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A SPECTRUM OF PHYTOPLANKTON FLORA ALONG SALINITY GRADIENT IN THE EASTERN NIGER DELTA AREA OF NIGERIA

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The distribution of phytoplankton at different salinities in the eastern Niger Delta of Nigeria was investigated. The paper aims to contribute to the dearth of salinity-based distribution of organisms as well as phytoplankton studies in the region. A total of 64 taxa of phytoplankton were identified and classified into four divisions of Bacillariophyta (49 taxa), Chlorophyta (7 taxa), Cyanophyta (4 taxa) and Dinophyta (4 taxa). Salinity was found to produce floristical gradients. Three assemblages of phytoplankton were recognized which were those found at low narrow salinity range, those occurring at wide salinity zone and those with high narrow salinity range. Phytoplankton found in narrow salinity range were predominantly chlorophytes, while those occurring at high and narrow salinity were dinoflagellates and some diatoms.

Key words: Niger Delta, phytoplankton, profile, salinity

INTRODUCTION

Some research work on phytoplankton in the Niger delta date back to the early thirties when Mill (1932) described the diatoms of Warri river in the western Niger Delta. Similarly, Fox (1957) and Hendy (1958) reported marine algae between Lagos and Port Harcourt. In 1986, Nwadiaro and Ezefili produced a check-list of phytoplankton in the new Calabar river in the lower Delta. Recent studies in the area are those of Opute (1990, 1991, 1992) on the phytoplankton flora of Warri/Forcados estuaries. Similarly, Nwankwo (1988, 1991, 1993, 1994, 1996*b*) studied the phytoplankton in Lagos Lagoon. Also Nwankwo (1996*a*) reported the desmids from the freshwater swamps in this region while Kadiri (1999) provided information on the phytoplankton distribution in Nigerian coastal waters.

Studies on salinity-based distribution of organisms in this region barely exist. This study therefore is aimed at making a contribution to the existing dearth of phytoplankton studies in the region as well as provides information on the salinity ranges of the phytoplankton species encountered.

Study area

The study area (Fig. 1) represents an extensive expanse of water between Sego Creek and San Batholomoeo in the eastern Niger Delta. It is situated between longitude 57°500 N and latitude 46°5 000 E. The area is located in the mangrove swamp areas. Generally, these are of three major types – the non-tidal freshwater swamps, tidal freshwater wamps and mangrove swamp (Nwankwo 1996*a*). The ecology of the area is regulated by semi-diurnal tides and flood associated with seawater and rainwater incursions (Nwankwo 1996*a*). The predominant aquatic macrophytic vegetation are *Rhizophora mangle, Avecinia, Acrotischum, Laguncularia* and *Paspalum* (Nwankwo 1996*a*).

MATERIAL AND METHODS

Sampling was done in the dry-wet season between 19 June and 11 July, 1996. Sampling was done along a continuum of salinities, 3.0–11.6‰ in the study area. Samples were collected at low tide. Two sets of samples were col-

