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Full Length Research Paper

The dynamics of *Desmidacean* populations in Ologe lagoon, Lagos, Nigeria

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An investigation into the dynamics of Desmidacean populations in Ologe lagoon was carried out for a period of 24 months. It covered identification, diversity and elucidating the influence of some physical and chemical parameters on temporal abundance and spatial distribution of the Desmidacea. Five villages around the lagoon were sampled using standard techniques. Data obtained were statistically analyzed using linear regression and hierarchical clustering. Eight Desmidacean populations were identified. The Pearson's correlation coefficient showed that positive correlation occurred between the Desmidacea and Salinity (r = 0.043) and with surface water dissolved oxygen (r = 0.300). Regression plots further revealed positive influence with surface water temperature (Rsq = 0.798) and conductivity (Rsq = 0.602). The correlations were positive with NO_3-N at Ibiye (Rsq = 0.022) and Gbanko (Rsq = 0.013), PO_4-P at Ibiye (Rsq = 0.259), K at Idoluwo (Rsq = 0.296) and SO_4-S at Oto (Rsq = 0.934) and Gbanko (Rsq = 0.457). The most dominant species was Staurastrum species followed by Micrasterias species. Proximities transcended the borders of genera. The Desmid populations in Ologe lagoon, were patchy in spatial distribution, undergo seasonal perturbations and were highly influenced by nutrient inputs from Agbara industrial estate and surrounding farmlands.

Keywords: Desmidaceae, dynamics, dominance, perturbations.

INTRODUCTION

Ologe Lagoon is situated in Lagos, the fast growing African mega city, with a recent (2007) census report of over 15 million inhabitants, squeezed within a land mass that is predominantly coastal-marine in the south western-most part of Nigeria.

The Ologe lagoon meets several socio-economic needs (aquaculture, fishing, sand dredging and drainage) of the various towns and villages bordering it. More importantly, it drains river Owo, into which partially treated/untreated effluents from the Agbara industrial estate is discharged and river Owo is the main fresh water supply point into the lagoon (Clarke et al., 2004). Ologe Lagoon is a brackish water body which opens into the Atlantic Ocean via the Badagry creeks and the Lagos harbor. Apart from providing income for fishermen in the satellite towns and villages; it is also a sinkhole for their domestic wastes. The lagoon is bounded by heavy Industry including paper and pulp, glass, plastics, breweries, pharmaceutical and beverages. These partially/largely untreated discharges coupled with domestic inputs from the Agbara residential estates and satellite communities cause significant levels of pollution. It is therefore of great economic importance not only to Lagos State and Nigeria but to the entire coastal countries of West Africa as upstream ecological damage or destruction, could have grievous consequences down stream, (through bioaccumulation of chemicals in aquatic organisms at the upper trophic levels of the food chain) if not controlled (Clarke et al., 2005).

There are peculiar interactions between the environmental driving variables (physical and chemical parameters) and site constants (topography, vegetation, influx of domestic and industrial effluents, sand mining, traffic of motorized canoes and logging of firewood). Vos et

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Table 1. Some indices of diversity for the Desmids in Ologe lagoon within the period of study.

Desmids	Sum of ni = N	Pi = ni/N	SHANNON WEAVER DIVERSITY INDEX s H = (- ∑ Pi log_2Pi) 1	SIMPSON'S DIVERSITY INDEX (Y=SUM Pi ^2)	RICHNESS INDEX (d = (S-1) / LOG N	BERGER-PARKER DOMINANCE INDEX =Nmax / Nwt
Spirotamia sp.	28,200.0	0.11051	-0.3512	0.01221	1.5729	2.3475
Netrium sp.	4,200.0	0.01646	-0.0975	0.00027	1.9319	15.7619
Staurastrium sp.	66,200.0	0.25942	-0.505	0.0673	1.4520	1.0000
Genicularia sp.	14,200.0	0.05565	-0.2319	0.0031	1.6858	4.6619
Micrasterias sp.	60,400.0	0.2367	-0.4921	0.05602	1.4641	1.0960
Closterium sp.	22,600.0	0.08856	-0.3097	0.00784	1.6076	2.9292
Cystodinium sp.	12,780.0	0.05008	-0.2163	0.00251	1.7046	5.1799
Rotaria sp.	46,600.0	0.18262	-0.448	0.03335	1.4994	1.4206
TOTAL	255,180.0	1	-2.6517	0.18261	1.2946	
			2.6517*	0.81739**		

* = -SUM (Pi log_2 Pi); ** = 1-SUM Pi^2

al. (2004) observed that chemical variables like nitrate-nitrogen (NO3-N) showed very strong relationships to site constant and temperature.

Desmidaceae

The *Desmidaceae* is part of the algal community of Ologe Lagoon, which forms the primary food source for aquatic organisms of the upper trophic levels of the aquatic food chain. It is known that Nitrates (NO_3) and phosphates (PO_4) don't exist in balanced ratios with other elements and ions and are often in short supply in surface waters. This disparity in concentration stimulates various biological activities and may end up being a limiting factor militating against the production of algae, which includes the *Desmidacean* populations. Other elements including Cu, Fe, Ca and Mn exist in trace amounts and may become limiting to the growth of algae.

This study is aimed at providing information on seasonal fluctuations of some ecological factors in Ologe lagoon and to establish the distribution pattern, abundance, seasonal variations and diversity in the total *Desmidacean* populations, relating to prevailing abiotic factors. This study is part of a continuing series of investigations which is an attempt to use both chemical (nutrient inputs) and biological (*Desmidacean* population structure) to explain the ecological status of the lagoon. More-so, the use of biological approach is already well established at community level (Cairns and Pratt, 1993).

MATERIALS AND METHODS

Sub-surface water samples were collected from January, 2001 to December 2002 for physical, chemical and phytoplankton analysis. The sampling density was for one sample in an average of 1.44km-9.28 km along transects designed to cover the whole lagoon system. In-situ salinity, conductivity and surface water dissolved oxygen concentration analyses were done using the Horiba U-10 water quality checker, while in-situ bottom water dissolved oxygen concentration and bottom water temperatures were measured using the YSI model 57 dissolved oxygen / temperature meter. Other physical parameters were measured in-situ according to standard methods (APHA, 1980)[1], using a mercury-in-glass thermometer for air and surface water temperature and a secchi disc for transparency. A standard phytoplankton net (55um mesh size) was hand-toed from a motorized canoe for ten minutes at each sampling station to concentrate sub-surface plankton. Collected samples were fixed and preserved, using 4% formalin. Enumeration was done per unit area of the floor of a Sedgwick rafter counting chamber while the identification was done using the taxonomic keys by Whitford et al. (1984) and Dillard (1991, 1993, 1999).

On gram of collected sediment samples was weighed out, dried on a filter paper and placed in an oven at 450°C for 8 h to destroy the organic matter content (OMC). The OMC is estimated as loss on ignition, while digestion was done according to FAO/SIDA (1983). The samples were analyzed for total nitrate-nitrogen (NO_3-N), total phosphate-phosphorus (PO_4-P), total sulphate-sulphur (SO_4-S) and potassium (K). Their concentrations were determined by comparing their absorbance with that of factory prepared AAS standard solution using the Pyrunicam SP2900 Atomic Absorption Spectrophotometer (AAS).

