Floristic Abundance and Diversity of Mangrove in Polluted Soil of Ikuru Town, Andoni, Rivers State, Nigeria

Gogo, T.E.A., Ukoima, H . N. & Chukunda, F. A
Department of Forestry/Environment
Rivers State University, Nkpolu-Oroworukwo
Port Harcourt, Nigeria

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Abstracts

This study investigated into the floristic abundance and diversity of mangrove in polluted soils in Ikuru town, Andoni Local Government Area, Rivers State. The study covered an area of about five hectares (ha) of land. The area was measured using a transect of 100m x 20m in each zone. 10m transects were used in the experimental study. A control was chosen within the mangrove forest at Eagle Island Port Harcourt. Soil samples were randomly collected from subtidal, middle intertidal and lower intertidal zones, and control location using soil augar. Composite soil Samples were carefully placed into well labeled poly bags for laboratory analysis. Standard sampling procedures were adopted for soil physical and chemical analysis. Floristic species richness and diversity were also accessed. The results of the floristic compositions of the mangrove tree species in the hydrocarbon polluted soil of Ikuru Town showed that five (5) species, Avicenmia, Rhizophora mangle, Laguncularia racemosa, Acrostichum aureum, Rhizophora racemosa, four (4) families; namely Avicenmia, Avicenruocerae, Rhizophoraceae, Combitaceae and Pteridaceae. Furthermore, the results also showed that in polluted soil, Avicennia germinas recorded (35); unpolluted (52); Rhizophora mangle polluted (22); unpolluted (35); Laguncualania, racemosa polluted (20); unpolluted (30); Acrostichum aureum polluted (25); unpolluted (25); Rhizophora racemosa polluted (42) and unpolluted (60); Axonopus compresus polluted (15) unpolluted (20) and Cynodon dactylon polluted) (10) unpolluted (22) However, the diversity of the mangrove species in both polluted and contro soils were significantly different ($P \leq 0.05$), Avicennia gramina (35.52), Rhizophora mangle (22.35); Laguncularia racemosa (20.30), Acrostichum aureum (25.30) and Rhizophora recemosa (42.60). The results showed that the percentage abundance of the mangrove species differ in the percentage occurrence of the species found in the mangrove ecosystem, Rhizophora racemosa (24.88%, 25.49%) in both polluted and control soils, followed by Avicemmia Africana (20.71%; 21.3%) and *the least abundant species was Laguncularia racemosa (11.82%; 12.30%). Therefore, rhizophora racemosa was highly recommended in a crude oil polluted sites and afforestation programmes in the mangrove.*

Keywords: *Floristic, mangrove species, Abundance, Diversity, Andoni LGA*

Introduction

Soil contamination by petroleum products and its derivatives is an environmental threat because of potential toxic impacts on different ecological receptors (Masakorala *et al.*, 2013) (Ukoima *et al* 2014a and 2016b). Among the decontamination solutions of hydrocarbon-polluted soils, phytoremediation is a sustainable, restic, less expensive and ecological process (Azadeh *et al.*, 2007). It relies on the fact that plants with a dense root system can explore large volume of soil, support many plant communities in the rhizosphere and produce root exudates, which may directly affect rhizobacteria activity (Bollag *et al.*, 1994). Plants play a major role (Azadeh *et al.*, 2007, Nwoko 2010) (Ukoima *et al*, 2014b and 2016a) in phytoremediation process by transporting and concentrating contaminants from the soil into the aboveground shoots (Phytoextraction), and reducing the bioavailability of pollutants in the environment (Phytostabilization). Plants can also extract volatile pollutants (e.g., selenium, and mercury) from the soil and volatilize them from the foliage (Phytovolatilization), or in association with microorganisms (plant-assisted bioremediation), as well as degrade organic pollutants. Although considered a long-term process where pollutant concentrations are low or moderately high, phytoremediation remains a cost effective and viable method of disposing certain types of hazardous waste such as oil waste. World oil consumption today exceeds 90 million barrels per day (93.5 million on average in 2015), but crude oil processing and handling processes can cause serious environmental and health damage (Wu *et al.*, 2011). The social and environmental effects of oil business include global warming, destruction of wildlife and biodiversity, loss of soil fertility, air and water pollution, degradation of agricultural land and damage to aquatic ecosystems (Liu *et al.*, 2015). Phytoremediation has long been recognized as a low cost technique of removing hazardous compounds from soil. This ability is often attributed to microorganisms living in the rhizosphere under the influence of plant roots (Jones *et al.*, 2004). Several studies have shown the ability of different plants to clean-up oil-polluted soils (Masu *et al.*, 2013, Njoku *et al.*, 2014, Xiao *et al.*, 2015). However, research reports on plants that have phytoremediation potentials are scanty and fairly undocumented in tropical areas; particularly in Cameroon (Ogbo *et al.*, 2009). Therefore, screening plant species to determine those with the capacity to grow on hydrocarbon-polluted soils remains an essential step in phytoremediation (Messou *et al.*, 2013). Due to uncontrolled oil spills in Cameroon (D eversement accidental d'hydrocarbures dans l'environnement au Cameroun – 25 janvier 2007-16:31 (Par Pierre Melquiot)) bib7, Komya 2014), the Cameroonian government is currently seeking for means to clean-up polluted sites (Anonymous 2007).

