Morphoanatomy of *Pangasionodon hypopthalmus* Reared Under Controlled Photoperiod

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Abstract  Fish morphoanatomy is affected by environmental condition such as photoperiod duration. A research on the effects of shortened photoperiod on the morphoanatomy of *Pangasionodon hypopthalmus* has been conducted. There were 3 treatments applied, namely, 24 hours dark (24D), 18 hours dark (18D) and natural photoperiod (control). The fish, 8 cm total length (TL) and 4 gr body weight (BW) were reared in circular plastic tanks filled with 100 L freshwater and completed with aerators and circulation pumps, 30 fishes/tank. The fish was reared for 8 weeks and fed with commercial fish feed pellets, twice/day, at satiation. The dark condition was created by placing the tanks under dark tarp tents. Morphoanatomy data were studied by the end of experiment. Results shown that the survival of fish was 100%. The growth of fish reared in 24D and 18D was better, more than 20 cm TL and 85 gr BW, while that of the control was 18 cm TL and 72 gr BW. The condition factor as well as the liver condition of fish in all treatment was not different, it was around 1.2. The liver was reddish brown color, smooth and oily in which hepatosomatic index (HSI) value 0.023 in 24D; 0.027 in 18D and 0.048 in control. The visceralsonatic index (VSI) was 0.090 in 24D; 0.70 in 18D and 0.161 in control. In most of fishes reared in 24D and 18D, the gonad were in the 1st maturity stage (gonadosomatic index; GSI 0.0058 to 0.0068), while the gonad of some control fishes were in the 2nd maturity stage (GSI 0.0080). Data obtained shown that the morphoanatomical data (HSI, VSI and GSI) of the fish reared in lengthened dark were lower, but the growth data (TL and BW) was higher than those of the control, indicated that the fish reared in dark condition may allocated more energy for growing.

1. Introduction

A type of consumption fish that can be found easily in every market in Riau, Indonesia fish is *Pangasionodon hypopthalmus* of *patin* fish. This fish is may be sold fresh as well as processed such as smoked and salted fish. Many Riau’s traditional cuisines use this fish as a main ingredient as it has specific delectable taste. Due to high demand of this fish, the *P. hypopthalmus* culture is commonly conducted, by using a floating net cage in lakes and dam and also in ponds.

Even though the *P. hypopthalmus* culture can be conducted in many areas in Riau, the culture related problem faced by most of fish farmer is similar, namely the high operational cost needed for fish feed. To increase the effectiveness of the fish culture, several efforts have been conducted such as applying a better management [2], using a biofloc system [12] and applying a photoperiod manipulation, where the fish was reared in dark condition [16; 8; 13 and 19].
The results of previous researches find out that *P. hypopthalmus* reared under dark condition performed better growth than that of the fish reared under natural photoperiod [19; 13; 8; 17] stated that during dark condition, the fish was less active in swimming but well response to feed provided. The fish was also healthy as it shown by normal hematology condition [18] and no abnormality in gill, kidney and liver tissue structures [19]. It means that applying the dark rearing technique has no negative impacts on growth as well as health of *P. hypopthalmus*.

By rearing *P. hypopthalmus* in dark condition, the length and weight of the fish grew faster. However, the food conversion rate (FCR) of the dark reared fish was lower than those of fish reared in 18 hours dark and under natural photoperiod [19]. This fact indicates that the fish reared under dark condition allocates more energy for growing.

As the physiology of fish is affected greatly by the environmental condition, the application of short photoperiod in *P. hypopthalmus* will affect the physiology of the fish in general. Lee et al. (2017) stated that photoperiod is considered to be the most effective environmental factor in controlling the reproductive cycle of fish. Fish that were reared in natural photoperiod condition shown better gonad development [6; 9; 8] than that of the fish reared under continuous dark. The gonad development is related to the work of hypothalamus in producing hormones related to reproduction activities. As the hypothalamus work was hampered due to lack of light, the preparation of gonad development may also be delayed and it may be reflected in the morphoanatomical condition of the fish. To understand the morphoanatomy of fish reared under controlled photoperiod, it is worth to conduct a study titled “Morphoanatomy of *P. hypopthalmus* Reared Under Controlled Photoperiod”

2. Methodology

In this study, a CRD with 3 treatments and 3 replication was applied. The treatments applied were as follow:

- **24D0L** : the fish were reared under continuous dark condition
- **18D6L** : the fish were reared under dark for 18 hours and 6 hours light
- **Co** : the fish were reared under natural photoperiod

During the study, the fish was reared using 120 L plastic tanks that were filled with 100 L of freshwater and completed with aerators and circulation pumps. In the 24D0L treatment, the rearing tanks were placed under a dark colored tarp tent continuously. In the 18D6L treatment, the tanks were placed under the tarp for 18 hours and during the day time, the tarp tent was opened for 6 hours. The control tanks were placed under clear plastic tent that enable the sunlight to reach the water.

