BIRDS OF THE SEWAGE STABILIZATION PONDS AT OBAFEMIAWOLOWOUNIVERSITY, ILE-IFE, NIGERIA

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ABSTRACT
A qualitative study of aquatic macroinvertebrates and birds associated with sewage stabilization ponds was carried out on the campus of ObafemiAwolowoUniversity, Ile-Ife, Nigeria. Thirteen macroinvertebrate species were recorded out of which Ephemeroptera, Chironomus larvae, mosquito larvae and pupae and Notonecta sp. accounted for 95.4% of the total number of macroinvertebrates. All were found within the littoral region except Chironomus which occurred in both littoral and benthic samples. They serve as food, either directly or through the cyprinodont fish and tadpoles found in the receiving stream, for the twenty-nine bird species belonging to sixteen families that were identified. Ten of these were palaearctic visitors and African migrants. The dry season comparatively favoured increased number of bird species as opposed to lower numbers of aquatic macroarthropods recorded during the same period. The absence of predators on birds, little disturbance to the surrounding habitat and the traditional aversion man has for human sewage coupled with the offensive odour has created a relatively safe haven for the birds in and around the sewage stabilization ponds.

Keywords: *Stabilization ponds, macroarthropods, birds*

INTRODUCTION
Birds regularly visit the sewage stabilization ponds at ObafemiAwolowoUniversity to drink and eat. It is generally known that animals and plants respond to intermittent pollution and that organic pollution affects the organisms in a pond by lowering the available oxygen in the water (Shitu, 1981; Masons, 1992; and Moskoff and Bevier, 2002). Increased turbidity of the water reduces the light available to oxygen producing photosynthetic organisms. Organic wastes settle at the bottom of the pond, thus altering the characteristics of the substratum (Haslem 1987). Clean water fauna are thus eliminated from such a pond. Severe organic pollution usually results in a restriction in the variety of macroinvertebrates to only the most tolerant ones and a corresponding increase in the density of those tolerating the polluted condition, usually of low dissolved oxygen concentration (APHA, AWWA, WEF, 1995). Inspite of these restrictions, a number of birds have been observed to be closely associated with the stabilization ponds.

Macroinvertebrates are fed upon by fish and eventually birds, hence the type and diversity of macroinvertebrates will determine the bird species associated with such ponds.

This work is aimed at compiling a list of the birds at the sewage stabilization ponds and it also attempts to unravel the predisposing factors for the choice of the area by the various bird species.

MATERIALS AND METHODS
Study area
The sewage stabilization ponds of ObafemiAwolowoUniversity, Ile-Ife lies within latitudes 7º 27’ N and 7º 32’ N and longitudes 4º31’E and 4º35’E, and at an altitude 300m above sea level. The climate is characterized by a rainy season (April through October) and a dry season (No-vember to March). The mean ambient temperature ranges from 20ºC to 30ºC with a mean at 26ºc. The annual rainfall ranges from 15.0cm to 18.5cm. Ile-Ife is dominated by thick tropical forest which dries out during the harmattan while it is favoured during the rainy season (Adeboye, 2000).

The two stabilization ponds are located close to the southwestern boundary of ObafemiAwolo-woUniversity (Figure 1). The two ponds are designed to operate alternatively, so that when pond I is put into function (usually for one week). Pond II is at rest, and vice-visa. The ponds drain sewage and wastewater from the central campus of the university. Each pond measures 150cm by 32m (480m^2) and 1.1m deep. They are separated by a 10m-wide dyke. The receiving points are equipped with iron gauze, which screens off floating objects from the ponds. Wastes are conveyed to the ponds through sewers of concrete pipes with manholes at some points to change the direction of flow in the sewers. Wastewater and sludge are retained in the ponds for about two weeks during which bacteria, algae, fungi, micro- and macro-organisms act on them (Asibor, 2001). Effluents from the ponds are discharged into a receiving stream closeby that eventually link up with Opariver.

