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INFLUENCE OF SOME PHYSICO-CHEMICAL PARAMETERS ON THE COMPOSITION AND DISTRIBUTION OF BENTHIC FAUNA IN WOJI CREEK, NIGER DELTA, NIGERIA

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ABSTRACT

Investigation into the influence of certain physico-chemical parameters on the distribution of macrobenthic invertebrates in Woji creek was done between April, 2001 and March, 2002. Temperature of the sub-surface water ranged from 25.5^{0}C to 30.9^{0}C. T' e degree of hydrogen ion concentration, pH varied between 5.5-7.8. Salinity showed spatial variation ranging from 0 – 12.7‰ while Dissolved Oxygen Concentration (DO) had values between 1.6mg/l and 10.1mg/l. A total of thirty taxa of benthic macroinvertebrates were encountered. These belong to 20 families within 5 classes. Regression analyses revealed that pH significantly ($P<0.05$) affected the distribution of 5 out of the 11 most common species while salinity influenced 7 of the 11 species. DO significantly affect the spread of 6 of the 11 fauna examined. Based on the regression square, the amounts of variation in the distribution of the species accounted for by pH, salinity and DO ranged from 16 to 99%.

KEYWORDS: Physico-chemical parameters;distribution; macrobenthic invertebrates; biomarkers; Woji creek

INTRODUCTION

Animals living within or on sediments surface known as benthic fauna are good biomarkers necessary in the potential evaluation of aquatic pollution. Benthos are relatively less mobile, diverse in form and also occupy variable habitats. These organisms are also exposed permanently to elevated concentration of toxicants buried in sediments (Jones, 1987; Odiete, 1999).

Ecological studies involving benthic fauna have revealed differences in species composition, abundance, biomass and distribution patterns in various water systems. Physico-chemical parameters like temperature regime (Ward, 1974), Dissolved Oxygen Concentration (Young et al; 1976), salinity (Jones, 1987), Biological Oxygen Demand and biotope (Umeozor, 1996) are some of the factors that determine the structural assemblages of benthic animals. Other factors identified as having links with the community structure of benthos include age class of the organism (Hart, 1994), organic enrichment and thermal conditions (Barton, 1986), texture and stability of substrate (Darlington, 1976).

Toxic materials like ammonia, heavy metals, pesticides, polychlorinated biphenyls, hydrocarbons and phenols usually cause a shift in the species composition of benthic organisms (Hellawell, 1986; Ramade, 1989; Ekweozor, 1992).

This study was aimed at investigating the influence of some physico-chemical variables on the composition and distribution of benthic macroinvertebrates along Woji creek, off the Bonny River in the lower Niger Delta of Nigeria.

STUDY AREA

Woji creek, located between latitudes 7^{0}3'N, 7^{0}1'3" N and longitudes 4^{0}48' E, 4^0 52' E is within Port Harcourt, the capital of Rivers State, South-South Nigeria. The main river channel (Fig. 1), which is a tributary of the Bonny River, bifurcates at Okujagu, forming Woji creek on the left. This creek (Woji) extends inland of Port Harcourt with several meanders and decreases considerably in water dimension (depth and width) upstream. Woji creek has its head in a freshwater swamp forest at Rumuodara (Fig.1). This upper reaches freshwater flows uni-directionally down stream (traversing Port Harcourt – Aba road) up to Rumuogba Bridge where significant tidal fluxes are observed. The study area also borders the Port Harcourt Trans-Amadi industrial layout with myriad of companies or factories located on the surrounding banks. There is also a prominent slaughterhouse located on the creek while other types of human activities go on in the area.

MATERIALS AND METHODS

Sampling Locations: For the purpose of the present study, five sampling stations were established on the creek channel (Fig.1). The distance between the sampling locations ranged from 500 metres to 700 metres apart.

- Station 1:Located at Rumuogba is made up of a tidal freshwater body. Water hyacinth (*Eichornia crassipes*) dominates the surrounding vegetation of this station.
- Station 2 : Located down stream of station 1at Rumuobiakani is before an overhead rail bridge. *E. crassipes* is still the prominent vegetation although with decreasing density probably due to increasing salinity.
- Station 3:Located at Oginigba and down stream of station 2 is opposite a boat building company on the right bank. Small stands of white and red mangrove species (*Avicenia africana* and *Rhizophora* spp) are the dominant surrounding vegetation.
- Station 4 :This is located directly opposite the major Port Harcourt abattoir before an overhead road bridge. The slaughterhouse bank is bare of vegetation.
- Station 5: Located at Okujagu-ama is the most down stream location of the study area and is situated some metres before the point of bifurcation of the

