DYNAMICS OF SOLAR SALTWORKS ECOSYSTEM IN INDIA

T.D. SUNDARARAJ [1], M. AMBIKA DEVI[2], C. SHANMUGASUNDARAM[3] and ABDUL A. RAHAMAN

[1]Joint Director (Industries) Tamilnadu Salt Corporation Ltd.,,
735, Anna salai, Chennai-600002, India.
[2]Uniroyal Marine Exports Ltd., Calicut-673 303, Kerala, India.
[3]Resource Bio-Techs Private Ltd.,
21, Vidhya Nagar, Erode-638 009. India
e-mail : rahaman@eth.net

EXTENDED ABSTRACT

Salt pan ecosystem is highly dynamic where the organisms are subjected to vulnerable physico-chemical disturbances. The studies on ecology and distribution of *Artemia* in solar salt works have been an area of scientific interest for many years. However, relatively little is known about the ecology of Indian solar saltworks and *Artemia* strains. The present study was undertaken in two typical solar saltworks of Tamilnadu, India. In India seawater is rich in nutrients and is biologically highly productive because of eutrophication. The nutrient-rich seawater in salt works favours algal blooms in reservoirs and evaporators. Hydrobiological conditions of the solar salt works were influenced by the tidal oscillations etc. An examination of phytoplankton population revealed that the density and diversity varied in relation to salinity. Totally 31 species comprising of 25 genera were identified. The phytoplankton community consisted of Cyanophyceae, Chlorophyceae, Bacillariophyceae and Dinophyceae. The presence of *Lynbgya majuscula*, *Oscillatoria salina*, *Xenococcus acervatus* and *Pluerosigma salinarum* through out the study period indicates that they can tolerate wide fluctuations in salinity. As the salinity increases the species diversity decreases, mostly due to environmental stresses, while the various population densities increase. The increase in phytoplankton population during higher salinities was due mainly to the abundance of hyper saline algal species like *Coccochloris elabens*, *Dunaliella salina*, *Spirulina platensis*, *Oscillatoria salina*, *Gloeocapsa sp.* and *Synura sp*. The zooplankton was generally poor in composition and abundance in comparison to phytoplankton. The zooplankton population mainly consisted of ciliate protozoans, harpactcoid copepods and insect larvae, besides, *Artemia*. Rotifers, amphipods, calanoid copepods and fishes were present at low salinity. Higher *Artemia* bio mass were observed during low saline period. The distinctive faunal composition observed in the present study was similar to the faunal composition of saline lakes of other continents. Except for protozoan *Bodo sp.* and *Artemia* in general, the diversity of organisms found to decrease with an increase in salinity. However, the solar salt works also functions as feeding and breeding grounds of many migratory birds.

Keywords : Hydrobiology, Micro algae, Zooplankton, *Artemia.*

INTRODUCTION

Salt pan ecosystem offers a number of unique ecological niches having a strange combination of environmental factors. In the extreme astatic physico-chemical conditions of these hypersaline habitats only few plant and animal species can live. Studies on ecology of solar salt ecosystem have been an area of scientific interest for many years. Although the phytoplankton communities of saline lakes were studied in detail(Davis, 1978; 1980 and Borowitzka, 1981) only very little emphasis have been given to investigate the magnitude of variation in the faunal composition in relation to changing physico-chemical features of the environment(Bayly, 1970, Wongrat, 1986). In comparison relatively little is known about the ecology of Indian salt works. The solar saltworks in India consist of privately owned small artisamal salt fields and large industrial installations. In a typical saltwork seawater is allowed to flow to the next pond of the series until the water (by solar evaporation) becomes saturated with sodium chloride. This brine is stored in reservoirs. The brine is then pumped into crystallizers ponds where sodium chloride precipitates. In the traditional salt fields, seawater is pumped directly into crystallizers. These widely varying physico-chemical parameters induce great physiological modifications in the organisms to adapt themselves to these extremes. The main objective of this investigation was to collect sufficient information on the changes in the ecological features for a proper understanding of the biodynamics of saltpan ecosystem.

