

Continental Shelf Islands of the Konkan Coast

by

N. K. PANIKKAR, A. H. PARULEKAR AND A. C. UNTAWALE

*Arabian Sea Islands Project (INSA),
National Institute of Oceanography, Panaji (Goa).*

ABSTRACT.

The Arabian Sea Islands are broadly divided into three groups: (1) Saurashtra group, (2) Konkan group, and (3) the Laccadive group. The Konkan group, comprising of 36 continental or nearshore islands, extend from Lat. $18^{\circ} 55' N$ to $12^{\circ} 51' N$ and Long. $71^{\circ} 50' E$ to $74^{\circ} 50' E$.

The islands, in general, influence the coastal environments, hydrology, nutrient cycle, production at various tropic levels, distribution, abundance and reproduction of marine organisms. In spite of their importance and proximity to the mainland, the Continental Shelf Islands of the Konkan have remained unexplored and very little scientific information is available. For the last two years, these Islands are being studied under a special project, namely 'Investigations of the Arabian Sea Islands, 'sponsored by the Indian National Science Academy.

The islands have been investigated as a single ecological unit in which the geological formations, floristic composition and faunal assemblages have been described. The paper suggests the broad classification of these ecosystems and also discusses the commercially important marine algae and animal resources.

INTRODUCTION

The Continental Shelf region of the Arabian Sea harbours a number of islands. The Shelf Islands are presumed to be formed due to marine and subaerial erosion or rifting or glaciation, giving rise to a natural canal, resulting in an island being formed from the sea-ward fragments of mainland (Cotter, 1965). The physical connection is demonstrable from a consideration of the geological and the biological features of the island and the mainland.

The shelf islands, in general, influence the coastal environment, hydrology, nutrient cycle, production at various trophic levels, distribution, abundance and reproduction of marine organisms and consequently of their surrounding ecosystems. In spite of their proximity to the mainland, there is considerable difference in certain natural features in terms of geological, biological and oceanographic aspects. A general neglect of these islands has kept the scientific world in the dark about their geological formations, flora, fauna and natural history. The economic and strategic significance of the islands can hardly be overlooked.

The necessity for a detailed scientific investigation of the islands in the Arabian Sea has been realized and consequently a research project sponsored by the Indian National Science Academy has been in progress for the last two years.

The present paper deals with the geological aspects, flora and fauna of the Continental Shelf islands along the Konkan coast.

DESCRIPTION OF THE KONKAN ISLANDS

The Continental Shelf islands (Map 1) along the Konkan coast are located between Lat. 19°58'N to 12°51'N and Long. 72°53'E to 74°50'E and these are broadly divisible into the following sub-groups:-

1. Bombay Sub-group.
2. Malwa Sub-group.
3. Goa Sub-group.
4. Karwar Sub-group.
5. Malpe Sub-group.

In addition, there are a few more islands such as the Vengurla Oyster Rocks, Redi Port Basin Islands, Basrajurg Island of Honavar and Pate Rocks of Coondapur. Table I

shows the sub-group, the area, distance from mainland and the mean elevation of the 36 islands which form the Konkan group.

TOPOGRAPHY OF THE KONKAN COAST.

The Konkan coast, forming a part of the West Coast of India, consists of more or less dentate coastline with creeks, inlets, rivers, deltas and islands. The sandy and rocky water-front is interrupted by saline marshes covered with their own characteristic vegetation. The coastal plains almost abruptly lead to ascending heights of the Western Ghats with graded elevations rising upto 1200 metres. In general, the topography is of undulating nature.

CLIMATE.

The climatic conditions of the Konkan conform to the broad pattern characteristic of the West Coast of India. The total annual rainfall varies over a wide range with an average of about 230 cm. Most of the rainfall is received between June and October from the South-West monsoons. There are some sporadic thunder-showers in April and May.

The temperature during the monsoon is fairly steady around 32° C-35° C with negligible diurnal variations. The minimum winter temperature ranges from 14°C to 16°C and the maximum temperature during the summer ranges from 35°C to 39°C. Relative humidity varies with the season and the elevation and the diurnal rhythmic changes may range from 60-70% in the morning and 25% in the afternoon.

There are short-amplitude local sea-breezes during the morning and evening hours. Apart from this, there are seasonal trade winds received from the south-west from June to August and north-east during summer months.

GEOLOGICAL FORMATIONS.

