

Distribution of calcareous nannoplankton from the sediments of the northwestern continental shelf of India

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Abstract

Fifty-four snapper samples from the northwestern continental shelf of India have yielded fifteen species of calcareous nannoplankton along with a few reworked ones. Among the species encountered, *Gephyrocapsa oceanica* was most predominant, being distributed in all the stations. The patchy and sparse distribution of nannoplankton suggests that the flora has undergone intense grazing. Low diversity of nannoplankton indicates a marginal environment.

INTRODUCTION

The biogeographic distribution of calcareous nannoplankton from the surficial sediments of the northwestern continental shelf of India are studied with an emphasis on the variation in abundance of some species. Earlier studies on calcareous nannoplankton from the northern Arabian Sea include that of Norris (1965), Martini and Muller (1974) and Guptha (1974, 1976 and 1979).

MATERIAL AND METHODS

The material consists of 54 snapper samples from a depth range of 9-270 m collected during December 1973—May 1974 in the northwestern Arabian Sea (Fig. 1A). The smear slides of the above samples were prepared and examined under a Reichert polarising microscope at magnification of 1500X. Twenty random fields of view in each of the evenly smeared slides were scanned, counted and computed for the percentage of various nannoplankton flora in each sample.

PHYSIOGRAPHIC AND OCEANOGRAPHIC SETTING

The area falls under the influence of southwest monsoon. There are many rivers in this region which flow into the Arabian Sea. The largest among them is the river Indus which drains the western portion of the Indo-Gangetic plain. The others are Mahi, Narmada and Tapti emptying into the Gulf of Cambay. The sedimentary facies shows marked difference in the inner and the outer shelf. The inner-shelf consists of modern terrigenous muds and the outer-shelf is covered by relict carbonate sands (Nair, 1975). Hashimi and Nair (1976) have reported that the 80% insoluble residue contour is found close to the coast along Ratnagiri and Saurashtra suggesting greater sediment influx in the nearshore region (Fig. 1B). In the Gulf of Cambay, this 80% contour protrudes into the Gulf. Besides the river discharge, high tidal range in the Gulf of Cambay and prevailing tidal currents result in highly turbid waters. On the other hand, insoluble residue decreases abruptly on the outer continental shelf off Bombay which is attributed to the fact that the bulk of terrigenous material is confined to the inner-shelf leaving the outer-shelf free from sediment accumulation.

