Length-Weight Relationship and Relative Condition Factor of the Kissing Gourami (Helostoma temminckii) from Sungai Batang River, Indonesia

by Ahmadi .

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Abstract

The length-weight relationship and relative condition factor of the Kissing Gourami (*Helostoma temminckii*) from Sungai Batang River, Indonesia were investigated. The fish were collected using *tempirai* (bamboo stage-trap), *lukah* (portable trap), and *hancau* (hand liftnet). A total of 120 males and 86 females (55-190 mm total length and 4-109 g weight) were analyzed using SPSS-16 software. There was no significance difference in the total length between sexes ($P>0.05$). However, female had body depth, body weight, the W/TL ratio and relative condition factor greater than male ($P<0.05$). About 27% of total catch falls within the range of 120 and 129 mm TL. The heaviest catch (30.83%) weighed between 30 and 49 g. The W/TL ratio of *H. temminckii* female in the present study was higher than *H. temminckii* species from other different geographical areas. The fish grew negatively allometric (b = 2.78-2.90). Outcomes of this study could be useful for fisheries management and conservation measures in this river.

Key words: Allometric, *Helostoma temminckii*, length-weight, relative condition factor, and Sungai Batang

1. Introduction

Like other freshwater fish species, the Kissing Gourami (*Helostoma temminckii*) belongs to family Helostomatidae are also widely distributed and commercially sold particularly in Southeast Asia (Vidthayanon, 2012). It beneficially supports fish farming, aquarium fish industry and recreational fishing activities. It can be found in rivers, wetlands, peat forest and swamps (Fahmi-Ahmad, Rizal, & Amirrudin, 2015; Thornton, Dudin, Page, Upton, & Harrison, 2018), and can tolerate low dissolved oxygen (DO) and pH. It can also be cultured in the earthen pond, and the best growth is achieved during the 9-month culture period, the body weight increases ranged from 46 to 123% (Zohrah & Haji Kasim, 2002). Pollution, overfishing and wetland conversion may potentially threaten to this species (Umbamnata, Diantari, & Hasani, 2015).

Numerous studies on *H. temminckii* have been dedicated to describe for example, visual sensitivity (Sakai, Wang, & Naka, 1995), hearing ability (Yan, 1998), meristic and morphometric characteristics (Muryati, Putra, & Efizon, 2016), genetic diversity (Arifin, Cahyanti, & Kristanto, 2017a), 'kissing behavior' (Ferry, Konow, & Gibb, 2012), skin color changes (Kopecký, Král, Čurlej, & Mrázová, 2012), food and feeding habits (Prianto, Husnah, Nurdawaty, & Asyari, 2016; Asyari, 2007), functional morphology of the head (Liem, 1967) and fishing activity (Thornton *et al*., 2018), as well as overview of aquaculture technology for this species (Yurisma, 2009). 7 To manage the *H. temminckii* fishery resource rationally, it is therefore needed in-depth knowledge of its biology, feeding habit and ecology (Khairul Adha *et al*., 2009). 10 The length-weight relationship is commonly used for analyzing growth pattern, condition factor, survival, maturity and reproduction of various fish species from different geographical areas (23 Asadi, Sattari, Motalebi, Zamani-Faradonbeh, & Gheytasi, 2017; Buragohain, 2018), and advanced techniques for morphometric analysis was recently presented (Mojekwu & Anumudu, 2015).

The Kissing Gourami locally is called *Tambakan* or *Biawan* (Figure 1). They are being caught from the river/swamp using different types of fishing gears such as *lukah* (portable trap), *tempirai* (bamboo stage-trap) and *hancau* (hand liftnet). ***Lukah*** is an elongated tube-shaped made of bamboo (150 cm) diameter of 20 cm containing one entry funnel mounted on the inside of conical-shape and tapering inside to about 2.5 cm, called 4 *hinjap* (one-way valve, made of elastic rattan; about 40 cm one to other), and containing one exclusion funnel at the opposite side. Thus, fish can enter easily but it is difficult to escape.

Tempirai is made of heart-shaped bamboo, 52 cm high, 37 cm width, and 5 cm wide opening of the entrance slit. A small trap door on the top allowed for removal of catches. ***Hancau*** is consisted of *tampuatar* (4 m long bamboo), *rangau* (bamboo lath of 175 cm, diameter of 2 cm for connecting between nets) and *tabulilingan* (buffer). The net size is about 1.5 m^2 with 15 mm mesh size. There is no published literature on fisheries and aquaculture of *H. temminckii* particularly in Sungai Batang River. For this reason, we investigated the length-weight relationship and condition factor of the fish to provide some fundamental suggestions for better fisheries management.

2. Materials and Methods

The research was conducted in Sungai Batang River, Martapura of South Kalimantan Province (Figure 2), located on 03°22'36 S and 114°49'29 E, determined by GPS-60 Garmin, Taiwan. The river supports the local economic activities such as fishery, agriculture and irrigation. The village consists mostly of wetland area with water level fluctuation between 0.5 and 2 m.