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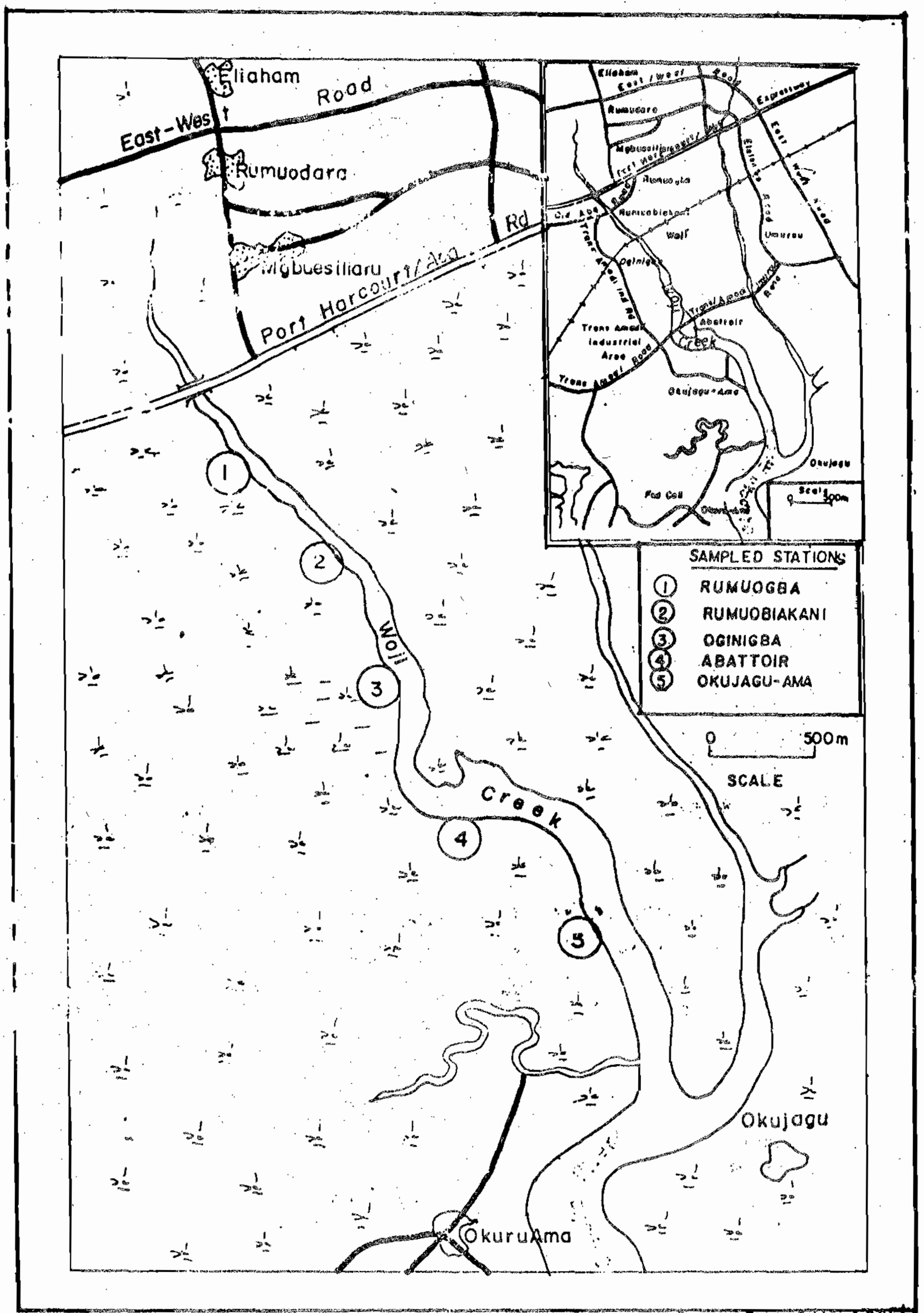

Source : Street Guide of P/H by SPDC

Fig1: Map of Woji Creek showing Sampled Stations

main river channel. Nypa palm (*Nypa fructicans)* dominates the surrounding vegetation.