The indices utilized to obtain estimates of species diversity include: -

a) Richness Index = A measure of species diversity calculated as

$$d = \frac{(S-1)}{\log N.}$$

Where S = Number of species in the habitat or community and N = the total number of individuals of all species.

b) Shannon-Weiner (1963) information function

$$`H' = -\sum_{i} pi \log pi$$

Table 2. Proximity matrix for the Desmids in Ologe lagoon within the period of study, with a measure of intervals, using Pearson's correlation coefficient.

Observations	*Spirotamia sp.*	*Netrium sp.*	*Staurastrium sp.*	*Genicularia sp.*	*Micrasterias sp.*	*Closterium sp*	*Cystodinium sp*	*Rotaria sp.*
Spirotamia sp.	0.00	0.17	0.46	0.37	0.27	0.18	0.56	0.59
Netrium sp.	0.17	0.00	0.34	0.06	0.56	0.25	0.04	0.05
Staurastrium sp.	0.46	0.34	0.00	0.11	0.19	0.76	0.40	0.27
Genicularia sp.	0.37	0.06	0.11	0.00	0.44	0.12	0.39	0.00
Micrasterias sp.	0.27	0.56	0.19	0.44	0.00	0.18	0.01	0.17
Closterium sp.	0.18	0.25	0.76	0.12	0.18	0.00	0.29	0.03
Cystodinium sp.	0.56	0.04	0.40	0.39	0.01	0.29	0.00	0.29
Rotaria sp.	0.59	0.05	0.27	0.00	0.17	0.03	0.29	0.00

Table 3. Correlation coefficient "r" values of the Total Desmids and some physical and chemical factors in Ologe lagoon within the period of study (Significant values at P ≤ 0.05).

	Spirotamia sp.	*Netrium sp*	*Staurastrium sp*	*Genicularia sp*	*Micrasterias sp*	*Closterium sp.*
Bottom water Temperature	-.4921 P= .124	-.1437 P= .673	.7219 P= .012	.6019 P= .050	.1674 P= .623	.3422 P= .30
Bottom water Dissolved Oxygen	-.7462 P= .008	.0099 P= .977	.4765 P= .138	.6139 P= .045	.1173 P= .731	.2881 P= .390
Surface water temperature	-.3648 P= .270	-.1729 P= .611	.6782 P= .022	.5757 P= .064	.2498 P= .459	.4580 P= .157
Surface water dissolved Oxygen	-.5390 P= .087	.2172 P= .521	.1360 P= .690	.0068 P= .984	-.3089 P= .355	-.0109 P= .975
Depth	.0961 P= .779	.1672 P= .623	-.1310 P= .701	.2424 P= .473	-.3993 P= .224	-.3981 P= .225
Air temperature	-.7079 P= .015	.1765 P= .604	.3696 P= .263	.6572 P= .028	-.0887 P= .795	.0179 P= .958
pH	-.8029 P= .003	.1063 P= .756	.4810 P= .134	.5861 P= .058	.0735 P= .830	.2346 P= .487
Conductivity	-.6297 P= .038	-.3414 P= .304	.7314 P= .011	.7046 P= .015	.4979 P= .119	.4765 P= .138
Rainfall	.0470 P= .891	-.4028 P= .219	.0889 P= .795	.2479 P= .462	.5413 P= .085	.6941 P= .018
Transparency	.3086 P= .356	.1497 P= .660	-.2805 P= .403	-.5076 P= .111	-.2999 P= .370	-.5872 P= .058
Salinity	-.2988 P= .372	-.5943 P= .054	.5694 P= .067	.6488 P= .031	.6571 P= .028	.7405 P= .009
(Coefficient / (D.F.) / 2-tailed Significance)						
" . " is printed if a coefficient cannot be computed						
Significant correlations emboldened.						

Where pi = the proportion of the ith species in the sample.

(c) Sipmson's Index (D) = An index of diversity based on the probability of picking two organisms at random that are different species; calculated as

$$D = 1 - \sum_{i=1}^{s} (Pi^2)$$

Where Pi = the proportion of individuals of species I in a community of "S" species.

(d) Berger-Parker dominance index

$$\text{'d'} = \frac{Nmax}{Nwt.}$$

Where Nmax = value of most abundant species and Nwt = total number of individuals.

(e) Linear regression to decipher the relationship between plankton population flush/crash, physical and chemical parameters and nutrient imputes into Ologe lagoon.

(f) Absolute correlation between vectors of values of the individual organisms was done using the Pearson methods, to produce a proximity matrix.

(g) A dendrogram was drawn to show the actual proximity between species, pictorially.