Methods

Between January and December, 2002 sampling of the ponds for macroinvertebrates was done monthly with the aid of a fine-meshed sweep net. Ten random collections were taken during each sampling period and transferred into separate bowls containing 4% formalin for laboratory analysis. Sorted macroinvertebrates were preserved in 4% formalin and later identified using a dissecting compound microscope and identification guides such as APHA, AWWA, WEF (1995), Odiete (1999), Brown (1980) and Madsen (1985). The species diversity was calculated using Margalef diversity index expressed as:

$$D = \frac{S - l}{Log_e\ N}$$

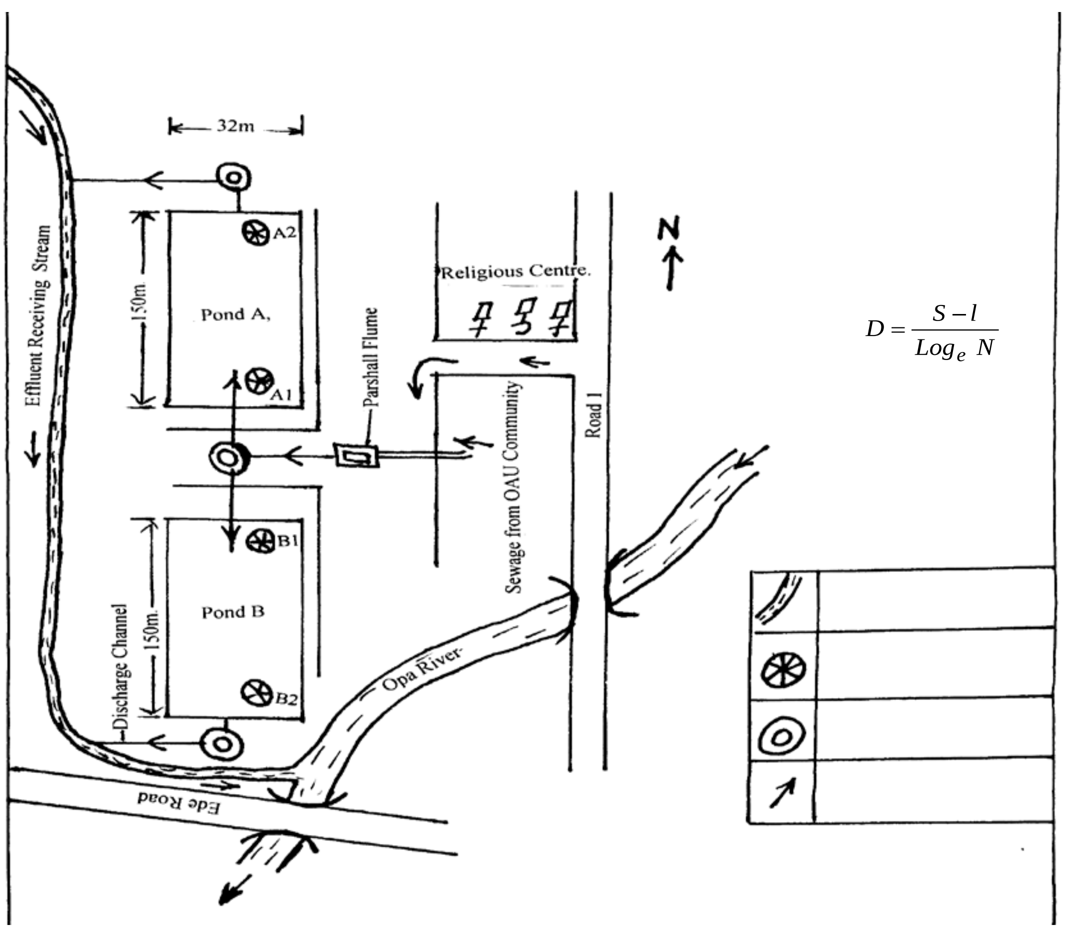
where S = total number of species and N = total number of individuals.

