

Growing need to study foraminifera in the laboratory culture experiments : an attempt from the central West Coast of India

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ABSTRACT : In recent past much emphasis has been laid on the high resolution reconstruction of the paleoclimatic conditions to help in preparing the futuristic climatic model. Many such efforts have used foraminifera as proxy indicators of the climate. No doubt these proxies were well tested in the modern environmental setup, prior to be considered as climate indicators. Nevertheless, if the same effect is studied under controlled conditions in the laboratory, it will definitely enhance the reliability of the field observations. This necessitated the need to initiate the laboratory culture programme on foraminifera. As a beginning we selected benthic foraminifera, *Rosalina leei* (as it is abundant among living species collected from Goa Coast) to establish a laboratory culture programme. Initially, we monitored the effect of different media (like plain sea water and Erdschreiber medium), food and antibiotic drug on the growth of foraminiferal tests. The results suggest that Erdschreiber medium is conducive for general growth. Further observation suggests that food is another governing factor for their growth in sea water. However, in case of Erdschreiber medium excess food supply retards the overall growth. Therefore, this media can be used to harvest second generation specimens for further experiments. Results also suggest that small amount of antibiotic can be used for monitoring effect of physico-chemical parameter through growth studies. But the quantity of antibiotic is yet to be determined to obtain reproduction.

