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CILIATES AND OTHER MICROORGANISMS IN THE PLANKTON FROM AL-SAMMALIAH ISLAND- ARABIAN GULF-UNITED ARAB EMIRATES

By

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ABSTRACT

Al-Sammaliah Island is one of more than 200 islands belonging to United Arab Emirates in the Arabian Gulf. This inshore shallow island lies at the north east coast of Abu Dhabi and is connected to the Arabian Gulf through Khor Laffan. It has a surface area of about 24 km^2.

The abundance of ciliates at Al-Sammaliah Island water showed an annual cycle with the highest numbers (23 ml^{-1}) in the spring, and the lowest values (5 ml^{-1}) in the summer. The ciliate community generally was dominated by non-loricate oligotrichs, tintinnids. Other planktonic forms also in abundance. Nanoflagellates that could provide a food supply for the filter - feeding ciliates were especially numerous in the spring, but this was not the case for bacteria. The high populations of ciliates and flagellates reflect the productivity of the water column of the island while the production of bacteria will presumably be the important component at the base of the food chain at the island water.

Total nanoflagellates, heterotrophic nanoflagellates and bacteria were enumerated to gain some indication of the food resources for ciliates. In this connection the filtration activities of the heterotrophic flagellates and ciliates are compared with the population densities of bacteria, flagellates and filterfeeding ciliates. The time required for the whole water body to be filtered by flagellates and ciliates was estimated.

INTRODUCTION :

United Arab Emirates (UAE) has many islands on the Arabian Gulf. The exact number of these islands is not known, because some of them are too small to appear on the largest scale topographic maps, or are liable to complete or partial submergence, so that they might be hidden under sea water or be divided temporarily by tidal water into two or more smaller, separate islands. The largest of UAE islands is "Abu Al-Abyad", with a maximum length of 35 km and a maximum width of 12 km, while the smallest one is "Zarkud Island" which lies in the western part of the Arabian Gulf and doesn't extend for more than several hundreds of meter in any direction.

United Arab Emirates Islands can be classified into three categories according to their origin. These are: 1) barrier islands, 2) salt dome islands and 3) submerged hill islands. Barrier islands are the most numerous and widespread. They differ in size and shape according to depositional environment, but they are most recently formed and all are low islands rising only a few meters above sea level. Salt dome islands are usually circular or elliptic in shape and they are comparatively high islands, varying between 46 and 160 meters in height. Submerged hill islands are tiny rocky islands. They have shapes, heights and slopes similar to the adjacent features of the main land. This similarity suggests that they were separated from the adjacent land by a rise in sea level. For this reason they are called "submerged hill islands". A study of the flora and fauna of Al-Sammaliah Island is valuable for its own sake to explore its composition for purposes of exploitation and conservation. However, the lack of information, especially concerning Al-Sammaliah Island is very regrettable bearing in mind the islands importance as recreational, commercial and heritage area.

In this study, the author followed the changes in abundance of ciliates throughout one year of sampling and followed changes in community structure to learn more of the characteristics of ciliate populations. This area was to find, whether these ciliate forms formed suitable conditions at the island waters. The abundance of flagellates & bacteria and following changes in chlorophyll a were estimated to gain information of the trophic relationships of ciliate communities in the island.

MATERIALS AND METHODS

STUDY AREA

Al-Sammaliah Island (Fig. 1) is one of the UAE inshore islands in the Arabian Gulf. It belongs to that group of barrier islands. It lies in the Arabian Gulf, north to Umm Al-Nar Island and with a distance of 12 km to the north East Coast of Abu Dhabi. Al-Sammaliah Island is surrounded by a group of islands viz. Balrimayd Island from the west, Umm Al-Yihal Island from the east. Umm Al-Nar Island from the south and unidentified island from the north. It is elliptic flat island with an undulating surface. It has neither sand dunes nor rocky hills with one exception of the presence of few rocky out crops in a small area at the southeastern bank of the island. Its sandy soil is generally salt with a variable percentage of salt.

