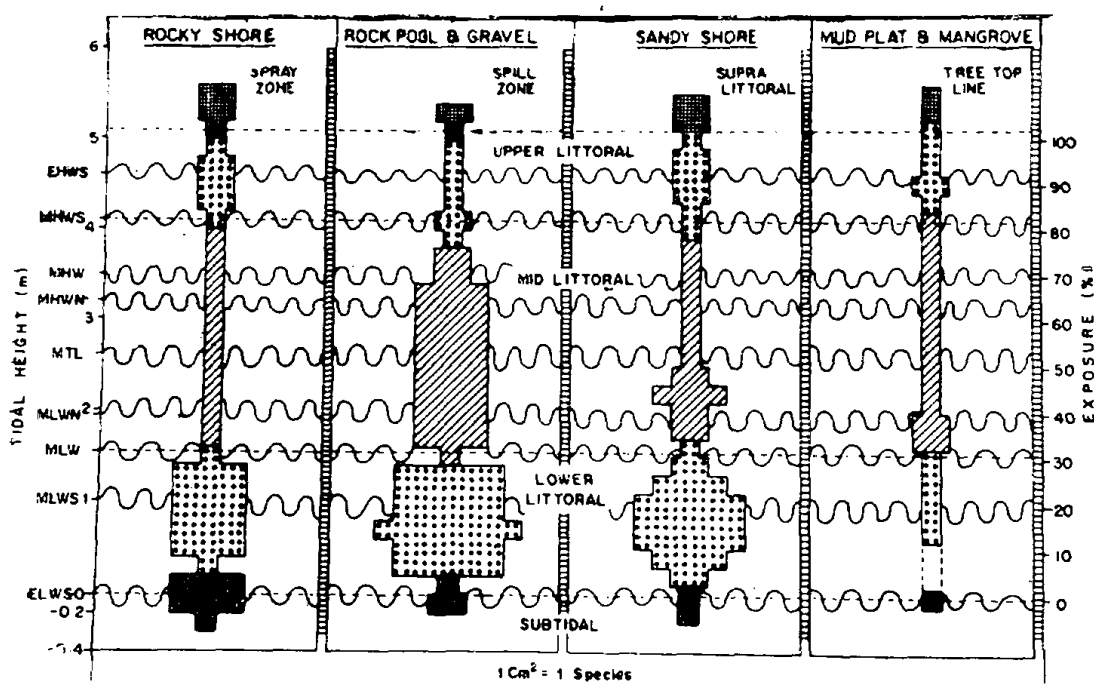


Fig. 2. Zonation and distribution of intertidal fauna of Malvan in relation to tidal height and percent exposure.

An examination of Fig. 2 indicates that in the intertidal region of Malvan, there exists three critical levels in relation to tidal amplitude and percent exposure. The critical levels as given below, act as limiting factor in the vertical distribution of intertidal animals.

(i) Between ELWS and MLW	—	Lower Limit
(ii) Near MLWN	—	Upper Limit
(iii) Around MHW	—	Upper Limit

Bhatt (1959) and Parulekar (1973) also identified three zones (upper littoral, mid littoral and lower littoral) and three critical levels for the intertidal fauna of Bombay and Anjidiv Island respectively. Seshappa (1966) while reviewing the vertical distribution of the intertidal organisms has remarked "there seems to be an agreement among all workers, however, that the zones are clearly related in a certain way to the tidal levels, this relationship is of complex nature, variable from place to place, and not amenable to any mathematical assessment". Thus though the expanse of a zoned shore and the vertical limits of animals vary widely according to exposure regime, there exists an uniformity in the salient features as evidenced by the existence of three critical levels at Malvan, Bombay (Bhatt, 1959) and Anjidiv Island (Parulekar, 1973). All the three localities are situated along the central west coast of India and have similar climatological, hydrobiological and tidal characteristics.

A comparison based on the presence or absence of commonly occurring taxa of the intertidal fauna of Malvan with those of the alien localities like Bombay and Anjidiv Island (Table IV) indicate that in overall faunal composition, there is a close similarity. The intertidal fauna of Bombay which is less than 200 km, north of Malvan, is comprised of 260 species from the rocky, sandy and muddy shores (Bhatt, 1959). Similarly, the rocky and sandy intertidal fauna of Anjidiv, a near-shore Arabian Sea island about 150 km south of Malvan, has got similar faunal composition but less (75) number of species (Parulekar, 1973). In spite of the faunal

Table IV. Comparison of intertidal fauna from different localities along the central west coast of India.

Locality	Geographical position	Tidal Amplitude (m)	Number of Species									Source
			Porifera	Ceclen-terata	Annelida	Sipuncu-loidea	Echiu-roidea	Arthro-poda	Mollusca	Echino-dermata	Pisces	
Bombay	Lat 19.00' N Long 72°50' E	2.57	2	16	40	1	1	68	105	5	22	Bhatt (1959)
Anjidiv Island	Between Lat-14-15° N and Long-74-75° E	2.05*	1	4	17	1	-	21	26	3	2	Parulekar (1973)
Malvan	Lat-16°05' N Long-73°30' E	2.25	2	30	47	1	1	47	70	5	5	Present Investigation

*Based on tidal predictions for Karwar (Lat. 14°48' N; Long. 74°07' E)

similarity existing in the three localities, the intertidal fauna of Malvan is unique in the presence of live corals, including the rare variety of 'red coral' which has been discovered (Parulekar, unpublished) recently in November 1979 and also the live pearl oysters. Earlier report (Ranade, 1977) about pearl oysters at Malvan is based on dead shells, washed ashore.

The foregoing account on the intertidal fauna of rocky, sandy and muddy shores of Malvan, a scientifically little known place along the Indian coastline, reveals the richness and diversity of tropical marine fauna and also serves as a case study for the intertidal ecology of different types of shores. The results, especially pertaining to the occurrence of corals and pearl oysters, contradict the common belief that these species occur in oceanic waters where euhaline (>30‰) conditions and high degree of transparency of water prevails. Such a richness of fauna as evidenced in the course of the present investigation, in the vicinity of an urbanized area also shows that the marine environs of Malvan are still free from the adverse effects of environmental pollution. However, it must be recorded here that the sandy beaches of Malvan are subjected to faecal pollution and also oil pollution, due to tar ball deposition, especially during rainy season (Dwivedi and Parulekar, 1974). It, therefore, necessitates the monitoring of environment for proper conservation of rich marine life of Malvan.

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