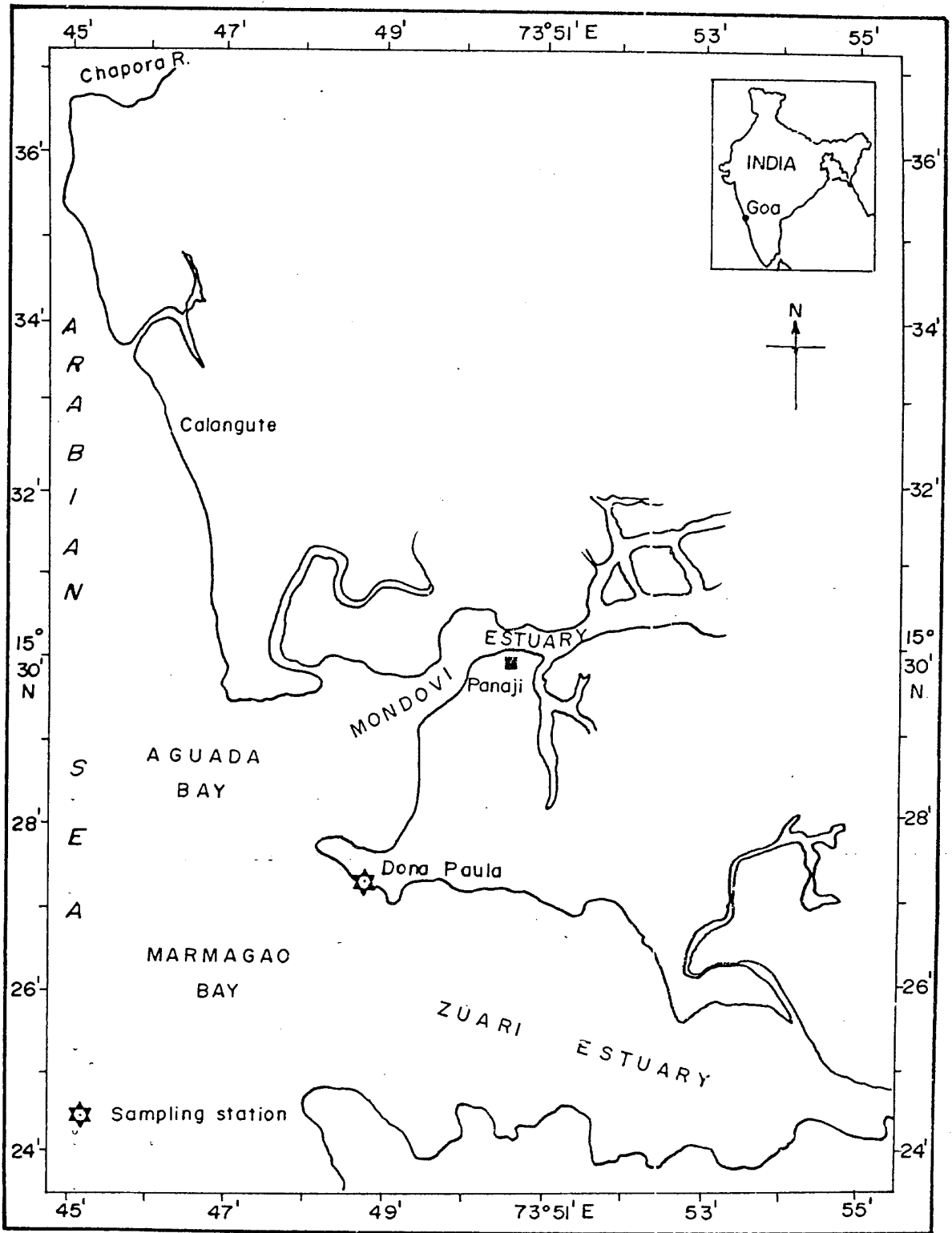
INTRODUCTION

In recent years, climate change and climate variability assume great importance, as it is now almost certain that the increase in anthropogenic gases will effect the future climate. Out of several consequences of global warming, likelihood of change in monsoonal rainfall pattern is crucial to countries like India as it requires changes in agricultural strategies due to economic and social factors. The extremes of monsoons (floods and droughts) can be faced with less hardship if they can be predicted in advance with less hardship if they can be predicted in advance with increased accuracy. Though available data on rainfall (over 100 years) have been used to decipher pattern for prediction potential but long term prediction requires data of last few thousand years. In order to obtain highly resolved paleomonsoonal data over this period, shallow water coastal regions having high sedimentation rates are most suitable sites. These areas can be studied through foraminifera as proxy for climatic reconstructions. Foraminifera are useful due to their widespread occurrence in marine ecosystems and significant role as paleoceanographic markers (Lee and Anderson 1981).

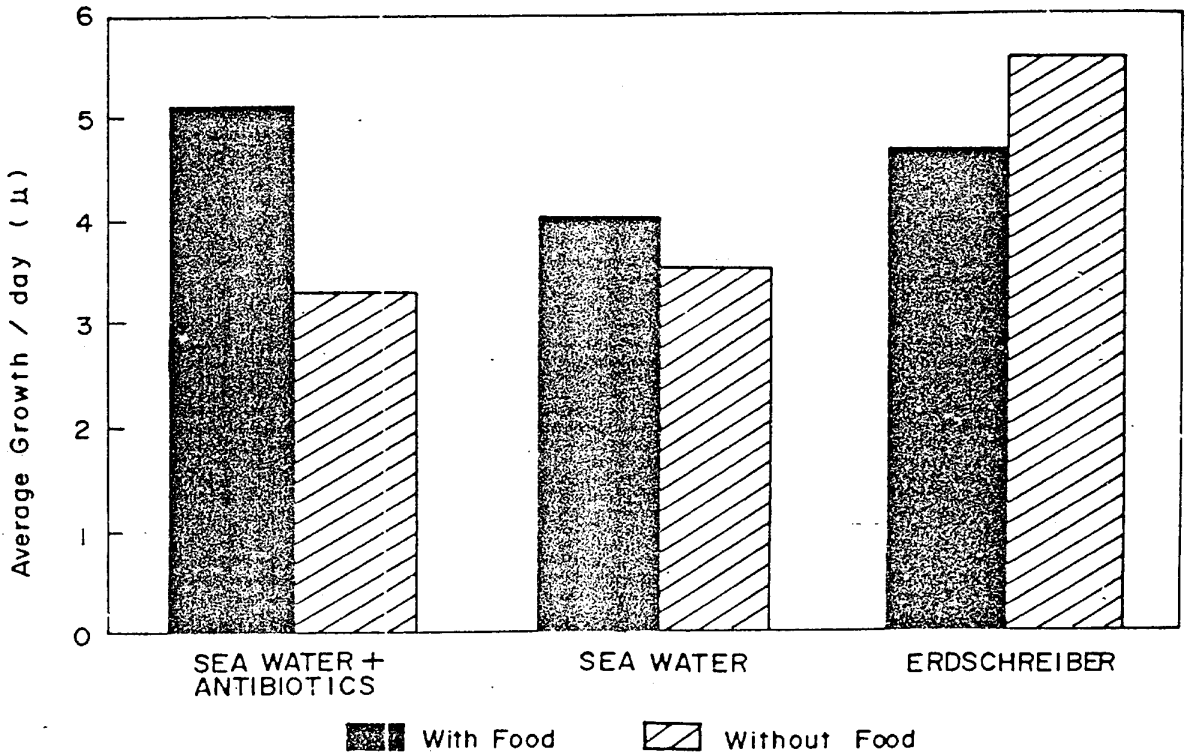
The last few decades witnessed "increasing interest in the shells of planktic foraminifera as indicators of the history of the earth, revealed through the sedimentary record and by

application of modern isotopic analytical techniques" (Hemleben *et al.* 1988). But when we consider coastal areas, emphasis should shift from planktic to benthic foraminifera. Use of benthic foraminifera to infer paleomonsoonal precipitation requires formulation of different strategies.

