Morphometric Characteristic and Condition Factor of Snakeskin Gourami (Trichogaster pectoralis) from Sungai Batang Swamp, Indonesia

by Ahmadi .

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Ahmadi

Faculty of Marine and Fisheries, Lambung Mangkurat University, Indonesia
Tel.: +62-81298471995. E-mail: ahmadi@ulm.ac.id

Abstract: The Snakeskin gourami (*Trichogaster pectoralis*) from Sungai Batang swamp, Indonesia has high commercial value and high pressure on population caused by fishing, while the fish growth condition is poorly studied. Samples of 848 fishes having size range of 75-200 mm (119.14±18.43 mm) total length (TL) and 5-132 g (29.76±14.76 g) weight were taken to estimate its length-weight relationship and condition factors. Local fishermen mostly collected them by using *Lalangit* (horizontal gillnet) and also electrofishing. The Snakeskin gourami grew allometrically (b=2.7748-2.8971), indicating that fish becomes slender as the length increases. Total length and weight of female were significantly higher than those of male (P<0.001). More than 21% of total catch was found between 105 and 114 mm TL, and more than 34% existed between 15 and 24 g weight classes. No statistical difference was observed in the percentage of catch number between male and female, as well as in condition factor (K) value of species (P>0.05). The mean K values obtained for male and female were 1.64±0.24 and 1.66±0.21, indicating that fish in the swamp was good condition. Outcomes of this study could be useful for fisheries management and conservation measures in this swamp.

Keywords: Allometric, condition factor, Snakeskin gourami, Sungai Batang, weight-length.

Introduction

Trichogaster pectoralis Regan 1910, commonly known as Siamese gourami or Snakeskin gourami, is one of economically important freshwater fish species due to a great taste and flavor, high price and availability throughout the year. The fish is either sold alive or in salted form, while the Dwarf gourami *Trichogaster lalius* is traded as ornamental fish (Awasthi et al. 2015). In Indonesia and Malaysia, it is locally called "Sepat Siam" (Fig. 1) while in Thailand it is known as "pla-salid". Paepke (2009) gives the native range as southern Viet Nam, Lao PDR, Thailand, the Malay Peninsula, and Myanmar. This species has been introduced widely to other countries e.g., Indonesia, the Philippines, Southern China (Hong Kong), Sri Lanka and elsewhere. This species can be found in marshlands, swamps and peatlands, and occasionally in running waters as well as in impounded and man-made water bodies, but it does not tolerate polluted waters (Vidthayanon 2012). It is adapted to low oxygenated waters, being able to breathe air in a similar way to Climbing perch and Snakehead because of having labyrinth organ (Tate et al. 2017). It is also more tolerant to high salinities up to 23 psu (Arenas & Acero 1992). As a Root grazer fish, it can be used to control *Eichhornia crassipes* population (Ismail et al. 2018). This species is successfully cultured in paddy field (Ali 1990; Vromant et al. 2001), in the earthen pond (Boonsom, 1984), in fish farm (Yoonpundh & Little 1997; Tansatit et al. 2014) and in the blue tank (Ninwichian et al. 2018). At the same time, culture strategies for Snakeskin gourami are also being developed (Chesoh et al. 1995; Baishya et al. 2012; Lee et al. 2016; Jintasataporn & Chumkam 2017; Ninwichian et al. 2018), as well as conservation measures for this species (Wijeyaratne & Perera 2000; Morioka 2018). Nevertheless, the use of potassium and electricity, indiscriminate fishing, pollution in wetlands, infrastructure development and wetland clearance impact the species (Vidthayanon 2012; Hossain et al. 2015).

Several works on biological and physiological characteristics of *T. pectoralis* have been broadly reported. Amornsakun et al. (2004) stated that Siamese gourami has high fecundity and has the fertilized eggs diameter been similar to Climbing perch but smaller than Red-tail catfish. Hails and Abdullah (1982) observed oocyte distribution in selected ovaries and concluded that *T. pectoralis* was a total spawner, although a batch of ripe oocytes may be released over an extended period of time. Ninwichian et al.

(2018) reported that *T. pectoralis* reared in blue tanks had a significantly higher average final body weight and significantly lower average feed conversion ratio than the fish reared in black tanks. The use of a blue tank resulted in normal skin color and not affects the customer acceptance of the fish. For bionomic considerations, Chesoh et al. (1995) suggested that it is suitable to nurse Snakeskin gourami fingerling from the size 1 to 2 inches in cement tanks with the stocking density of 100 fish/square meter. Tan et al. (1980) found evidence for polymorphism in the liver esterase of "Sepat Siam" that could be useful for genetic markers. In addition, like other fish species (e.g. Snakehead, Nile tilapia), Snakeskin gourami is also susceptible to virus or parasites infection (Paperna et al. 1987; Tansatit et al. 2014).

Length-weight data on fishes are useful to biologists for a variety of purposes. The data presented are especially valuable because they are derived from measurements of fishes taken from all types of natural body waters (e.g. rivers, lakes, swamps, reservoirs, estuaries) over a period of time. They can be considered typical average weights of that species for each of the given lengths. The length-weight relationship is the most common scientific approach that used for analyzing growth or morphometric for an individual species of Snakeskin gourami (Kalita et al. 2016; Jumawan & Seronay 2017), as well as for understanding survival, maturity and reproduction (Satrawaha & Pilasamorn 2009; Paswan et al. 2012) of various species from different geographical regions. It is also useful in local and interregional, morphological and life historical comparisons in species and populations (Rahim et al. 2009; Khan et al. 2012). Ghorbani et al. (2012) stated that the fish length is the best indicator of production efficiency, while Lawson (2011) reported that fecundity may increase with increased body size in fish. Studies on length-weight relationships of threatened and commercially important fish species are highly significant for management and conservation of populations in natural waterbodies (Khan et al. 2011).

