Aspects of Biodiversity Studies in a Small Rural Tropical Reservoir (Lamingo Reservoir) in Jos, Nigeria

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Abstract: Monitoring of a water body (i.e. sampling and analyzing water, sediments and biotas) helps to generate information on the system's biodiversity, as well as on the health status of the water body. There is a dearth of information on the ecology of the many freshwater bodies that dot Jos, a town in Nigeria. This study involved a description of phytoplankton and macroinvertebrate communities in Lamingo reservoir. The study was undertaken during the month of July 2011 with the aim of establishing a preliminary inventory of biotas within these groups in the reservoir. Phytoplanktons were identified to the species level, while macroinvertebrates were identified to the family level of classification. A total of 62 taxa (comprising 53 species of phytoplankton and 9 families of macroinvertebrates) were recorded during this study. The relevance of this taxon diversity is discoursed based on the principles of ecosystem structure and functioning. Reasons on why the ecosystem and its biotas should be conserved are proffered. Steps that should be taken to preserve the reservoir are also suggested. It is hoped that Lamingo reservoir and the other reservoirs in Jos, Plateau State, Nigeria will continue to receive the attention of researchers to enable us fully understand their ecology and health status, with the view of conserving them for posterity.
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1. Introduction

Monitoring of a freshwater water body (i.e. sampling and analyzing water, sediments and biotas) helps to generate information on species richness in the ecosystem, as well as information on the health status of the water body being studied. Continuous monitoring is likely to generate new information each time the exercise is carried out (see Rees et al., 1999) - information that is useful for effective management of the ecosystem. From an ecosystem services to society point of view, the study of freshwater habitats is of utmost importance, especially when we consider the fact that they are among the most threatened and valuable ecosystems we have (De Meester and Declerck, 2005). They are the most threatened because they are frequently in direct contacts with human beings and their socio-economic activities, some of which have grave impacts on the ecosystem. From the points of view of Oertli et al. (2002), Williams et al. (2004) and De Meester et al. (2005), freshwater ecosystems (particularly small water bodies) should be given adequate attention by the research community since they are immeasurably beneficial to humankind in many different ways that include:

a. Socio-Economic benefits that include serving as sources of domestic water supplies in some places as well as their use for irrigation projects and for recreation), and

b. Ecological benefits such as contributing to regional species richness as a consequence of their high ß diversity (i.e. there is compositional dissimilarity among sites).

The high contribution to regional diversity, credited to small freshwater ecosystems, is due both to the fact that smaller water bodies often strongly differ in species composition amongst each other, and to the occurrence of species that are specific to them. For instance, if we should consider temporary pools as a reference ecosystem, specific adaptations are required to deal with variable and often extreme local environmental conditions, including time stress for development and reproduction, and mechanisms to bridge dry periods. This results in very specific biota (Wiggins et al., 1980; Brendonck and Persoone, 1993; King et al., 1996; Simovich, 1998). This scenario can be witnessed in small tropical reservoirs, especially those that are strongly influenced by the seasons, i.e. those with high water levels during the rainy season and an almost dry basin during the dry season. The high ß diversity of small water bodies is, thus, related to their:

a. High diversity in characteristics [e.g. length of hydroperiod (or habitat stability), trophic (food web) structure, abundance and species composition of some key elements like macrophytes (which offer both shelter and food to some aquatic animals), as well as disturbance by, for example, a herd of cattle that drink from them].

b. Chance effects associated with their isolated nature, and

c. Second-order effects (see Moss, 1998; De Meester et al., 2005; Humphries and Winemiller, 2009).

