

## RECENT FORAMINIFERA FROM POLLUTED MARINE ENVIRONMENT OF VELSAO BEACH, SOUTH GOA, INDIA

by

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### ABSTRACT

The beach sands of Velsao, South Goa, have yielded twenty-seven species of Recent foraminifera. The Velsao beach has been found polluted due to effluent discharged by M/s Zuari Agro Chemical Ltd., which is rich in ammonia and arsenic. Due to environmental stress caused by toxicity of this discharge, a very high foraminiferal number (7500 in 2 g) was recovered. Distortion and abnormal growth in *Ammonia* spp. were observed as an impact of pollution.

### I. INTRODUCTION

Foraminifera are very sensitive to environmental stress and are being increasingly used for pollution studies all over the world. In India, however, a little work has been done in this direction. Coastal water pollution due to growing industrialization along the coasts of India is now an environmental problem.

Beaches are integral parts of marine environment and are subjected to extensive faunal studies. Recent foraminifera from sandy beaches of India have been studied by several workers but the southern half of the western coast of the country remains practically untouched. The purpose of the present paper is to report the occurrence of Recent foraminiferal assemblage from Velsao beach and to study the effect of pollution on the microfauna.

Velsao beach, facing Velsao Bay, is situated at the northern extremity of a sandy belt along the coast-line of South Goa bordering the Arabian Sea (Fig. 1). Velsao Bay receives waste discharged by a fertilizer factory - M/s Zuari Agro Chemical Ltd. (ZAC). This discharge is rich in ammonia and arsenic. Of these, ammonia is found to be most toxic for animals (SPOTTE, 1973) and hence, Velsao beach was considered as a polluted beach for the purpose of present investigation.

### II. ENVIRONMENTAL PARAMETERS OF THE STUDIED AREA

The pollution studies of the area commenced with KURUP *et al.* (1976) for near-shore circulation of water in the Velsao Bay. They (KURUP *et al.*, 1976, p. 7) installed four observation stations along the axis of the Bay (Fig.

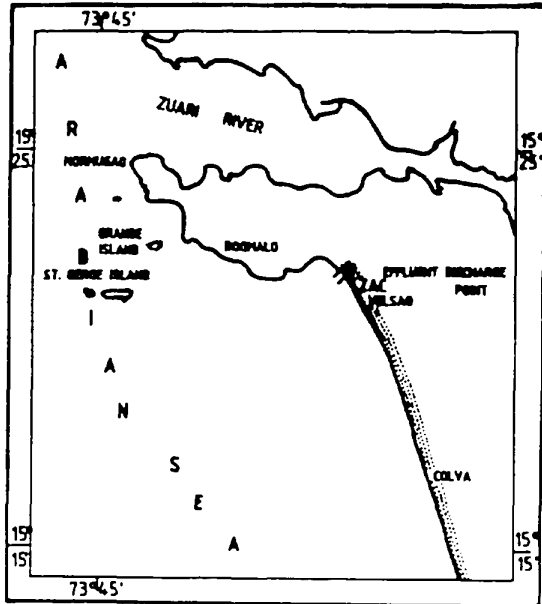
2); recorded data for period between November, 1973, to September, 1974; and concluded, "Studies indicate that at stations I and II the currents are oscillatory while at stations III and IV there is less onshore component of the current and a better dispersal of the material due to current." SINGBAL *et al.* (1976) studied chemical characteristics of the inner shore water of the area and observed that the salinity varies from 17‰ to 35‰; dissolved oxygen from 3.49 ml/l to 5.7 ml/l; and temperature from 27° C to 30°C. They also noticed that pH (7.8 to 8.6) and organic phosphate (26-84 ug-at/l) values are high near the outfall but low away from it. Arsenic concentration was also found to be high (3.00 to 583.20 ug/l) near the outfall as compared to the values in normal marine conditions (1 ug/l to 43 ug/l). VERLENCAR and D'SILVA (1977) studied water qualities at Velsao and nearby Colva beaches and noticed that in comparison to Colva, urea and NH<sub>4</sub><sup>+</sup> was very high at Velsao. They also observed that nitrate and nitrite values at Velsao were also much higher than at Colva.

### III. MATERIAL AND METHODS

Sand samples from Velsao beach were collected in October, 1976, as a part of the University Grants Commission, New Delhi, research project on Recent foraminifera from the sandy beaches of Western India.

Samples were screened through a sieve (ASTM 35) and representative 2 g material was then taken for quantitative studies. The remaining material was subjected to Carbon-tetra-chloride flotation for concentrating rare foraminiferal tests. Drawings of foraminifera are by camera lucida.

Fig. 1 : Map showing study area



Sand samples were also collected from relatively "clean" beaches, viz., Calangute and Colva, in North and South of Velsao beach respectively for the purpose of comparison.

#### IV. RESULTS

##### Total foraminiferal Number (TFN) :

A total of 7500 specimens of foraminifera were encountered in 2 g material from Velsao beach sand. The percentage distribution of total foraminiferal number belonging to eight families is shown in Table 1.

