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Research Note

Noctiluca scintillans (Macartney) Kofoid and Swezy Bloom and its Impact on the Coastal Water Quality off Alappuzha, Arabian Sea

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Noctiluca scintillans (Macartney) Kofoid and Swezy is a bloom-forming marine dinoflagellate. Incidence of *N. scintillans* blooms and discolorations of water in the Indian seas have been reported by Prasad (1953) in Palk Bay, Subrahmanyan (1953) and Katti et al. (1988) in the Arabian Sea; Sargunam et al. (1989) in Kalpakkam coastal waters and by Naqvi et al. (1998) off Cochin. However, the causes for the occurrence of blooms are not well understood. It has been suggested that the formation of *N. scintillans* blooms is regulated by hydrographical and biological factors (Elbrachter & Qi, 1998). Miyaguchi et al. (2006) have also suggested that bloom formation by *N. scintillans* can be due to an increase in optimum hydrographical and biological factors. The availability of phytoplankton prey is an important factor affecting the abundance of *N. scintillans* (Elbrachter & Qi, 1998). The increased frequency of appearance of blooms throughout the world in the recent past, is a result of change in the marine planktonic ecosystems, mostly due to the anthropogenic activities in the coastal zone.

In the present study, a prominent discolouration of the surface water was noticed off Alappuzha coast, Arabian Sea at lat. 9°. 49'N and long. 76°.31'E (Fig. 1) on 8th July 2015. The bloom was dense and created red-coloured patches on the sea surface covering an area of approximately 4000 m 500 m wide. The foul smelling bloom persisted for three days and disappeared suddenly. The phytoplankton responsible for discolouration was identified as *N. scintillans*.

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Surface sea water samples were collected onboard fishing vessel from three stations. Station 1, Thumpoly beach (Non-bloom area- lat.9°.51'N, long.76°.31'E), Station 2, Alappuzha beach (Bloom area-lat 9°.49'N, long.76°.31'E) and station 3, Vadackal beach (Non-bloom area-lat.9°.46'N, long.76°.31'E). stations 1 and 3 were chosen as reference stations as no indication of the bloom was observed. The distance between station 1 and 2 was 5.1 km and station 3 was 3.9 km away from station 2. The samples were collected within a period of 90 min. Various physico-chemical parameters such as temperature, dissolved oxygen (DO), pH and salinity were measured *in situ* using HACH™ multiple parameter portable meter. Water samples for the analysis of nutrients were transported to the laboratory in an ice-box. Concentrations of nutrients, *viz.*, nitrite, nitrate, ammonium and phosphate were determined in accordance with standard methods (Grasshoff et al., 1999) and by using MERCK spectroquant NOVA 60 spectrophotometer. Phytoplankton density was measured by filtering known quantity of surface sea water in 198 μm plankton net. *N. scintillans* was identified by following standard taxonomic monographs for dinoflagellates (Subramanian, 1968; 1971).

Phytoplankton bloom often occurs as patches, lanes, lines and streaks and exists as massive accumulation of single or, less often, two coexisting phytoplankton species (Mohanti et al., 2007). In the present study, the water column exclusively recorded dense homogenous population of *N. scintillans*. The present observation corroborates the findings of Dharani et al., (2004) from Minnie Bay, Port Blair.

N. scintillans cells were circular in shape and measured 300 µm in diameter with a twisted flagellum (Fig. 1). The small cell size (340-450 µm) was attributed to better nutritional conditions while longer cell size (400-1200 µm) to poor, nutritional status in the surrounding enviornment (Murray & Suthers, 1999; Dela-Cruz et al., 2003). Consequently, the small size (270–380 µm) of *N. scintillans* cells constituting the blooms in the present study reflects a good nutritional status for its growth.