SAMPLING PROCEDURES

Sampling was undertaken monthly for one year between April, 2001 and March, 2002. The sub-surface water temperature was measured in-situ with a thermometer. Samples for the determination of pH, salinity and dissolved oxygen (DO) were collected and preserved in accordance with the standard procedures (APHA, 1998) before transportation to the laboratory for analyses. In the laboratory, pH was measured with a pH meter model EC10 Hach while salinity was determined using conductivity meter model CO150 Hach. DO was determined by the Alkaline-Azide modification of Winkler's method (APHA, 1998).For benthic faunal analysis, three subtidal sediment samples were taken from each location to make a composite sample. The samples were collected with an Eckman's grab (225 cm^2) from a dugout boat. The composite samples were washed using 0.5mm mesh sieve and the retained residues were emptied into well-labeled wide mouth plastic containers. The samples were then preserved with 10% formalin to which Rose Bengal stain had been added. Macroinvertebrates were sorted out in a white plastic tray containing moderate volume of clean water. Organisms were also preserved in 10% formalin prior to identification and counting exercise. Identification and numerical count were performed under light and stereo microscopes using keys (Day, 1967; Mellanby, 1975 and Fauchald,1977). Regression analysis was done to test whether pH, salinity and DO significantly affected the distribution of some of the wide spread and abundant organisms. Each of these environmental variables was treated as the independent variable while the number of the 11 common species per station was the dependent variable.

RESULTS AND DISCUSSION

The pertinent physico- chemical data of the study area are given in table 1. Temperature mean values ranged from 27.3°C to 28. 7°C. This parameter also showed a characteristic increase down stream with the maximum temperature recorded at station 4. The temperature range (25.8-30.9°C) of Woji Creek is normal with respect to its location in the Niger Delta, which has been described as humid/semi-hot equatorial area (NEDECO, 1980). Generally, the temperature of natural inland waters in the tropics varies between 25°C and 35°C (Alabaster and Lloyd, 1980). The maximum mean temperature (28.7°C) recorded in station 4 is to be expected due to the lack of marginal vegetation, fire activities associated with the burning of animal skin and also the high degree of decomposition of organic wastes from feacal droppings associated with slaughtered animals which characterize the site.

The degree of hydrogen ion concentration (pH) of the area ranged from 5.5-7.8.This tended to increase down stream. Stations 1 to 4 had slight acidic mean values while station 5 mean pH value was neutral (7.0 $\pm$ 0.4). Salinity of the creek depicted a gradual transition from freshwater to brackish water. Station 1 had the lowest mean salinity (0.025‰) whereas station 5 recorded the peak mean salinity (6.12‰). According to the Venice (1959) classification standard, the area of Woji Creek investigated could be conveniently divided into two distinct saline zones. Stations 1, 2 and 3 are oligohaline (0-5‰) stations 4 and 5 are mesohaline (5-8‰).

Do mean values ranged from 1.6mg/l to 10.1mg/l. DO also varied slightly among the sampling locations. Stations 1 and 2 had the maximum mean DO of 6.6mg/l while station 4 had the lowest mean DO (5.4mg/l). The least DO recorded at location 4 is to be expected with reference to the relatively high temperature measured at the site. At high temperature,

Table 1: Physico-chemical characteristics of Woji Creek.

PARAMETER	STATIONS 1	2	3	4	5
Temperature (°C)	25.8-28.4 27.3+0.9	25.9-28.9 27.4+1.0	26.0-29.1 27.4+0.9	26.9-30.8 28.7+1.3	26.9-30.9 28.5+1.9
Ph	5.5-7.4 6.0+0.7	5.7-7.2 6.4+0.5	6.1-7.3 6.7+0.4	6.3-7.8 6.8+0.5	6.4-7.8 7.0+0.4
Salinity (‰)	0.0-0.1 0.025+0.04	0.0-5.9 1.6+2.1	0.1-8.5 4.0+2.9	0.2-10.5 5.07+3.6	0.6-12.7 6.12+3.8
DO (mg/l)	3.7-8.9 6.6+2.1	3.7-9.7 6.6+2.0	3.3-9.2 5.8+1.6	1.6-8.5 5.4+2.3	2.8-10.1 5.9+2.0

Table 2
DENSITY (ORG. PER MONTH) AND COMPOSITION OF BENTHIC MACROINVERTEBRATES OF WOJI CREEK.