The maximum length of this island is about 8 km while the maximum width is about 3 km to give a total surface area of 24 km^2. Its average depth is about 5 m, while its maximum depth is about 13 m. Its sandy shores are moderately interrupted by rocky hills. Bottom of the island is usually sandy with black mud and free from natural and/or artificial reefs. The water current is usually wind driven while the fluctuation in the water level in the island is usually tidal.

Inter-tidal fauna of Al-Sammaliah island coasts tends to be rich of Mollusca and Crustacea. Seashells and brachyuran crabs lead the inter-tidal fauna at Al-Sammaliah Island; they are abundant in both species and individuals. On the other hand, trees of the mangrove *Avicennia marina* are distributed extensively along the coasts of the island.

SAMPLES COLLECTION

Sampling was carried out monthly from September 1996 until August 1997. On each sampling visit three separate samples of 800 ml each were collected from a depth of about 15 cm in glass jars closed by plastic tops. Sampling was carried out during daytime high tide and between 18:00 and 20:00. Sub samples (180 ml) were fixed with Lugol's lodine solution for enumeration of microorganisms. Lugol's Iodine solution (Throndensen 1978) to a final concentration of 1%. Ciliates in the Lugol's fixed samples were identified after settlement by the Utermohl method (Utermohl 1958). The settled planktonic ciliates were examined with a Wild M40 inverted microscope (with phase contrast) at a magnification of 400 x. The settled sample was scanned and all ciliates were identified to the genus level. With three sub-samples examined per bottle and three bottles per collection, there were nine replicate counts per sample; the counts were expressed as numbers per liter of water. The live ciliates were counted within 2 hours of collection. Three sub-samples of 6 ml each were taken from each bottle and placed in a Bogorov counting chamber. The live ciliates were counted under a stereomicroscope at a magnification of x 25-50.

A further 100-ml was taken from each bottle of well mixed sample and fixed with 10 ml of 25% glutaraldehyde (filtered through 0.22 μm Millipore filter). Two 2-ml sub-samples of each thoroughly mixed glutaraldehyde-fixed water sample were taken to estimate the numbers of bacteria, nanoplanktonic flagellates and autotrophic flagellates. Each sub-sample was separately mixed with 0.6 ml of 0.3% DAPI (4,6 diamidino-2-phenylindole (Sigma) stain (Porter and Feig 1980). The counts were made in 20 microscope fields under an Olympus BH-2 microscope fitted with a reflection fluorescence attachment. There were 6 replicate filters per each sample.

The chlorophyll *a* content of the water was also measured according Parsons *et al.* (1984). The temperatuer of the water was immediately measured with a thermometre calibrated to 0.1 °C. Also, salinity of samples was routinely measured by titration against standard silver nitrate and periodically cross-checked with a salinometer bridge.

RESULTS

The three chosen sites were broadly similar to one another, as revealed by their similar salinity, temperature regime, chlorophyll *a.* So, mean values of water temperature, salinity and chlorophyll *a* at the surface water in Al-Sammaliah Island are shown in Figure (2). The temperature had a clear trend reflecting expected seasonal variations with a lowest value of 19 °C in the winter months (January) and highest value of 35.7 °C in late summer (August). The salinity values recorded through the study period fluctuated within the ranges of 33.2 and 43‰ Measurements of chlorophyll *a* concentrations in water samples varied seasonally as shown in Figure (2 c). The highest levels being found between February and April (2 - 3 µg/l), while the lowest values were recorded between July and September with values ranged between 0.1 and 0.5 µg/l.

