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CLUSTER ANALYSIS OF THE FORAMINIFERAL FAUNA FROM THE BEACHES OF THE EAST AND WEST COASTS OF INDIA WITH REFERENCE TO FORAMGEOGRAPHICAL PROVINCES OF THE INDIAN OCEAN

S. N. BHALLA[1] AND RAJIV NIGAM[2]
[1] Department of Geology, Aligarh Muslim University, Aligarh
[2] National Institute of Oceanography, Dona Paula, Goa

Abstract

Q-mode cluster analysis of thirty species of foraminifera from six sandy beaches of India reveals that the East and West coasts belong to two different faunal realms. Some possible ecological factors responsible for differences in fauna are summarised.

Introduction

Assignment of the East and West coasts of India to the known models of foramgeographical provinces is a controversial topic amongst the foraminiferologists in this country. Cushman (1948) was probably the first to classify the Recent warm water foraminiferal fauna of the world into four main geographical provinces, namely, East African, Indo-Pacific, West Indian and Mediterranean. According to him (Cushman *op. cit.*), the entire West coast and partly the East coast of India fall under the East African province while the remaining part of the East coast belong to the Indo-Pacific province and the two are separated by a 'mixed zone'. Later, Bhatia (1956) assigned Indo-Pacific affinity to the majority of the foraminiferal fauna from the West coast of India. His observation was based on foraminiferal assemblages from Juhu, Chowpatty and Bhogat beaches. Bhalla (1968, 1970), while working on Recent foraminifera from Visakhapatnam and Marina beach sands on the East coast of India, compared the East coast assemblage with the reported occurrence of foraminifera from the West coast and observed that almost the entire East coast falls under 'mixed zone' and the East and West coasts of India belong to two different faunal realms. The mixing of the East African and Indo-Pacific fauna results in the development of a 'mixed zone' which extends from the Bay of Bengal to the Great Australian Bight. Boltovskoy and Wright (1976) also maintained the view that East and West coasts of India belong to two different faunal realms.

All the above views were based on visual observations and manual comparisons. In order to gain a clear picture of the foramgeographical affinities of the East and West coast foraminiferal assemblages of India, it was considered desirable to give a statistical treatment to the available information. Amongst the various statistical analyses, a dendogram based on Q-mode cluster analysis has been found useful for environmental analysis by several authors (Ujiie and Nagase, 1971; Nigam and Sarupria, 1981) and, therefore, this method was applied to solve the present problem. The identification of the foraminiferal species was done by the first author while statistical analysis was done by the second author.

Material and methods

The foraminiferal assemblage data have been taken from the published papers covering six beaches of India (Fig. 1).

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Station Number	*Beach*	*Author/s*
1. East Coast		
A	Puri beach (Orissa)	Bhatia and Bhalla (1959)
B	Vishakhapatnam beach (Andhra Pradesh)	Bhalla (1968)
C	Marina beach (Tamil Nadu)	Bhalla (1970)
2. West Coast		
D	Calangute beach (Goa)	Bhalla and Nigam (1979)
E	Juhu beach (Maharastra)	Bhatia (1956)
F	Bhogat beach (Gujarat)	Bhatia (1956)

