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Different Shelters to Domesticate Dwarf Snakehead (*Channa limbata,* Cuvier 1831) From the Progo River, Magelang, Central Java

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Abstract

This study's main focus is how the adaptation level affects the treatment of shelter composition in controlled containers. Parameters observed included growth rate, stress level, fish survival rate, and water quality during rearing. The research design used a completely randomized design (CRD) and was analyzed using SPSS. The results showed that the shelter composition was good for the *C. limbata* survival in experimental group 3 (P3) by placing the addition of sand, stones, gutters, and aquatic plants in the aquarium. The effect of the composition of the shelter in a controlled container on the adaptation level of *C. limbata* was shown in experimental group 3 (P3), which experienced an increase in length of up to 5 mm, and an increase in weight of 25 g and a survival rate of 60%. This value is the best among 1st, 2nd, and control. This shows that *C. limbata* can adapt its life to an artificial habitat that is as suitable as its natural habitat.

INTRODUCTION

The Hubert *et al*. (2015) report indicates that there are 1,218 species of freshwater commodities in Indonesia, belonging to 84 families, with 1,172 native species from 79 families and 630 endemic species. Based on LIPI data (2015), it is estimated that there are as many as 4,000 – 6,000 species of fish in all Indonesian waters. The dwarf snakehead (*Channa limbata*) belongs to the Channidae family, also known as the red-tailed snakehead. This species is considered rare and only found in shallow rivers near forests and waterfalls near mountains (Khoomsab and Wannasri, 2017). Due to this scarcity, there is a need for conservation and protection efforts through domestication. Domestication is the controlled breeding and maintenance of animals, including fish that typically live in the wild, to keep them alive and productive (Juliana *et al*., 2018).

The present study aims to take the next step in managing fish resources by attempting to domesticate or cultivate potential commodities in Magelang. Specifically, the study focuses on domesticating *C. limbata* from the Progo River in Magelang through substrate-based maintenance and stocking density, thereby allowing the fish to adapt to controlled containers and live productively. The data obtained in this study could inform future policy-making regarding the management and conservation of freshwater fish resources at the study site.

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METHODOLOGY

Ethical Approval

Animal samples in this study were given appropriate treatment, samples were taken using good fishing gear. The number of samples will certainly not affect the number of fish populations in nature. Samples caught below the minimum size will be released again. After the research was completed, the remaining research samples were released back into the Progo River.

Place and Time

This research was carried out from August to September 2022 in the Aquaculture wet laboratory, Faculty of Agriculture, Tidar University.

Research Materials

The tools used in this research were aquarium, net, aerator (Rosston, China), filter (Rosston, China), heater (Kandila, China), pH meter (ATC, China), thermometer (Nikita Star, China), DO meter (Lutron, Taiwan), wooden ruler, digital scale (I-2000, China), cool box (Marina, Indonesia). The materials were pellet, sand substrate, gravel substrate, soil substrate, and label paper.

Research Design

Fish treatment is done for 30 days to observe the development of fish, including growth and adaptation levels during rearing. The research method 3 replications.

K: Control (sand addition); P1: Treatment 1 (sand and stone addition); P2: Treatment 2 (sand, stone, and PVC pipe addition); and P3: Experimental group 3 (sand, stone, PVC, and aquatic plant addition).

The basis for the determination is based on observations in the field about the habits of *C. limbata* in nature which are solitary and like to hide.

Work Procedure

The fish used in this study were fish from the Progo River measuring 3-4 cm, as many as 120 fish based on Research development Snakehead Larvae (Hidayatullah *et al*., 2015). Fish are taken from the river at several locations using sampling. Fish are caught using nets/shears and then collected in a plastic container then tied and placed in a cool box.

Fish caught from the Progo River were acclimatized for 15 minutes by placing them above the water's surface of the aquarium water until it was thought that the temperature was uniformly distributed and comfortable for the fish.

The container used is an aquarium measuring 50x30x30cm. The aquarium is washed first before use and then air-dried. After that, filled with clean water to a height of 2/3 in each aquarium, and the aerator, heater, and filter. Then each aquarium was given an experimental group label and replicates. According to Nen *et al*. (2018), using a stocking density of 5 fish/L.

The feed used is in the form of commercial F-999 pellets with a protein content of 38%. The frequency of feeding is 2 times a day, namely morning and evening, with 5% of body weight (Suryanti *et al*., 1997).