In this connection number of parameters were proposed as useful indicators (Nigam 1986; 1988a, 1988b; Nigam and Rao 1987; Nigam *et al.* 1992, Nigam and Khare 1995 etc.). However, most of these studies are field based and it was repeatedly stressed that laboratory experiments should be conducted for more conclusive results (Nigam and Rao 1987; Nigam and Khare 1992). This is because fundamental biological information on benthic foraminifera facilitates the paleoecological interpretation of this group's extensive fossil record and enhances the usage of benthic foraminifera as environmental indicators or monitors (Moodley 1992). The status of experimental studies have been reviewed by Lee and Anderson (1991) who stated "As the various experts in our field review our current knowledge on the biology of foraminifera, it has become clearer to us, from our perspective as editors, that we really know very little about most aspects of foraminiferan biology". Since we need to know biology of foraminifer (geologically useful responses) for paleoclimatic interpretations and little is known even internationally and



TEXT-FIGURE 1
Location of sample collection.



TEXT-FIGURE 2
Average growth of foraminifera (microns) per day in different media and food experiments.

benthic foraminifera diversity is more site specific, we must give priority to foraminifera culture experiments using benthic species occurring along Indian coasts.

With above objective we initiated a culture experiment on *Rosalina leei* species collected live from nearshore region off Dias beach, Goa and preliminary results of media screening, food and effect of antibiotics are presented here. Details of experiment on life cycle, dimorphism and various ecological parameters will be taken up on this as well as on other species in due course of time with sole aim of generating experimental data on modern foraminifera to aid the paleoecological interpretations of fossil assemblages.

MATERIAL AND METHODS

Following the methods suggested by Anderson *et al.* (1981) field collections were made on location off Dias beach, Dona Paula, Goa (text-fig. 1). The Sargassum (Pl. 1, fig. 1) attached to subtidal rocks and housing many living foraminifers was removed by diving into the waters. The live foraminiferal specimens were obtained by repeated shaking and wet sieving using sea water. The specimens were picked from the residue by mouth pipette with fine capillary tube. The separated specimens were kept one by one in each well of six well coster

culture dishes. The second generation specimen of *Rosalina leei* were used to monitor effect of food and different culture media. Three different media viz. sea water, sea water + antibiotic and Erdschreiber were used to monitor growth of specimen. For first medium, plain sea water was sieved through Whatman filter no. 42. Erdschreiber medium was prepared by formula given in Scheriber (1927). For third medium, 0.1 gm of Streptomycin (antibiotic) was dissolved in 100 ml of distilled water and pipette out 3ml of stock solution and poured in one litre of sea water.

Navicula subinflata species of diatom was cultured separately and used as food for foraminifera. This is a common species in the area of field collection.

RESULTS AND DISCUSSION

In the initial experiment on an average 30 off springs were produced by an individual. Being tiny in size they appeared as black dots under the microscope field. After 4-5 days when they got stabilized in the wells, the individual offsprings were transferred to various wells to start different experiments. The number of specimen kept in each experiment and number of specimen reproduced are given in table 1. The initial and final sizes of the specimens were measured after 30 days and

TABLE 1
Number of specimens kept and responded in each culture experiment.

Sr. No	Name of the Experiment	No. of specimens in Expt.	No. of specimens responded
1.	Sea water	6	5
2.	Sea water + Food	6	6
3.	Sea water + Antibiotic	6	6
4.	Sea water + Antibiotic + Food	6	5
5.	Erdschreiber + Food	6	5
6.	Erdschreiber	6	4

TABLE 2
Growth of foraminifera in different experiments.

Size (μ)	Media					
	Sea water + Antibiotic		Sea water		Erdschreiber	
	With Food	Without Food	With Food	Without Food	With Food	Without Food
Avg. initial size	273.3	295	290	295	303.3	205
Avg. size after 30 days	426.6	393.3	410	400	443.3	372.5
Growth/day	5.11	3.27	4	3.5	4.66	5.58

presented in table 2. During this period specimens have shown growth and spread of pseudopodia (Pl. 1, fig. 2). The results of each experiment were determined in terms of average growth per day (text-fig. 2). In these experiments 'with food' means food provided weekly and 'without food' means food provided only at the beginning of the experiment and specimens left starving during the experiment period. Half of the media was changed alternate day. While discussing the role of nutrition in foraminiferal studies Boltovskoy and

Wright (1976) concluded that nutritive material is among the most important factors governing foraminiferal distribution and abundance and may influence the size and morphology of the test. In our experiment (text-fig. 2) we have observed that growth is faster in case of 'food provided' with sea water and sea water + antibiotic as media. The slow growth rate when food is provided with Erdschreiber as medium needs explanation. It is possible that food (diatom) is also growing very fast in this medium and creating a condition of "excess food" which is proving detrimental to growth. Arnold (1954) also suggested that the density of food ("algal choking") shut off pseudopodial activity and starved the animal in the midst of plenty.

