

Diurnal Variation of Zooplankton in Malad Creek, Bombay

S N GAJBHIYE, VIJAYALAKSHMI R NAIR & B N DESAI

National Institute of Oceanography, Regional Centre, Versova, Bombay 400 061

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Variation in zooplankton biomass and composition in relation to the prevailing hydrographical conditions was studied for 24 h in Malad creek, which was highly polluted by sewage. The adverse effect of pollution was more during the ebb tide with relatively low values of salinity and zero values of dissolved oxygen. Zooplankton biomass varied from 0.01 to 13.2 ml. (100 m³)⁻¹ [av. 3.4 ml. (100 m³)⁻¹] during different tidal conditions. Zooplankton standing stock and total population were higher in night than in day collections. Abundance and diversity of zooplankton were directly correlated to the prevailing tide and pollution load. Copepods formed the predominant group followed by decapods, gastropods, chaetognaths and mysids. Variations in the incidence of different groups species of zooplankton were discussed in detail.

In a tidal creek, environmental parameters and zooplankton population may change in magnitude over very short periods. Diurnal variation of zooplankton in such an environment is chiefly influenced by changes in physico-chemical parameters induced by tide, fresh water influx and vertical migration of zooplankton associated with light intensity. Information regarding diurnal variation of zooplankton from Indian seas particularly from the coastal waters of India is limited¹⁻⁵. Hence the present study was taken up to evaluate short term variations in zooplankton at the mouth of a tidal creek, in Bombay.

Materials and Methods

Malad creek is a prominent narrow inlet located towards north of Bombay city (lat. 19° 8' N and long. 72° 48' E). It receives approximately 200 mld of effluents⁶, mainly from Versova and Malad pumping stations. The collective effluents from the creek flow downstream into the tidal water and affect the water quality of the area.

The station selected for the study is located towards the mouth of the creek at a depth range of 12-15 m. Samples from surface and bottom were collected on 18/19 Feb. 1981 at hourly intervals during day and once in 2 h during night. Water samples were collected for salinity, dissolved oxygen (DO), pH, and nutrients and estimations were made as per Strickland and Parsons⁷. Zooplankton samples were collected by oblique hauls using a Heron Tranter net (mouth area of 0.25 m² and mesh size of 0.3 mm) fitted with a calibrated TSK flow meter. The net was towed for 5 min. The samples were preserved in 5% seawater formalin for biomass, taxonomical and numerical studies.

Results and Discussion

Physico-chemical characteristics—At 0830 hrs when

sampling started ebb to flood tide was in progress. It attained the slack period around 1230 hrs, then ebb tide started which continued up to 1830 hrs. The second flood was recorded during 0030 to 0130 hrs.

Variations in physico-chemical parameters studied are given in Fig. 1. Fluctuation in water temperature was not much and the maximum difference was 2.3°C for the surface and 1.7°C for the bottom. The pH values were relatively lower than that can normally be expected for nearshore waters. In general, the recorded pH values for the ebb period was relatively low. Diurnal variations of salinity, dissolved oxygen, BOD, and nutrients were considerable. Salinity decreased during flood to ebb period and well defined stratifications of this parameter was also observed. It appears that the influx of sewage into the creek lowered the salinity to a great extent resulting in the movement of less dense water of low salinity to the surface and dense water of high salinity to the bottom layer of the creek. The occurrence of zero values of DO at Versova creek was a common feature during the ebb period. This trend in the variation of DO and salinity is in agreement with the earlier reports^{6,8}. The amount of BOD was very often high during ebb tide amounting to 80 mg.l⁻¹. The distribution of reactive phosphate, nitrite, nitrate and ammonia were also directly related to the tide and discharge of effluents. Consequently, nutrient values were relatively high during the ebb than the flood period. In general, the hydrographical features of the area indicated the prevailing pollution load.