CLASS FAMILY	SPECIES	NUMBER OF INVERTEBRATERS PER MONTH APRIL 2001	MAY 2001	JUNE 2001	JULY 2001	AUG. 2001	SEPT. 2001	OCT. 2001	NOV 2001	DEC. 2001	JAN. 2002	FEB. 2002	MAR. 2002	TOTAL NO. RECOVERED
OLIGOCHAETA														
Naididae	*Ophidonais sp*	10	11	65	101	408	[illegible]	330	457	1126	1095	129	11	3782
	Dero sp			23					36					59
	Paranais sp					1	11		5	7				24
	Styleria lacustris			1			1							2
POLYCHAETA														
Nereidae	*Nereis virens*				3	1								4
	Nereis diversicolor				5	18			2	1		9		35
	Leonnates decipens		2											2
Nephtyidae	*Nephtys hombergi*	4	3	55	80	110	12	13	54	262	122	74	54	843
	Nephtys hystricis	4											14	18
Amphinomidae	*Eurothoe complanata*		4											4
	Eurothoe capensis		5											5
Capitellidae	*Capitella* sp	8					1	11			3			23
	Notomastus tenuis				77	22							1	100
Eunicidae	*Marphysa* sp			1										1
Glyceridae	*Glycera capitata*					2					1			3
	Glycera convulata						5		1	2				8
Arenicolidae	*Arenicola marina*	1	1				1							3
Orbinidae	*Scoloplos* sp		1	7				2						10
Terebellidae	*Amphitrite gracilis*		4											4
	Amphitrite sp			2						1				3
Lumbrineridae	*Lumbrineris* sp			1										1
Syllidae	*Syllis* sp			1					7	5	16		4	33
Sabellidae	*Sabella pavonina*		3											3
CRUSTACEA														
Mysidae	*Mysis* sp		2											2
Palaemonidae	*Palaemonetes africanus*		2											2
Gammaridae	*Gammarus* sp			2										2
Sphaeromatidae	*Sphaeroma* sp		4											4
INSECTA														
Hydrophilidae	*Amphiops* sp		5	1							1	1	1	9
Chironomidae	*Chironomus* sp	8	16	4			3		1	5	1		1	39
BIVALVIA														
Tellinidae	*Tellina nymphalis*	11	4	4	9	4	4	2	17	2	4	1	2	64
TOTAL		46	67	167	275	566	407	358	580	1411	1243	214	88	5092

the solubility of oxygen decreases while the reverse is the case at lower temperatures (Plimmer, 1978).

Thirty taxa of macro-invertebrates were encountered in the study. These belong to 20 families and 5 classes (Table 2). The class Polychaeta dominated the faunal composition with 19 species from 12 families (63.3%). Oligochaeta had 4 representative species from one family (Naididae). In terms of abundance, oligochaetes came first. These accounted for 77.3% of the faunal assemblage. Polychaetes ranked second in relative abundance and constituted 20.3% of the benthic community. The other three representative animal groups, namely, crustacea, Bivalvia and Insecta accounted for 0.2%, 1.2% and 0.9% of the fauna respectively.

The data relating to the influence of pH, salinity and DO on the distribution of Ophidonais sp,Paranais sp, Dero sp, Nereis diversicolor, Nephtys hombergi, Capitella sp, Notomastus tenius, Glycera convulata,Syllis sp, Tellina nymphalis, Amphiops sp; the 11 most common species in the study are presented in table 3. The results show that pH significantly (P<0.05) affected the distribution of Ophidonais sp, Nereis diversicolor, Nephtys hombergi, Notomastus tenius, Glycera convulata,Syllis sp, Tellina nymphalis out of the 11 species examined (Table 3). Based on the slope (β) of the regression analysis, there was a positive relationship between the number of each species per sample station and pH in 3 of the 5 species. Negative relationship was observed in Ophidonais sp and Notomastus tenius. According to the R square (Table 3), the amount of variation in the distribution of these species accounted for by pH ranged from 20 to 69%. Salinity significantly (P<0.05) affected the distribution of Ophidonais sp, Nereis diversicolor, Nephtys hombergi, Notomastus tenius, Syllis sp, Tellina nymphalis, Amphiops sp; 7 out of the 11 most common species along the creek (Table 3). In 4 of these, the relationship was positive while the relationship was negative between the ecological variable (salinity) and Ophidonais sp, Notomastus tenius and Amphiops sp. From the regression square (Table 3), the amount of variation in the distribution of these species accounted for by salinity ranged from 16 to 66%.