MATERIALS AND METHODS

The present investigations were made at two selected salt pans located at Vedaranyam(10,01"N,79'50"E) in Nagapattinam district (station-I) and Kelambakkam(12',08"N,80'02"E) in Chengleput district of Tamilnadu, India(station-II). Materials for the present study were collected at monthly intervals for a period of two year extending from November 1989 to October 1991. Along with phyto and zooplankton collections surface water samples were also taken from 10cm. below the surface. Hydrographical factors such as temperature, salinity, dissolved oxygen, pH, total alkalinity, magnesium and calcium hardness, total solids, nutrients (nitrite, nitrate, phosphate, ammonia) and primary productivity were studied. Water temperature was recorded with a centigrade thermometer, salinity by using a salimometer and pH with a pH meter. Standard methods of seawater analysis were followed for the estimation of other parameters (Strickland and parsons, 1972). Phytoplankton samples were collected by filtering 100 litres of water through a plankton net having a mesh size of 10 m. For zooplankton studies samples were taken with the help of a 50 m mesh plankton net. Samples were also preserved in 5% formalin and were identified referring published papers and monographs (Hecky and Kilham,1973;Post *et al*, 1983; Robert and Peter, 1973; Wongrat, 1986).

RESULTS

Generally the water temperature, salinity, magnesium, total sulphide, total dissolved solids, nitrite, nitrate and ammonia were higher in solar salt works.The water temperature varied from 23.5 to 33.1°c in Vedaranyam. In Kelambakkam the values ranged from 24.8 to 33.1°c. A sharp decline in salinity was observed during the monsoon period. The values fluctuated from 44 to 188 ppt in station-I and 41.8 to 187 ppt in station-II. At both stations dissolved oxygen values were comparatively low and decreased with an increase in salinity. The dissolved oxygen varied from 1.85 mg/l to 6.6 mg/l in station-I and 2.2 mg/l to 5.02 mg/l at station-II. The pH values ranged from 7.5 to 8.9 in both stations. At both stations wide fluctuations were observed in total alkalinity in relation to rainfall and salinity; the values ranged from 74 to 212 mg/l at station-I and 46 to 207 mg/l at station-II.

Magnesium hardness was found to increase with salinity. The maximum concentration noticed in station-I was 9679 mg/l and minimum was 1769.5 mg/l. the maximum value observed at station-II was 8249.1 mg/l and minimum value was 2013.8 mg/l. The calcium concentration was lower than the magnesium concentration in both stations. The calcium concentration varied from 151.13 to 306.9 mg/l at station-I and 50.46 to 303 mg/l at station-II. The total solid values ranged from 5.1 to 25.1% at station-I and 6.02 to 39.7% at station-II. Considerable variations occurred in the concentration of nutrients. The nutrient values were lower at station-II than at station-I. The ammonia-nitrogen values ranged between 9.019 and 5.62 μgat/l at station-I and 0.004 and 3.44 μgat/l at station - II. The primary productivity values were comparatively higher at Vedaranyam solar salt works. The values increased from 0.06 to 0.195 mgc/m^3/h at station-I and 0.009 to 0.14 mgc/m^3/h at station - II.

PRIMARY PRODUCERS

Primary producers in a salt pan ecosystem consists of phytoplankton community such as Cyanophyceae, Clorophyceae, Bacillariophyceae and Dinophyceae. The relative abundance of phytoplankton are depicted in Figs1 to 4. An examination of phytoplankton population revealed that the density and diversity at Station-II were very poor when compared to Station-I.