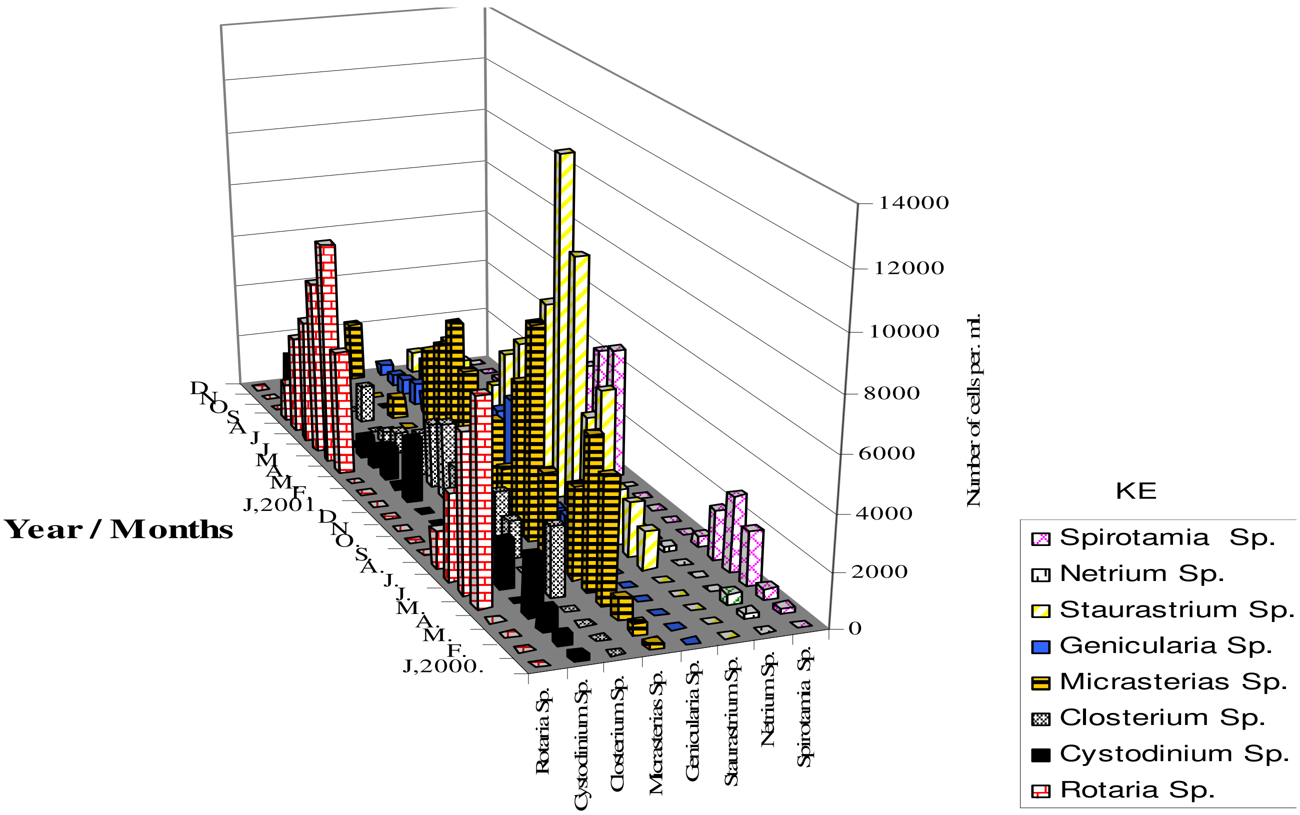


Figure 1. Seasonal variation in the population of Desmids in Ologe lagoon within the period of study.

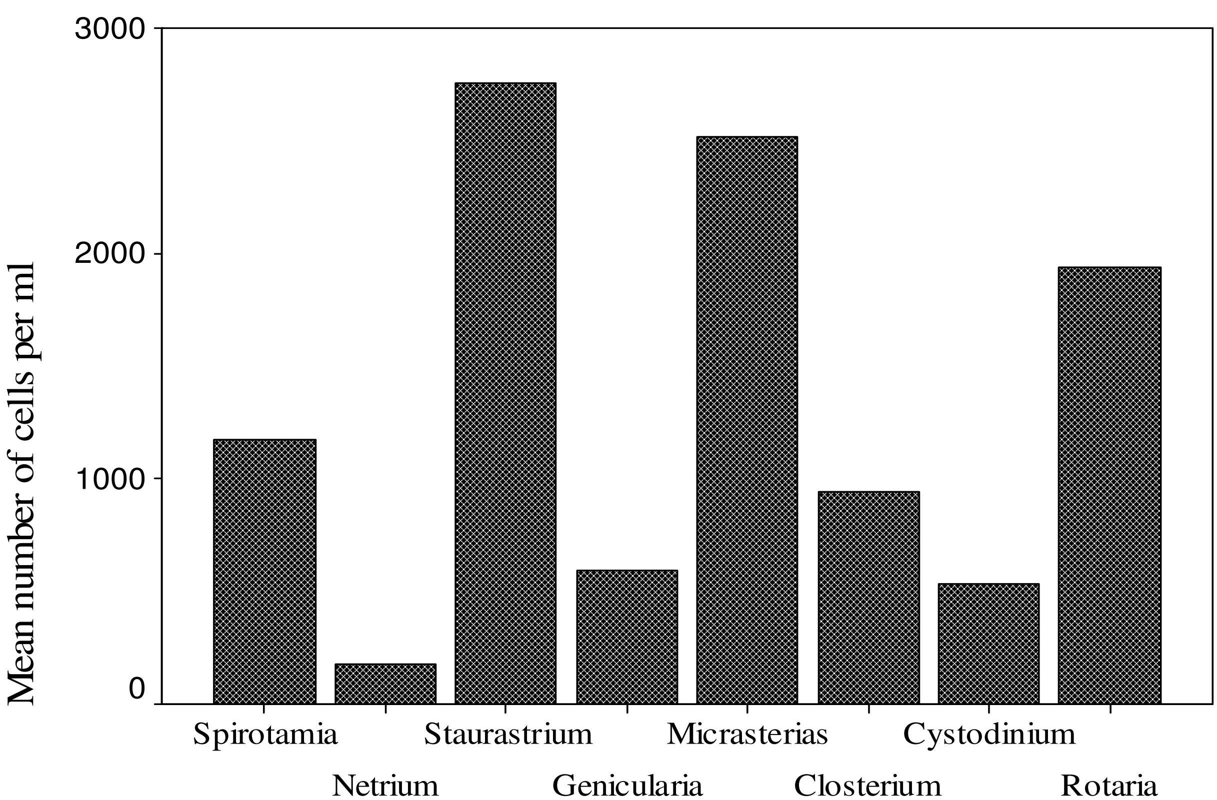
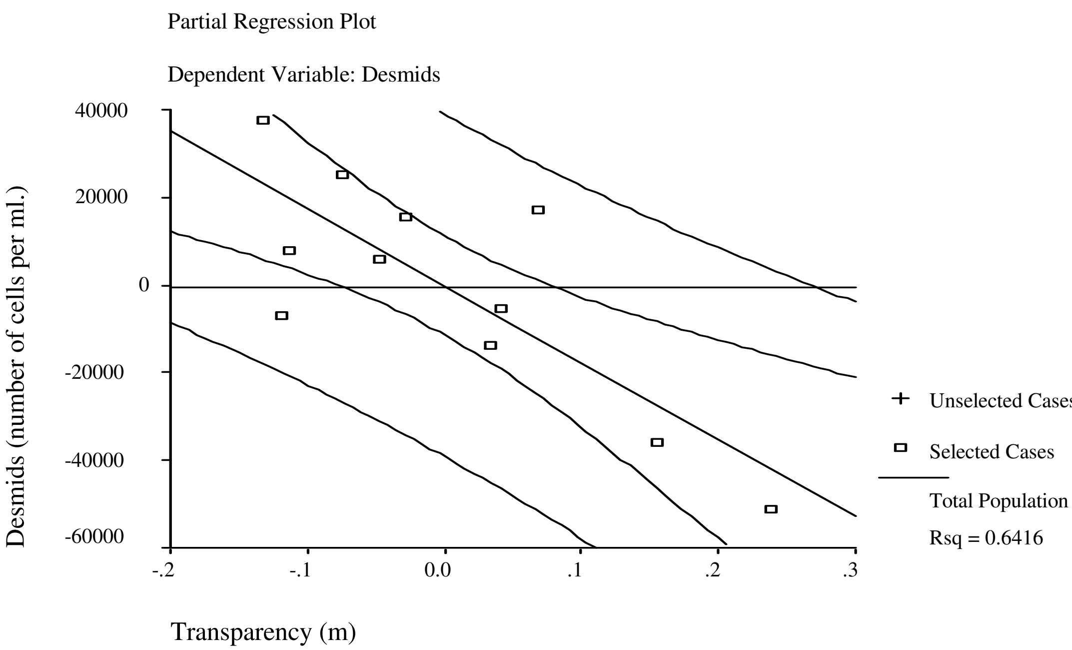
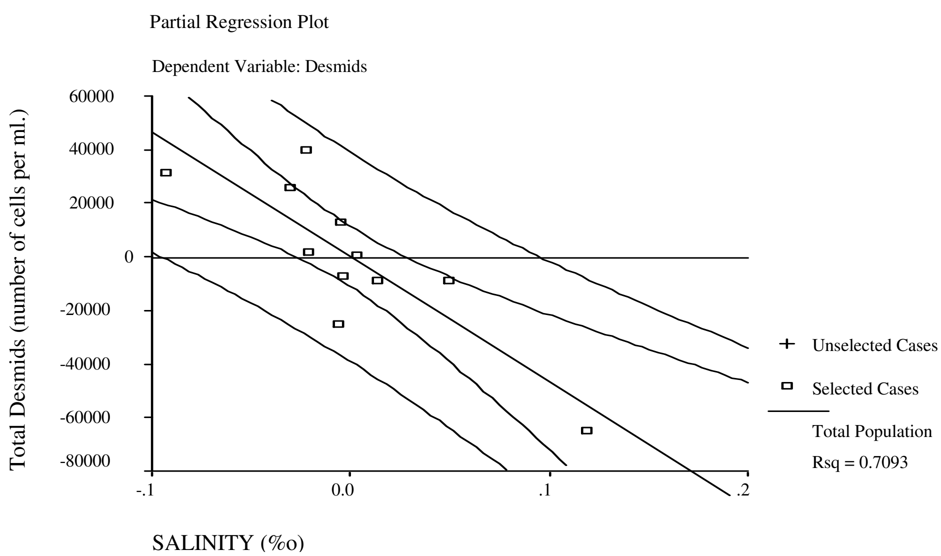