Zooplankton biomass, total population and composition—The zooplankton biomass in the area varied from 0.01 to 13.2 ml. (100 m³)⁻¹ (Fig. 2). The biomass decreased drastically with the advent of the ebb tide and again increased when flood tide had set in. In general, biomass values were higher for the night

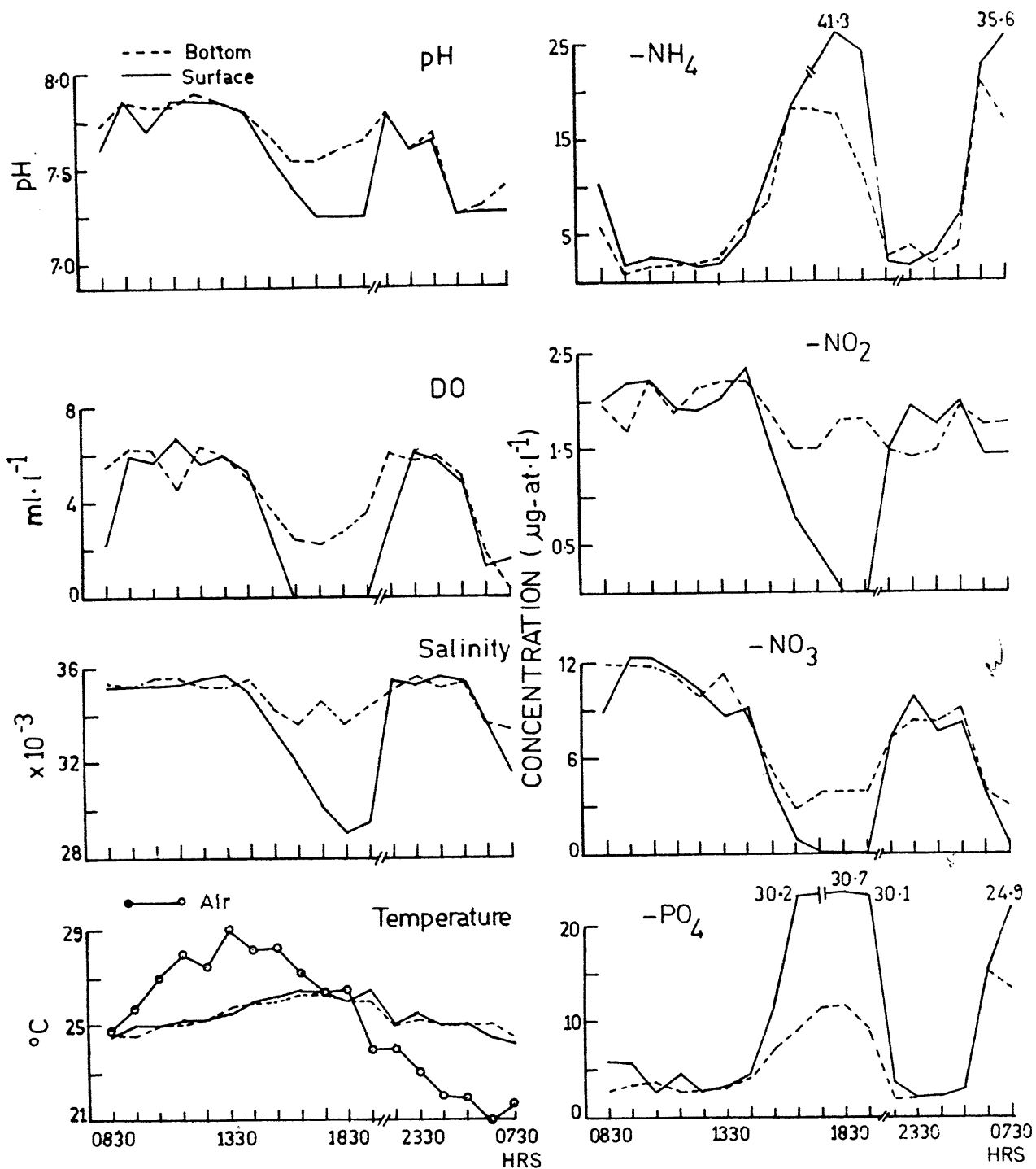


Fig. 1—Variation in physico-chemical parameters at Malad creek

collections and average values for night and day samples were respectively 5.1 and 2.32 ml. (100 m³)⁻¹.