A total of 206 individuals of *H. temminckii* comprising 120 males and 86 females were directly collected from local fishermen who living in Sungai Batang village in the early morning and purchased periodically every two weeks during April to May 2018. However, we cannot distinguish the catch based on the three types of fishing gear used because the fish sold were mixed. As a result, no additional data about the catch per unit effort were presented in this study. Fish were identified for sex, and measured for total length (TL) and body depth (BDD) and weight (W). The total length was taken from the tip of the snout to the extended tip of the caudal fin, while body depth was measured from the dorsal fin origin vertically to the ventral midline of the body using a ruler to the nearest mm. The whole body weight was determined with a digital balance to an accuracy of 0.01 g (Dretec KS-233, Japan). The length-weight size distribution of fish sampled was set at 10-interval class, and was stated in percent. The length-weight relationship of fish was expressed in the allometric form (Froese, 2006):

$$W = aL^b \quad (1)$$

The length-weight relationship of fish can also be represented in logarithmic equation:

$$\text{Log } W = \text{Log } a + b \text{ Log } L \quad (2)$$

Where: W is the weight (g), L is the total length (mm), *a* is the constant showing the initial growth index and *b* is the slope showing growth coefficient. The *b* exponent with a value between 2.5 and 3.5 is used to describe typical growth dimensions of relative wellbeing of fish population (Bagenal, 1978). The analysis of covariance (ANCOVA) was applied for checking any difference between male and female in term of growth pattern. The statistical significance of the isometric exponent (*b*) was analyzed by a function (Sokal & Rohlf, 1987):

$$t_s = (b-3) / S_b \quad (3)$$

Where t_s is the t student statistics test value, *b* is the slope and S_b is the standard error of the slope. The obtained value of t-test was compared to the respective critical value to determine the *b* value statistically significant and its inclusion in either isometric or allometric range. The *b* value has an important biological meaning; if fish retains the same shape, it grows increase isometrically (b=3). When weight increases more than length (b>3), it shows positively allometric. When the length increases more than weight (b<3), it indicates negatively allometric (Hossain *et al*., 2006). Determination coefficient (R^2) and regression coefficient (r) of morphological variables between male and female were also computed. The condition factor of fish was estimated using the following formula (Weatherley & Gill, 1987):

$$K = 100(W/L^3) \quad (4)$$

Where K is the Fulton's condition factor, L is total length (cm) and W is weight (g). The factor of 100 is used to bring K close to a value of one. Relative condition factor (K_n) was also further estimated by following Le Cren (1951) formula:

$$K_n = W/\hat{W} \quad (5)$$

Where K_n is relative condition factor, W is the observed weight and ^W is the calculated weight derived from length-weight relationship. The metric indicates that the higher the K value the better the condition of fish. The K value is used in assessing the health condition of fish of different sex and in different seasons. In addition, the t-test was employed to compare the body sizes and condition factor of male and female. All tests were analyzed at the 0.05 level of significance using SPSS-16 software.

3. Results

All estimated length-weight relationship parameters and the ratio of body sizes of *H. temminckii* collected from Sungai Batang River are presented in Tables 1-3. The body size of male (n = 120) ranged of 60-155 mm TL (108.11 ± 18.60 mm) and 4-84 g weight (28.25 ± 13.26 g). While the body size of female (n = 86) ranged of 55-190 mm TL (113.98 ± 25.53 mm) and 4-109 g weight (36.09 ± 21.76 g), with the ratio of male to female was 1.4 : 1.0.

Significant differences were observed at length-weight relationship of male and female (Figure 3A), while *b* values implied that the body shape displays a negative allometric growth pattern ($b<3$), which means that the length increases more than weight. The estimated *b* values in the WLR equations were 2.78 for male and 2.90 for female; with the R^2 values ranged from 0.915 and 0.952 indicating that more than 95% of variability of the weight is explained by the length. The index of correlation (r) of male and female were 0.956 and 0.976, found to be higher than 0.5, showing the length-weight relationship is positively correlated. Statistical analysis showed that female had body depth and body weight greater than male ($P<0.05$), but no significant difference was observed in the total length between female and male ($P>0.05$). Figure 3B clearly demonstrates that the mean ratio of body weight to total length of female was considerably higher than that of male ($P<0.001$). The ratio of

W/TL for male ranged from 0.067 to 0.542 (0.25 ± 0.08), while for female varied from 0.070 to 0.617 (0.29 ± 0.12). The descriptive statistics and estimated parameters of length-weight relationship and relative condition factor of *H. temminckii* are given in Table 2. As described in Table 3, the R^2 values were found between 0.814 and 0.895 indicating that more than 80% of variability of the ratio is elucidated by the length. The 'r' values of male and female were 0.902 and 0.946, found to be higher than 0.5, showing the ratio relationship is highly correlated. The increased of body depth was directly proportional to total length (Figure 4A). The exponent values obtained from the equation curve were 0.98 for male and 1.07 for female. There was no significance difference in the mean ratio of body depth to total length between male and female ($P>0.05$) (Figure 4B). The ratio of BDD/TL for male ranged from 0.219 to 0.471 (0.40 ± 0.03), while for female varied from 0.219 to 0.492 (0.41 ± 0.04).

The size distribution of *H. temminckii* samples in the present study is displayed in Figure 5. The highest number of catch was distributed between 130 and 149 mm TL (22.06%) for male and between 140 and 149 mm TL (30.00%) for female. A low number of catch was observed for larger size class more than 150 mm TL. The heaviest catches of male (19.12%) and female (23.33%) weighted between 25 and 34 g. Regardless the sex, we observed that there was a difference in the exponent value for smaller length class as compared to larger ones indicating that the species has two growth levels (Figure 6). The smaller individuals (< 115 mm TL) grew with the exponent lower than the cubic value ($W = 0.00003\ TL^{2.93}$, $R^2 = 0.961$). While the larger individuals (≥ 115 mm TL) grew with exponents being equal to the cubic value ($W = 0.00002\ TL^{3.03}$, $R^2 = 0.969$). It is indicating that more than 96% of variability of the fish growth is explained by the length. The condition factor (K) value of female was significantly higher than that of male ($P<0.001$). The mean K values obtained ranged from 1.66 to 2.55 (2.15 ± 0.16) for male and from 1.37 to 2.50 (2.08 ± 0.14) for female. Further analysis also visibly showed that female had the relative condition factor (1.15 ± 0.15) greater than male (0.97 ± 0.14). The length based relative condition factor for male and female was plotted in Figure 7.