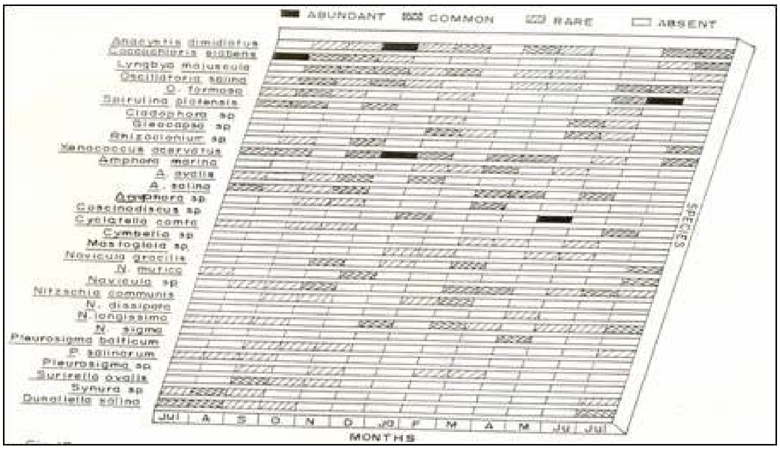

Figure 1.Monthly variations in relative abundance of phytoplankton at Vedaranyam-I

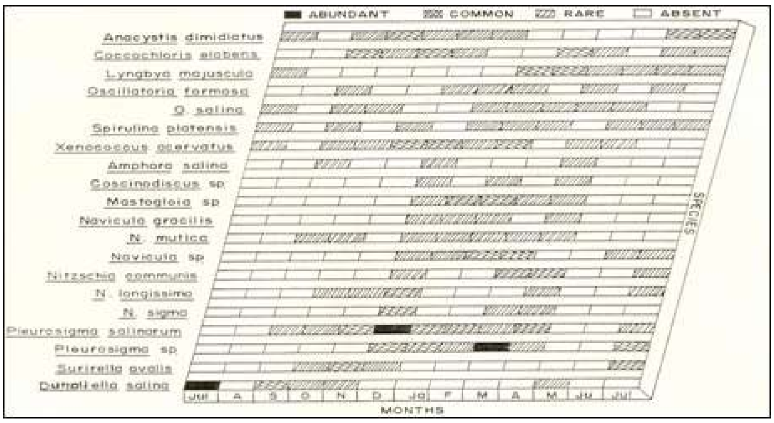

Figure 2 Monthly variations in relative abundance of phytoplankton at Vedaranyam-II

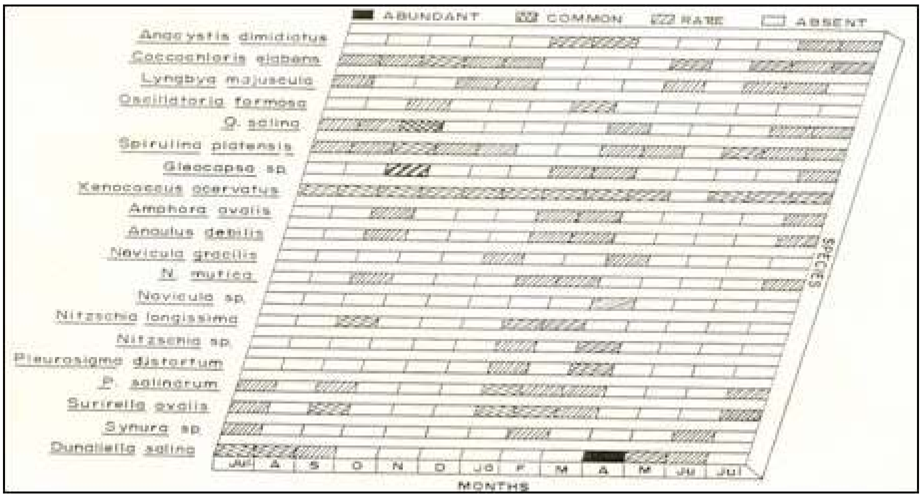

Figure 3 Monthly variations in relative abundance of phytoplankton at Kelambakkam-!.