DO significantly (P<0.05) affected the distribution of *Ophidonais* sp,*Paranais* sp, *Dero* sp, *Capitella* sp *Glycera convulata,Syllis* sp, *Tellina nymphalis, Amphiops* sp; 6 out of the 11 most common species (table 3). According to the slope (β) of the regression analysis, positive and negative relationships occurred in 3 each of the 6 species respectively. Based on the regression square, the amount of variation in the distribution of these organisms accounted for by DO varied from 21 to 99%.

The fact that some of the benthos occurred in excluded locations throughout the period of the study, explains, the importance of including diverse microhabitats in ecological studies. Some of the species recovered were well distributed, occurring in all the sampling locations in variable numbers. There was also the observed tendency for certain species that were apparently absent in particular sites for sometime having to suddenly appear in those sites in high densities. For instance, *N. hombergi* occurrence was initially restricted to stations 3,4 and 5 from April to November. The species eventually occurred in the collections of stations 1 and 2 from December to March. Moreover, the species abundance of the two most upstream sites (1,2) during the months of occurrence was high compared to the downstream brackish water stations. The ability of *N. hombergi* to thrive in the unexpected freshwater/low salinity sector (stations 1,2) presupposes the organism's euryhaline property. Onwuteaka (1991) rated *Nephtys* as the most dominant benthos in the subtidal sediments of the Niger Delta and described the species as euryquitous, having the ability to accommodate variable conditions including salinity. Certain euryhaline species might be absent in one biotope and be present in

Table 3: Effects of pH, Salinity and Dissolved Oxygen on macroinvertebrates distribution along Woji Creek.

SAMPLE	STATIONS					Ph		Salinity		DO	
	1	2	3	4	5	Slope (β)	R. square	Slope (β)	R. square	Slope (β)	R. square
Mean pH per station	6.0	6.4	6.7	6.8	7.0						
Mean salinity (%o) per station	0.025	1.6	4	5.07	6.12						
Mean DO (mg/l) per station	6.6	6.6	5.8	5.4	5.9						
Ophidonais sp	1230	2160	511	47	64	-0.76*	0.51*	-0.81*	0.66*	-0.46*	0.21*
Paranais sp	7	1	5	11	0	-0.17	0.03	-0.07	0.01	0.77*	0.60*
Dero sp	0	27	9	0	23	0.30	0.09	0.17	0.03	-0.52*	0.27*
Nereis diversicolor	5	6	0	5	18	0.45*	0.20*	0.46*	0.21*	-0.15	0.02
Nephtys hombergi	76	92	28	42	606	0.54*	0.29*	0.55*	0.30*	-0.30	0.09
Capitella sp	0	3	11	9	0	0.35	0.12	0.33	0.11	0.47*	0.22*
Notomastus tenius	77	0	1	0	0	-0.83*	0.69*	-0.74*	0.55*	-0.24	0.06
Glycera convulata	1	1	5	0	1	0.86	0.07	0.04	0.02	-0.47*	0.22*
Syllis sp	0	0	0	28	1	0.34	0.12	0.41*	0.16*	0.99*	0.99*
Tellina nymphalis	0	4	1	2	36	0.62*	0.39*	0.62*	0.39*	-0.25	0.06
Amphiops sp	2	2	4	1	0	0.35	0.13	-0.40*	0.16*	-0.30	0.09

*Significant effect on distribution

another within the same water body. They may also occur in large numbers in the most ecologically unpredictable zones (Cognetti, 1982).

From Table 3, it is obvious that pH, salinity and DO are amongst the factors that collectively influence the distribution of some of the benthos of Woji Creek. The positively or negatively influential pattern of the ecological variables on the distribution of the organisms could be related to physiological adaptation. Boltovskoy and Wright (1976) observed that pH is an important ecological parameter that has a strong relationship with the physiology of most aquatic organisms.

Although, Nwadiaro (1984) observed that the distribution of molluscs in the lower Niger Delta was limited to neutral/slightly alkaline brackish water zones, *Tellina nymphalis* (a bivalve mollusc) was encountered during the study at stations 2, 3 and 4 having mean slight acidity values. Thus, it is likely that the pH ranges of these stations (6.4$\pm$ 0.5 to 6.8 $\pm$ 0.5) are within the tolerance limit of *T. nymphalis*. Based on the salinity data (Table 1), Woji creek provides a gradual transition from fresh to salt water and the significant effect of salinity on the distribution of benthos in the creek is not abnormal. Wells and Demas (1979) implicated salinity along with other factors in the structural pattern of the benthic invertebrate community of the lower Mississippi River.

