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Foraminiferal studies along the littoral zone of the east coast of India and its zoogeographical affinity: an overview

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Abstract: An overview of the studies, mostly related to the taxonomy, ecology of the littoral Recent foraminifera (Protozoa) and the zoogeographical affinity of the east coast of India has been attempted on the basis of the published literature. The study shows that the Recent foraminifera along the east coast of India show affinity with the Indo-Pacific faunal province.

Keywords: Foraminifera, Taxonomy, East coast beaches, India

Introduction

Foraminifera, the shelled protozoans thrive as the most diverse group in the modern oceans. They derived their name from 'foramen' the 'pores' connecting the chambers in their tests. Varying in size/diameter size from less than a millimetre (micro-foraminifera) to 100 mm (mega-foraminifera they also occur as fossils in the marine Phanerozoic rocks (560 Million Years to Recent) and a wide range of applications in geological, biological, environmental and oceanographic studies.

Some of foraminifera are agglutinated that acquire foreign-material to make a test, but most of them form calcareous 'test' (shell) by secreting calcium carbonate present in dissolved state in the marine waters. Being unicellular, highly abundant in sea and very sensitive to even minute changes in the environmental parameter, their ecological studies help deducing the paleoenvironmental conditions of the sediments/rocks besides wide geological applications, like- oil exploration, higher resolution biostratigraphy, environmental /paleoenvironmental interpretations. Their 'planktic' forms display 'surface water-' while the 'benthic' species help studying the 'bottom water' conditions of the oceans of the present/past.

Although the studies on Recent foraminifera along the east coast of India started quite early indeed (Schwager, 1857; Chapman, 1895; Hofker, 1927 & 1933; and Cushman, 1939) yet it received less attention in comparison to the studies carried out, elsewhere.

It has been endeavoured here to make a review of the work conducted on the Recent foraminiferal fauna obtained from the littoral-zone along the east coast of India in order to pave way for future studies in this field of research.

Observations

Sastry (1963), Shetty (1982) and Khare *et al.* (2007) have reviewed the literature but no detailed account on studies made exclusively on the Recent foraminifera from the exposed littoral-zone of the eastern coast of India has been given.

So far as the beaches of 5800 km long coastal stretch of the east coast of India are concerned, a total of 27 papers have been published (Table 1) covering taxonomy, ecology, geographical distribution of the Recent foraminifera and establishing the zoo-geographical affinity of the east coast of India based on the Q-mode cluster analysis (Kathal, *et al*., 2000 and Kathal and Bhalla, 2001). Besides, paleoenvironment/climate studies (Kathal, 1996 and Kathal and Bhalla, 1996a) show their utility in petroleum exploration.

Taxonomic and ecological studies

The taxonomic and ecological studies on the Recent foraminifera in the beach sediments beaches along the east coast of India (Fig 1) include the work carried out by Sarojini (1958), Bhatia and Bhalla (1959), Bhalla (1968, 1970), Gosh (1966), Ameer Hamsa (1971, 1973), Kathal (1989, 1991, 1999, 2002a, 2002b, 2004), Bhalla and Kathal (1998), Kathal and Bhalla (1996b, 1998), Kathal and Matoba (2001), Kathal and Singh 2010), Singh (2009) and Singh and Kathal (2010).

Singh and Kathal (2011) compared foraminiferal species from littoral-zone along east coast of India with that of the east coast of Japan.

Foramgeographical affinity of the east and west coasts of India

The cluster analysis of the Recent foraminiferal assemblages obtained from the 26 beaches from the two coasts was carried out to delineate their foramgeographical affinities. The study shows that the east coast belongs to the warm water 'Indo-Pacific' realm while the west coast shows close affinity to the 'East African' realm with a 'mixed-zone' in between (Kathal *et al*., 2000) and Kathal and Bhalla (2001).