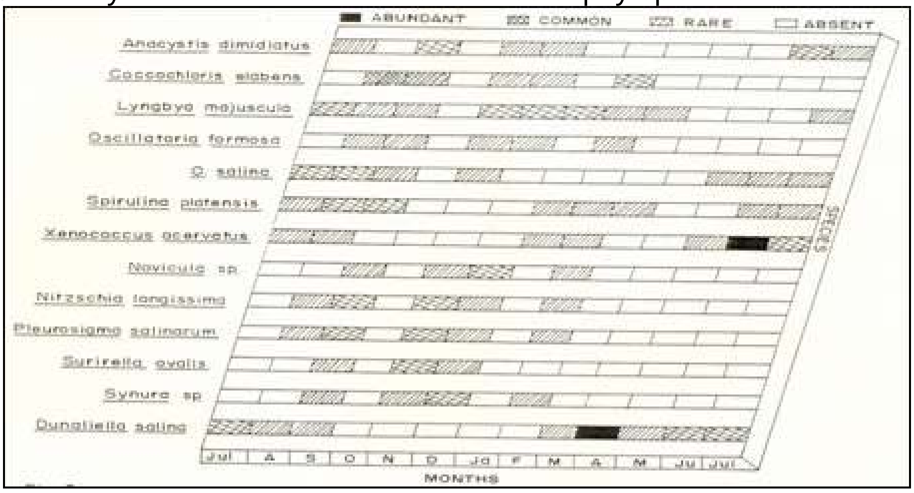

Figure 4 Monthly variations in relative abundance of phytoplankton at Kelambakkam-II

Totally 31 species comprising of genera were identified from Vedaranyam saltworks. While at Kelambakkam only 20 species were identified. *Lyngbya majuscula, Oscillatoria salina*, *Xenococcus acervatus* and *Navicula sp*. were the dominant algae at station-I. The dominant species at station-II were *Xenococcus acervatus*, *Coccochloris elabens*, *Spirulina platensis* and *Oscillatoria salina*. Certain species such as *Lyngbya majuscula*, *Xenococcus acervatus*, *Oscillatoria salina Pleurosigma salinarum* were encountered through out the larger part of the study period and tolerated wide ranges of salinity. However, *Amphora marina*, *Mastogloia* sp., *Nitzschia sp.*, *Navicula gracilis* and *Conscinodiscus sp*., were observed only during low saline periods.

CONSUMERS

The main consumers of the salt pan ecosystem are the ciliate protozoans, harpacticoid copepods, insect larvae and *Artemia.* The zooplankton was generally poor in composition and abundance in comparison to phytoplankton (Fig.5 to 8).

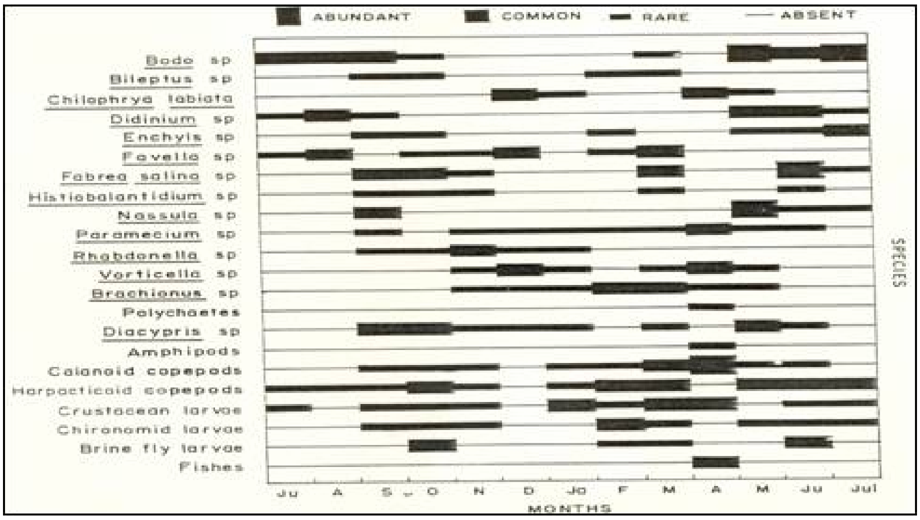

Figure 5 Monthly variations in relative abundance of zooplanktons at Vedaranyam-I