REFERENCES

Alabaster, J.S. and Lloyd, R. 1980. Water quality criteria for freshwater fish; Butterworths, London. 297pp.

Allan, J. D., 1995. *Stream Ecology-Structure and Function of running waters.* 1st ed. Chapman and Hall, USA. 388pp

American Public Health Association (APHA) 1998. Standard methods for the Examination of water and wastewater 20th ed., Washington, D.C. 116IPP.

Barton, D. R., 1986. Nearshore benthic invertebrates of the Ontario waters of lake Ontario Journal of Great lakes Resources. 12(14): 270-280

Boltovskoy, E. and Wright, R., 1976. *Recent foraminifera.* Junk publication, the Hague. 575 pp.

Cognetti, G. 1982. Adaptive strategy of brackish water fauna in pure and polluted waters *Marine Pollution. Bulletin. 13(7):* 247 – 250.

Darlington, J.P.E., 1976. Temporal and spatial variation in the benthic invertebrate fauna of lake George, Uganda. Journal of Zoology, London 1980: 95 – 112.

Day, J. H., 1967. A monograph on the *Polychaeta* of Southern Africa, Part 1Errantia, British Museum (Natural History), London. 458 pp.

Ekweozor, I. K. E., 1992. The levels and effects of some industrial pollutants in the Bonny estuary, Nigeria. Ph.D Thesis, Rivers State University of Science and Technology, Port Harcourt.

Fauchald, K. 1977. *The Polychaete* worms. Definitions and keys to *orders,families and genera.* Natural History Musuem, Los Angles 188pp

Hart, A.I., 1994. The Ecology of the communities of benthic macrofauna in the mangrove swamp of Port Harcourt area of the Niger Delta. Ph.D Thesis, University of Port Harcourt, River State, Nigeria. 262pp

Head, K. H., 1992. Manual of soil laboratory testing 2nd ed. Soil classification and compartment tests. Pentech press. London.

Hellawell, J. M., 1986. Biological indicators of freshwater pollution and environmental management. Elsevier Applied Science Publishers, London. 546pp.

Jones, A R., 1987. Temporal pattern in macrobenthic communities of the Hawkesbury estuary, New South Wales. Australia Journal of Marine and Fresh Water Resource,s 38: 607 – 624

Mellanby, H., 1975. Animal life in freshwater. A guide to freshwater invertebrates. Chapman and Hall, London. 308pp.

NEDECO, 1980. The waters of the Niger Delta. Reports of an investigation by NEDECO (Netherlands Engineering consultants). The Hague. 210 –228

Nwadiaro, C. S., 1984. The longitudinal distribution of macroinvertebrates and fish in the lower Niger Delta river (River Sambreiro) in Nigeria. Hydrobiology Bulletin 18: 133 – 140.

Odiete, W.O., 1999. Environmental physiology of Animals and pollution. Inno Obonna and Associates, Lagos. p220 – 246.

Onwuteaka, J. N., 1992. The diversity and assocaition of polychaete fanua in Niger Delta Ph.D thesis, University of Port Harcourt, Rivers State, Nigeria.294pp

Plimmer, R. J., 1978. Degradation methodology – Chemical and physical effects in: Proceedings of the workshop on microbial degradation Pensacola Beach, Florida. 423 – 431..

Ramade, F., 1989. The Pollution of the hydrosphere by global contaminants and its effects on aquatic ecosystems. In Boudou, A., Ribeyre, F. (eds.) Aquatic Ecotoxicology: Fundamental concepts and methodologies. R.C press, Boca Raton (Florida) 151 – 183.

Umeozor, O. C., 1996. Influence of Biotope, salinity and Biochemical Oxygen Demand on the composition and distribution of aquatic insects in New Calabar River, Nigeria. Tropical Fresh Water Biology, 5: 31 – 42.

Venice System 1959 Symposium on the classification of brackish water. Venice April 4 – 8 (1958) Archives of Oceangraphy and Limnology, 11: 1 – 248.

Ward, J. V. 1974. A temperature-stressed stream ecosystem below a hypolimnial release mountain reservoir Archives of Hydrobiology, 74 :247 – 275.

Wells, F.C. and Demas, C.R., 1979 Benthic invertebrates of the lower Mississippi River: Water Resources Bulletin. 15: 1565 – 1577.

Young, W. C., Kent, D.H. and Whiteside, B.G., 1976. The influence of a deepstorage reservoir on the species diversity of benthic macroinvertebrate communities of Guadalupe River, Texas. Journal of Science, 27: 213 – 224.