Figure 2. The relative density of desmidaceaen populations in Ologe lagoon within the period of study.



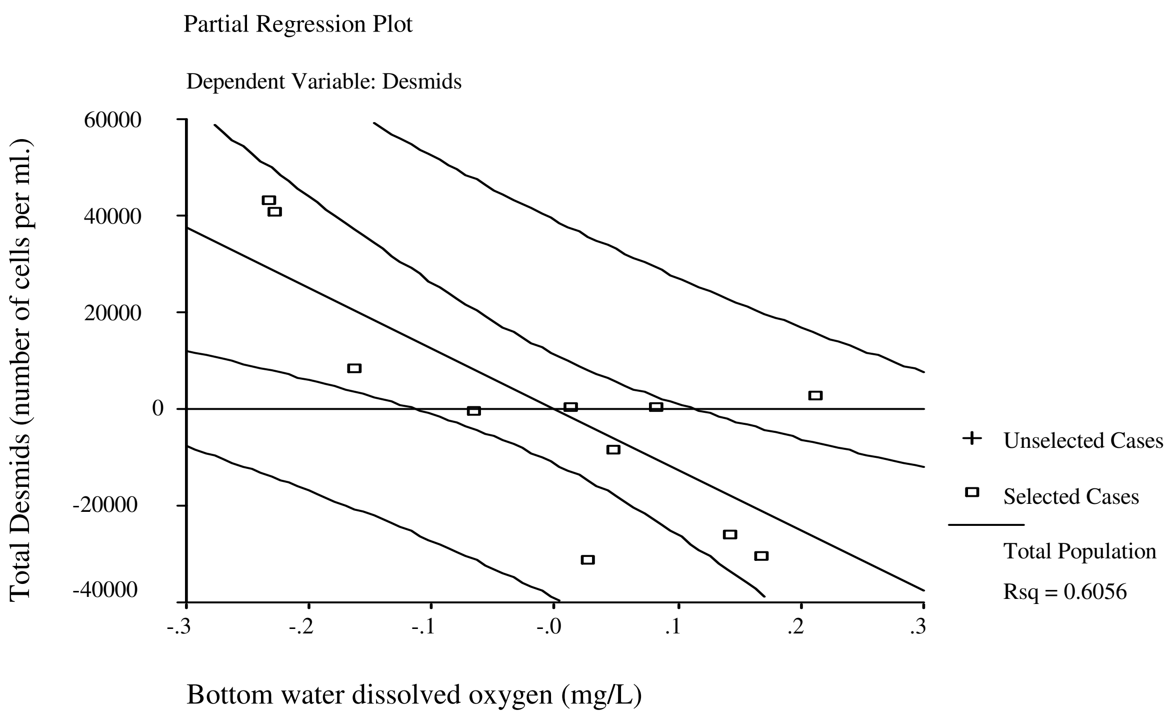
3**(a)**



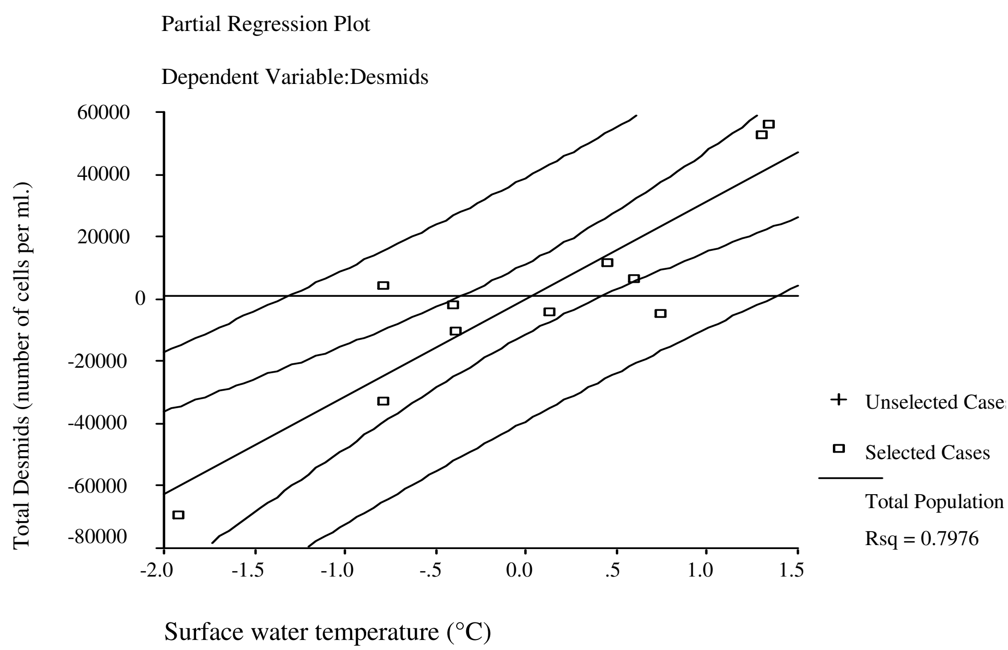
3**(b)**

RESULTS

Members of the class *Desmophyceae* were evenly spread throughout the lagoon except in January and February when they were only present in sample stations 1, 3 and 6. Spatial colonization was highest between September and October when all the stations recorded the presence of Desmids. There was a cyclic distribution of Desmids in Ologe lagoon (Figure 1), with only *Micrasterias sp.*, being perennial. The *Rotaria sp., Cystodinium sp.* and *Spirotamia Sp.* were rainy season annuals. *Staurastrum sp.* and *Closterium sp.* were dry season annuals while the *Closterium sp.* was only a rainy season ephemeral, the *Netrium sp.* was also an ephemeral, both in late dry season and peak rainy season. The percent-tage Desmid density (Figure 2) decreased in the order of Staurastrium sp. (25.6%), Micrasterias sp. (23.7%), Rotaria sp. (18.3%), Spirotamia sp. (11.1%), Closterium sp. (8.7%), Cystodinium sp. (5.0%) and Genicularia sp. (5.6%). Only Netrium sp. was less than 5%, recording 2.0% abundance relative to others. The Desmids presented a polymictic distribution with several dominant species (Table 1). More-so, evidence showed that the *Micrasterias sp.* was more temporally and spatially domi-



