TABLE 2 — PLANKTONIC AND BENTHONIC FORAMINIFERA AT DIFFERENT STATIONS — *contd*

Depth (99 and 201 m)	Stations	
	354	378
BENTHONIC FORAMINIFERA		
Operculina complanata[b]	×	×
Operculinoides sp.[b]	×	
Patellina inconspicua[c]		×
Peneroplis pertusus[c]	×	
Planorbulinella larvata[c]	×	×
Planulina ornata[c]		
Poreponides cribrorepandus[c]	×	×
Psuedoeponides umbonatus[c]		×
Psuedononion japonicum[b]	×	×
Pyrgo sarsi[c]		×
Quinqueloculina agglutinans[a]	×	
Q. lamarckiana[a]	×	
Q. tropicalis[b]	×	×
Rectocibicides sp.[c]	×	×
Rotalia nicobarensis[b]	×	×
Ruessela spinulosa[c]		×
Spiroloculina antillarium[a]	×	
S. communis[a]	×	
Spirosigmoilina tenuis[c]		×
Sigmoilina celata[c]	×	
Textularia aura[b]	×	
T. candeiana[c]	×	
T. secasensis[a]	×	×
Trifarina bradyi[b]	×	×
Triloculina tricarinata[a]	×	×
Trimosina milletti[c]		×
Uvigerina senticosa[c]		×
Valvulineria glabra[c]		×

(a) Abundant; (b) common; (c) rare.

prolific in growth at 1000-2000 m range, is also present as rare, in st. 378.

Textularia secasensis is found in depth of >60 m, hence abundant in both regions. *Eponides tenera* and *Pseudoeponides umbonatus* are typical deep water forms, but found, as rare, at st. 378. These species are common in the outer slopes of Bikini and other atolls in the Pacific[8]. *Cibicides lobatulus* found here is also found in the outer shelf region of Andros island of Bahama Bank[8]. *Dyocibicides biserialis* found to be abundant in 50-62 m depth, occurs at the shelf (st. 354) at 99 m depth also.

Comparison of the benthonic species of this region with that of Visakhapatnam[10] shows that several species are common to both. Bhalla[11] reports the occurrence of *Spiroloculina antillarium*, *S. communis*, and *Triloculina tricarinata* from the beach sands of Visakhapatnam also.

Spiroloculina antillarium and *Q. tropicalis* are not found in the west coast sediments. But species like *Textularia secasensis*; *Triloculina tricarinata*, *Dentalina communis*, *Bolivina robusta*, *Cancris sagra*, *Cornuspira involvens*, *Elphidium fax barbarense*, *Spiroloculina communis*, *Poreponides cribrorepandus*, and *Pseudoeponides umbonatus* are common to both the areas[12]. Such a comparison has shown that the east coast shelf fauna though similar in some respects, is somewhat different from that of the west coast shelf fauna of India in the presence and absence of a few species[12].

Many of the species recorded here are reported from the Neogene and Holocene deposits of south and central Pacific[8]. Thus the assemblage shows an Indo-Pacific affinity. Similarly, *Rotalia nicobarensis* and *Triloculina tricarinata* are significant as they are known to occur since the Miocene time. These species are common in the present study area and the East African coast foraminiferal assemblages. Earlier, Bhalla[13] while studying the foraminifera of the beach environment of Visakhapatnam and Madras observed that the elements of Indo-Pacific and East African assemblages exist in this region. Therefore, it may be stated that the foraminiferal assemblage of this regime includes both the Indo-Pacific and East African constituents.

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Coincident Occurrence of *Sagitta enflata* (Chaetognatha) & *Cypridina dentata* (Crustacea: Ostracoda: Cypridinidae) Off Maharashtra Coast

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Coexistence of unusual congregations of the chaetognath *S. enflata* and the ostracod *C. dentata* was observed in the zooplankton off the Maharashtra coast between 17°20′ to 19°14′N and 72°21′ to 72°56′E during the 12th cruise of *RV Gaveshani* in the west coast of India. They contributed 54 to 80% of the total biomass. Oceanic associations of plankton species usually exhibited high diversity and the coincident occurrence of 2 swarms of the distinct species was rare. Such dense concentrations of a few species may be considered as population explosions resulting in a situation referable to a 'monotone' plankton.

