Spirogyra africana (Fritsch) Czurda bloom and associated fishing impairment in a tropical freshwater lagoon

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Abstract. Greenish and slimy materials clogging fishing nets in parts of the Lekki Lagoon, Nigeria, were investigated in relation to water quality characteristics. Blooms were caused by the filamentous green alga *Spirogyra africana* (Fritsch) Czurda, which was the sole causative organism. Evaporative concentration leading to higher nutrients levels, increased light availability, hydrological stability, and absence of aquatic macrophytes covering the water surface are factors that probably encouraged the bloom. Reduced floodwater inputs and improved insolation are also possible implicated causative factors. The bloom condition was only recorded in the dry season and was absent during the rains.

Key words: green algae, filament, fishing net, lagoon, rainfall, salinity.

INTRODUCTION

Literature on algal blooms in Nigeria is scanty although in the last two decades the number of papers dealing with blooms in the fresh, brackish, and marine zones has been increasing (Nwankwo, 1993; Nwankwo et al., 2003, 2004; Onyema & Nwankwo, 2006, in press). Nwankwo et al. (2003) surveyed harmful and/or toxic algal species in coastal waters of south-western Nigeria. Recently, a report by Onyema & Nwankwo (in press) documented an incidence of substratum discolouration of parts of the Lagos Lagoon. According to the report the discolouration was caused by the cyanobacterium *Oscillatoria tenuis*. Blooms of other cyanobacteria (*Microcystis*, *Anabaena*, *Trichodesmium*) as well as of diatoms (*Coscinodiscus*, *Bellerochea*, *Chaetocerus*, *Cerautolina*) and dinoflagellates (*Ceratium*, *Noctiluca*) have also been reported in waters of south-western Nigeria (Nwankwo, 1993; Nwankwo et al., 2003, 2004; Onyema & Nwankwo, 2006).

The lagoons of south-western Nigeria are a meandering net of nine lagoons with innumerable creeks (Webb, 1958; Nwankwo, 2004; Emmanuel & Kusemiju, 2005; Onyema & Nwankwo, 2006). Fishing in these lagoons is an important livelihood for folks in the region. Fishing in this regard is largely artisinal with an array of gear types used, especially nets (Emmanuel, in press). Cast nets and gill nets, are according to workers, the most widely used artisanal fishing gears in Nigerian waters (Reed et al., 1967; FAO, 1969; Udolisa & Solarin, 1979; Emmanuel & Kusemiju, 2005). According to Fagade (1969) and Kusemiju (1973), the cast net is the commonest fishing gear in the Lagos and Lekki lagoons. In the Lekki Lagoon most fish species are caught with boat seine, a community-based fishing operation, which requires between 15 and 30 individuals of high strength. Reports from the Lekki Lagoon in 2006 and particularly in the dry season, implicated a web of greenish slime in water, which clogged up the net meshes as it was hauled hence impairing fishing operations. Algal blooms are usually a reflection of the nutrient levels of an aquatic system and these in turn affect the fish assemblages and fisheries components.

Previous works on the Lekki Lagoon include those of Ikusemiju (1973, 1975) and Ikusemiju & Olaniyan (1977), which deal with the diverse fishes of the lagoon and present biological information on the catfish species endemic to the lagoon. We report here an investigation into the greenish and slimy materials observed to smear and attach to fishing nets impairing fishing operations and diminishing catches for the fishermen in parts of the Lekki Lagoon.

MATERIALS AND METHODS

Description of the study site

The Lekki Lagoon is a large expanse of shallow fresh water located in both Lagos and Ogun states of Nigeria. The lagoon covers an area of nearly 247 km^2 (Kusemiju, 1973) (Fig. 1). A greater part of the lagoon is shallow and less than 3.0 cm deep, while there are areas of up to 6.4 km in depth (Kusemiju, 1973). The lagoon is located between longitudes 4°00′ E and 4°12′ E and latitudes 6°25′ N and 6°37′ N. The lagoon is fed by the Oni River in the north-eastern part, while the Oshun and Saga rivers flow into its north-western part. The lagoon supports a major fishery with as many as 30 fishing villages/settlements located on the edge of the lagoon including Origbe, Dopemu, Lupaye, Imoba, and Emina. There are well over 2000 fishing canoes operating in the lagoon and at least 10 000 active fishermen in the region. The fish species common to the area are freshwater endemic species.

