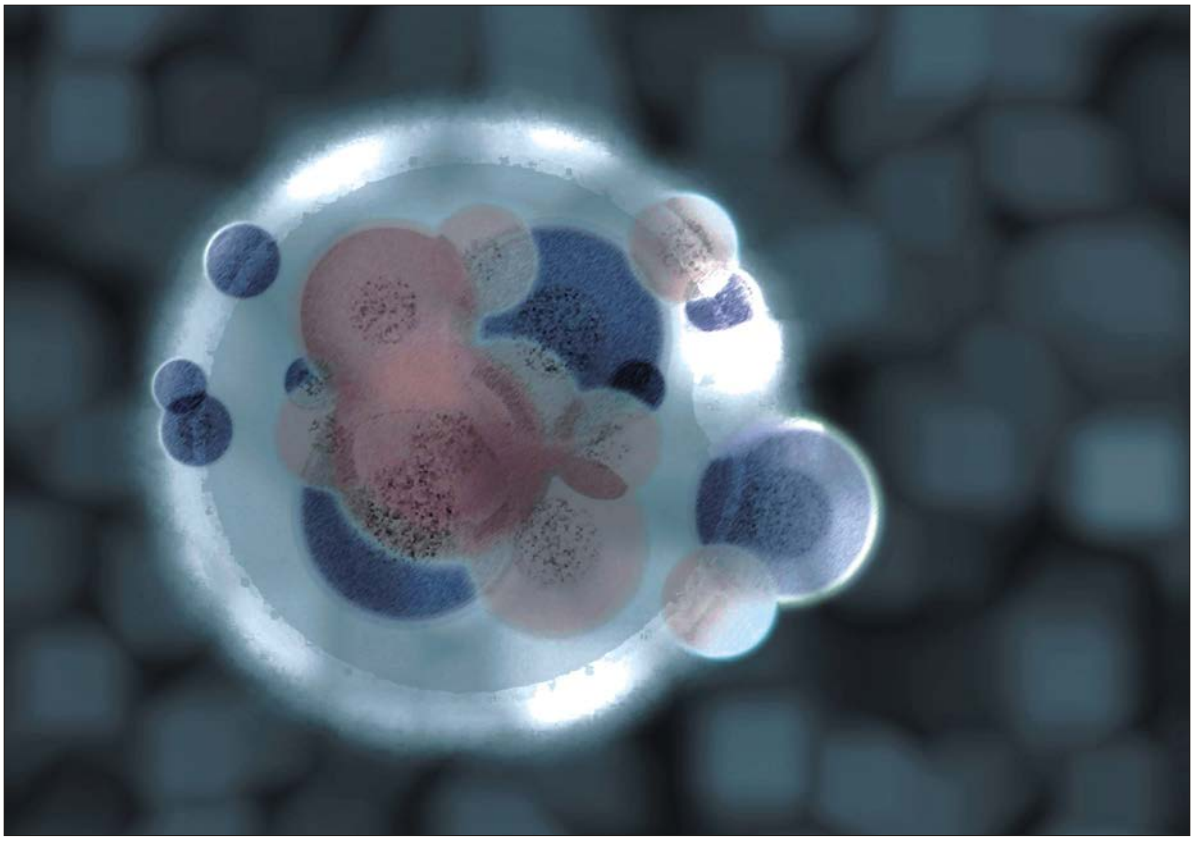

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Effect of Water Hyacinth (*Eichornia crassippes*) Infestation on Zooplankton Populations in Awba Reservoir, Ibadan South-West Nigeria

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Abstract: The effects of water hyacinth infestation on the distribution, abundance and species composition of zooplankton in Awba reservoir were investigated. Samples were collected in each of the sampling areas (water hyacinth infested and open water) by vertical zooplankton hauls using 64 um bolting silk net. The samples were immediately fixed in 4% formalin for preservation. The species composition of the zooplankton from the sampled areas consisted of 3 taxa, comprising of 6 species of Cladocera (*Moina* sp., *Ceriodaphnia* sp., *Pleuroxus* sp., *Diaphanosoma* sp., *Chydorus* sp. and *Leydigia* sp.) 6 species of Rotifers (*Asplanchna* sp., *Trichocerca*, *Filinia* sp., *Polyarthra* sp., *Brachionus* sp. and *Lecane* sp.) and 3 species of Copepoda (*Cycloid copepods*, *Copepodite* and *Calanoid copepods*. However, the study showed that the Rotifers had higher numerical abundance in the study areas. Water hyacinth infested area had a total density of 95 individuals/L while open water had 215 individuals/L. The study showed that the density of zooplankton were significantly lower ($p<0.05$) in the infested area. Biotic indices such as Margalef's and Simpson's indices were lower in the infested area while Shannon-wiener diversity index was significantly lower ($p<0.05$) in the water hyacinth infested area. The result suggests that water hyacinth dense mats affected the numerical abundance of the zooplankton and therefore should be controlled because of their negative impact on fish abundance.