4. Discussion

The villagers greatly paid attention to *H. temminckii* fishery resource because fish have high economic value around IDR 30,000 per kg and they are typically considered slow-growing fish. Moreover, they are also vulnerable to destructive fishing practices. The other way, in Malaysia, Khairul Adha *et al*. (2009) found that *H. temminckii*, which formed a major part of the fish catch in the Bakong River and the Batang Kerang floodplain, was not favored by the local fishermen. The domination of this species may threaten the diversity of native species and spark competition for food, habitats, spawning, and refuge. Contrariwise, Azham Yahya, & Singh (2012) found none of *H. temminckii* in the Keniam River of Taman Negara Pahang, as well as *H. temminckii* in Agusan Marsh, the Philippines (Jumawan & Seronay, 2017) during the sampling periods. In addition, the genetic diversity among the generations of *H. temminckii* was low, with the percentage of polymorphism ranged from 6.45% to 35.48% and the value of heterozygosity ranged from 0.03 to 0.16 (Arifin *et al*., 2017a).

The maximum size (190 mm TL, 109 g) of *H. temminckii* in the present study was larger than those of *H. temminckii* collected from Bencah Kelubi swamp, Riau Province (155 mm, 88 g) (Muryati *et al*., 2017) and from Bukit Udal ponds, Malaysia (172 mm, 108 g) (Zohrah & Haji Kasim, 2002), but it was lower than maximum size of *H. temminckii* (277 mm, 358 g) from Bogor, West Java Province (Arifin, Cahyanti, Subagja, & Kristanto, 2017b). During fishing season, it is very likely to collect *H. temminckii* smaller than 55 mm TL and 4 g weight using the nets, but fishermen prefer release them back to the river rather than sold them with no or lower price, conversely the smaller fish might be untrappable because of fishing gear selectivity (Ahmadi & Rizani, 2013). The other way, it is also possible for fishermen to collect fish with the size larger than 190 mm TL (109 g weight) in the study;

however, it is beyond our investigation due to the transactional selling of fish is usually occurred in early mooring before the fish transported to the local market and it can be categorized as unreported fishing.

In the present study, *H. temminckii* grew negatively allometric, which is contrary to *H. temminckii* from Bawang Latak swamp in Lampung Province and Lubuk Lampam floodplain in South Sumatera Province (Ubamnata *et al*., 2015; Jubaedah, Kamal, Muchsin, & Hariyadi, 2016) those grew positively allometric. Meanwhile, *H. temminckii* sampled from Bencah Kelubi swamp in Riau Province (Muryati *et al*., 2016) were reported to have isometric growth pattern (b=3). Variation in slope may be attributed to sample size variation, life stages and environmental factors such as food and space (Jobling, 2008).

A trend for *H. temminckii* population growth was observed and there is critically low numbers of catch over 150 mm TL reflects a decline in larger stocks of *H. temminckii* in this river. It should be of concern to us to protect fishery resource against overfishing practices and environmental degradation. Considering the number of catch on the bar chart, the percentages of fish size distribution both length and weight was more visible in female than in male. We could find none of catch beyond 85 g weight classes particularly in male (see Figure 5). From the exponent values obtained, it can be expressed that *H. temminckii* female (b = 2.90) grow faster than male (b = 2.78). Such growth pattern was also well-documented in *H. temminckii* collected from Bawang Latak swamp in Lampung Province (Ubamnata *et al*., 2015). In case of the growth pattern, we found the exponent value for the larger individuals of *H. temminckii* (>140 mm TL) was 2.79. Compared to other fish species, this value was lower than the exponent value (3.15) for *M. cavasius* from Indus River, Pakistan observed at the maximum size of 148 mm (Muhammad, Iqbal, Bashir, & Hanif, 2017). It meant that such ontogenic variations in the cubic law differ from other fish species; however, a more detailed analysis regarding the reasons contributing to such variations is necessary.

There was a variability of the ratios of body weight to total length among *H. temminckii* species from different geographical areas. The ratio (W/TL) of *H. temminckii* female in the present study (1.845) was relatively higher than that of *H. temminckii* from Bukit Udal, Malaysia (0.630) (Zohrah & Haji Kasim, 2002) and from Bencah Kelubi swamp, Riau Province (0.565) (Muryati *et al*., 2016). While the ratio (W/TL) of *H. temminckii* male (0.574) was considerably lower as compared to those sampled from Bogor, West Java Province (1.309) (Arifin *et al*., 2017b). Regrettably, all studies mentioned above did not describe the length-weight relationship and condition factor of the fish to be compared.

As shown in Table 1, the mean K values obtained for male (2.08) and female (2.15) of *H. temminckii* in the present study was higher than those of *H. temminckii* from Bawang Latak swamp, Lampung Province (0.99) (Ubamnata *et al*., 2015), but considerably lower than *H. temminckii* from Bukit Udal, Malaysia (20.82) (Zohrah & Haji Kasim, 2002). Variation in the value of the mean K may be attributed to biological interaction involving intraspecific competition for food and space between species including sex, stages of maturity, state of stomach contents and availability of food (Sani *et al*., 2010; Vicentin, Costa, & Suarez, 2012). 'Condition', 'fatness' or well-being of fish expressed by relative condition factor (K_n), according to Bagenal & Tesch (1978) the heavier fish for a given length are in better condition. The mean K_n value of female (1.15 ± 0.15) in the present study was considerably higher than that of male (0.97 ± 0.14). It means that female grew faster and heavier than male under natural conditions.