Collection of water and algal samples

Water samples for the analysis of water chemistry characteristics were collected between 12 and 2 h on each occasion with a 1.50 cl plastic container with a screw cap. Samples were collected from five stations of the area where these green smears appeared on fishing nets during and after fishing to provide data for the wet and dry season conditions. Samples were collected just below the water surface in 500 mL plastic containers with screw caps.

Algal samples were collected from at least five fishing nets after fishing operations in the Lekki Lagoon for the dry season. No smears were recorded in the wet season. The suspected algal smears were scraped off the nets into a 100 mL wide mouth screw capped container with a spatula. Collections from

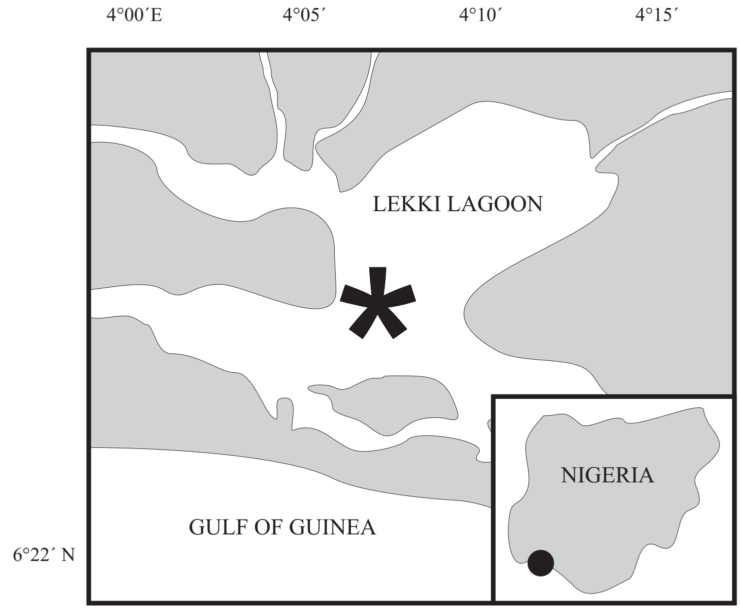

Fig. 1. Lekki Lagoon, Lagos. The ★ sign shows the area were blooms were recorded in the dry season.

different nets in the area were also carried out for comparison. The collected samples were preserved with 4% buffered formalin and the containers were labelled appropriately before transportation to the laboratory for microscopic analysis.

Physico-chemical analysis

Air and surface water temperatures were measured in situ using a mercury thermometer while water depth was estimated with a calibrated pole. Total dissolved solids were determined by evaporating a 100 mL aliquot at 105 °C and total suspended solids were estimated by filtering 100 mL of sample through a pre-weighed filter paper, dried to constant weight, and reweighed. Conductivity was measured using a HANNA instrument. Salinity was determined using the silver nitrate chromate method. Surface water pH was determined with a Griffin pH meter (Model 80) and dissolved oxygen was measured using a Griffin oxygen meter (Model 40). Biological and chemical oxygen demands were measured using methods described in APHA (1998) for water analysis. Calorimetric methods using a Lovibond Nesslerier were adopted for the direct determination of phosphate phosphorus and nitrate nitrogen values while sulphate levels were measured using the gravimetric method. Calcium and magnesium ions were determined using a 400 single channel, low flame photometer. Concentrations of copper, iron, and zinc were determined with an atomic absorption spectrophotometer (A.A.S.) Uni Cam 99 model as described in APHA (1998).

Biological analysis

In the laboratory the smear samples were investigated at different magnifications using a Wild II binocular microscope with a calibrated eyepiece. The averages were recorded. To create a suitable sample mount, a dropper was used to take in at least 1.5 mL of the sample. After shaking the sample properly one or two drops of concentrated sample from the dropper were gently placed on a glass slide (7.5 cm by 2.5 cm) and covered with a glass slide (2 cm by 2 cm). The mount was then placed on the microscope stage, fitted in, and all transects were thoroughly inspected for algae. Appropriate materials including Smith (1950), Bold (1967), Whitford & Schmacher (1973), and Gerrath (2003), were used to aid identifications.