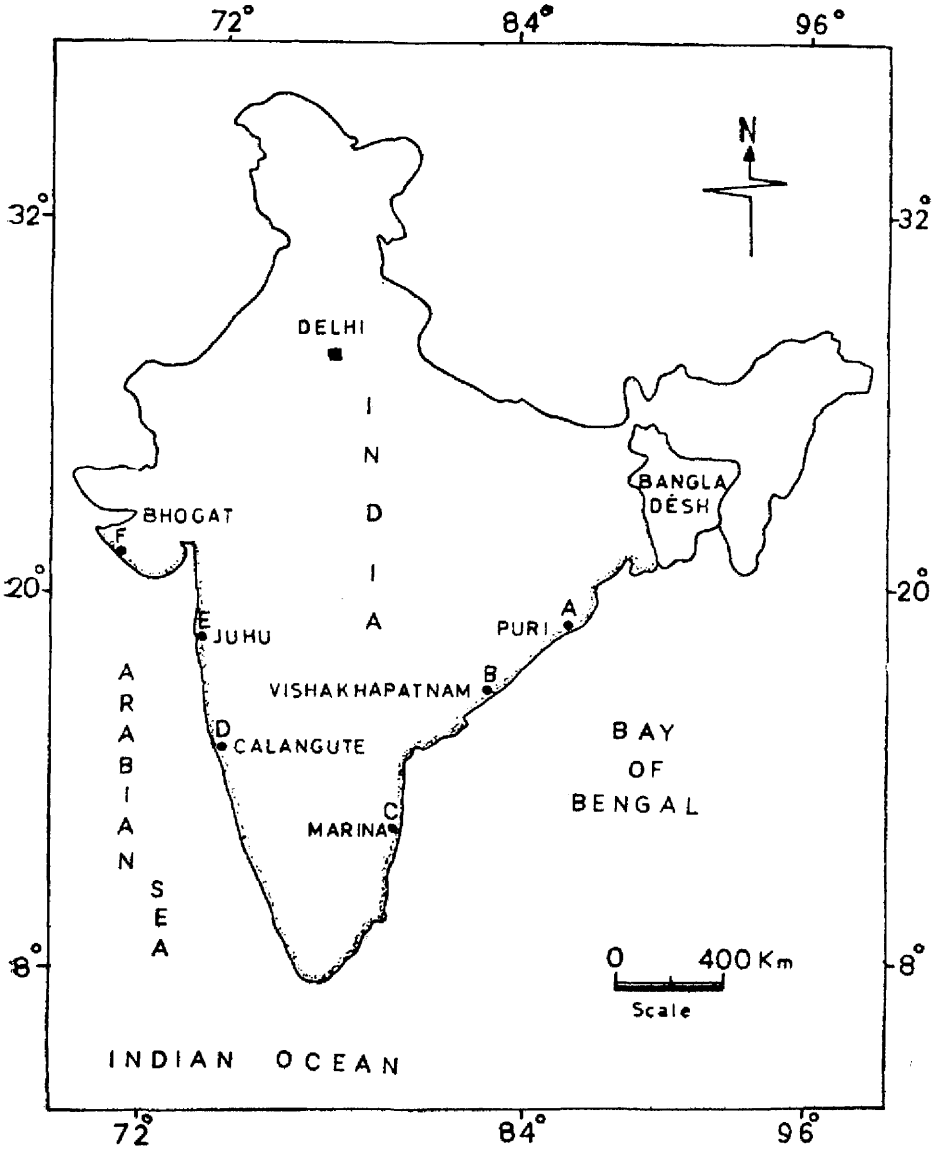

Figure 1. Map showing locations referred to in cluster analysis.

Foraminiferal species from the above papers were re-arranged according to the latest generic position and only those species were selected for statistical analysis which were common to at least two beaches. Finally, thirty species were considered for cluster analysis (Table I).

TABLE I

List of foraminiferal species referred to in cluster analysis

1. *Spiroloculina antillarium* d' Orbigny
2. *S. eximia* Cushman
3. *S. indica* Cushman and Todd
4. *Quinqueloculina seminulum* (Linnaeus)
5. *Q. venusta* Karrer
6. *Q. vulgaris* d' Orbigny
7. *Q. lamarckiana* d' Orbigny
8. *Q. crassa subcuneata* Cushman
9. *Q. undulosa-costata* Terquem
10. *Q. tropicalis* Cushman
11. *Triloculina terqumiana* (Brady)
12. *T. tricarinata* d' Orbigny
13. *T. rotunda* d' Orbigny
14. *T. trigonula* (Lamark)
15. *Cancris auricula* (Fichtel and Moll)
16. *Cavarotalia annectens* (Parker and Jones)
17. *Ammonia papillosus* (Brady)
18. *Asterorotalia trispinosa* (Thalmann)
19. *A. dentata* (Parker and Jones)
20. *Pararotalia nipponica* (Asano)
21. *Elphidium advena* (Cushman)
22. *E. cràticulatum* (Fichtel and Moll)
23. *E. crispum* (Linnaeus)
24. *E. indicum* Cushman
25. *E. minutum* (Reuss)
26. *E. simplex* Cushman
27. *Eponides repandus* (Fichtel and Moll)
28. *Poroeponides lateralis* (Terquem)
29. *Cibicides lobatulus* (Walker and Jacob)
30. *Florilus scaphum* (Fichtel and Moll)