Fishing activity for Snakeskin gourami in Sungai Batang swamp is open throughout the year regardless of seasonal periods, which is done by both villagers and beyond using various fishing gears. Although prohibited by the law, electrofishing is still being used for collect them because it is considered as a fast and easy way to earn money. It is about behavioral change; if it is allowed it will affect to ecosystem and socio-economic as the whole. Meanwhile, baseline information on the fish growth and exploitation rates is not available. We carried out the field survey by collecting Snakeskin gourami samples from local fishermen and investigating the length-weight relationship and condition factor of fish to provide some fundamental suggestions for better fisheries management and conservation of this species.

Materials and methods

Study site: The research was carried out in Sungai Batang swamp, Martapura of South Kalimantan Province (Fig. 2), located on 03°22' S and 114°49' E, determined by GPS-60 Garmin, Taiwan). The village consists mostly of wetland area with water level fluctuation between 0.5 m and 2 m. The wetland is regulated mainly by the rainfall resulting in two contrasts environmental conditions. During rainy season (October-April), the wetland is entirely flooded by water and the fishes are difficult to be caught. Inversely, during the dry season (May-September) the wetland is covered by very dense vegetation and the fish are concentrated on the sludge holes or backwater and allow for people to catch them. This regular changing from water environment to high plant biomass is an important factor in regulating high production of freshwater fishes in the wetland.

Data collection and Statistical analysis: A total of 848 individuals of Snakeskin gourami comprising 405 males and 443 females were obtained from local fishermen during April 2017 and February 2018. Fish samples were mostly collected by using *Lalangit* (horizontal gillnet) and also electrofishing. *Lalangit* made of polyamide monofilament in a rectangular-shape: 85 cm^2 with 2.54 cm stretched mesh that is attached between two bamboos laths of 100 cm long. In operation, fisher making a square hole just at the middle of the floating aquatic plants and then over the surface of this square hole, they put *Lalangit* to catch the fish targeted. In case of using bait, the fisher usually spread rice bran powders over the net to attract the fish come up taking air-breath and are gilled on the net. A total of 50-100 units of *Lalangit* were deployed around the swamp with the vegetated habitats (e.g. *Hydrilla verticillata*, *Eichornia crassipes*, *Ipomea aquatic*), starting from 8 am till 4 pm. After soaking, the gear was retrieved every 30 minutes and applied again with the same procedure. The size of *Lalangit* in the present study is typically smaller than that used in Bangkau swamp of Hulu Sungai Selatan District (Irhamsyah et al. 2017). Electrofishing is usually conducted at the nighttime with the help of a lamp. It is not easy to describe the detailed electrofishing devices used in this study due to a technical barrier (unwillingness of fishermen to share information as it is illegal way).

The Snakeskin gourami catches were identified by sexes, and measured for total length (TL), body depth (BDD) and weight (W). Total length was taken from the tip of the snout to the extended tip of the caudal fin. Body depth was measured from the dorsal fin origin vertically to the ventral midline of the body. The total length and body depth were measured with a ruler to the nearest mm, while body weight was determined with a digital balance to an accuracy of 0.01 g (Dretec KS-233, Japan). The size distribution of fish sampled was set at 15-mm amplitude and 10-g amplitude. The length-weight relationship of fish can be expressed in either the allometric form (Froese 2006):

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

or in the linear form (Garcia 2010):

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

Where W is the total 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 *b* value has an important biological meaning; if fish retains the same shape, it grows 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 (Senguttuvan & Shivakumar 2012). The coefficient of determination (R^2) and the coefficient of correlation (r) of morphological variables between male and female were also computed. The data used for length weight relationship were also utilized for calculating Fulton's condition factor of male and female by mean of formula (Pauly 1983):

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

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. The K value is used in assessing the health condition of fish of different sex and in different seasons. In addition, the Mann-Whitney test was employed to verify if there are no differences between sexes for lengths and weights and for the condition factor. All tests were analysed at the 95%

significance level. SPSS for windows version 16.0 statistical software was used for all data analysis.

Results

All estimated length-weight relationships and condition factor of Snakeskin gourami is presented in Table 1. A total of 848 individuals of Snakeskin gourami consisted of 405 males and 443 females were analyzed. The male size was ranged from 75 to 170 mm (120.48±18.49 mm) total length and 5 to 80 g (30.37±14.14 g) weight; while the female was ranged from 80 to 200 mm (117.91±18.31 mm) total length and 8 to 132 g (29.05±15.12 g) weight. The pooled size was ranged from 75 to 200 mm (119.14±18.43 mm) total length and 5 to 132 g (29.76±14.76 g) weight.

The length-weight relationship of male and female was found to be significantly difference (Fig. 3), while the *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 are within the range of 2.7748 for male and 2.8971 for female, with the coefficient of determination (R^2) values ranged from 0.8970 to 0.9339, indicating that more or less 90% of variability of the weight is explained by the length. The index of correlation (r) of male and female were 0.9471 and 0.9664, found to be higher than 0.5, showing the length-weight relationship is positively correlated. Regardless the sex, the pooled *b* value obtained was 2.8366 with R^2=0.9164 confirming fish grew allometrically. The Mann-Whitney test showed that male had the average total length greater as compared to female ($P<0.05$), but no significant difference was observed in the average weight between them ($P>0.05$). Further analysis revealed that there were no statistical significant differences in the ratio of body depth to total length (BDD/TL), as well as the ratio of weight to total length (W/TL) between male and female ($P>0.05$) as shown in Figs. 4A and 4B. Figure 6 clearly shows no statistical difference in condition factor (K) between male and female ($P>0.05$). The mean K values obtained for male, female and pooled were 1.64±0.24, 1.66±0.21 and 1.65±0.23 respectively (see Table 1).