The taxonomic composition and seasonal abundance of the ciliate, flagellate and bacterial communities at the three sites were broadly similar to each other. A total of 11, 15 genera of ciliates were recorded during the present study (Table 1). The monthly variation in abundance of ciliates in the surface waters of Al-Sammaliah Island is shown in Figure (3). Live counts and those from fixed samples taken from the same collection were similar throughout, the differences were monthly less than 7%. The ciliate populations were higher during late winter and early spring with highest values recorded between February and March. In almost every month the non loricate oligotrich ciliates *Lohmaniella* and *Strombidium* (in similar numbers) were the largest in number . The predatory *Didinium* formed a significant proportions of the ciliate community in several months, but its populations varied erratically. Loricate tintinnids (mainly *Favella* and *Tintinnopsis*, with some *Helicostomella* and few *Stenosmella*) were present in almost every sample, reaching their highest numbers in February, March and April. Hypotrichs (*Euplotes, Uronychia, Diophrys* and few *Litonotus*), typical benthomic, were generally present in these samples.

The density of heterotrophic nanoflagellates is shown in Figure (4-a) with maximum values of 25 x 10^3 cells/ml during *September.* The numbers of autotrophic flagellates Fig. 4-b were in order of magnitude lower than the numbers of heterotrophic forms (Fig. 4-b) with lowest number of 0.1 x 10^2 during August and highest number of 20 x 10^2 cells/ml during March.

Fluctuation in the abundance of bacteria at the surface water of Al-Sammaliah Island through the year (Fig. 4-c) followed the same general trends as those of ciliate numbers with highest values of 5 x 10^5

cells ml^{-1} and lowest values of 0.09 x 10^5 recorded during March and August respectively.

DISCUSSION

Chlorophyll *a* levels indicate photosynthetic activity in the water column at Al-Sammaliah Island, and it will be necessary to find out what contributes. The number of autotrophic flagellates in participating with high density of phytoplankton which may be enhanced by increased organic matter from mangrove trees and by the high sun radiation can only be a part of the answer. As it is of interest to report that this research area has a daily solar radiation averages ranging between a minimum of around 180 wh/m^2 (in December) to a maximum of around 250 wh/m^2 (in June). However, it is unlikely that phytoplankton growth is light-limiting (Nypkinn 1993).

The annual cycle of ciliate population with a spring maximum and summer minimum, is typical of subtropical coastal area and contradict with temperate coastal waters of summer maximum and winter minimum (Fenchel 1987 and Verity 1987). The mean abundance of ciliate community observed at Al-Sammaliah Island during the period September 1996 August 1997, may be conveniently compared with estimates from other water sites such as central tropical Indian Ocean (Sorokin *et al.* 1985), western Indian Ocean (Moiseyev 1986) and southern California (Beers *et al.* 1980). However, the peak ciliate abundance of 23000/l observed at Al-Sammalih water was, however higher than peaks recorded at the previously mentioned sites with ciliate abundance of 3000/l observed at western and central tropical Indian Ocean and 16000/l observed at southern California. On the other hand, the peak ciliate abundance of the present study was less than that recorded at the Gulf of Main, USA with peak ciliate abundance of 54000/l. Eventually, considerable differences between populations of ciliates are likely to be according to the difference in environmental conditions. The taxonomic composition of the heterotrophic ciliate community found at Al-Sammaliah Island was similar to that found in other comparable sites, with *Tintinnopsis* and *Favella* as the dominant tintinnid genera and *Lohmaniella* and *Strombidium* as the dominant non-loricate genera (e.g. Smetacek 1981, Revelant and Gilmartin 1983 & 1987, Verity 1987, Dale and Dale 1987and Abd El-Rahman 1993).

Bacterial population densities at Al-Sammaliah Island water with values of 0.09-5 x 10^5 ml^{-1} are lower than those of other coastal marine areas, for examples: Southern California Bight (0.06-2.1 x 10^6 ml^{-1} (Fuhrman and Azam 1980); Cape Lookout USA (0.5-0.81 x 106 ml^{-1}) (Ferguson and Rublee 1976); English Channel (0.23-0.59 x 10^6 ml^{-1}) (Linley *et al.* 1983); Celtic Sea (0.28-0.59 x 106 ml^{-1}) (Linley *et al.* 1983). On the other hand, bacterial population densities at Al-Sammaliah Island water were similar to that recorded in neighbouring areas on the Arabian Gulf with 1.4-6.4 x 10^5 ml^{-1} at Dubai; Sharjah and Ajman Emirates of United Arab Emirates (Abu-Hilal *et al.*

1994) and with 0.5-7.8 x 10^5 ml^{-1} at coastal and creek waters of northern UAE (Banat *et al.* 1993).

