

## ON THE OCCURRENCE OF GREEN *NOCTILUCA SCINTILLANS* BLOOMS IN COASTAL WATERS OF PAKISTAN, NORTH ARABIAN SEA

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### Abstract

The green *Noctiluca scintillans* (Macartney) Kofoid & Swezy 1921 and its green water discolouration are reported here for the first time from the coastal waters of Northwest Arabian Sea bordering Pakistan. The symbiont present inside was recognized as *Pedinomonas noctilucae* (Subrahmanyam) Sweeney. Patches of green water were observed occasionally in the highly polluted coastal areas with dense mangrove vegetation during five-year period. The concentration of the organism was as high as 2.4 million cells per liter imparting green coloration to the seawater, which lasted for about a week.

### Introduction

*Noctiluca scintillans* (Macartney) Kofoid & Swezy 1921 (syn.= *Noctiluca miliaris* Suriray) is a large cosmopolitan marine dinoflagellate species occurring preferably in coastal and estuarine waters (Bhimachar & George, 1950; Le Fevere & Grall, 1970; Taylor, 1976, 1987; Okaichi, 1984; Saifullah & Chaghtai, 1990). It is phagatrophic and omnivorous consuming an array of different types of organisms including phytoplankton, small zooplankton, eggs of fish and detritus (Taylor, 1987; Elbrächter & Qi, 1998). It is also symbiotic (Sweeney, 1970, 1976).

It is long known to cause red water discoloration or red tides in the sea forming red streaks on the surface of sea water (Venugopal *et al.*, 1979; Taylor, 1987; Saifullah & Chaghtai, 1990). However, there have also been occasional reports on occurrence of green *Noctiluca* (Subrahmanyam 1954; Elbrächter & Qi, 1998). The occurrence of green water discoloration phenomenon has been reported in detail during the last three decades from the tropical waters (Sweeney, 1970, 1976; Devassy & Nair 1987). It is believed by marine biologists that there occur two strains of *Noctiluca*, the red and the green. Sweeney (1976) was perhaps the first ever to coin the term "Green *Noctiluca*".

The occurrence of *N. scintillans* and its red water discoloration has been a common phenomenon in the North Arabian Sea. It has been reported to form long red streaks on the surface of water (LeFevere & Grall, 1970; Venugopal *et al.*, 1979; Saifullah & Chaghtai 1990). The present paper reports for the first time the occurrence of green *Noctiluca scintillans* and its bloom strictly from coastal waters of Pakistan.

### Material and Method

Samples of seawater were collected from different coastal localities, on different occasions along the coast of Pakistan (Fig.1, Table.1) where the green water phenomenon was observed. Simultaneous to the collection of phytoplankton samples, salinity and temperature were also recorded by a refractometer and a thermometer respectively. Samples were brought alive in laboratory and were fixed in Lugol's fixative for studies

under the microscope. One ml of bloom water was counted for numerical estimation of cell density in a Sedgwick rafter cell. Chlorophyll "a" was estimated by standard UNESCO method (Anon., 1966).