Observation of the number of fish is carried out every day so that the number of live and dead can be known (Mulqan *et al*., 2017). Fish growth measurements were carried out every 10 days by weighing the body weight of each individual, and calculating fish survival was also carried out from the beginning to the end of the study (Nen *et al*., 2018). Weighing fish using an analytical balance with an accuracy of 0,1 is done by taking a small container of the fish in and weighed again. The resulting weight is the difference between the final Measure of the length of the fish using calipers and a ruler with an accuracy of 0,1.

Measured parameters include Growth Rate (GR), Absolute Length Gain (Pm), Absolute Weight Gain (Bm), and Survival Rate (SR). The absolute length gain is the difference in the length of the

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fish's body measured from the tip of the head to the tip of the tail. The calculation uses the formula (Effendie, 1997):

Lm = Lt (cm)–L0 (cm)

Where:

Lm = Absolute length gain

Lt = Final average length

L0 = Initial average length

Calculation of absolute weight gain can be calculated using the formula (Effendie, 1997):

Wm = Wt (g) – W0 (g)

Where:

Wm = Absolute Weight Growth

Wt = Biomass weight at the end of the study

W0 = Biomass weight at the start of the study

SR is calculated using the equation from (Effendie, 1997):

$$SR \frac{N0 - Nt}{N0} \times 100\%$$

Where:

SR = Survival Rate

N0 = Number of fish at the start of the study

Nt = Number of fish at the end of the study

The water samples analyzed were the water from fish-keeping containers. The measured water quality includes temperature, pH, and DO (Dissolved Oxygen).

Data Analysis

Data analysis was carried out in the form of tables, graphs, and descriptions, and the results of data analysis were adjusted with water quality standards and analysis regression.

RESULTS AND DISCUSSION

Length Growth

The growth in length of the *C. limbata* increased during the 30 days of experiencing a varied growth in length for each treatment. the measurement results can be seen in Figure 1.

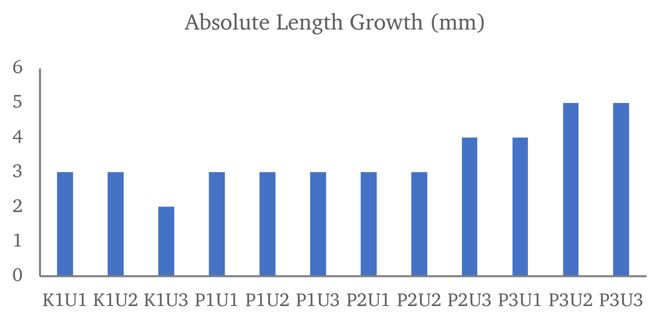

Figure 1. Absolute Length Growth Chart (mm).

The graph above illustrates that the highest growth in absolute length of *C. limbata* was in the 3rd experimental group of repetitions 2 and 3 (P3U2 and P3U3) with a value of 5 mm, and the lowest growth in length was in the Control 1 repetition 3 (K1U3) with a value of 2 mm. This is presumably because the stocking density is below the minimum requirement of 2 fish/L, so there is no competition for space when looking for food so that the feed given can be used optimally. In addition, the water quality assessed was still under the minimum requirements for fish to live, but the differences in growth in the control and treatment were more towards the aggressive habits of *C. limbata*. The different stocking density treatments on the nursery of fish larvae have a significant effect on the growth of absolute length and absolute weight (Hidayatullah *et al*., 2015).

According to the research results of Muflikhah (2007), artificial feed is given for seeds and the enlargement of the snakehead which in the process of domestication is an effort to use efficient fish as snakehead feed. The growth of *C. striata* which is fed with the addition of vitamins has higher weight gain. So, the difference in length growth results is thought to be due to the first difference in the type of feed used which in this study used only artificial feed. Secondly, it is suspected that the research fish have not gone through the initial adaptation process to the new environment, because the fish samples obtained are natural catches. Treatment of K, P1, P2, and P3 had no significant effect on growth, or treatment of habitat conditions to suppress the cannibalism of *C. limbata*. According to Qin and Fast (1999), cannibalism between *C. striata* is very difficult to avoid.

Weight Growth

The weight growth of *C. limbata* increased during 30 days of rearing, and the weight growth varied for each treatment. The measurement results can be seen in Figure 2.

