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Research Article
Blooms of *Noctiluca scintillans* and its Association with *Thalia* sp. (Salps) along Dubai Coastal Waters

[1]Karuppaiyan Murugesan, [2]Ibrahim Mohammed Ibrahim Ali Juma and [1]Shadab Alam Khan

[1]Department of Environment, Coastal Zone and Waterways Management Section, Dubai Municipality, Baniyas Street, P.O. Box 67 Dubai, UAE
[2]Department of Environment, Coastal Zone and Waterways Management Section, Dubai Municipality, Baniyas Street, P.O. Box 67 Dubai, UAE

Abstract

Background and Objective: *Noctiluca scintillans* (*N. scintillans*) (green dinoflagellate) blooms were spotted in significant scale at various locations along Dubai coastal water during January 2017. The investigation mainly focused on the extent of *N. scintillans* bloom and its association with water quality, phytoplankton and zooplankton. **Materials and Methods:** The phytoplankton bloom and water samples were collected from off Dry dock, South of world islands and Ras Ghantoot from Dubai coast. Further, high density of *Thalia* sp., known as salps (zooplankton tunicate) were recorded along the blooms of *N. scintillans* and remain persisted after the decline of bloom. **Results:** *Noctiluca scintillans* blooms were inhibited in the form of isolated patches of 200-300 m along sampling stations. The phytoplankton cell counts during *N. scintillans* bloom were 2.0-5.4×10^3 nos. mL^{-1} at different sampling stations. Nutrients analysed in water quality showed a significant reduction in nitrate-nitrogen (NO_3-N) and high values of phosphate-phosphorous (PO_4-P) at two locations during *N. scintillans* blooms. Elevated levels of chlorophyll a, phaeophytin and carotenoids were also evident during the bloom of *N. scintillans* along sampling stations. **Conclusion:** The study conclude that the density of *Thalia* sp. increased drastically when *N. scintillans* population decline. This further indicates *Thalia* sp. (salps) as an active grazer of *N. scintillans*.

Key words: Algal blooms, *Noctiluca scintillans*, *Thalia* sp., numerical abundance, physico-chemical, chlorophyll a, phaeophytin, carotenoids

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Corresponding Author: Karuppaiyan Murugesan, Department of Environment, Coastal Zone and Waterways Management Section, Dubai Municipality, Baniyas Street, P.O. Box 67, Dubai UAE Tel: +971509677615

Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Noctiluca scintillans Macartney, 1810 is a marine planktonic dinoflagellate capable to have bioluminescent characteristics. *Noctiluca scintillans* is a cosmopolitan organism, found in tropical and subtropical waters, recorded as one of the most important species causing red tide in many areas of the world[1]. *Noctiluca scintillans* occurs in red and green *Noctiluca* blooms. The red bloom of *Noctiluca* is heterotrophic grazing microzooplankton whereas green bloom contains the photosynthetic association[2].

Red *Noctiluca* species are distributed in the temperate to sub-tropical coastal regions of the world temperature in a temperature range of 10-25°C with high salinity while green *Noctiluca* occurs mainly in the tropical waters restricted to a temperature range of 25-30°C. Recently it has been recorded in the Arabian Sea, Red Sea and Gulf of Oman. Red and green *Noctiluca* blooms intersect in their distribution in accordance to winter and summer seasons in the Arabian Sea. The green *Noctiluca* bloom usually occur during winter seasons with higher productivity, whereas red *Noctiluca* bloom follow pattern of oligotrophic productivity during warmer summer season[3-8]. *Noctiluca scintillans* is unable to produce any toxin therefore considered as a non-toxic species. However, *N. scintillans* in many occasions have been linked with fish and other micro-invertebrate mortality due to accumulative toxic levels of ammonia, which excreted into the adjacent waters during the period of bloom[9]. *Noctiluca scintillans* and other dinoflagellate blooms, was associated not only with eutrophication, but also with stable temperatures and salinities[10].

Salps occur in high densities and blooms over large areas have its existence to environmental conditions, such as temperature and food regimes are not well understood. The events which triggered salps bloom are not clear[11]. However, low chlorophyll concentrations have been recorded during salps blooms along the Antarctic Peninsula[12]. Salps are known as filter-feeding thaliaceans that feed continuously[13]. The water is forced through the sieve by rhythmic reduction of muscles in the body wall of the salps and the filtered water acts as a jet that propels the organism, meaning that salps must swim while eating[14-18].