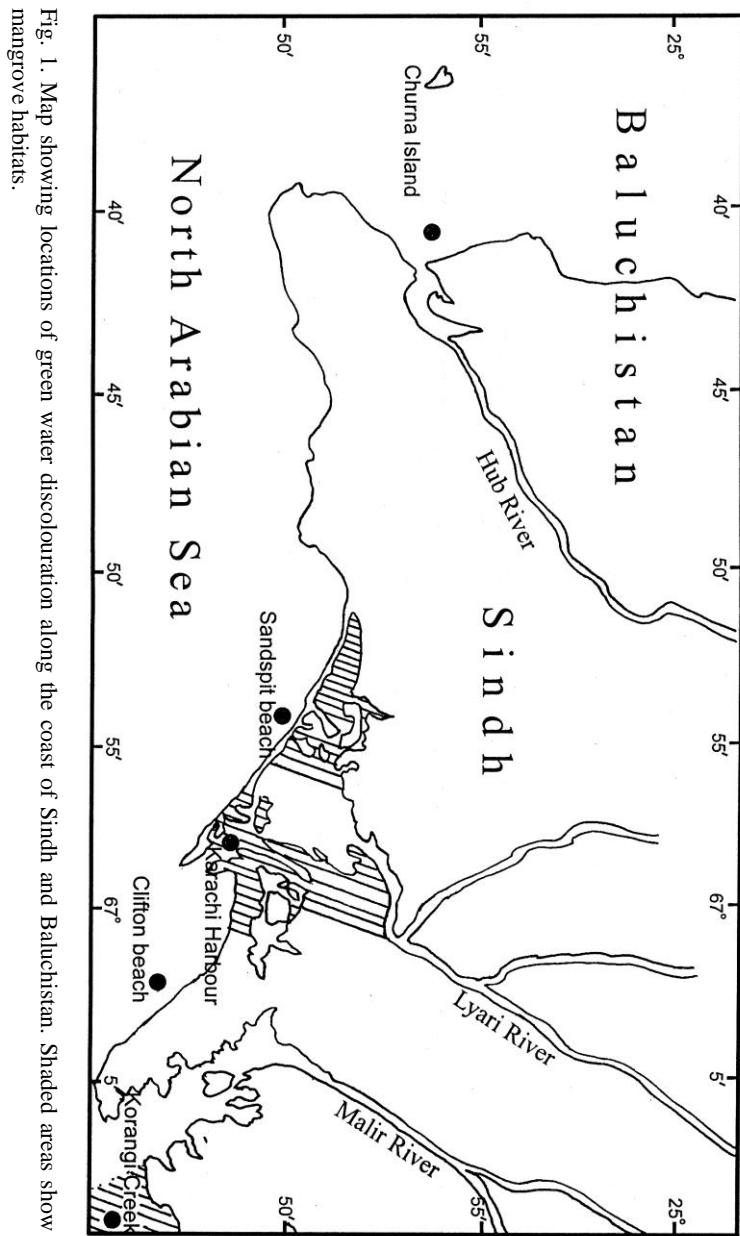


Fig. 1. Map showing locations of green water discolouration along the coast of Sindh and Baluchistan. Shaded areas show mangrove habitats.



### Results and Discussion

Table 1 lists the coastal localities where the green water phenomenon was observed on different occasions (Fig. 1) along with the physical and biological parameters during a period of five years (04.12.1999 -17.12. 2004). The site of Miani Hor (Lat. 25° 31' N; Long. 66° 20' E) has already been described by Saifullah & Rasool (2002). It is a semi enclosed lagoon about 100 km northwest of Karachi. It may be noted that all these localities except for Churna Island are very close to the shore and also in the neighborhood of dense growth of mangroves. They are also heavily polluted with the discharge of huge amounts of domestic and industrial effluents of the mega city Karachi through Malir and Lyari rivers (Fig. 1). Only one species *Avicennia marina* occurs along the Sindh coast whereas three species viz., *A. marina*, *Ceriops tagal* and *Rhizophora mucronata* are from Miani Hor. This indicates that green *N. scintillans* require large amounts of organic matter and humus substances for their growth. Earlier Saifullah (1987) has reported blooms of phytoplankton with very high values of chlorophyll from the coastal area of Pakistan.

The concentration of the *N. scintillans* varied generally between 2,300 cells and 31,000 cells per liter, with exception of two values of about two million cells (Table 1), which caused the seawater to appear as thick green slimy water. The bloom was so intense on 2<sup>nd</sup> February, 2002 that not only water but also the entire sandy beach of Sandspit appeared green in colour because of the left over individuals of *Noctiluca* at low tide. Devassy & Nair (1987) reported as high as 51,360 cells per litre as compared to Bhimachar & George (1950) with 525,000 cells per litre. The chlorophyll 'a' value measured was 2.34 µg per litre on 19.03.2004 when the cell concentration was very low as compared to a value of 16.70 µg per litre at peak concentration reported by Devassy & Nair (1987). The duration of the bloom lasted from 3 to 14 days with an average period of one week. It is noteworthy that all the green water phenomena occurred in the area during winter or northeast monsoon season. Devassy & Nair (1984) and Subrahmanyam (1954) also found the same situation to be true in their areas of studies in India. Saifullah & Chaghtai (1990) have also reported earlier the occurrence of the red *Noctiluca* and its red tide on northwest Arabian Sea shelf of Pakistan during February and March. This indicates that whether it is green or red *Noctiluca*, both forms occur preferably at low temperatures in the tropical waters of south Asia.

The symbiont inside *Noctiluca scintillans* was identified as *Pedinomonas noctilucae* (Subrahmanyam) Sweeney. This is a unicellular microscopic flagellate with a single flagellum belonging to the class Prasinophyceae (Sweeney, 1976). It is 3-6 µm long similar to that described by Sweeney (1976), whereas Subrahmanyam (1954) and Devassy & Nair (1987) described their length as 5-6 µm and 5-9.5 µm respectively. Their concentration varied between 8000 and 10000 cells per individual *Noctiluca* as against 6000 to 12000 cells reported by Sweeney (1971). The symbionts were found swarming inside the *Noctiluca* and upon release showed rapid movement in all directions outside (Fig. 2).