Many active and passive fishing gears are being used for collecting *H. temminckii* from their natural habitats. In the investigated area, local fishermen used *lukah* (portable trap), *tempirai* (bamboo stage-trap), and *hancau* (hand liftnet); while other workers used the cast net in Sababila Lake, Barito Central Kalimantan (Prianto *et al*., 2006), the multi-mesh gillnet in Bukit Merah reservoirs, Malaysia (Mohd Shafiq *et al*., 2014), *tampirai, pangilar* and *buwu* in Sebangau River, Central Kalimantan (Thornton *et al*., 2018), portable traps in Lubuk Lampam Floodplain, South Sumatera Province (Jubaedah *et al*., 2016), *selambau* (filtering device) in Batang Kerang, Serawak (Khairul Adha *et al*., 2009), and *sero* (guiding barriers) in Bawang Latak swamp, Lampung (Ubamnata *et al*., 2015). Aminah & Ahmadi (2018) reported that the catchability of the gear is higher during the dry season compared to the wet season, because the fish are being concentrated on the sludge holes or shallow areas and allow for catching them easily. While Kamaruddin, Mustafa Kamal, Christianus, Daud, & Yu Abit (2011) found the opposite condition, with the reason is the wet season indicates the main feeding and growing time for the fish (Meye & Ikomi, 2012), and it is very likely to catch the fish. Variation in the catches may be attributed to the catchability of the gears, species target, fishing ground characteristic, fishing operation, and the abundance of the fish in that area (Ahmadi, 2018). There are two main constraints being faced in this area of study: the first, there is no daily record for *H. temminckii* catch in quantity (e.g. number, length and weight) because fishes are directly sold to traders or consumers in some places; and secondly, fishing activity is on-going throughout the year regardless of seasonal periods, thus resulted in the ratio of the fish exploitation rate to the fish growth rate in this river is still unpredictable. So, it is a great challenge for Marine and Fisheries Services of Banjar District to improve the quality of inland fishery statistical data.

5. Conclusion

H. temminckii sampled from Sungai Batang River grew negatively allometric. The present length-weight key for *H. temminckii* could be used to assess the stock population and aquaculture practices.

REFERENCES

Ahmadi & Rizani, A. (2013). Light traps fishing in Sungai Sipai flood swamp of Indonesia. Recommendations for future studies. *Kasertsart University Fisheries Research Bulletin*, *37*(2), 17-30

Ahmadi. (2018). The catching efficiency of light traps and morphometric characteristics of the native species from Barito River, Indonesia. *Ege Journal of Fisheries and Aquatic Sciences*, *35*(1), 63-72. DOI:10.12714/egejfas.2018.35.1.11

Arifin, O. Z., Cahyanti, W., & Kristanto, A. H. (2017a). Genetic diversity of three generations of kissing gourami (*Helostoma temminckii*) under a domestication program. *Jurnal Riset Akuakultur*, *12*(4), 295-305

Arifin, O. Z., Cahyanti, W., Subagja, J., & Kristanto, A. H. (2017b). Phenotype performance on male and female from second generation of domesticated Kissing gouramy (*Helostoma temminkii* Cuvier 1829). *Media Akuakultur*, *12*(1), 1-9

Asadi, H., Sattari, M., Motalebi, Y., Zamani-Faradonbeh, M., & Gheytasi, A. (2017). Length-weight relationship and condition factor of seven fish species from Shahrbijar River, Southern Caspian Sea basin, Iran. *Iranian Journal of Fisheries Sciences, 16*(2), 733-741

Asyari, E. (2007). Food habit of Biawan fish (*Helostoma temminckii*) at Sababila, Barito South Kalimantan. *Journal of Protein, 14*, 1-11.

Azham Yahya, M., & Singh, H. R. (2012). An assessment of the distribution of the freshwater fishes of the Taman Negara Pahang, Malaysia. IEEE Symposium on Business, Engineering and Industrial Applications, pp. 175-180. DOI: 10.1109/ISBEIA.2012.6422863

Bagenal, T. (1978). Methods for assessment of fish production in freshwaters. 3rd ed. Oxford: Blackwell Scientific Publication. Oxford, London, p. 365.

Bagenal, T. B., & Tesch, A. T. (1978). Conditions and growth pattern in fresh water habitats. Oxford: Blackwell Scientific Publications, p. 75-89.

Buragohain, A. (2018). Study of absolute fecundity of *Mystus carcio* (Hamilton, 1822) of Puthimari River (Hajo) of Kamrup (R) District of Assam, India. *International Journal of Zoology Study, 3*(2), 268-270

Fahmi-Ahmad, M., Rizal, S. A., & Amirrudin, B. A. (2015). Ichthyofaunal diversity of Tasek Bera Samsar site, Pahang, Peninsular Malaysia. *Journal of Wildlife and Parks, 30*, 27-43

Ferry, L. A., Konow, N., & Gibb, A. C. (2012). Are kissing gourami specialized for substrate-feeding? Prey capture kinematics of *Helostoma temminckii* and other anabantoid fishes. *Journal of Experimental Zoology, 9999A*, 1-9.

Froese, R. (2006). Cube law, condition factor and weight-length relationships: history, meta-analysis and recommendations. *Journal of Applied Ichthyology, 22*, 241-253. http://dx.doi.org/10.1111/j.1439- 0426.2006.00805.x

Hossain, M. Y., Ahmed, Z. F., Leunda, P. M., Jasmine, S., Oscoz, J., Miranda, R., & Ohtomi, J. (2006). Condition, length–weight and length–length relationships of the Asian striped catfish *Mystus vittatus* (Bloch, 1794) (Siluriformes: Bagridae) in the Mathabhanga River, southwestern Bangladesh. *Journal of Applied Ichthyology*, *22*, 304-307.

