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Length-Weight Relationship and Relative Condition Factor of Fishes in Talisay and Bagac River Systems, Bataan, Philippines

Mark Nell C. Corpuz[*1,2], Hildie Maria E. Nacorda[2], Christine Marie E. Casal[2], Decibel V. Faustino-Eslava[2], Patricia Ann Jaranilla-Sanchez[2], Sonnie A. Vedra[3], Hermogenes M. Paguia[1], Ma. Victoria O. Espaldon[2]

[1]College of Agriculture and Fisheries, Bataan Peninsula State University, Bataan, Philippines, [2]School of Environmental Science and Management, University of the Philippines Los Baños, College, Los Baños Laguna, Philippines, [3]Mindanao State University at Naawan, Naawan, Misamis Oriental, Philippines

Abstract *— This preliminary study was conducted to assess the length-weight relationship (LWR), and condition factor (K) dynamics of poorly evaluated fish assemblages thriving in the Talisay and Bagac river systems (Bataan, Philippines). In Talisay, fish species including Arius manillensis, Sarotherodon melanotheron, Oreochromis niloticus, Carassius carassius, Platycepalus indicus, and Mugil cephalus were evaluated for LWR, K. In Bagac, S. melanotheron, Ambassis miops, Eleutheronema tetradactylum, O. hornorum, Carangoides hedlandensis, Glossogobius giuris, O. niloticus, and Clarias batrachus were also included in LWR and K analyses. The b values of the length-weight equations ranged from 2.20 to 3.33. In Talisay, Oreochromis niloticus and the native Platycepalus indicus attained K values greater than 1.0, whilst the rest had K < 1. In Bagac, all fish species had K values greater than 1.0, except for the A. miops and C. batrachus. Monthly observation on LWR, K, and water quality variables is open for further investigation. It is hoped that the baseline dataset generated from this study can be used for improved conservation management of native riverine fish faunas and their habitat.*

Keywords — *Balanga, endemic, fish assemblages, growth coefficients,*

I. INTRODUCTION

Morphological analyses are widely used to evaluate the population dynamics, biology, and ecological condition of different aquatic resources (Sangun et al 2007; Isa et al. 2012; Santos et al. 2020). Length-weight relationship (LWR), for instance, is a fundamental indicator for fish stock assessment and can be used in estimating fish weight from a given length (Froese 2006). In addition, the length-length relationship is important in fisheries management for comparative growth studies (Moutopoulos and Stergiou 2002; Corpuz et al. 2013). Length and weight data of fish are also used to obtain invaluable information such as the stock biomass, growth, and fish condition (Sangun et al. 2007; Das and Bordoloi 2013; Ayo-Olalusi, 2014). Further, the physiological state or condition factor (K) of the fish calculated from length and weight data could reflect the present ecological status of aquatic environments. The heavier the fish species of a given length, the better the physiological condition, indicating the abundance of food in the respective habitat (Bagenal and Tesch 1978).

Looking at the aforementioned evidence, length, and weight data can provide vital information not only on the fish species involved but also on the environment in which the fish live. However, available data particularly on the biology of fluvial fish assemblages in Bataan are considerably scanty and requires further (Romero et al. 2016; Corpuz and Espaldon 2023). River systems are impacted by various anthropogenic disturbances and for this reason, ecological evaluation is necessary to assess the ecological integrity of streams (Roque et al. 2019). The study could provide an invaluable database that could be useful in fishery management and conservation of both stream freshwater fishes and aquatic environments in Bataan, Philippines. As no studies are focused on such, this research could catalyze the efforts on the protection and preservation of the selected Bataan rivers. The aim of the study was to evaluate the growth coefficient, and condition factor dynamics of selected stream fishes in Bataan, Philippines. Specifically, the study aims to determine and compare the LWR of fluvial fish assemblages based on the samples collected from Talisay and Bagac; and to evaluate the variability of the condition factors of fish assemblages from selected streams in Bataan.