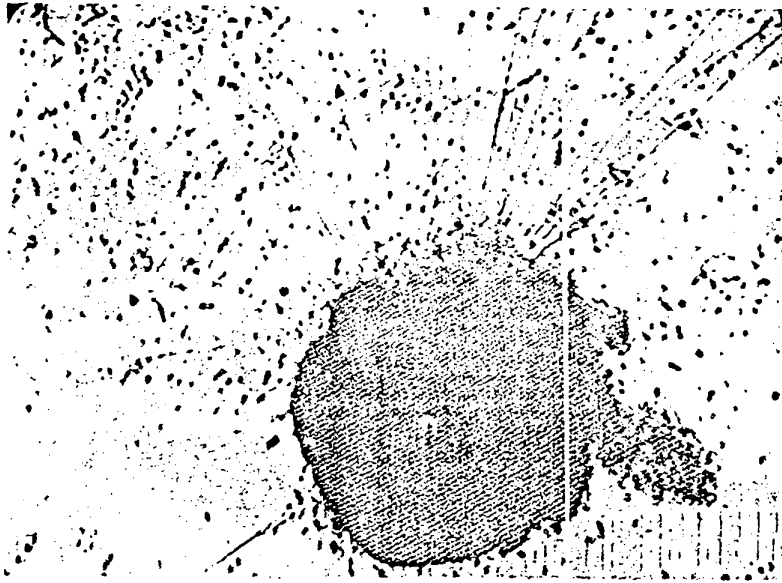
The best growth is observed in the case of Erdschreiber medium as compared to other two media screened with food served only in the beginning of the experiment. This leads us to important conclusion that this medium may be used for quick harvesting of second generation of specimen for future experiment through clone culture. However, the use of this medium for monitoring the effect of physico-chemical parameters on foraminiferal growth may not be very fruitful due to artificiality of environment.

Initial attempts to establish bacteria free culture for foraminifera (Lee and Pierce 1963; Lee *et al.* 1966) met with failure. Later, Müller and Lee (1969) suggested that presence of some bacteria might be indispensable to foraminiferal growth. It was inferred that bacteria has some nutritional factors required by the foraminifera that is either not available or available in insufficient quantities, in the exclusively algal diet tested (Lee, 1980). However, it was general arrangement that it is necessary to prevent the excessive development of bacteria in culture. In view of this we decided to test the effect of antibiotic (Streptomycin) drug in the culture media with two sets of specimens, i.e. 'with food' and 'without food'. The comparison of results shows that in 'no food' conditions additions of antibiotics does not show any significant changes in growth (little retardation), i.e. 3.50 microns to 3.27 microns/day. Whereas additions of antibiotic was very conducive to growth of specimen 'with food' in sea water which showed better average growth of 5.11 microns/day as compared to without antibiotic, i.e. 4.0 microns/day.

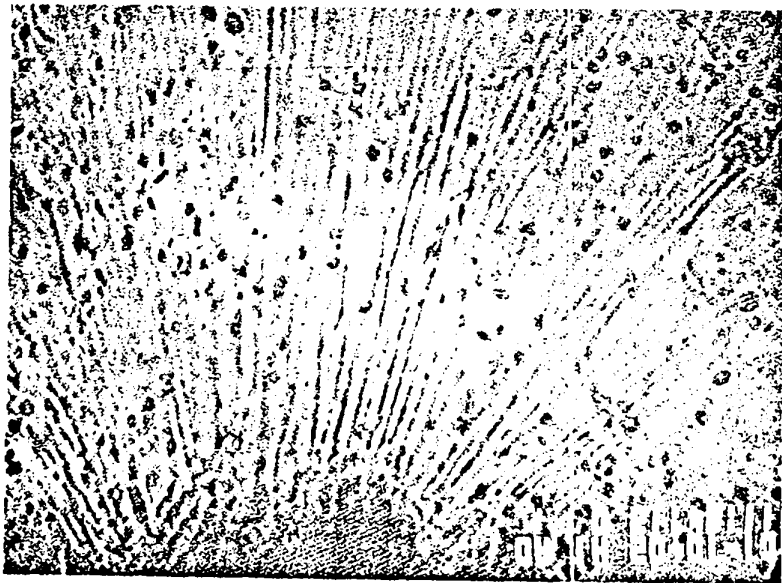
Therefore, it is concluded that for growth monitoring effect of physico-chemical parameter on foraminifera, addition of small quantity of antibiotic may be useful. But in experiments related with life span of reproduction, the same not be true as

PLATE 1

- 1 Living foraminifera with pseudopodia (x 500).
- 2 Magnification of pseudopodia (x 800).



1



2

reported by Lee (1980), "Bacteria were required for the sustained reproduction of *Allogromina laticollaris*, *Spiroloculina hyalina*, *Rosalina leei* and *Quinqueloculina lata* in gnotobiotic culture". Experiments are required to assess the quantity of antibiotic required which will check the excess growth of bacteria without damaging their capability to reproduce.

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