However, the tracer studies conducted during the monsoon months of 1970 have shown that the material dumped at an area, 2 km north of the channel and 5 km west of the coast does not find its way back to the channel. Present studies also show that beyond sector 20 there is a falling tendency (Fig. 2) for siltation confirming that sediment transport is comparatively very negligible beyond this sector. Hence any dredged material dumped beyond offshore of this sector is not likely to find its way back to the channel.

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References

Distribution & Seasonal Abundance of Oscillatoria nigroviridis Thwaites ex. Gomont in the Waters of Visakhapatnam Harbour

V. E. Premla & M. Umamaheswara Rao
Department of Botany, Andhra University, Waltair 530003
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O. nigroviridis and other blue-green algae are abundant in the waters of harbour area indicating the polluted nature of the Visakhapatnam harbour. In the surface waters of 4 stations, standing crop of O. nigroviridis varies in all months of the year with 2 peaks, a primary peak between September and December and a secondary peak between January and April. Production of O. nigroviridis is higher in the sewage polluted waters of station I than in the waters of other 3 stations, which are relatively less polluted.

WATERS of Visakhapatnam harbour are polluted by town sewage, effluents of industries like Caltex Oil Refinery and Coromandel Fertilizers and also by the loading and unloading operations carried out in different channels. During the course of studies to assess the effects of polluted sea water of the harbour on the growth of marine algae, data have been collected on the species composition and abundance of phytoplankton of the harbour area. Results obtained on the distribution and seasonal abundance of Oscillatoria nigroviridis Thwaites ex. Gomont during 1975 are presented in this paper.

Four stations were selected in different channels of the Visakhapatnam harbour. Station I is located near the town sewage canal where it joins the Southern Lighter Canal and Station II is about 900 m away from the outfall area. Stations III and IV are situated in the northern arm and the western arm of the harbour. For phytoplankton analysis, 2 l of surface water were collected once a month from each station between 1800 and 1900 hrs, brought to the laboratory and centrifuged. After a preliminary examination of the live plankton, the samples were fixed in 5% formalin. These samples were diluted further to a known volume and stained in Lugol's solution. While analysing the plankton samples, filaments, fragments and hormogonia of O. nigroviridis present in 1 cc of the subsample were counted separately, using a Sedgwick-Rafter cell. From an average value of 2 counts of the subsample, total number of filaments per litre of sea water was estimated.

O. nigroviridis is very abundant in the phytoplankton of Visakhapatnam harbour associated with many diatoms, dinoflagellates, green algae and blue green algae like Arthrospira, Spirulina, Microcystis, Merismophedia and it also grows as thin mats on harbour walls and other substrata in the mid-littoral zone in the harbour area.

Fig. 1 shows the seasonal abundance of O. nigroviridis in the 4 stations selected. Data could not be collected for March 1975, during the study. Standing crop of O. nigroviridis varied markedly in all months of the year with 2 peaks, a major peak between September and December and a minor peak between January and April. Peak periods varied slightly from one station to the other. In waters of station I the number of filaments per litre ranged from 4800 to 2437500 with a small peak in February and a primary peak in December. In station II counts per litre varied from 262 to 60063 with a secondary peak in February and primary peak in October. In station III, although 2 peaks were found with values ranging from 150 to 12900 filaments/litre, major peak was observed in February and minor peak in October, not coinciding with the seasonal periodicity of the plankton samples of the other stations. In station IV, number of filaments varied from 187 to 7938 with primary and secondary peaks in the month of October and April respectively. Low values observed in stations I to III in the month of November (Fig. 1) were not obtained in this station. In all these stations O. nigroviridis occurred sparsely between May and August.

Though there was no regular pattern in the occurrence of fragments or hormogonia, the percentage frequency values were higher during or
just before the peak periods, as shown below:

<table>
<thead>
<tr>
<th>Station</th>
<th>Jan.-March/April</th>
<th>July-Aug./S.-Sept.</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>14.1-14.3</td>
<td>7.2-12.2</td>
</tr>
<tr>
<td>II</td>
<td>16.23-1</td>
<td>31.9-35.5</td>
</tr>
<tr>
<td>III</td>
<td>11.4-24.4</td>
<td>9.5-12.5</td>
</tr>
<tr>
<td>IV</td>
<td>16.7-20.8</td>
<td>5.6-8.7</td>
</tr>
</tbody>
</table>

Yearly means of abundance calculated for each station are plotted in Fig. 2 to show the fluctuation in the standing crop of *O. nigroviridis* in the waters of different stations. Near sewage outfall, where station I is situated, the yearly mean value obtained was 270648 filaments/litre. Low standing crop values can be seen in the other stations with lowest values ranging from about 2000 to 2300 filaments/litre in stations III and IV.