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II. MATERIALS AND METHODS

A. *Collection Sites*

The fish specimens were collected directly in the two main rivers of Bataan, Philippines (Figure 1). Talisay River is one of the largest river systems of Bataan that separates the Municipality of Pilar and Balanga City. The main sources of water are coming from the upstream of Liyang Pilar and run 13 km before emptying into Manila Bay. On the other hand, Bagac River is located in the northwestern portion of Mount Mariveles (Luzon Island) and water-fed by the springs and run-offs from highlands and adjacent tributaries before draining to the West Philippine Sea. The fish specimens were collected every three months (February until November 2021) through the help of local fisherfolks.

Captured fish were immediately counted and identified at the lowest possible taxon. Specimens were immediately housed in Bataan Peninsula State University laboratory for fish analyses. Subsequently, fish specimens were preserved in 10% buffered formaldehyde solution for further documentation and identification.

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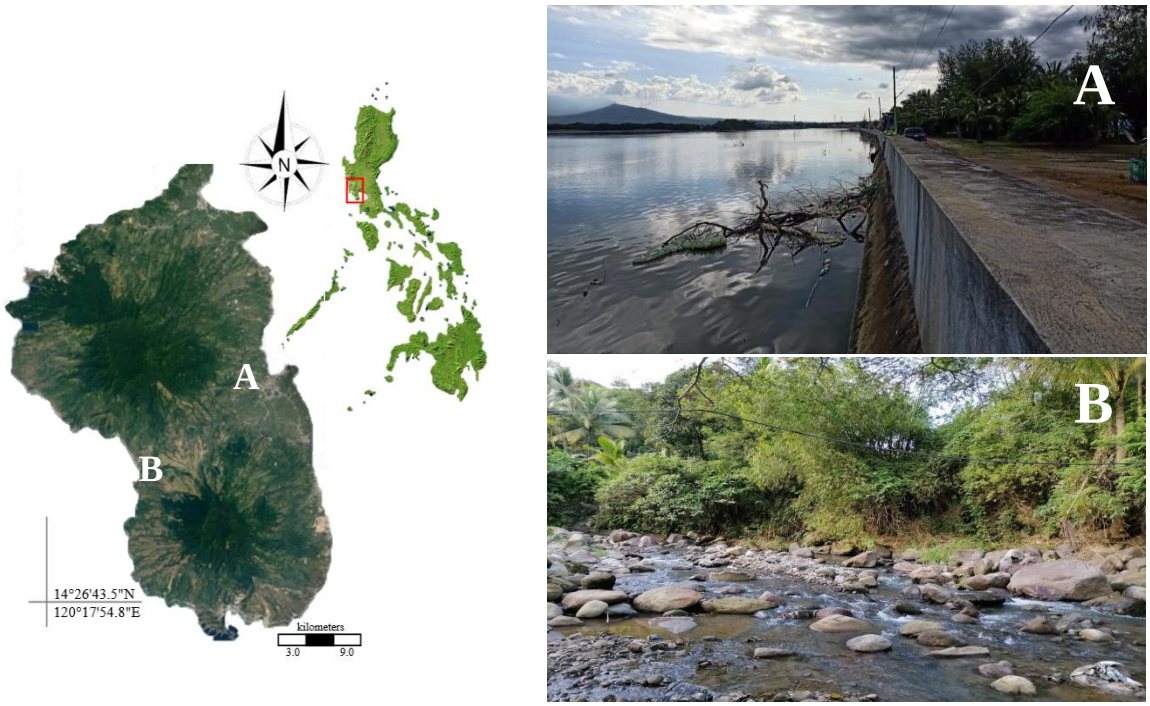

Fig. 1. Map of Bataan showing the collection sites (A) Tagumpay in Orani and (B) Parang in Bagac

B. *Fish Analysis*

Selected fishes were measured in the laboratory for total length (TL) (Figure 2) to the nearest 0.01 mm using a Vernier caliper and the weight of the fish was determined using a weighing scale to the nearest 1 g.