The Konkan coast is located in the region of the Deccan Trap and the Archaean rocks. The southern limit of the Deccan Trap almost coincides with the north-eastern boundary of Goa; and then follows the Dharwarian quartzites and granite gneiss, forming a part of the extensive Archaean system. Geological formations of the Konkan islands may be broadly classified as shown in Table II.

Almost the whole of the region is occupied by the Archaean and mainly by Dharwar rocks which are a complex of much crushed quartzites, phyllites and few other metamorphic forms. Most of the ferruginous quartzites (1. Haematite 2. Magne-

tite) have resulted by replacement at a later age. Isolated small outcrops of granite gneiss are an extension of the peninsular gneiss group. It has also been crushed and locally even mylonitised.

The newer dolerites consist of slightly uralitised dolerites and gabbros made up of basic plagioclase, varying amount of orthrhombic and or monoclinic pyroxene and accessory iron ore. Some contain olivine and others quartz in small quantities.

The Deccan Trap lava covers quite an extensive area and its southern edge is traceable upto Goa. The Deccan Trap also occurs in the form of isolated dykes which are fairly numerous and are common throughout the area. The dyke rocks are dolerites made up of labradorite, a monoclinic pyroxene free from uralitisation, small amounts of olivine and glassy base which has been more or less changed to palagonite.

The laterite is of the detrital type and is mostly found along the mainland. It is seen all over the area concealing the earlier formations. Locally, it forms deposits of iron and manganese ores, in several places. Other minerals of economic value include low grade bauxite and mica, building stones, clays for brick and ceramic industry, mineral pigments, etc.

FLORA OF THE KONKAN ISLANDS.

The Konkan or western coastal islands on the Continental Shelf, have more or less common topographical, ecological and general climatic features. These islands thus exhibit considerable resemblance regarding broad vegetational aspect. The average elevation of the mainland does not exceed 100-150 metres and, therefore, the adjacent islands show a considerable homogeneity in floristic features.

The flora of these islands is typically of tropical or sub-tropical sea coasts. The average precipitation is 100-200 inches per annum, resulting in luxuriant growth of plants belonging to different groups of the plant kingdom. Moreover, these islands represent almost the same vegetational pattern as the mainland. The growth and development of the plants is healthy as these islands are separated from the mainland by a water mass for quite a long time. Moreover, there is not much biological interference.

(a) INTER-TIDAL FLORA.

The waterfront of the Konkan islands is mostly rocky with meagre sandy shores. During low tide, the shore gets exposed and several species of seaweeds are seen growing in the inter-tidal region. The prominent seaweeds are *Ulva* sp; *Enter-*

omorpha sp., *Caulerpa peltata*, *C. taxifolia*, *C. racemosa*, *Corallina*, *Padina*, *Dictyota*, *Sargassum*, *Spatoglossum*, *Acanthophora* and *Colpomenia* etc. The inter-tidal region of Sindhudurg and Padam-gad Islands (Table I) shows a dense growth of seaweeds in the post-monsoon months (November-May).

(b) FRESH-WATER FLORA.

On some of these islands like Elephanta and Anjidiv, where fresh-water springs are present, a few fresh-water algae like *Spirogyra*, *Oedogonium* and *Oscillatoria* are found. Other fresh-water floristic elements are *Utricularia reticulata*, *Eriocaulon* sp., some sedges and grasses.

(c) SAND DUNE FLORA.

On almost every island there are sandy soils on beaches supporting typical sand dune flora represented by *Ipomea biloba*, *Cyperus arnarius*, *C. rotundus*, *Spinifix squarossus*, *Launea pinnatifida* and *Fimbristylis schenoides*. In the region of supralittoral fringe and sub-terrestrial fringe, there is an intrusion of some drought loving plants, like *Boerhavia diffusa*, *Trainthema monogyna*, *Glycus lotoides*, *Crotolaria lutescens* and finally lined by the bushes of *Cleodendron inerme*. At some of the places on these islands, thickets of *Pandanus* are observed along with *Erythrina indica*.

(d) MANGROVE VEGETATION.

The regions showing diurnal variations in soil-salinity usually have the plant communities consisting of *Avicinnia officinalis*, *Rhizophora mucronata*, *Sonneratia apetala*, *Acanthus illicifolius* and *Brugulera* sp. This type of vegetation is present around Elephanta Island and to some extent on Sindhudurg.

(e) TERRESTRIAL VEGETATION.