3**(c)**



3**(d)**

Figure 3a, b, c, d. Partial regression plots showing the relationship between the population of Desmids, Transparency, Salinity, Bottom Water dissolved Oxygen and Surface Water Temperature within the period of study.

nant. Proximity was highest between *Staurastrium* species and *Closterium* species, measuring 0.76 on the proximity matrix (Table 2). The Pearson's correlation coefficient ("r" values) between *Desmidacean* populations and some physical and chemical parameters (Table 3) showed some significant correlations. The linear regression plots (Figures 3 and 4) indicated that, the total population of Desmids were mainly influenced, and only

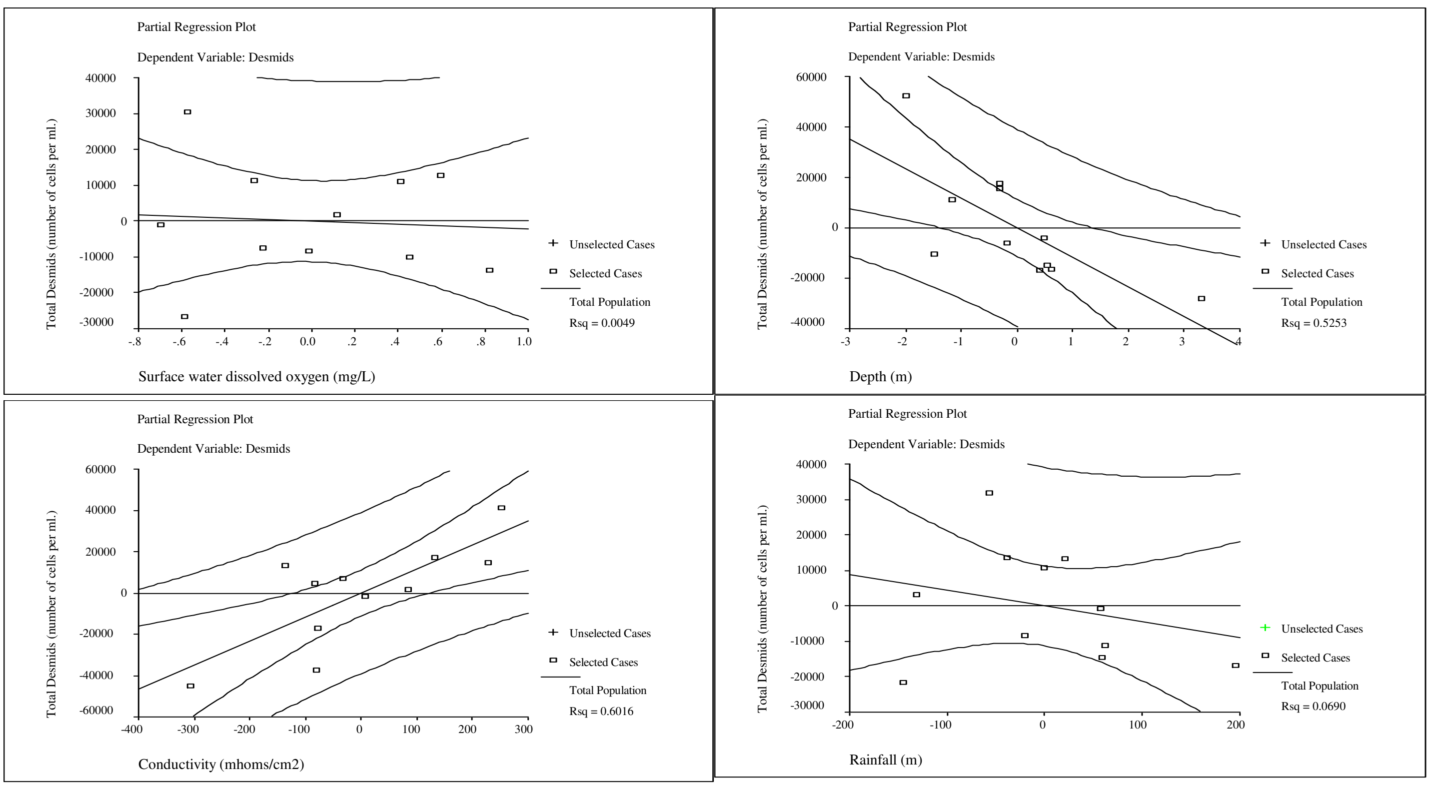


Figure 4. Partial regression plots showing the relationship between the total population of Desmids, Surface Water Dissolved Oxygen, Depth, Conductivity and Rainfall within the period of study.

increased with an increase in value of surface water temperature and conductivity. The total population of Desmids had a near neutral (zero correlation) with the surface water dissolved oxygen and thus, does not significantly change with a change in the level of the SDO. The members of the Class Desmidaceae were observed to have population flushes at Ibiye (Rsq = 0.0217) and Gbanko (Rsq = 0.0132), as a result of the NO3-N imputs at these stations (Figure 5). They were negatively correlated with NO3-N at Idoluwo (Rsq = 0.0520) while the population was indifferent to NO3-N at the Oto (0.0004) sampling station. The Desmids increased in population at Ibiye (Rsq = 0.2586), with a corresponding rise in the concentration of phosphate-phosphorus (PO4-P). However the population dropped with every rise in the concentration of PO4-P (Figure 6) at Idoluwo (Rsq = 0.1325) and was indifferent at Oto (Rsq = 0.0001).

The impact of Potassium was positively felt (Figure 7) at Idoluwo (Rsq = 0.2957) and negatively at Oto (Rsq = 0.1576) and Gbanko (Rsq = 0.0786), while the correlation was zero at Ibiye (Rsq = 0.0035).The correlation between sulphate-sulphur (SO_4-S) and the population of Desmids (Figure 8) was positive at Oto Rsq = 0.0939) and Gbanko (Rsq = 0.4572). The relationship was negative at both Idoluwo (Rsq = 0.2102 and Ibiye (Rsq = 0.3506). Members of the Class *Desmidaceae* (Figure 9) were in two clusters, respectively branching into three, and then two, sub-clusters. There was an exhibition of closeness or proximity between *Staurastrium sp. /Closterium sp., Spirotamia sp. /Rotaria sp. and Netrium sp./Micrasterias sp.* Non-the-less, the greatest similarity showed between *Staurastrium sp. /Closterium sp.*

DISCUSSION

The even distribution of the Desmids in Ologe lagoon is an indication of a spatial preponderance by this class of algae in active competition with others in tandem with the "Van Valen's Law of constant extinction" which states that for every group of related organisms sharing a common ecology there is a constant probability of extinction of any taxon per unit time (Lincoln et al., 1985).The Desmids presented a polymictic distribution, having several dominant species. There was a positive correlation in the distribution between the Desmids and the OMC in Ologe lagoon. The OMC in the lagoon increased with a corresponding rise in the population of the Desmids. Sprules et al. (1986), asserted that plankton-size-spectra significantly correlate with ecosystem productivity, size and perturbation. The results of this study emphasized a sparsely occurring assemblage marked by low densities, short temporal presence and low diversity, agreeing with the studies of a two dimensional system that arises in