Fish length and weight relationship were estimated using the function $W = aTL^b$; where W is fish weight (g.), TL is the fish total length (mm), *a* is the regression intercept and b is the regression slope (Ricker 1973). The transformation of fish length and weight was used to determine *a* and *b* (Froese 2006). The fish body condition factor was estimated using the function:

$$K = \left(\frac{w}{aL^b}\right)$$

where w is fish body weight (g), L is total length (mm), and n is the number of individuals of the fish species (Le Cren 1951; Froese 2006).

The growth patterns of the species determined by the *b* calculated from the linear equation of the length-weight relationship were tested using a *t*-test as described by Froese (2006) (Santos et al 2020). The value of *b* will be tested for theoretical value for isometry: when $b = 3$, growth was regarded as isometric, $b < 3$, negatively allometric, and $b > 3$, positively allometric ($P < 0.05$). SPSS v21 and SigmaPlot v 13 were used for statistical analyses.

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III. Results and Discussion

A. Length-Weight Relationships

The estimated LWR parameters of various fish species collected in Talisay and Bagac are summarized in Table 1. The computation of LWRs and *K*s was limited to those 12 fish species as they were the only species represented by more than ten (10) individuals in the total fish individuals (Moutopoulos and Stergiou 2002). In general, exotic cichlids *viz, Sarotherodon melanotheron* and *Oreochromis niloticus* are the species present in both rivers. The *b* values of the length-weight equations among the studied species ranged from 2.20 to 3.33. In Talisay, the smallest *b* value was 2.20 for *S. melanotheron,* while the highest was 3.11 for *Platycepalus indicus.* In the case of Bagac, the smallest *b* value was 2.25 for *Ambassis miops* while the highest was 3.33 for *Carangoides hedlandensis*.

Table I.
Species composition, abundance, total length (TL) and weight (mean ± SD), and linear regression of fishes collected from Talisay and Bagac river system in Bataan, Philippines.

Fish Species	*n*	Mean TL (cm)	Mean weight (g)	*a*	*b*	r^2
Talisay						
Arius manillensis	134	20.38 ± 4.93	91.05 ± 61.89	0.03	2.75	0.79
Sarotherodon melanotheron	118	10.88 ± 3.16	30.77 ± 20.98	0.10	2.20	0.99
Oreochromis niloticus	30	13.04 ± 3.79	52.74 ± 46.79	0.07	3.04	0.85
Carassius carassius	44	15.78 ± 3.55	48.96 ± 40.99	0.08	2.92	0.92
Platycepalus indicus	19	10.82 ± 1.54	15.28 ± 5.67	0.07	3.11	0.96
Mugil cephalus	38	14.44 ± 2.99	34.43 ± 24.54	0.02	2.86	0.94
Bagac						
Sarotherodon melanotheron	134	13.98 ± 3.98	71.33 ± 66.45	0.02	3.10	0.98
Oreochromis niloticus	50	10.17 ± 1.04	24.23 ± 7.57	0.05	2.68	0.84
Oreochromis hornorum	12	9.30 ± 0.60	19.16 ± 3.46	0.04	2.75	0.88
Ambassis miops	56	8.82 ± 1.03	11.30 ± 3.86	0.08	2.25	0.72
Eleutheronema tetradactylum	23	12.07 ± 0.77	16.22 ± 2.81	0.02	2.67	0.88
Carangoides hedlandensis	35	10.17 ± 3.19	20.32 ± 17.39	0.01	3.33	0.97
Glossogobius giuris	12	7.76 ± 6.41	11.77 ± 24.07	0.02	2.56	0.99
Clarias batrachus	13	21.02 ± 4.30	81.69 ± 35.50	0.02	2.77	0.93

The LWR is a very important tool in fisheries assessment as it provides information on the growth patterns of animals (Morato et al. 2001). The present study revealed that most of the fishes had negative allometric growth ($b < 3$) except for the *O. niloticus, P. indicus, S. melanotheron* (Bagac specimens), and *C. hedlandensis* which had positive allometric growth ($b > 3$). A negative allometric growth implies that the fish is becoming thinner as it increases in weight; hence, the fishes become slender. A positive allometric growth, on the other hand, implies that the fish becomes relatively stouter or deeper-bodied as it increases in length (Riedel et al. 2007). Obviously, the assessed fish samples had varying growth patterns which was largely due to, not only to the inherent capacity of the fishes to grow but also to their capabilities to adapt to their environment. In general,

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almost all of the *b* values calculated in the present study were in accordance to the expected normal range of *b* which is between 2.5 to 3.5 (Froese 2006).

