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The algae of crude oil impacted mangrove soil in the Niger delta, Nigeria

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The problem of oil pollution in wetlands of the Nigerian Niger Delta is enormous. This is so not only because of the obvious environmental consequences but because of the political undertone. Oil pollution in the Niger delta creates serious environmental and socio-economic stresses typified by depletion of biodiversity and the loss of means of livelihood for fisherfolk communities scattered all through the delta.

All field data were collected between 11.0 h and 13.00 h. The ambient air temperature was measured to the nearest 1.0°C by holding a mercury thermometer 10 cm above the ground level for three minutes while soil temperature of impacted site was determined in situ by inserting a paraffin coated mercury thermometer at a depth of 10 cm for 10 min. Impacted soil pH was determined with a Griffin digital pH meter (model 80) in 1:5 soil solution in distilled water. Percentage organic matter content was determined by heating 10 g of impacted mangrove soil at 500°C in an oven for 24 h as described by Andrews (1973).

Duplicate topsoil samples (top 5 cm) were collected from four different sites at the impacted area. A total of four trips were made between December 1990 and November 1992. Duplicate soil samples were collected immediately after impact (December 1990), one month after impact (January 1991), six months after impact (July 1991) and sixteen months after impact (November 1992). All soil samples were collected in properly labeled transparent plastic bags, moistened and investigated within 24 h. In the laboratory two methods, the first count and the one-day count methods, described by Round (1953) were used to estimate the soil algal flora. These two methods were necessary to trap both actively motile and less motile forms. For diatoms both live materials and cleaned frustules were thoroughly investigated, and counted using an M11 wild binocular microscope with a calibrated eye piece. Identified diatoms were recorded as number of cells cm^{-2} while in the case of colonies and filamentous forms, number of cells refers to whole colonies or length of filaments only, as suggested by Round (1953). Identification of soil algae taxa were done using relevant texts (Desikachary 1959; Hustedt 1930; Prescot 1961; Patrick & Reemer 1975). Two indices, Margalef (1951) species richness and Shannon & Weaver (1963) diversity index were used to estimate species diversity at the impacted site (Table 1).

Physico-chemical factors and diversity indices of impacted makaraba mangrove soil are also presented in Table 1. The ambient air and impacted soil temperature were high (27.9°C) all through the investigation. This observation agrees with those of Webb (1960) that temperature is not a limiting factor in the tropics. The acidic nature of the soil (pH <6.3 in the dry months and pH > 6.5 in the wet months) may be due to microbial utilisation of hydrocarbons which leads to organic acid formation (Alexander 1977), or the presence of pyritic or sulphidic materials in mangrove soils (Dublin-Green 1986) while the high organic matter content (> 58.8%) could be attributed to the dense ramification of mangrove roots and litter in the Ma-

Table 1. Some physico-chemical and community structure properties of crude oil impacted mangrove soil.

Features	Sampling periods			
	I (Dec '90)	II (Jan '91)	III (Jul '91)	IV (Nov '92)
Air temperature (°C)	29.2	29.1	27.7	27.8
Soil temperature (°C)	30.0	29.9	27.0	29.6
Soil pH	6.2	6.3	6.9	6.5
Soil organic content (%)	59.8	62.3	58.8	59.4
Soil texture	Loamy	Loamy	Loamy	Loamy
Number of species (S) cm^{-2}	0	12	18	20
Total number of individuals (N) cm^{-2}	0	410	270	370
Species richness (d)	0	0.9	2.6	3.1
Shannon and Weaver diversity index (H)	0	0.0	0.1	0.1

Code for sampling periods: I, immediately after impact; II, 1 month after impact; III, 6 months after impact; IV, 16 months after impact.

karaba mangrove soil. A similar observation was made in Buguma mangrove soil in the Niger Delta, Nigeria (Dublin-Green 1986).

Pennate diatoms, green algae including euglenoids and the blue greens were algal groups recorded at the site. Six diatom genera comprising 12 taxa of living diatoms were recorded and out of these, the biraphidinae (8 taxa) and the araphidinae (94 taxa) were prevalent. Two diatom genera, *Navicula* and *Nitzschia* were frequent and developed abundantly.