Total zooplankton population fluctuated during different tidal conditions (Fig. 2). The maximum density [37570.(100 m³)⁻¹] was recorded at 1030 hrs during ebb to flood tide, while the density decreased drastically during flood to ebb cycle and attained a

minimum [70.(100 m³)⁻¹] at 1730 hrs. The recorded population was relatively more during the night [av. 18846.(100 m³)⁻¹] than during the day [av. 11649.(100 m³)⁻¹]. The highest population density was represented by 14 faunal groups and the most abundant group was copepods (92.9%). The rest includes gastropods, decapods, chaetognaths, mysids,

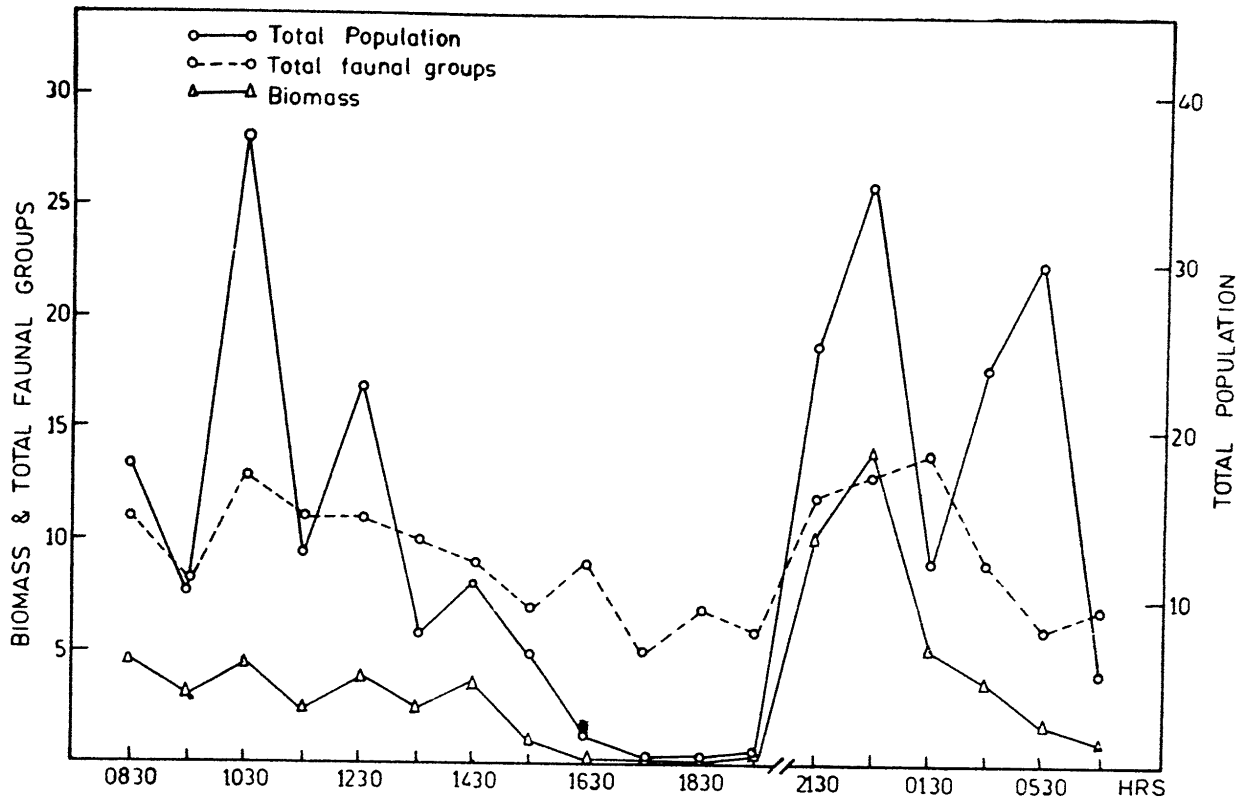


Fig. 2—Variation in biomass ($\text{ml. (100 m}^3\text{)}^{-1}$), population ($\times 10^3$) and faunal groups (No.) of zooplankton at Malad creek

