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Length-weight relationship, condition factor, and environmental parameters of *Puntigrus tetrazona* from Kelekar River, Ogan Ilir, South Sumatra, Indonesia

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Abstract
Length-weight relationships, condition factors, and environmental parameters are important parts of fisheries management. The freshwater fish species *Puntigrus tetrazona* is endemic to Indonesia. The objective of this study was to determine the length-weight relationship, condition factors, and environmental parameters of *P. tetrazona* from the Kelekar River in South Sumatra. A total of 121 *P. tetrazona* were used in this study. The results showed that the length-weight relationship of *P. tetrazona* was negative allometric, with the regression equation $W = 0.0656 \times L^{1.9002}$ (R^2 =0.5603). The *P. tetrazona* population was in good condition, as indicated by a condition factor value of 1.00. Environmental parameters including water temperature, pH, dissolved oxygen, electrical conductivity and oxidation reduction potential are suitable for the life of *P. tetrazona*. The findings of this study will be of significant value in informing the management of *P. tetrazona* resources.

Keywords: Aquarium fish, endemic fish, Sumatra barb, small fish, tiger barb

Introduction
The Sumatra barb (*Puntigrus tetrazona*) is a member of the Cyprinidae family and a popular aquarium fish. This is inextricably linked to its behavioral and color patterns, rendering it highly attractive when housed in an aquarium. As the name suggests, this fish is indigenous to the waters of Sumatra. It is found in the Kelekar River in Ogan Ilir Regency, South Sumatra. The subject displays a flat, round body shape with a relatively tall stature. The body of the fish is golden yellow in color and bears four black vertical lines. The aforementioned lines are situated in the following locations: the eyes, the region posterior to the pectoral fins, and the dorsal fins. In the regions proximate to the mouth, pelvic fins, and caudal fins, there is a discernible reddish hue. *P. tetrazona* differs from *S. anchisporus* in that it possesses an incomplete lateral line and a longer body than the latter (Roberts 1989) [24]. Nevertheless, the color pattern is nearly identical to that of the latter. As documented by Axelrod *et al*. (1985) [4] and Kottelat *et al*. (1993) [12], color images were published. Additionally, Petrovicky (1988) [21] provided illustrations and samples of various color variants available in the aquarium trade.
As posited by Shiraishi *et al*. (1972) [26], Sumatra barbs are typically omnivorous, feeding on phytoplankton, terrestrial and aquatic insects, and other aquatic invertebrates. The food composition of the tinfoil barb fish (*B. schwanenfeldii*) caught in the Tasik River has been determined to consist of phytoplankton as the primary food source, with mosses, worms, and plant pieces serving as complementary foods. Insects and zooplankton represent additional food sources (Desrita *et al*., 2021) [6]. The fish were classified as omnivores and were observed to engage in nocturnal foraging behaviors. It has been observed that the fish in question engage in schooling behavior, which is thought to facilitate the process of spawning. During this event, the fish temporarily form pair bonds. A single spawning event can result in the release of up to 500 eggs, which are laid on submerged aquatic vegetation (Tamaru *et al*., 1997) [30].
The length-weight relationships, condition factor, and environmental parameters represent crucial and fundamental components of the instruments utilized for fisheries management (Kumari *et al*., 2019) [13]. It is of great importance for understanding a variety of biological aspects of the species (Freitas *et al*., 2017) [8], ecological assessments and monitoring (Orlov & Binohlan, 2019) [20], and the life history of fishes (Ferdaushy & Alam, 2015) [7]. These studies have been instrumental in population stock assessment (Augustina *et al*., 2022) [3], understanding maturity and reproduction (Soni & Ujjania, 2017) [28], and growth and body condition (Zuchi *et al*., 2020) [33]. As a consequence of their capacity to furnish data on growth, survival, mortality, and overall production, they constitute an indispensable instrument in the field of aquaculture management (Kaur & Rawal, 2017) [11]. As posited by Ighwela *et al*. (2011) [10], the condition factor provides insights into the fish's physiological well-being, encompassing aspects such as its weight and whether it is within an optimal range.
A number of studies have been conducted on the length-weight relationship of Indonesian freshwater fish species. These include studies on *Puntius hexazona* (Rananda *et al*., 2020) [22], *Helostoma temminckii* (Ahmadi, 2021) [1], and *Bolantia hasselti* (Soetignya *et al*., 2023) [27]. Additionally, studies have been conducted on *Puntius tawarensis* and *Poropuntius tawarensis* (Muchlisin *et al*., 2010) [14], *Oryzias nigrimas* (Serdiati *et al*., 2021) [25], *Pristolepis grootii* (Muslim *et al*., 2020) [15], *Notopterus notopterus* (Muslim, 2023) [17], and others. A review of the literature revealed no studies on the length-weight relationship of freshwater fish species native to Indonesia that included *P. tetrazona*. The objective of this study was to ascertain the length-weight relationship and condition factor of *P. tetrazona* from the Kelekar River in the Ogan Ilir District of South Sumatra, Indonesia. The findings of this study offer fundamental insights into the biological characteristics of *P. tetrazona*, particularly with regard to its length-weight relationship and condition factors.