RESULTS

Physico-chemical characteristics

Estimates for air temperature, depth, and other water quality indices from the five different stations sampled were averaged and are presented in Table 1. Differences

Table 1. Water quality characteristics representing the wet and dry season conditions of parts of the Lekki Lagoon

Parameter	Wet season (August, 2005)	Dry season (March, 2006)
Air temperature, °C	26.2 ± 1.31	31.5 ± 1.85
Water temperature, °C	28.4 ± 1.43	32.0 ± 1.52
Depth, cm	1.42 ± 0.62	1.31 ± 0.51
Total dissolved solids, mg L^{-1}	296 ± 1.73	556 ± 1.87
Total suspended solids, mg L^{-1}	40.8 ± 5.85	38.9 ± 4.21
Chloride, mg L^{-1}	150 ± 1.67	344.2 ± 2.75
Total hardness, mg L^{-1}	100.0 ± 2.42	278 ± 3.83
pH	7.49 ± 0.04	6.8 ± 0.08
Conductivity, μS cm^{-1}	480 ± 2.78	862 ± 3.50
Salinity, ‰	0.44 ± 0.03	0.65 ± 0.05
Alkalinity, mg L^{-1}	20.0 ± 0.05	28.2 ± 0.07
Acidity, mg L^{-1}	10.8 ± 0.23	8.9 ± 0.57
Dissolved oxygen, mg L^{-1}	4.2 ± 0.13	4.5 ± 0.21
Biological oxygen demand, mg L^{-1}	13.3 ± 0.79	8.1 ± 0.62
Chemical oxygen demand, mg L^{-1}	49.5 ± 3.65	21.2 ± 2.76
Nitrate nitrogen, mg L^{-1}	10.1 ± 0.45	23 ± 0.62
Phosphate phosphorus, mg L^{-1}	0.42 ± 0.05	2.3 ± 0.68
Sulphate, mg L^{-1}	5.2 ± 0.98	12.5 ± 1.31
Silica, mg L^{-1}	5.4 ± 0.62	2.4 ± 0.78
Calcium, mg L^{-1}	25 ± 0.34	60.0 ± 0.41
Magnesium, mg L^{-1}	5.1 ± 0.08	31.2 ± 3.45
Copper, mg L^{-1}	0.001 ± 0.00	0.003 ± 0.00
Iron, mg L^{-1}	0.39 ± 0.01	0.22 ± 0.02
Zinc, mg L^{-1}	0.001 ± 0.00	0.002 ± 0.00

between the wet and dry season values were recorded. For instance, higher estimates were recorded in the dry than in the wet season for air and water temperatures, total dissolved solids, chloride, total hardness, conductivity, salinity, alkalinity, dissolved oxygen, nitrate nitrogen, phosphate phosphorus, sulphate, calcium, magnesium, copper, and zinc. Conversely, depth, total suspended solids, pH, acidity, biological and chemical oxygen demands, silica and iron showed higher values in the wet than in the dry season.

Microscopic analysis of the green smear samples from fishing nets in the Lekki Lagoon revealed *Spirogyra africana* as the sole organism constituting the fishing impairment through clogging the nets. Figure 2 shows smear of *Spirogyra africana* on a boat seine net in the Lekki Lagoon. Numerous very long filaments forming thick mats (Fig. 3) were observed. Each cell within each filament was between 40 and 90 μm in length with at least more than 35 cells forming any single filament.

DISCUSSION

The air and water temperature values presented in Table 1 are known for the tropics (Webb, 1960). According to the literature, the Lekki Lagoon is essentially a freshwater lagoon as reflected by its water chemistry characteristics and regime. For instance, Williams (1961), cited in Trewavas (1983), described the Lekki Lagoon as fresh while Vanden Bossche & Bernacsek (1990) recorded a salinity range of 0.0–0.5‰ for this lagoon. The highest salinity recorded for this study was 0.65‰. Kusemiju (1973) recorded a range between 0.04 and 0.30‰.

