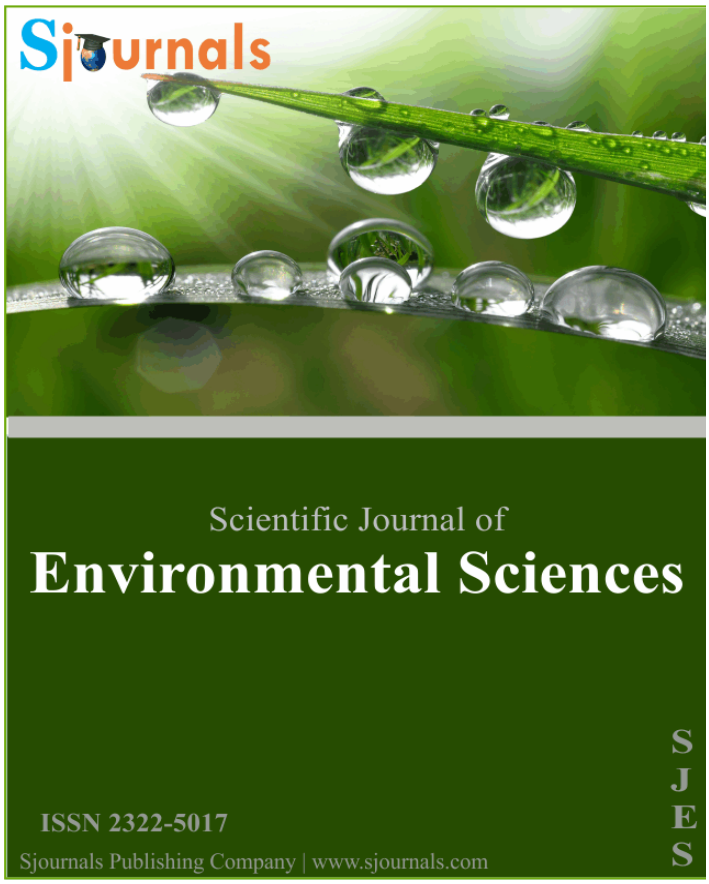

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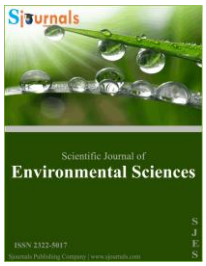

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Original article

Diurnal variability of water temperature, pH and DO in the underground type fish shelter

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ABSTRACT

We newly developed artificial deep pool (ADP) that secures a shelter and habitat space in bottom of the pond for fish escape from unfavorable conditions in freshwater ecosystem. Because the ADP is an underground structure, we were compared by measuring the diurnal basic water quality (water temperature, pH, DO saturation) in St. 1 (open water) and St. 2 (inside of ADP) in shallow small pond for one year. In result, ADP provides constant optimal temperatures and DO level to help fish survival in extreme water environment conditions. Therefore, ADP is able to reduce thermal stress in the hot season, and to minimize energy expenditure in the cold season for freshwater fish. If the ADP will be introduced in shallow ponds it will be able to significantly increase the fish survival during the year.

1. Introduction

Aquatic environment is very important because fish is to live their lifetime in the water. In this regard, water quality is direct limiting factors that influence fish survival. Especially, water temperature, pH and DO are the most important factors in physiological changes in the fish. Therefore, fish shelter is one of the best choices when there is a physicochemical change of open water. In this study, we developed ADP that secures a shelter and habitat

space for fish escape from unfavorable conditions in freshwater ecosystem. The aim of this study was to examine the variations of water temperature, pH and DO in open water and inside of the ADP and verify function of fish shelter in shallow pond.

2. Materials and methods

We conducted the experiments in a small pond that applied ADP. The specifications of the pond are as follows: surface area = 110 m^2, average water depth = 0.5 m, maximum water depth = 0.7 m, bed material = gravel (diameter ≤ 60 mm), sand (diameter ≤ 2 mm) and bottom material (bentonite). The ADP (width 1.5 m × length 1.5 m × height 1.5 m) was constructed at the 0.7 m depth point in the pond. In the ADP, holes were perforated on the cover (diameter = 20 cm) and four sides (height = 20 cm) were left open to allow fish to access the shelter. Also, basalt (diameter ≤ 250 mm) was used to make the complicated space for fish habitat.

A water quality monitoring sensor (XLM6000, YSI, USA) was installed at each point St. 1 and St. 2, and water quality data were collected during one year. The season were each separated by Period 1 (circulated condition), Period 2 (no circulated condition) and Period 3 (no circulated condition), depending on the season and water circulation. The water quality monitoring sensors, which were used to measure the water temperature, pH and DO saturation were installed at depths of 0.4 m and 2.0 m for St. 1 and St. 2, respectively.

