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Original Article

Length-weight relationships and growth parameters of five freshwater fishes in Raban Lake, Perak, Malaysia

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Abstract

This study describes the Length-Weight relationships and growth parameters of five dominant freshwater fishes in Raban Lake, Perak, Malaysia; bonylip barb (*Osteochillus vittatus*), tinfoil barb (*Barbonymus schwanenfeldii*), tiny scale barb (*Thynnichthys thynnoides*), crossbanded barb (*Puntioplites bulu*) and Indonesian leaffish (*Pristolepis grootii*). In this study, LWRs were estimated according to the power function $W = aL^b$, while the number of opaque zones in the sectioned otolith were counted for age determination for further estimation of the von Bertalanffy growth parameters. A total of 318 individual was collected in August and October 2018 and January 2019. The LWRs reveals four species with the exception of crossbanded barb, displays negative allometric growth pattern. Growth coefficient ranged from 0.28 to 0.70, shows that these species are slow to medium growth species. The findings from this study help in understanding the ecological health of five dominant and data deficient freshwater fishes in Raban Lake, Malaysia.

Keywords: fisheries management, fish population dynamics, freshwater fishes, Raban Lake

1. Introduction

Raban Lake in Perak, Malaysia is famously known for its freshwater fishes, which supported the fermented fish industry and recreational fisheries in the area. The locally known Raban Lake is part of Chenderoh Reservoir (Desa & Aidi, 2013), host to a high diversity of freshwater fishes where 20 species from 10 families were recorded by Leng (2008). Some of the species that mostly found in this lake were bonylip barb (*Osteochillus vittatus*), tinfoil barb (*Barbonymus schwanenfeldii*), tiny scale barb (*Thynnichthys thynnoides*), crossbanded barb (*Puntioplites bulu*) and Indonesian leaffish (*Pristolepis grootii*). These fishes supported the artisanal and recreational fisheries in the area which directly attracting the fisheries related tourism activities. Freshwater fishes from the lake also supported the fermented fish industry of the locals, hence contributing to the income of the subsistence fishermen and locals who works in the fermented fish processing factory.

The abundance of freshwater fishes in this lake however may be under threat. An invasive alien species, Peacock Bass, *Cichla* sp., was found inhabited this lake, abundantly. This fish is aggressive, fast growing and prey on small native fishes, which can affect ecological imbalance in the habitat (DoA of Malaysia, 2013). Some management action should be taken to maintain and conserve the native freshwater fishes of Raban Lake, Perak but prior knowledge of their population characteristics should be well understood. The biological information of these freshwater species however is still lacking, where only a few studies has been conducted such as by Leng (2008) and Ali (1996). In addition, tinfoil barb, tiny scale barb and bonylip barb were listed as *'Least Concern'* (LC) in the IUCN Red List, while Indonesian leaffish listed as *'Not Evaluated'* (NE) and crossbanded barb listed as *'Data Deficient'* (DD) (Froese & Pauly, 2018), which calls for a research on their population characteristics such as the length-weight relationships and growth parameters to be

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conducted. The findings from this study may help in understanding the characteristics of fish population in formulation of fisheries management plan for sustainability of freshwater fishes in this ecosystem.

The study of fish LWRs can be used as an indicator of environmental changes and fish ecological health for freshwater fishes (Radhi, Fazlinda, Amal, & Rohasliney, 2018) and important for better understanding of the fish population (Velamala, Naranji, & Kondamudi, 2018). Growth parameters on the other hand, are essential for stock assessment methods and management strategies (Stergiou, 2000), as well as important for sustainable use and exploitation of their aquatic life (Saxena, Patiyal, Dude, & Tiwari, 2016). The Length-Weight relationships (LWR) is extensive in fisheries and biology studies for the conservation and management of wild fishes in aquatic system, including in freshwater ecosystem (Lawson, 2011), while growth and age structure is one of the important aspects to maintain long-term sustainable population levels (Berkeley, Hixon, Larson, & Love, 2004). Demirci (2016) supported this statement by emphasized that the growth parameters data can be used to identify biodiversity issues and for stock enhancement practices in freshwater ecosystem. This study aims to provide some population characteristics information for five dominant and data deficient freshwater fish species in Raban Lake, Perak, Malaysia by describing the LWRs and growth parameters which importance to understand fish ecological health.