Discussion

The length-weight relationship and its parameters (*a* and *b*) have a wide application in fish biology and fisheries management. In fish, the weight is considered to be a function of length (Weatherley & Gill 1987), while the fish length, according to Ghorbani et al. (2012), is the best indicator of production efficiency. From genus Trichogaster, a negative allometric growth pattern in the present study was also documented in *T. pectoralis* from Agusan Marsh, the Philippines (Jumawan & Seronay 2017), *T. fasciata* and *T. sota* from Jorhat District of Assam, India (Paswan et al. 2012), *T. fasciata* from Nitai Beel, India (Kalita et al. 2016), *T. leerii* from Toh Daeng peatswamp, Thailand (Kaewsritong et al. 2009), *T. leerii* from Gomti River, India (Awasthi et al. 2015), and *T. trichopterus* from Martapura, Indonesia (Aminah & Ahmadi 2018). According to Vicentin et al. (2012), fish with *b* value less than 3 consumed more of its energy in axial growth rather than weight. Our finding was contrary to *T. pectoralis* from Thai Rivers, Thailand (Sidthimunka 1973). *T. pectoralis* and *T. trichopterus* from Agusan Marsh, the Philippines (Talde et al. 2008; Jumawan & Seronay 2017), and *T. lalius* from Nitai Beel, India (Kalita et al. 2016) in which exhibited a positive allometric growth ($b>3$). Considering the value of the *b* coefficient and its significant differences for male and female in the future, one should think about examining the differences in the condition coefficient separately, dividing the fish not only in terms of sex but also in terms of size (sexual maturity), because with the increase in length, differences in the coefficient of fitness between the sexes should vary. Variation in slope may also be attributed to life stages and environmental factors such as food and space (Kleanthids et al. 1999; Khan et al. 2012; Vicentin et al. 2012). Snakeskin gourami grew allometrically in the current study may also be attributable to impact of seasonal hydro-climatic change in which dry season came earlier than usual. The effect of climate change on catchability of fish is further described by Dematawewa et al. (2008) and Gu et al. (2015).

The maximum total length of *T. pectoralis* recorded in the present study (200 mm) was larger than size of *T. pectoralis* collected in Boralasgamuwa reservoir, Sri Langka: 168 mm (Wijeyaratne & Perera 2000), in Lake Taliwang, Indonesia: 168 mm (Tampubolon & Rahardjo 2011), or *T. pectoralis* in Martapura, Indonesia: 110 mm (Aminah & Ahmadi 2018), but it was lower than size of *T. pectoralis* in Thailand: 220 mm (Sidthimunka 1973) or *T. pectoralis* in Agusan Marsh, the Philippines: 250 mm (Talde et al. 2008). In this study, the ratio of body weight to total length of *T. pectoralis* (0.660) was lower than that of *T. pectoralis* (0.833) sampled from Agusan Marsh, the Philippines (Jumawan & Seronay 2017), but it was higher as compared to other species of genus Trichopterus, such as *T. trichopterus, T. fasciata, T. lalius*, *T. sota* and *T. leerii* (Aminah & Ahmadi 2018; Kalita et al. 2016; Paswan et al. 2012; Kaewsritong et al. 2009) ranged from 0.047 to 0.187 (Table 2). Dealing with the total length and weight size distribution of *T. pectoralis* samples, more than 21% of total catch was found between 105 and 114 mm TL (Fig. 5A) and more than 34% existed between 15 and 24 g weight classes (Fig. 5B). No statistical difference was observed in the percentage of catch number between male and female ($P>0.05$).

The K values gained for *T. pectoralis* in the current study are also agreement with other fish species of genus Trichogaster from different geographical areas (Table 2). The present K value was found to be higher than unity, according to Nash et al. (2006), *T. pectoralis* living in the swamp was good condition. Variation in the value of the K may be attributed to biological interaction involving intraspecific competition for food and space (Arimoro & Meye 2007) between species including sex, stages of maturity, state of stomach contents and availability of food (Saikia et al. 2012; Widodo et al. 2013). The K gives information when comparing two populations living in certain feeding, density, climate, and other conditions; when determining the period of gonad maturation; and when following up the degree of feeding activity of a species to verify whether it is making good use of its feeding source (Weatherley 1972). Information on condition factor of fish is considerably needed for aquaculture system management particularly to understand specific condition and healthy of fish being cultured. When the fish becomes leaner as the length increases, the manager or fish farmer should take management strategies, for example, by improving the quality of feed contents and its feeding ratio, and rearranging fish density to reduce competition for food and space.