Because of heavy rainfall in this part of the country, the vegetation in genera on these islands is of deciduous type. Aerial Flora is luxuriant on the trunk of trees. A few species of mosses are present along with some epiphytes like *Vanda* sp. and ferns like *Dryneria* sp. The arboreal vegetation consists of *Terminalia tomentosa*, *T. arjuna*, *Mangifera indica*, *Ficus bengalensis*, *F. religiosa*; and a few palms like *Urena* sp.

In shady places, the vegetation mainly consists of the shrubby plants like *Carissa carundus*, *Ixora nigricans*, *Vitex nigandu*, *Pavetta crassicaulis* etc. On the sides of the rocks in more shady places plants like *Seleginella* sp. and *Peperomia nellucida* are abundant. In some places especially on the seaward side there is not much vegetation except grasslands supporting *Setaria pallidifusum*, *Sporobolus* sp. *Themeda* sp.

mixed with few members of Cypraceae like *Cyperus* sp., *Fimbristylis*, *Bulbostylis* and *Scleria*.

Thus on the islands of the Konkan Coast almost the same vegetational pattern as on the mainland is observed. Except stray reports, these islands have not been fully explored. However, McCann (1942) visited Karwar and reported a few general plants from the Kurumgad island.

FAUNA.

An overall study of the fauna, both intertidal and terrestrial, of the Continental Shelf islands of Konkan when compared with that of the adjacent mainland, clearly shows that as far as the intertidal marine organisms are concerned, the faunal elements are almost alike. (Parulekar 1971). As shown in Table III, the phylum wise representation does not indicate wide variations but when it comes to the number of species, the difference is significant. The ratio of species of mainland and island is almost 2:1 except for Malpe sub-division where it is almost 1:1.

Another notable feature is in respect of the size and a few morphological characters. The island forms appear to be more variable, both in size and in texture. There appears to be a clear difference in body size and density of population of the same species between the mainland and the island. The difference in size is probably due to almost unlimited supply of food on the mainland and its limitations on the island. The greater variability in island forms arises from inbreeding.

The terrestrial fauna of the Shelf islands of the Konkan coast exhibit a wide variety of mainland forms. An exquisite assemblage of moths and butterflies is observed during post monsoon months the conspicuous being Atlas moth, bird wings (*Troides* sp.), *Papilio* sp. *Pareronia ceylanica*, *P. helena*, *Pareronia* sp. and painted grasshopper, *Aularches*, *scabiosae*.

Among myriapods, *Spirostreptus* sp. are found in great aggregations in the later part of monsoon (August-September) whereas the centripedes, *Scolopendra* sp. and *Geophyllus* sp. are found in their typical environment of decaying bark or underneath the stones. Two species of Scorpion, namely the black-rock form (*Palamaeus* sp.) and red form (*Buthus tammulus*) are frequently encountered in the Karwar group.

McCann (1942) has reported earthworms from Kurumgad island but in the present survey, except in St. Georges (Goa sub-division) no terrestrial oligochaetes were observed and the species was *Pheretima posthuma*.

Four species of anurans have been recorded from Bombay, Malwan and Karwar groups. The species composition is *Rana tigrina*, *R. cynophletis*, *Hyla arborea* and *Bufo melanostictus*. The last named species is found throughout the year whereas the first three are purely seasonal.

The reptilian elements are represented by the skink (*Riopa guentheri*), garden lizard (*Coleles viridis*), monitor lizard (*Varanus monitor*) and *Mobula* sp. McCann (1942) reported a terrapin (*Geomyda trijuga*) from the upper reaches of Kurumgard island but except a carapace of a dead tortoise from Kavde (Malwan sub-division) there is no record of Chelonians. Among apodes, a single specimen of *Natrix piscator* was collected from Daryabahadurgard (Malpe).

The Continental Shelf Islands of the Konkan coast, because of their proximity to the mainland and secondly due to the dense forestation, offers an unique habitat for avifauna. Common forms are white-bellied sea eagle (*Haliaeetus leucogaster*) and blue rock pigeons (*Columba livia intermedia*). A number of migrants make their tropical winter homes on these islands.

The mammalian faunal elements in wild state are few. Notable are the flying foxes (*Pteropus giganteus*) which abound in Karwar islands. On Anjidiv Island, which was inhabited till 1962 by the Portuguese military personnel, there was an attempt to introduce domesticated elements like cattle, pigs etc., which with the lapse of time have become almost wild. Many of these islands have extensive grasslands which can support an appreciable quantum of rodents and ungulates.