Enormous numbers of *Thalia* sp. (salps) were recorded during the bloom and persisted after the decline of *N. scintillans* bloom from Dubai coastal waters during January 2017 (Fig. 1). Salps respond very quickly to algae blooms and can grow much faster than other multi cellular animals. Based on the information collected by the Ministry of Environment and Climate Change in the UAE through satellite image on 10th January 2017 related to the increase in the biological active (chlorophyll a) concentration in Arabian Gulf (Fig. 2). In this study phytoplankton, zooplankton and water quality was commenced along Dubai coast during January 2017 by Dubai Municipality.

MATERIALS AND METHODS

Methods of sample collection and analyses: Phytoplankton and water samples were collected at three locations off Dry dock (25°16′ 06.00″ N, 55°14′ 29.40″E), South of world islands (25°09′ 54.70″ N, 55°07′ 50.70″E) and Ras Ghantoot (25°59′ 39.80″ N, 54°55′ 08.20″E) on 19th January, 2017 from surface

Fig. 1: Algal blooms sampling locations

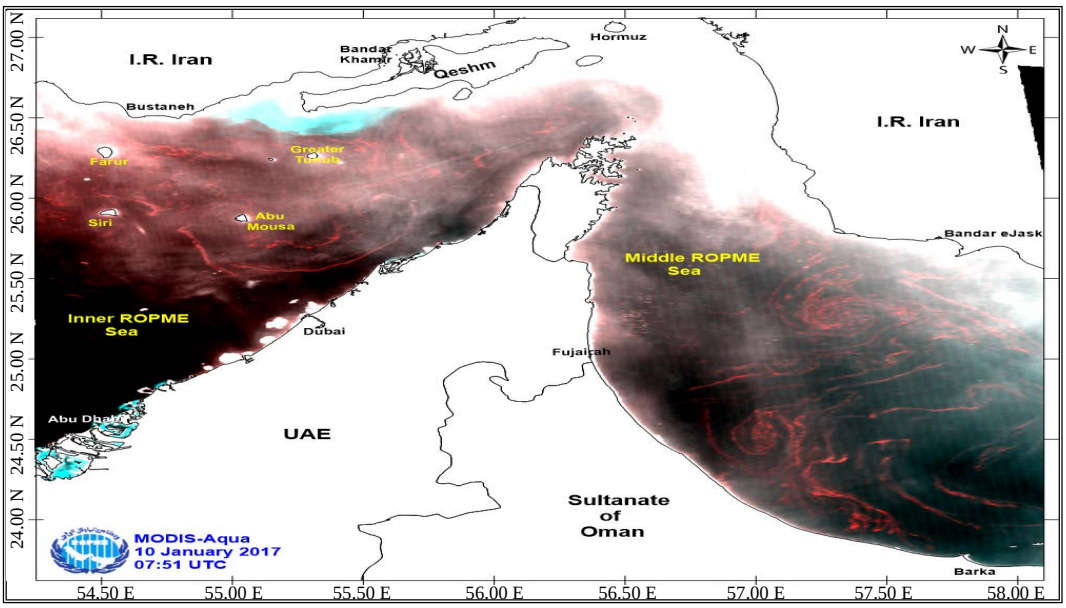

Fig. 2: Chlorophyll concentrations by satellite image

samples were drawn by lowering a clean plastic bottle form the locations as shown Fig. 1. The phytoplankton samples were collected from the surface water using a Niskin water sampler and preserved in Lugol's iodine solution. The phytoplankton samples will be allowed to settle and the supernatant solution will be decanted, leaving a concentrated plankton volume of 50 mL. A 1 mL sample of settled plankton were then transferred to a Sedgwick-Rafter slide (1 mL capacity) using a glass dropper. Initially the samples were examined for qualitative analysis and then the taxa were counted under Leica inverted microscope (model: DMI1) with attached camera (Leica, Eclipse 50i with 10-100X magnification). The same procedure were repeated three or four times. The numbers of individuals, in each taxon of phytoplankton, present 1 L^{-1} of sample, were calculated. Oblique haul with Bongo net (mesh size 300 µm, mouth area 0.3 m diameters were used in sampling of zooplankton. The samples were preserved with 5% formaldehyde and organisms were examined under stereo zoom microscope. The identification of phytoplankton bloom and zooplankton tunicate was done by following standard taxonomic guide[19,20].

Temperature, dissolved oxygen, pH and Salinity was measured by a pre calibrated YSI 6600 V2 multi parameter water quality measurement. Water quality nutrients samples from surface water were collected using Niskin water sampler at three locations as described in the phytoplankton. The samples were preserved in amber glass bottles in an ice box during transportation and analyzed by Dubai Municipality Central Laboratory Department. Analyses were carried out for the parameters using standard methodologies and detection limits as specified in EPA, USEPA and APHA.