##### Total Species Number (TSN) :

In all, twenty-seven species of Recent foraminifera belonging to eight families were recorded from Velsao beach. A check-list of the foraminiferal species is given below :

- Spiroloculina antillarum* d'ORBIGNY  
*S. exima* CUSHMAN  
*S. planissima* WIESNER  
*S. rotunda* d'ORBIGNY  
*S. tricarinata* TERQUEM  
*Quinqueloculina karimbatica* (HERON ALLEN and EARLAND)  
*Q. lamarkiana* d'ORBIGNY  
*Q. ludwigi* REUSS  
*Q. parkeri* (BRADY)  
*Q. seminulum* (LINNE)  
*Q. vulgaris* d'ORBIGNY  
*Triloculina tricarinata* d'ORBIGNY  
*Ammonia annectens* (PARKER and JONES)  
*A. sobrina* (SHUPACK)  
*A. papillosus* (BRADY)  
*Pararotalia calcar* (d'ORBIGNY)  
*P. nipponica* (ASANO)  
*Elphidium advenum* (CUSHMAN)  
*E. crispum* (LINNE)  
*E. indicum* CUSHMAN  
*E. minutum* (REUSS)  
*E. craticulatum* (FICHEL and MOLL)  
*Poroepionides cribrorepandus* ASANO and UCHIO  
*Amphistegina madagascariensis* d'ORBIGNY  
*Cibicides refulgens* MONTFORT  
*Nonion boueanum* (d'ORBIGNY)  
*Florilus elongatum* (d'ORBIGNY)

The family Miliolidae is represented by seven species (25.5 %); Nubecularidae, Rotaliidae and Elphidiidae by five species each (18.5 %); Nonionidae by 2 species (3.7 %); and Eponididae, Amphisteginidae and Cibicidae by one species each (1.85 %) (Fig. 3).

#### V. DISCUSSION

The foraminifera found in beach sands do not live on beach but reside very near to the shore-line and are washed into beach region by wave action (BHALLA, 1970). Hence, the results of the present study are being discussed with reference to water characteristics of the nearby Velsao Bay.

Velsao and Colva beaches are different areas of a long and continuous tract and are situated 7 km apart (Fig. 1). Under normal circumstances, the same foraminiferal fauna (TFN and TSN) is expected on both the beaches but this is not the case. The richness of the total foraminiferal number in 2 g material at Velsao (TFN, 7500) as compared to Colva beach in the south (TFN, 307; unpublished data) and Calangute beach in the north (TFN, 480; NIGAM, 1978), which are far away from ZAC effluent discharge point and may be treated as "clean" beaches, is due to local pollution in the Velsao Bay. The toxic discharge increases the mortality rate and after death, empty tests of foraminifera are washed on to the Velsao beach.

The results obtained from studies of foraminifera from the near shore region off Velsao (SETTY and NIGAM, 1984) show that from the topmost 1 cm layer, 12 out of a total of 25 species were found living at the time of collection but from samples below the topmost layer, as much as 70 species of foraminifera were identified. This indicates that the toxic effluent discharged by ZAC resulted in the gradual reduction in the number of the foraminiferal species from 70 to 25 and then only to 12. In an effort to adopt the new environment, some of the species got deformed and finally, some learnt to live and flourish even to the extent of total exclusion and/or elimination of the other species of foraminifera.

Certain morphological abnormalities were also noticed in the foraminiferal population of Velsao beach. *Ammonia* was found to be the most affected genus in which the last four to seven chambers show distortion and abnormal growth (Fig. 4). LIDZ (1965) observed abnormal specimens of *Criboelphidium*, *Buccella* and *Quinqueloculina* from Nantucket Bay, Massachusetts, U.S.A., and inferred that it was due to pollution. Similarly, the abnormalities in the tests of *Ammonia* spp. from Velsao beach assemblage may also be attributed to the effect of pollution.

In view of the foregoing, it is inferred that the foraminifera of the Velsao beach are not indigenous but were washed in from the nearby shallow Velsao Bay. The present foraminiferal assemblage with its abnormally high total foraminiferal number and morphologically abnormal specimens reflects the effects of polluted marine environmental conditions prevailing in Velsao Bay where ammonia and arsenic are the major pollutional elements.

After the samples for the present work were collected, the ZAC Ltd. instead of discharging the waste material at a point shown in figure 1, laid a pipe-line up to a position of station IV in Figure 2 on the basis of surveys done by the National Institute of Oceanography, Goa, where current pattern was found to be helpful in transporting it towards the open sea for dispersal.

Table 1 : Percentage distribution of different families in total foraminiferal number.