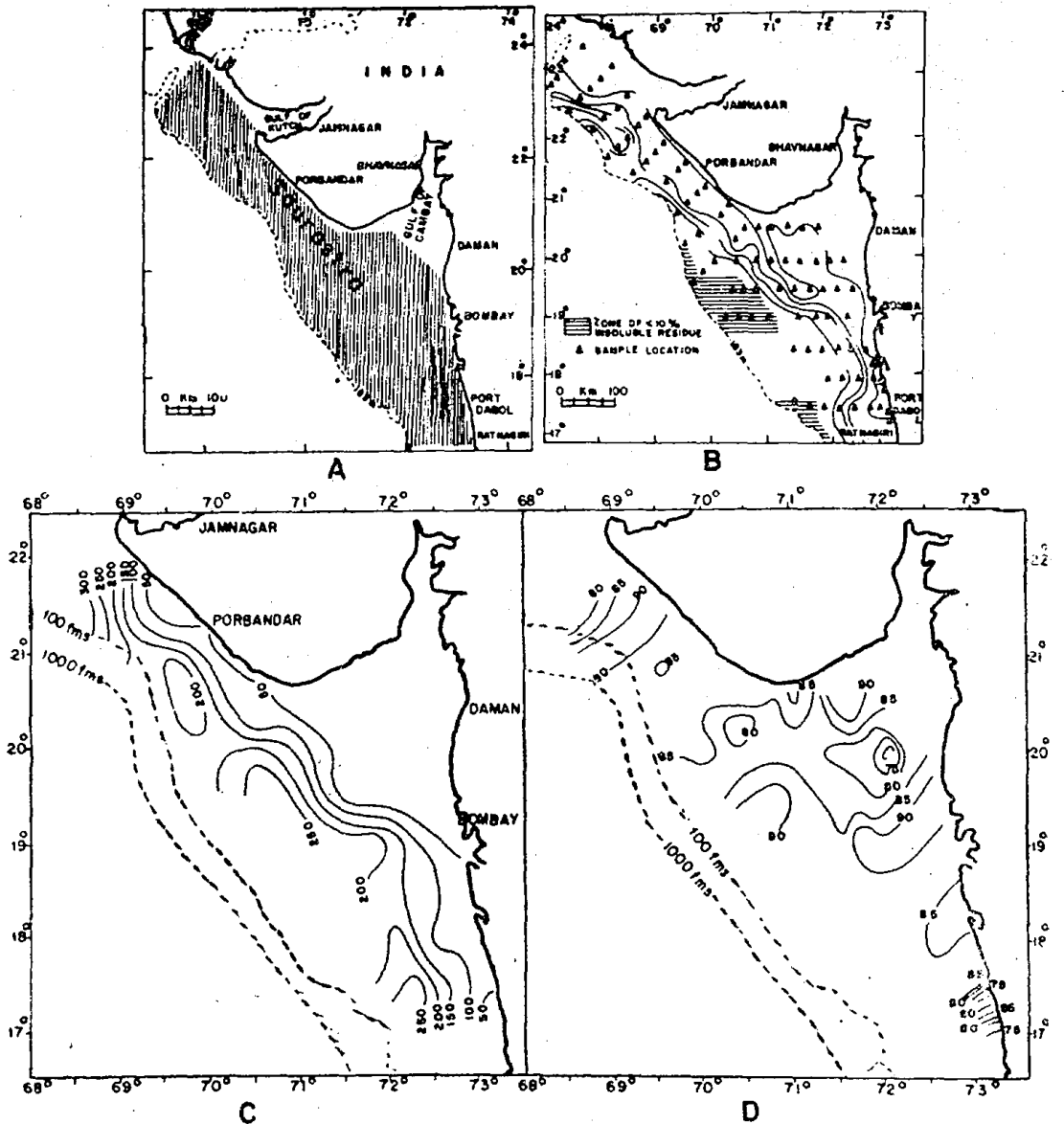


Figure 1. A - D showing the area of investigation, distributional pattern of insoluble residue (%); areal distribution of total nannoplankton (specimens per unit area) and areal distribution of *Gephyrocapsa oceanica* (%) respectively.

The distribution of calcium carbonate on the inner-shelf over the entire area is very low, with weight ratio of less than 25%. Although the carbonate value is reported abundant on the outer-shelf off Saurashtra coast, it is comparatively lower than the region off Bombay (Rao, 1978).

The studied area is affected by southwest monsoon from June-September, with an average rainfall of about 3000 mm. The average winter and summer temperatures of the region are 26.6°C and 29.3°C respectively. Based on the hydrographic studies carried out from December 1973 to May 1974, it is observed that salinity

is almost uniform with a slight fluctuation between 35% and 36.3% and oxygen between 4.4 and 5.36 ml.l⁻¹, whereas the phosphate content varies from 0.2 to 2.0 mg^{-at}₁⁻¹.

RESULTS AND DISCUSSION

It is evident from Figure 1C that the percentage of total nannoplankton in each sample progressively increases from near-shore to offshore regions (12-344 specimens per unit area) throughout the study area. The sediment yielded 15 species of calcareous nannoplankton, among which, *Gephyrocapsa oceanica* was by far the most abundant. Species of lesser abundance included: *Cyclococcolithina leptopora*, *Helicosphaera carteri*, *Umbilicosphaera sibogae*, *Emiliana huxleyi*, *Syracosphaera pulchra*, *U. hulburtiana*, *Coecolithus pelagicus* and *Thoracosphaera* sp., which are distributed in most of the samples. Other species more sparsely distributed at a very few stations included: *Syracosphaera hystrica*, *Braarudosphaera bigelowi*, *Ceratolithus cristatus*, *Aspidorhabdus stylifera* and *Discolithina* sp.

A few reworked fossils like *Watzeneura barnesae*, *Arkangeliskiella cymbiformis*, *Reticulofenestra pseudoumbilica*, *Tetralithus* sp. were also encountered.

Gephyrocapsa oceanica was the most abundant species (68-96%) of the total flora. Off the Saurashtra coast it gradually increased from 80-90% seaward. Similar trends are seen on the shelf off Bombay region (Fig. 1D).

Helicosphaera carteri was the next abundant species encountered. Off Saurashtra coast, it showed a decreasing trend towards the middle shelf from 20-5%, and again gradually increased in the offshore regions. Similarly, on the shelf off Bombay it gradually increased to a maximum concentration of 15% (Fig. 2B).