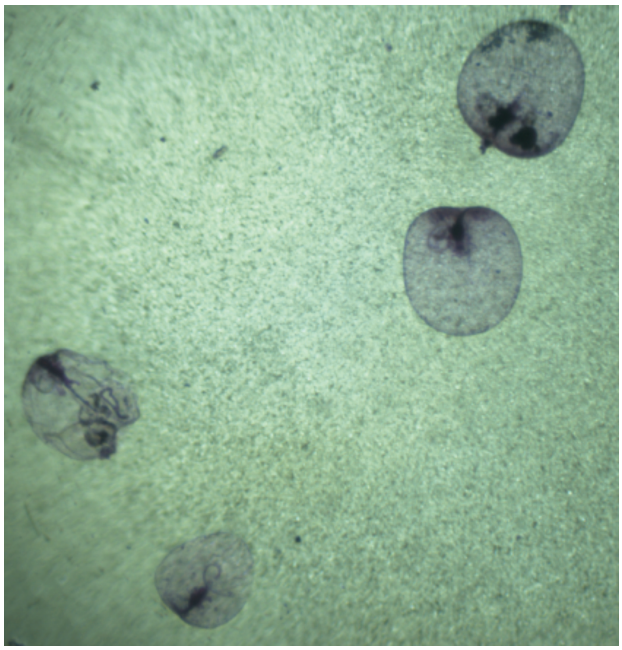

Fig. 2. Photomicrograph of *Noctiluca scintillans*

Physico-chemical parameters showed some interesting features in the bloom and non-bloom areas. In the coastal waters of the tropical environment, eutrophication and low-temperature are identified as the important factors for the development of *N. scintillans* blooms (Harrison et al., 2011). The temperature (27.9°C) recorded in the present study was in the optimal range (18–29°C) for *N. scintillans* proliferation (Tada et al., 2004; Miyaguchi et al., 2006). Surface water temperatures were marginally higher in the non-bloom areas, when compared to that of the bloom area (Table 1). It has been reported that a relatively low temperature and high salinity is favourable for triggering the appearance of the bloom (Mishra et al., 2006). As expected, a gradual increase in salinity (33.53 ppt) was observed in the patches of bloom area.

There was a decrease in dissolved oxygen (DO) at the bloom area compared to the non-bloom areas studied, which could be due to rapid consumption of oxygen by *N. scintillans* (Mohanti et al., 2007). Since the bloom was in the month of July, it appears from the historical data of the Arabian Sea that low oxygen during South West monsoon is also a factor to be considered (Matondkar et al., 2012). No significant difference in pH of surface seawater was observed between the blooming and non-blooming areas except a slight decrease in pH (8.02) did occur in the *N. scintillans* bloom area (Table 1). Reports from the earlier studies imply that the minor reduction in pH could be due to the generation of carbon dioxide by the respiratory activity (Dharani et al., 2004; Nayar et al., 2001).

Previous studies have reported that upwelling events along coasts deliver relatively high amounts of nutrients, which trigger the blooms of diatom and dinoflagellates (Dela-Cruz et al., 2002). Nitrate, considered to be the most stable nitrogenous nutrient responsible for the metabolism and growth of phytoplankton, is readily assimilated by them leading to its large scale variation in level. Compared to the non-bloom areas, the onset of bloom in the waters of Alappuzha coast led to a marginal reduction in nitrate (NO_3^-) level (3.1 µM l^{-1}). It is unlikely that the reduction in macronutrient concentration NO_3^- in the bloom area during the present study was due to consumption by *N. scintillans*, owing to its heterotrophic nature. The high concentrations of nutrients initially available at the surface water might have got exhausted due to autotrophic production of phytoplankton which was consumed by *N. scintillans* (Sahayak et al., 2005; Mohamed & Mesaad, 2007). Our study did not record any significant variation in the concentration of nitrite level. Nevertheless, a marginal decrease in nitrite level (0.37 µM l^{-1}) was noticed in the bloom area. Mohanti et al. (2007) reported a marginal decrease in the concentration of nitrite during the *N. Scintillans* bloom in near-shore waters, off the Rushikulya River, Bay of Bengal.

Surface water samples were analyzed to determine the concentration of ammonium (NH_4^+) and phosphate (PO_4^{3-}). Ammonium and phosphate concentrations at the surface layer of the water column seemed to be related to cell abundance of *N. scintillans* at the sampling location (Montani et al., 1998). The station located in the area of bloom patch recorded very high concentrations of ammonium (46.2 mg l^{-1}) and phosphate (2.20 µM l^{-1}) than in the non-bloom areas (Table 1). The findings of Montani

Table 1. Physico-chemical parameters of surface sea water during *Noctiluca scintillans* bloom

Parameter	Station 1	Station 2	Station 3
Sea-water temperature (°C)	28.1	27.9	29.0
Salinity (‰)	32.61	33.53	32.15
DO (mg l^{-1})	7.8	6.31	7.2
pH	8.12	8.02	8.09
Nitrite (NO_2^-) (µM l^{-1})	0.43	0.37	0.48
Nitrate (NO_3^-) (µM l^{-1})	4.0	3.1	4.29
Ammonium (NH_4^+) (mg l^{-1})	36.5	46.2	37.2
Phosphate (PO_4^{3-}) (µM l^{-1})	0.98	2.20	0.87

et al. (1998) showed that patches of *N. scintillans* provided very high concentrations of ammonium nitrogen and phosphate in the surface layer of the water column than those in the ambient seawater. It is suggested that high concentration of ammonium in the bloom area can be due to autochthonous nutrient generation by *N. scintillans* cells, which contain high levels of ammonia in their vacuoles. (Montani et al., 1998; Elbrachter & Qi, 1998). An increase in phosphate level during the bloom period may be due to the decomposition of plankton, resulting in oxygen consumption and liberation of phosphate.

The precise cause for the blooms remains unclear; it is suggested that eutrophication of rivers and coastal waters of Alappuzha may be one of the important factors to be considered. Estuaries and backwaters are all now facing serious threat of environmental pollution and thereby eutrophication (Korakandy, 1999). In conclusion, continuous and long term monitoring of this organism along with physico-chemical parameters, should be carried out along the coastal waters, in order to discover the factors triggering such harmful algal blooms.

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