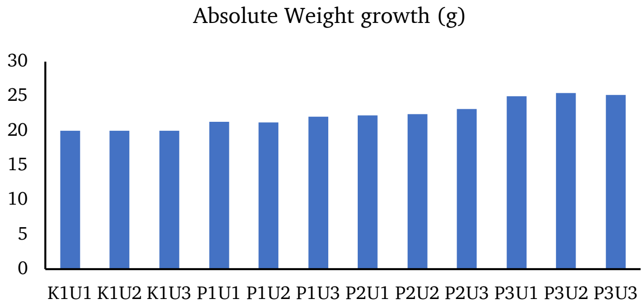

Figure 2. Absolute weight growth chart (g).

The results of measurements of the absolute weight data of *C. limbata* showed that the highest increase was in treatment 3 repetitions 1, 2, and 3 (P3U1, P3U2, P3U3) which was 25 g, and the lowest weight growth was in controls 1, 2 and 3 (K1U1, K1U2, K1U3) of 20 g, it is suspected that ad libitum feeding can provide feed stock in aquaculture ponds and allow fish to eat whenever and as much as they want, so this has an impact on weight growth. Another prediction of differences in weight gain in *C. limbata* is the availability of shelter or hiding places because of their aggressive nature.

Dwarf snakehead belongs to the class of carnivorous fish whose main food is meat. Under natural conditions, snakehead fish in the post-larvae phase like to eat natural food according to their mouth opening, such as *Daphnia* and *Cyclops*, while adult fish eat crustaceans, insects, frogs, worms, and small fish. Feed size for adult snakehead fish has a total length range of 5.78-13.4 cm including aquatic insects, pieces or carcasses of aquatic animals, shrimp, and detritus (Sinaga *et al*., 2019).

Growth in length and weight of C. *limbata* is also influenced by the origin of the sample fish, namely from natural catches. In nature, many factors affect differences in fish growth, including differences in habitat, eating habits, fish activities, and season. Temperature, food availability, and trophic levels also affect fish growth (Lowe-McConnell, 1987). In general, snakehead fish (*Channa striata*) have an allometric growth pattern or faster weight gain than body length, this is related to its aggressive nature in searching for food.

Survival Rate (SR)

Survival rate is a measure that can be used and is a reference to determine how much tolerance and ability of *C. limbata* fish to live during maintenance during research. The results of measuring the SR value can be seen in Figure 3.

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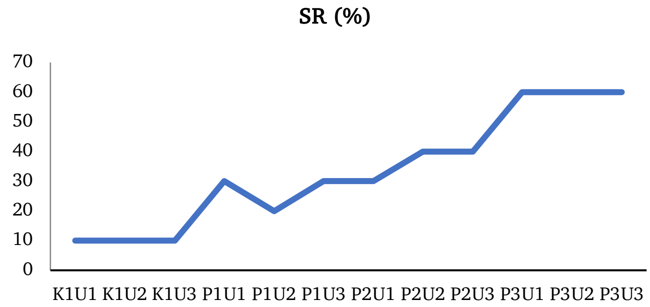

Figure 3. Graph survival rate measurement.

The results showed that the best survival rate was in the 3rd experimental group repetitions 1, 2, and 3 (P3U1, P3U2, P3U3) with a value of 60% while the lowest was in the control of repetitions 1, 2, and 3 (K1U1, K1U2, K1U3) with a survival value rate 10%. The low survival rate of a cultivated biota is influenced by several factors, one of which is inappropriate nutrition. The low SR value in the control was due to the aggressive and solitary nature of the *C. limbata* made it easy to attack one another when looking for food. It was different from the 2nd and 3rd experimental group which experienced an increase in SR due to the provision of shelter or hiding places so it was proven to reduce the level of aggressiveness and cannibalism of *C. limbata*. Another benefit of aquatic weeds is the shelter for snakehead fish from predation, both same-sex and other predators.

The different addition of shelter in this study greatly influences fish behavior, because shelter is used as a hiding place for fish, so *C. limbata* feels safe from predators. Cannibalism occurs when there is predation between individuals in a maintenance population, either all or most of the body. Cannibalism in fish is of particular concern because it can affect aquaculture production. Cannibalism in snakehead fingerlings is influenced by the type and availability of feed and the degree of difference in size between individuals (Folkvord, 1997; Qin and Fast, 1996). According to Obirikorang *et al*. (2014), cannibalism is a basic habit in teleost fish, namely killing and eating all or part of individuals of the same species after their developmental stages have begun to be perfect. Another influencing factor is the origin of the samples collected from various locations of the Progo tributaries which have different activities and habitat characteristics.

Relationship of Water Quality and Fish Length Growth

The water quality parameters that have been tested and obtained various data, then the effect of water quality on length growth is known which is illustrated in Figure 4.

