Short Communication

Noctiluca Scintillans (Dinophyceae) in Central Coastal Waters of Tanzania: A New Phytoplankton Record for the Area

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Abstract—A one-year study (July 2003 – June 2004) to explore the spatial and temporal variability of potentially harmful dinoflagellates was carried out in the central coastal waters of Tanzania. During the course of the study a green dinoflagellate, Noctiluca scintillans, which has cosmopolitan distribution, was encountered for the first time in the coastal waters of Tanzania. It demonstrated a clear temporal distribution with high biomass (up to 30 cells/l) during the northern monsoon period and showed significant negative correlation with temperature and salinity. Noctiluca scintillans was possibly introduced by ballast waters or currents and became established for at least one season, but later disappeared due to the physical-chemical environment and/or competition or predation from other organisms in the water column. The need for a monitoring programme for potentially harmful micro-algae, and introduced alien species in Tanzanian coastal waters, is justified.

INTRODUCTION

The dinoflagellate Noctiluca scintillans (MacCartney) Ehrenb. is characterized by having large, up to 2,000 µm, bladder shaped vegetative cells associated with an oral pouch in which are located the tentacle and one emergent flagellum (Lucas, 1982). Vertical movements of Noctiluca in the water column are due to active ionic regulation of the specific gravity. Potassium ions are accumulated in the cell sap relative to its concentration in seawater, whereas the concentrations of the heavier ions calcium and magnesium are reduced (see Elbrächter and Qi, 1998 and references therein). Noctiluca has no chloroplast, but may form symbiotic association with a photosynthetic green flagellate, Pedinomonas noctilucae (Sweeney, 1976). When the endosymbiont is present, Noctiluca can apparently thrive photosynthetically without the need for phagotrophic food uptake.

Noctiluca scintillans is known to have a cosmopolitan distribution and is found in all temperate, subtropical and tropical coastal waters (Elbrächter and Qi, 1998). In the Indian Ocean, blooms of Noctiluca scintillans have been reported from Indian waters (e.g. Subrahmanian, 1985; Devassy, 1989), in Hong Kong waters (Ho and Hodgiss, 1992), far offshore from the equatorial Indian Ocean (Taylor 1976), and more recently in the Indian waters again (Eashwar et al., 2001; Dharani et al., 2004). Adnan (1989) provided a review of the green Noctiluca blooms in Jakarta Bay, Indonesia.

In some cases fish kills have been associated with blooms of Noctiluca (e.g. Subrahmanian, 1985; Ho and Hodgiss, 1992). The fish kill may be caused by different mechanisms. In many cases oxygen depletion is proposed as the causative agent for fish kill (Subrahmanian, 1985; Ho and Hodgiss, 1992; Xie et al. 1993). Another possible mechanism

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of fish kill by *Noctiluca* may be through the release of ammonia (Okaichi and Nishio, 1976). This is particularly the case at the end of the blooms when *Noctiluca* no longer feed and accumulate ammonia in their cells before lysing.

Several studies (e.g. Bryceson, 1977; Lyimo, 1995; Lugomela, 1996; Wallberg et al., 1999; Lugomela et al., 2001) have reported on phytoplankton species composition in Tanzania coastal waters but did not report on the existence of *Noctiluca scintillans* in the area. This paper represents the first reported observation of this nuisance dinoflagellate in the coastal waters of Tanzania and presents its temporal distribution in the area in relation to some physical chemical environmental parameters.

**MATERIALS AND METHODS**

Samples for dinoflagellate identification and quantification were collected twice per month in Dar es Salaam station and once per month in Zanzibar station, between July 2004 and June 2005, from an outboard engine boat. Dar es Salaam station is located in the open waters near Mbudya Island while Zanzibar station is located in the open waters near Bawe Island (Fig. 1 & 2). Samples were taken by concentrating 20 l of surface seawater through a...
20 $\mu$m mesh size plankton net into a 100 ml volume dark glass sample bottle. The samples were then immediately fixed using acid Lugol’s solution and brought to the laboratory. The dinoflagellated were counted in a Sedgewick-Rafter cell (Woelkerling et al., 1976).

Water samples were collected from each sampling site for nutrients ($\text{NO}_3^-$, and $\text{PO}_4^{3-}$) determination. The collected water was filtered through 0.22 $\mu$m pore sized Millex-GS Millipore filters (France). The filtered water samples were kept in 50 ml acid cleaned plastic vials and stored on ice for transport to a deep-freezing facility (– 20°C) to await analysis. Analyses for nitrate ($\text{NO}_3^-$), and phosphate ($\text{PO}_4^{3-}$) were undertaken using the methodology of Parsons et al. (1984). Two
other environmental parameters, water temperature and salinity, were measured in the field using a thermometer and refractometer (ATAGO, Japan).