Materials and Methods
The present study was conducted on the Kelekar River in Ogan Ilir District, South Sumatra, Indonesia. Three different stations were selected for the collection of *P. tetrazona*

during the rainy season (from February 2023 to May 2023) of the study period. The three stations were station 1 (3° 16' 45.1" S 104° 35' 39.7" E), station 2(3° 16' 37.8" S 104° 35' 31.7" E), and station 3 (3° 16' 26.9" S 104° 35' 15.8" E) (Figure 1). The morphology of *P. tetrazona* used in this study was presented in Figure 2.

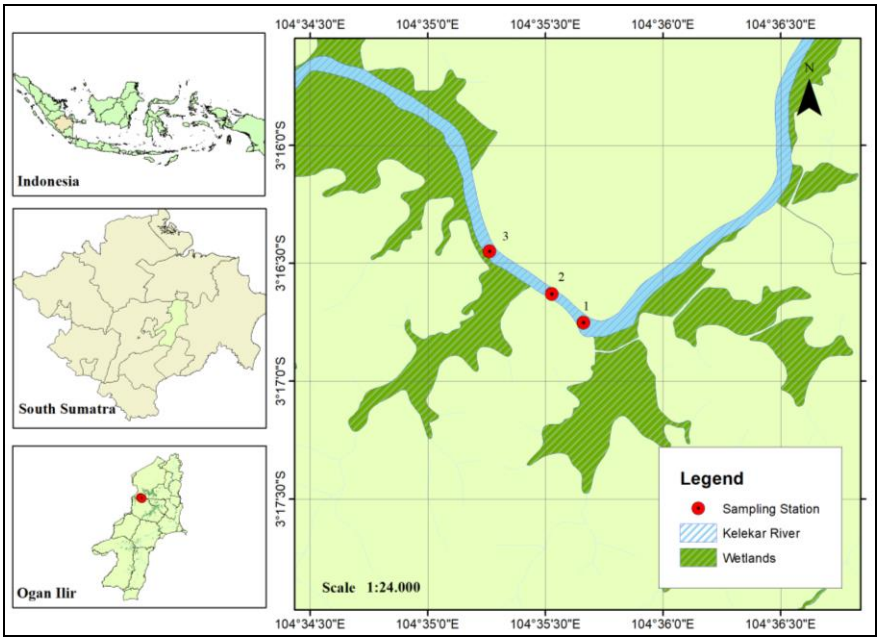

Fig 1: Map of *Puntigrus tetrazona* sampling locations in Kelekar River, Ogan Ilir Regency, South Sumatra, Indonesia

Fig 2: Morphology of *Puntigrus tetrazona* from Kelekar River, Ogan Ilir Regency, South Sumatra, Indonesia

A total of 121 *P. tetrazona* specimens were collected from three distinct sampling sites within the Kelekar River. Fishing was conducted using traditional fishing gear, specifically the bubu payung (fish trap). The environmental parameters measured in this study include water temperature, dissolved oxygen, water acidity, and ammonia. These were measured using a thermometer, DO meter, pH meter, and spectrophotometer, respectively. The *P. tetrazona* samples were transported to the Batanghari Sembilan Hatchery Unit in Indralaya, Ogan Ilir Regency, South Sumatra. The total length (TL) and body weight (BW) of each specimen were determined using a caliper with an accuracy of 0.1 cm and digital scales with an accuracy of 0.1 g.