Evaporative concentration and reduced or minimal floodwater/river inputs could have encouraged increases in salinity, chloride, total dissolved solids, total hardness, conductivity, and cation values among others in the dry season. However, reduced values were recorded for total suspended solids, pH, biological and chemical oxygen demands in the same season. It is possible that these key changes in water chemistry characteristics between seasons coupled with higher nutrient levels, water clarity, and insolation encouraged the *Spirogyra* bloom. The low cation content recorded is probably a reflection of the low salinity, total dissolved solids, and conductivity values.

According to Bold (1967), the genus *Spirogyra* usually forms floating, bright green frothy or slimy masses, usually referred to as pond scums. Occurrence of *Spirogyra africana* was reported in south-western Nigeria also earlier (Nwankwo, 1988; Onyema et al., 2003, 2007). According to Gerrath (2003), *Spirogyra* is extremely common and occasionally an abundant genus in standing water with most species collected from permanently or temporarily stagnant water habitats with neutral or slightly acidic pH values. In this study, reduction in pH from 7 in the wet season to 6.8 in the dry season could also have acted as a complementary factor inducing the bloom. In addition, a broad range of habitat preferences are exhibited by various members of the conjugating green algae (Gerrath, 2003). Onyema & Nwankwo (in press) also reported blooms of a

Fig. 2. Smears of *Spirogyra africana* filaments on a fishing net in the Lekki Lagoon (March, 2007).

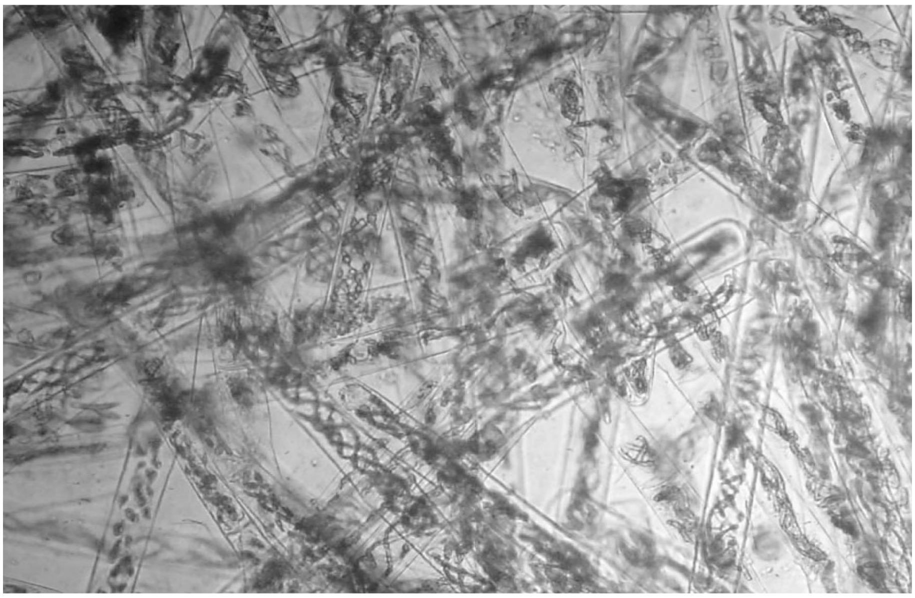

Fig. 3. The smear on fishing nets reveals *Spirogyra africana* (Fritsch) Czurda as the causative organism.

cyanobacterium in parts of the Lagos Lagoon floor. These authors implicated high nutrient levels, suitable sediment type, absence of flood conditions, and low salinity as possible causal factors that lead to the cyanobacterium substratum discolouration. *Oscillatoria tenius* was the causative organism in that study.

The disappearance of the *Spirogyra africana* bloom with the onset of the rains could have been due to the flushing effect of floodwaters and dilution. It is possible that nutrient levels remained high enough throughout the dry season hence sustaining favourable conditions for the bloom as reflected by its persistence until the onset of the rains. According to Wehr & Sheath (2003), a large body of data clearly indicate that phytoplankton production and biomass in most benthic systems are controlled by nutrients and especially by the phosphate supply. Rains in this region are known to break down environmental gradients in aquatic ecosystems (Nwankwo & Akinsoji, 1989). Webb (1960) is of the opinion that rainfall in the tropics is more important than temperature in the control of ecological variability.