Second order effects could be related to the presence or absence of keystone species – e.g. top-down regulators of populations (i.e. top predators), which promote coexistence among prey populations by disproportionately cropping the most abundant species, which otherwise might attain even greater densities and displace competitively inferior species (Paine 1966); and bottom-up regulators of populations, where each trophic level derives its energy from the level below it. For example, resource supply rates have a strong influence on the diversity and abundance of primary producers (Nielsen and Navarrete, 2004). The role of primary resources in structuring communities has long been emphasized in terrestrial and freshwater systems (Carpenter et al., 2001; Loreau et al., 2001; Urabe et al., 2002; Dyer and Letourneau, 2003; Schmitz, 2003). On the other hand, studies of terrestrial (Sergio et al., 2008) and marine (Myers et al., 2007) ecosystems established that biodiversity may be influenced by the presence of top predators, and this is likely to be the case also for freshwater systems.

Several aquatic biodiversity studies have been done in relatively large ecosystem like oceans (e.g. Worm et al., 2006), seas (e.g. Rees et al., 1999), estuaries (e.g. Middelboe et al., 1998), as well as large rivers (e.g. Junk et al., 2007) and lakes (e.g. Hori et al., 1993). Likewise, much attention in conservation biology is directed towards large-scale coastal and inland ecosystems, such as vast wetlands (e.g. the tropical floodplains in South America), lakes and river ecosystems, coral reefs, rain forests, Antarctica, and marine systems (e.g. Hori et al., 1993; Thiollay, 1995; Meffe and Carroll, 1997; Gutt and Starmans, 1998; Constable et al., 2000 plus references there-in; Williamson et al., 2004; Junk et al., 2007). Though the huge attention given to larger aquatic ecosystems by scientists has enabled us to know and appreciate biodiversity trends in them (e.g. Worm et al., 2006), a commensurate attention, however, has not been given to smaller inland aquatic ecosystems, like inland reservoirs, ponds and ephemeral pools (see De Meester et al., 2005).

Small landscape elements, such as small freshwater reservoirs, have important ecosystem functions, including provision of migration corridors and "stepping stones" for dispersal of organisms (Merriam, 1991), thus fulfilling an important ecological role at the landscape level, for instance in a metapopulation and metacommunity context (Jeffries, 1994; Caudill, 2003). Therefore, to conserve biota at the landscape level, attention to small-scale water bodies is needed, as least, because of their own specific characteristics and communities, as well as the role they play in metapopulation and community dynamics (De Meester et al., 2005). In order to ensure the preservation of the biodiversity and ecosystem services of small water bodies, the processes contributing to their specific characteristics must be understood, and the key environmental stressors affecting them must be identified and addressed, as well. For example we must consider the human pressures on the ecosystems and their effects, which may be associated with erosion and sedimentation that results from, say, agricultural practices (e.g. soil tilling) within the watersheds of small water bodies (see Humphries and Winemiller, 2009). The possible effects of trampling on benthic fauna by cattle that drink from such water bodies cannot be overemphasized. Humphries and Winemiller (2009) while noting the possible impacts of human pressures on aquatic ecosystems pointed out that the use of freshwater bodies near growing human populations for irrigation, discharge of waste, and water extraction imposes negative impacts on freshwater biota.

Although the number of publications dealing with tropical freshwater systems has been increasing steadily over the last decade, we still lack a clear picture of how they function (Wantzen et al., 2008). A lot of reliance is placed on information from other geographic regions when dealing with questions about the ecological integrity of tropical freshwater bodies or to interpret impacts of human activities. The need is pressing for more detailed research, both basic and applied, to inform management and conservation decisions. Moreover, potential reference freshwater bodies are being impacted rapidly in most tropical regions. Thus, irreplaceable information that could guide restoration is being lost (Wantzen et al., 2008). The main purpose of this work was to investigate the diversity of phytoplankton and macroinvertebrates in Lamingo reservoir with the view of establishing a preliminary inventory of these biotas for the system. It was also deemed necessary to discuss the roles these organisms play in the ecosystem, as well as the need for the conservation of the ecosystem. This study was necessitated by the fact that there is a dearth of information on biodiversity studies in the many freshwater bodies that dot Jos, Plateau State, Nigeria.