Among the fish samples, only the *S. melanotheron* had LWR and K values from the two sampling sites. The most evident finding is that the *S. melanotheron* from Talisay had negative allometric growth ($b < 3$), while the population from Bagac displayed positive allometric growth ($b < 3$). The growth pattern of *S. melanotheron* from Almacen was similar to those reported by several authors. According to Atama et al (2013), the growth of *S. melanotheron* from Lagos and Benin was also observed to be negatively allometric. The same was also observed by Anwa-Udondiah and Pepple (2012), where the fish also manifested negative allometic growth when cultured in sheltered outdoor tanks. Meanwhile, a positive allometric growth of *S. melanotheron* from Bagac was observed in the present study. This indicates that the fish become stouter as it increases in length. This particular growth pattern could be attributed to the combination of two or more factors such as the availability of food, environmental conditions, population, sex, reproductive status of the fish, and other ecological conditions (Nehemia et al. 2012; Freitas et al. 2017). Positive allometric growth was also an indication of better growth of the fish in Bagac than in Talisay.

The *b* values reported in previous and present studies were always different from one another. This can be attributed to differences in sexes, area/season effect, and differences in the number of specimens examined (Moutopoulos and Stergio 2002). Further, variations in the *b* values of a species within the same habitat could also be observed which could be attributed to various parameters including feeding rate (Tarkan et al. 2006), degree of gut fullness (Hossain et al. 2012), sexes (Roque et al. 2022), response to habitat and environmental variables (Khallaf et al. 2003), and reproductive behavior (Muchlisin et al. 2010).

B. Condition Factor Dynamics

In general, the condition factors of several fishes assessed in the study were all more than or near the ideal *K* value of 1 (Figure 2 and Figure 3). In Talisay, the introduced *O. niloticus* and the native *P. indicus* attained *K* values greater than 1, while the other speices obtained *K* values slightly lower than 1. On the other hand, almost every fish species assessed in Bagac manifested *K* values greater than 1.0 except for the *A. miops* and *C. batrachus*. The observed *K* values of assessed fishes between rivers suggest that the Bagac river offers a more suitable environment for its aquatic fauna than Talisay. As discussed, the condition factor is an index reflecting the interaction between biotic and abiotic factors in the physiological conditions of fishes. It is based on the hypothesis that heavier fishes of a given length are in better condition (Santos et al. 2020). Similar to the *b* values, *K* values may vary among fish species in different locations due to differences in the sexes, sexual maturity, season, food availability, and other environmental factors (De Leon et al. 2017; Hamid et al 2015). Overall, the calculated *K* values of various fish species imply that the Talisay and Bagac are still in good condition.