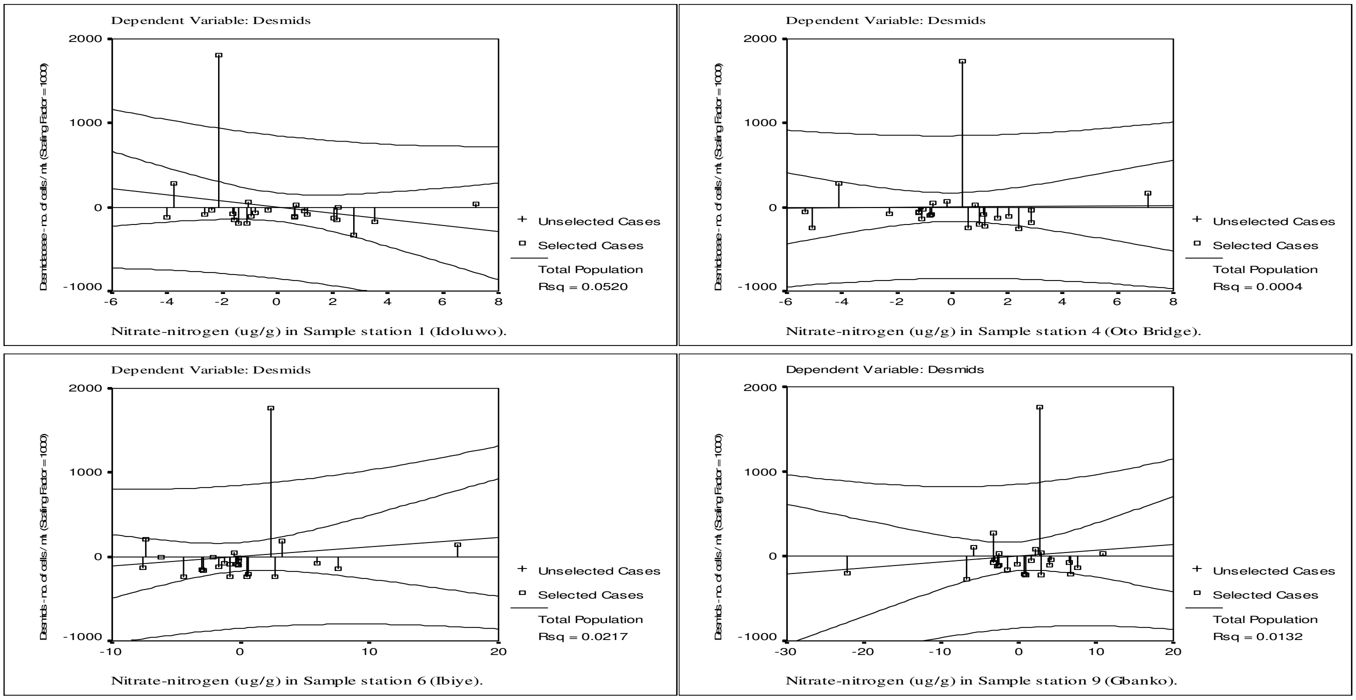


Figure 5. Partial regression plots showing the relationship between the Total Desmid population, and Nitrate-nitrogen (NO3-N) at the Upstream, Midstream and Downstream portions of Ologe lagoon within the period of study.

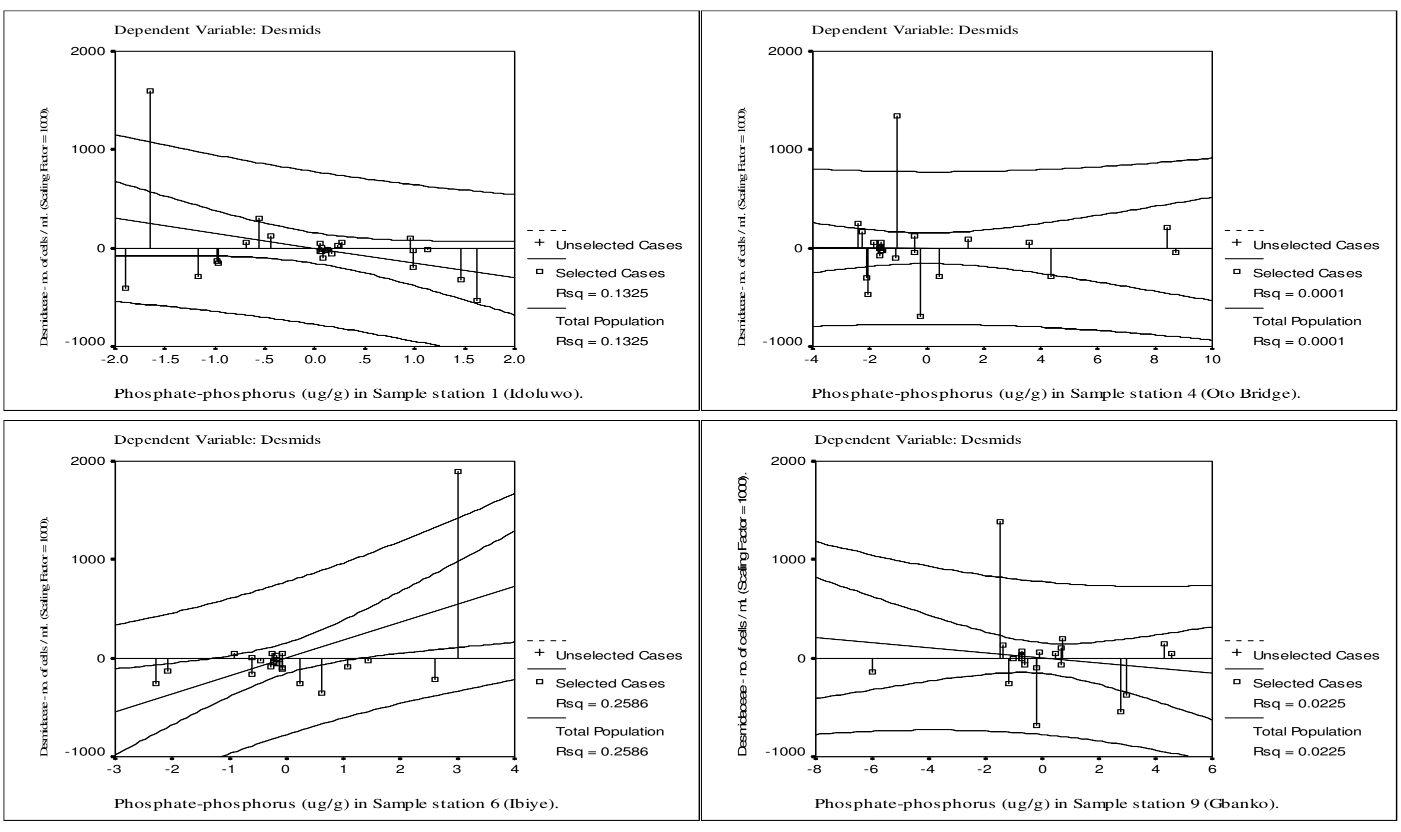


Figure 6. Partial regression plots showing the relationship between the total desmid population and phosphate-phosphorus (PO4-P) at the upstream, midstream and downstream portions of Ologe lagoon within the period of study.