The numbers of heterotrophic nanoflagellates at the island water with values of 0.5-25 x 10^3 ml^{-1} are similar to those recorded in other coastal areas. Caron (1983) reported populations of heterotophic nanoflagellates between about 2 x 10^2 and 3 x 10^3 ml^{-1}, with lower values in open sea and higher values at inshore waters. Autotrophic nanoflagellates were generally less than 10% of the total nanoflagellate numbers. These autotrophs are probably a minor component of the food web, but the mixotrophd among them may have an advantage in the sediment-laden waters of the island. They are less numerous in the island water than in the nearshore water sampled by Caron (1983).

These small microorganisms were investigated to gain some indication of the food resources for ciliates. In this connection the filtration activities of the heterotrophic flagellates and ciliates, with the population densities of bacteria, flagellates and filter feeding ciliates in April and August at the island waters were compared in Table (2). Filtration rates from the literature are used to calculate the potential rate of capture of prey of different categories, and the time required for the whole water body to be filtered by flagellates and ciliates. It is clear from Table (2) that the high populations of nanoflagellates filter the whole body of water every 3 hours in spring. So, bacteria must be reproducing quickly to maintain their populations, or there must be a continuous and very active recruitment of bacteria into the plankton from sediments and surfaces.

The number of bacteria that may be caught per flagellate per hour is very small even in April. Fenchel (1982) calculated a maximum ingestion rate of 27-254 bacteria/flagellate/hour and Sherr *et al.* (1983) found ingestion rates of 10-75 bacteria/flagellate/hour. Thus, the flagellate population of Al-Sammaliah Island might not be able to maintain itself with this very low ingestion rate (4 bacteria/flagellate/hour) unless it might be suggested that island bacteria could be so large, that few of them would be sufficient sustain the flagellates.

The ciliates could be consuming bacteria. Flagellates more likely form a food source, and presumably a more "attractive" in view of much greater nutritive value and the coarser filter required (Fenchel 1987). The population of filter-feeding ciliates in the island water during April is large enough to filter the whole water body twice a day, and a ciliate could catch enough flagellates to provide ordinary growth and maintenance of an average oligotrich. Nevertheless the possible food capture rate per ciliate in August gives less scope for growth. It is conceivable that the balance must depend on the relative sizes of the organisms involved (Rassoulzadegan *et al.* 1988).

In conclusion, the high populations of flagellates and ciliates suggest that the water column at Al-Sammaliah Island water is productive especially during spring months and the production of bacteria will presumably be the most important component at the base of the food chain at this island.