A study on the ecology and distribution of intertidal organisms of Anjidiv island (Paruler 1971) revealed that the faunal elements in the intertidal region are divisible into 3 well-defined zones, namely, *upper-mid* and *lower littoral*, on the rocky shores. The organisms on the sandy shores are divisible into three groups, according to their distribution in the vertical plane. The lower littoral and subtidal regions are densely populated. Correlation of the distribution of species with the factor of exposure and submergence has indicated about the existence of three critical levels.

REMARKS.

A study of the Shelf Islands of Konkan coast reveals some facts of biological significance. In spite of the luxuriant vegetation and rich fauna, there is no endemisms in species. This is probably due to the proximity of these islands to the mainland. It is a well-known fact that evolution has proceeded at an accelerated rate on various islands and rich flora and fauna of these islands offer an opportunity for research on speciation.

A comparison of the species distribution of intertidal organisms of island and mainland indicates apparent differences in size and other morphological features. A particular species common to an island and the mainland has richer representation in the former habitat than in the latter. Another feature is the difference in colour pattern and structural modification. Kohn (1971) has observed that in tropical oceanic islands the intertidal and subtidal regions of the islands support more species, lower populations density and animals of larger size than do intertidal marine beaches. These observations are not applicable to the continental shelf islands of the Konkan coast. In contrast, the Shelf islands have less number of species but more individuals. This is mainly due to breeding consequently giving rise to species diversity. Other factors for species diversity are adaptive radiation and persistent co-occurrence of large number of species in a number of genera, particularly of higher in-vertebrates, like arthropoda, mollusca and echinodermata.

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TABLE I—KONKAN GROUP OF ISLANDS (Lat. 19° 58'N to 12° 51' N & Long. 72° 50'E to 74° 50'E)

| Sub-division | Island | Area in km ² | Distance from mainland in kms. | | Elevation in metres | | Remarks |
|---------------------------------|--|-------------------------|--------------------------------|------|---------------------|----|-------------------------------|
| | | | 3 | 4 | 5 | 6 | |
| a. Bombay 19° 58'N 72° 53'E | 1. Elephanta | .. | 10.4 | 8.0 | 50 | .. | Tourist resort, National Bird |
| | 2. Butcher | .. | 5.0 | 6.5 | 10 | .. | Oil terminus [Sanctuary |
| | 3. Armoury | .. | 2.5 | 1.5 | 17 | .. | Naval Ammunition Dump. |
| | 4. Nhava | .. | 8.0 | 7.0 | 60 | .. | Mercantile Naval Academy |
| | 5. Sheva | .. | 12.0 | 8.0 | 65 | .. | Harbour development |
| | 6. Manori | .. | 18.5 | 0.5 | 6 | .. | Inhabited—tourist resort |
| | 7. Madh | .. | 40.0 | 2.5 | 5 | .. | Inhabited—Naval Establishment |
| b. Malwan 16° 03', 73° 28' E | 8. Sindhurg | .. | 5.0 | 1.5 | 10 | .. | Inhabited—Maratha fort |
| | 9. Padamgadh | .. | 2.0 | 0.5 | 3 | .. | Ruins of fort |
| | 10. Don Tara | .. | 2.0 | 0.5 | 4.5 | .. | |
| | 11. Kavde Bakal | .. | 6.0 | 7.0 | 6.5 | .. | |
| | 12. Vengurla Oyster rocks (off Vengurla Port) | .. | 6.0 | 17.5 | 15.0 | .. | Light House |
| d. | 13. Redi Islets—Off Redi Port.. | 4.0 | 1.0 | 10.0 | .. | | |
| c. Goa 15° 25'N, 73° 40'E | 14. Chorao | .. | 40.0 | 1.0 | 5.0 | .. | Estuarine island, inhabited |
| | 15. Grande | .. | 5.0 | 2.0 | 17.0 | .. | Naval Establishment |
| | 16. St. Georges | .. | 7.0 | 4.5 | 20.0 | .. | Coconut plantation |
| | 17. Oyster rocks | .. | 2.5 | 4.5 | 8.0 | .. | |
| | 18. St. Jacinto | .. | 4.0 | 0.5 | 15.0 | .. | Estuarine island, inhabited |