During the 12th cruise of *RV Gaveshani* in Nov. 1976, vertical zooplankton samples were collected from areas off the west coast of india using Indian Ocean Standard Net[1]. A few stations occupied between 17°20′ to 19°14′N and 72°21′ to 72°56′E parallel to the coast of Maharashtra yielded high numbers of *Sagitta enflata* Grassi, considered to be the dominant chaetognath in the Indian Ocean[2] and *Cypridina dentata* (Müller), the most abundant planktonic ostracod in the Arabian Sea[3]. At stations 199, 200, 201 and 202, aggregation of *S. enflata* and at stations 201 and 202, high densities of *C. dentata* were noticed (Table 1). These 2 species representing different phyla and ecologically occupying distinct levels in the food chain had given rise to a 'mixed swarm' of zooplankton especially in the latter 2 stations.

Chaetognath populations at st. 199, 200 and 201 were constituted mainly by the single species *S. enflata* along with a few specimens of *S. bedoti*. At st. 202 also, *S. enflata* constituted nearly 85% chaetognath component. Although all the developmental stages were found in the samples, preponderance of juveniles was noted. Maximum number of *S. enflata* recorded from a single station during the International Indian Ocean Expedition was 14200/100 m³ from a station located off Somalia (04°09′N and 53°10′E) with 6 other well represented species in the sample[2]. Density range of 15800-18700/100 m³ was recorded for the single species, *S. enflata* in the present collections.

C. dentata dominated in the samples of stations 201 and 202. George[3] recorded maximum number (10300/100 m³) of this species from a station in the Arabian Sea located off Cochin (10°29′N and 75°31′E). Compared to this, the present record of 65400/100 m³ was considerably high. The specimens were mostly contributed by egg bearing females.

Salinity and temperature values did not vary much from one station to the other (Table 1). At all stations the whole water column was sampled leaving a few metres below. Hence zooplankton populations in the present samples may give a true representation of different groups from the area and layer sampled. Wet zooplankton displacement volume expressed as ml/100³ was considered as the biomass. The biomass at this region was the maximum recorded during the whole survey[4]. *S. enflata* and *C. dentata* contributed an appreciable part of the total biomass (Table 1). Siphonophores constituted mainly by *Diphyes* and *Bassia* spp also formed a fair percentage of the total biomass, particularly at stations 119-201 (Table 1). Excluding copepods, other taxa which are commonly encountered in the off shore collections were rare in the present samples. Fish eggs were totally absent and fish larvae were present at a single station. Medusae, polychaetes, amphipods, euphausiids, mysids, decapod larvae, pteropods, lamellibranchs, gastropods, atlantids, appendicularians, doliolids and salps were the other groups represented in low numbers. In general, preponderance of carnivores to the other groups is conspicuous, suggesting the area to be a mature ecosystem.

Oceanic plankton usually exhibit a rather high diversity and this is clearly seen in the zonation of chaetognath species off the west coast of India[5]. However, congregation of a single species of chaetognath spreading to a wide area (from station 199-201) is quite unusual and worth recording. In addition, the occurrence of the swarm of ostracod species in synchronization with the abundance of chaetognaths makes it an unrecorded phenomenon.

A characteristic feature referable to any natural assemblage of individual is its biotic diversity. A theoretical situation in which a *minimum* (null) or *maximum* diversity attained is something improbable in nature[6]. The present observation may be referred to a situation close to 'monotone' plankton[6], in which a few species become highly dominant. Such dense concentrations of a few species of zooplankton may be considered as population explosions that may perhaps occur either seasonally or at regular intervals when environmental conditions are exceptionally favourable for their growth and reproduction.

Table 1 — Station Details, Hydrographic Data and Abundance of *S. enflata* and *C. dentata* in Relation to Total Biomass for Different Stations

Station	Time hrs	Stratum[a] sampled to surface m	Temp. °C	Salinity ‰	Biomass, ml/100 m³				Number/100 m³		
					Total	*S. enflata*	*C. dentata*	Siphonophores	Chaetognaths	*S. enflata*	*C. dentata*
199*	0830	20	28·06-28·2	34·74-34·76	100	68·5	0·4	17·5	17900	17400	1400
200*	1430	25	28·42-29·3	35·03-35·05	124	65	0·6	25	15900	15500	2100
201*	1900	25	28·28-29·0	35·01-35·32	100	60	20	14	19000	18700	65400
202†	0024	30	28·90-29·1	35·50-35·52	80	37	17	8	18600	15800	47100

*Sampled on 24-11-76.
†sampled on 25-11-76.

(a) Station positions: 199—19°14′ N lat. and 72°21′ E long.; 200—18°34′ N lat. and 72°33′ E long.; 201—17°59′ N lat. and 72°44′ E long; and 202—17°20′ N lat. and 72°56′ E long.