In wild sources, Snakeskin gourami are being caught by using different fishing gears, for instance, hook and line (*Bingwit*), improvised purse seine (*Lambat*), cast net (*Pukot*), improvised fyke net trap (*Bantak*), and electrofishing in Agusan Marsh, the Philippines (Jumawan & Seronay 2017), gillnet in Lake Taliwang, Indonesia (Tampubolon & Rahardjo 2011) or in Batang Kerang floodplain, Malaysia (Khairul et al. 2009), cast net in Boralasgamuwa reservoir, Sri Langka (Wijeyaratne & Perera 2000), beach seine in the upstream of Bangpakong River, Thailand (Petsut et al. 2013), and light traps in Martapura, Indonesia (Aminah & Ahmadi 2018). All these studies outlined above describing only on the length-weight relationships of fish that are collected using various fishing gears without considering the detailed composition of fish lengths by each typical gear used. Therefore, it is necessary to use different fishing gears to determine the composition of fish lengths that will be analyzed and compare the results of work with other work done on the species, particularly on the basis of catch selectivity and typical growth dimensions of relative well-being of fish population. In the investigated area, Snakeskin gourami experienced high pressure on population caused by fishing because of having a high commercial value. Local fishermen mostly used horizontal gillnet (*Lalangit*) and also electrofishing to collect them and this is on-going throughout the year regardless of seasonal periods. *Lalangit* is created by considering the behavior of fish itself where they often emerge to breathe air at the surface waters. The size of *Lalangit* used here was smaller than the size of *Lalangit* operated in Bangkau swamp, Indonesia (Irhamsyah et al. 2017). The acquisition of fish from fishermen is associated with fishing selectivity and the preferences of the fishermen themselves. Often, larger individuals do not reach scientists because of their market value. The use of *Lalangit* is much better than electrofishing in term of gear selectivity because it only captures the larger fish, but the catch is usually no longer survived due to being gilled on the net. In the future, it would be worth considering whether to use, for example, fishing with the use of electricity. Such catches are, firstly, non-selective and, secondly, they allow carrying out this kind of research in an experiential way. For further research, we intend to investigate the catching efficiency of *Lalangit* associated with underwater lamps of different color and light intensities to promote a responsible fishing method (Ahmadi 2012; Ahmadi & Rizani 2013; Ahmadi et al. 2018) and the results are open for discussion.

It is important to point out that there was no records for Snakeskin gourami catch in quantity (e.g. number, length and weight) because fishermen or their family members directly sold alive fish to trader or consumer in some places, resulted in the ratio of fish exploitation rate to fish growth rate in this river is unpredictable. It is a great challenge for Fisheries Services of Banjar District to improve the quality of inland fishery statistic data for some species of commercial importance including Snakeskin gourami fishery, and our finding provides the first reference on the length-weight relationship and condition factor of this species. Such information could be useful for biologist or researcher to assess the biomass of fish captured and to take conservation measures for them since catch tends to decline.

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References

Ahmadi. 2012. An introduction of light traps for sampling freshwater shrimp and fish in the Barito River, South Kalimantan. Journal of Fisheries and Aquatic Sciences 7(2): 173-182. https://doi.org/10.3923/jfas.2012.173.182

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

Ahmadi; Muhammad. & Lilimantik, E. 2018. Phototactic response of climbing perch Anabas testudineus to different colors and light pattern of LED light traps. AACL Bioflux 11(3): 678-689

Ali, A.B. 1990. Some ecological aspects of fish populations in tropical ricefields. Hydrobiol 190(3): 215-222

Aminah, S. & Ahmadi. 2018. Experimental Fishing with LED Light Traps for Three-spot gourami (*Trichogaster trichopterus*) in Martapura, Indonesia. International Journal of Fisheries and Aquatic Studies 6(1): 37-42

Amornsakun, T.; Sriwatana, W. & Promkaew, P. 2004. Some aspects in early life stage of Siamese gourami, *Trichogaster pectoralis* (Regan) larvae. Songklanakarin Journal of Science and Technology 26: 347-356

Awasth, M.; Kashyap, A. & Serajuddin, M. 2015. Length-weight relationship and condition factor of five sub-populations of *Trichogaster lalius* (Osphronemidae) of Central and Eastern Regions of India. Journal of Ichthyology 55(6): 849-853.

Arenas, P. & Acero, A. 1992. Presencia del gourami piel de Culebra *Trichogaster pectoralis* (Regan, 1910) (Perciformes: Belontiidae), en la región de la Ciénaga Grande de Santa Marta, Caribe Colombiano. Memorias del VIII Seminario Nacional de las Ciencias y las Tecnologias del Mar y Congreso Centroamericano y del Caribe en Ciencias del Mar. Santa Marta, Octubre 26-30, 1992, pp. 491-500.

Arimoro, F.O. & Meye, J.A. 2007. Some aspects of the biology of *Macrobrachium dux* (Lenz, 1910) (crustacea: decapoda: natantia) in river Orogodo, Niger Delta, Nigeria. Acta Biologica Colombiana 12: 111-122

Baishya, S.; Kalita, K.; Phukan, B.; Dutta, M.P. & Bordoloi, R. 2012. Growth performance of Snakeskin gourami, *Trichogaster pectoralis* (Regan, 1910) through weaning strategies. The Bioscan 7(3): 553-556

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

Barnham, C. & Baxter, A. 1998. Condition Factor, K, for Salmonid Fish. Fisheries Notes 1-3.

Boonsom, J. 1984. Zooplankton feeding in the fish *Trichogaster pectoralis* Regan. Hydrobiologia 113(1): 217-221

Chesoh, S., Sihiranwong, A., Angsuphanit, A. 1995. Nursing of snake-skined gourami, *Trichogaster pectoralis* (Regan) in cement tank from the size of 1 inch to 2 and 3 inches. AGRIS. 48(4): 319-329.

Dematawewa, C.M.B.; Wickremasinghe, E.S. & Edirisinghe, U. 2008. Some effects of seasonal hydro-climatic factors on catchability of fish in minor-perennial Sorabora reservoir, Sri Lanka. Sri Lanka Journal of Animal Production 9: 39-53.

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

Garcia, L.M.B. 2010. Species composition and length-weight relationship of fishes in the Candaba wetland on Luzon Island, Philippines. Journal of Applied Ichthyology 26: 946-948.

Ghorbani, A.; Salamatdoustnobar, R.; Ghaem, M.S.S. & Motallebi, V. 2012. The effect of different levels of prebiotic on the length of fingerling rainbow trout. African Journal of Biotechnology 11(36): 8928-8931.