siphonophores, fish larvae, *Acetes* sp., medusae, fish eggs, stomatopods and polychaetes. Maximum group diversity was also noticed at 2330 and 0130 hrs. In general, there were more groups found during flood tide than during ebb tide. The lowest population density was represented by 5 faunal groups, viz. copepods (81.43%), gastropods, amphipods, ostracods and isopods.

Copepods: In all the zooplankton samples, the density of copepods varied from 38.22-97.26% (Fig. 3). Their abundance was relatively low during the peak ebb period. Copepods were represented by 19 species. The maximum number of copepods species (8) was obtained at 1130, 0130 and 0330 hrs. The most common species were *Acartia spinicauda*, *Acrocalanus similis*, *A. gracilis*, *Euchaeta concinna*, *Eucalanus subcrassus* and *Paracalanus crassirostris* and *P. aculeatus*. The other species found were *Canthocalanus pauper*, *Paracalanus parvus*, *Acrocalanus inermis*, *A. monachus*, *Labidocera pectinata*, *Acartia pacifica*, *A. plumosa*, *A. centrura*, *Acartia* sp., *Cyclops buxtoni*, *Laophonte* sp. and *Idyaea* sp.

Chaetognaths: The frequency of occurrence of this group was 94.4% and the percentage composition varied from 0.12-3.83% of the total zooplankton count. The occurrence of chaetognaths was closely related to the phase of the tide. The highest [502.(100

$\text{m}^3\text{)}^{-1}$] and lowest [6.(100 $\text{m}^3\text{)}^{-1}$] population were recorded respectively at 2130 and 1830 hrs. Mean density of chaetognaths was 2.2 times more during night than the day collections. *Sagitta bedoti* was the dominant species in the collection contributing to the bulk of the population (95%). The other species, *S. enflata* and *S. pulchra*, were restricted to the flood period. However, the lowest density was represented entirely by *S. bedoti*.

Hydromedusae: Frequency of occurrence of this group was 72.22%. However, the percentage composition of medusae was negligible (0.004-0.31%) and they were often absent during the ebb period. The maximum population density [78.(100 $\text{m}^3\text{)}^{-1}$] was recorded at 2130 hrs during flood period, whereas stray individuals [1.(100 $\text{m}^3\text{)}^{-1}$] were observed at 1430 to 1630 and 0330 hrs. Mean population of hydromedusae was 1.95 times more during the night than the day samples. Nine species of medusae were recorded, of these, *Euphysora* sp., *Solmundella bitentaculata* and *Streenstrupia bigelowi* were relatively more common.

Decapods: Percentage of prevalence of decapod larvae was 88.89%. Their percentage composition varied from 0.74-61.15% of the total zooplankton (Fig. 3). The common groups of decapods were zoea of *Brachyura* and *Porcellanidae*, alpheids and