2. Materials and Methods

This study was conducted at Raban Lake, Perak located at 4° 58′ N 100° 57′ E, northern part of Peninsular Malaysia, Malaysia (Figure 1). Due to logistic reason, the samples of freshwater fishes were collected in August and October 2018 and January 2019 at three randomly selected stations. The sampling was done by hook and line fishing and gillnet deployment of three different size of gillnets; 1) 50 m x 4 m, 2 inch mesh size; 2) 30 m x 3.5 m, 4 inch mesh size; and 3) 30 m x 3.5 m, 4.5 inch mesh size. Gill nets were deployed for 12 hours, twice a day (7 am- 7 pm; 7 pm- 7 am) for three days a month. The hook and line sampling method also was conducted at the same area and time as gill net deployment. Due to the number of sample collected from hook and line fishing and gillnet deployment was small (less than 20 for each species) which makes the analysis of LWRs and growth parameters are impossible, so additional samples were bought from a small fish stall located at nearby village where local subsistence fishermen sold their catch. The interview with the stall owner confirms that the fish sold at this stall was caught only from Raban Lake, Perak. Fish samples were identified; the standard length was measured to the nearest 0.01 cm by measuring board and weighed to the nearest 0.01 g by analytical balance.

LWRs were estimated for the entire sample of each dominant species according to the power function $W = aL^b$ where, W is total weight of individual for each species in grams and L is the standard length in centimeters of the fish with a and b is the y-intercept (initial growth coefficient) and slope (growth coefficient) values of the relationships respectively (Froese, 2006; Le Cren, 1951). The values of constants a and b were estimated after logarithmic

Figure 1. Map of Peninsular Malaysia, Malaysia showing the location of Raban Lake, Perak in black dot

transformation of the power function into log W = log a + blog L + ε, $\varepsilon \sim N(0, S^2)$ with addition of error term ε which assumed to be normally distributed that has zero mean and constant variance (Brodziak, 2012). In addition, the coefficient of determination r^2 and 95% confidence limits of the constants, a and b, were estimated. All statistical analysis was carried out using Excel 2010 for Windows. The growth pattern was determined following the methods by Nunes, Sousa, RêgoR, Sousa, & Bonfim, (2019) referring to the value of b where b = 3 is isometric growth; b < 3 is the negative allometric growth; and b > 3 is positive allometric.

For growth parameters analysis, a pair of otolith was extracted from individual fish by up through the gills method as described by Secor, Dean, & Laban, (1992). The techniques for embedding, sectioning, mounting and reading of the otoliths were based on the procedures described by Anderson, Morison, & Ray, (1992). In this study, the otolith was embedded in the mixture of epoxy resin and epoxy hardener. The block containing otolith then was sectioned close to the nucleus or primordium using BUEHLER Isomet 1000 precious saw to 300 µm thickness. The sectioned otolith then was polished by BUEHLER twin variable speed grinder polishing machine until a good section was obtained.

The otolith sections were mounted on glass slides with mixture of epoxy resin and hardener before covered with a cover slip. Age determination was by counting the number of opaque zones present in the sectioned otolith (Figure 2), following the procedures proposed by Anderson, Morison, & Ray, (1992) and Francis *et al*. (1992). The length-at-age data was created and was used to estimate the growth parameters.

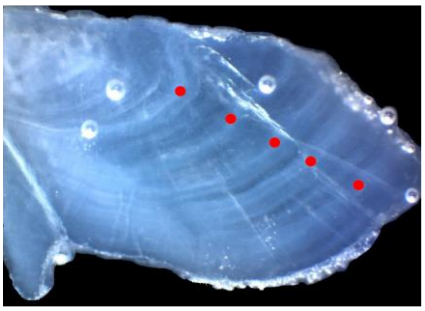

Figure 2. Example of reading plane of a sectioned otolith of five years old fish. One red dot represent one opaque zone.