Key words: *Eichhornia crassipes*, abundance, diversity, species richness, zooplankton, Awba reservoir

INTRODUCTION

Eichhornia crassipes (Mart Solms) popularly known as water hyacinth, is a free floating aquatic weed which belongs to the family Pontedriaceae (Cronk and Fennessy, 2001). This obnoxious aquatic weed has been implicated in fresh and brackish waters in 20 out of 36 States and Federal Capital Territory of Nigeria (Bolorunduro, 2000), thus causing considerable economic losses especially with respect to aquatic fauna which need to be conserved.

Awba reservoir-a repository of domestic waste from the Halls of residence and Staff quarters in University of Ibadan, Nigeria has experienced an explosive growth of this weed. It has been reported that such alien species as water hyacinth alters the ecosystem functions and thus constitute a threat to biological diversity of organisms (aquatic flora and fauna) in such ecosystems and food chains associated with them (Luken and Thieret, 1997). Community composition, distribution and abundance of invertebrates appear to be regulated by water chemistry, substrate type, depth and the presence or absence of aquatic vegetation (Watkin II *et al*., 1983). Zooplankton constitute a major component of food chain in aquatic ecosystem. They play important role in channeling primary production into fish production (Dejen *et al*., 2004). Zooplankton studies are necessary since these organisms play important role in the energy transfer from primary producers to orgamisms of higher trophic levels (Aoyagui and Bonecke, 2004). Therefore variations in terms of species richness of zooplankton may negatively affect the reproductively biology of aquatic fauna. According to Aoyagui and Bonecka (2004) dissolved oxygen, pH, Conductivity and Environmental morphometry have the greatest effect on zooplankton.

The objective of the study therefore is to examine the influence of water hyacinth infestation on the composition, abundance and distribution of zooplankton in Awba reservoir.

MATERIALS AND METHODS

Study area: Awba reservoir is located within the University of Ibadan Campus at an altitude of 185 meters above sea level. It lies between latitude 3°53[1] E and 17°26[1] N (Akin-Oriola, 2003). The reservoir has a surface of 6 hectares, maximum depth of 5.5 m and maximum length of 700 m (Omotosho, 1981). The reservoir is marked by two seasons. The Wet and Dry seasons. Rainy (Wet) season occurs between April and October while Dry season is between November and March.

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The dominant aquatic plants on the fringes of the reservoir are *Pistia stratiotes*, *Nymphaea lotus*, *Canna indica*, *Bahima* sp. and *Typha australis*.

Sampling areas and procedures: The study was carried out between July and November, 2005. The reservoir was divided into 2 sampling areas viz., Water hyacinth infested and Open water areas for the purpose of the study. Sampling for water quality properties and zooplankton were carried out forth nightly between 0700-1100 h on each sampling day. Zooplankton were collected using 64 μm bolting plankton net. Plankton samples concentrated into 1 L container and were immediately preserved in 4% formalin (Jeje, 1990). Zooplankton were identified using the taxonomic keys of Jeje and Fernando (1986), Jeje (1990) and Boney (1983). All results were expressed as number of organisms per litre.

The percentage occurrence and relative numerical abundance of zooplankton were calculated. Biotic indices such as Margalef's (1949), Shannon-Weiner (1949) and Simpson's (1945) were used to estimate diversity. Shannon-Weiner diversity values of the sampling areas were further subjected to Student's t-test. Sorenson's and Jaccard indices of community similarity were used to determine how zooplankton in both areas are closely related.

RESULTS

Physico-chemical properties: The variations in the Physico-chemical properties of the sampled areas are shown in Table 1. Water temperature and Alkalinity were not significantly different ($p>0.05$). While dissolved oxygen, pH, turbidity and total suspended solids were significantly different ($p<0.05$) between infested and Open water areas (Table 1).