Gu, H.; Yu, Z.; Wang, G.; Ju, Q.; Yang, C. & Fan, C. 2015. Impact of climate change on hydrological extremes in the Yangtze River Basin, China. Stochastic Environmental Research and Risk Assessment 29: 693-707. http://dx.doi.org/10.1007/s00477-014-0957-5

Hossain, M.Y.; Sayed, S.R.M.; Mosaddequr Rahman, M.; Ali, M.M.; Hossen, M.A.; Elgorban, A.M.; Ahmed, Z.F. & Ohtomi, J. 2015. Length-weight relationships of nine fish species from the Tetulia River, southern Bangladesh. Journal of Applied Ichthyology 31: 967-969. https://doi.org/10.1111/jai.12823

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

Ismail, S.N.; Abd Hamid, M. & Mansor, M. 2018. Ecology, diversity and seasonal distribution of wild mushrooms in a Nigerian tropical forest reserve. Biodiversitas 19: 279-284

Jintasataporn, O. & Chumkam, S. 2017. Effects of biofloc in Snakeskin gourami (*Trichogaster pectoralis* Regan) culture system on growth performance and fillet quality. In: Symposium Proceedings, No. 07003. The JSFS 85th Anniversary-Commemorative International Symposium “Fisheries Science for Future Generations”, pp. 1-2

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.

Kalita, B.; Sarma, S.R. & Deka, P. 2016. A Comparison on Length-Weight relationship and relative condition factor of two species of Trichogaster of Nitai Beel of Kamrup District of Assam, India. International Journal of Zoology Studies 1(3): 9-12

Kaewsritong, C.; Seehirunwong, S.; Uraiprasit, J. & Khoowkheaw, W. 2009. Some biological aspects of Pearl Gourami, *Trichogaster leerii* (Bleeker, 1852) in Toh Daeng Peatswamp, Narathiwat Province. Technical Paper No. 8/2552, p. 37

Khan, S.; Khan, M.A.; Miyan, K. & Mubark, M. 2011. Length-weight relationship for nine freshwater teleosts collected from River Ganga, India. International Journal of Zoology Research 7(6): 401-405.

Khan, M.A.; Khan, S. & Miyan, K. 2012. Studies on length-weight and length-length relationships of four freshwater fishes collected from River Ganga. Journal of Fisheries and Aquatic Sciences 7(6): 481-484. http://dx.doi.org/10.3923/jfas.2012.481.484

Khairul, A.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(1): 7-16

Kleanthids, P.K.; Sinis, A.I. & Stergiou, K.I. 1999. Length-weight relationships of freshwater fishes in Greece. Naga, ICLARM Quarterly 22: 37-41

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. Cannadian Journal of Fisheries and Aquatic Sciences 6: 264-271.

Lee, S.W.; Farhan, R.; Wee, W.; Wan Zahari, M. & Ibrahim, C.O. 2016. The effects of tropical almond *Terminalia catappa* L., leaf extract on breeding activity of Siamese Gourami, *Trichogaster pectoralis*. International Journal of Fisheries and Aquatic Studies 4(4): 431-433

Morioka, S. 2018. Research on indigenous fish species in Lao PDR: A Review of investigations into aquaculture development, fisheries management and conservation. International Journal of Oceanography and Aquaculture 2(1): 000125.

Moses, B.S.; Udoidiong, O.M. & Okaon, A.O. 2002. A statistical survey of the artisanal fisheries of south-eastern Nigeria and the influence of hydro climatic factors on catch and resource productivity. Fisheries Research 57(3): 267-278.

Nash, R.D.; Valencia, A.H. & Geffen, A.J. 2006. The origin of Fulton's condition factor-setting the record straight. Fisheries 31(5): 236-238.

Ninwichian, P.; Phuwan, N.; Jakpim, K. & Sae-Lim, P. 2018. Effects of tank color on the growth, stress responses, and skin color of Snakeskin gourami (*Trichogaster pectoralis*). Aquaculture International 26(2): 659-672

Paepke, H.J. 2009. The nomenclature of *Trichopodus pectoralis* Regan, 1910; *Trichopus cantoris* Sauvage, 1884 and *Osphronemus saigonensis* Borodin, 1930 (Teleostei: Perciformes: Osphronemidae). Vertebrate Zoology 59(1): 53-60.

Paperna, I.; Ventura, T.M. & de matos, A.P. 1987. Lymphocystis infection in Snakeskin gourami, *Trichogaster pectoralis* (Regan), (Anabantidae). Journal of Fish Diseases 10(1): 10-19 . https://doi.org/10.1111/j.1365-2761.1987.tb00713.x

Paswan, G.; Abujam, S.K.S.; Dey, M. & Biswas, S.P. 2012. Length-Weight Relationship of two species of *trichogaster* (Calisa) from Brahmaputra Basin of Assam. Journal of Biology Innovation 1(1): 6-13.

Patrick, A.E.S.; Kuganathan, S. & Edirisinghe, U. 2015. Effects of hydro-climatic fluctuations on catchability of fish in Vavuniya reservoir, Sri Lanka. Tropical Agricultural Research 26(2): 402-408.

Pauly, D., 1983. Some simple methods for the assessment of tropical fish stocks. FAO Fisheries Tech. Pap., FAO. Rome, 234, p. 52

Petsut, N.; Kulabtong, S. & Petsut, J. 2013. Preliminary survey of freshwater fishes from acid soil area in upstream of Bangpakong River, Nakhon Nayok Province, Thailand. Journal of Biodiversity and Environmental Sciences 3(1): 33-36

Saikia, A.K., Abujam, S.K.S., Biswas, S.P. 2012. Food and Feeding habit of *Channa punctatus* (Bloch) from the paddy field of Sivsagar District, Assam. Bulletin of Environment Pharmacology and Life Science 1(5): 10-15

Satrawaha, R. & Pilasamorn, C. 2009. Length-weight and length-length relationships of fish species from the Chi River, northeastern Thailand. Journal of Applied Ichthyology 25(6): 787-788. http://dx.doi.org/10.1111/j.1439-0426.2009.01293.x

Sidthimunka, A. 1973. Length-weight relationships of freshwater fishes of Thailand. International Center for Aquaculture Research and Development Series No. 3. Project: A.I.D./csd 2270. Task Order No. 9, p.25

Senguttuvan M. & Shivakumar A.A. 2012. Length weight relationship and condition factor of *Channa punctatus* (Bloch, 1793) and *Channa striata* (Bloch, 1793) in Ukkadam Lake, Coimbatore, Tamil Nadu, India. Fishery Technology 49(2): 219-221.