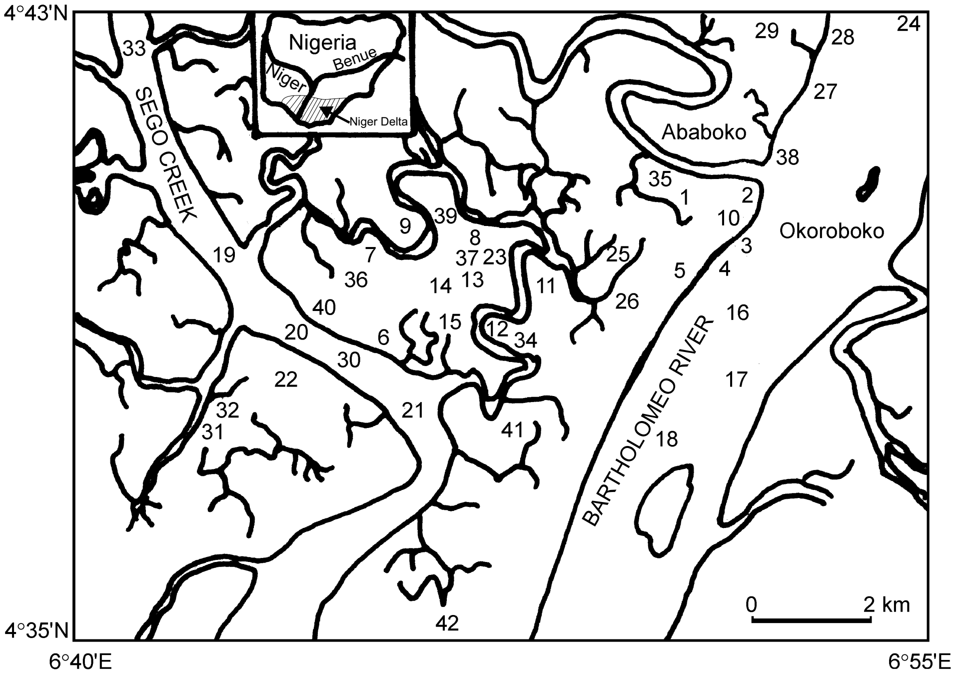

Fig. 1. The study area

lected. Water samples were collected from the different areas in the region into clean plastic containers for salinity estimation, which was later done in the laboratory by the Mercuric nitrate titrimetric method using a Hach Digital titrator. Phytoplankton samples were similarly collected from the different sites.

Taxonomic inventorization

For phytoplankton studies, samples were collected from the sampling locations employing the horizontal hauls of a 55 m mesh plankton net from the surface of the water. The samples were concentrated and preserved in 4% formalin. Prior to microscopic examination, temporary mount of the phytoplankton were made by taking a drop of the thoroughly mixed sample onto a slide, taking care to avoid trapping any bubble. These were then examined under a compound research microscope (Leitz Orthoplan Model 543437). These were identified using Subramanyan (1946), Hendey (1958), Klement (1964), Hustedt (1930–1966), Huber-Pestalozzi (1942–1985), Bourrelly (1970), Patrick and Reimer (1966, 1975) and Prescott (1975). The identifications were confirmed at the Fritsch Collection of Algal Illustration, U. K.

RESULTS

Composition

The range of salinity found was 3.1 through to 11.6‰ for the various sites studied.

A total of 64 taxa of phytoplankton were identified during the study period. The taxa are represented in Figure 2. The diatoms have been arranged according to Hartley (1986). All the taxa found belong to four divisions: Bacillariophyta, Chlorophyta, Cyanophyta and Dinophyta. The qualitative composition of the phytoplankton flora shows that the diatoms constitute the largest proportion of the flora with 76.6%. Of these a total of 65% were mainly Pennales and the rest 35% Centrales. The largest family represented is Naviculaceae with 10 taxa followed by Nitzschiaceae with 6 taxa, Thalassiosiraceae with 5 taxa. The families Eupodiscaceae with Surirellaceae were represented by 4 taxa each. The Chlorophyta or green algae on the other hand which contributed 10.9% to the total phytoplankton flora, were represented by Zygnematales (3 taxa, one Desmidiaceae and 2 Zygnemataceae), 1 Volvocales (Volvocaceae), 2 Chlorococcales (Hydrodictyaceae) and 1 Ulothricales (Ulothricaceae). The blue-green algae (Cyanophyta) with 6.3% occurrence were composed of 1 Chroococcales (Chroococcaceae) – a unicellular *Chroococcus* *limneticum* and a colonial *Merismopedia elegans* and filamentous *Anabaena* and *Oscillatoria* species. Four taxa represented the Dinophyta, 2 taxa of *Ceratium* and 1 *Peridinium*, both members of Peridiniales and 1 *Dinophysis* species of