Bird observations were made twice a month through 8/50m/m binocular from hidden positions (hides) about 10m from the ponds. The sites were visited twice daily with the morning session from 0800 to 1100hrs, while the evening session was from 1600 to 1900hrs. The number of birds, their species, habitats and activities were recorded. The number recorded is assumed to correlate with frequency as the birds were not tagged. The birds were identified using Bannerman (1953) and Serle*et al.*, 1977).

A regression analysis was employed to determine whether there is any correlation between macroarthropod numbers and bird numbers.

RESULTS

Species composition and Abundance of macro-arthropods: Table 1 shows that a total of thirteen species of macroinvertebrate fauna were collected which revealed abundance of species composition in the pond as Ephemeroptera of the Caenidae, *Chironomus* larvae, mosquito larvae and *Notonecta* sp. These were ubiquitous though the highest numbers were found between the months of May and September. The most abundant was *Notonecta*sp (53.78%), with Ephemeroptera (18.33%) forming the second most abundant. The predatory invertebrates living on the surface were the beetle *Corixa*sp and the spider *Argyroneta* sp. Ephemeroptera, *Chironomus* sp., mosquito larvae and pupae, *Notonecta* and ants occurred in almost all the collections and throughout the year. *CyprisHydrophilus*sp., Coleoptera larvae, *Eristalis* sp., *Ischnura*, *Belostoma*and*Argyroneta* sp. were sparsely distributed along the sampling stations and they accounted for only 1.91% of the annual total. Benthic samples showed the presence of very sparse population of only *Chironomus* larvae.



Diversity

Table 2 shows Margalef's index of general diversity with Station B_2, having the highest diversity of organisms (4.147) while Station A_2 had the least diversity (3.328). Station B_1 and B_2 (4.042 and 4.147 respectively) were almost similar in diversity.

Species Composition and Abundance of Birds

A total of nineteen families and twenty-nine species of birds were recorded at the sewage stabilization ponds. The most frequented habitat observed was the littoral zone. Only *Podicepsruficollis* was found over the open water of the ponds and relatively small numbers were found on perches around the ponds. Not all the birds were resident, but nine palaearctic migrants were included such as *Egretaintermedia*, *Tringaocrophus, Tringastagnatilis, Tringa tetanus, Apusapus, Halcyon leucocephala,Motacilla alba, Motacillaflava*and *Sylvia atricapilla*(Table 3). Their populations tend to diminish towards the end of the dry season (March to April) and by May were no long seen. All the species increased in numbers towards the dry season. Eight species (i.e. *Podicepsrucifollis, Bubulcus ibis, Tringaocrophus, Apusaffinis, Hirundoabyssinica, H. aethiopica, H. nigrita and Malimbusscutatus*) accounted for 68.81% of the total number of species.

The higher mean and standard deviation (Table 4) recorded in the seasonal variation of macro-arthropod and bird abundance showed that macroarthropods were more abundant during the rainy season than the dry season but the birds showed reversed situation in that they were more during the dry season.

Figure 2 represents the relative abundance of the 20 commonest bird species on linear and log scales. This clearly shows that the distribution of commonness and rarity of the bird species are log-normal.

A plot of the number of birds against macroarthropods numbers shown in the scatter gram of Figure 3 puts the linear regression equation, at $y= -0.2067x + 264.91$ and a negative correlation coefficient $(r) = -0.8423$. A test of this values shows that it is significant at 0.05 level.

Table 2: Margalef's Index of Species Diversity at the Sampling Sites

Macroinvertebrates (Lithoral)	Sampling Sites			
	A_1	A_2	B_1	B_2
Total No of Organisms	1186	4039	930	783
Margalef's Index	3.904	3.328	4.042	4.147

Table 3: Bird Species Associated with Sewage Stabilization Ponds at ObafemiAwolowoUniversity, Ile-Ife. (m = winter migrant)