Zooplankton composition, density and distribution: A total of 15 species of zooplankton were identified in the study (Table 2). The total number of species and individuals present at the sampled areas (Water hyacinth infested and Open water) are 9 (95) and 15 (225), respectively (Table 3). Analysis of Variance (ANOVA) showed that water hyacinth infested area was significantly lower ($p<0.05$) than the open water area. Rotifers were the dominant zooplankton group in the infested and open water accounting for 61.1 and 44.1%, respectively; it was followed by Cladocerans 16.9 and 28.1%, respectively, while the least is Copepoda 22.1 and 28%, respectively in the sampled areas as shown in Table 3.

Cladocerans were represented by three families: Moinidae which is made up of only 1 genus each *Moina* sp. Daphninidae comprising of one specie *Ceriodaphnia cornuta*, Chydoridae comprising of 1 specie namely *Pleuroxus similes* which was absent in the infested area; *Chydorus* sp. and *Leydigia* sp. was also not represented in the infested area). Cladocerans had a density of 16 org L^{-1} in the infested area as against open waters 63 org L^{-1} (Table 3).

Rotiferans were represented by 6 families: Asplanchnidae made up of One genus *Asplanchna* sp. Trichocerchidae, Synchaetidae and Brachionnidae comprised of a genus and are represented by *Trichocerca* sp., *Polyarthra* sp. and *Brachionus* sp., respectively. These genus was absent in the infested area. Filinidae and lecanidae were made up of one genus each represented by *Filinia* sp. and *lecane* sp., respectively. In the water hyacinth infested area Rotiferans were 58 org L^{-1} while open water had 99 org L^{-1} (Table 3).

Copepodans comprised of one family: Cyclopidae which is made of 3 species namely *Cycloid Copepods*, *Copepodite* and *Calanoid copepods*. Copepods in water hyacinth infested area accounted for 21 org L^{-1} while in the Open water, it accounted for 63 org L^{-1} (Table 3).

Margalef's species richness, Shannon-Wieners index as well as Simpson's index was lower in the water hyacinth infested area when compared to open water. The diversity of zooplankton in water hyacinth infested area is significantly lower ($p<0.05$) in water hyacinth infested area when subjected to students t-test than in open water (Table 4). However, Sorensen's and Jaccard Coefficients of Community Similarity showed that zooplankton in the sampling area were related.

Table 1: Variations in water quality (Mean-standard error) between water hyacinth infested and open water areas in Awba reservoir between July and November, 2005

Parameters	Water hyacinth infested	Open water	p-value	ANOVA probability
Water temperature	27.16±0.64	26.70±0.52	0.28	$p>0.05^{NS}$
Dissolved oxygen	1.92±0.29	5.89±0.85	0.00	$p<0.05^{*}$
Alkalinity	48.90±5.11	36.15±4.09	0.07	$p>0.05^{NS}$
pH	6.92±0.04	7.71±0.05	0.00	$p<0.05^{*}$
Turbidity	31.75±1.23	18.67±1.99	0.00	$p<0.05^{*}$
TSS	92.48±4.00	54.0±5.58	0.00	$p<0.05^{*}$

p indicates significance of One way ANOVA, * = Significant $p<0.05$, NS = Not Significant $p>0.05$; TSS = Total Suspended Solids

Table 2: Distribution of zooplankton species in infested and open water areas of Awba reservoir during the study period

Taxa	Sr. No.	Species	Water hyacinth infested	Open water
Cladocera	1	Family: Moinidae		
		Moina sp Goulden, 1968	+	+
	2	Family: Daphinidae		
		Ceriodaphnia cornuta Sars, 1888	+	+
	3	Family: Chydoridae		
		Pleuroxus similes Vavra, 1900	-	+
	4	Family: Sididae		
		Diaphanosoma sp. Fischer, 1850	-	+
	5	Family: Chydoridae		
		Chydorus sp. Leach, 1816	+	+
	6	Family: Chydoridae		
		Leydigia sp. Kurz, 1875	-	+
Rotifera	7	Family: Asplanchnidae		
		Asplanchna sp. Crosse, 1850	+	+
	8	Family: Trichocerchidae		
		Trichocerca sp. Lamarck, 1801	-	+
	9	Family: Filinidae		
		Filinia sp. Bory de St. Vincent, 1925	+	+
	10	Family: Synchaetidae		
		Polyarthra sp. Ehrenberg, 1834	-	+
	11	Family: Brachionidae		
		Brachionus sp. Pallas, 1776	-	+
	12	Family: Lecanidae		
		Lecane sp. Nitzsch, 1827	+	+
Copepoda	13	Family: Cyclopodae		
		Cycloid copepods	+	+
	14	Family: Cyclopidae		
		Copepo phii	+	+
	15	Family: Cyclopidae		
		Calanoid copepods	+	+

