MAHASAGAR
Vol.22, No.4 (December), 1989, pp.159-164

AFTER EFFECTS OF A DINOFLAGELLATE BLOOM ON THE HARD BOTTOM COMMUNITY IN KALPAKKAM COASTAL WATERS

N. SASIKUMAR, *V.P. VENUGOPALAN, J. AZARIAH AND *K.V.K. NAIR
Department of Zoology, University of Madras, Guindy Campus, Madras 600025

ABSTRACT

A bloom of the dinoflagellate, *Noctiluca scintillans* (Macartney) was observed in Kalpakkam coastal waters during the second and third week of October, 1988. Associated with the incidence of the bloom, significant variations in the distribution of intertidal hard bottom communities were observed. Considerable difference in the dissolved oxygen content was also recorded during the bloom period.

A sudden disappearance of grazers like limpets was observed after the onset of the bloom. Subsequent to this, there was a recolonization process, which showed a regular succession. Following limpet disappearance there was a rapid "greening" of the surface by *Enteromorpha* Later, *Dictyota dichotoma* excluded *Enteromorpha.*

Experimental teak wood panels also showed a decline in cyprid settlement during the bloom.

Key-words: Bloom, dinoflagellates, *N. scintillans,* sedentary benthic life.

INTRODUCTION

Dinoflagellate blooms are nearshore phenomena, triggered by a combination of multiple interacting physical, chemical and biological factors that end up in the selective proliferation and persistence of certain organisms (Pearl, 1988). These blooms generally have deleterious side effects in the sense that they lead to mortality of other fauna by way of production of (endo- or exo-) toxins, clogging and chocking of respiratory structures and depletion of dissolved oxygen in the ambient environment (Southgate, Wilson, Cross and Myers, 1984). Though blooms have been reported from Indian waters (Prasad, 1953; Devassy and Nair, 1987; Katty, Gupta and Shetty, 1988) no studies have been undertaken to understand the effects of a bloom on the sedentary benthic life. This might have been partly due to the unpredictability of the onset of the blooms and their ephemeral nature.

Kalpakkam coastal waters experienced a bloom of the dinoflagellate *Noctiluca scintillans* (Macartney) during 11-17 October 1988 (Sargunam, personal communication). Associated with the bloom there was some fish mortality and a general decline in the local fish landing. As we have an

* Water and Steam Chemistry Lab. (WACD/BARC), IGCAR, Kalpakkam, Tamil Nadu 603102.

ongoing programme on the biofouling organisms of the Kalpakkam waters, it was possible to monitor the effect of the bloom on the intertidal benthic community before, during and after the bloom. The pattern of variations in the intertidal benthic community as a result of the bloom and the subsequent recolonization pattern that ensued are described in this paper.

MATERIAL AND METHODS

Samples of the sedentary fauna were collected from the piers of Madras Atomic Power Station (MAPS) jetty covered in quadrats of 100cm^2 from supralittoral, littoral and infralittoral zones. For this purpose the highest watermark during lowtide was taken as the lower limit of the supralittoral zone and lowest watermark during lowtide as the upper limit of the infralittoral zone (Stephenson, 1949). Samples were analysed for numerical density except algae which were quantified by taking percentage cover. In addition, data were collected on the settlement of the barnacle cypride on test panels of teakwood (15 x 10 cm). Three sets of panels were exposed before, during and after the bloom. Settlement data were collected for a period of 15 days, counting being done on the 1st, 3rd, 5th, 9th and 15th day of exposure. On these days, data on daily settlement were also taken on freshly exposed panels, immersed for 24 hours. Dissolved oxygen content of the surface waters was measured using Winkler method on three occasions, i.e. before the bloom, during the bloom peak and after the bloom. Transparency measurements were made with the help of Secchi disc.

RESULTS AND DISCUSSION

The population density of the benthic organisms in the sampling quadrats is given in Table I. In general, the organisms included periwinkles (*Littorina* sp.), barnacles (*Chthamalus malayensis*, *Balanus tintinnabulum*, *Balanus variegatus*), limpets (*Cellana radiata*), chitons, serpulids (*Serpula vermicularis*), oysters (*Crassostrea* sp.), snails (*Thais tissoti*), mussels (*Perna viridis*) and algae (*Enteromorpha* sp. and *Dictyota dichotoma*).

The supralittoral forms consisted of only species of *Littorina* and *Chthamalus*. As a result of the bloom no appreciable changes were observed in this zone except for the disappearance of the barnacles (Table I). On the contrary, species diversity in the littoral zone declined during the bloom period, the most notable event being the disappearance of limpets and chiton. In the presence of limpets, i.e. before the bloom, the algal coverage was about 30%. However, with the disappearance of grazers, algae colonized with a coverage of 60-70%. During the bloom and for about 15 days during the post bloom period, a greenish patch of *Enteromorpha* dominated the littoral zone. Subsequently, *Dictyota dichotoma* outcompeted *Enteromorpha* and occupied about 60% of the area. Snails appeared at this juncture. However, limpets and chitons were still missing. The infralittoral quadrat showed the presence of balanids, serpulids, oysters and mussels before the bloom. The mussels (*P. viridis*) were absent during and after the bloom.

