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The effect of fish bioturbation in the quality of water

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Abstract
The study generally aimed to determine the effect of different fish bioturbations in the quality of water. The use of tilapia, carp and/or catfish as bioturbators had no effect on altering the temperature, pH, total dissolved solids (TDS), total ammonia nitrogen (TAN) and nitrite of the water. With or without the use of bioturbator, the above mentioned water quality parameters were maintained within optimum ranges. Fish bioturbation had significant effect on water quality parameters such as dissolved oxygen (DO) and phosphorus. Specifically, the use of African catfish as bioturbator significantly increased the DO and phosphorus of water when compared to control.

Keywords: Bioturbation, aquaculture, water quality, organic carbon, catfish

1. Introduction
Soil refers to the weathered surface layer of the earth's surface in which plants grow, and animals and human thrive while sediment refers to the geological material that has been suspended and transported by water to another place where it settles and forms a deposit [1]. According to Avnimelech and Ritvo [2], the pond bottom soil and the accumulated sediments are integral parts of ponds.

Organic matters such as uneaten feeds, feces, dead algae and manure settle and accumulate at the pond bottom in extensive, semi-intensive and intensive ponds [2]. The excessive accumulation of organic matter in soil can cause anaerobic condition in the pond bottom causing unsuitable environment for aquatic organism [3]. The development of anaerobic layer can be avoided through resuspension of the sediment which raises particles and organic matter up to the oxidized water, where it can undergo processes such as chemical oxidation and aerobic microbial degradation[4]. The resuspension of material in pond bottoms may be due to various processes such as bioturbation, erosion and resedimentation, decoloration and salinization [5].

Bioturbation in aquatic environment is generally defined as all transport processes carried out by animals that directly or indirectly affect sediment matrices [5]. The process of sediment mixing that result from macrofauna burrowing, feeding and reworking within the surficial sediment can be considered as bioturbation [7]. Bioturbations significantly alter rates of chemical reactions and sediment-water exchange, destroy signals of stratigraphic tracers, bury reactive organic matter, exhume buried chemical contaminants and change sediment physical properties such as grain size, porosity, and permeability [8]. Bioturbation helps to expose more organic particles to the oxygenated water, enhances aerobic metabolism of the organic residues and prevents the development of anaerobic conditions [9, 4]. The study of Phan-Van *et al.* [10] concluded that fish bioturbation not only enhances the aerobic conditions of the overlying water column but also improves aerobic conditions in the pond bottom. The study generally aimed to determine the effect of different fish bioturbators on the quality of water.

2. Materials and Methods
2.1 Collection and analysis of soil samples
Soil was collected in empty fishponds at the Freshwater Aquaculture Center-Central Luzon State University (FAC-CLSU), Science City of Muñoz, Nueva Ecija, Philippines. Boyd (2008) categorized the organic carbon content of the soil as excessive (>2.5%), optimum (1.01-2.50%) and low (0.51-1.00%). The study only considered soil samples with organic carbon of 1.01-2.50%. Soil samples were taken at a depth of 5 cm using an improvised soil borer [1]. Analysis of soil organic carbon content was done at the Soil and Water Quality Laboratory of FAC-CLSU.

2.2 Experimental unit and design

Outdoor circular tanks (0.28 m^3) were used as experimental units. Two-centimeter thick dried soil sample was placed at the bottom of each tank. Fertilized pond water was added gently in the tank. Each treatment was stocked with three fish weighing 90-100 g [11]. The fishes were fed twice daily with an artificial feed. The experimental set-up lasted for 7 weeks. The study used one-factor in Randomized Complete Block Design (RCBD) with four treatments replicated three times (Table 1).

Table 1: Description of treatments that were used in the study

	Description
Control	No bioturbator
Treatment 1	Carp as bioturbator
Treatment 2	Tilapia as bioturbator
Treatment 3	African catfish as bioturbator
Treatment 4	Carp, tilapia and African catfish as bioturbators

2.3 Data collection

Water parameters such as temperature, dissolved oxygen (DO), pH and total dissolved solids (TDS) were analyzed using YSI multi-parameter equipment. Meanwhile, other water quality parameters such as total ammonia nitrogen (TAN), nitrite and phosphorus were analyzed following the laboratory manual of the course Aquatic Ecology of the College of Fisheries-CLSU. Analysis of water samples was done at the last week of the experiment.

3. Results and Discussion

The use of fish as bioturbator had no effect on altering the temperature, pH, TDS, TAN and nitrite of the water since the experiment showed non-significant results when values of treatments were compared to control. With or without the use of bioturbator, the above mentioned water quality parameters were maintained within optimum ranges [3]. In general, it was observed that the presence of bioturbators increased the turbidity of the water column [5] and this was true in case of T1, T2 and T4 (Table 2). In contrary in some studies, the increased level of TAN in set-up with bioturbators is due the excretion of the organism and the resuspension of nutrient-laden sediments. However, in this experiment, the low level of TAN in treatments with bioturbators could be due to the exposure of resuspended materials to the oxygenated water allowing it to decompose aerobically, thus, producing more beneficial substances [4].

Fish bioturbation had significant effect on water quality parameters that include DO and phosphorus. The use of African catfish as bioturbator (T3) significantly increased the DO of water as compared to control. The activities of bioturbators help to expose organic particles to the oxygenated water, thus, enhance aerobic metabolism and aerobic conditions [4]. As compared to control, the use of African catfish as bioturbator (T3) also resulted to significantly higher phosphorus level (Table 2). Resuspension of bottom soil by benthivorous fish not only affected the water quality but also the phosphorus accumulations in water and bottom soil [12].

Table 2: Results of water quality analysis during the 7th week of the experimental set-up using tilapia (T1), carp (T2), catfish (T3) and combination of the three fishes (T4) as bioturbators

Water Quality Parameters	Treatments				
	Control	T1	T2	T3	T4
Temperature (°C)	24.94±0.93^a	23.87±0.34^a	23.88±0.54^a	23.92±0.37^a	24.07±0.65^a
DO (ppm)	6.56±2.17^b	7.66±0.39^{ab}	9.59± 2.84^{ab}	13.81±2.87^a	10.39±3.03^{ab}
pH	7.76±0.10^a	7.73±0.12^a	7.90 ±0.16^a	8.15±0.20^a	7.90±0.28^a
TDS (ppm)	340.74±118.89^a	407.33±23.96^a	444.17±87.23^a	296.44±67.40^a	409.72±110.31^a
TAN (ppm)	0.17±0.24^a	0.11±0.11^a	0.08±0.04^a	0.08 ±0.02^a	0.38±0.21^a
Nitrite (ppm)	0.03±0.04^a	0.05±0.05^a	0.02±0.01^a	0.07 ±0.01^a	0.14±0.14^a
Phosphorus (ppm)	0.05±0.02^b	0.13±0.09^{ab}	0.01±0.03^b	0.57 ±0.36^a	0.08±0.05^b

4. Conclusion

The use of fish as bioturbator had no effect on altering the temperature, pH, TDS, TAN and nitrite of the water. Fish bioturbation had significant effect on water quality parameters such as DO and phosphorus. The use of African catfish as bioturbator significantly increased the DO and phosphorus of the water when compared to control.

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