Irhamsyah, Ahmadi, & Rusmilyansari. (2017). Fish and fishing gears of the Bangkau Swamp, Indonesia. *Journal of Fisheries,* *5*(2), 489-496 DOI: http://dx.doi.org/10.17017/jfish.v5i2.2017.223

Jobling, M. (2008). Environmental factors and rates of development and growth. In P. J. Hart, & J. D. Reynolds (Eds.), *Hand book of fish biology and fisheries: Vol.1. Fish Biology* (pp. 97-122). Oxford: Blackwell Publishing Ltd.

Jubaedah, D., Kamal, M. M., Muchsin, I., & Hariyadi, S. (2016). The Trophic status of the Lubuk Lampam floodplain in South Sumatera, Indonesia. *Makara Journal of Science, 20*(2), 61-70. doi: 10.7454/mss.v20i2.5949

Jumawan, J. C., & Seronay, R. A. (2017). Length-weight relationships of fishes in eight floodplain Lakes of Agusan Marsh, Philippines. *Philippine Journal of Science*, *146*(1), 95-99

Kamaruddin, I. S., Mustafa Kamal, A. S., Christianus, A., Daud, S. K., & Yu Abit, L., (2011). Fish community in Pengkalan Gawi - Pulau Dula Section of Kenyir Lake, Terengganu, Malaysia. *Journal of Sustainability Science and Management, 6*(1), 89-97.

Khairul Adha, A. R., Daud, S. K., Siraj, S. S., Arshad, A., Esa, Y., & Ibrahim, E. R. (2009). Freshwater fish diversity and composition in Batang Kerang Floodplain, Balai Ringin, Sarawak. *Pertanika Journal of Tropical Agricultural Science, 32*, 7-16.

Kopecký, J., Král, M., Čurlej, J., & Mrázová, L. (2012). Influence of Astaxanthin and β-carotene on Kissing Gourami (*Helostoma temminckii*) Colouring. Scientific Papers: *Animal Science and Biotechnologies, 45*(2), 57-60

Lawson, E. O. (2011). Length-weight relationships and fecundity estimates in mudskipper *Periophthalmus papilio* (Bloch and Schneider, 1801) caught from the mangrove swamps of Lagos Lagoon, Nigeria. *Canadian Journal of Fisheries and Aquatic Scienc*es, *6*, 264-271.

Le Cren, E. D. (1951). The length-weight relationship and seasonal cycle in gonad weight and condition in the Perch (*Perca fluviatilis*). *Journal of Animal Ecology, 20*(2), 201-219.

Liem, K. F. (1967). Functional morphology of the head of the anabantoid teleost fish *Helastoma temmincki*. *Journal of Morphology, 121*, 135-157.

Meye, J. A., & Ikomi, R. B. (2012). Seasonal fish abundance and fishing gear efficiency in River Orogodo, Niger Delta, Nigeria. *World Journal of Fish and Marine Sciences, 4*(2), 191-200.

Mohd Shafiq, Z., Amir shah Ruddin, M. S., Zarul, H. H., Khaled, P., Syaiful, M., & Wan Maznah, W. O. (2014). The effect of seasonal changes on freshwater fish assemblages and environmental factors in Bukit Merah reservoir (Malaysia). *Transylvanian Review of Systematical and Ecological Research, 16*(1), 97-108.

Mojekwu, T. O., & Anumudu, C. I. (2015). Advanced techniques for morphometric analysis in fish. *Journal of Aquaculture Research and Development, 6*, 354. doi:10.4172/2155-9546.1000354

Muhammad, H., Iqbal, Z., Bashir Q., & Hanif, M. A. (2017). Length weight relationship and condition factor of catfish species from Indus River, Pakistan. *Punjab University Journal of Zoology*, *32*(1), 35-38.

Muryati, S., Putra, R. M., & Efizon, D. (2016). A Study on morphometric and meristic of *Helostoma temminckii* from swamp area in the Bencah Kelubi Village, Tapung Kiri Sub-Regency, Kampar Regency, Riau Province. *Jurnal Online Mahasiswa Fakultas Perikanan dan Ilmu Kelautan Universitas Riau*, *3*, 1-10.

Prianto, E., Husnah, Nurdawaty, S., & Asyari. (2016). Food habit of Biawan fish (*Helostoma temminckii*) at Sababila, Barito South Kalimantan. *Jurnal PROTEIN*, *14*(2), 161-166

Sani, R., Gupta, B. K., Sarkar, U. K., Pandey, A., Dubey, V. K., & Lakra, W. S. (2010). Length–weight relationships of 14 Indian freshwater fish species from the Betwa (Yamuna River tributary) and Gomti (Ganga River tributary) rivers. *Journal of Applied Ichthyology, 26*(3), 456-459. DOI: 10.1111/j.1439-0426.2009.01388.x

Sakai, H. M., Wang, J. L., & Naka, K. (1995). Contrast gain control in the lower vertebrate retinas. *The Journal of General Physiology*, *105*(6), 815-835. http://doi.org/10.1085/jgp.105.6.815

Sokal, R. R., & Rohlf, F. J. (1987). Introduction to biostatistics. 2nd edn. New York: F.H. Freeman Publication and co., 363 p.

Thornton, S. A., Dudin, Page, S. E., Upton, C., & Harrison, M. E. (2018). Peatland fish of Sebangau, Borneo: diversity, monitoring and conservation. *Mires and Peat, 22*(4), 1-25. DOI: 10.19189/MaP.2017.OMB.313

Ubamnata, B., Diantari, R., & Hasani, Q. (2015). Growth study of fish Tembakang (*Helostoma temminckii*) in Rawa Bawang Latak Tulang Bawang, Lampung. *Jurnal Penelitian Pertanian Terapan, 15*(2), 90-99.