2. Materials and Methods

2.1. Study site

Lamingo reservoir is a water body formed by the trapping of water running down the hills that line sections of Lamingo village in Jos North Local

Government Area of Plateau State, Nigeria, at a point along the course of a local stream, the Rafin Sainyi stream. The reservoir holds water permanently for water supplies to parts of Jos metropolis (See Plate 1). It is an open water body that is ca. 2.2 km^2 in area (see Goselle et al., 2008), and with no trees on its banks, though the rip rapped dyke has sparsely populated shrubs. There are also isolated shrubs that sparsely dot the eastern, western and northern flanks or the basin. During the rainy season aquatic macrophytes are in abundance, since the basin expands further landwards as more water empties into it as a result of direct precipitations and runoffs. Some locals fish in the reservoir. Cattle are frequently driven to the reservoir to quench their taste and to graze on grass patches on the reservoir's watershed. There are no farming activities within the catchment area of the reservoir. Cow dungs and human faeces are a common sight on the land that surrounds the reservoir – something very common in the tropics. Biggs et al. (2004) observed that whereas temperate freshwater ecosystems tend to be affected by channelization and excessive nutrient runoff from fertilizers, many tropical ones receive direct inputs of municipal sewage. The ecological effects of faecal matter washed into a water body from the surrounding land might mimic those of direct sewage discharge. Faecal contamination from domestic and livestock sources can lead to water-borne diseases, if not checked.

Plate 1. Water extraction pipes that supply water to a water treatment unit located nearby the reservoir.

2.2. Sampling

Sampling was done twice in the month of May 2011. The first sampling was on 19 May 2011 and the second on 26 May 2011. Air and water temperatures were measured using a mercury-in-glass thermometer. Water temperature was measured by horizontally placing the thermometer a few centimetres below the water surface. Water samples were then collected in plastic bottles and taken to the laboratory for pH, nitrate, and phosphorous tests. For dissolved oxygen determination, a 250 ml stopper bottle was used to collect water sample. The bottle was filled and capped under water, and without air bubbles. When the filled bottle was taken out of the water, 2 ml of manganese sulphate ($MnSO_4$) and 2 ml of alkaline iodide sodium azide solutions were added to fix the water sample. This caused precipitates to form in the bottle. The bottle was then re-stoppered and taken to the laboratory for dissolve oxygen determination.

For phyotplankton studies, water samples were collected with a bucket and filtered through a 20 µm mesh sieve. Materials that were retained by the sieve were washed into small (200 ml) screw-cap plastic bottles, with 10 % formol added to preserve the algae. The preserved material was taken to the laboratory for phytoplankton identification. This was purely a qualitative exercise. For macroinvertebrate studies, a pond net was used to collect benthos (sand, silt, detritus and animals living at the bottom of the reservoir). The sediment was gently disturbed with the feet while a hand-held pond net trailed after. Materials collected were washed through a vegetable sieve and a tea sieve to do away with silt and fine sand, as well as tiny gravels - a procedure which made it possible to pick out and sort the macroinvertebrates. Sometimes a magnifying glass was employed to fish out smaller macroinvertebrates from among coarse sand and small-sized gravels. The captured macroinvertebrates were put in sample bottles containing 96% ethanol and taken to the laboratory for further studies.

2.3. Laboratory studies

A pH meter was used for the determination of the reservoir's pH. Both nitrate and phosphate contents in the water samples were determined spectrophotometrically (AOAC, 1980). Dissolved oxygen was determined by the Winkler titration method (APHA, 1992). For phytoplankton identification, a drop of the water sample was placed on a microscope slide, covered with a cover slip and viewed under the light microscope. The algae were identified to species level. The organisms were identified with the aid of works by Bourrelly (1966), Belcher and Swale (1978), Durand and Leveque (1980), Pentecost (1984), Anagnostidis and Komarek (1988), Baker and Fabbro (1999) and Lawton et al. (1999). Macroinvertebrates were viewed under the stereo microscope for further identification. The animals were identified to the Family level with the aid of taxonomic guides, which included Fitter and Manuel (1986) and Clifford (1991).