**RESULTS**

Water temperature at the sampling points ranged from 25.5°C in March 2004 at Mbudya station to 29.5°C during January 2004 at Mbudya (Fig. 3). Salinity varied only slightly ranging from 34.5 ppt in March at Bawe to the highest value of 36 ppt in September and October at Bawe and in November at Mbudya (Fig. 4). PO$_4^-$ concentration in the water column ranged from 0.21 nMol PO$_4^-$/l at Mbudya during October and November 2003 to 26.4 nMol PO$_4^-$/l at Bawe in January 2004 (Fig. 5). NO$_3^-$ concentration ranged from 23.2 nMol NO$_3^-$/l at Bawe in July 2003 to 81.9 nMol NO$_3^-$/l at Mbudya in February 2004 (Fig. 6). Significantly high nitrate concentration ($t = 3.02, p = 0.016$) was observed
during the northeast monsoon period (October-March) compared to the southern monsoon period (June-September).

Green *Noctiluca scintillans* with turbid cell contents (Plate 1) were encountered among plankton from both Mbudya and Bawe stations. The dinoflagellate showed a clear seasonal distribution appearing among the plankton during the northern monsoon period. The species reached a peak value of 30 cells per litre at Mbudya during March 2004 (Fig. 7). However, no *Noctiluca scintillans* was encountered in the study sites during the months of July to November (2003) and May to June (2004). Correlations between the biomass of *Noctiluca scintillans* and the various environmental parameters are given in Table 1.
In general, low temperature values were recorded during the southern monsoon period (May to September) as compared to the northern monsoon period (November to March). This observation therefore waters acquire more neritic characteristics with increased nutrients (Bryceson, 1977). In general, nutrient values along the Tanzanian coast are low as a result phytoplankton blooms, apart from those of the nitrogen fixing cyanobacterium *Trichodesmium* species, have not been documented.
However, with the apparent increase in pollution and eutrophication in the coastal waters of Tanzania (Mohammed, 2002), it is likely that such blooms may occur in the future.

The biomass of *Noctiluca scintillans* was low compared to that reported by Dharani et al. (2004) from Minnie Bay, India, and there were no signs of a bloom nor fish kills in this case. However, a significant negative correlation was observed between the biomass of *Noctiluca scintillans* and water temperature and salinity at both Mbudya and Bawe stations (Table 1) suggesting that this dinoflagellate does not perform well in waters with high temperatures and salinity. This is similar to the report by Huang and Qi (1997) in Dapeng Bay, South China Sea, from where these authors reported that the seasonal occurrence of *Noctiluca* occurred at water temperatures between 15.8°C to 28.6°C, with that mass development at temperatures between 19 to 22°C. This could explain why *Noctiluca* is not common in inshore waters, where temperature and salinity fluctuations are usually higher than those of oceanic water masses. There was also a significant negative correlation between the biomass of *Noctiluca scintillans* and concentrations of nitrate in the water column at Mbudya station. However, a significant positive correlation (Table 1) was observed between the biomass of *Noctiluca* and the concentration of phosphate in the water column at Mbudya station suggesting that phosphorus may also be a limiting factor for growth.

*Noctiluca* is regarded as one of the most common red-tide organism (Elbrächter and Qi, 1998), though it has never been reported before from the coastal waters of Tanzania (see e.g. Bryceson, 1977; Lyimo, 1995; Lugomela, 1996). The possibility exists that *Noctiluca* is not a native phytoplankton species in the area, but was introduced perhaps through ballast waters or ocean currents. Being mixotrophic, *Noctiluca* can remain viable in the dark ballast waters for long period and therefore easily transported over great distances (e.g. Hallegraeff, 1993, 1998). It disappeared with the onset of the southern monsoon and was not encountered again in subsequent phytoplankton samples from the area (Personal Observ.). That the dinoflagellate managed to establish for at least one season supports the introduction hypothesis, but the evidence also suggests that it might have been later out-competed by other organisms or eliminated due to inhospitable physical-chemical conditions. The occurrence of this potentially harmful dinoflagellate in Tanzanian waters supports the need for the establishment of a monitoring programme for this and other potentially harmful algal alien species.

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<table>
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<th>Station</th>
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REFERENCES