The fish used in this study was fingerlings of *P. hypopthalmus*, 7-8 cm TL and around 4 grams BW, obtained from a local fish breeder in Pekanbaru, Riau. Only healthy fish or fish with good performance such as active swimming, no wound in their skin and normal mucus production were chosen for this study. The fish was adapted for a one week period prior to the treatments. The density of fish was 30 fishes/ tank. The fish was reared for 8 weeks. During the research they were fed on commercial fish feed pellets produced by PT Central Proteina Prima Indonesia, F 999 during the first 4 weeks, F781-1 during the 4th and 5th weeks and F781-2 during the 7th and the 8th weeks. The fish was fed at satiation.

The water in the rearing tanks were monitored daily. The water volume decrement due to evaporation was replaced with the fresh clean water every day. Once/week, any debris in the bottom of the tank altogether with around 25% of the rearing water was removed and then replaced.

The morphoanatomical parameters of the fish were studied 2 times, prior to the treatment and by the end of the experiment. Morphoanatomical parameters measured were as follows: the growth of fish (length and body weight), Hepatosomatic Index (HIS), Visceralsomatic Index (VSI) and Gonadosomatic Index (GSI). The gonad maturity stage, liver’s color and texture and also the presence of fat in the viscera were noted. The growth of fish was measured at baseline and then monitored weekly. Every week, 3 fishes from each tank were measured using a ruler (1 mm accuracy) and weighed using a digital scale (0.01 gr accuracy). The growth and morphoanatomical characteristics of fish were calculated using this following formulas:
1) Mean Weight Gain = Final Mean Weight (W1) – Initial Mean Weight (W0)
2) Mean Length Gain = Final Mean Length (L1) – Initial Mean Length (W0)
3) Hepatosomatic Index = (Liver Weight / Body Weight) x 100%
4) Visceralsomatic Index = (Viscera Weight / Body Weight) x 100%
   * Note: the viscera weight was not included the gill
5) Gonad maturity stage was described, and Gonadosomatic Index = (Gonad Weight / Body Weight) x 100%
6) Liver color = as there is no standard for the color of the liver, it was decided by comparing the color of this organ with a Jotun paint color standard card
7) Liver texture = the texture of the liver was identified by touching that organ and it is categorized into soft or rubbery.

Data obtained in this study were then analyzed descriptively.

3. Results and Discussion

3.1. Growth of P. hypophthalmus
In this research the survival of the fish was checked every day. Surprisingly, there was no fish died during the research or the fish survival was 100% in all treatment. The fish was healthy and no abnormal behavior nor did peculiar morphological characteristics occur. The fish was active in swimming and showing good response toward feed provided.

Even though there was no difference in survival, the growth of the fish was varied in each treatment. The fish that was reared under shortened photoperiod (24D0L and 18D6L) shown better growth than fish that was reared under natural photoperiod (Co). By the 8th week, the fish reared under dark condition (24D0L) grew longer and heavier than the fish reared in natural photoperiod (Co). However, that fish was not different compared with fish reared in 18D6L. The fish reared in longer dark condition (24D0L and 18D6L) were >20 cm TL and 84.74–98.78 g BW (the SGR 5.39 – 5.52 and FCR 1.51 to 1.62) (Table 1). The growth of fish reared under natural photoperiod was lower, around 18.93 cm TL and 17.2 g BW (SGR 4.96 and FCR 1.77). This fact indicates that the 24D0L treatment was the best condition for rearing the fish (Figure 1, 2). Similar results were obtained in other nocturnal fish species such as Ompok hypophthalmus [15] and Clarias batractus [17], which indicate that the fish reared in dark condition growing faster than the fish reared in the longer light condition. In the salmonid fish that is categorized as diurnal fish, however, the long daylength stimulates growth [4]. These facts proof that photoperiod duration affects the physiological function of the fish.