3. Results

A total of 62 taxa (comprising 53 species of phytoplankton and 9 families of macroinvertebrates) were recorded during this study (Table I). For the phytoplankton group, there were 21 species in the division Bacillariophyta, 18 in Chlorophyta, 9 in Cyanophyta, and 5 species in Dinophyta. Two phyla of macroinvertebrates, i.e. Arthropoda and Mollusca, were recorded. The observed arthropods belonged to two classes, i.e. Arachnida (aquatic spiders) and Insecta (aquatic insects). The molluscs included Gastropoda (which were mainly minute aquatic snails) and Pelecypoda (mainly tiny bivalves). Full descriptions of these invertebrates are reported elswhere (see Ajuzie, 2012). The mean air temperature was 30.5°C while that of water was 29 °C. The mean pH was 8.1 whereas that of dissolved oxygen was 8.4. The mean nutrient levels for nitrate-nitrogen (NO_3-N) and phosphate-phosphorus (PO_4-P) were 243µg/L and 453µg/L, respectively.

4. Discussion

Lamingo reservoir serves as a drinking water source for inhabitants of Jos. Some villagers go there to fish and/or to directly fetch water for domestic use. Cattle herders drive their cattle to the reservoir to drink. Thus, the reservoir is a very important socio-economic resource to Jos town and the surrounding villages. The reservoir is also ecologically important. As noted in this study, it harbours an appreciable diversity of microalgae and macroinvertebrates, which perform different ecological and conservation roles within the ecosystem. Students of biology and ecology will find the reservoir an interesting site to do research, as fish, reptiles (e.g. snakes) and aquatic birds (e.g. heron and cormorants) also form part of the biotic components in and around the reservoir.

Freshwater ecosystems provide microhabitats which macroinvertebrates frequently exploit as refuges (Moss, 1998). Such habitats include inorganic benthic substrates, e.g. mud, sand, gravels, pebbles, boulders, and rocks (Clements, 1987; Peckarsky, 1991; Holomuzki and Messier, 1993); submerged woody debris (Benke et al., 1985; Smock et al., 1989; O'Connor, 1991); leaf litter beds (Cummins and Merritt, 1984; Dobson, 1994); submerged macrophyte beds (Soszka, 1975; Cyr and Downing, 1988); and detritus beds. This offers one reason why they should be conserved. In terms of microhabitats, the macroinvertebrates recorded in this study were collected from a diverse habitat that included leaf litter, minute-gravel, sand, mud/silt, and detritus beds.

What does this diversity of organisms in the reservoir mean in terms of the system's ecology? In other words, what is the relevance of the taxonomic diversity in terms of their functional diversity? There are many reasons (including aesthetic, cultural, and economic) why aquatic biodiversity should be conserved. From a strictly functional point of view, species matter so far as their individual traits and interactions contribute to maintain the functioning and stability of ecosystems and biogeochemical cycles (Loreau et al., 2001). If we should consider the productivity aspect of the reservoir, the phytoplankton group must be reckoned the primary drivers of productivity in the ecosystem. They make use of primary nutrients (e.g. nitrate-nitrogen and phosphate-phosphorus) to provide the basal energy that drives the system into bubbling with a diversity of life. Many phytoplankton species are dominant food for macroinvertebrate grazers (e.g. gastropods) and filter-feeders (e.g. bivalves) (see Rooke, 1984, 1986; Epler, 2001). Macroinvertebrates, in turn, are prey items for fish, amphibians, and aquatic birds. Additionally macroinvertebrate shredders are capable of breaking down comparatively large pieces of organic matter (e.g. leaves) into smaller components, which are readily mineralized by microorganisms. The mineralized particles then provide a stock of primary nutrients for primary producers to utilise.

