NOTES

QUANTITATIVE INDICES OF PHYTOPLANKTON IN A BAR-BUILT ESTUARY

ABSTRACT

Bimonthly observations on cell density and distribution indices of phytoplankton were made at Thengapattanam estuary (8°12'-8°21' N;77°8'-77°15'E) in the south west coast of India. The system was marked by the near total elimination of salinity in the monsoon and strong vertical salinity stratification in pre-monsoon season. Phytoplankton cell density in the study sites varied between 5.2 and 52.6 × 10^3 cells/m^3. Blooms or single species dominance was not recorded. Phytoplankton species diversity index varied between 1.72 and 5.01; Species Richness Index between 0.55 and 5.86; Species Evenness Index fluctuated from 1.4 to 2.96. Phytoplankton similarity Index was studied for the whole group. Salinity distribution and mixing apparently played a crucial role in phytoplankton cell density and diversity in the estuary.

PHYTOPLANKTON community structure and dynamics in estuaries are generally analysed by several methods. The quantitative indices offer an effective tool in understanding their organisation (Margalef, 1967). Indices such as diversity, richness, evenness and similarity are useful in the critical appreciation of the distribution of plankton populations in space and time. Though detailed reports are available on spatial and temporal changes in phytoplankton indices in typical estuaries of peninsular India (Chandran, 1985; Jagadeesan, 1986; Devassy and Goes, 1988), information available on temporary estuaries is meagre. To fill this gap an annual study on plytoplankton indices was carried out in Thengapattanam estuary during 1991.

One of the authors (K.V.) gratefully acknowledges the award of Teacher Fellowship by the University Grants Commission and the technical assistance offered by Mr. S. Arockiasamy, SRF, C.A.R.E.

Study area: The Thengapattanam estuary (8°12'–8°21' N'77°8'-77°15'E) is situated at the south west coast of India. The estuary runs through a stretch of 7.2 km and is formed by the confluence of river Thamiraparani (Kanyakumari District) at Thengapattanam. The system remains closed to tidal influx during summer and certain periods during post and premonsoon seasons.

The present study was carried out at four sites based on preliminary investigations (Vareethiah, 1989). Station 1 was fixed at Mankad, representing the head of the estuary (fresh water zone); station 2 and 3 were fixed at Ganapathiyankadavu and Vykalloor respectively representing the tidal zone and station 4 was fixed at Erayumanthurai about 0.4 km ahead of the estuary mouth.

Material and methods: Salinity was monitored for the surface and bottom waters following standard method (APHA, 1978). Regular bimonthly collections were made with No. 25 nylon net (mesh width at 55μm) fitted with a T.S.K. flow meter. Nanoplankton were accounted for by collecting 20 ml of water sample from each station subjecting the same to centrifugation at 1500 to 2000 rpm for 15 to 30 min. By repeated removal of supernatant water the volume was brought to 1/30th of the original volume. Plankton analysis was done with standard keys. Population density and species diversity of phytoplankton was determined by analysis of aliquotes of 25-40% of the sample for common forms and the entire sample for rare groups.

Indices:

Species Diversity Index (H')

Shannon Weaver information index (Mac Arthur, 1965) was employed to determine:

Species Diversity Index (H'):

$H' = -\Sigma\ pi\ \log_2\ pi.$

where H' is the Species Diversity Index and pi is the proportional abundance of species.

Species Richness Index (Gleason, 1922)

Species Richness = S-1 / ln N

where S is the number of species and ln N is the natural logarithm of the total number of individuals.