Talde, C.M.; Mamaril Sr, A.C. & Palomares, M.L.D. 2008. Composition and length-weight relationships of fishes in the three floodplain lakes of Agusan Marsh Wildlife Santuary. Asian Fisheries Sciences 21: 55-65

Tampubolon, P.A.R.P. & Rahardjo, M.F. 2011. Spawning aspects of Snakeskin gourami, *Trichogaster pectoralis*, Regan 1910 in Lake Taliwang, West Nusa Tenggara. Jurnal Iktiologi Indonesia 11(2): 135-142

Tan, S.K.; Tan, S.G. & Gan, Y.Y. 1980. Liver Esterase Polymorphisms in Sepat Siam (*Trichogaster pectoralis*). Pertanika 3(2): 92-96

Tansatit, T.; Sobhon, P.; Sahaphong, S.; Sangsuriya, P. & Klinsrithong, S. 2014. Prevalence and histopathology of *Trichogaster pectoralis* harbouring Metacercaria of *Clinostomum piscidium* (Southwell and Prashad, 1918) in Central Thailand. The Thai Journal of Veterinary Medicine 44(2): 223-230

Tate, M.; McGoran, R.E.; White, C.R. & Portugal, S.J. 2017. Life in a bubble: the role of the labyrinth organ in determining territory, mating and aggressive behaviours in anabantoids. Journal of Fish Biology 91(3): 721-1006

Vidthayanon, C. 2012. *Trichopodus pectoralis*. The IUCN Red List of Threatened Species 2012: e.T188087A1852593. http://dx.doi.org/10.2305/IUCN.UK.2012-1.RLTS.T188087A1852593.en. Downloaded on 8 August 2018.

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): 143-145. DOI: 10.1111/j.1439-0426.2011.01890.x

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

Weatherley, A.H., 1972. *Growth and ecology of fish populations*. Academic Press, London, p. 293.

Widodo, M.S.; Marsoedi, Susilawati, T. & Agung Permana, W.M. 2013. Maturity level and somatic index of Gonado at dwarf Snakehead (*Channa gachua*) during January to December 2009. Journal of Basic and Applied Sciences Research 3(3): 387-393

Wijeyaratne, M.J.S. & Perera, W.M.D.S.K. 2000. Population dynamics of potential fish species for exploitation in presently under developed fisheries of some perennial reservoirs in Sri Lanka. ACIAR Proceedings, pp. 188-200.

Yoonpundh, R. & Little, D. 1997. Trends in the farming of the Snakeskin gourami (*Trichogaster pectoralis*) in Thailand. Naga, the ICLARM Quarterly 18-19.

Table 1. Total length, weight and condition factor of male and female of Snakeskin gourami taken from Sungai Batang swamp

Sex	n	Total length (mm)			Weight (g)			a	b	R^2	r	Allometric pattern	K
		Min	Max	Mean ± SD	Min	Max	Mean ± SD						Mean ± SD
Males	405	75	170	120.48±18.49	5	80	30.37±14.14	0.00005	2.7748	0.8970	0.9471	A-	1.64±0.24
Females	443	80	200	117.91±18.31	8	132	29.05±15.12	0.00003	2.8971	0.9339	0.9664	A-	1.66±0.21
Pooled	848	75	200	119.14±18.43	5	132	29.76±14.76	0.00004	2.8366	0.9164	0.9573	A-	1.65±0.23

n = Number of fish samples, SD = standard deviation, a = constant, b = exponent, R^2 = coefficient of determination, r = coefficient of correlation, A- = negative allometric, K = condition factor

Table 2. Comparative length-weight relationships and factor conditions of genus Trichogaster from different geographical areas.

Species	n	Ratio of W/TL	a	b	R^2	Allometric pattern	K	Location	Country	References
Trichogaster pectoralis	848	0.660	0.00004	2.8366	0.9164	A-	1.65	Sungai Batang swamp	Indonesia	Present study
T. pectoralis	350	0.864	-2.0120	3.182	-	A+	15.61	Thai Rivers	Thailand	Sidthimunka 1973
T. pectoralis	107	-	0.0072	3.238	0.9663	A+	4.92	Agusan Marsh	Philippines	Talde et al. 2008
T. pectoralis	27	0.833	0.0170	2.904	0.9550	A-	-	Agusan Marsh	Philippines	Jumawan & Seronay 2017
T. trichopterus	246	0.187	0.0290	3.046	0.9660	A+	-	Agusan Marsh	Philippines	Jumawan & Seronay 2017
T. trichopterus	26	0.144	0.0002	2.404	0.7027	A-	1.88	Martapura	Indonesia	Aminah & Ahmadi 2018
T. sota	114	0.047	-2.523	1.042	0.6810	A-	24.47	Jorhat district of Assam,	India	Paswan et al. 2012
T. fasciata	128	0.109	-9.795	2.424	0.6990	A-	19.18	Jorhat district of Assam,	India	Paswan et al. 2012
T. fasciata	83	0.085	-1.390	2.580	0.7761	A-	1.02	Nitai Beel	India	Kalita et al. 2016
T. lalius	85	0.099	-1.830	3.140	0.9194	A+	0.99	Nitai Beel	India	Kalita et al. 2016
T. leerii	421	-	0.0216	2.880	0.9456	A-	3.70	Gomti River	India	Awasthi et al. 2015
T. leerii	199	0.081	0.0268	2.5880	0.8941	A-	-	Toh Daeng peatswamp	Thailand	Kaewsritong et al. 2009

n = Number of fish samples, W = weight (g), TL = total length (mm), a = constant, b = exponent, R^2 = coefficient of determination, A- = negative allometric, A+ = positive allometric, and K = Fulton's condition factor.