Such shredders are found in the following orders: Trichoptera, Ephemeroptera, Coleoptera, and Diptera (see Noble and Cowx, 2002), all of which, as recorded in this study, have representatives in Lamingo reservoir. Macroinvertebrates represent an enormous diversity of body shapes, survival strategies, and adaptations. Many of them require clear, cool water, adequate oxygen, stable flows, and a steady source of food in order to complete their life cycles. Most of the macroinvertebrates recorded during this study fall under macroinvertebrates that tolerate pollution-free surface waters, i.e. good status water. This is an important point if we consider the fact that the reservoir is a source of municipal water supply. But has lamingo reservoir achieved this status?

Table I. Phytoplankton and macroinvertebrate taxa recorded in Lamingo reservoir during the current study

Main Group	**Sub-group**	**Taxa**
Phytoplankton	Bacillariophyta (21 taxa*)	*Achnanthes exiguoides*, *Cylindrotheca closterium*, *Cymbella kappii, Cymbella turgida, Cymbella ventricosa, Diatoma* sp., *Diatomella balfouriana, Epithemia zebra, Fragilaria capucina, Frustulia rhomboides, Gomphoneis* sp., *Gomphonema parvulum, Melosira* sp., *Navicula cuspidata, Navicula cf. margalithii, Navicula radiosa, Nitzschia acicularis, Nitzschia cf. palea, Stephanodiscus hantzschii, Surirella linearis, Synedra ulna*
	Chlorophyta (18 taxa*)	*Botryococcus braunii* , *Closterium* sp, *Coccomyxa dispar, Coelostrum microporum, Cosmarium circulare, Dictyosphaerium* sp., *Eremosphaera viridis, Oocystis lacustris, Scenedesmus perforatus, Scenedesmus quadricauda, Spondylosium planum, Staurastrum arachne, Staurastrum subcruciatus, Staurastrum teliferum, Staurastrum trifidum, Staurastrum validus, Ulothrix* sp ., *Xanthidiums* sp
	Cyanophyta (9 taxa*)	*Calothrix parietina, Coelosphaerium confertum, Dermocarpa aquae-dulcis, Gloeocapsa sanguine, Gomphosphaeria aponina, Microcystis aeruginosa* f. *aeruginosa, Microcystis aeruginosa* f. *flos*-aquae, *Nostoc* sp. *Synechocystis aquatilis*
	Dinophyta (5 taxa*)	*Gymnodinium aeruginosum*, *Gymnodinium inversum, Peridinium cinctum, Peridinium inconspicuum, Peridinium willei*
Macroinvertebrates	Arthropoda (6 taxa**)	Chironomidae , Cybaeidae, Goeridae, Heptageniidae, Libellulidae, Notonectidae
	Mollusca (3 taxa**)	Lymnaeidae, Planorbidae, Sphaeriidae

N/B: * represents taxa determined at the species level of classification
** represents taxa determined at the family level of classification
Total number of taxa = 62

The EU Water Framework Directive (EU, 2000) prescribes "good status" as a target for all water bodies within a river basin. In the case of surface waters, good status definition includes good ecological status on the basis of biological, hydro-morphological and physical-chemical characteristics (Goethals and De Pauw, 2001). To attain this good status, each EU country has to develop an optimal management strategy that would include analysis of actual situation of the water body (its actual condition) and analysis and selection of conservation and/or restoration scenarios (Kolisch et al., 2000).

The prescribed "good status" for European water bodies is a laudable policy that should be applicable in Nigeria for the preservation of freshwater ecosystems. The condition of Lamingo reservoir, with respect to aspects of its biological and physico-chemical properties, has been determined and presented in this work. These will serve as a preliminary record for the system. pH, water temperature, dissolved oxygen and nutrient levels were determined to be quite okay for the sustenance of life in the reservoir. This condition needs to be conserved. But attention must be paid to phosphate-phosphorus levels in the reservoir to make sure the system does not develop into a hypereutrophic system. Monitoring of the chemical and physical parameters of the reservoir water must be regular and continuous, year-in and year-out. This must, however, be done in conjunction with biological monitoring. Such an exercise will allow lake managers to take prompt actions that would be beneficial in the prevention and control of any worrisome scenario or phenomenon (e.g. eutrophication and the development of harmful algal blooms) in the reservoir.