Off the Saurashtra coast, *Cyclococcolithina leptopora* gradually decreased from north to south showing increasing abundance off the Gulf of Cambay and Bombay regions and also towards the south of Bombay. The maximum concentration of 5% occurred in the shallow regions of the Gulf of Cambay and Bombay (Fig. 2A).

Umbilicosphaera sibogae is considered to be a temperate to tropical species (Mc Intyre and Be, 1967). Like *C. Leptopora* it gradually decreased from north to south on the continental shelf off Saurashtra. Off the Gulf of Cambay it increased from 3-5%, whereas, in the off Bombay region it decreased further (Fig. 2C). On the inner-shelf to the south of Bombay *C. leptopora* increased from 2-5% seaward.

Although *E. huxleyi* was encountered at most of the stations, it was very sparsely distributed. Its maximum abundance (9%) and minimum value (1%) were observed off the Gulf of Cambay and on the middle and outer-shelf off Bombay and Saurashtra regions, respectively (Fig. 2D).

Syracosphaera pulchra increased (0.5-8.3%) from north to south on the shelf off Bombay, whereas in the shelf off Saurashtra coast, it gradually decreased from north to south. The maximum value of 8% was recorded in the sediment off Bombay region (Fig. 3B).

Thoracosphaera sp., was confined mostly to the outer-shelf, its maximum relative abundance was 5% (Fig. 3A).

U. hulburtiana with its maximum abundance of 3.5% was found on the outer-shelf off the Gulf of Cambay, which gradually decreased seaward off Bombay to the south (Fig. 3C).