Vicentin, W., Costa F. E. D. S., & Suarez, Y. R. (2012). Length-weight relationships and length at first maturity for fish species in the upper Miranda River, southern Pantanal wetland, Brazil. *Journal of Applied Ichthyology, 28*(1), 143145. DOI: 10.1111/j.1439-0426.2011.01890.x

Vidthayanon, C. (2012). *Helostoma temminckii*. The IUCN Red List of Threatened Species 2012: e.T181326A1722150. http://dx.doi.org/10.2305/IUCN.UK.2012-1.RLTS.T181326A1722150.en. Downloaded on 6 December 2018.

Weatherley, A. H., & Gill, H. S. (1987). The biology of fish growth. London: Academic Press, 443 p.

Yan, H. Y. (1998). Auditory role of the suprabranchial chamber in gourami fish. *Journal of Comparative Physiology A, 183*, 325-333

Yurisma. (2009). The influence of injection ovaprim by different dosage to ovulation and hatching of Tambakan (*Helostoma temminckii* C.V). *Jurnal Perikanan Terubuk, 37*(1), 68-85.

Zohrah, H. S., & Haji Kasim, H. D. (2002). Pond aquaculture of Kissing gourami *Helostoma temminckii* (Pisces: Helostomatidae) in Bukit Udal, Tutong. A preliminary investigation. *Bruneiana: Anthology of Science Articles, 3*, 34-41.

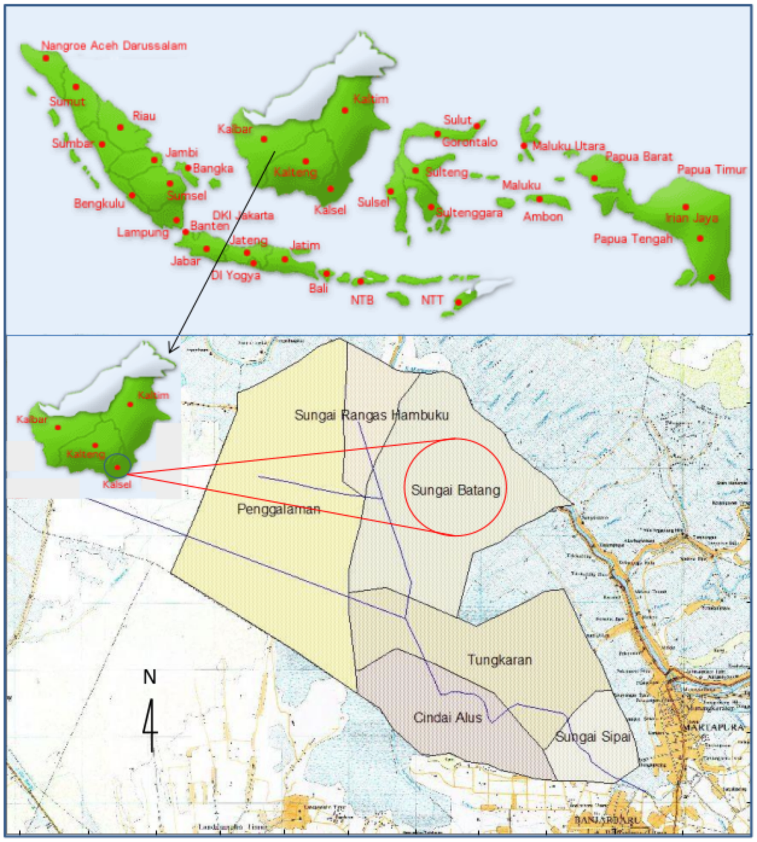

Figure 1. The location of sampling site in Sungai Batang River, Indonesia

Figure 2. A fish sample of *H. temminckii* from Sungai Batang River.

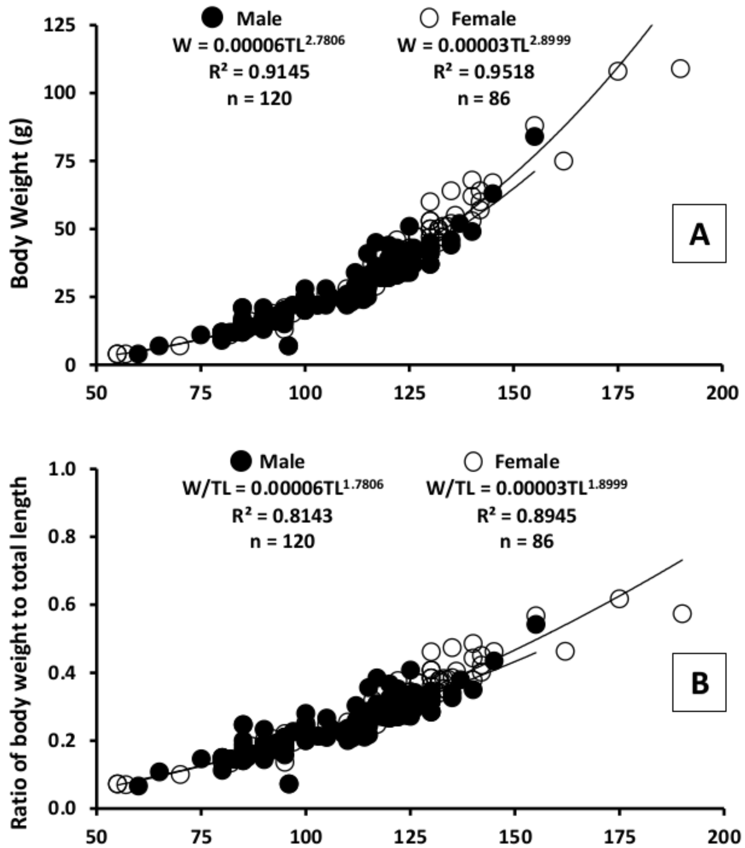

Figure 3. [**A**]. *H*. *temminckii* grew negatively allometric. [**B**]. Female had the ratio (W/TL) value greater than male.