Table 1. Total length and body weight of P. hypophthalmus reared under manipulated photoperiod.

| Treatments | Total length (cm) | Body weight (g) | SGR (%/day) | FCR |
|------------|-------------------|-----------------|--------------|-----|
| 24D0L      | 22.5 ± 1.84 abc   | 98.76 ± 6.54 *  | 5.51±0.35    | 1.52±0.05 a |
| 18D6L      | 20.95 ± 1.41 abc  | 84.73 ± 1.53 b  | 5.38±0.23    | 1.63±0.03 a |
| Control    | 18.95 ± 0.57 bc   | 71.61 ± 7.61 b  | 4.97±0.27    | 1.78±0.08 b |

Explanation:
- 24D0L: 24 hours of darkness;
- 18D6L: 18 hours of darkness
- Control: natural photoperiod.
- Mean with standard error followed by different letters are significantly different (P<0.05)
3.2. **Condition factor (K)**

During the research, the condition factor (K) of fish in all treatments were almost the same. The condition factor was almost steady. Before being treated, the K values of the fish around 1.00 and slightly increased into around 1.10 by the end of the experiment. Similar results were obtained by [3], who stated that the K value of *Pangasius pangasius* ranged from 0.85 – 1.30. The condition factor in fish serves as an indicator of physiological state of the fish in relation to its welfare [5]. The K value greater than 1 indicates that fish is in good general condition.

In this study, the K value of fish in all treatments ranged from 1.00 – 1.10, indicating that the fish was in good condition. In this research, the size of the fish by the 8th week was around 20 cm TL and in that time the fish was in early gonad developmental stage. Most of fish was in 1st or even undeveloped gonad stage and only few was in 2nd gonad development stage. As the K value is related to gonad development stage, the presence of undeveloped or early developed gonad stage may caused the lowness of the K value. The condition factor (K) are important to evaluate the way the species get resources from the habitat [11]. The value of the condition factor of fish in this recent study was normal and it indicates that the fish in all treatments lived in suitable environment and it means that the application of photoperiod manipulation did not affect the condition factor of the fish.

![Graph showing total length and body weight of P. hypophthalmus reared under manipulated photoperiod.](image)

**Figure 1.** Total length and body weight of *P. hypophthalmus* reared under manipulated photoperiod.

| Treatments | Condition Factor (K) |
|------------|----------------------|
|            | Pre treatment | 4th week | 8th week |
| 24D0L      | 1.00          | 1.03      | 1.10      |
| 18D6L      | 1.03          | 1.03      | 1.08      |
| Co         | 1.02          | 1.08      | 1.10      |

3.3. **Hepatosomatic Index (HSI)**

During the research, the liver condition of fish in all treatments were similar. The fingerlings that were dissected before being treated has fresh red liver color (RAL 3013). The liver was not oily and the texture was soft. This condition indicate that the liver was not been used for accumulating energy (fat) for the preparation of gonad development. As the fish was in juvenile condition, the energy intake may be allocated more for growing instead of being accumulated for reproductive activity preparation.

By the 8th week of treatment, the fish has already bigger and part of energy intake might be accumulated for the preparation of gonad development. The energy originated from feed consumed might be accumulated in the liver and served as energy stock for reproductive activities preparation [1]. Even though there was almost no increase in the HSI value, but the liver was getting bigger as the fish was also bigger, become brownish red color and its texture became more rubbery (Table 3). These facts indicate that the treated fish started to accumulate fat in the liver in order to fill the energy needed for gonad development once the fish reach the maturity size. The similarity of liver condition
in fish of all treatments indicate that the photoperiod manipulation do not negatively affects the energy accumulation in the liver.

**Table 3.** Liver condition of *P. hypophthalmus* reared under manipulated photoperiod.

| Treatments | Liver condition | Hepatosomatic Index |
|------------|-----------------|---------------------|
|            | Pre treatment   | 8<sup>th</sup> week |
| 24D0L      | Fresh red liver color (RAL 3013), non oily, soft texture | Brownish red liver color (RAL 3014), less oily, slight-rubbery texture | 1.00 | 1.03 |
| 18D6L      | Fresh red liver color (RAL 3013), non oily, soft texture | Brownish red liver color (RAL 3014), less oily, slight-rubbery texture | 1.03 | 1.03 |
| Co         | Fresh red liver color (RAL 3013), non oily, soft texture | Brownish red liver color (RAL 3014), less oily, slight-rubbery texture | 1.02 | 1.08 |

*Note:* The standard color used for explaining the liver color (Jotun paint standard color).