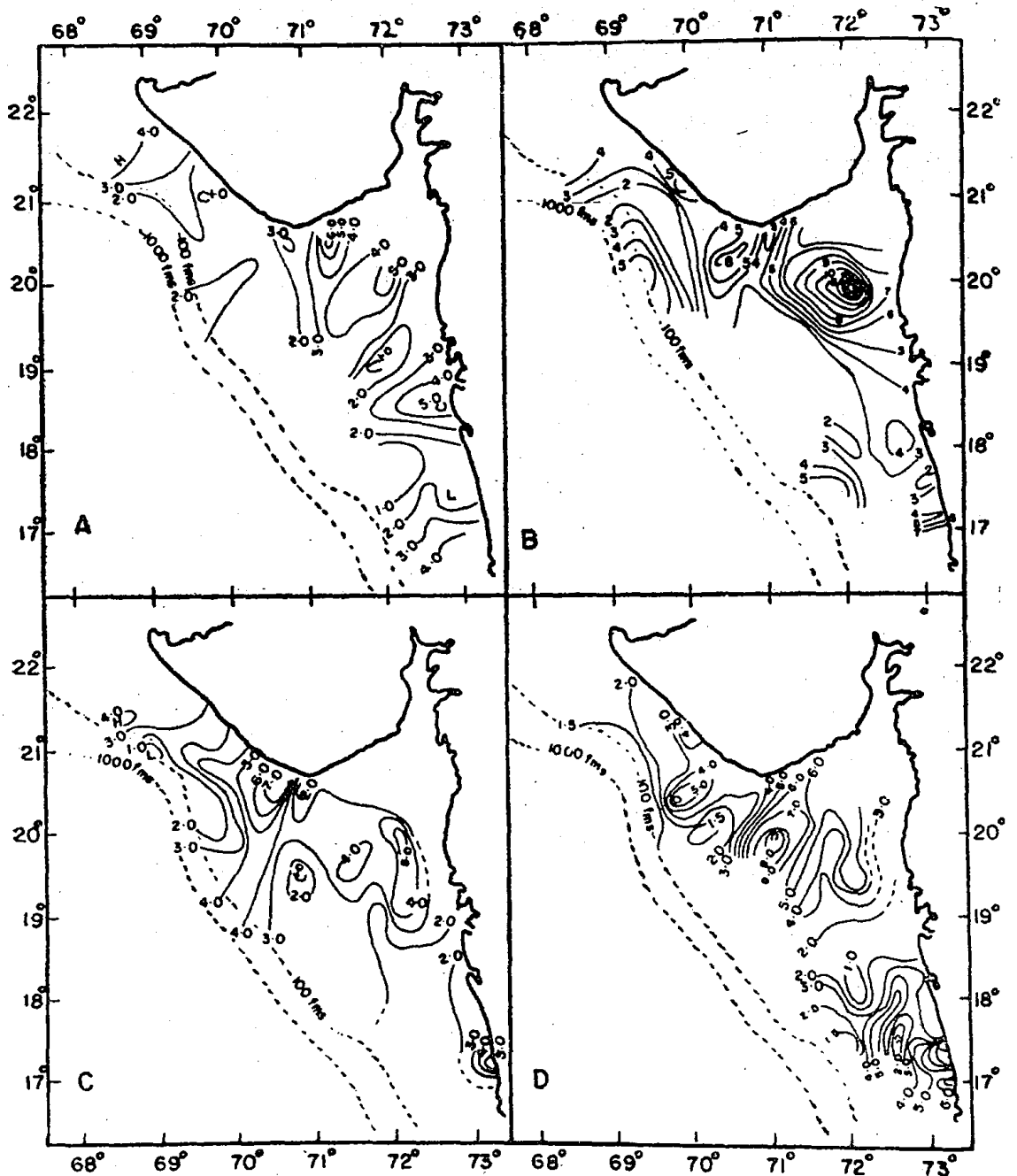


Figure 2. A - D showing the areal distribution of *Cyclococcolithina leptopora*, *Helicosphaera carteri*, *Umbilicesphaera sibogae* and *Emiliana huxleyi* (%) respectively.

Coccolithus pelagicus, a typical cold water species decreased in abundance (0.3-5.2%) on the shelf off Gulf of Cambay; increased on the shelf off Saurashtra coast from south to north, and gradually increased in abundance on the shelf to the south of Bombay (Fig. 3D).