Key: + Present, - Absent

Table 3: Percentage composition and abundance of zooplankton in water hyacinth infested and open water areas of Awba dam during the study period

		Water hyacinth		Open water	
Taxa	Species	Freq.	%	Freq.	%
Cladocerans	*Moina* sp.	10	10.5	40	17.8
	Ceriodaphnia sp.	3	3.2	8	3.6
	Pleuroxus sp.	0	0.0	4	1.8
	Diaphanosoma sp.	0	0.0	3	1.3
	Chydorus sp.	3	3.2	4	1.8
	Leydigia sp.	0	0.0	4	1.8
Sub-total		16	16.9	63	28.1
Rotifera	*Asplanchna* sp.	3	3.2	2	0.9
	Trichocerca sp.	0	0.0	6	2.7
	Filinia sp.	4	4.2	4	1.8
	Polyarthra sp.	0	0.0	6	2.7
	Brachionus sp.	0	0.0	4	1.8
	Lecane sp.	51	53.7	77	34.2
Sub-total		58	61.1	99	44.1
Copepoda	*Cyclopoid copepods*	14	14.7	54	24.0
	Copepodite	7	7.4	5	2.2
	Calanoid copepods	0	0.0	4	1.8
Sub-total		21	22.1	63	28.0
Total zooplankton		95		225	

Table 4: Diversity of zooplankton in the sampling areas of Awba Reservoir

	Sampling areas	
Indices	Water hyacinth infested	Open water
Number of species	8.00	15.00
Margalef's species richness	1.53	2.60
Shannon-weiner index (H)	0.65	0.84
Simpson diversity index	0.50	0.79
Coefficients of community similarity		
Sorenson's index	69%	
Jaccard's index	53%	

DISCUSSION

The quest for factors that influence zooplankton diversity is of great interest to Researchers. It has been reported that zooplankton composition and diversity gives an insight into the characteristics and quality of water body (Marson, 1983). The abundance of zooplankton were low in water hyacinth infested area

when compared to open water. The reason could be due to the formation of dense mats of Water hyacinth on the water surface, thus a reduction of dissolved oxygen content of the infested area. This is in agreement with Rommens *et al.* (2003) who reported that low oxygen level inhibited the growth of zooplankton in a water hyacinth infested sub tropical impoundment. The quest for factors that influence zooplankton diversity by researchers is of great interest. According to Aoyagui and Bonecka (2004), Dissolved oxygen, pH, conductivity and environmental morphometry have the greatest effect on zooplankton Therefore the low diversity of zooplankton in the infested areas can also be attributed to dense mats of water hyacinth in the infested area which affects the Physicochemical variables of the area. Zooplankton abundance was low in the infested areas because of high turbidity in the infested area. Egborge (1979) opined that high density of Phytoplankton in a water body associated with less suspended matter boosts zooplankton population as result of transfer in food chain. So the high level of turbidity as a result of heavy load of suspended particles in the infested area will not favour the composition and abundance of zooplankton organisms. Also the ability of *Eichhornia crassippes* to absorb and utilize nutrients deprives Phytoplankton of them. This leads to a reduced zooplankton population. The Shannon-Weiner zooplankton diversity was significantly lower ($p<0.05$) in water hyacinth infested area because of non-mixing of autochthonous materials due to dense mats of water hyacinth on the surface of the water body. Evans (2003) reported that the mixing of autochthonous materials in a water body facilitates primary production resulting in zooplankton abundance.

Rotifers had the highest numerical abundance in the sampled areas. It could be due to the fact that rotifers undergo vertical migration, which minimizes competition through niche exploitation and food utilization (Moss, 1988). Moreso, rotifers has the ability to desiccate and the possession of an intra-epidermal curticle which has developed into a thick case or lorica in some species gives extra protection to rotifers and as well as enhances its survival and proliferation under adverse environmental conditions (Ward and Whipple, 1966). Hutchinson (1967) reported that the presence of rotifers for the non vegetated orange lake region may be due to ability to avoid predation, owing to their small size or physiological avoidance of aquatic plants. Among zooplankton, those Cladocera and Copepod taxa which preferred aquatic plants are forms which either feed among them, owing to their large size avoid open water, and use aquatic plants to avoid predation (Green, 1967; Hutchinson, 1967).