Mangroves are one of the world's most productive ecosystems. This is because they enrich coastal waters and serve as supermarket of the sea. They are globally distributed and occupy more than 150,000 km^2, occur in over 123 countries and are made up of more than 73 species and/or hybrids (Bunt, 1992; Spalding, 1997; Spalding *et al.*, 2020). Mangroves are divided into the Indo-West Pacific (IWP) and the Atlantic East Pacific (AEP) groups (Duke, 1990; Macnae, 1968). They originated from a hot environment (Plaziat, *et al.*, 2001) and their distribution is influenced by meteorological events (Alongi, 2008) such as temperature (Duke, 1992) and precipitation (Saenger *et al.*, 1993). These climatic parameters influence their distribution to different habitat (Feller, et al., 2010). Although, tolerance to warm conditions dictates their distribution, they sometimes drift to temperate regions where intense cold weather threatens their survival (Hogarth, 1999). Tropical conditions are the best for mangroves, but excessive heat cause rapid evaporation leading to increase in salinity (Gilman, *et al.*, 2008), which triggers the succession of salt tolerant mangrove species (e.g. *Avicennia germinans*) over less salt-tolerant species (e.g. *Rhizophora* species) (Lugo, 1980). Increase in temperature affects water body (Dai *et al.*, 2009)). Temperature greater than 35°C affects root structure, seedling establishment and photosynthetic activity in mangroves (Chakraborty, 2013). Unrestricted increase in temperature can lead to the migration of species into subtropical salt marsh areas (Perry, *et al*, 2009) and Arctic pole (Cavanaugh *et al.*, 2014). Precipitation regulates nutrient up-take and affects productivity (Snedaker, 1995) and survivability (Tomlinson, 1998) of mangroves. Moderately warm and wet equatorial areas with high rainfall have rich supply of mangrove populations (Record, 2013). However, increase in sea level (Lyu, et al., 2014) can drown fringe mangroves (Gilman, *et al.*, 2008). In the same vein, global cooling and warming (IPCC, 2014; Scherer, *et al.*, 2014) can lead to range shifts and the extinction of organisms (Hewitt, 2004a; Yokoyama, *et al.*, 2001). Mangrove propagules are dispersed by tidal currents, but land barriers prevent their free movement (Duke, 1990) leading to a discontinuous distribution. This discontinuity causes intra-specific, morphologic and genetic variation in Rhizophora species (Dodd, *et al.*, 1998), which is one of the most dominant mangrove species in the world.

The mangrove trees conserve water resources and serve as wind breaks in many communities. Specifically, in the Niger Delta, there are several uses of mangroves by the indigenous people, these include; fire wood, building materials, medicinal products, food baskets and fishing tools etc. (Ukoima *et al* 2010)

The objectives of the study are to determine physico-chemical property of polluted and non- polluted.