The length-weight relationship is calculated using a power regression model. In order to obtain the values of a and b, the weight and length changes of the sampled fish were measured. A bias correction based on the mean weight change of logarithmic units was employed to predict weight and length parameters, according to the following equation: The weight (W) of a sample can be calculated using the following equation: $W = a L^b$, where W is the sample weight (in grams), L is the total length of the sample (in centimeters), and a and b are constant values. The condition factor can then be determined using the following equation: $K = W.L^{-3} \times 100$, where K is the condition factor and W.L is the weight (in grams) multiplied by the length (in centimeters) of the sample. This equation was proposed by Okgerman (2005) [19].

The growth pattern of fish is contingent upon the value of b. If the value of b is 3, the growth pattern is isometric; conversely, if the weight gain is equal to the fish's length, the growth pattern is allometric. A value of 3 indicates that the growth pattern is allometric. Two types of this development pattern have been identified: positive and negative allometric. Positive allometric relationships are defined as those in which length gain is smaller than weight gain whenever the b value is less than 3 ($b < 3$) (Kirankaya *et al*., 2014). To determine the relationship between the length and weight of the sampled fish, a one-way analysis of variance was employed, with the Microsoft Office Program application utilized for the statistical analysis.

Results and Discussion

A total of 121 specimens of *P. tetrazona* were utilized in this study. The body weight range of *P. tetrazona* was 0.14–1.42 g, with an average of 0.69–0.25 g. The total length of the specimens was 1.90–4.50 cm, with an average of 3.34–0.48 cm (Figure 3). The frequency distribution of body weight was obtained for seven class intervals, as well as length. The greatest frequency of fish body weight was observed in the size interval from 0.54 cm to 0.75 cm, while the greatest frequency of fish length was observed in the size interval from 3.10 cm to 3.49 cm. In the study conducted by Yuliansyah *et al*. (2021) [32], the specimen of *P. tetrazona* utilized was 2.5–3 cm in length. According to Kotellat *et al*. (1993), the maximum total length of this fish is 7 cm, indicating that the *P. tetrazona* obtained in this study still has the potential to grow larger.

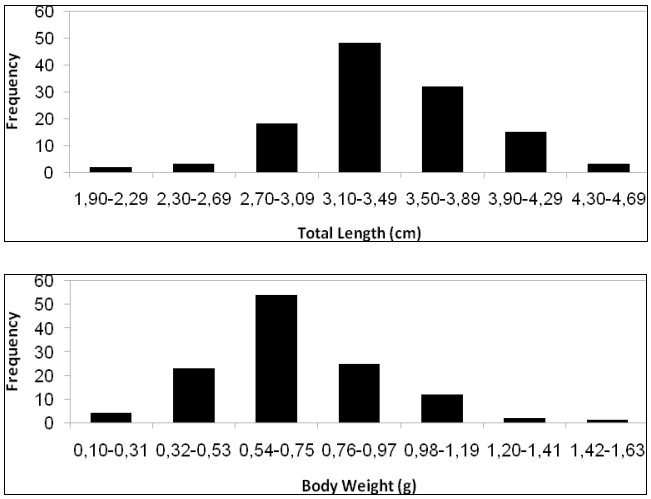

Fig 3: Total length and body weight of *Puntigrus tetrazona* collected from the Kelekar River, South Sumatra, Indonesia