Family	Species	Numbers Observed in													% Composition
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	
Podicipedidae	*Podicepsruficollis*	27	36	36	45	45	00	00	00	16	16	22	27	270	15.47
Ardeidae	*Bubulcus ibis* (m)	46	46	21	28	01	02	00	07	00	02	14	25	192	11.00
	Egretaintermedia(m)	17	12	05	05	00	00	00	00	00	00	02	09	50	2.87
	Ixobrychusminutus	07	02	02	01	00	00	01	00	00	01	03	03	20	1.15
Accipitridae	*Haliaetusvocifer*	01	02	00	00	00	00	00	00	00	00	01	01	05	0.29
Charadriidae	*Tringaocrophus*(m)	17	19	13	03	00	00	00	00	04	07	11	15	89	5.10
	Tringastagnatilis(m)	12	14	10	02	00	00	00	00	06	05	08	09	66	3.78
	Tringatotanus(m)	08	06	06	02	00	00	00	00	00	02	02	02	28	1.60

Columbidae	*Streptopeliasemitorquatus*	01	00	01	00	00	00	01	00	00	00	01	00	04	0.23
	Treronaustralis	00	00	00	00	00	00	00	01	00	00	00	00	01	0.06
Cuculidae	*Cuculussolitarius*	00	00	00	00	02	00	00	00	00	00	00	00	02	0.11
Apodidae	*Apusaffinis*	22	22	12	00	00	00	00	00	00	02	13	21	92	5.27
	Apusapus(m)	16	13	07	02	00	00	00	00	01	05	11	16	71	4.07
Alcedinidae	*Ceyxpicta*	06	08	07	01	01	05	00	09	02	05	07	07	58	3.32
	Halcyon leucocephala(m)	11	06	02	01	00	00	00	00	00	00	00	02	22	1.26
	Halcyon senegalensis	05	04	01	05	00	03	00	00	08	01	01	05	33	1.89
Hirundinidae	*Hirundoabyssinica*	12	21	15	10	02	07	06	16	14	11	14	19	147	8.42
	Hirundoaethiopica	11	18	10	08	03	03	02	03	02	09	06	13	88	5.04
	Hirundonigrita	20	16	13	02	05	06	08	09	09	06	20	18	132	7.56
Motacillidae	*Motacilla alba* (m)	21	14	08	00	00	00	00	00	01	02	06	07	60	3.44
	Motacillaflava(m)	05	05	03	02	00	00	00	00	00	02	03	02	22	1.26
Laniidae	*Prionopscaniceps*	00	01	00	00	00	00	00	00	00	00	00	00	01	0.06
Oriolidae	*Oriolusbrachyrhynchus*	00	00	00	00	00	00	00	00	00	00	02	00	02	0.11
Timaliidae	*Turdoidesreinwardii*	00	00	02	00	00	00	00	00	00	00	00	00	02	0.11
Muscicapidae	*Muscicapaaquatica*	06	03	00	01	00	00	01	00	01	04	02	01	19	1.09
	Muscicapacassini	00	02	00	00	00	00	00	00	00	00	00	00	02	0.11
Sylviidae	*Sylvia atricapilla* (m)	12	07	03	02	00	00	00	00	00	00	02	06	32	1.83
Ploceidae	*Ploceuscucullatus*	15	06	08	03	00	00	00	01	00	00	03	08	44	2.52
	Malimbusscutatus	21	18	13	13	14	16	14	14	14	14	18	22	191	10.95
Total		**319**	**301**	**198**	**137**	**73**	**42**	**33**	**60**	**78**	**94**	**172**	**238**	**1745**	**100**

Table 4: Seasonal Variation in the Mean of Macroarthropod and Bird Numbers

Season	Period	Macroarthropods Mean ∀ S.D	Birds Mean ∀ S.D
Rainy	April-October	849.14 ∀ 308.52	73.86 ∀ 34.85
Dry	November-March	198.80 ∀ 58.80	245 ∀ 63.63