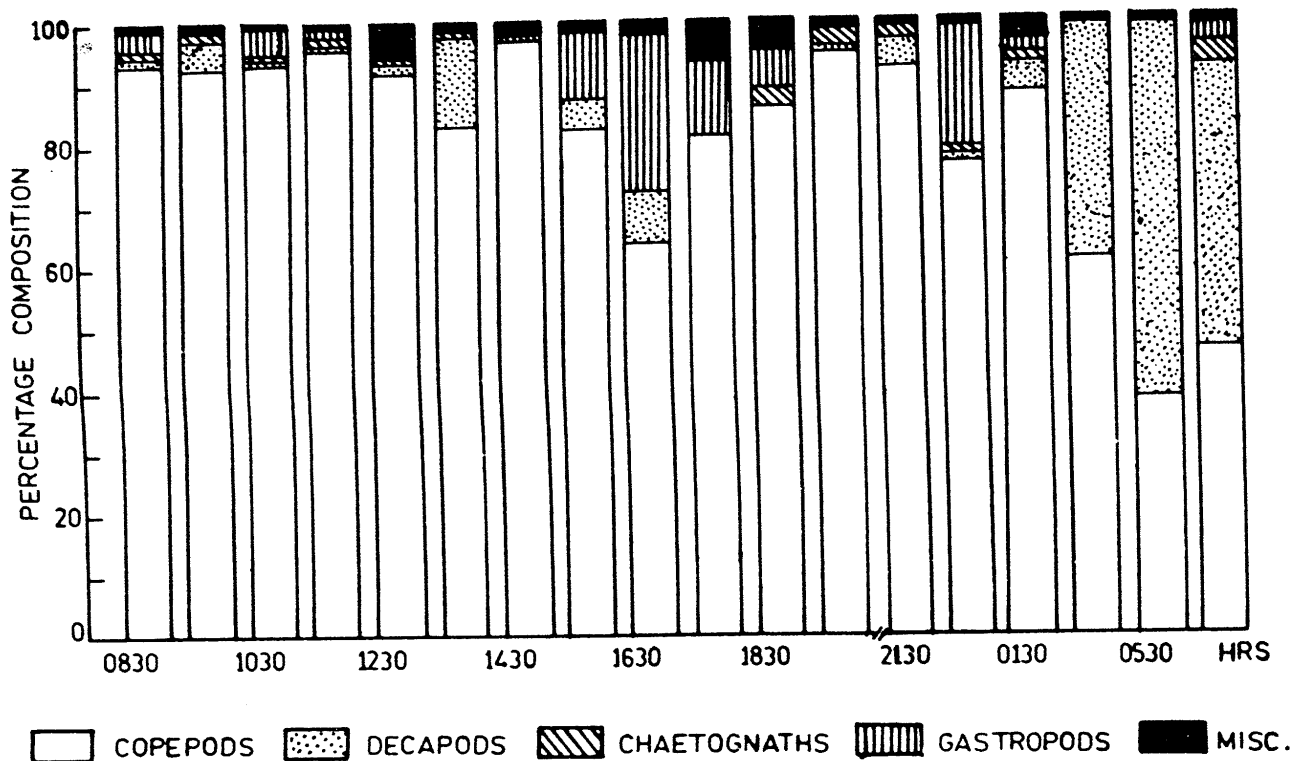


Fig. 3—Variations in percentage composition of zooplankton at Malad creek

palemonids. The highest density [$18475.(100\text{ m}^3)^{-1}$] was noticed at 1530 hrs represented by the brachyuran zoea (95%) and larvae of Palaemonidae (5%). The density was lowest [$4.(100\text{ m}^3)^{-1}$] at 1930 hrs solely represented by palaemonids (100%). During the night their density was usually very high and the average population for the night was 11.76 times more than that observed for the day.

Lucifers were represented by the single species *Lucifer hanseni* contributing 11.11% of the total count. The percentage composition of this species varied from 0.003 to 0.011.

The genus *Acetes* was represented by the single species *Acetes indicus* contributing 0.04-0.5% of total zooplankton. The frequency of occurrence of this species was 16.57% and the highest density [$125.(100\text{ m}^3)^{-1}$] was recorded at 2130 hrs.

Mollusca: Molluscs were represented by larval forms of gastropods and lamellibranchiates. Their frequency of occurrence was respectively 94.40% and 16.67%. Gastropods contributed 0.05-25% of the total zooplankton. The highest [$7115.(100\text{ m}^3)^{-1}$] and lowest [$4.(100\text{ m}^3)^{-1}$] population densities were recorded at 2330 and 1930 hrs respectively. Average density of gastropods during night was 2.23 times more than the day collections: The contribution of lamellibranchiates was 0.01-1.16% of the total

zooplankton and their incidence was limited to the samples collected during day.