It is noteworthy that *N. scintillans* observed on the offshore of northwest Arabian Sea shelf and deep sea vicinity was red in colour and formed long red streaks on the surface of water (Saifullah & Chaghtai, 1990), whereas the present observations from inland coastal waters showed it to be green, forming green water discolouration. Devassy & Nair (1987), Subrahmanyam (1954) and Bhimachar & George (1950) also reported the green form from the coastal waters. This may be due to the fact that the red *Noctiluca*

occurred in oligotrophic offshore waters while the green one in highly eutrophic and polluted coastal waters. The organic and humic substances released from the mangrove sediments and also brought into the area by runoff from the land may have favoured the intense growth of the symbiotic *Pedinomonas* inside the host. It is therefore suggested that both red and green forms of *Noctiluca* belong to the same species and not different ones. It is probably a facultative heterotroph and, therefore, it behaves both as phagotrophic and symbiotic depending upon the environmental conditions. It remains therefore, to cultivate the offshore red *Noctiluca* in eutrophic coastal water rich in organic matter and likewise cultivate the coastal green *Noctiluca* in offshore oligotrophic water in the laboratory to see if they change their colours.

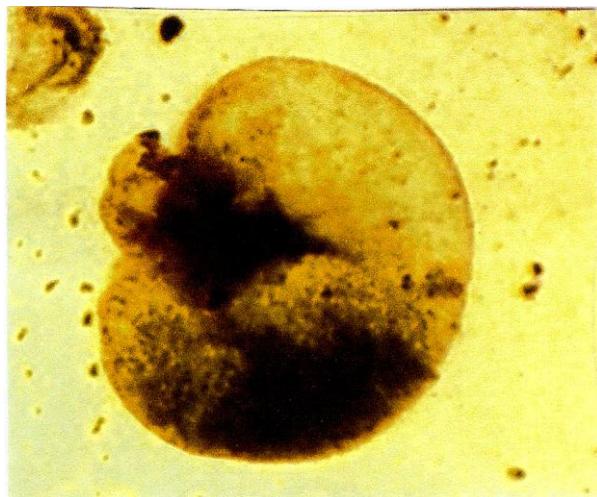


Fig. 2. Green *Noctiluca scintillans* (diam. 550  $\mu\text{m}$ ) with symbiont *Pedinomonas noctilucae* living inside and also swarming outside it.

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#### References

- Anonymous. 1966. Determination of photosynthetic pigments in seawater. *UNESCO Monograph on Oceanography Methodology*, UNESCO, Paris; 1-69.
- Bhimachar, B.S. and P.C. George. 1950. Abrupt set-backs to fishery of the Malabar and Kanara coasts and "Red Water phenomenon and their probable cause. *Proceedings of Indian Academy of Sciences.*, 13: 339-350.
- Devassy, V.P. and S.R. Sreekumaran 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.
- Elbrächter, M. and Y.-Z. Qi. 1998. Aspects of *Noctiluca* (Dinophyceae) population dynamics. In: *Physiological ecology of Harmful Algal Blooms*. (Eds.): D.M. Anderson *et al.*, *NATO ASI Series, G 41*. Berlin: Springer-Verlag, pp. 315-335.

Kofoid, C. A. and Swezy, O.1921 The free living unarmoured Dinoflagellata. *Memoirs of the University of California*, 5: 1-562.

LeFevre, J. and J. R. Grall. 1970. On the relationship of *Noctiluca* swarming off the Western coast of Brittany with hydrological features and plankton characteristics of the environment. *J. Exp. Mar. Biol. Ecol.*, 4: 287-306.

Okaichi, T. 1984. Red tides in Japanese waters. Paper delivered at the red tide workshop 18-20 June, 1984, held at the CSIRO Marine Laboratories, Cronulla, NSW, Australia.

Saifullah, S.M.1979. Occurrence of Dinoflagellates and distribution of chlorophyll "a" on the Pakistani shelf. In: *Toxic Dinoflagellate Blooms*, (Eds.): D.L. Taylor and H.H. Seliger. Elsvier, N.Y., 203-208.

Saifullah S. M. and F. Chaghtai. 1990. Incidence of *Noctiluca scintillans* (Macartney) Ehrenb., blooms along Pakistan's shelf. *Pak. J. Bot.*, 22: 94 - 99.

Saifullah, S.M. and F. Rasool. 2002. Mangroves of Miami Hor lagoon on the North Arabian Sea Coast of Pakistan. *Pak. J. Bot.*, 34: 303-310.

Subrahmanyam R. 1954. A new member of Euglenineae, *Protoeuglena noctilucae* gen. et sp.n., occurring in *Noctiluca miliaris* Suriray, causing green discoloration off the sea of Calicut. *Proc. Ind. Acad. Sci.*, 39: 120-127.

Sweeney. B.M. 1971. Laboratory studies of a green *Noctiluca* from New Guinea *J. Phycol.*, 7: 53-58.

Sweeney. B.M. 1976. *Pedinomonas noctilucae* (Prasinophyceae), the flagellates symbiotic in *Noctiluca* (Dinophyceae) in Southeast Asia. *Indian Journal of Phycology*, 6: 79-86.

Venugopal, P., P. Haridas, M. Madhu-Pratap and T.S.S. Rao. 1979. Incidence of red water along south Karala coast. *Indian.J. Mar.Sci.*, 8: 94-97.

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