Table I — Abundance of sedentary organisms in 100 cm^2 quadrats at three different zones. Abundance is given as percentage cover in the case of algae and as numerical density in the case of other organisms.

Organisms	Abundance		
	Before bloom	During bloom	After bloom
Supralittoral quadrat:			
Littorina sp	4	6	8
Chthamalus malayensis	16	26	-
Littoral quadrat:			
C. malayensis	8	20	-
Chellana radiata	7	-	-
Chiton sp	4	-	-
Algae	30	70	60
Balanus variegatus	-	-	10
Thais tissoti	-	-	-
Infralittoral quadrat:			
Balanus tintinnabulam	17	14	*
Serpula vermicularis	11	12	*
Crassostrea sp	3	3	4+
Perna viridis	6	-	-
T. tissoti	-	8	*

* Present, but samples could not be collected due to rough weather;
- Absent and + Number of organisms counted visually.

Settlement of barnacles (on test panels) before, during and after the bloom is given in Table II. Daily settlement on freshly immersed panels was reduced considerably during the bloom period. The average daily settlement before, during and after the bloom was 11, 2 and 17 nos/150 sq.cm respectively.

Table II — Settlement of barnacle cyprids on teakwood panels. Daily counts were taken on separate freshly immersed panels.

No. of days	Before bloom			During bloom			After bloom		
	Date	Cumulative settlement	Daily settlement	Date	Cumulative settlement	Daily settlement	Date	Cumulative settlement	Daily settlement
1	26.9.88	12	20	11.10.88	1	1	26.10.88	1	8
3	28.9.88	36	12	13.10.88	24	4	28.10.88	19	12
5	30.9.88	95	8	15.10.88	75	2	30.11.88	63	24
9	4.10.88	419	12	19.10.88	104	1	3.11.88	267	16
15	10.10.88	838	7	25.10.88	472	0	9.11.88	752	29

Other effects observed during the bloom include fish mortality and a reduction in water transparency. However, fish mortality was not quantified. The Secchi disc depths on 24.9.88, 13.10.88 and 12.11.88 were 2.2, 1.7 and 2.6m respectively. Dissolved oxygen content also showed an increase during the bloom period (Table III) as compared to periods before and after the bloom. A diel variation of 1.3 mg/l was observed during the bloom period, in contrast to 0.3 mg/l difference generally observed in Kalpakkam waters.

Table III – Variation in dissolved oxygen concentration (mg/l) at different periods of time. Samples were taken on 24.9.88, 13.10.88 and 12.11.88.

Time (hrs.)	Before bloom	During bloom	After bloom
0600	5.41	5.61	4.92
0930	5.60	6.31	5.09
1515	5.74	6.87	5.10
1800	5.13	6.17	5.06
2000	-	5.89	-

- No data.

Mortality of fauna associated with dinoflagellate blooms has been reported earlier (Tangen, 1976; Forster, 1979; Ottway, Parker, McGarth and Growley, 1979; Cross and Southgate, 1980; Parker, 1981). The present bloom was caused by *N. scintillans* harbouring the motile green flagellate *Pedinomonas noctilucae*. This species has been reported to be toxic to marine fish (Collins, 1978) due to the presence of ammonia. A reduction in fish catch was observed at Kalpakkam during the bloom period.

The composition of a rocky seaweed based ecosystem and nature of its community interactions will vary depending on the physical stresses and species available to interact (Menge, 1976; Menge and Sutherland, 1976). Importance of such interactions, especially limpet grazing, in regulating algal vegetation has been demonstrated by limpet removal experiments (Southward, 1953). The dynamic equilibrium that exists in such natural communities between predators, grazers and macrophytes, if subjected to pressure by environmental fluctuations, may result in recolonization, as observed in the present studies.

Mortality of the molluscan grazers following dinoflagellate blooms has been documented earlier (Cross and Southgate, 1980; Southgate, Wilson, Cross and Myers, 1984). Natural colonization of hard substrate by algae is kept under control by grazing herbivores. A disruptrion in the equilibrium following the grazer removal may result in an imbalance, favouring a regular succession by algae (Southward and Southward, 1978). Hawkins (1981) experimentally showed that the succession constituted of a transition phase of diatoms followed by a "greening" by *Enteromorpha* which was in turn succeeded by *Fucus* sp. In the present study it has been observed that the

disappearance of grazers such as limpets and chitons, results in an equilibrium instability and colonization by *Enteromorpha*. Subsequently *Dictyota dichotoma* replaced *Enteromorpha*, gaining a percentage cover of about 60. Snails were found to be the first group invading the area, under the recolonization process.