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Continuous Culture of the Brine Shrimp, *Artemia salina*

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Continuous culture of the brine shrimp, *A. salina*, yielding many generations of individuals, and the collection of dry viable eggs from the culture using only pellets of prepared dry fish food as feed are reported.

IT is well known that the resting eggs (cysts) of brine shrimps (*Artemia salina*) remain viable for a number of years when stored in dry and fairly cool places. Collection of their eggs from salt pans and coastal waters and marketing them on a commercial basis is a profitable industry in many places[1-3]. Larval stages of the brine shrimp are mainly used as food of tropical aquarium fishes. They are also used as zoological teaching material and also for testing insecticides and other toxicants[4].

A few generations of brine shrimps have been cultured successfully using different species of live marine algal cultures in the laboratory[5,6]. The present paper reports continuous culture of brine shrimps yielding many generations of individuals and the collection of dry viable eggs from the culture using pellets of prepared dry fish food as the only feed. The purpose of the culture is to obtain sufficient number of adult brine shrimps for testing the toxicity of different types of metallic compounds, detergents, crude oil and its derivatives.

A small glass aquarium (70 cm × 20 cm × 30 cm) was used for culturing the brine shrimps. As the fluctuation in the outside temperature was high from June to the end of Sept. 1977, the tank was kept in an airconditioned room with sufficient day light. From the end of Sept. 1977, the use of air conditioner was discontinued. Throughout the period of continuous culture (June to Dec. 1977), the air temperature in the room ranged from 25·3°C to 22·5°C. The sea water in the culture tank was vigorously aerated continuously. Range of salinity was from 40·3‰ during July to 37·2‰ during December, whereas *p*H varied from 8·2 to 7·8·

The culture was started on 4th June 1977, by introducing 2 g of the resting eggs in 30 l of sea water. Dried eggs of *A. salina* were obtained from M/s Long Life Aquarium Products, Division of Sternco Industries, Ontario, Canada. The net weight of the eggs was 1·3 kg. Within 30-40 hr brine shrimp larvae were observed. From the 3rd day onwards 4-6 g of dried Japanese fish food (Madai No. 1; Nippon Noson Kogyo K.K. Japan) pellets were put into the tank. The chemical composition (%) of the food is, protein, 53·5; fat, 4·7; fibre, 1·5; ash, 18·5; calcium, 3·9; potassium, 1·85; and vitamin A and other vitamins. Total calorific value of the feed is 2760 cal/g dry weight and the material composition (%) being, fish meal, 69·5; wheat flour, 19; and minerals, 11·5. Within 1-2 hr the food pellets dissolved in water into fine particles of less than 10 μm diam. suitable for ingestion by *Artemia*. At the end of every 30 days the sea water in the tank was replaced with fresh sea water. Before changing the water all the animals and the bottom sediments were filtered out using nylon netting of 68 μm mesh size, and were reintroduced to the fresh sea water in the culture tank. No additional live food materials like diatom cultures were given. About 120 adult brine shrimps (av. length of 1·3 cm) were removed every week from the tank for bioassay studies.

During the culture it was observed that the number of adult animals reached their peak within about 15 days after the addition of fresh sea water (110 adult animals/litre) and their numbers reduced to 30 adult animals/litre by the 30th day. Number of copulating pairs were also more during the peak periods. Developing eggs in the brood pouch of the females were white at first. They were accompanied by the males clasping and holding the brood pouch and were seen moving about in this condition for a long time. As the eggs matured they gradually changed colour to yellow and finally to dark brown and were shed into the water. All stages of the animals from eggs to adults were seen throughout the culture period. However, within 3-4 days after the replacement of sea water the number of young brine shrimps increased indicating the hatching of more resting eggs by the stimulus given by the fresh sea water.

As the waste food materials were not removed they accumulated at the bottom of the tank and became dark brown in colour. While changing sea water, settled sediments were agitated and the water became turbid. There was also the strong smell of hydrogen sulphide liberated from the decaying sediments. But within a few hours the sediments settled again and the brine shrimps were not visibly affected. The average caloric value of the sediments was 1915 cal/g dry weight. Microscopical analysis of the sediment revealed the presence of numerous dark brown shrimp eggs, decaying particles of food materials, faecal pellets of *Artemia*, ciliates and small worms. The worms were observed in the body of some of the adult shrimps during certain times. However, the majority of the animals were not affected by them and there were no indications of any deleterious effects. Maksimova[7] has established that *A. salina*