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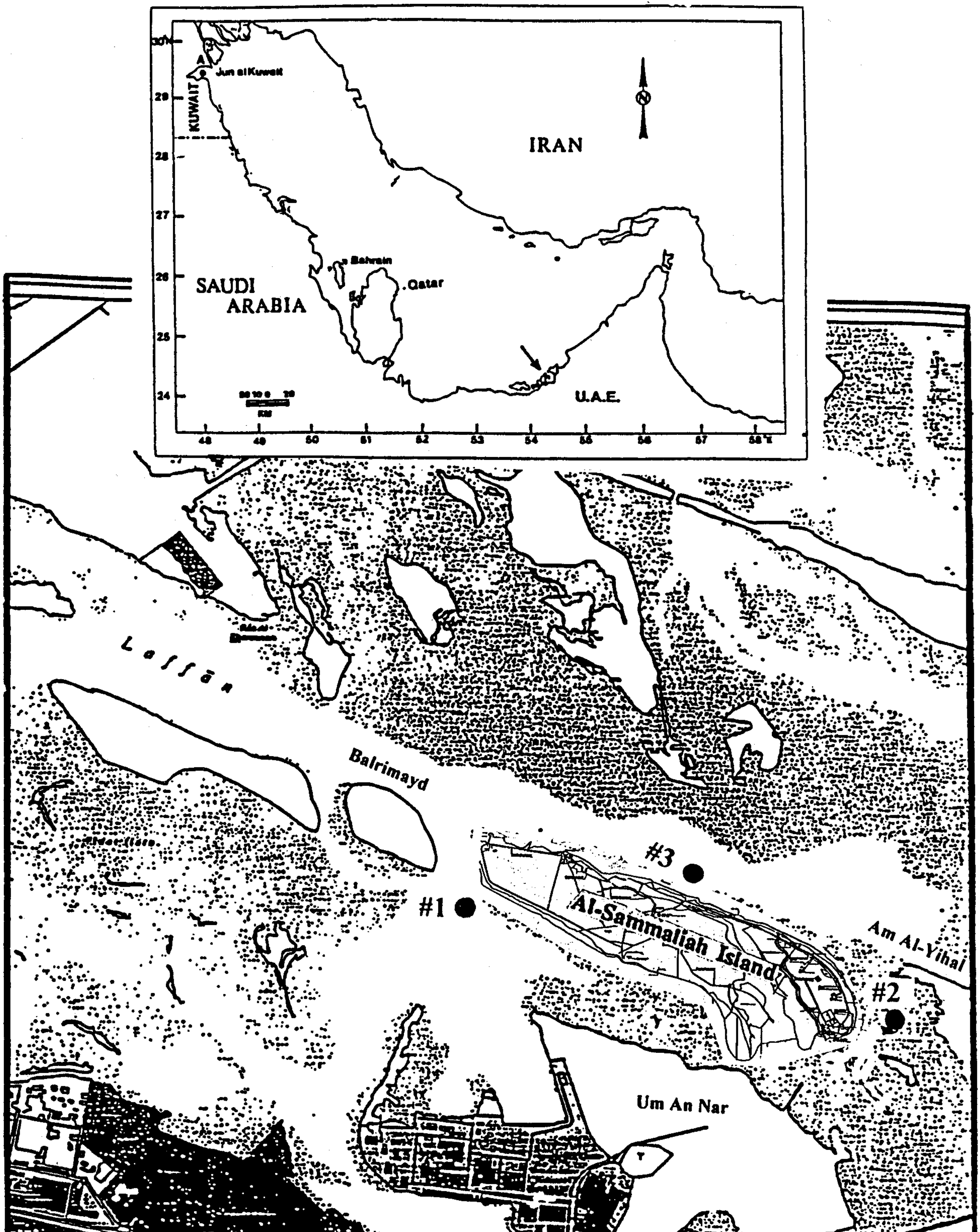

Fig. 1- A map showing the position of Al-Sammaliah Island and sample collection sites. Scale 1:60000