Nutrient enrichment can occur as a result of human activities (i.e. cultural eutrophication which occurs over a short period of time as a result of human encroachment and nutrient inputs into affected water body), and by natural means (natural eutrophication, which involves a buildup of nutrients, sediment, and plants in a water body over a longer period of time). Runoff is one of the means through which nutrients get into surface water bodies. Lamingo reservoir receives runoffs from the hills located at its catchment area. Such runoffs carry with them both organic (e.g. animal faecal matter, as well as dead and decayed animal and plant remains) and inorganic (e.g. leached soil and weathered rock particles) sources of nutrients which they deposit into the reservoir. Moderate deposition is good for phytoplankton growth. Phytoplankton, in turn, helps to oxygenate the ecosystem when communities utilize nutrients and CO_2, in the presence of sunlight, to build up their biomass. Nevertheless, the reservoir might become hypoxic or anoxic if too much nutrients washed into it cause the development of very high algal biomass (i.e. development of algal blooms). Algal blooms, if not detected in time, may cause the collapse of the structure and function of the ecosystem because all of the available oxygen in the system would be eventually consumed. When this happens, it will be difficult for other aquatic biota to live and thrive in the ecosystem. A possible mechanism is that an excessive growth of algae in the reservoir will provoke competition for space and for available nutrients among the algal community. As soon as nutrients are depleted and the system's carrying capacity for algae exceeded, the community will crash (die-off). When algae die, bacteria will move into action to hasten their decomposition. The action of bacteria will lead to the conversion of the organic matter (i.e. algal biomass) into primary nutrients for algal growth. However, the decomposition process uses oxygen; hence, it is during this process that most of the available oxygen in the affected water body is consumed. Should the concentration of dissolved oxygen get too low, beyond the tolerance limits of most aquatic biota (e.g. zooplankton, macroinvertebrates and fish), mass mortalities of the animals will result. Mass mortalities of aquatic biota will produce an ugly sight in the ecosystem. The water will become smelly and may not serve the needs of man any longer; for such a water body will neither be suitable for drinking, bathing, and swimming, nor for fishing. Such a devastating situation could be avoided and, thus, ensure the preservation of the ecosystem and its biota if the water body is monitored on a regular basis, year after year. Such monitoring exercises will help detect, among others, when the ecosystem is becoming hypereutrophic. Early detection of a hypereutrophic condition will enable lake managers to take appropriate actions that will help in the reduction of nutrient loadings into the freshwater body. It will also help them to implement measures that will assist in the control of, say, harmful algal blooms and the mitigation of the effects of such blooms.

Small in-land water bodies, like reservoirs, do have scientific values. They can serve as excellent model systems for hypothesis-testing in ecology, evolutionary biology and nature conservation (Blaustein and Schwartz, 2001; De Meester et al., 2005). This is because:

a. They could be abundant. Although there are a number of regions in which small water bodies are relatively rare, small-scale aquatic habitats are, nevertheless, generally abundant throughout the world. This ensures the possibility of carrying out field surveys or field experiments covering broad latitudinal, longitudinal and altitudinal gradients. Because of their large number, it is relatively easy to find a sufficiently high number of such water bodies along the whole spectrum of an ecological gradient. This allows for the proper application of statistical tests (De Meester et al., 2005).

b. There is a very wide variety in types. Reservoirs, ponds and pools indeed span a very broad range of ecological gradients, e.g. in terms of the length of the hydroperiod, size, and nutrient concentration. This allows the study of the associations between their characteristics (e.g. biodiversity, community composition, food-web structure) and these gradients (De Meester et al., 2005).