Morphological aspects of foraminifera

Importance of various morphological features and their response to ambient physico-chemical conditions has been well recognized. Along the east coast of India

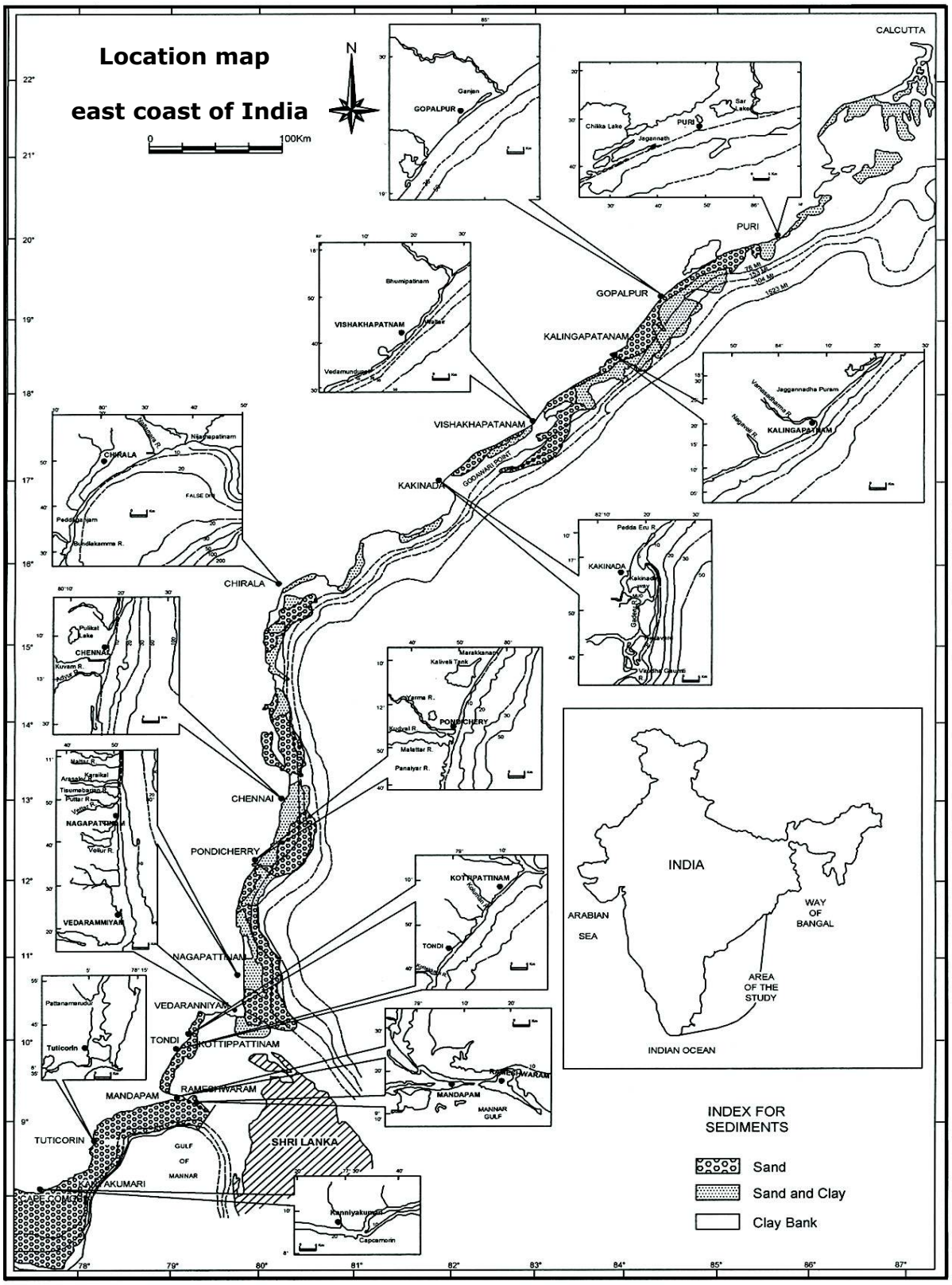

Fig.1 : Beaches, Littoral-Zone and bathymetry, east cost of India

Kathal and Bhalla (1996b) studied migratory trends and morphological variations in *Rotorboides granulosum* – a less known Recent foraminifera of tropical region that lived in 'low oxygen' conditions between latitudes 25 N° to 25° S in shallow warm water conditions since Middle Miocene. (23.03 million year ago).