Species Evenness Index (Pielou, 1966)

Evenness = H! / log S

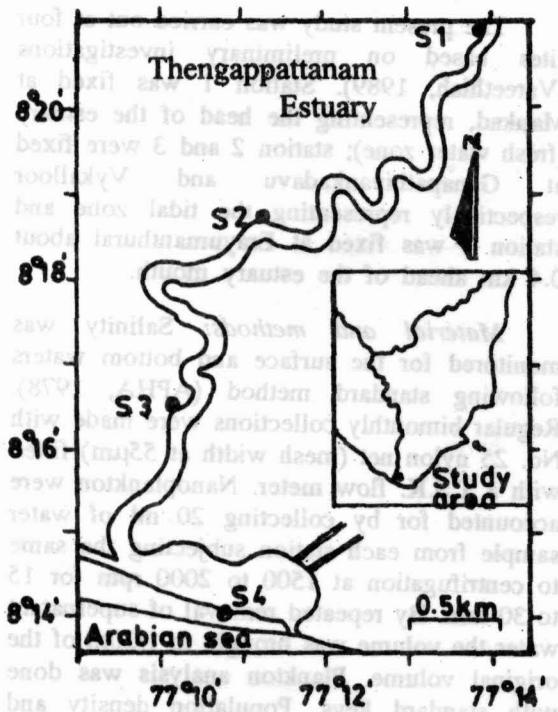

FIG. 1. Location of Stations

where H! is the species diversity and S is the number of species.

Similarity Index (Sorenson, 1948)

S.I. = (2c / a+b) × 100

Where 'a' equals number of species at station X and 'b' number of species at station Y and 'c' number of species common to both stations.

RESULTS AND DISCUSSION

Salinity: Salinity in the surface water showed annual variations between 0 and 0.7‰ at station 1, 0.2 and 2.06‰ at station 2, 0.3 and 6.8‰ at station 3 and 0 and 7.7‰ at station 4; variations in bottom waters were between 0 and 3.4‰ (station 1), 0.3 and 20.2‰ (Station 2), 0.5 and 21.6‰ (Station 3) and 2.1 and 26.8‰ (Station 4). (Fig. 1). The pre-monsoon season was marked by highest mean salinity and minimum fluctuation due to stagnancy. Haloclines were prominent features of this season. During the monsoon and postmonsoon seasons the estuary manifested minimum salinity, marked temporal variation and poor satisfaction owing to heavy land drainage and tidal influence.

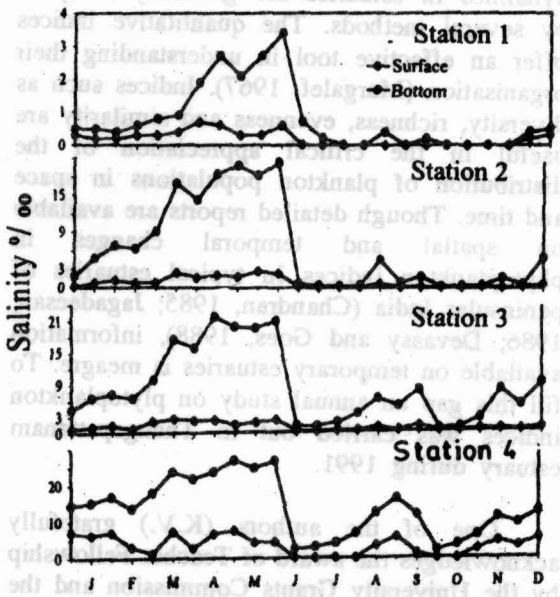

FIG. 2. Salinity changes (‰) in the estuary during 1991.

Phytoplankton cell density: Phytoplankton cell numbers in the estuary evinced annual variations as follows:

Station 1 (fresh water zone): 8×10^3 -41.1×10^3 cells/m^3; station 2 (tidal zone) 8.1×10^3 -$40.4x^3$ cells/m^3 and station 3 (tidal zone) 9.2×10^3 - 52.6×10^3 cell/m^3 and station 4 (gradient zone) 5.2×10^3 - 51.6×10^3 cells/m^3 (Fig. 2).