Foraminiferal assemblages from two beaches were compared using Jaccard Coefficient of association (Sj):

$$Sj = \frac{C}{N_1 + N_2 - C}$$

Where C represents the number of species common to two beaches being compared :

N_1 represents total number of species present in first beach ; and,

N_2 represents total number of species present in second beach.

The above formula was earlier used by Schafer and Scott (1976) for environmental analysis and these authors also mentioned the merit of this coefficient. Values of association range from O (complete dissimilarity) to 1 (complete similarity). In this way, the foraminiferal data from six beaches were compared and a matrix was obtained. On this matrix ' weighted pair group method with simple arithmetic average ' of Sokal and Sneath (1963) was applied for Q-mode cluster analysis.

Results

Final results of cluster analysis were plotted in the form of a two-dimentional hierachy dendrogram in which degree of association showed on Y-axis and stations were listed on X-axis (Fig. 2).

The above cluster analysis of thirty foraminiferal species covering six stations reveals two distinct clusters at 0.30 level of clustering. Cluster 1 consists of stations A, B and C (all from the West Coast) and cluster 2 comprises stations D, E and F (all from the East Coast).

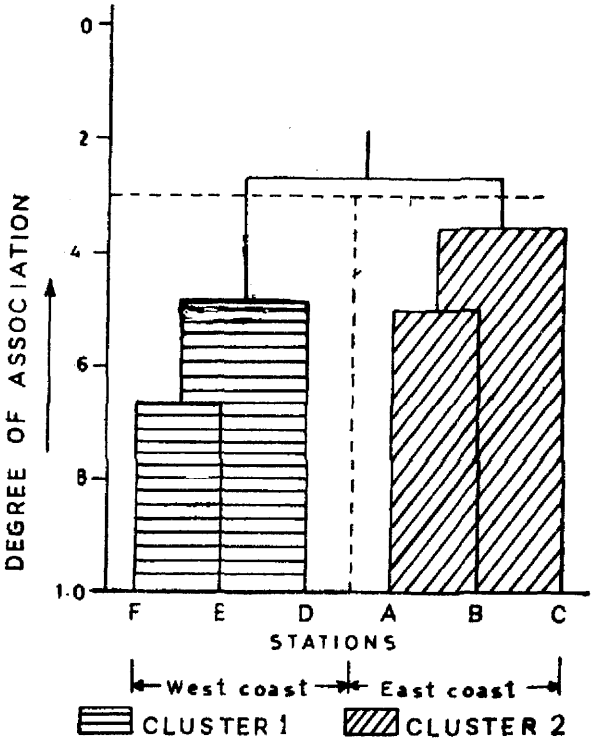

Figure 2.
Dendrogram showing results of Q-mode cluster analysis.

In view of the foregoing, it may be concluded that the East and West coasts of India belong to two different faunal provinces (*vide etiam* Satyanarayana Rao, 1979).

The possible reasons for the differences in the foraminiferal fauna of the East and the West coasts of India are, perhaps, due to differences in the ecological factors of the Bay of Bengal and the Arabian Sea, some of which are summarised below:

Parameters	East Coast (Bay of Bengal)	West Coast (Arabian Sea)	Author/s
1. Salinity	30–33%	34–37%	Panikkar and Jayaraman (1966)
2. Temperature	27–29°C	23–29°C	,,
3. Organic carbon	0.88%	1.5%	Wiseman and Bennett (1940); Subba Rao (1960)
4. Biological Productivity			
(i) Surface productivity per unit area	High	Low	Qasim (1977)
(ii) Column production	Low	High	,,

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