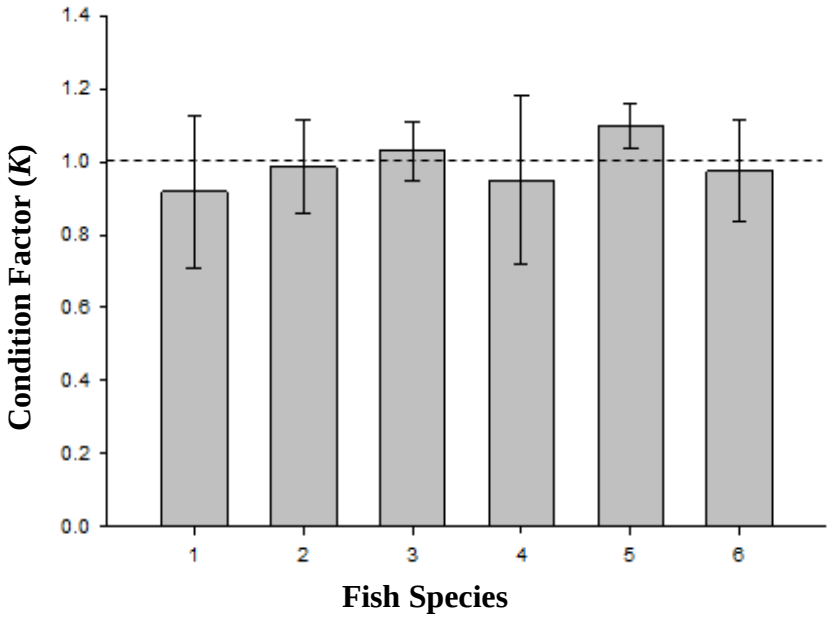

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Fig. 2. Condition factor of fishes collected from Talisay river systems. (1) *Arius manillensis*, (2) *Sarotherodon melanotheron*, (3) *Oreochromis niloticus*, (4) *Carassius carassius*, (5) *Platycepalus indicus*, and (6) *Mugil cephalus*. Dashed line represents the ideal *K* value. Error bars = SD.

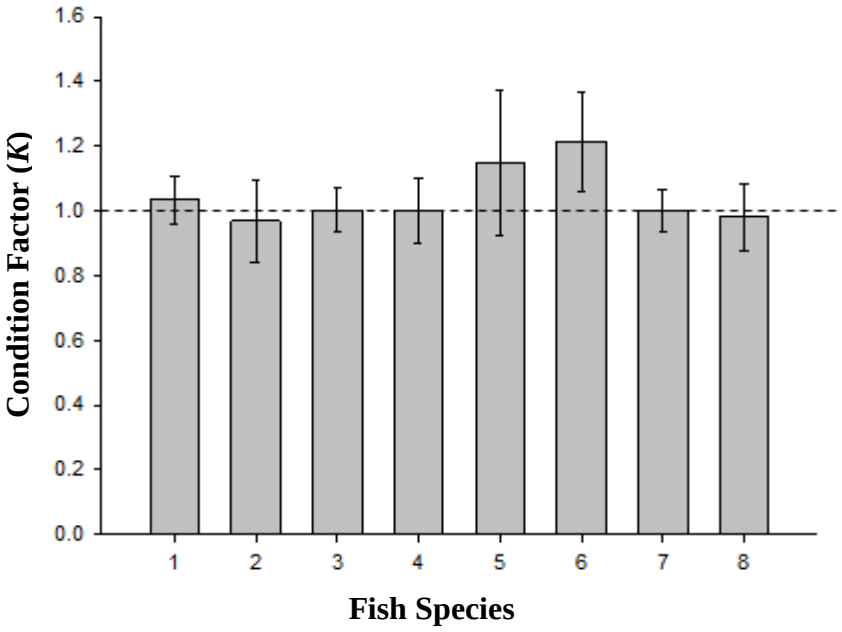

Fig. 3. Condition factor of fishes collected from Bagac river systems. (1) *Sarotherodon melanotheron*, (2) *Ambassis miops*, (3) *Eleutheronema tetradactylum*, (4) *Oreochromis hornorum*, (5) *Carangoides hedlandensis*, (6) *Glossogobius giuris*, (7) *Oreochromis niloticus*, and (8) *Clarias batrachus*. Dashed line represents the ideal K value. Error bars = SD.

IV. Conclusions and Recommendations

The present study provides evidence on the ecological health status of fish assemblages in the studied river systems. Despite the variabilities in LWR of the representative fish species, the condition factor, with values being closed to 1.0 signified the wellbeing of the studied fishes. The results also explain the fair condition of the river, particularly the sub-habitats where the fish species are thriving.

Related study can be done in other river systems in Bataan and the Central Luzon to further shed-light the conservation status of fluvial fish assemblages. Also, monthly monitoring of LWR and condition factor of fish assemblages complemented with water quality analyses can be performed for future investigation of the riverine ecological health condition.

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