As reported by fishermen using cast net and beach seines as their chief fishing gear, fish catches were better in the dry than wet season. According to Emmanuel & Kusemiju (2005), apart from being the best fishing gear in terms of catch per unit effort of fish caught, the cast net also captures fish live in its pocket. The most common fish caught at that time was *Tilapia guineensis*. This species was reported as a phytophagous feeder (Fryer & Iles, 1972), hence it possibly benefits in terms of diet from the bloom. *Tilapia guineensis* is endemic to the lagoon and the region (Kusemiju, 1973; Emmanuel & Kusemiju, 2005; Emmanuel & Onyema, 2006). Other common fish species caught include *Caranx hippo*, *Chrysicthys nigrodigitatus*, *C. walkeri*, and *Mormyrus rume*.

The effect of the bloom was much felt in fishing with the boat seine net: it was reported by fishermen that it increases the fishing period by extra two to four hours. It was further noted to destroy the seine cod-end, thus resulting in catch loss. The smear also gives off a putrefying odour due to the rotting of the algae if left unwashed after the fishing operation. This also affects the longevity of the nets. Finally, however, there is need for further studies on the effect of the bloom on the fish assemblage and fisheries composition in the lagoon.

REFERENCES

APHA (American Public Health Association). 1998. *Standard Methods for the Examination of Water and Waste Water*. 20th edn. APHA, New York.

Bold, H. C. 1967. *Morphology of Plants*. Harper and Row Publishers, New York.

Emmanuel, B. E. In press. The Artisanal Fishing Gears, Crafts Technology and Their Efficiency in the Lekki Lagoon, Nigeria. PhD Thesis. University of Lagos, Nigeria.

Emmanuel, B. E. & Kusemiju, K. 2005. Variations in cast net catches in a tropical brackish water pond. *J. Sci. Technol. Environ.*, **5**(1&2), 6–14.

Emmanuel, B. E. & Onyema, I. C. 2006. The plankton and fishes of a tropical creek in south-western Nigeria. *Turkish J. Fish. Aquat. Sci.*, **7**(2), 105–114.

Fagade, S. O. 1969. The Biology of Some Fishes and the Fisheries of the Lagos Lagoon. PhD Thesis. University of Lagos, Nigeria.

FAO. 1969. *Fisheries Survey in the Western and Mid-Western Regions of Nigeria*. FAO/Sf: 74/NIR 6.

Fryer, G. & Iles, T. D. 1972. *The Cichlid Fishes and the Great Lakes of Africa*. Oliver and Boyd, Edinburgh.

Gerrath, J. F. 2003. Conjugating green algae and desmids. In *Freshwater Algae of North America. Ecology and Classification* (Wehr, J. D. & Sheath, R. G., eds), pp. 353–381. Academic Press, New York.

Ikusemiju, K. 1973. A Study of the Catfishes of Lekki Lagoon with Particular Reference to the Species, *Chrysichthys walkeri* (Bagridae). PhD Thesis, University of Lagos, Nigeria.

Ikusemiju, K. 1975. A comparative racial study of the catfish *Chrysichthys nigrodigitatus* (Lacepede) from Lagos and Lekki lagoon, Nigeria. *Bull FAN*, **37A(A)**, 887–898.

Ikusemiju, K. & Olaniyan, C. I. O. 1977. Distribution, reproduction and growth of the catfish, *Chrysichthys walkeri* (Gunther) in the Lekki Lagoon, Nigeria. *J. Fish Biol.*, **8**, 453–458.

Kusemiju, K. 1973. A Study of the Catfishes of Lekki Lagoon with Particular Reference to the Species *Chrysichthys walkeri* Bagridae. PhD Thesis. University of Lagos, Nigeria.

Nwankwo, D. I. 1988. A preliminary check-list of planktonic algae of Lagos Lagoon. *Nigerian J. Basic Appl. Sci.*, **2**(1), 73–85.

Nwankwo, D. I. 1993. Cyanobacteria bloom species in coastal waters of South Western Nigeria. *Arch. Hydrobiol. Suppl.*, 90, 553–542.

Nwankwo, D. I. 2004. *The Microalgae: Our Indispensable Allies in Aquatic Monitoring and Biodiversity Sustainability*. Inaugural lecture series. University of Lagos Press, Nigeria.