MATERIALS AND METHODS

Study Area

The study was carried out in the mangrove vegetation of Ikuru Town, in Andoni Local Government Area, Rivers State. Ikuru Town is situated at Latitude 4.47^{o}N and Longitude 7.45^{o}E (Ukoima *et al* 2014a). The town has an approximate population of six hundred thousand (60,000) persons according to the Nigeria 1999 census (ERA, 1999). (Fig 1)

The annual rainfall is 2500mm, within a mean value of 70% relative humidity in February and 80% in July, the mean minimum temperature is 25°C with maximum temperature of 29°C. The area is predominantly brackish water and consequently dominated by the mangrove forest. The main occupation of the people is fishing. Economically the people are also wealthy in palm oil merchant across Akwa Ibom and Abia States.

Fig. 1.1: A Map showing Ikuru Town Study Area. (Extract from map of Andoni)

Sampling Techniques and Experimental Design

The study covers an area of about 5 hectares (ha) of land. The entire area was divided into subtidal, middle intertidal, and lower intertidal zones. A transect measuring 100m x 20m were laid in each zone, 10m away from each other. A total number of 12 transects were used in the study. A control location was chosen within the mangrove forest at Eagle Island. Soil samples were randomly collected from subtidal, middle intertidal and lower intertidal zones and control location using auger and composite soil samples were carefully placed into well labeled poly bags for laboratory analysis. Survey design was used for this study. A systematic sampling technique was adopted since the population of study is not homogenous and area was constituted into subgroups or subpopulations. In systematic random sampling research samples are drawn at fixed interval on a continuum.

Determination of Mangrove Species Diversity in the Study Areas

Mangrove species diversity was done using systematic random sampling based on standard procedure for Ecological assessment studies (Kershew, 1975), along the specific transit at distance of 100m around the affected site and 20m from the control sites, however the mangrove species were identified in the field. Microbial diversity will be calculated as described by Morisita (1959).

Measures of Species Distribution

Simpson = index of diversity

Species diversity index was calculated with the Simpson's (1949) index as follows:

$$I = q\,\frac{\Sigma ni\,(n-1)}{N\,(N-1)}$$

Where I = the index of diversity
N = total number of individuals encountered
ni = Number of individual of iith each species encountered.
q = Number of different species encountered
Shannon = Index
It is calculated using the following equation:
H = - P1 (InPi)
Where P1 is the proportion of each species in the sample. Given a very large sample size with more than 5 species. The S-W index value (H) can range of 0 to – 4.6 using the natural log (in).

Evenness = Shannon Equitability

(E_H) can be calculated by dividing it by Hmax. (here Hmax = Ins). Equitability assumes a value between 0 and 1 with 1 being complete evenness.
$E_H = H11t_{max} = H/ins$

Determination of Floristic Species Abundance in the Polluted Site

Floristic species abundance refers to numerous plant spices found in the environment or location. The Floristic species abundance in this study were determined by counting the species available in each of the transects using the long series methods. (Fisher *et al.*, 1943).

RESULTS

The effect of crude oil spillage on the mangrove species compared to the control is presented in Table 1. The results revealed that the following mangrove species were present both polluted and unpolluted sites and include; *Avicemia germinas, Rhizohora mangle, Laguncularia racemosa, Acrostichum aureum, Rhizophora recemosa* and *Acrostichum aureum*.

However, the diversity of the mangrove species in both polluted and contro soils were significantly different (P≤0.05) *Avicennia gramina* (35.52), *Rhizophora mangle* (22.35); *Laguncularia racemosa* (20.30), *Acrostichum aureum* (25.30) and *Rhizophora racemosa* (42.60).

Generally, it was observed that plant species performed better in control soil compared to polluted soil indicating that effect of crude oil on the mangrove species growth and development was drastic in the plants.