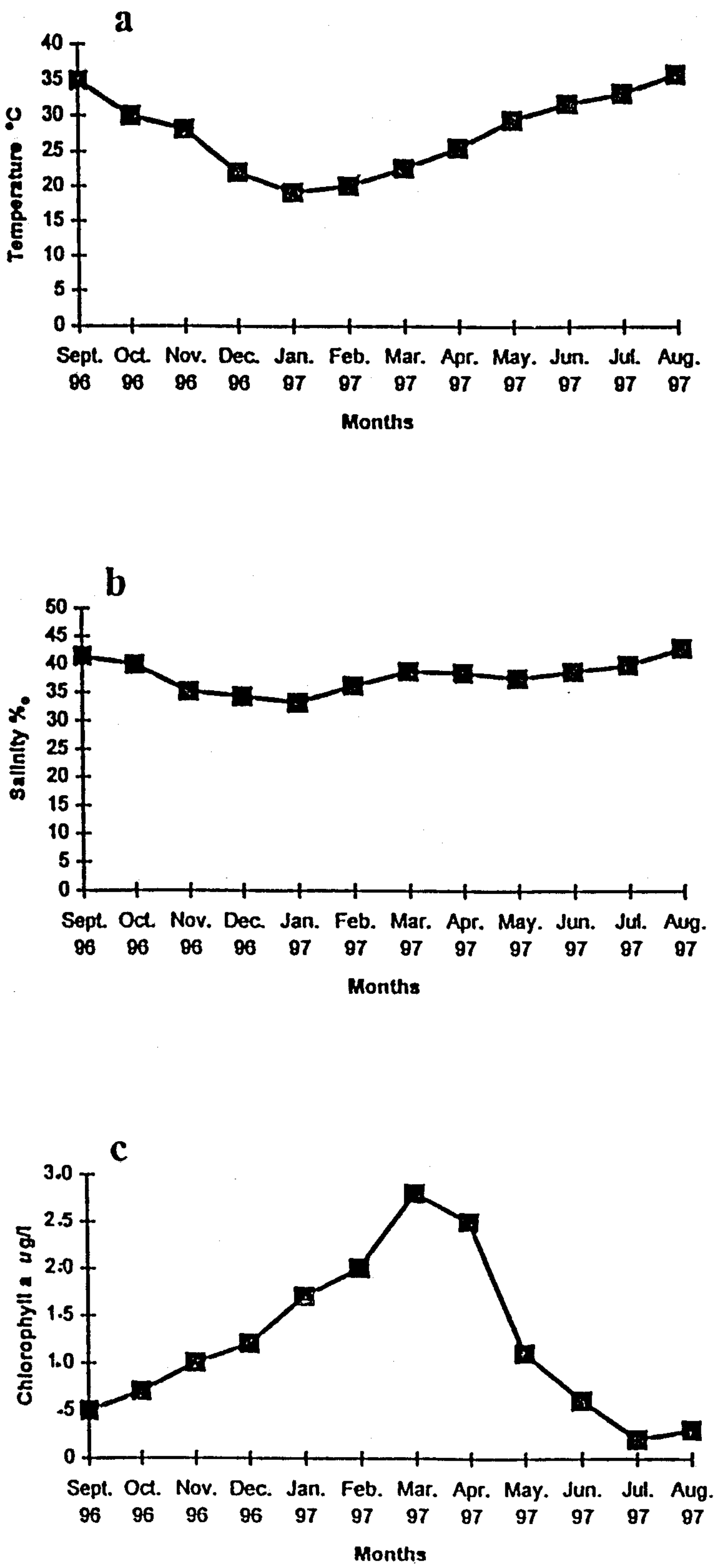

Fig. 2: Measurements made on samples collected in the period from Sept. 96-Aug. 97.
a- Mean temperature; b-Mean salinity; c- Mean chlorophyll a values.

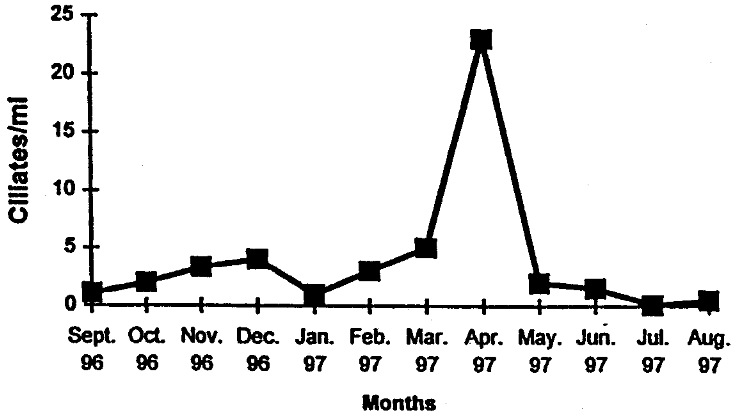

Fig. 3 : The monthly mean population density of ciliates in the samples from the surface water.
The standard error ranged from < 1 cell/ml for small values to 5 cells/ml on high values.