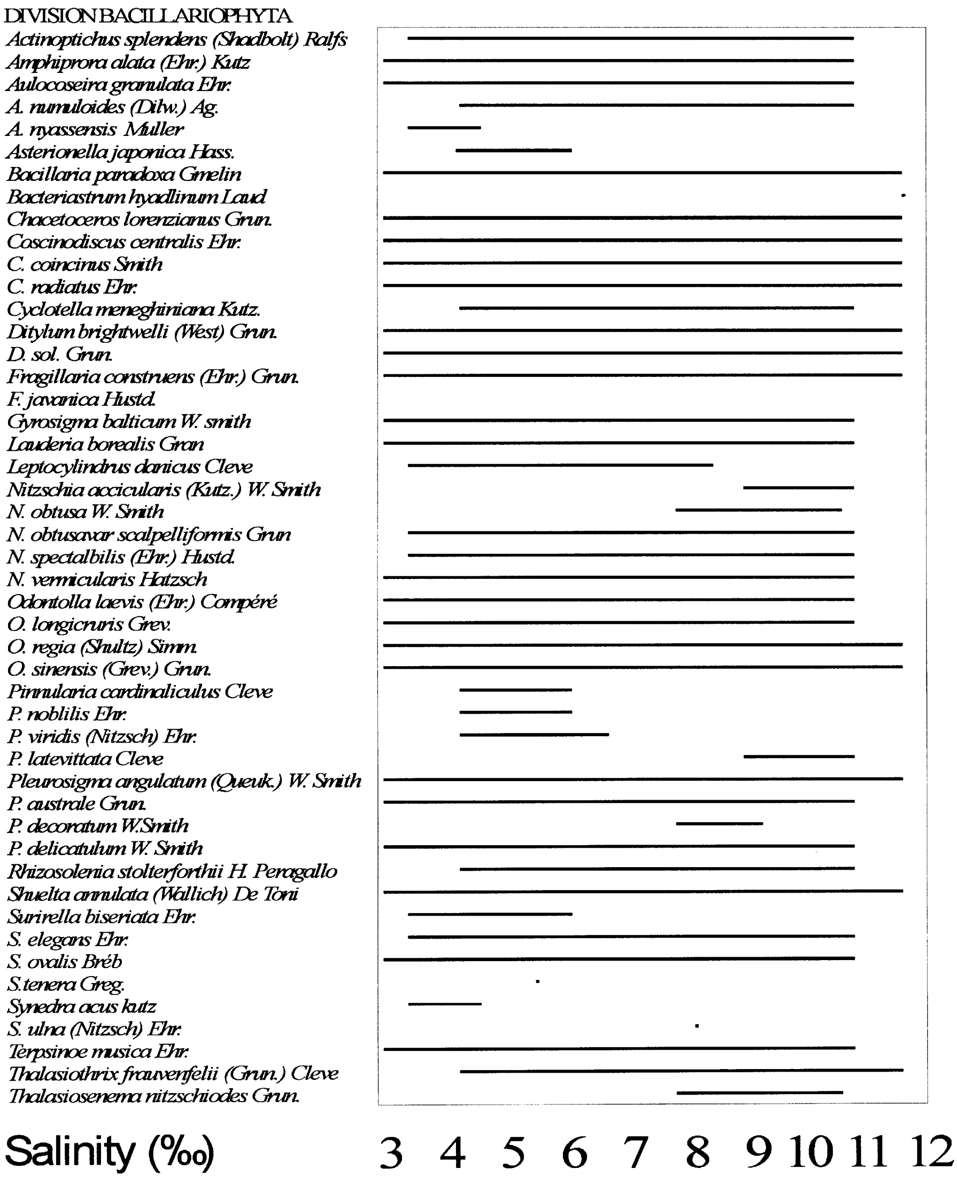

Fig. 2. Phytoplankton array along salinity gradient

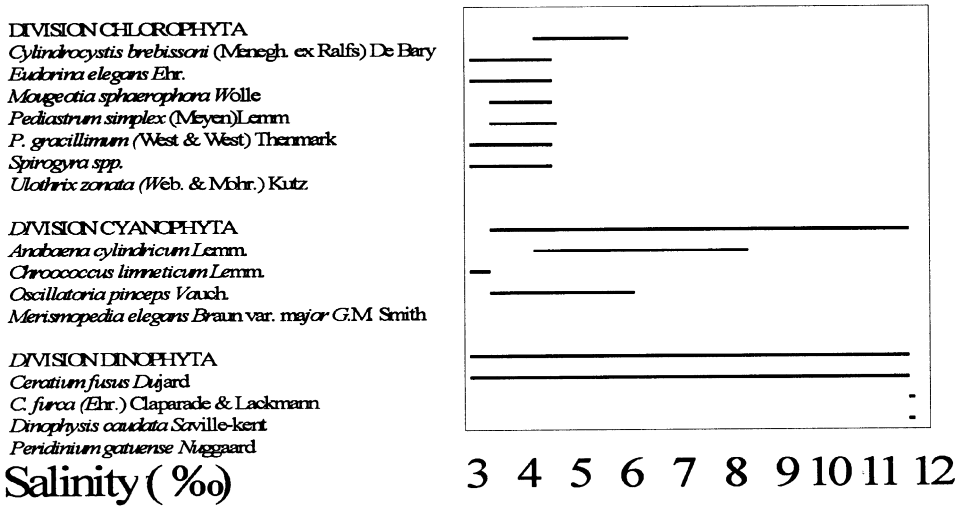

Fig. 2 (continued)

Dinophysiales. All Dinophyta division put together constituted 6.3% of the entire phytoplankton flora.

Distribution

The distribution of phytoplankton flora is depicted in Figure 2. The flora could conveniently be distinctly separated into three categories as follows:
– stenohaline species with low narrow salinity range,
– euryhaline species,
– stenohaline species with high salinity range.

Low stenohaline species. These represent species with low and narrow range of salinity of values between 3.1 and 4.7‰. The phytoplankton found in this group were predominantly Chlorophyta. Some members of Cyanophyta such as the filamentous *Oscillatoria princeps* and colonial *Merismopedia elegans* also belong to this group.

Euryhaline species. These are species, which were prevalent in salinity regions of between 3.1 to 11.6‰. Most of these can be said to exhibit typical euryhaline characteristics. Conspicuous species in this group include, among the diatoms, *Bacillaria paradoxa, Chaetoceros loernzianus, Coscinodiscus* species, *Ditylum brightwelli, Odontella longicruris, O. sinensis, Pleurosigma angulatum* and *Shuelta annulata*. Of the dinoflagellates were *Ceratium