Table 1: Mangrove Species and Diversity found in the Polluted and Control Sites

S/N.	Species name	Common names	Polluted			Control		
			Density	Standard Deviation	Remark	Density	Standard Deviation	Remark
1	*Avicennia Africana*	-	35.52	7.69	++	52	8.96	++
2	*Rhizophora mangle*	-	22.35	6.42	++	35	7.69	++
3	*Laguncularia racemosa*	-	20.30	5.98	++	30	7.27	++
4	*Acrostichum aureum*	-	25.30	6.87	++	25	6.87	++
5	*Rhizophora racemosa*	Red mangrove	42.60	8.96	+++	60	9.86	+++

++++ very abundant, +++ abundant, ++ scarce, + very scarce

Floristic Species Abundance in Polluted and Control Soil

The result of the mangrove floristic species abundance in the polluted and control soils is presented (Table 2). The results showed that the percentage abundance of the mangrove species differ in the percentage occurrence of the species found in the mangrove ecosystem, *Rhizophora racemosa* (24.88%, 25.49%) in both polluted and control soils, followed by *Avicemmia Africana* (20.71%; 21.3%) and the least abundant species was *Laguncularia racemosa* (11.82%; 12.30%) (Table 2). The result also showed the forest is composed of true mangrove species such as *Rhizophora recemosa* with a relative abundance of 24.85 on polluted site and 24.54 on the control site. Also found in the studied are mangrove associates such as a *Acrostichum* having 14.79 in the polluted and 10.25 in the unpolluted while *Axonopus* 8.88 in the polluted and 8.19 in the control.

Table 2 Floristic Species Abundance in Polluted and Control Soils

Relative Abundance (%)

S/N.	Species	Common Names	Family	Polluted	Control	Polluted (%)	Control (%)
1	*Avicennia*		Avicenruocerae	35	52	20.71%	21.31
2	*Rhizophora mangle*	Red mangrove	Rhizophoraceae	22	35	13.02	14.34
3	*Laguncularia racemosa*	White mangrove	Combitaceae	20	30	11.82	12.30
4	*Acrostichum aureum*	Mangrove fem	Pteridaceae	25	25	14.79	10.25

5	*Rhizophora racemosa*	Red mangrove	Rhizohoraceae	42	60	24.85	24.59

The mangrove plant species which were recorded as frequently occurring in the site include, *Avicennia germinas, Rhizophora aureum* and *Rhizophora recemosa.*(Ukoima et al, 1996)
Shown in Table 2, the forest is composed of true mangrove species such as *Rhizophora recemosa* with a relative abundance of 24.85 on polluted site and 24.54 on the control site. Also found in the studied are mangrove associates such as a *Acrostichum* having 14.79 in the polluted and 10.25 in the unpolluted while *Axonopus* in the polluted and 8.19 in the control. This work is in agreement of the works of (Ukoima *et al,* 1996).
However, using the Simpson index, both the polluted and control site showed equal species diversity of 0.83. The Species diversity indices observed in both locations fall within the acceptable limited of 0-1, where 1 represent infinite diversity and zero no diversity, this implies that the higher the index value the higher the diversity. It agrees with the works of (Ukoima and Amakiri, 2009)

A total of seven (7) individual species were observed in the mangrove vegetation within the study area, while seven (7) individuals were observed in the control area. Seven (7) plant species and seven (7) families were encountered in the study site. The families recorded consist of the following; *Avicenniaceae*, *Rhyzohoraceae*, *combritaceae*, *Pteridaceae*, *Rhizohoraceae*, *Proaceae*, and *Praceae*. While some of the plants species encountered are; *Avicennia germinnas*, *Rhizophora mangle*, *Laguncularia racemosa*, *Acrostichum aureum*, *Rhizophora racemosa*, *Axonopus compresus and Cynodon dactylon*, all these are seen in Table 3, which collaborates the works of Ukoima et al, 2014.

In conclution, seven (7) individual species were observed in the mangrove vegetation at Ikuru town, Andoni, Rivers State. Also, Racemosa is highly recommended for afforestation programmes in crude oil polluted sites.

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