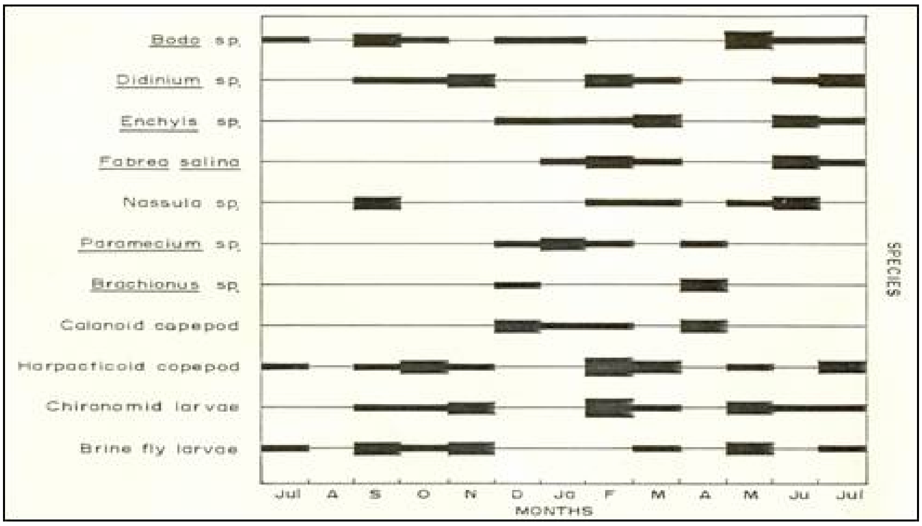

Figure 6 Monthly Variation in relative abundance of zooplankton at Vedaranyam-II

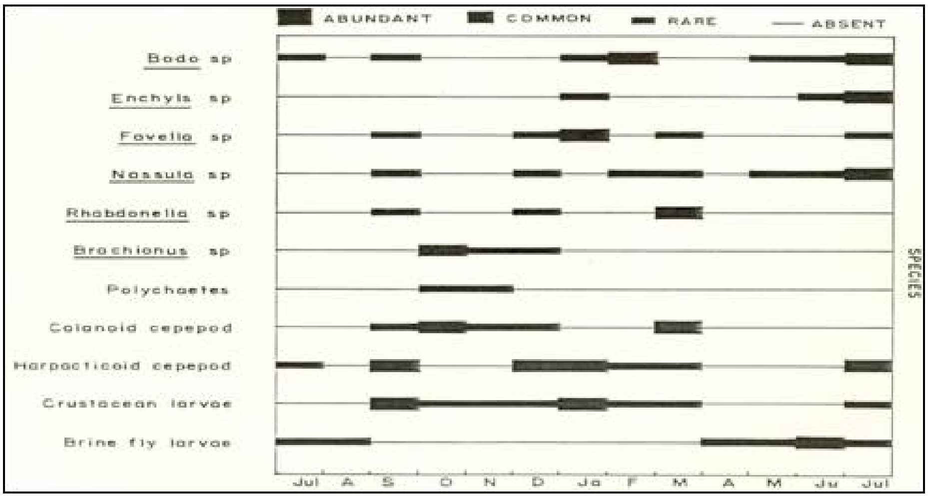

Figure 7 Monthly variations in relative abundance of zooplankton at Kelambakkam-I