fusus* and *C. furca* and Cyanophyte *Anabaena cylindrica*. These taxa all thrive up to the upper limit (11.6‰) of salinity studied. Others which though also with wide tolerances of salinity survived lower upper limit of salinity (10.8‰). These include *Actinoptichus splendens, Amphiprora alata, Aulacoseira granulata, A. numuloides, Cyclotella meneghiniana, Nitzschia* sp., *Gyrosigima balticum, Lauderia borealis, Terpsinoe musica, Pleurosigma australe* and *P. delicatulum* among others. A few taxa such as *Synedra ulna, Pleurosigma decoratum* and *Surirella tenera* occurred at moderate salinity range of 6.2–8.5‰.

High stenohaline species. The phytoplankton flora of this group occurred at salinities of about 8 and 11.6‰. Such species are exclusively Bacillariophyta such as *Nitzschia accicularis, N. obtusa, Triceratium favus, Thalassiosira nitzschiodes, Pleurosigma decoratum, Pinnularia latevittata, Ditylum sol* and *Bacteriastrum hyalinum.*

Remarkably, dinoflagellates such as *Dinophysis caudata* and *Peridinium gatuense* were restricted to the highest salinity zone of 11.6‰.

DISCUSSION

The total of 64 taxa of phytoplankton reported in the area is considered of high diversity comprising mostly diatoms. A comparison of the qualitative taxonomic composition of phytoplankton in this study with that of Opute