The growth was described by using the von Bertalanffy Equation;

$$L_t = L\infty\ (1 - \exp\ [-\ K\ (t - t_o)])$$

where L_t is the length at age t, L_∞ is the asymptotic length that the species would reach, K is growth coefficient and t_o is the theoretical age at length zero. Initial value of K and L∞ was obtained from Ford-Walford analysis (King, 1995). The values then was inserted into non-linear regression analysis of SPSS program

Growth performance indexes (Munro & Pauli, 1983) were calculated as*:*

$$\theta = \log (K) + (2 \times \log \infty)$$

where the values of K and ∞ were obtained in growth parameters analysis.

3. Results and Discussion

During the study, there are five species that mostly found from sampling activity and in the fish stall which are bonylip barb (*Osteochillus vittatus*), tinfoil barb (*Barbonymus schwanenfeldii*), tiny scale barb (*Thynnichthys thynnoides*), crossbanded barb (*Puntioplites bulu*) and Indonesian leaffish (*Pristolepis grootii*). This study described the LWRs of the fishes in Raban Lake, Perak as shown in Table 1. A total of 318 individual fish was collected from three sampling trips; bonylip barb (n=78), tinfoil barb (n=69), tiny scale barb (n=56), crossbanded barb (n=57) and Indonesian leaffish (n=58), with the individual size ranges were presented in Table 1.

The parameter b for LWRs of all species analysis in this study ranged from 2.4735 to 3.1071, and the regression values of the relationships were more than 0.9 (r^2>0.9) with exception for Tiny scale barb (r^2=0.87). Comparison of the LWRs of each species obtained from this study (Raban Lake) and from other freshwater ecosystem in Malaysia was conducted to understand the stock condition (Bagenal & Tesch, 1978).

In terms of individual species, Tinfoil barb from Raban Lake recorded lower value of b compared to the fish in other parts in Malaysia such as Pedu Lake in Kedah (Isa *et al*., 2010), Pahang River, Pahang (Zulkafli *et al*., 2014, 2015) and in Tembeling River, Pahang (Zulkafli *et al*., 2016). Similar result was observed for bonylip barb where the value of b was lower than the fish of the same species from Pahang River, Pahang (Zulkafli *et al*., 2014, 2015) and in Tembeling River, Pahang (Zulkafli *et al*., 2016) or from Temenggor Reservoir, Perak (Muzzalifah *et al*., 2015). Tiny scale barb recorded the lower value of b compared to the fish in Pahang River, Pahang (Zulkafli *et al*., 2014, 2015). No information on LWRs was found for Indonesian leaffish in any freshwater ecosystem in Malaysia. This study also found that only crossbanded barb displayed positive allometric growth while the remaining four species showed negative allometric growth.

This study also presented growth parameters (K and L∞) of five freshwater fishes in Raban Lake, Perak as in Table 2. Sparre and Venema (1998) classified growth coefficient (K) into three category; (K) = 1.0 yr-1 is fast growth, (K) = 0.5 yr-1 is medium growth and (K) = 0.2 yr-1 is slow growth. The findings of this present study showed that Tiny scale barb (K=0.28) and Crossbanded barb (K=0.39) are slow growing species, Bonylip barb (K=0.43) falls in medium growth species, while Tinfoil barb (K=0.68) and Indonesian leaffish (K=0.7) grew just slightly faster than medium growing species but cannot be classified as fast growing species. There is limited information on growth parameters of freshwater fishes in Malaysia. There is only one reported study was found which is for Bonylip barb in Bukit Merah, Perak, where Yap (1984), stated that the L∞ and K of Bonylip barb are 27.8 cm and 1.15, respectively. This showed that the fish in Bukit Merah grew faster than the fish in Raban Lake. The difference of growth parameters however due to the different techniques used to estimate growth parameters where this present study used age-at-length data from sectioned otolith, while Yap (1984) used cohort analysis from catch-at-length data.

Comparison of K and L∞ does not make any biological contribution because fish has different growth rate during their life stages (Etim *et al*., 2002), and growth performance index (Ø*'*) is a more comprehensive method to compare the growth performance of a different population of fish species (Pauly & Munro 1984). In this study, Munro*'*s growth performance indices were analyzed for all species and the values were in between 2.42 and 3.00 as shown in Table 2. Ragonese *et al*. (2012) defined Munro*'*s growth performance indices as the growth rate of a fish of unit length, and fish with higher value of Munro*'*s growth performance indices is in better condition. In this present study, the growth performance calculated for Indonesian Leaffish in Raban Lake, Perak is lower compared to other four species.