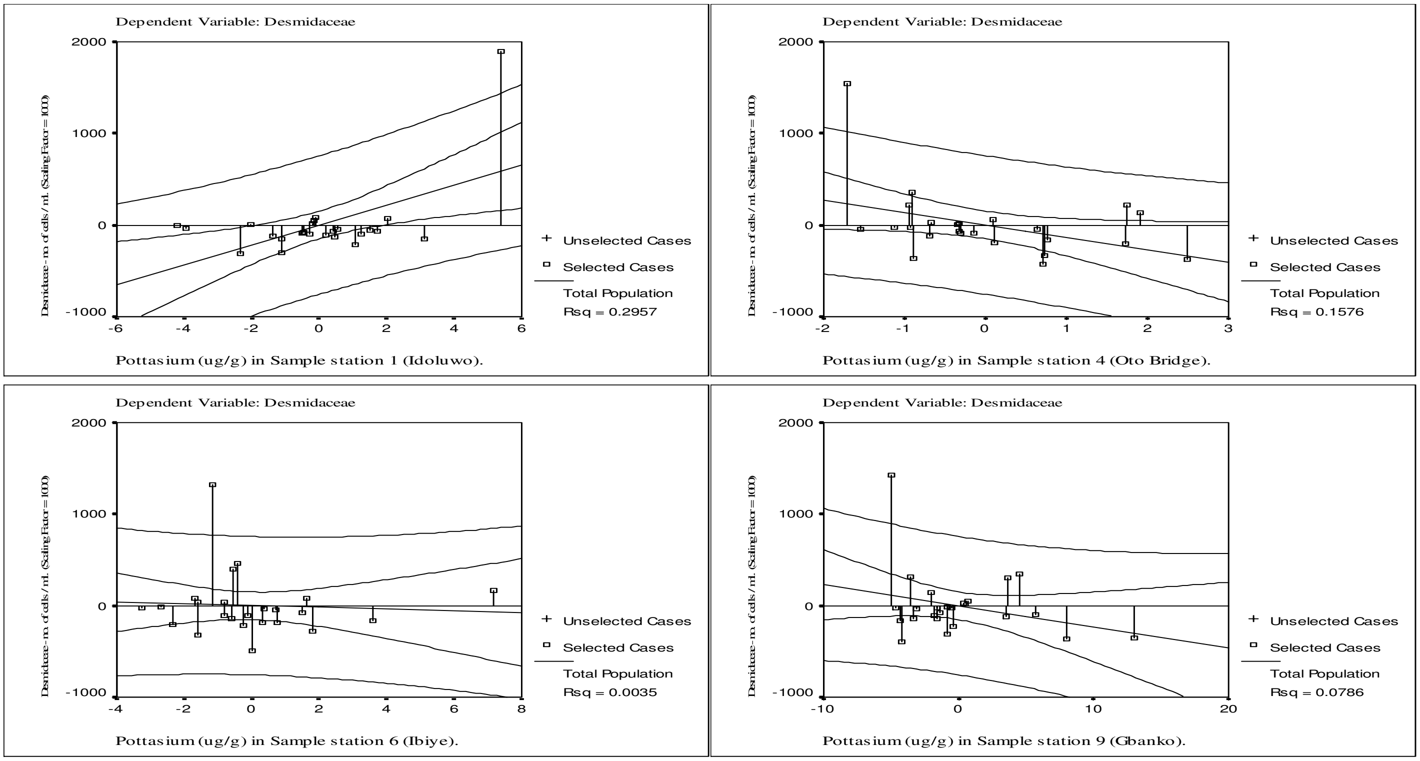


Figure 7. Partial regression plots showing the relationship between the Total Desmid population, and Potassium (K) at the Upstream, Midstream and Downstream portions of Ologe lagoon within the period of study.

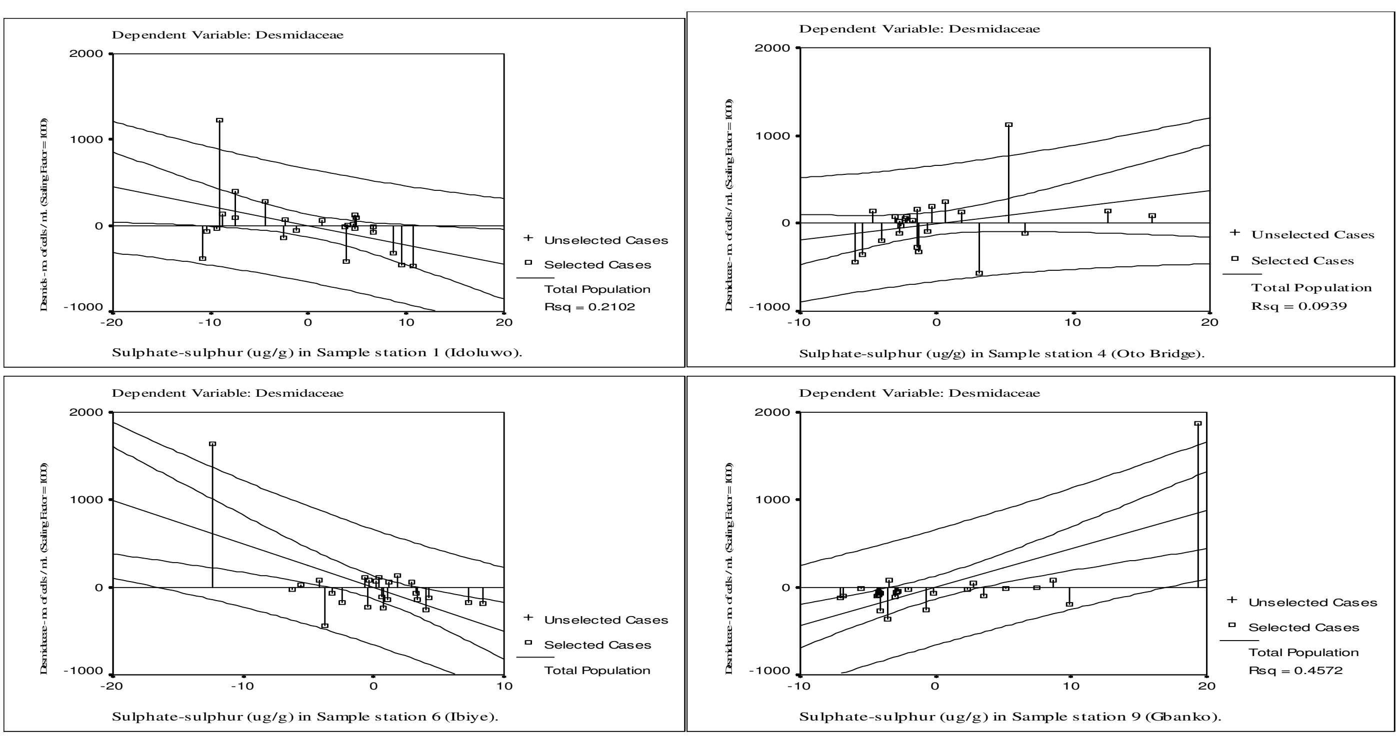


Figure 8. Partial regression plots showing the relationship between the Total Desmid population, and Sulphate-Sulphur (SO4-S) at the Upstream, Midstream and Downstream portions of Ologe lagoon within the period of study.