**Table 4.** The Visceralsomatic Index of *P. hypophthalmus* reared under manipulated photoperiod.

| Treatments | Visceralsomatic Index |
|------------|-----------------------|
|            | Pre treatment | 8<sup>th</sup> week |
| 24D0L      | 6.33          | 8.77           |
| 18D6L      | 6.33          | 7.00           |
| Co         | 6.04          | 6.63           |

3.4. *Visceralsomatic Index*

By the end of the experiment, the Visceralsomatic Index (VSI) of fish in all treatment were higher than those of the pre treatment, it ranged from 6.04 – 6.33 in the pre treatment fish and became 6.33 – 8.77 by the end of the 8 weeks of the experiment. The increment of the VSI value may caused by the accumulation of fat as energy saving for preparing the reproductive activities. Before the treatment, the viscera of the fish had less fat.

By the end of the experiment, however, whitish amount of fat was covering the viscera organs. The presence of this fat may increased the VSI value in general (Table 4). It is predicted that the VSI value will increase during the following weeks, as the energy accumulation is ongoing. The accumulation of fat is continuous until the fish reach the 3<sup>rd</sup> gonadal maturity [1]. After this stage, the energy will be used more for gonad development and the energy accumulated in the viscera is reduced. The VSI value of laboratory reared *Ompok hypophthalmus* increased up to 17 weeks of rearing and then reduced as gonad developed [10]. The decrement of the VSI value indicated that the energy accumulated had been used for gonad development.

In the fish that was reared under continuous dark condition, the VSI value was higher than those of fish reared in 18D6L and natural photoperiod (Control) in general. The fat accumulation in the fish’s
viscera may related to food intake [11] as well as fish activity [14]. *Ompok hypophthalmus* reared under dark condition shown less active in swimming and respons well toward food provided [14]. In another study, *P. hypophthalmus* mostly stay calmly in the water surface and they were rarely swimming and agresive in taking food offered under dark condition [17]. As the fish less active during dark condition, they may accumulate energy intake in the viscera instead of using it for swimming. The fish reared under natural photoperiod may spent more energy for swimming and less energy that was accumulated in the viscera.

3.5. Hepatosomatic Index
In the fish of all treatments, by the 8th week of the experiment, the gonads were not fully developed. Most of fish showing early developed gonad (stage 1) that was characterized by the presence of blood vessel in the gonad area and the gonad itself was small, transparent and thread-like form. In this stage, the sex of the fish can not be identified. In this stage, the gonad could not be taken nor weighed and the Gonadosomatic Index (GSI) could not be calculated.

Several fishes shown more advance gonad development. The gonads were slightly bigger than that of the stage 1 gonad, whitish colored for testes and creamy white with unclear tiny granules of oocytes for ovary. These fish might entred the 2nd maturity stage. In this stage, the gonad can be removed and weighed. The gonad condition and the GSI of the fish are presented in Table 5.

| Treatments | Number of fish | GSI of the 2nd maturity level |
|------------|----------------|-----------------------------|
|            | 1st maturity level | 2nd maturity level          |
| 24D0L      | 77.78% | 22.22% | 0.0058                      |
| 18D6L      | 66.67% | 33.33% | 0.0068                      |
| Co         | 33.33% | 66.67% | 0.0080                      |

Data presented in Table 5 indicate the gonad condition of fish in each treatment was slightly different. In the fish that was reared in 24 hours dark, the gonad of most fish was in the 1st maturity level (77.78%) and 22.22% of fish was in the 2nd maturity level. In the fish reared in 18D6L and the control fish that was reared under natural photoperiod, more fish was in the 2nd gonad development stage. These data indicate that the presence of fish with advance gonad development was positively related to the light duration. Light is a complex external and ecological factor whose components include color spectrum (quality), intensity (quantity) and photoperiod (periodicity) [4]. The gonad of fish reared under longer dark condition developed slower than that of the fish reared under longer light condition and the photoperiod is considered to be the most effective environmental factor in controlling the reproductive cycle of fish [6]. In this recent study, the fish reared under natural light condition (in Control) shown faster gonad development than that of the fish reared in 18 hours and 24 hours dark. Ths fact indicated that even though *P. hypophthalmus* is a nocturnal fish, but the lack of light may delay the gonad development.