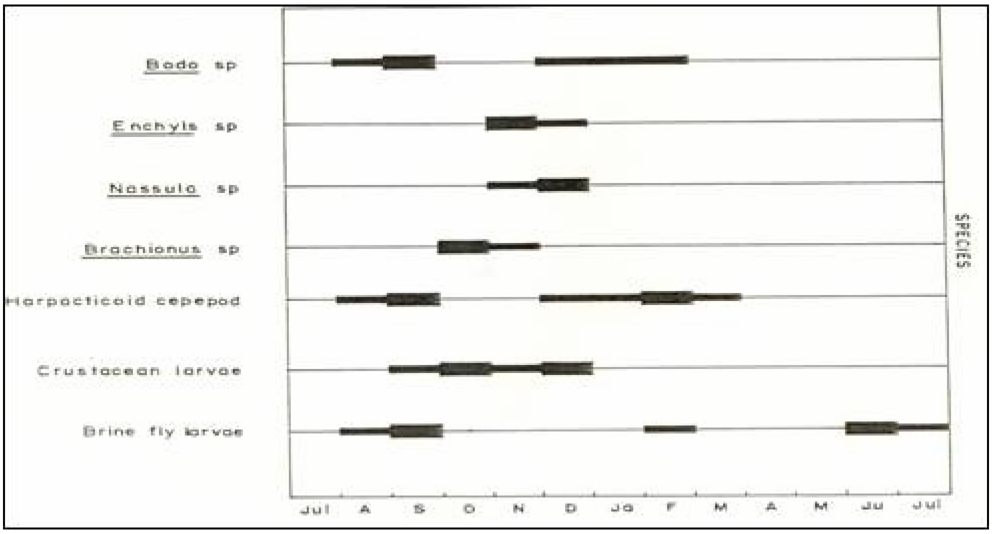

Figure 8.Monthly variations in relative abundance of zooplankton at Kelambakkam-II

The number of species encountered at Kelambakkam were very low when compared to Vedaranyam. A total of 21 species were noticed from Vedaranyam, whereas only 11 species were noticed from Kelambakkam. Rotifers, amphipods, calanoid copepods and fishes were observed during low saline periods. *Artemia* was the dominant organism in both the saltworks.

DISCUSSION

Hydrobiological conditions of the solar saltworks were influenced by the tidal oscillations, north-east monsoon winds, cyclonic showers, pumping of water for salt operations etc. A definite correlation was not noticed between physico-chemical factors due to the complex environmental characteristics of salt works. High salinity, physical impermanence, physico-chemical instability, low concentration of oxygen, high temperature, high concentration of calcium and magnesium and low productivity had been the most characteristic features of the solar saltworks. Salinity values showed a decreasing pattern with the onset of monsoon. A decline in oxygen values was noticed with salinity. High salt concentration particularly when combined with high temperature, restrict the solubility of gases such as oxygen, which explains the lower oxygen values observed during high salinity. The hyper saline habitats are characterized by large seasonal fluctuations in salinity and large diel changes in temperature and dissolved oxygen (Dana, 1981). The values of total alkalinity, magnesium, total sulphide and total dissolved solids were found to increase with an increase in salinity. Highly saline waters contain high concentration of HCO^-, Mg++ and SO_4^{--}(Oren and Shilo, 1982). The calcium content was always found lesser than magnesium. The relative ionic proportion for the various elements varies with salinity. The variability in ionic proportion with increasing salinity was reported by Bayly and Williams (1966). Nutrient values were very low in all stations. High nutrient concentration was recorded during low saline periods. The presence of *Lyngbya majuscula*, *Oscillatoria salina*, *Xenococcus acervatus*, *Nitzschia sp.* and *Navicula sp*. throughout the study period indicates that they can tolerate wide fluctuations in salinity (Wongrat, 1986). As the salinity increases the species diversity decreases mostly due to environmental stress, while the various population densities increase. The increase in phytoplankton population during higher salinities were due mainly to the abundance of hypersaline algal species like *Coccochloris elabens*, *Dunaliella salina*, *Gloeocapsa sp*., and *Synura sp*. (Ortega and Martinez, 1987; Rahaman *et al*., 1990).

The distinctive faunal composition observed in the present study was similar to the faunal composition of saline of lakes of other continents (Bayly, 1970). Except for protozoan

Bodo sp. and *Artemia*, in general, the diversity decreased with salinity. *Bodo* sp., was found to tolerate salinity beyond 200ppt. (Post *et al*., 1980) also reported the occurrence of *Bodo* sp., in a western Australian hypersaline lagoon. A decrease in *Artemia* population noted in Vedaranyam salt works during low salinities were due mainly to the presence of predators like fishes and shrimps. This is further supported by Davis(1980) that decrease in *Artemia* population when the phytoplankton population reached its maximum may be related to the appearance of predators and competitors like amphipods, copepods, larvae and juveniles of crustaceans and molluscs at low salinities and the presence of migratory birds including flamingos.

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