Fig. 1. Snakeskin gourami sampled from Sungai Batang swamp

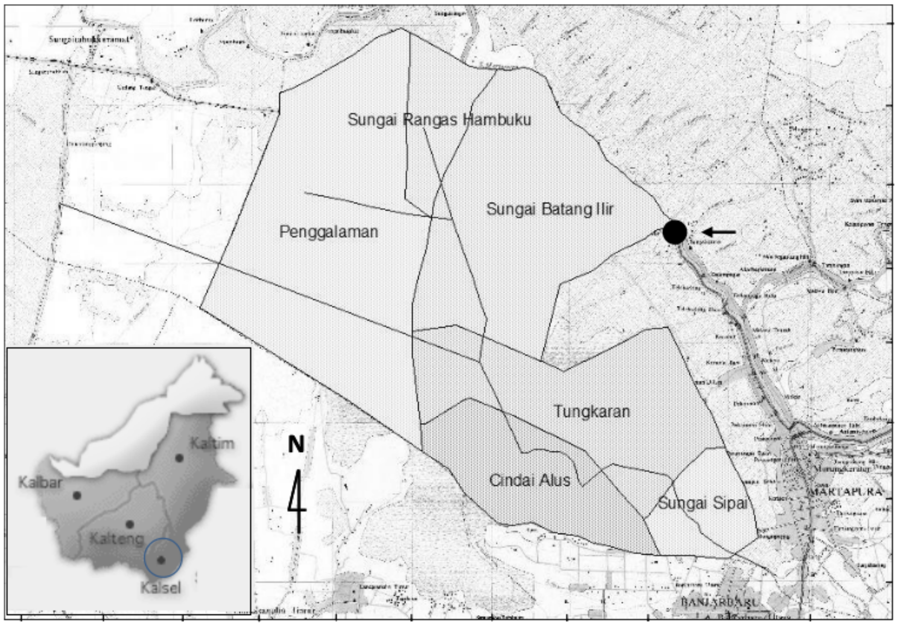

Fig. 2. Map showing the location of sampling site in Sungai Batang swamp

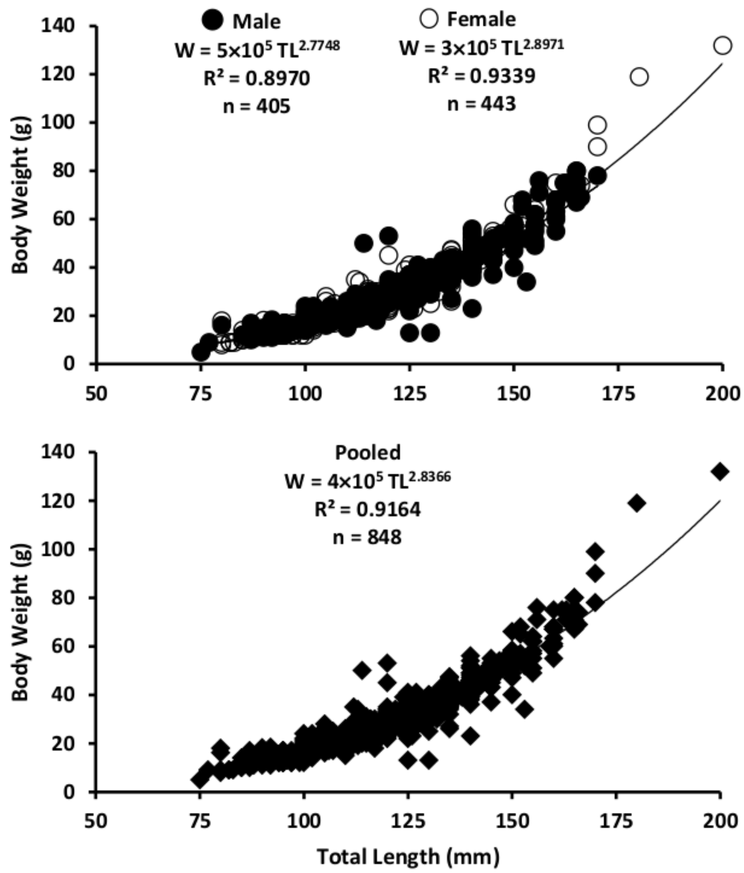

Fig. 3. The relative growth curves for Snakeskin gourami sampled from Sungai Batang swamp, displaying a negative alometric growth pattern. The *b* exponent values obtained were lower than the cubic value (b<3) across the sampling periods.