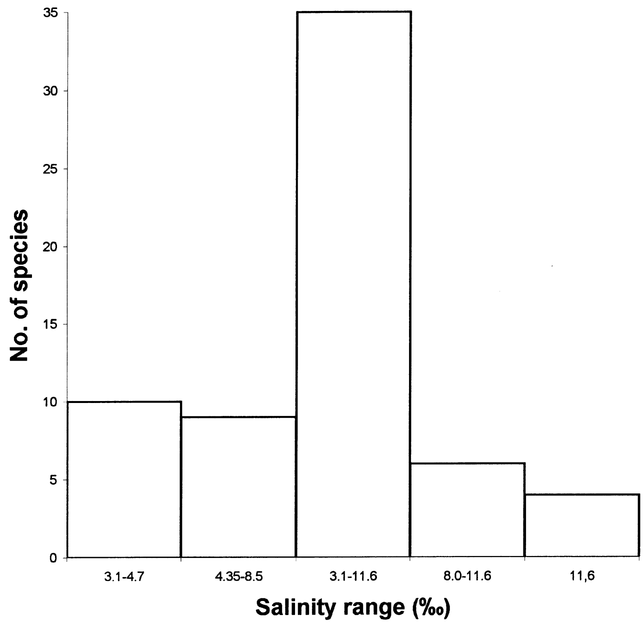

Fig. 3. Relative occurrence of species at different salinity ranges

(1990) in the western Niger Delta area shows that the study of Opute (1990) reported a total of 204 taxa of phytoplankton of which diatoms constituted 39.2%, Chlorophyta 44.1%, Cyanophyta 7.8%, Dinophyceae 4.9% and Euglenophyta 3.9%. The inclusion of such a large proportion of green algae was due to the fact that the study included freshwater zones where most of the Chlorophyta occurred.

The euryhaline species, i.e. species with a wide range of salinity (3.1–11.6‰) in this study was high. This was higher than that occurring in the narrow salinity ranges, whether low or high. This discrepancy can be aptly explained on the basis of diversity of flora. According to Margalef (1960) higher diversity results when different communities mix along a boundary. In a wide salinity range, different taxa are afforded the opportunity to exploit the environment and thus establish themselves in the available niches. This is corroborated by the report of (Reynolds 1984, 1997) that plankton diversity is related to the number and longevity of simultaneously coexistent exploitable niches.

The above observation is contrary to the situation at the narrow salinity ranges. In the low salinity range, only such species which could tolerate low salinity thrived while in the high salinity region, only such taxa which can withstand such salinities, i.e. stenohaline species survived. The occurrence of green algae at low and narrow salinity regions is not surprising, as this group of phytoplankton is intolerant of high salinities. This is consistent with the observation of Opute (1990) in the Warri Forcados River. In this latter study Chlorophyta in addition to Cyanophyta and Euglenophyta were exclusively freshwater in distribution, occurring at salinities less than 0.5‰.

The observation of dinoflagellates at restricted and high salinity levels also corroborates the findings of Opute (1990) in which he regarded the majority of dinoflagellates found as exhibiting stenohaline peculiarities. Andreoli *et al.* (1997) also reported few dinoflagellate taxa in their study in Caleri Lagoon. Among these were the toxic or potentially toxic forms – *Dinophysis sacculus* and *Prorocentrum minimum.* The dinoflagellates identified in this study were *Ceratium fusus* and *C. furca.* The occurrence of such typical oceanic forms in a lower region of salinty is an attestation of the probable displacement of such forms from regions of high salinity owing to tide.

Although no incidence of bloom formation was noticed in this study, various workers have stressed that both dinoflagellates and Cyanophyta are capable of producing nuisance blooms at varying salinities (Pearl 1988, Fujimoto *et al.* 1997, Hamiliton *et al.* 1997, Nwankwo 1993). While it is opined that oligohaline regions, i.e. areas of salinities of 0–5‰ are conducive sites for cyanophyta bloom formation, salinities greater than 5‰ are favourable for the formation of bloom by dinoflagellates (Pearl 1988, Opute 1990). Salinity has been implicated as the most important factor controlling the phytoplankton assemblages in such environments as the one studied (Nwankwo 1996*b*). Though it has been possible to successfully delineate species on the basis of salinity, other factors, either alone, or operating in synergism with salinity could also contribute in determining the distribution of such species.

In conclusion, this study concurs with the remark of Nwankwo (1991, 1996*b*) that floristical horizontal gradient is always evident so long as horizontal environmental gradient exist.

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