TABLE II.—GEOLOGICAL FORMATIONS OF KONKAN ISLANDS (Broad classification)

| S. No. | Type | Geological time-scale |
|--|------|-----------------------|
| 1 | 2 | 3 |
| 1. Detrital laterite, transported soils and alluvium, shore sands | .. | Recent and sub-recent |
| 2. Deccan trap—mostly dykes and flows | .. | Early tertiary |
| 3. Newer dolerite | .. | Lower Cuddappah |
| 4. <i>Simaite-gneiss</i> (Peninsular gneiss), sericite-quartzite, quartzites and schistose quartzites, phyllites, epidiorites and hornblende-schists, a few bands of ferruginous quartzites, biotite, muscovite and chlorite-schists, talc chlorite and carbonate schists, crushed biotite and biotite—hornblende granulites of the Dharwar Age. | .. | Archaean |

| | 1 | 2 | 3 | 4 | 5 | 6 |
|--------------------------|----|----|-----|-----|------|--------------------------|
| f. Karwar | | | | | | |
| 14° 45' N, 74° 10' E | | | | | | |
| 19. Karnguda | .. | .. | 7.0 | 3.0 | 40.0 | Densely wooded |
| 20. Kanga | .. | .. | 4.5 | 3.0 | 20.5 | |
| 21. Kurungad | .. | .. | 5.5 | 6.0 | 73.5 | Temple of Lord Narasimha |
| 22. Sunghiri (Shimkguda) | .. | .. | 3.0 | 4.5 | 40.0 | |
| 23. Oyster rocks | .. | .. | 2.5 | 7.0 | 8.0 | |
| 24. Devgad | .. | .. | 6.0 | 6.5 | 65 | Light House |
| 25. Karkal | .. | .. | 3.0 | 6.5 | 30.5 | Densely forested |
| 26. East | .. | .. | 1.5 | 6.0 | 9.0 | Bare rocks |
| 27. Mandal | .. | .. | 2.0 | 7.2 | 26.5 | |
| 28. Mogarguda (Elephant) | .. | .. | 4.0 | 4.5 | 70.0 | Densely forested |
| 29. Anjidiv | .. | .. | 7.5 | 4.5 | 62.0 | Forest Department |
| 30. Round or Tarach | .. | .. | 1.5 | 4.0 | 27.0 | |
| g. Basarajdurg | .. | .. | 3.0 | 1.0 | 20.0 | Ruins of Fort |
| (Of Honavar) | | | | | | |
| h. Pate rock | .. | .. | 1.5 | 2.2 | 4.0 | Bare rocks |
| (Of Coondarpur) | | | | | | |
| i. Malpe | | | | | | |
| 12° 51' N, 74° 50' E | | | | | | |
| 33. North | .. | .. | 4.0 | 2.5 | 15.5 | Light House |
| 34. Daryabhadurgarh | .. | .. | 6.0 | 2.0 | 16.2 | Ruins of fort |
| 35. South or Malati | .. | .. | 3.0 | 5.0 | 14.3 | |
| 36. Coconut | .. | .. | 5.0 | 6.5 | 15.2 | Inhabited |

TABLE III—Comparative study of inter-tidal animals on mainland and shelf islands of Konkan.

| Sub-division | SOURCE Mainland Island | Total No. of species | INVERTEBRATES | | | | | | | | | | VERTEBRATES | | |
|--------------|------------------------------|----------------------------|---------------|---------|-------|----------------|---------------|---------------|--------------|----------------|-----------------|--------|-------------|--|--|
| | | | Porifera | Coelent | Platy | Crus- tacea | Anne- lids | Mollus- ca | Echi- nod | Minor phyla | Proto- chord | Pisces | Misc | | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | | |
| Bombay | Bhatt (1959) | 238 | 2 | 19 | 2 | 56 | 43 | 97 | 7 | 3 | 1 | 8 | .. | | |
| | Present work | 129 | 1 | 8 | .. | 23 | 33 | 57 | 3 | 1 | .. | 3 | .. | | |
| Malwan | Present work | 103 | .. | 4 | .. | 27 | 8 | 54 | 3 | 1 | .. | 5 | 1 | | |
| | Present work | 67 | 3 | 6 | .. | 11 | 6 | 33 | 5 | 1 | .. | 2 | .. | | |
| Karwar | Patil (1953) | 146 | 2 | 18 | 2 | 37 | 9 | 63 | 5 | 2 | 2 | 5 | 1 | | |
| | Present work | 82 | 1 | 9 | .. | 21 | 11 | 32 | 4 | 2 | .. | 2 | .. | | |
| Malpe | Present work | 65 | 2 | 7 | 1 | 14 | 8 | 24 | 4 | 1 | 1 | 2 | 1 | | |
| | Present work | 60 | 2 | 9 | .. | 9 | 7 | 31 | 2 | .. | .. | .. | .. | | |