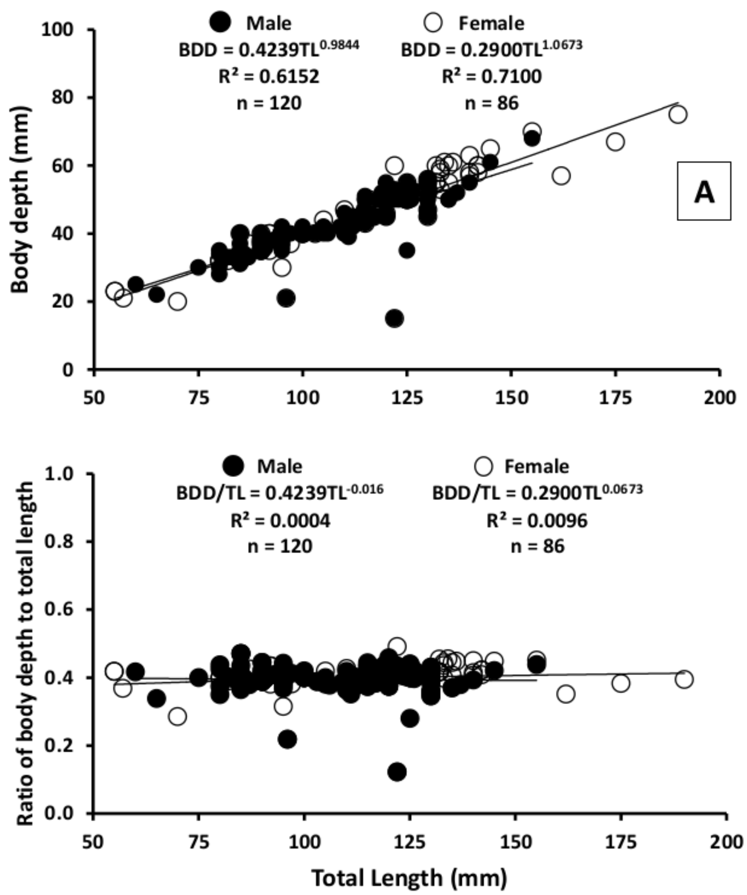

Figure 4. [**A**]. The body depth of *H. temminckii* increases proportionally to the total length. [**B**]. No significant difference in the ratio (BDD/TL) values between male and female was observed.

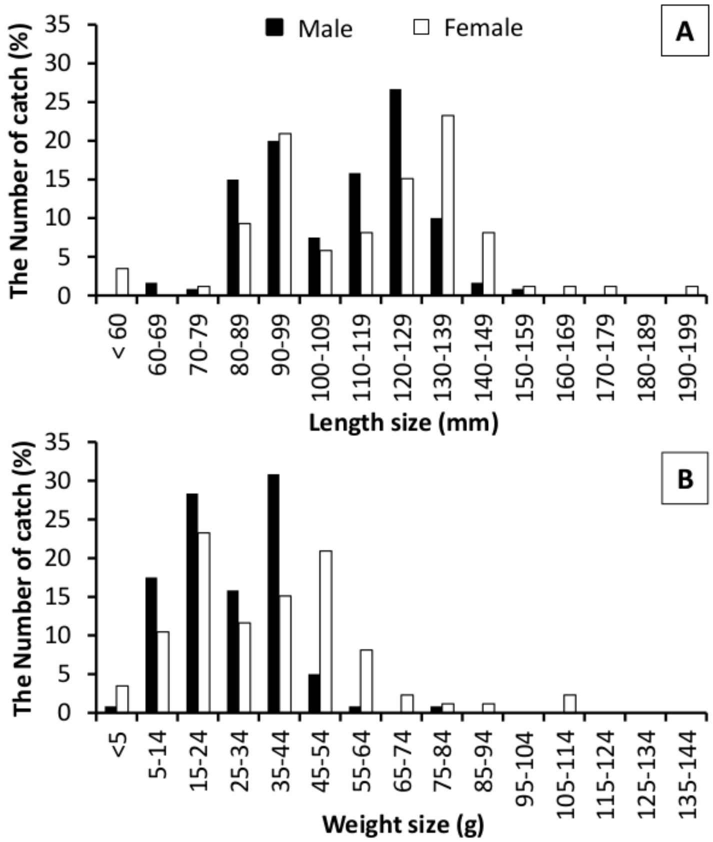

Figure 5. The length size [A] and weight size [B] distribution between male and female of *H. temminckii* taken from Sungai Batang River.

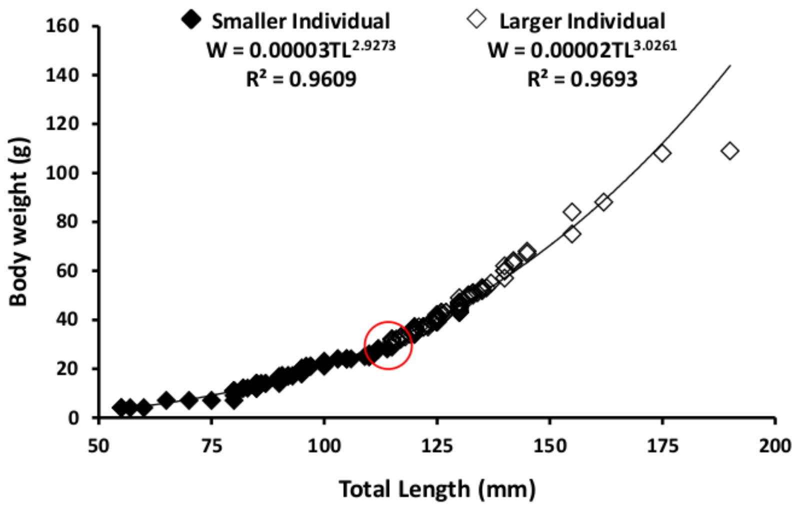

Figure 6. The circle mark on the curve indicates the intersection points of smaller (<115 mm TL) and larger individuals (≥115 mm TL) of *H. temminckii*