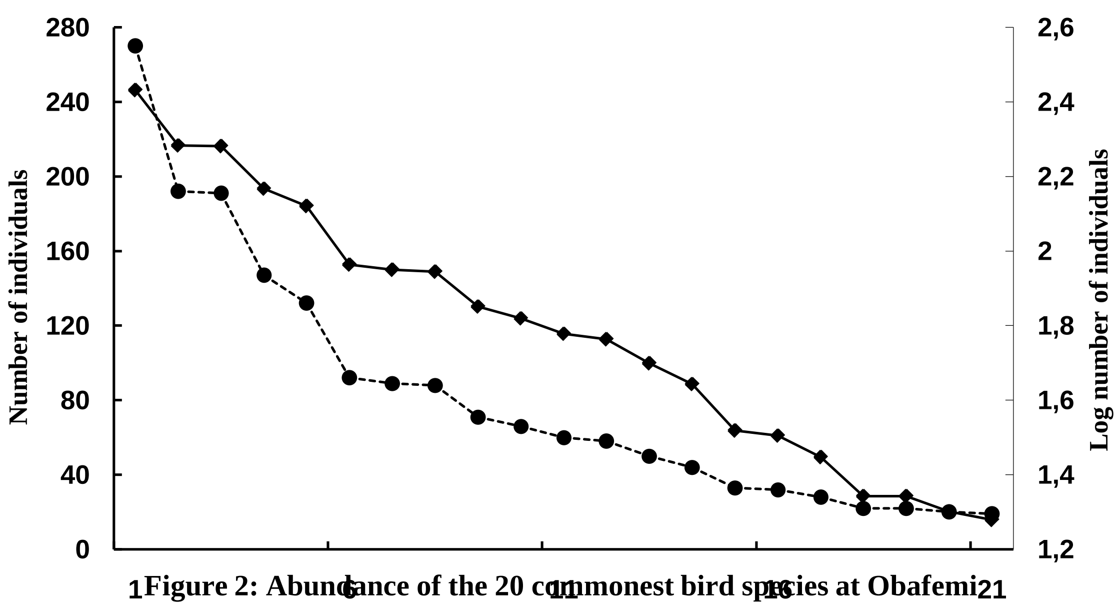


Figure 2: Abundance of the 20 commonest bird species at Obafemi Awolowo University stabilization ponds. Curve A is a plot of abundance on a linear scale and curve B a plot of abundance of the same 20 species on a log scale.

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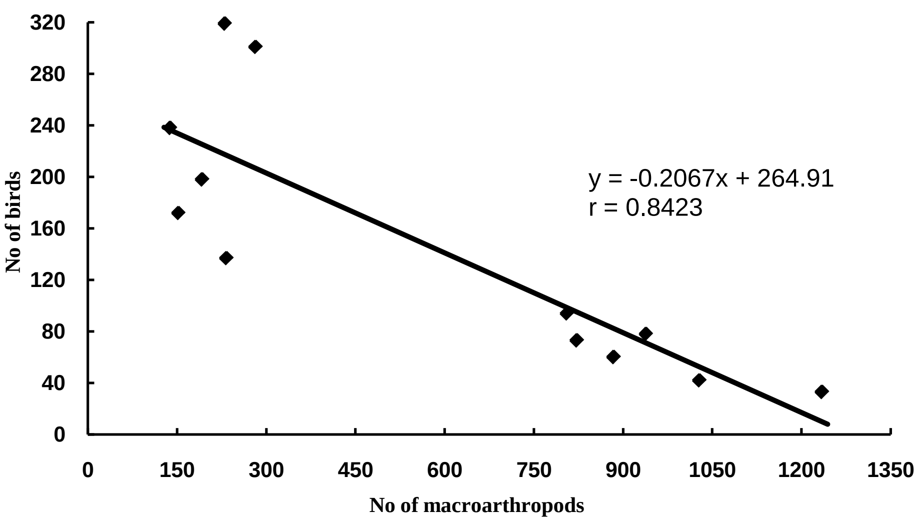

Figure 3: Regression of the number of birds on the number of macroarthropods

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Table 5: Stomach contents of Fish and Amphibian Species Collected in the Receiving Stream

Taxa	Food Found in the Gut
Amphibian	
- *Bufo* sp. (Tadpoles)	Ants, detritus; Mosquito larvae
Pisces Cyprinodontidae	
- *Aphyosemionbivittatum*	Ants, detritus, Chironomid larvae
- *Aphyosemiongardneri*	Ants, detritus, *Eristalis*sp
- *Epiplatyssexfasciatus*	Ants, Caterpillar, Chironomid larvae, Filamentous algae

Table 5 shows that Cyprinodont fishes and tadpoles abound in the receiving stream and their stomach content shows that they depended on both aquatic and terrestrial macroinvertebrates.