RESULTS

The physical appearance of *N. scintillans* bloom patches at the surface water of the sampling stations along the Dubai coast during 19 January 2017 are depicted in Fig. 3a. The bloom of *N. scintillans* persisted for short duration of 3 days and then slowly disappeared. Microscopic examination of the phytoplankton samples shows bloom of *N. scintillans* (Fig. 3b). The extent of *N. scintillans* bloom was observed in form of patches covering an area of 200-300 m along the coast off Dry docks, South of world island and Ras Ghantoot (Fig. 1). Quantitative abundance of phytoplankton cell counts were 2.0, 5.4 and 2.4×10^3 mL^{-1} at off Dry dock, South of world island and Ras Ghantoot, respectively.

Physico-chemical properties of the sampling locations during the bloom event are shown in Fig. 4, 5 and 6. During the bloom the surface water temperature values were found in a range of 22.41-21.77°C. Surface salinity variation was 37.73-38.59%. Variation in dissolved oxygen and pH were in the ranges of 7. 21-7.91 and 7.98-8.04, respectively.

The concentrations of total nitrogen were 1.12 mg L^{-1}, nitrate-nitrogen value of 0.2 mg L^{-1} and phosphate-phosphorus was 2.29 mg L^{-1} from off Dry dock. During the bloom period total nitrogen concentrations was 0.4 mg L^{-1}, nitrate-nitrogen <0.05 mg L^{-1} and the phosphate-phosphorus concentration was 5.99 mg L^{-1} at South of world islands. The