Table 1. Estimated length-weight parameters and descriptive statistics of five freshwater fishes in Raban Lake, Perak

Species	SL (cm)			W (g)		Length-Weight parameters					Growth pattern
	N	Min	Max	Min	Max	a	95% CL of a	b	95% CL of b	r^2	
Tinfoil barb, *B. schwanenfeldii*	69	10.0	16.5	34.7	138.3	0.0597	0.0359 – 0.0990	2.7435	2.5454 – 2.9416	0.9167	Negative allometric
Bonylip barb, *O. vittatus*	78	9.0	16.8	20.5	127.6	0.0637	0.0413 – 0.0979	2.7127	2.5486 – 2.8769	0.9325	Negative allometric
Crossbanded barb, *P. bulu*	57	12.2	18.9	54.0	188.7	0.0287	0.0202 – 0.0407	3.0143	2.8823 – 3.1463	0.9733	Positive allometric
Indonesian Leaffish, *P. grootii*	58	9.0	14.8	35.7	170.4	0.0823	0.0473 – 0.1427	2.8134	2.5814 – 3.0454	0.9098	Negative allometric
Tiny scale barb, *T. thynnoides*	56	14.2	23.5	59.7	296.7	0.0400	0.0181 – 0.0882	2.7736	2.4936 – 3.0535	0.8747	Negative allometric

Table 2. Values of growth parameters and growth performance indices of five freshwater fishes in Raban Lake, Perak

Species	N	Growth parameters		Growth performance indices
		K	L∞	
Tinfoil barb, *B. schwanenfeldii*	69	0.68	36.84	2.97
Bonylip barb, *O. vittatus*	78	0.43	33.68	2.69
Crossbanded barb, *P.bulu*	57	0.39	46.63	2.93
Indonesian Leaffish, *P. Grootii*	58	0.70	19.37	2.42
Tiny scale barb, *T.thynnoides*	56	0.28	59.89	3.00

Teubner, Klein, Paulus & Wesch (2019), described that oxygen, pollution, disease and parasites, infestation, nutrition, density-dependent growth and occurrence of non-native species invasive alien species (IAS) contributed to the growth performance of fish in freshwater ecosystems. The occurrence of Peacock Bass which is one of the IAS in Malaysia, which aggressively feeding on the small native fishes (Khairul Adha, Esa & Arshad, 2013), may affect the ecological health of the native fishes of this lake. The results presented in this study may reveals that with exception for crossbanded barb, four other studied species that displayed negative allometric growth pattern and recorded lower growth performance index may be in great danger. The assumption is based on the following statements; negative allometric growth pattern shows that there are possibilities of unsuitable environmental conditions which influence the condition to the species (Radhi, Fazlinda, Amal, & Rohasliney, 2018) and, fish with higher performance index will have greater survival strategies adaptation in avoiding predator by rapidly increasing its size and reducing its risk of becoming prey (Abowei, 2010).

4. Conclusions

In conclusion, four freshwater fishes in Raban Lake, Perak which is Bonylip barb, Tinfoil barb, Tiny scale barb, and Indonesian leaffish displays negative allometric growth, while crossbanded barb shows positive allometric growth. Growth coefficient of these five freshwater fishes were in between 0.28 to 0.70, which shows that they are slow to medium growth species. Based on growth performance indices, Indonesian leaffish recorded the lowest index compared to other species. The findings from this study provides new information on the length-weight relationships, growth parameters and growth performances of five freshwater fishes in Malaysia especially for *'Data Deficient'*, crossbanded barb and Not Evaluated, Indonesian leaffish as listed in IUCN Red List Status. It is necessary to further study about the negative allometric growth of four freshwater fishes in Raban Lake, Perak or the low Indonesian leaffish's growth performance index, whether it is affected by the occurrence of an invasive alien species or other environmental factors. It is recommended that some management plan can be formulate to conserve these slow to medium growing species for future sustainability of the resources.

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