Nwankwo, D. I. & Akinsoji, A. 1989. The benthic algal community of a sawdust deposition site in Lagos Lagoon. *Int. J. Ecol. Environ. Sci.*, **15**, 197–204.

Nwankwo, D. I., Onyema, I. C. & Adesalu, T. A. 2003. A survey of harmful algae in coastal waters of south-western Nigeria. *J. Nigerian Environ. Soc.*, **1**(2), 241–246.

Nwankwo, D. I., Onyema, I. C., Labiran, C. O., Otuorumo, O. A., Onadipe, E. I., Ebulu, M. O. & Emubaiye, N. 2004. Notes on the observations of brown water discolouration off the light house beach, Lagos, Nigeria. *Discovery Innov.*, **16**(3), 111–116.

Onyema, I. C. & Nwankwo, D. I. 2006. The epipelic assemblage of a polluted estuarine creek in Lagos, Nigeria. *Pollut. Res.*, **25**(3), 459–468.

Onyema, I. C. & Nwankwo, D. I. In press. An incidence of substratum dicolouration in a tropical West African lagoon. *Zoologist*.

Onyema, I. C., Otudeko, O. G. & Nwankwo, D. I. 2003. The distribution and composition of plankton around a sewage disposal site at Iddo, Nigeria. *J. Sci. Res. Develop.*, **7**, 11–24.

Onyema, I. C., Okpara, C. U., Ogbebor, C. I., Otudeko, O. & Nwankwo, D. I. 2007. Comparative studies of the water chemistry characteristics and temporal plankton variations at two polluted sites along the Lagos lagoon, Nigeria. *Ecol. Environ. Conserv.*, **13**, 1–12.

Reed, W., Burchard, J. A., Hopson, J., Jennes, J. & Ibrahim, Y. 1967. *Fish and Fisheries of Northern Nigeria*. Ministry of Agriculture, Northern Nigeria, Gaskiya Cooperation, Zaira.

Smith, G. M. 1950. *The Fresh-water Algae of the United States*. McGraw-Hill, London.

Trewavas, E. 1983. *Tilapine Fishes of the Genera* Sarotherodon*,* Oreochromis *and* Danakilia. The Dorset Press, Dorchester.

Udolisa, R. E. K. & Solarin, B. B. 1979. Design characteristics of cast nets and gillnets in Lagos lagoon, Nigeria. NIOMR Occasional Paper No. 31.

Vanden Bossche, J. P. V. & Bernacsek, G. M. 1990. Source book for the inland fishery resources of Africa. CIFA Technical Paper 18/2. FAO, Rome.

Webb, J. E. 1958. The ecology of Lagos Lagoon. 1: The lagoons of the Guinea coast. *Philos. Trans. Roy. Soc. Lond., B*, **241**, 307–317.

Webb, J. E. 1960. Biology in the tropics. *Nature* (London), **188(4151)**, 617–619.

Wehr, J. D. & Sheath, R. G. 2003. Freshwater habitat of algae. In *Freshwater Algae of North America. Ecology and Classification* (Wehr, J. D. & Sheath, R. G., eds), pp. 11–57. Academic Press, New York.

Whitford, L. A. & Schmacher, G. H. 1973. *A Manual of Freshwater Algae*. Sparks Press Raleigh, NC.

Spirogyra africana (Fritsch) Czurda õitseng ja sellega seotud kalandusprobleemid troopilises mageveelises laguunis

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Lekki laguunis Nigeerias uuriti veekvaliteediga seotud näitajaid ja selgitati välja, mis põhjustab kalavõrkude ummistumist. Selle nähtuse taga oli niitja rohevetika *Spirogyra africana* (Fritsch) Czurda ulatuslik õitseng. Õitsengu põhjustas mitme keskkonnafaktori koosmõju: suurenenud aurumisest tingitud kõrgemad vee toiteelementide sisaldused, paremad valgustingimused, hüdroloogiline stabiilsus ja suurtaimestiku puudumine. Alternatiivseteks võimalusteks on veel vähenenud magevee sissevool ja suurenenud päikesekiirgus. Õitseng esines vaid kuival aastaajal ja puudus vihmaperioodil.