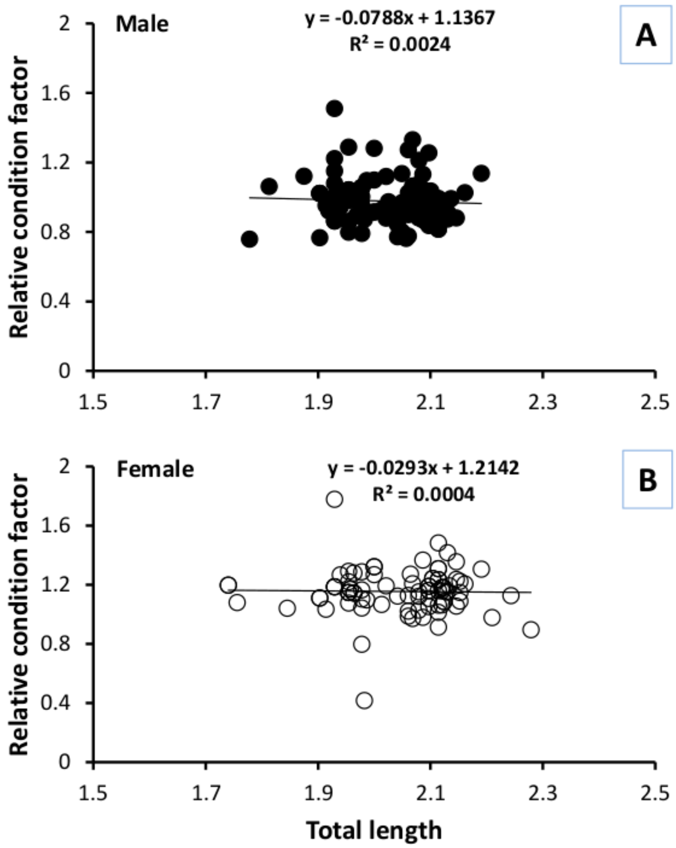

Figure 7. Relationship between total length and relative condition factor of *H. temminckii*. Female had the relative condition factor greater than male (Kn = B>A).

Table 1. The body sizes, growth parameters and relative condition factor of *H. temminckii* collected from Sungai Batang River.

Sex	n	Total length (mm)			Weight (g)			a	b	R^2	r	Growth pattern	K	Kn
		Min	Max	Mean ± SD	Min	Max	Mean ± SD						Mean ± SD	Mean ± SD
Male	120	60	155	108.11 ± 18.60	4	84	28.25 ± 13.26	0.00006	2.78	0.915	0.956	A-	2.08 ± 0.14	0.97 ± 0.14
Female	86	55	190	113.98 ± 25.53	4	109	36.09 ± 21.76	0.00003	2.90	0.952	0.976	A-	2.15 ± 0.16	1.15 ± 0.15

a = constant, b = exponent, R^2 = determination coefficient, r = regression coefficient, A- = negative allometric, K = condition factor, Kn = relative condition factor

Table 2. Descriptive statistic of length-weight relationship and relative condition factor of *H. temminckii* samples

Sex	n	Log L	Log W	Logarithmic equations	a	b	R^2	r
Male	120	2.03 ± 0.08	1.40 ± 0.23	y = 2.7806x - 4.2386	-4.237	2.78	0.915	0.956
Female	86	2.05 ± 0.10	1.47 ± 0.31	y = 2.8999x - 4.4652	-4.465	2.90	0.952	0.976
Sex	n	Log L	Log BDD	Logarithmic equations	a	b	R^2	r
Male	120	2.03 ± 0.08	1.62 ± 0.08	y = 1.0234x - 0.4478	-0.448	1.02	0.806	0.898
Female	86	2.05 ± 0.10	1.65 ± 0.12	y = 1.0887x - 0.5758	-0.576	1.09	0.869	0.933
Sex	n	Log L	Kn	Logarithmic equations	a	b	R^2	r
Male	120	2.03 ± 0.08	0.98 ± 0.13	y = -0.0788x + 1.1367	1.137	-0.08	0.002	0.049
Female	86	2.04 ± 0.10	1.15 ± 0.15	y = -0.0293x + 1.2142	1.214	-0.03	0.000	0.020

a = constant, b = exponent, R^2 = determination coefficient, r = regression coefficient, Kn = relative condition factor

Table 3. The ratio of body sizes of *H. temminckii* sampled from Sungai Batang River

Sex	n	BDD/TL	a	b	R^2	r	W/TL	a	b	R^2	r
Male	120	0.40 ± 0.04	0.4239	-0.02	0.000	0.020	0.25 ± 0.08	0.00006	1.78	0.814	0.902
Female	86	0.40 ± 0.05	0.2900	0.07	0.010	0.098	0.29 ± 0.12	0.00003	1.90	0.895	0.946

a = constant, b = exponent, R^2 = determination coefficient, r = regression coefficient, BDD = body depth, W = body weight, TL = total length

Length-Weight Relationship and Relative Condition Factor of the Kissing Gourami (Helostoma temminckii) from Sungai Batang River, Indonesia

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