Polychaetes: Polychaetes were represented by *Nereis* sp. and *Tomopteris* sp. The frequency of occurrence of the group was 33.33% and the percentage composition varied from 0.003-0.86%.

Mysids: Mysids were dominated by *Mesopodopsis zeylonica*. The percentage composition of mysids was 0.03-0.53% of the total zooplankton. Their frequency of occurrence was 61.11%.

Siphonophores: The frequency of occurrence of siphonophores was 55.5%. The percentage composition of this group varied from 0.01 to 2.28%. Their highest population density [$62.(100\text{ m}^3)^{-1}$] was recorded at 2330 hrs.

Ostracods: The ostracods were represented by the single species *Cypridina dentata* and higher density was recorded during night collection. The frequency of occurrence was 44.44%.

Fish eggs and larvae: The frequency of occurrence for fish eggs and larvae were 44.44 and 61.11% respectively. The density of fish eggs and larvae was very poor contributing 0.01-2.61% and 0.003-0.43% respectively of the total zooplankton. They were usually absent during ebb tide.

Miscellaneous groups: The other groups rarely encountered in the samples were ctenophores, stomatopods, appendicularians, isopods, amphipods,

cirripede larvae, cumacae, salps, cladocerans and insect larvae. Of these, percentage composition of ctenophores varied from 0.003-0.04% with the maximum population density [$2(100\text{ m}^3)^{-1}$] recorded at 0330 hrs. Appendicularians were dominated by the genus *Oikopleura*. Their frequency of occurrence was 44.4%. Stomatopods were represented by Alima larvae of squilla and the percentage of prevalence was only 16.67%. The percentage composition of isopods, amphipods, cirripede larvae, cumacae, salps, cladocerans was very low.

Mean biomass of zooplankton during the period of study was 3.4 ml. $(100\text{ m}^3)^{-1}$ and the value is comparatively lower than that reported off Malad creek⁹. Biomass, total population and diversity of various groups of zooplankton increased during the flood tide and decreased during ebb tide attaining the minimum values during the peak ebb period. In the nearshore waters off Thal, shoreward increase in zooplankton during the flood period and reverse trend during the ebb period were observed¹⁰ while no significant effect of tides was recorded in Cochin backwaters².

Zooplankton population was invariably high during the night collections (Fig. 2) and this was reflected on the species composition. *Acrocalanus inermis*, *A. gracilis*, *Labidocera pectinata*, *Canthocalanus pauper*, *Paracalanus parvus*, *Acartia pacifica*, *A. plumosa*, *Oithona* sp., *Idyaea* sp., *Acetes* sp., *Cypridina dentata* and *Sagitta pulchra* were recorded only in the night collections. Groupwise populations of most of the groups were more during the night time showing an increase of 2.2 to 43 times than that recorded for the day. Mature individuals of *S. bedoti* were caught only during the night samples.

Associated with the phase of the tide there was significant variation in the representation of various species/groups. Euryhaline copepod species *Acartia spinicauda*, *Acrocalanus similis* and *A. gracilis* were more abundant during ebb tide whereas *Acrocalanus inermis*, *Cyclops buxtoni*, *Laophonte* sp. and *Idyaea* sp.

were obtained only during ebb tide. The chaetognath species *S. bedoti* alone could tolerate the ebb conditions of the creek mouth. Fish larvae and stomatopod larvae were obtained only during the flood period. Preference of appendicularians to the creek water was quite significant.

The overall pattern of diel rhythm of zooplankton in the Malad creek is directly linked to the tide and other environmental parameters. In the nearshore waters variations in the environmental parameters are greatly influenced by the tide. However, in a polluted environment the adverse conditions will affect the water quality leading to significant variations in the disposition of zooplankton.

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