4. Conclusion
Based on data obtained, it can be concluded that the manipulated photoperiod treatments affects the growth of fish, but it does not affect the morphoanatomy of *P. hypophthalmus* in general. The growth of fish reared in 24D and 18D was higher than that of the control, it reached more than 20 cm TL and 85 gr BW, and 18 cm TL and 72 gr BW in control fish. There were no difference in morphoanatomical characteristics of all the fishes treated, the liver was reddish brown color, smooth and oily in which hepatosomatic index (HSI) value 0.023 in 24D; 0.027 in 18D and 0.048 in control. The visceralsomatic index (VSI) was 0.090 in 24D; 0.70 in 18D and 0.161 in control. However, the gonad development of the treated fishes was slower compared to fish reared under natural photoperiod. In most of fishes
reared in 24D and 18D, the gonad were in the 1st maturity stage (gonadosomatic index; GSI 0.0058 to 0.0068), while the gonad of some control fishes were in the 2nd maturity stage (GSI 0.0080).

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References
[1] Affandi R, Heltonika B and Supriatna I 2017 Jurnal Iktiologi Indonesia 11 2 p 195-200
[2] Aquaculture Stewardship Council 2017 Better Management Practices for Pangasius. WWF https://www.asc-aqua.org/wp-content/uploads/2017/07/ASC-Pangasius-Better-Management-Practices_v1.01.pdf
[3] Deka P and Gohain A B 2015 International Journal of Fisheries and Aquatic Studies 3 1 p 162- 4
[4] Gilles B and Falcón J 2010 Vie et Milieu 51 4 p 247-266
[5] Le-Cren E D 1951 J Anim Ecol 20 p 201-219.
[6] Lee C H, Park Y J and Lee Y D 2021 Chromis notate. Dev. Reprod. 21 2 p 223- 8
[7] Lubis S, Windarti, Riauwaty M 2018 Berkala Perikanan Terubuk. 46 3 p 58-68
[8] Magwa R J, Windarti and Siregar M R 2020 Jurnal Ruaya 8 2 p 104-113
[9] Pratiwi L, Windarti dan Syafriadiiman 2020 Jurnal Ruaya 8 2 p 86-98
[10] Rahmitasari M, Windarti dan Sukendi 2017 Berkala Perikanan Terubuk, 45 1 p 112-124
[11] Rizzo E and Bazzoli N 2020 Biological Indices in Biology and Physiology of Freshwater Neotropical Fish. https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/hepatosomatic-index
[12] Sasry A M, Supono and Wardiyanto 2020 e-Jurnal Rekayasa dan Teknologi Budidaya Perairan 9 1 p 1076-84
[13] Sihombing CUA, Fauzi M and Windarti. 2021 Depik 10 2 p 98-102
[14] Syafri R, Efizon D and Windarti 2016. Behavior of Ompok hypophthalmus reared under different photoperiod. Jurnal Online mahasiswa Fakultas Perikanan dan Ilmu Kelautan Universitas Riau Pekanbaru 3 2 p1-8
[15] Windarti, B. Heltonika, 2016. Manipulasi fotoperiod untuk memicu pematangan gonad pada ikan selais (Ompok hypophthalmus). Laporan Penelitian. Lembaga Penelitian Universitas Riau. Tidak diterbitkan
[16] Windarti, RM Putra, D. Efizon, Efawani, Eddiwan, N. Safrina 2018 Ketrampilan Dasar Laboratorium Biologi Perairan (Pekanbaru: UNRI Press)
[17] Windarti, Riauwaty M, Putra R M and Simarmata A H 2019 ICFAES 2019 IOP Conf. Series: Earth and Environmental Science 348 (2019) 012050
[18] Windarti, Amin B and Simarmata A H 2021a IOP Conf. Ser.: Earth Environ. Sci. 695 012011
[19] Windarti, Amin B and Simarmata A H 2021b F1000Research 10 154