c. Small aquatic ecosystems are often threatened by direct habitat destruction (e.g. filling up of reservoirs; deepening of ephemeral pools so that they become permanent) or other forms of strong human impact (e.g. pollution, eutrophication, introduction of exotic species, and trampling by cattle). Within and among regions, it is often possible to identify small aquatic ecosystems with widely different anthropogenic stress. As small water bodies are characterized by a high aquatic–terrestrial contact zone, they may be ideal sentinel systems that can reflect changes in larger-scale ecosystem health. Owing to their small sizes and simple community structure, small aquatic ecosystems may also function as early warning systems for long-term effects on larger aquatic systems (e.g. changes in hydroperiod due to global warming) (De Meester et al., 2005).

d. Small water bodies are very well delineated in the landscape, being aquatic "islands" in a terrestrial landscape. As such, the boundaries of local populations and communities are easily determined. As a result, they fit nicely into the basic scheme of metapopulation and metacommunity theory: for obligatory aquatic organisms, such small water bodies are suitable patches in an unsuitable habitat matrix. Landscape characteristics (e.g. number, size and permanence of neighbouring reservoirs, regional species richness) and aspects of connectivity (e.g. presence of and dispersal rates through direct connections, Brendonck and Riddoch, 2000; Michels et al., 2001) are also relatively easy to quantify, which makes small water bodies excellent model systems for quantitative research on metacommunities (e.g. Conrad et al., 1999; Caudill 2003; Cottenie et al., 2003; McAbendroth et al., 2005).

e. Because of their small size, small water bodies are relatively easy to sample in a repeatable, quantitative and representative way. Whereas a pooled sample at, for instance, three random locations in a large system will be considered representative by many people, one may argue whether an equal number of randomly selected sampling stations can yield a representative measure of the abiotic and biotic characteristics of a large lake. In biodiversity studies, sampling large systems in an encompassing way could be really difficult. In comparison with larger systems, small water bodies also tend to be less heterogeneous in space, and show less interference from, e.g., wind effects. The ease with which a large number of systems can be sampled offers great potential for field surveys, especially with respect to the ever-recurrent compromise between the need for standardization and deep-reaching, quantitative analyses on the one hand and the need for many study systems on the other. It should be noted that year-to-year variability in small water bodies may be higher than in larger-sized systems, and this needs to be incorporated into the design of field studies (De Meester et al., 2005).

f. As communities in small water bodies are relatively simple, they are amenable to standardized experimental manipulation using *in situ* enclosures or even whole-ecosystem approaches. This allows replicated experiments to be carried out under relevant field conditions (e.g. Shurin, 2000; Jeffries, 2002; Cottenie and De Meester, 2004; Louette et al., 2006). Small reservoirs can also easily be mimicked as a whole by digging out new systems (Blaustein and Schwartz, 2001; Jeffries, 2002). In a similar approach, one may also take advantage of the opportunities offered by the many small water bodies that are created as part of nature conservation programmes (e.g. Fairchild et al., 2000; Louette and De Meester, 2005); and

g. The relative simplicity of small water bodies allows them to be reasonably mimicked in mesocosms; thus, increasing the scope for large-scale replicated experimental work, both in outdoor facilities and in the laboratory (Shurin, 2001; Ebert et al., 2002; Williams et al., 2002; Chase, 2003; Hall et al., 2004). This allows complex experimental designs and the testing of hypotheses that need large-scale replication (Rowe and Dunson, 1994; Moss et al., 2004). Moreover, it allows testing of the effects of anthropogenic stressors, which is not feasible at the whole-pond level (DeNoyelles et al., 1982; Hardersen et al., 1999; Boone and James, 2003).

It is hoped that Lamingo reservoir and the other small reservoirs in Jos, Plateau State, Nigeria will continue to receive the attention of researchers to enable us fully understand their ecology and health status, with the view of conserving them for posterity.

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