3. Results

In this study, the water temperature, pH, DO saturation showed a statistically significant difference (ANOVA, $p<0.05$). St. 1 showed clear diurnal variability, but, St. 2 showed stable space with less fluctuations of water quality. Also, the experimental results in this study revealed that the water temperature in St. 2 was lower in summer and higher in winter than open space. Moreover, St. 2 showed reduction effect of supersaturation during winter. In this period, especially harsh winter, fish was estimated to be on the ADP to reduce the energy expenditure. Overall, ADP provides constant optimal temperatures and DO level to help fish survival in extreme water environment conditions. As shown in Table 1, we represent the summary of characteristic depend on the measured site and seasonal change in this study.

Table 1
Characteristic of the St. 1 and St. 2 during different period.

Description	St. 1	St. 2
Period 1*	•Dense aquatic plant • High water temperature in summer	•Water circulation by underwater pump • Shading effect inside of the ADP
Period 2**	• Ice cover on surface area and decrease of water volume • Low water temperature, supersaturation • Remove of aquatic plant	• No water circulation • Stable water environment (repression of supersaturation) • Maintain constant water depth • Fish hiding in ADP
Period 3***	• Increase of water volume • Increase of nutrients level	• No water circulation • Survive of the mature fish

* Period 1 denotes April 2013 to December 2013, ** Period 2 denotes December 2013 to February 2014, *** Period 3 demotes March 2014 to April 2014.

Figure 1 shows diurnal variations of mean water temperature in this study. Water temperature was higher at 15:00 to 17:00 in St. 1. But, St. 2 showed constant water temperature level all day long in case of no circulation condition (Fig. 1). In general, high water temperatures can cause thermal stress in fish (Carveth, 2007). In this result, because the water temperature in St. 2 was lower and stable than St. 1 during Period 1, the ADP is considered to be useful as a fish shelter in hot season. On the other hand, water temperature in St. 1 showed very low value in Period 2. But, water temperature in St. 2 was higher than St. 1 in the early morning and the whole night in Period 2. This findings showed a possibility that ADP will be able to minimize the energy expenditure of fish in cold season.

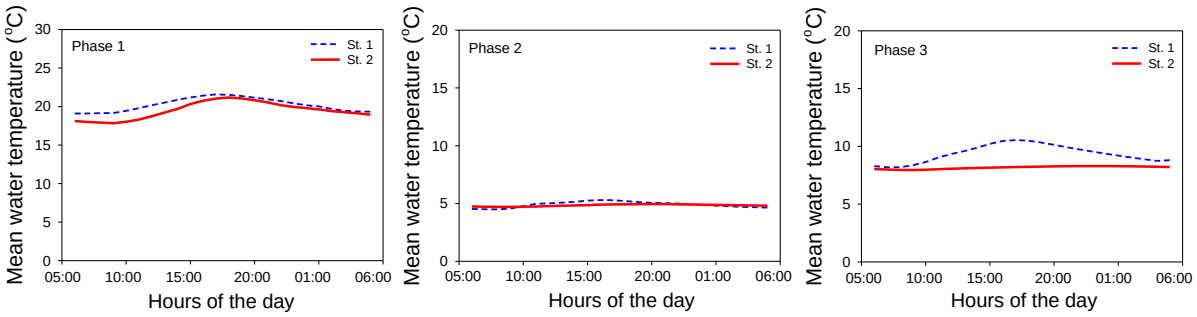

Fig. 1. Diurnal variations of mean water temperature.

Figure 2 shows diurnal variations of mean pH in this study. In this result, pH showed similar trend between St. 1 and St. 2 in circulated condition (Period 1), but, pH in no circulation conditions (Period 2 and Period 3) showed different trend between St. 1 and St. 2. Although the pH had a little change, the overall level range is about 7 to 8 that represent suitable value for fish habitat.