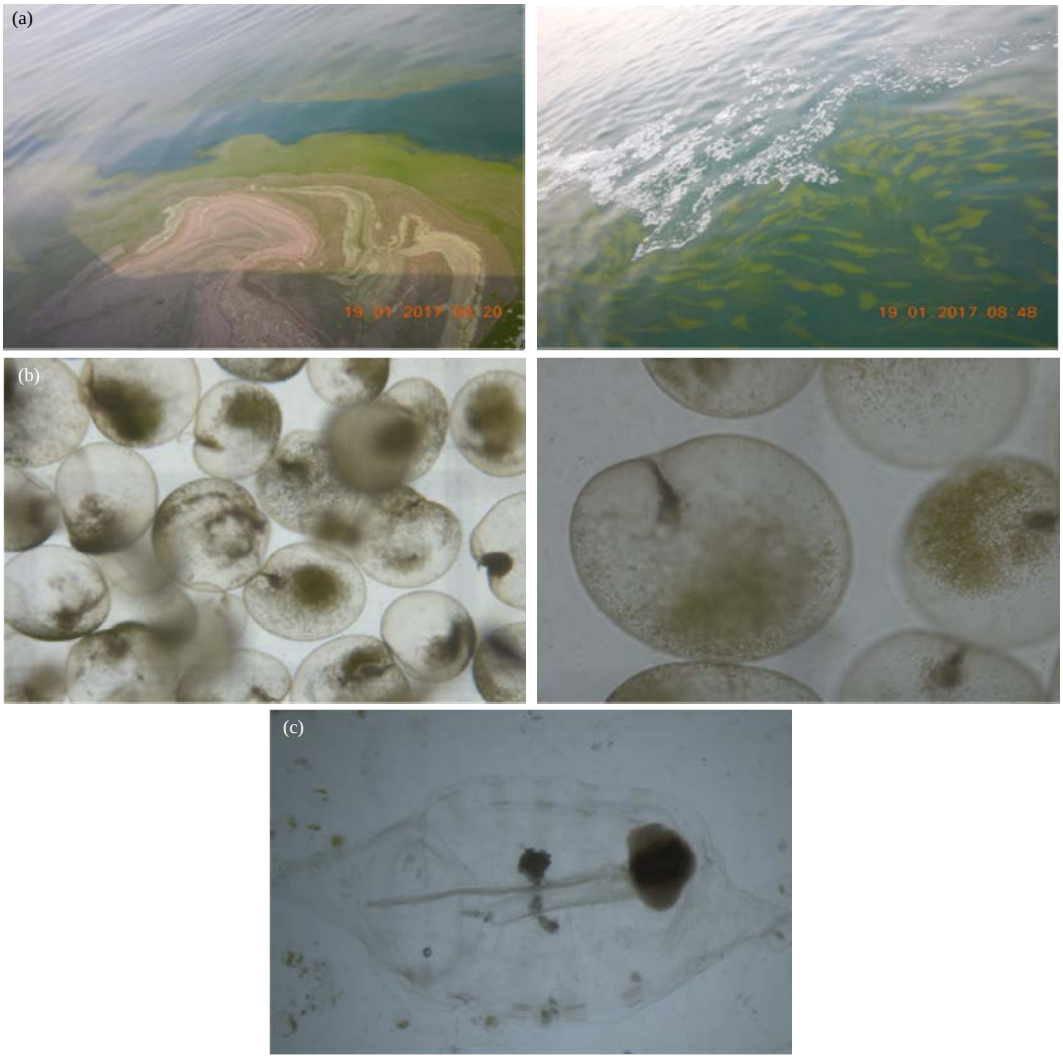

Fig. 3(a-c): (a) Algal blooms, (b) *Noctiluca scintillans* and (c) *Thalia* sp. (Salps)

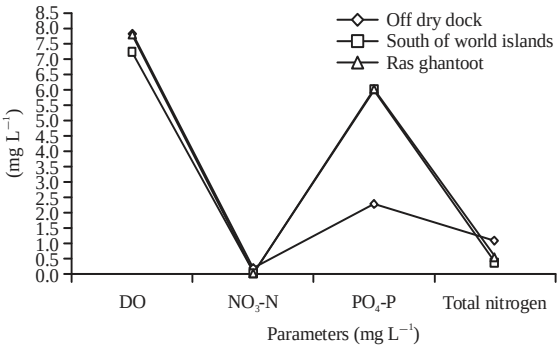

Fig. 4: Concentrations of dissolved oxygen and nutrients from different locations

surface water nutrients such as total nitrogen concentrations was 0.61 mg L^{-1}, phosphate-phosphorus value of 6.02 mg L^{-1} and nitrate-nitrogen concentration was found to be less than 0.05 mg L^{-1} from Ras Ghantoot. The values of Chlorophyll were observed as 586 mg m^{-3}, carotenoids of 603 mg m^{-3} and phaeophytin of 367 mg m^{-3} from off dry dock. Chlorophyll values were found to be 713 mg m^{-3}, carotenoids of 1992 mg m^{-3} and phaeophytin of 1883 mg m^{-3} from South of world islands. Chlorophyll values recorded were 842 mg m^{-3}, carotenoids of 1544 mg m^{-3} and phaeophytin of 1045 mg m^{-3} from Ras Ghantoot. The identified species of salps in the coastal water of Dubai was *Thalia* sp. (salps) as shown Fig. 3c.

DISCUSSION

Patches of dense green algal blooms were observed during a short period of 19-21 January, 2017 along Dubai