Environmental/climatic inferences from foraminifera

Studies have been made to infer/reconstruct paleoclimatic changes (Kathal, 1996 and Kathal and Bhalla, 1996c). Accordingly, these micro-organisms have emerged as reliable proxies of paleoclimatic/ paleoenvironmental conditions. However, studies on the role of foraminifera in addressing various issues related to climatic/ environmental changes especially along the littoral regions of east coast of India still has a lot of scope.

Table 1 - Major work carried out on littoral sediments region along the East coast of India.

Sr.	Year	Author	Area	Remarks
1.	1958	Sarojini	Bay of Bengal	Studies on littoral foraminifera
2.	1959	Bhatia & Bhalla	Beach sand of Puri	Recorded and illustrated 14 species of Recent foraminifera
3.	1966	Ghosh	Digha beach Southern Bengal	*Asterorotalia trispinosa* (Thalmann) a spinose rotalid
4.	1968	Bhalla	Visakhapatnam	Recent foraminifera and its relation to foramogeographical province in Indian Ocean
5.	1970	Bhalla	Marina beach (Madras)	Identified 15 species of foraminifera
6.	1971	Ameer Hamsa	Palk Bay, Gulf of Mannar	Reported some foraminifera
7.	1973	Ameer Hamsa	Palk Bay, Gulf of Mannar	Listed 34 species from the beach sands and illustrated 12 species
8.	1989	Kathal	East coast of India	Recent foraminifera from the beach sands
9.	1991	Kathal	Puri to Vishakhapatnam	Recent foraminifera from the beach sands of the east coast of India (Puri to Vishakhapatnam)
10.	1996	Kathal	Kakinada Bay	Significance of ecophenotypes in paleolatitudinal interpretations
11.	1996a	Kathal, & Bhalla	East coast of India	Distribution of Recent foraminifera from littoral zone
12.	1996b	Kathal, & Bhalla	East coast of India	Intraspecific variation and Palaeolatitudinal significance of *Rotorboides granulosum*
13.	1996c	Kathal & Bhalla	East coast of India	Migratory trends and paleolatitudinal significance of *Rotorboides granulosum*
14.	1998	Bhalla & Kathal	Gulf of Mannar	Reported 43 species of Recent foraminifera discussed the 'mixed-zone' of the East African and Indo-Pacific realms

Sr.	Year	Author	Area	Remarks
15.	1998	Kathal & Bhalla	Palk Strait & Kakinada Bay	Presented the taxonomic observations of *Rotorboides granulosum*
16.	1999	Kathal	Gulf of Mannar	Foramgeographical affinity of the Indian Ocean during Quaternary
17.	2000	Kathal *et al*.	East and West coasts of India	Statistical treatment of 26 beaches, coasts of India showed 'Indo -Pacific' affinity to the east coast of India (up to Vedranniyam) and the east African affin ity to the west coast of India
18.	2001	Kathal & Bhalla	Indian coasts	Reported 56 species and discussed the foramgeographical affinity of east coast of India with the known foramgeographical provinces
19.	2001	Kathal & Matoba	East coast of India and Japan	Reported 85 common species of the two distantly located areas within the warm - water Indo-Pacific province
20.	2002a	Kathal	Sixteen stations	Taxonomy and distributional pattern of Recent foraminifera
21.	2002b	Kathal	Sixteen stations	Distribution and ecology of Recent species
22.	2004	Kathal	Kakinada bay	Biostratigraphic and paleolatitudinal implications of ecophenotypes
23.	2009	Singh	East coast of India and Japan	Morphological comparison 41 common species out 120 species.
24.	2010	Kathal & Singh	Seven beaches	First reported of 12 foraminiferal species from the Indian water
25.	2010	Singh & Kathal	Five beaches	First reported of 12 foraminiferal species from the Indian water and 1 from east coast
26.	2011	Singh & Kathal	East coast of India and Japan	Out of 41species, 20 show narrow; 17 show medium; and 4 show medium to wide ranges of intraspecific variations

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