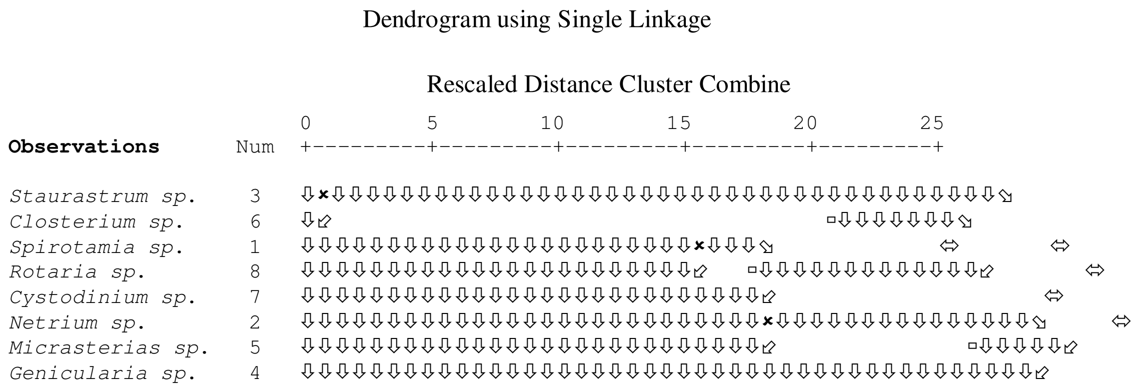


Figure 9. Dendrogram showing the hierarchical cluster analysis for Desmids (using single linkage between groups) in Ologe lagoon within the period of study.

plankton allelopathy involving discrete time delays and environmental fluctuations. This study agrees with the suggestions of Harrison et al, 1997, that phosphates and sulphates might also be potentially limiting nutrients in addition to nitrogen, phosphorus and Potassium (a micro-nutrient) as observed in this study. The environmental parameters are assumed to be perturbed by white noise characterized by a Gaussian distribution with mean zero and unit spectral density (Tapaswi et al., 1999). The Gause's hypothesis states that "two species with the same ecological requirements cannot coexist in the same place indefinitely; that is they cannot form steady state populations if they occupy the same niche". This assertion is in agreement with Therriault (2002) on temporal patterns of diversity, abundance and evenness for invertebrate communities from coastal freshwater and brackish water rock pools. It was implied that some temporal changes in community metrics could be linked to temporal changes in environmental variables (Van Der Gucht et al., 2001). In brackish water pools, a significant increase in pool salinity corresponded to an increase in species richness, likely due to an increase in marine fauna. Similarly, changes in abundance and evenness corresponded to changes in temperature, dissolved oxygen, and pH (Erondu et al., 1991). In addition, physiccochemical variables used in this study were shown to affect community metrics and those relationships depended on season, location or sample station and their attendant anthropogenic pressures (domestic, agriculture and industry). Most relationships between community metrics and environmental variables were negative with the exception of salinity and surface water dissolved oxygen for which positive relationships were found. This may indicate that, as the conditions in Ologe Lagoon become less favorable, a few *Desmidacean* species (*Staurastrium, Micrasterias and Rotaria*) flourish and dominate the community. The results of this study show a similar trend with work of Hanse et al. (2003), on Lake Metabolism with regards to the relationship between plankton and dissolved organic carbon and phosphorus.

REFERENCES

American Public Health Association (1980). Standard Methods for the examination of water and waste water. *A.P.H.A. Washington* D.C.15th Ed. p.1134.

Clarke EO, Anetekhai MA, Akin-Oriola GA, Onanuga AIS, Olarinmoye OM, Adeboyejo OA, Agboola I (2004). The Diatom (*Bacillariophyta*) diversity of an open access lagoon in Lagos, Nigeria. J. Res. Rev. Sci. 3:70 – 77.

Clarke EO, Anetekhai MA, Onanuga OA, Olarinmoye MO, Adeboyejo OA (2005). The population dynamics of *Prorocentraceae, Gonyaulacaceae, Euglenophyceae* and *Ceratiaceae*, in a lagoon bordering heavy industry in Lagos State, Nigeria. Proceedings of the 4th Faculty of science annual conference, Lagos State University. 4. pp. 60 – 62.

Clarke NV (1978). A comparison of the zooplankton of lake Kainji and of the rivers Niger and Swashi. Hydrobiologia. 226: 153 – 166.

Dillard GE (1991). Bibliotheca Phycologica. Band 89. Freshwater Algae of the Southeastern United States. Part 4. Chlorophyceae: Zygnematales: Desmidiaceae (Section 2). J. Cramer, Stuttgart.

Dillard GE (1991). Bibliotheca Phycologica. Band 90. Freshwater Algae of the Southeastern United States. Part 5. Chlorophyceae: Zygnematales: Desmidiaceae (Section 3). J. Cramer, Stuttgart.

Dillard GE (1993). Bibliotheca Phycologica. Band 93. Freshwater Algae of the Southeastern United States. Part 6. Chlorophyceae: Zygnematales: Desmidiaceae (Section 4). J. Cramer, Stuttgart.

Dillard GE (1999). Common Freshwater Algae of the United States. An Illustrated Key to the Genera (Excluding Diatoms). Balogh Scientific Books, E. Schweizerbart'sche Verlagsbuchhandlung, Stuttgart.

Erondu ES, Chinda AC (1991). Variations in the physico-chemical features and Phytoplankton of the New Calabar River at Aluu, Rivers State, Nigeria. NIOMR Tech. Paper. No. 75.

Lincoln RJ, Boxshall GA, Clark PF (1985). A Dictionary of Ecology, Evolution and Systematics. Cambridge University Press. p. 298.

Tapaswi PK, Mukhopadhyay A (1999). Effects of environmental fluctuation on plankton allelopathy. J. Mathematical Biol. 39: 39 – 58.

Therriault TW (2002). Temporal patterns of diversity, abundance and evenness for invertebrate communities from coastal freshwater and brackish water rock pools. *Aquatic Ecology*, vol. 36(4) 529-540 (12). Kluwer Academic Publishers.

Van der Gucht K, Sabbe K, De Meester L, Vloemans N, Zwart G, Gillis M, Vyverman W (2001). Contrasting bacterioplankton community composition and seasonal dynamics in two neighboring hypertrophic freshwater lakes. Environ. Microbiol. Vol. 3(11): 680-690. Blackwell Publishing.

Whitford LA, Schumacher GJ (1984). A Manual of Fresh-Water Algae. Sparks Press, Raleigh, N.C.