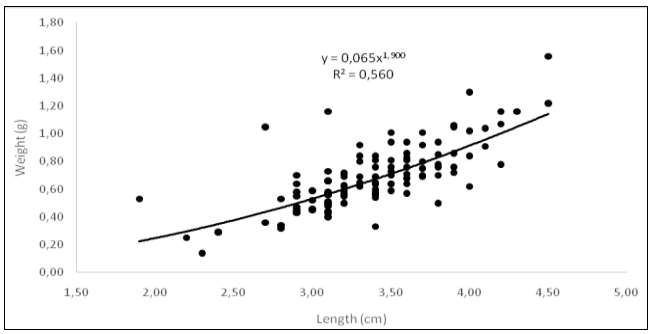

Fig 4: The length-weight relationship of *Puntigrus tetrazona* collected from the Kelekar River, South Sumatra, Indonesia

The growth pattern of *P. tetrazona* is negative allometric (b < 3), indicating that length growth occurs at a faster rate than weight growth. The R^2 value of 0.57 suggests that the relationship between the length and weight of the sample fish is moderate. The mean value of the condition factor (K value) of the *P. tetrazona* in the study was 1.00, indicating that the fish were in good condition.

The *P. tetrazona* is frequently bred for its ornamental qualities (Umar *et al*., 2018) [31]. Juliansyah *et al*. (2021) recommend maintaining the optimal conditions for the care of *P. tetrazona* within an aquarium with a water depth of 10 cm. To enhance the brightness of the fish's color, one may consider the use of Spirulina flour (Nafsihi & Hudaidah, 2016) [18], shrimp head flour (Tania *et al*., 2018) [29], or carrot flour (Alfandi *et al*., 2019) [2]. As stated on the Fishbase website, the Puntigrus genus is comprised of five distinct species. The genus includes five species: *P. tetrazona*, *P. anchisporus*, *P. navjotsodhii*, *P. partipentazona*, and *P. pulcher*. This species is one of the native and endemic freshwater fish species of Indonesia, with the potential to be cultivated as an ornamental fish commodity (Muslim *et al*. 2020) [15].

As indicated by Riehl & Baensch (1996) [23], the optimal pH range for sustaining the life of *P. tetrazona* is 6.0–8.0, with a recommended temperature range of 20–26 °C. The findings of water quality parameter measurements conducted at the sampling site are presented in Table 1, which demonstrates that the water quality conditions at the study site are conducive to the survival of *P. tetrazona*.

Table 1: Water quality parameters of Kelekar River for *P. tetrazona* habitat

Parameters	Station 1	Station 2	Station 3
Water temperature (°C)	26.4-29.8	25.8-30	25.9-30.8
Water acidity / pH (unit)	5.34-6.13	5.32-6.74	5.47-6.81
Dissolved oxygen ($mg.L^{-1}$)	6.31-6.12	5.11-5.81	5.14-6.37
Electrical conductivity ($\mu s.cm^{-1}$)	35-45	35-59	38-49
Oxidation reduction potential (mV)	125-145	164-251	174-356

Conclusions

This study presents preliminary data on length-weight relationships and environmental parameters for *P. tetrazona* specimens collected from the Kelekar River in the Ogan Ilir District of South Sumatra, Indonesia. The most effective model for predicting fish body weight from fish length was exponential, with the equation $y = 0.0656x^{1.9002}$ ($R^2 = 0.57$, $P < 0.01$), where y represents fish body weight, x represents fish length, and a and b are coefficients and constants, respectively. The coefficient a was 0.0656, and the constant b was 1.9002. Therefore, the weight gain of *P. tetrazona* was slower than its body length gain because the b value of 1.9002 was smaller than 3, indicating that the fish were in good condition. Environmental parameters, including water temperature, pH, dissolved oxygen, electrical conductivity, and oxidation reduction potential, are conducive to the survival of *P. tetrazona*.

Author contributions

MM: design study methods, supervise data analysis and manuscript preparation. VRY: collecting data and draft manuscript. EP: collecting data and draft manuscript. WJS: collecting data. MRAP: collecting data, design sampling maps, and data analysis, and draft manuscript.

Conflict of interest statement

We declare that there is no conflict of interest in this study.

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