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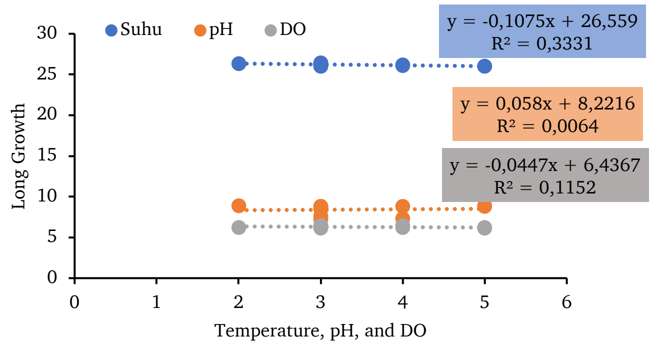

Figure 4. Graph of the effect of water quality on length growth.

Table 1. Regression Results.

SUMMARY OUTPUT	
Regression Statistics	
Multiple R	0,583625976
R Square	0,34061928
Adjusted R Square	0,093351511
Standard Error	0,857283361
Observations	12

Based on the regression calculation, it was determined that the correlation value between temperature, pH and DO on length growth was included in the "medium" category. The coefficient of determination is 0.093 or 9%, which means that temperature, pH, and DO affect length growth by 9%, presented in Table 1.

Table 2. ANOVA Analysis.

	df	SS	MS	F	Significance F
Regression	3	3,037188584	1,012396195	1,37753206	0,317853807
Residual	8	5,879478083	0,73493476		
Total	11	8,916666667			

The results of the ANOVA test analysis showed that there was not a significance value of > 0.05 which means that there was no significant effect between temperature, pH and DO on length growth. This is because the water quality parameter values have met the needs of fish life, as presented in Table 2.

Relationship of Water Quality and Fish Weight Growth

The water quality parameters that have been tested and obtained various data, then it is known that the effect of water quality on weight growth is depicted in Figure 5.

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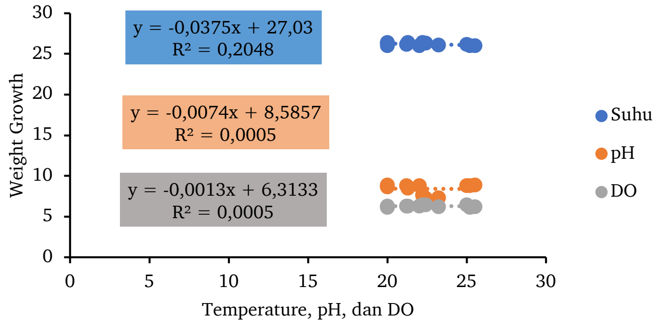

Figure 5. Graph of water quality correlation to weight growth.

Table 3. Regression Results.

SUMMARY OUTPUT	
Regression Statistics	
Multiple R	0,594594445
R Square	0,353542554
Adjusted R Square	0,111121012
Standard Error	1,905360143
Observations	12

Based on the regression calculation, it was determined that the correlation value between temperature, pH and DO on weight growth was included in the "medium" category. The coefficient of determination is 0.11 or 11%, which means that temperature, pH, and DO affect weight growth by 11%, presented in Table 3.

Table 4. ANOVA Analysis.

	df	SS	MS	F	Significance F
Regression	3	15,88348847	5,294496156	1,458379278	0,296993399
Residual	8	29,0431782	3,630397275		
Total	11	44,92666667			

The results of the ANOVA analysis show that there is a significance value of > 0.05, which means that there is no significant effect between temperature, pH, and DO on weight growth, presented in Table 4.

Effect of Water Quality on Survival Rate (SR)

The water quality parameters that have been tested and obtained various data, then it is known that the effect of water quality on weight growth is illustrated in Fig 6.

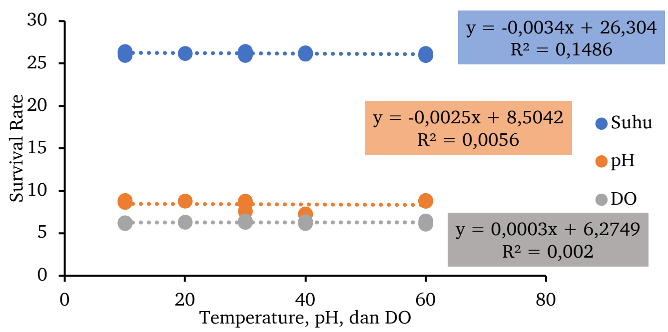

Figure 6. Graph of water quality correlation to weight growth.