Members of blue-green algae are considered as indicators of pollution and these are more abundant in places exposed to heavy organic and sewage pollution. But for some preliminary reports in estuaries, detailed quantitative studies have not been made in India on the planktonic blue-green algae of polluted marine habitats. In the present study, *Oscillatoria* and other blue-greens are found as a significant group in the plankton, and mat-like vegetation of blue-greens, as reported by Golubic, is also found in the Visakhapatnam harbour. Quantitative data collected (Figs. 1 and 2) show that the production of *O. nigroviridis* is very high in the different channels. Furthermore, *Oscillatoria* and other blue-greens presently observed in the harbour are not reported earlier in the coastal waters of Visakhapatnam. These observations clearly indicate that the waters of Visakhapatnam harbour are highly polluted by sewage and other pollutants rich in organic substances.

Seasonal changes with two peak periods in the production of phytoplankton have been reported from many inshore areas of the east and west coasts. At Visakhapatnam, major peak in the total phytoplankton production is found between March-April and a minor bloom in October and November. Results obtained with *O. nigroviridis* show a different trend in its seasonal abundance (Fig. 1) with major peak between September and December and a minor peak between January and April. However, in one station (station III) selected in the northern arm, major peak is observed from January to April. Though the values are less, similar seasonal abundance is also seen in Hoo-gly estuary with many blue-greens from August to December. As observed in the present study, *Oscillatoria* sp. and other blue-greens are found in good numbers in fresh water and saline zones in polluted Hooghly estuary into which many industrial pollutants are released.

From the preliminary data collected on the physicochemical conditions of the harbour and from the reduction in growth and survival of discs of *Ulva fasciata* cultured in water samples of stations I to IV, it is concluded that the Southern Lighter Canal (stations I and II) is a severely polluted zone and other arms of the harbour (stations III and IV) are relatively less polluted. Maximum production of *O. nigroviridis* in station I and variations in the standing crop observed in the 4 stations (Fig. 2) suggest that high concentration of sewage and low salinity appear to favour the growth of *O. nigroviridis*.

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References

Incidence of Fish Mortality from Industrial Pollution in Cochin Backwaters

R. V. Unnithan, M. Vijayan, E. V. Radhakrishnan & K. N. Ramani
Regional Centre, National Institute of Oceanography, Cochin 682018

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Incidence of mortality of fish *Ambassis gymnocephalus* (Lac.), due to industrial pollution, is reported from the upper reaches of Cochin backwaters. The effluents carrying a heavy load of ammonia at the rate of 432-560 ppm, which is far above the accepted lethal limit of 2.5 ppm, pouring into the incidence area together with many other pollutants such as acids and suspended solids in varying quantities, have changed the hydrographic conditions to extreme toxic proportions so as to cause heavy mortality of the animals in the area. Fish shoal entering the polluted zone could not tolerate the cumulative effect of pollution, resulting in their sudden killing due to asphyxiation. It is suggested that treatment of waste be adopted to recycle and recover the ammonia and other pollutants from the effluent before it is let out into the estuary.

Several reports \(^1\)–\(^5\) on fish mortality due to pollution of river water by domestic and industrial wastes are available. In Kerala, Periyar river especially its lower reaches contributing to Cochin backwaters has been observed to be polluted to a considerable extent by the domestic and municipal sewage. The variety of industrial wastes ranging from acid to ammonia and even to heavy metals like mercury, come from over dozen industries, which contribute to an Industrial Complex in Kalamassery (Udyogamandal) extending to a distance of nearly 5 km from Varapuzha to Alwaye along the upper reaches of the Cochin backwaters. Saline water is observed to extend to about 12 km upstream from the Cochin barmouth especially during high tide of summer months. The factories are located on either side of the river (about 50 m wide) which provides water front and receives the effluents from the factories throughout the seasons.

While engaged in routine pollution monitoring studies, dead floating specimens of *Ambassis gymnocephalus* (Lac.) were observed (in the morning of 27 Feb. 1976) in scattered patches in and around the major outfall areas especially downstream from the chain of factories in Kalamassery Industrial Complex. Random samples from the floating specimens, samples of the effluent from the relevant factories, and water samples from the effluent discharging areas were examined for physical and chemical properties. In the present paper the incidence of fish mortality is presented and discussed in the light of the analysis made.

Five sampling stations were selected for the investigation (Fig. 1) from Varapuzha in the lower reaches of the effluent outfall to 1 km above the effluent confluence in the estuary. Station 1 located near Varapuzha is about 4 km downstream from the main effluent outfall and stations 2, 3 and 4 are located at varying distances from the respective discharge points. Station 5 is about 1 km upstream from the major effluent discharge point. Samples of the industrial effluent of 2 factories located closely on opposite sides of the river (points A and B, Fig. 1) were collected for chemical analysis from the main outfalls, immediately before it falls into the estuary. Water samples from the surface were collected with a plastic bucket while sampling was done with a Hytech water sampler from the bottom of each

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