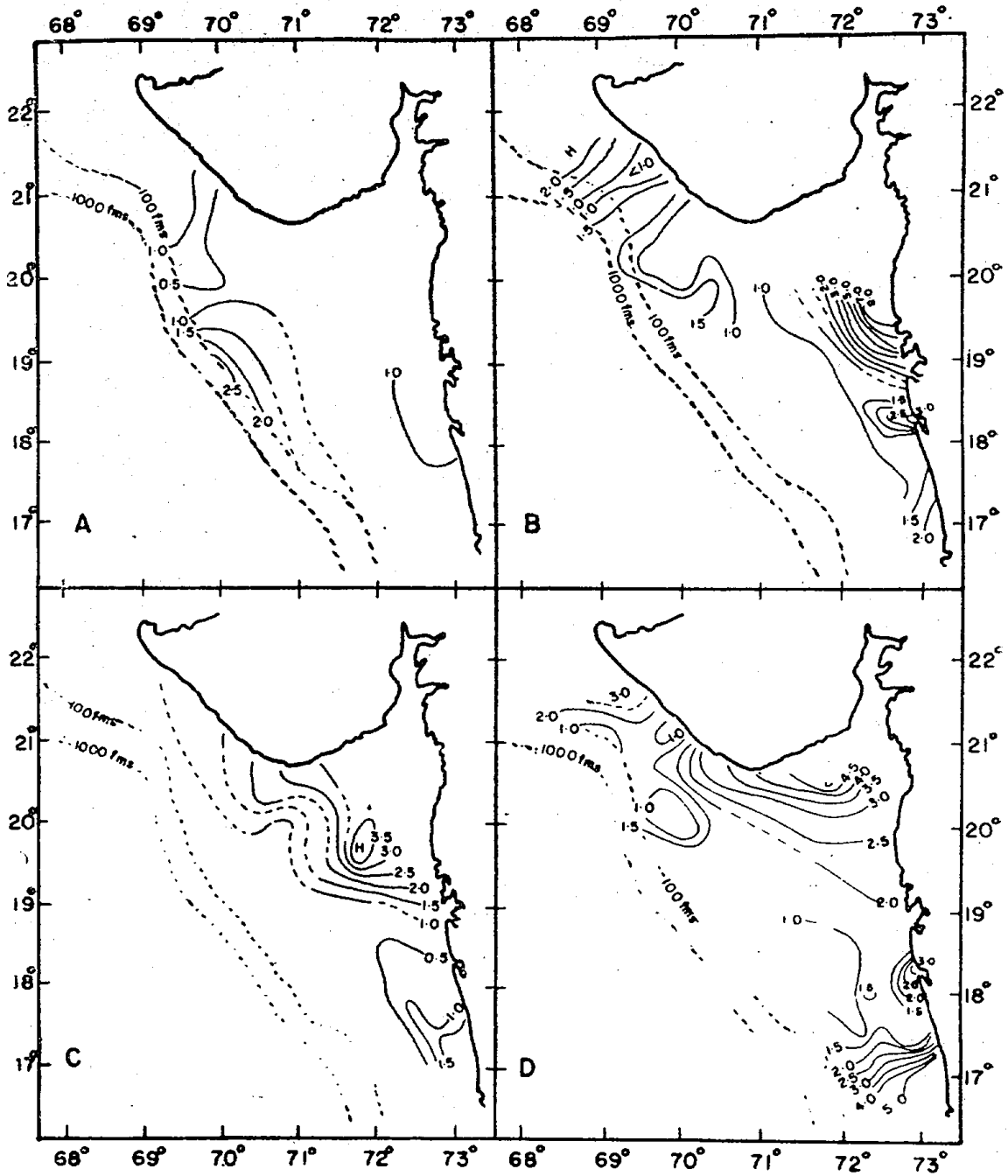


Figure 3. A - D showing the areal distribution of *Thoracosphaera* sp., *Syracosphaera pulchra*, *Umbilicosphaera hultburtiana* and *Coccolithus pelagicus* (%) respectively.

Among the minor nannoplankton species encountered, *A. stylifera* showed a patchy distribution of eleven random stations with a maximum abundance of 2%. *B. bigelowi* was also distributed at very few stations on the middle and outer-shelf off Saurashtra coast and on the outer-shelf off Bombay region. Its maximum recorded occurrence was 0.9%. *Syracosphaera hystrica* was encountered at six stations