Station 3, the lower reaches of the tidal zone, recorded maximum mean cell numbers and station 1 (fresh water zone - head of estuary) minimum value. Poor cell density and marginal temporal fluctuations were

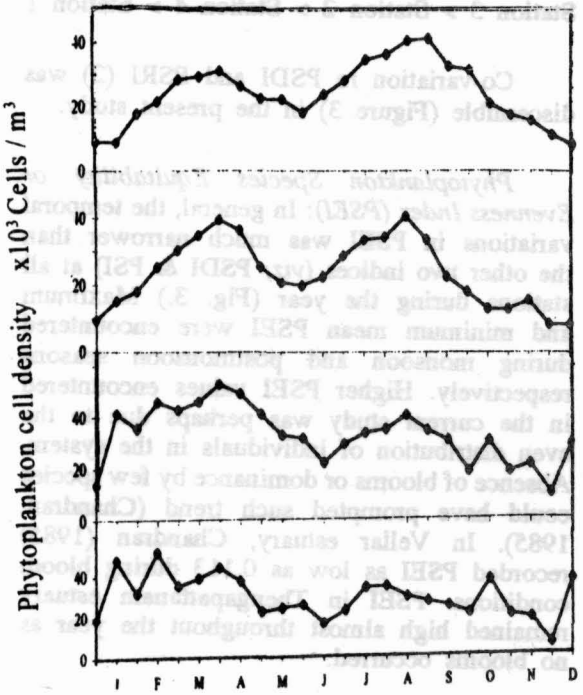

FIG. 3. Phytoplankton cell density (x 10^3 cells / m^3) in Thengapattanam estuary during 1991.

characteristic features of the estuary. Annual variations in cell density showed a bimodal pattern: early pre monsoon season recorded the primary maximum with highest counts in all stations and the late post monsoon season showed the secondary maximum (Fig. 2). None of the encountered species reached blooming proportion during the year.

Among the 101 taxa recorded in the estuary very few species were present in sizeable numbers. Following were the most numerous forms encountered seasonwise:

PREMONSOON: *Coscinodiscus centralis, C. oculo-iridis, Fragilaria oceanica, Leptocylindrus danicus, Navicula membranacea, Nitzschia bilobata, N. closterium, Rhizosolenia imbricata, Schroderella delicatula, Skeletonema costatum, Thalassionema nitzchioides, Ceratium furca, C. fuses, Chaetoceros macroceros, Trichodesmium erythraeum and* fresh water algae *Anabaena sp. and Oscillatoria sp.*

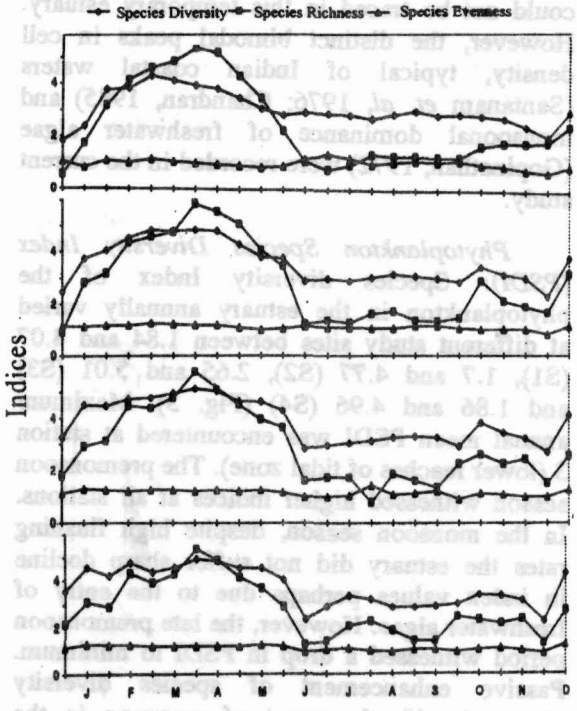

Fig. 4. Phytoplankton Species Diversity (PSDI), Species Richness (PSRI) and Species evenness (PSEI) indices in Thengapattanam estuary during 1991.