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Table 5. Regression Results.

SUMMARY OUTPUT	
Regression Statistics	
Multiple R	0,545150727
R Square	0,297189315
Adjusted R Square	0,033635308
Standard Error	18,90137821
Observations	12

The results of the regression calculation show that the correlation value between temperature, pH and DO on the SR value is in the "moderate" category. The coefficient of determination is 0.03 or 3%, which means that temperature, pH, and DO affect the SR value by 3%, presented in Table 5.

Table 6. ANOVA Analysis.

	df	SS	MS	F	Significance F
Regression	3	1208,569881	402,8566269	1,12762207	0,394112666
Residual	8	2858,096786	357,2620982		
Total	11	4066,666667			

The results of the ANOVA analysis show that there is a significance value of >0.05, which means that there is no significant effect between temperature, pH, and DO on the SR value, presented in Table 6.

Effect of Treatment on Domestication Activities

Domestication efforts are seen from the success of the stages in a fish cycle that can survive in new, controlled containers with habitat adjustments. The first stage in domestication activities involves placing fish in conditions similar to their natural habitat so that fish can survive. In the second stage, the fish that have been conditioned in the controlled container can adapt to the feed given during rearing, then in the third stage, the fish can preserve their species by reproducing. In this case, the research results are still in the first and second stages, namely moving the *C. limbata* from nature (river) into a controlled container (aquarium) by being treated in the form of differences in shelter composition.

The treatment in the form of differences in the composition of the shelters used during rearing showed an effect because *C. limbata* that live in nature have housing and solitary habits so natural selection pressure arises due to the inability of the parents. *C. limbata* to survive. The cannibalism of snakehead as a carnivorous fish (Webster and Lim, 2002). The pressure of natural selection is reflected in the behavior patterns of the cannibal fish *C. limbata*. The level of cannibalism of *C. limbata* increases due to several reasons, including being unable to endure hunger because the amount of food is not sufficient and what is very influential here is the lack of shelter so that the fish can easily pounce on their prey. Providing shelter aims to suppress cannibalism and as a place to shelter of *C. limbata*, according to research by Saputra and Samsudin (2017) showing that providing aquatic plants can suppress the cannibalistic nature of *C. striata*. According to the results of research from Muliani *et al.* (2021) *C. striata* prefers shelter with a rare or not dense plant arrangement, this is because it is suitable for places to find food and enlargement.

The existence of shelter (and substrate) that is appropriate and by the life of *C. limbata* in nature can increase the level of survival of fish if it is maintained under controlled conditions (cultivation) because fish from nature that are transferred to aquaculture containers have time

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to adapt so they need artificial habitat to support domestication activities. The addition of sand, rocks, pipes, and aquatic plants in the test aquarium has the highest SR value when compared to aquariums that only use sand as a substrate. This shows the influence of the care provided by domestication efforts. Meanwhile, research from Sirodiana and Irawan (2020) found that sand-based substrates can provide quite good growth performance and survival rates.

The results of the study showed a low SR value because the sample fish obtained from nature failed in the initial adaptation process. This can be seen from the mortality rate in Figure 6. After 2 days of observation, the fish began to adapt to living in the shelter provided (each shelter contains 1 fish), from these observations it can be interpreted that providing shade with more numbers and types can reduce the mortality rate caused by cannibalism.

CONCLUSION

The shelter composition is good for the life of dwarf snakehead (*C. limbata*), namely in the 3rd experimental group (P3) by the addition of sand, stones, PVC pipes, and aquatic plants in the aquarium. The effect of the experimental group on the composition of the shelter in a controlled container on the level of adaptation of *C. limbata*, which was shown in 3rd experimental group (P3), which experienced an increase in length of up to 5 mm and an increase in weight of 25 g and a survival rate of 60%. This value is the best among the 1st experimental group, 2nd experimental group, and control. This shows that *C. limbata* can adapt its life to an artificial habitat that is as suitable as its natural habitat.

CONFLICT OF INTEREST

The author states that in the preparation of this article, there is no conflict of interest

AUTHOR CONTRIBUTION

The contributions of each author are as follows; Muhammad Tri Aji collected and analyzed data, Sri Hidayati followed conception and design experiments, Eric Armando and Annisa Novita Sari collected samples and surveys, Tholibah Mujtahidah compiled the manuscript, Abdul Qadir Jailani analyzed water quality.

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