Increased mortality observed in the sedentary fauna indicate the possibility of the production of a toxin or depletion of dissolved oxygen. However, our data preclude the possibility of the latter reason, because oxygen levels during bloom period were higher due to high photosynthetic activity. The changes in the colonization of littoral and sublittoral communities indicate the possibility of a direct relationship between the bloom and the disappearance of the fauna. Alternatively, the relationship could have been an indirect one i.e. a set of as yet of unknown conditions might have brought about the disappearance as well as the bloom itself (Tangen, 1976; Bolach, 1979). It is suggested that a comprehensive study of the assessment of the effects of bloom will throw more light on the interacting processes underlying natural ecosystems.

ACKNOWLEDGEMENTS

The authors are thankful to the Head, Water Chemistry Division, BARC, for facilities and encouragement. One of the authors (NSK) is grateful to the BRNS for financial assistance in the form of a fellowship.

REFERENCES

Bolach, G.T., 1979. The dinoflagellate bloom in the coast of south west England, Aug-Sept 1978. *Journal of the Marine Biological Association of the United Kingdom*, **59**: 515-517.

Collins, M., 1978. Algal toxins. *Microbiological Review*, **42**: 725-746.

Cross, T.F. and T. Southgate, 1980. Mortalities of fauna of rocky substrates in south west Ireland associated with the occurrence of *Gyrodinium aureolum* blooms during autumn 1979. *Journal of the Marine Biological Association of the United Kingdom*, **60**; 1071-1973.

Devassy, V.P. and S.R.S. Nair, 1987. Discolouration of water and its effect on fisheries along the Goa coast. *Mahasagar – Bulletin of the National Institute of Oceanography*, **20**: 121-128.

Forster, G.R., 1979. mortality of the bottom fauna and fish in St. Austell bay and neighbouring areas. *Journal of the Marine Biological Association of the United Kingdom*, **59**: 517-520.

Hawkins, S.J., 1981. The influence of season and barnacles on the algal colonization of *Patella vulgata* exclusion areas. *Journal of the Marine Biological Association of the United Kingdom*, **61**: 1-15.

Katty, R.J., T.R.G. Gupta and H.P.C. Shetty, 1988. On the occurrence of 'green tide' in the Arabian Sea off Mangalore. *Current Science*, **57**: 380-381.

Menge, M.A. 1976. Organisation of the New England rocky inter tidal community: Role of predation, competition and environmental heterogenity. *Ecological Monograph*, **46**: 355-393.

Menge, B.A. and J.P. Sutherland, 1976. Species diversity gradients: Synthesis of the roles of predation, competition and temporal heterogenity. *American Naturalist*, **110**: 351-369.

Ottway, B., M. Parker, D. McGarth and M. Growley, 1979. Observation on a bloom of *Gyrodinium aureolum* Hulburst on the south coast of Ireland, Summer 1976 associated with mortalities of littoral and sublittoral organisms. *Irish Fisheries Investigations (B)*, No.18, 9pp.

Pearl, H.W., 1988. Nuisance phytoplankton blooms in coastal, estuarine and inland waters. *Limnology and Oceanography*, **33**: 823-847.

Parker, M. (ed), 1981. Red tides. *Fisheries seminar series*, Dublin. No.1, 44 pp.

Prasad, R.R., 1953. Swarming of *Noctiluca* in Palk bay and its effect on the 'Choodai' fishery with a note on the possible use of *Noctiluca* as an indicator species. *Proceedings of the Indian Academy of Sciences*, **38B**: 40-47.

Southgate, T., K. Wilson, T.F. Cross and A.A. Myers, 1984. Rocky shore in south west Ireland following a toxic bloom of the dinoflagellate *Gyrodinium aureolum*. *Journal of the Marine Biological Association of the United Kingdom*, **64**: 485-492.

Southward, A.J., 1979. Cyclone fluctuations in population density during 11 year recolonization of rocky shores in West Cornwall following the "Torrey Canyon" oil spill. *Proceedings of the 13th Marine Biological Symposium, Isle of Man*, 85-92.

Southward, A.J., 1953. The ecology of some rocky shores in the south of the Isle of Man. *Proceedings of the Transactions of the Liverpool Biological Society*, **59**: 1-50.

Southward, A.J. and E.C. Southward, 1978. Recolonization of rocky shores in Cornwall after use of toxic dispersants to clean up the Torrey Canyon spill. *Journal of Fisheries Research Board of Canada*, **35**: 682-705.

Stephenson, T.A., 1949. The universal features of zonation between tide marks on rocky coasts. *Journal of Ecology*, **37**: 289-305.

Tangen, K., 1976. Blooms of *Gyrodinium aureolum* in north European waters, accompanied by mortality in marine organisms. *Sarsia*, **63**: 123-133.