MONSOON: Fresh water algae *Anabaena sp., Nostoc sp., C cillatoria sp., Pediastrum sp., Spirogyra sp., Spirulina sp., Ulothrix sp., and Volvox sp.*

POST-MONSOON: *Bellerochea malleus, Coscinodiscus centralis, C. marginatus, Coscinodicus sp., Fragilaria oceanica, Leptocylindrus danicus, Navicula membranacea, Nitzschia bilobata, Skeletonema costatum, Thalassionema nitzchioides* and fresh water algae *Anabaena sp., and Spirogyra sp.*

Phytoplankton cell density and its seasonal variation in estuaries are affected by factors like availability of nutrients, salinity and products of land drainage (Harris, 1986); sinking

rates of plankton, predation and the availability of micronutrients also influence seasonal scale. The post-monsoon rise in cell density characteristic of major Indian estuaries (Qasim and Kureishy, 1986; Devassy and Goes, 1988) could not be traced in this temporary estuary. However, the distinct bimodal peaks in cell density, typical of Indian coastal waters (Santanam *et. al,* 1976; Chandran, 1985) and monsoonal dominance of freshwater algae (Gopinathan, 1972) were recorded in the current study.

Phytoplankton Species Diversity Index (PSDI): Species diversity Index of the phytoplankton in the estuary annually varied at different study sites between 1.84 and 4.07 (S1), 1.7 and 4.77 (S2), 2.65 and 5.01 (S3) and 1.86 and 4.96 (S4) (Fig. 3). Maximum annual mean PSDI was encountered at station 3 (lower reaches of tidal zone). The premonsoon season witnessed higher indices at all stations. In the monsoon season, despite high flushing rates the estuary did not suffer sharp decline in index values perhaps due to the entry of freshwater algae. However, the late premonsoon period witnessed a drop in PSDI to minimum. Passive enhancement of species diversity observed with the onset of monsoon in the present study soon dropped (Margalef, 1967). Unlike the west coast estuaries like the Mandovi-Zuary systems (Devassy, 1983), salinity failed to enhance PSDI.

Phytoplankton species Richness Index (PSRI): The PSRI annually varied between 0.55 and 5.41, 0.87 and 5.86, 1.36 and 5.8 and between 1.24 and 5.33 at stations 1, 2, 3 and 4 respectively (Fig. 3). As with PSDI, station 3 (lower reaches of tidal zone) manifested maximum mean PSRI. Seasonal mean PSRI may be placed in the following order:

Premonsoon > Postmonsoon > Monsoon

On the spatial scale the PSRI indices diminished in the following order:

Station 3 > Station 2 > Station 4 > Station 1

Co-variation in PSDI and PSRI (2) was discernible (Figure 3) in the present study.

Phytoplankton Species Equitability or Evenness Index (PSEI): In general, the temporal variations in PSEI was much narrower than the other two indices (*viz;* PSDI & PSI) at all stations during the year (Fig. 3.) Maximum and minimum mean PSEI were encountered during monsoon and postmonsoon seasons respectively. Higher PSEI values encountered in the current study was perhaps due to the even distribution of individuals in the system. Absence of blooms or dominance by few species could have prompted such trend (Chandran, 1985). In Vellar estuary, Chandran (1985) recorded PSEI as low as 0.113 during bloom conditions. PSEI in Thengapattanam estuary remained high almost throughout the year as no blooms occurred.

Phytoplankton Similarity Index (PSI) : In the regular biomonthly collections dinoflagellates displayed low species number and hence PSI was computed for the whole sample and the analysis was based on annual data. PSI between any pair of study sites were fairly above 90%. Among the four stations highest PSI was encountered between the freshwater dominated station (stations 1 and 2) which was followed by the mouthward stations (stations 3 and 4). Uniform hydrographic conditions that prevailed in the estuary perhaps caused such high PSI values (Santhanam *et. al.,* 1976).

Centre for Aquaculture Research and Extension,
St. Xavier's College,
Palayankottai-627 002, S. India.

K. VAREETHIAH*
M. A. HANIFFA

**Present Address* : Dept. of Zoology, St. Jude's College, Thoothoor 629 176, S. India

REFERENCES

APHA. 1978. Standard methods for the examination of water and waste water. 17th Edn. American Public Health Association, Washington D.C.