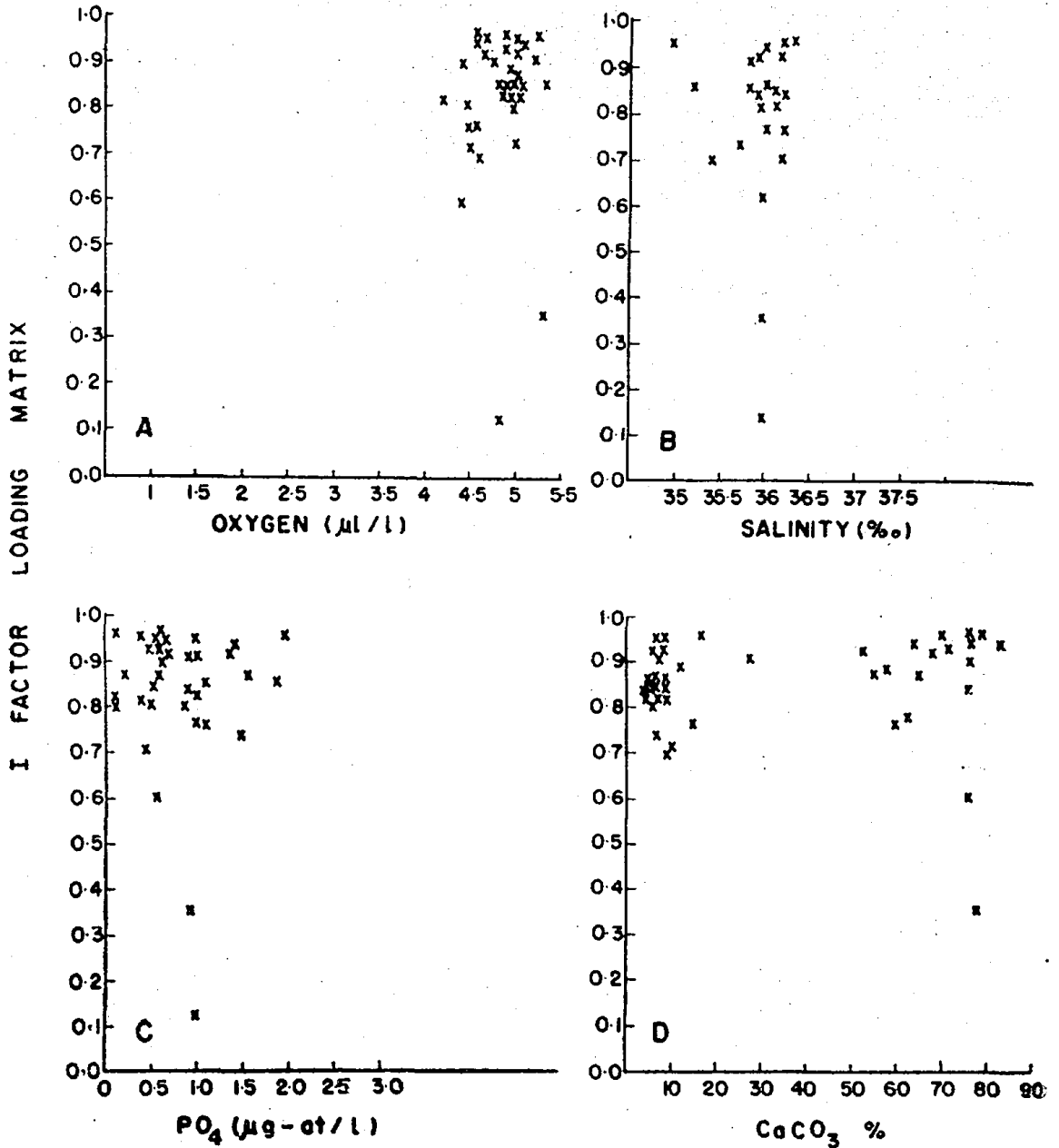


Figure 4. A - D showing the correlation between First Factor loading matrix and oxygen, salinity, phosphate and calcium carbonate respectively.

off the coast of Bombay and to its south, with the maximum concentration of the inner and middle-shelf (1.4%). *Discolithina* sp., was distributed sparsely at three stations on the outer-shelf off Bombay and *C. cristatus* was found in only one station on the outer continental shelf of Bombay.

The nanoplankton data were subjected to Q-mode factor analysis on TDC 316 computers. Of the four eigen values obtained (36.98; 4.21; 3.04 and 2.31), the first eigen value possesses 72.5% of the information contained in the data. Hence,

the first factor loading matrix has been correlated with the physical and chemical parameters such as salinity, oxygen, phosphate and calcium carbonate (Fig. 4 A-D). But none of these parameters showed a correlation with the factor loading matrix suggesting that the nanoplankton flora must have undergone some definite change before settling to the bottom.

Although the study area generally is a region of high productivity, the nearshore regions are turbid because of river run-off, thus inhibiting the light penetration essentially required for productivity. In the Gulf of Cambay, 1% illumination occurs at 1 m depth as a great amount of terrigenous material are suspended by strong tidal currents in the shallow regions (Varkey *et al* 1976). The transparency of water in the area south of Bombay increases towards offshore as there is no large scale land drainage. The reworked nanoplanktons of Upper Cretaceous age reported here are confined to the outer continental shelf. These fossils must have been supplied through the Gulf of Kutch (Guptha 1979).

Of the 15 species encountered, *G. oceanica* has monopolized the flora through the entire region. Their relative abundance ranges from 68-96%. It is a unique phenomenon observed in the present investigation.

The abundant occurrence of *G. oceanica* has been reported in warm coastal waters such as the Gulf of Panama (Smayda, 1963 and 1965), offshore waters of the southeastern United States (Hulbert and Mackenzie, 1971), on continental shelf sediment off the NW Florida shelf (Brohm, 1973), in marginal seas along the western Pacific Ocean, and in the Red Sea (Okada and Honjo, 1975). Brohm (1973) has attributed the abundance of *G. oceanica* in sediment cores from the northwestern Florida shelf to the decreased rate of sedimentation. This proposition is not applicable to the present environment, since the sedimentation rate is significantly high owing to the enormous amount of river discharge. Therefore, some factor other than productivity may be responsible for this phenomenon.

Although *E. huxleyi* is considered to be ubiquitous in oceanic and various neritic environments of modern oceans and is also known for its adaptability to a wide range of salinity and temperature, it is very scantily distributed in the area of investigation. Okada and Honjo (1975) opine that the rarity of *E. huxleyi* is a characteristic feature of marginal seas. Except for *G. oceanica*, the remaining nanoplankton constituted a very negligible percentage.

It is apparent from the foregoing discussion that the deposition of nanoplankton floral constituents, except for *G. oceanica*, is very scanty. This appears to be quite strange. The less abundance in nanoplankton distribution cannot be attributed to the possibility of underwater currents which would hinder the settling of nanoplankton to the bottom. Clay which is of nanoplankton size range is being deposited at present. Dissolution does not occur at shallow depths.

In order to understand whether deposition of nanoplankton by some other mechanism is being hindered or the actual production itself is poor in the euphotic zone, some knowledge on nanoplankton distribution in the overlying water masses is needed. The level of primary production in the northern Arabian Sea is generally high (Radhakrishna *et al* 1978). In view of the above, the patchy and sparse distribution of nanoplankton in general may be attributed to grazing as one of the factors responsible. The low diversity of calcareous nanoplankton suggests that the flora is of neritic environment.

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