Family	%
Nubecularidae	00.78
Miliolidae	02.48
Rotaliidae	95.58
Elphidiidae	00.57
Eponididae	00.26
Amphisteginidae	00.26
Cibicidae	00.03
Nonionidae	00.03

Fig. 2 : Map showing direction of water movement at Velsao Bay (after KURUP *et al.*, 1976)

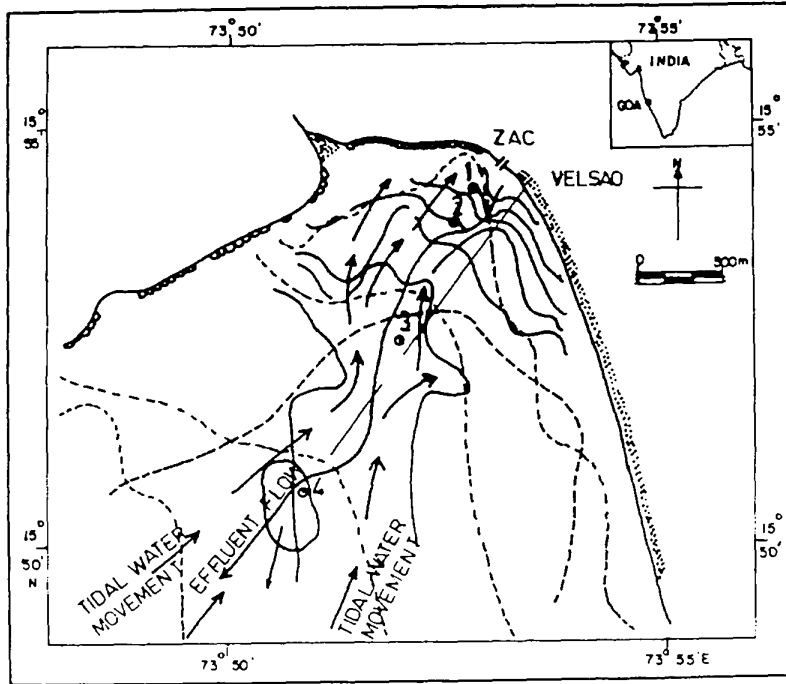
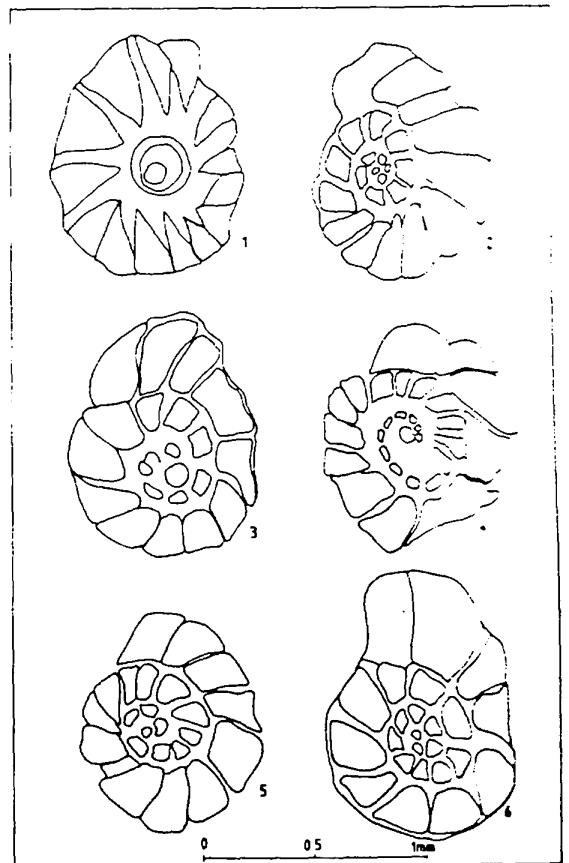
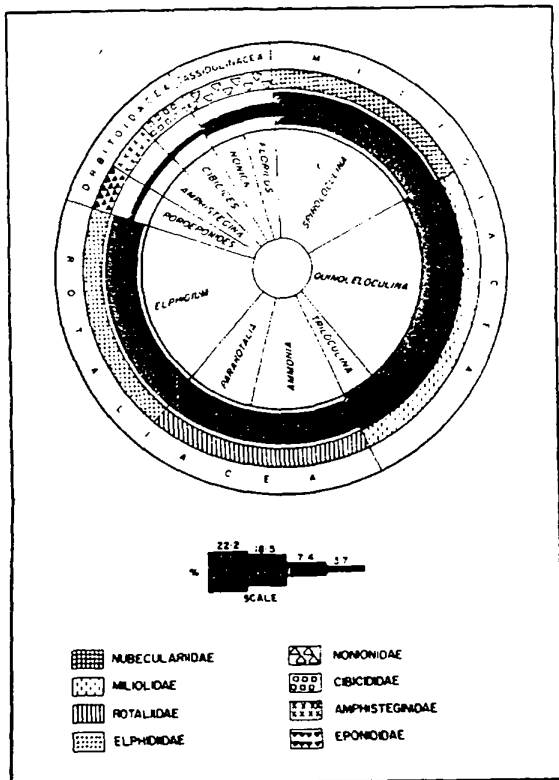


Fig. 4 : *Ammonia annectens* showing apertural test in the growth of tests.

Fig. 3 : Composition of total foraminiferal species from Velsao beach sands.



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