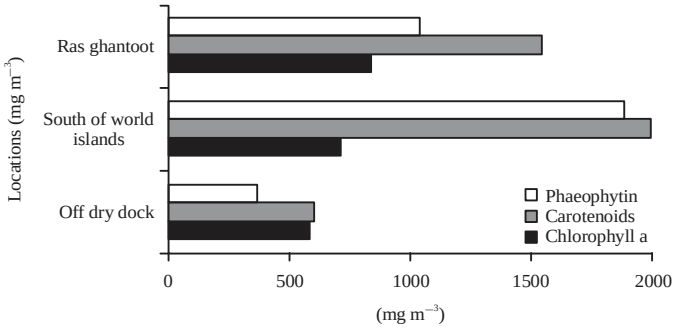

Fig. 5: Concentrations of chlorophyll pigments from different locations

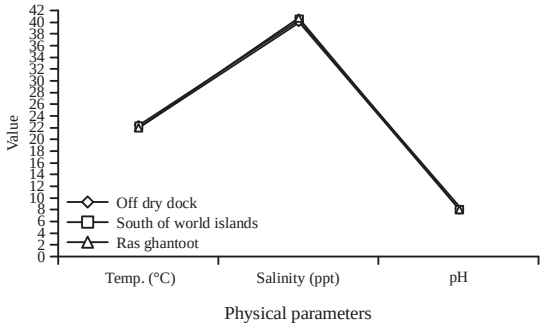

Fig. 6: Physico-chemicals parameters from different locations

coastal waters. The dense algal blooms in the phytoplankton samples were consist of one dominant species of dinoflagellate identified as *N. scintillans.* The blooms of *N. scintillans* were concurrently associated with enormous numbers of *Thalia* sp. (salps) in the zooplankton samples. Availability of food and calm sea conditions in the photic zone are recognized as key factors of sudden increase in abundance of *N. scintillans* during spring season[8]. The blooms of *N. scintillans* have been associated with higher levels chlorophyll a in many previous studies[21,22,23,24], which is coherent with this study results of elevated chlorophyll a, carotenoids and phaeophytin during the bloom period of January 2017. Our results further revealed that the levels of temperature and salinity were recorded in the range of 21.73-22.41°C and 39.73-40.59% with calm weather condition, respectively. Such levels and conditions were identified as most favorable for the bloom formation of *N. scintillans* along Dubai coastal waters. *N. scintillans* is a *euryhaline* species and growth and population generally affected by the salinity levels[25]. Previous assessment of primary production and plankton samples from the Arabian Sea also agree with our finding that *N. scintillans* dominant throughout the spring during inter-monsoon season[26]. Therefore, the prime factor identified for the bloom of *N. scintillans* was favorable temperatures and salinities rather than eutrophication in Dubai coastal water[10].

Phytoplankton blooms usually occurs in summer, when the concentrations of inorganic nutrients (silicates, nitrogen and phosphates compound) increases in the water column. Nitrogen and phosphorus compounds are essential plant nutrients, which occurs naturally in the water quality[27,28], however increased accessibility of these nutrients from point and non-point sources cause significant imbalances in the water quality and algal blooms[27]. The rich supply of nutrients brought in by the eutrophication events increases the concentrations of dissolved inorganic nitrogen in the water column to concentrations well above ambient levels[29]. Rapid population growth of *Noctiluca* has been recorded following phytoplankton blooms[30,31]. An increase in *Noctiluca* abundance has also been linked to increasing eutrophication, possibly caused indirectly by an increase in prey abundance[32]. However, *Noctiluca miliaris* has recently been observed to be dominating phytoplankton blooms in the Northeastern Arabian Sea during the winter monsoon[33]. During period of *N. scintillans* bloom, the nitrate concentrations in our study were low whereas the levels of phosphate (2.29-6.02 mg L^{-1} and total nitrogen (0.61-1.12 mg L^{-1}) were high. The high values of phosphate and total nitrogen during the *N. scintillans* bloom could be associated with flow of nutrients and decomposition of organic matter, respectively. Phosphate constitutes the most important inorganic nutrient that can limit the phytoplankton production in marine ecosystem and thereby the overall ecological processes. The sudden increase in the phosphate levels due to unknown source probably surge the phytoplankton density dominated by an emergent species *N. scintillans.* Climate change, clam sea condition, favorable temperature, salinity and high phosphate probably upwelling the *N. scintillans* bloom for a short period of time along in Dubai coastal water during January, 2017. Such incidences are quite common in the

Arabian Sea, where high concentration of chlorophyll *a* usually recorded in the satellite images of February-March[34]. The presence of *Thalia* sp. (Salps) in enormous number during the bloom of *N. scintillans* bloom could be associated with availability of feed along Dubai coastal waters. *Thalia* sp, which is a Thaliaceans are gelatinous holoplanktonic tunicates whose population dynamics, life history and feeding biology contrast to copepods and other planktonic crustaceans[35]. Several factors also attribute to salps growth such as seawater temperature, local rainfall and chlorophyll a concentrations. Therefore, high numbers of *Thalia* sp. (salps) along Dubai coastal water could be associated with the availability of the high concentrations of their feed.

CONCLUSION

Calm sea condition with favorable temperature and salinity in the presence of high phosphate leads to short term *N. scintillans* bloom in the coastal water of Dubai during early spring season. Elevated levels of chlorophyll a and satellite images support the nature of algal bloom along Dubai coastal waters and Arabian Gulf. Density of *Thalia* sp. increased drastically when *N. scintillans* population decline. This indicates *Thalia* sp. (salps) as an active grazer of *N. scintillans*.

The recorded incidence necessitates the need for continuous monitoring of physico-chemical parameters on a long-term basis with monitoring of planktons in the coastal waters of Dubai. Such monitoring program will also require for the prevention of harmful algal bloom.

SIGNIFICANCE STATEMENTS

This study discovers a significant relationship between the blooms of *Noctiluca scintillans* and *Thalia* sp. (salps-zooplankton tunicate) with reference to change in water quality. For first time in Dubai Coastal waters salps bloom was observed immediately after the bloom of *Noctiluca scintillans*. This study can be beneficial for the researchers, who are studying the biological phenomenon of the Arabian Gulf.

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