The two sampled areas were closely related based on the estimated Sorenson's (C_s and Jaccard's (C_j) indices of Community Similarity. The 69% (Cs) and 53% (C_j) are greater than the critical values of 50%.Thses suggests that the higher the joint occurrence (S or j); the higher the similarity. It can be deduced from these results that water hyacinth infestation did not support zooplankton abundance and diversity. Efforts should be intensified towards its management and control.

REFERENCES

Akin-Oriola, G.A., 2003. The Phytoplankton of Awba Reservoir, Ibadan, Nigeria. Rev. Bio. Trop., 51: 99-106.

Aoyagui, A.S.M. and C.C. Bonecker, 2004. Rotifers in different environments of the Upper Parana River floodplain (Brazil): Richness, abundance and relationship to connectivity. Hydrobiologia, 522: 281-290.

Bolorunduro, P.L., 2000. Water Hyacinth Infestation: Nuisance and Nugget. New-Bussa. Ladu, B.M.B., K. Kusemiju and F. Daddy (Eds.). Proceedings of the International Conference on Water Hyacinth, NIFFR, November 2000, pp: 183.

Boney, A.D., 1983. Phytoplankton. Edward Arnod (Publishers) Ltd. London, pp: 117.

Cronk, J.K. and M.S. Fennessy, 2001. Wetlands plants Biology and Ecology. CRC Press, USA., pp: 306.

Dejen, E., J. Vijverberg, L. Nagelkerke and F. Sibbling, 2004. Temporal and Spatial distribution of microcrustacean zooplankton in relation to turbidity and other environmental factors in large tropical water (*L. tana*, Ethiopia). Hydrobiologia, 513: 39-49.

Egborge, A.M.B., 1979. The effect of impoundment on the phytoplankton of Oshun River. Nigeria Freshwater Biol., 3: 569-572.

Evans, B., C.R. Townsend and Crowl, 1993. Distribution and abundance of coarse woody debris in some Southern New Zealand Streams from consisting forest catchments. New Zealand J. Marine Freshwater, 27: 227-239.

Green, J., 1967. The distribution and variation of Aaphina lumholtzii (Crustaceae:Cladocera) in relation to fish predation in lake Albert, East Africa. J. Zool. London, 151: 181-197.

Hutchinson, G.E., 1967. A treatise on Limnology. I. Introduction to lake biology and limnoplankton. John Wiley and Sons, New York, pp: 1115.

Jeje, Y. and C.H. Fernando, 1986. A Practical Guide to the Identification of Nigerian Zooplankton, Kainji Lake Research Institut, pp: 142.

Jeje, C.Y., 1990. Nigerian Freshwater Copepods: A Revision Nigerian J. Nat. Sci., 5: 1-26.

Luken, J.O. and J.W. Thieret, 1997. Assessment and Management of Plant Invasions. Springer; New York USA.

Margalef, D.I., 1949. A new Limnological method for the investigation of thin layered epilithic communities. Hydrobiologia, 1: 215-216.

Marson, C.F., 1983. Biology of Freshwater Pollution. Longman Group Ltd. England, pp: 250.

Moss, B., 1988. Ecology of Freshwaters: Man and Medium. 2nd Edn., Blackwell Scientific Publication, pp: 417.

Omotosho, J.S., 1981. Comparative studies of the reproductive biology of the two Cichlids: *Tilapia zilli* and *Sarotherodon niloticus* from small lake in Ibadan Nig. M.Sc. Thesis, University of Ibadan, Ibadan, pp: 125.

Rommens, W., J. Maes and L. Brendonck, N. Dekeza and P. Inghebreght *et al*., 2003. The impact of water hyacinth in a subtropical impoundment (Lake Chevero, Zimbabwe). Arch. Hydrobiol., 158: 373-388.

Shannon, C.E. and W. Weaver, 1949. The Mathematical Theory of Communication University of Illinois Press-Urbana, pp: 125.

Simpson, E.H., 1945. Measurement of diversity. Nature, 163: 688.

Ward, H.B. and G.C. Whipple, 1966. Freshwater Biology. 2nd Edn., John Wiley and Sons Inc. New York, pp: 1248.

Watkins II, C.E., J.V. Shireman and W.T. Haller, 1983. The influence of aquatic vegetation upon zooplankton and Benthic Macro-invertebrates in orange lake, Florida. J. Aqua. Plant Manage., 21: 78- 83.