The blue green algae were represented by eight taxa with the *Oscillatoria* spp. being the most abundant. *Nostoc* was the only heterocystous blue green alga recorded while all taxa identified were capable of movement to some extent. No algae were recorded immediately after impact in December 1990 probably as a response to stress imposed by the toxic effects of the fresh crude oil spillage. According to Nelson-Smith (1977) fresh crude oil rapidly kills microplants within the range of 2 ppm to 2%. The blue green algal population

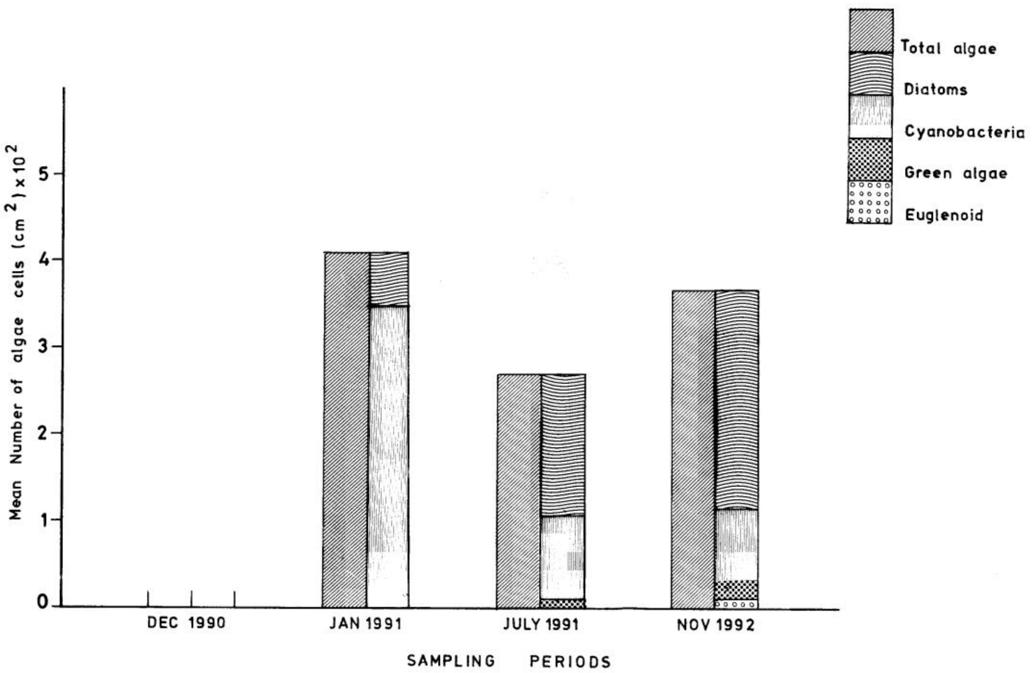

Fig. 1. The composition and abundance of algae in an impacted mangrove soil.

increased soon after impact (3.7 x 10^2 cm^{-2}) but declined (0.9 x 10^2 cm^{-2}) in the November 1992 collections. *Chlorococcum* sp. (green alga) was recorded in July 1991 and November 1992 while the euglenoids appeared only in January 1991. During the periods of investigation, there were changes in both the number of cells and number of taxa. For instance the number of taxa per cm^2 rose from 0 to 20 while the total number of individuals rose from 0 to 370 (cells, filaments) one moth after impact.

There was a drop in individual species number to 270 (cells, filaments) in July 1991 and an increase (470 cells, filaments) in November 1992 (Fig. 1). The species richness (d) increased from 0 to 3.13 while Shannon and Weaver index rose from 0 to 0.08 within the period of investigation.

In the impacted soil, the proliferation of *Oscillations* sp. may be due to availability of a suitable environment provided by the activities of hydrocarbon utilisers.

The availability of nitrogen sources may probably explain the paucity of heterocystous nitrogen fixing blue green algae. The occurrence of euglenoid flagellates suggest preference for freshly contaminated environments. The present investigation showed that the blue green algae were more resilient and therefore more successful in invading freshly impacted mangrove soil. The diatom species appeared to benefit more from the activities of blue green algae in improving the impacted soil. The increase in species richness and Shannon and Weaver index over time may be a response to an improving environmental status.

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