CHANDRAN, R. 1985. *Mahasagar* **18** (1) : 37-48.

DEVASSY, V. P. 1983. Ph.D. Thesis. Univ. of Kerala. *pp.* 272.

DEVASSY, V. P. AND J. I. GOES 1988. *Est. coast. shelf. Sci.*, **27**: 671-685.

GLEASON, H. A. 1922. *Ecol.* 3:156-162.

GOPINATHAN, C. P. 1972. *J. mar. biol. Ass. India.* 14 (2): 568-577.

HARRIS, G. P. 1986. Phytoplankton ecology: structure, function and fluctuation. Chapman and Hall.

JAGADEESAN P. 1986. Ph. D. Thesis. Annamalai Univ. p. 277.

MAC ARTHUR, R. H. 1965. Patterns of diversity. Biol. Rev. 40:510-533.

MARGALEF, R. 1967. *Oceanogr. and Mar. Biol. Ann. Review.* 5:257-299.

PIELOU, P. P. 1966. *J. Theoretical Biol.*, 13 : 131-144.

QASIM, S. Z. AND T. W. KUREISHY 1986. *Proc. Indian Acad. Sci., (Anim. Sci/Plant Sci.) Suppl.* Nov. 1986 pp 1-17.

SANTHANAM, R., K. KRISHNAMURTHY AND V. SUNDARARAJ, 1976. *Bull. Dept. Mar. Sci., Univ. Cochin.* 7 : 769-777.

SORENSON T. 1948. *K. danske Vidensk Selsk. Skr.*, 5 (4) : 1-34.

VAREETHIAH, K. 1989. M. Phil. Thesis, Madurai Kamaraj Univ. *p.* 53.

ON THE MICROALGAL SPECIES AS FEED FOR CONDITIONING ADULT OYSTER *CRASSOSTREA MADRASENSIS* (PRESTON)

ABSTRACT

The rate of removal of different microalgal cells in suspension at specific time interval in respect of six species differing in sizes such as *Tetraselmis* sp., *Cheatoceros* sp., *Chlorella* sp., *Dicrateria* sp., *Isochrysis* sp., *Chromulina* sp., by *Crassostrea madrasensis* has been studied. The study revealed that oysters exhibit a significant degree of selectivity in the rate of filtration of certain algae. Further it is recorded that the filtration rate is not uniform throughout the experimental period of 24 hours. Oysters showed periods of high filtering activity and periods of relative quiescence. This study helps in developing proper feeding protocol for oyster broods based on the species of algae, quantification of cells and timings.

MICROALGAL feeds are widely used for conditioning the broodstock of oysters and clams in the hatchery (Dupey *et al.*, 1977; Nayar *et al.*, 1987; Castagna *et al.*, 1981). Though there have been several studies on filtration and pumping rate of oysters by several authors (Loosanoff and Nomejko, 1946, Mattiessan and Toner, 1966; Pruder *et al.*, 1976; Galtsoff, 1964) the daily requirement of algal species for adult oysters has received only little attention (Epifanio and Ewart, 1977; Gerdes, 1983). Mattiessen and Toner (1966) calculated that an oyster could filter 1.1×10^9 of microalgal cells per day. Pruder *et al.*, have stated that an oyster weighing 50 g wholeweight cleared a maximum of 1.05×10^8 cells per g of wholeweight per day which would support both growth and conditioning of oysters. Epifanio (1977) and Gerdes (1983) have tried a few species of microalgae known to be good food for adult oysters to study the filtration rate and rate of removal in different concentration of algal cells, which differ markedly in size. Epifanio and Ewart (1997) have proposed a discontinuous feeding regime based on the results and formulated an equation for the maximum daily ration of oysters in respect to various sizes.

In the present study, the rate of removal of microalgal cells in suspension by the oyster *Crassostrea madrasensis* at given time intervals in respect of six species of microalgae which are available in the CMFRI Molluscan hatchery at Tuticorin has been investigated.