DISCUSSION

Fish ponds, reservoirs and sewage stabilization ponds are attractive for aquatic birds particularly now that their habitats are being disturbed by man. The population of a species within communities of organisms at any point in time reflects the interplay of birth rate, mortality rate, and gains and losses due to immigration and emigration according to Gilbertson *et al.* (1989) and Jadhav and Parasharya (2004). Thus, the observed gradual increase in the populations of bird species from August to a peak in January and the subsequent gradual decrease to the lowest level in July could be explained on the basis of gains and losses due to either immigration or emigration occasioned by the weather and food availability. The dry season tends to favour the movement of both palaearctic visitors and African migrants to the sewage stabilization ponds as opposed to the wet weather which promotes emigration. This is in conformity with the assertion of Curry-Lindahl (1981) and Waweru*et al.* (2005)that the seasonality of bird migrations in Africa, chiefly regulated by various climatic factors, food availability and which directly correlates with wet and dry seasons remains the ultimate cue. The commencement of the rains, apart from providing unsuitable climate for some of the birds, also provides other diverse sources of food elsewhere, hence emigration especially the winter migrants from the area.

The negative correlation between macroarthropods and bird numbers shows that large values of macroarthropods are associated with small values of bird numbers. The examination of the stomach contents of the small Cyprinodont fishes such as Ap*hyosemionbivittatum, A. gardneri*and *Epiplatyssexfasciatus*and tadpoles in the receiving stream adjacent to the stabilization ponds showed that these fishes eat terrestrial insects as well as aquatic macroinvertebrates such as Chironomid larvae etc. This is similar to the observation of Nicholson (1991)in some small fishes found in IdimEniong stream in Uyo, AkwaIbom. An appraisal of the feeding habits revealed that most of the birds feed on insects, seeds, snails and worms. The fish-feeding birds were *Podicepsruficollis, Haliatus ibis, Tringaocrophus, tringastagnatilis, Tringatotanus, Ceyxpicta, Halcyon leucocephala*, and *Halcyon senegalensis.*

So it is not far-fetched to opine that the fishes feed on macroinvertebrates and birds in turn feed on the fishes. This observation supports the view of Okaeme (1991) that fish predation by birds may cause severe problems, particularly when bird populations are high. Although in unpolluted water bodies one would expect that bird droppings in water would fertilize such ponds because of the presence of uric acid, nitrogen and phosphate. This in turn, according to Hutchinson (1950), would stimulate primary production and enrich the water, thus improving the possibilities for fish growth especially in the receiving stream.

The absence of predators on birds, little disturbance to the surrounding habitat and the aversion man has for human wastes coupled with the offensive odour has created a relatively safe haven for the birds in and around the sewage stabilization ponds.

CONCLUSION

Some of the recorded macroinvertebrate species such as Ephemeroptera, *Chironomus*larvae, Mosquito larvae and pupae, *Notonecta* and to some extent ants seem to be tolerant and able to adapt to polluted waterbodies with sewage. Apart from this, the macroinvertebrates serve as food for the birds either directly of through small Cyprinodont fish and tadpoles.

Potentially useful information on seasonal and year to year changes in some of the less spectacular palaearctic wintering visitors and African migrants is in danger of being lost by lack of attention given to it in this area. Although, the area of study is small and the stay of most visitors short, the sewage stabilization ponds has well-defined limits and it should be relatively easy to provide some assessment of the conspicuous changes by comparison with well-annotated lists.

There is every reason to opine that the birds (resident and migrants) will continue to utilize the confines of ObafemiAwolowo University Campus as a wintering base or safe haven as long as the present goodwill persists.

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