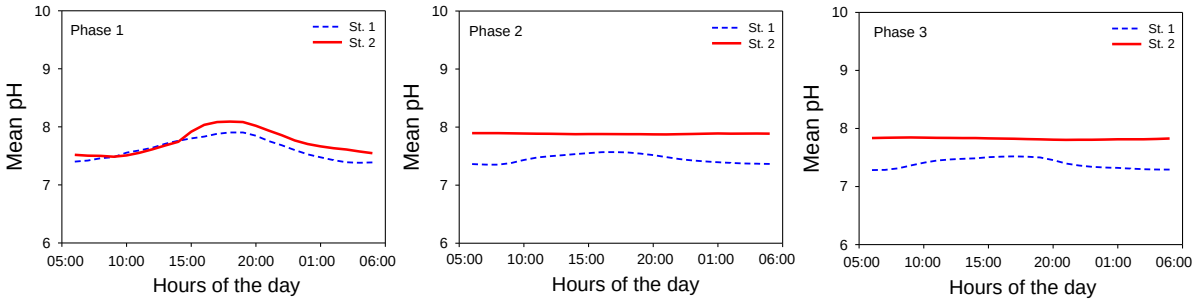

Fig. 2. Diurnal variations of mean pH.

Figure 3 shows diurnal variations of mean DO saturation in this study. Diurnal DO saturation in St. 1 tended to increase during the day and decreased in the night. Generally, DO level in open space indicate the highest value in mid-afternoon due to photosynthesis effect of plant (Bonachela et al., 2007). But, DO saturation in St. 2 showed constant level in no circulation conditions in this study. Therefore, it can be assumed a preponderance of photosynthesis in St. 1, and, dominance of respiration in St. 2, because the most important source of DO variation is known to photosynthesis-respiration balance (Bonachela et al., 2007).

Especially, Phase 2 and Phase 3 showed supersaturation in St. 1 that it is the DO concentration of water greater than 100%. In this season, during winter and early spring, St. 2 showed inhibitory effect of supersaturation. When the supersaturation persists, it can be an adverse effect on the fish survival (Espmark et al., 2010). Therefore, shelter in fish can escape as the ADP is able to increase the survival rate of fish during supersaturation season.

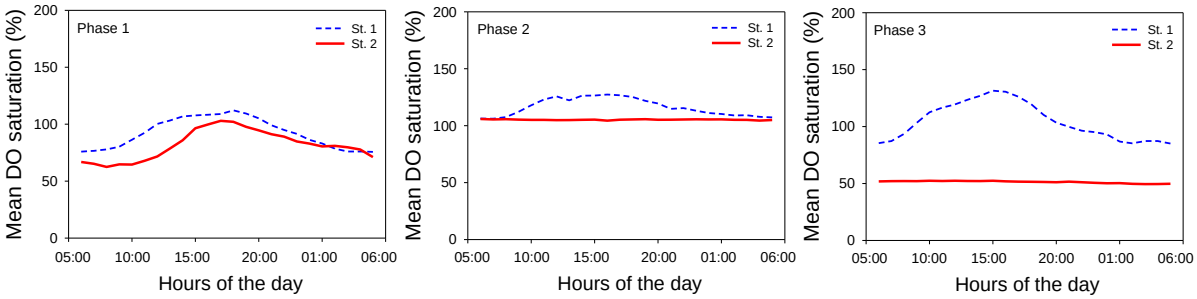

Fig. 3. Diurnal variations of mean DO saturation.

We conducted monitoring of water temperature, pH, and DO saturation at St. 1 and St. 2 in small shallow pond for a year. In many studies, researchers emphasized the importance of fish shelter (Finstad et al., 2007; Matsuzaki et al., 2012). Our findings in this study, ADP is able to reduce thermal stress in the hot season, and to minimize energy expenditure in cold season. Thus, if the ADP will be introduced in shallow ponds, it can significantly increase the fish survival during the year.

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References

Bonachela, S., Acuña, R.A., Casas, J., 2007. Environmental factors and management practices controlling oxygen dynamics in agricultural irrigation ponds in a semiarid Mediterranean region: Implications for pond agricultural functions. Water. Res., 41, 1225-1234.

Carveth, C.J., Widmer, A.M., Bonar, S.A., Simms, J.R., 2007. An examination of the effects of chronic static and fluctuating temperature on the growth and survival of spikedace, Medafulgida, with implications for management. J. Therm. Biol., 32, 102-108.

Espmark, Å.M., Hjelde, K., Baeverfjord, G., 2010. Development of gas bubble disease in juvenile Atlantic salmon exposed to water supersaturated with oxygen. Aquaculture, 306, 198-204.

Finstad, A.G., Einum, S., Forseth, T., Ugedal, O., 2007. Shelter availability affects behaviour, size-dependent and mean growth of juvenile atlantic salmon. Freshwat. Biol., 52, 1710-1718.

Matsuzaki, S.S., Sakamoto, M., Kawabe, K., Takamura, N., 2012. A laboratory study of the effects of shelter availability and invasive Crayfish on the growth of native stream fish. Freshwat. Biol., 57, 874-882.

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