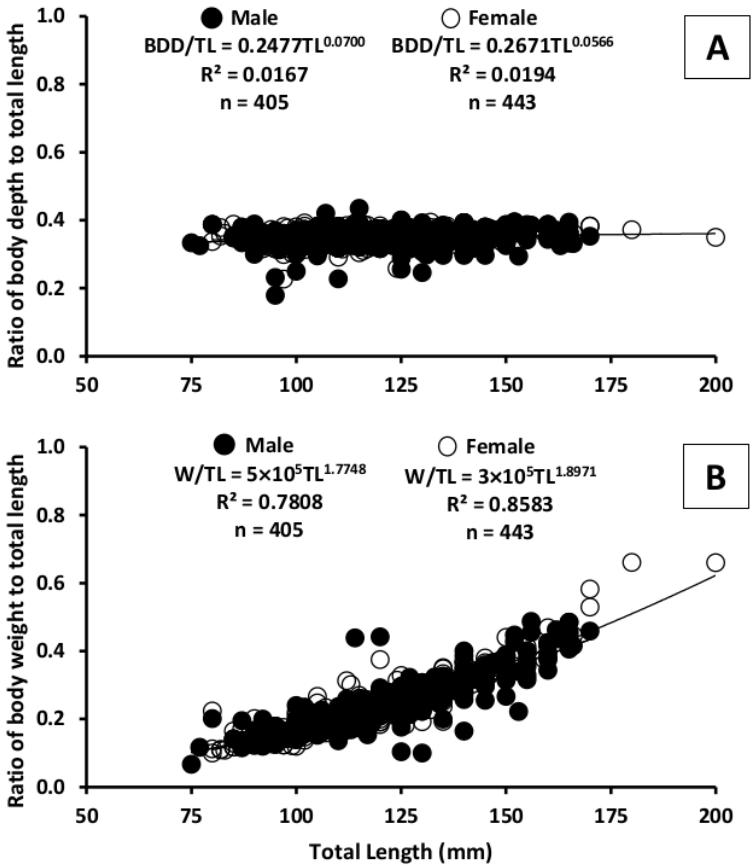

Fig. 4. The ratio of body depth to total length (A) and the ratio of body weight to total length (B) were found to be not significant differences between male and female of Snakeskin gourami (*P*>0.05).

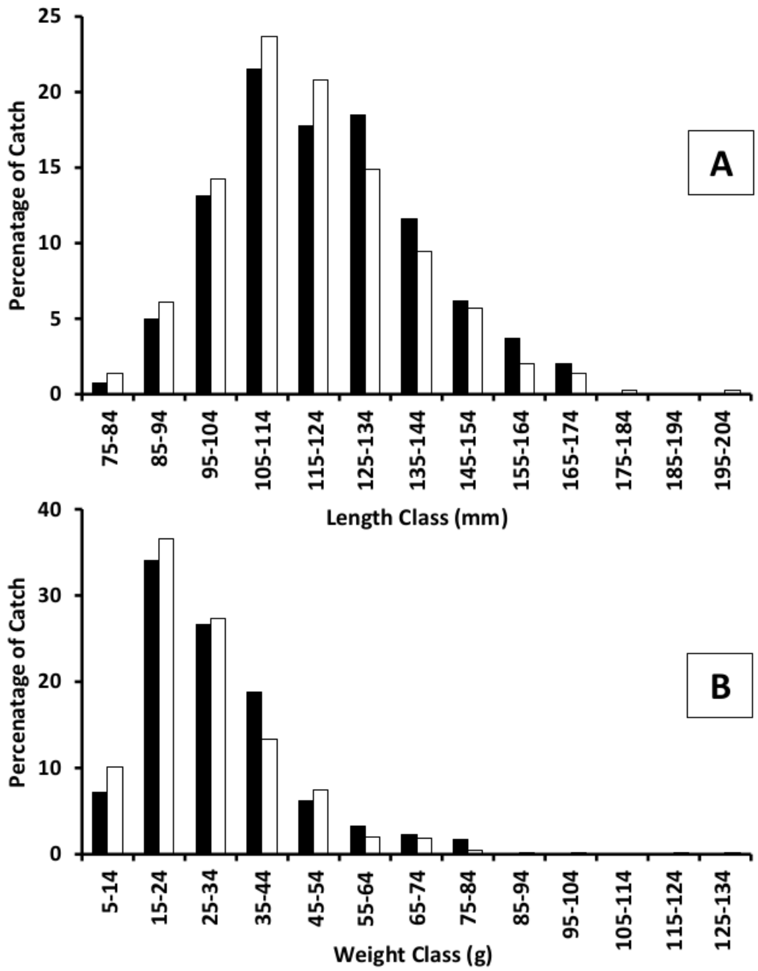

Fig. 5. Total length and weight sizes distribution of male and female Snakeskin gourami. More than 21% of total catch was found between 105 and 114 mm TL (A), and more than 34% existed between 15 and 24 g weight classes (B). No significant difference was observed in the percentage of catch between male and female ($P>0.05$).

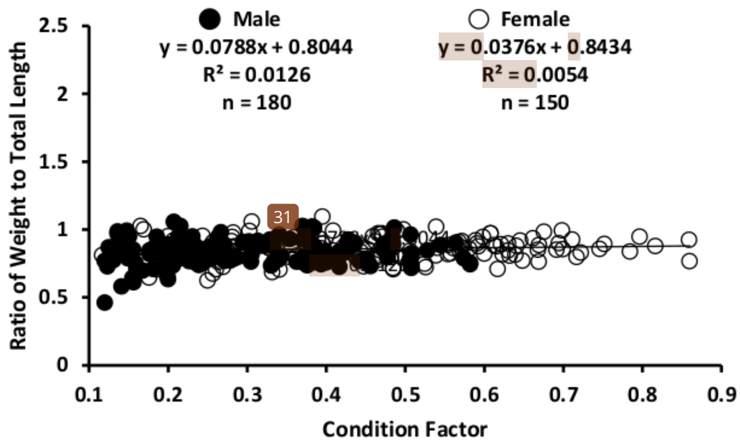

Fig. 6. The relationship between ratio of body weight to total length and condition factor of Snakeskin gourami. No significant difference in condition factors of male and female was observed (*P*>0.05).

Morphometric Characteristic and Condition Factor of Snakeskin Gourami (Trichogaster pectoralis) from Sungai Batang Swamp, Indonesia

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