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Length Weight Relationship and Condition Factor of Four Commercial Fish Species in Pathein Area, Ayeyarwady Region, Myanmar

Hsan Win[1]*, Nant Ei Myat Soe[1], Win Lai Lai Htay[1]

[1]Department of Marine Science, Pathein University, 10014, Pathein, Ayeyarwady Region, Myanmar

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Contact
*Hsan Win
hsanwin.ms@gmail.com (HW)

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Abstract
The present study was carried out length-weight relationship for four commercially important fish species namely *Lates calcarifer, Otolithoides pama, Polynemus paradiseus,* and *Tenualosa ilisha* from Koon Annawar Fishing Landing Center, Ayeyarwady Region, Myanmar. The three species *Lates calcarifer, Polynemus paradiseus,* and *Tenualosa Ilisha* were negative allometric but only one species *Otolithoides pama* was positive allometric. The value of 'b' ranged from 1.95 to 3.13 and the coefficient of determination 'r' values ranged from 0.71 to 0.97. Moreover, the mean condition factor of four commercial fish species was 1.70±2.50 (*L. calcarifer*), 0.69±2.23 (*O. pama*), 1.04±1.97 (*P. paradiseus*), and 1.65±2.20 (*T. ilisha*), indicating that its growth rate condition has perfected because the value of 'K' is greater than 1 so these species suitable for culture interest. Difference of length and weight of four commercial fish species were presented.

Keywords
Commercial fish, condition factor, length-weight relationship, Pathein Area, Myanmar

1. Introduction

The growth of a fish is defined as the change in size regarding time and weight is expressed as a function of length (Dars, et al., 2010). The habitat condition of fishes has a direct proportional relationship with length-weight (Kachari, et al., 2017). Length-weight relationship databases are important for fish biology, health, population dynamics, understanding of the ecosystem, fisheries management, and conservation. It has been widely used to estimate the mean weight of the fish based on the known length (Beyer, 1987).

The LWR has a wide application in delineating the growth patterns during their developmental pathways, in measuring the yield of fish from water masses, etc. (Kar, et al., 2005) and it is based on the hypothesis that heavier fish of a given length are in better condition than lighter fish of same length from the same population (Froese, 2006). It also allows estimating a fish population's productivity and biomass (Hossain, 2010).

It is also important to note that the physio-chemical parameters of water influence vertical and horizontal migrations of fishes in aquatic ecosystems, their distribution, and feeding patterns (Imam, et al., 2010). This relationship is used by fishery researchers and managers for two main purposes: one is to predict the weight from the length of a fish and the second is to compare the average associated parameters between fish groups spatially or temporally (Muzzalifah et al., 2015).

The Condition Factor (K) is used to compare the 'condition', 'fatness', or well-being of fish (Usman, 2012). This factor is calculated with the intention of describing the "condition" of a particular fish from the relationship drawn between the weight of the fish and its length (Froese, 2006). The condition factor usually increases with sexual maturation (Dutta et al., 2012). The length-weight relationship is used to obtain information about the condition of fish to determine whether somatic growth is isometric or allometric.

The LWR parameters and condition factor have been found very useful to evaluate the well-being of populations, and their biology for scientific management of fisheries in stock assessment (Ujjania, 2012).

The aims of this study are 1) to estimate the length-weight relationship for providing baseline data and biological knowledge of fish, and 2) to determine the condition factor of four commercial fish species in study area.

The research question of the present study is what factors affect the length-weight relationship in fish? The hypothesis of this research is body shape plays a significant role in the length-weight relationship of fish because it affects both their overall volume and density, which in turn influences their weight.

2. Materials and Methods

2.1. Sampling of Fish

A total number of 400 individuals of four commercial fish species such as *Lates calcarifer, Otolithoides pama, Polynemus paradiseus*, and *Tenualosa ilisha* were randomly collected from Koon Annawar Fishing Landing Center in February 2025 (Fig. 1).

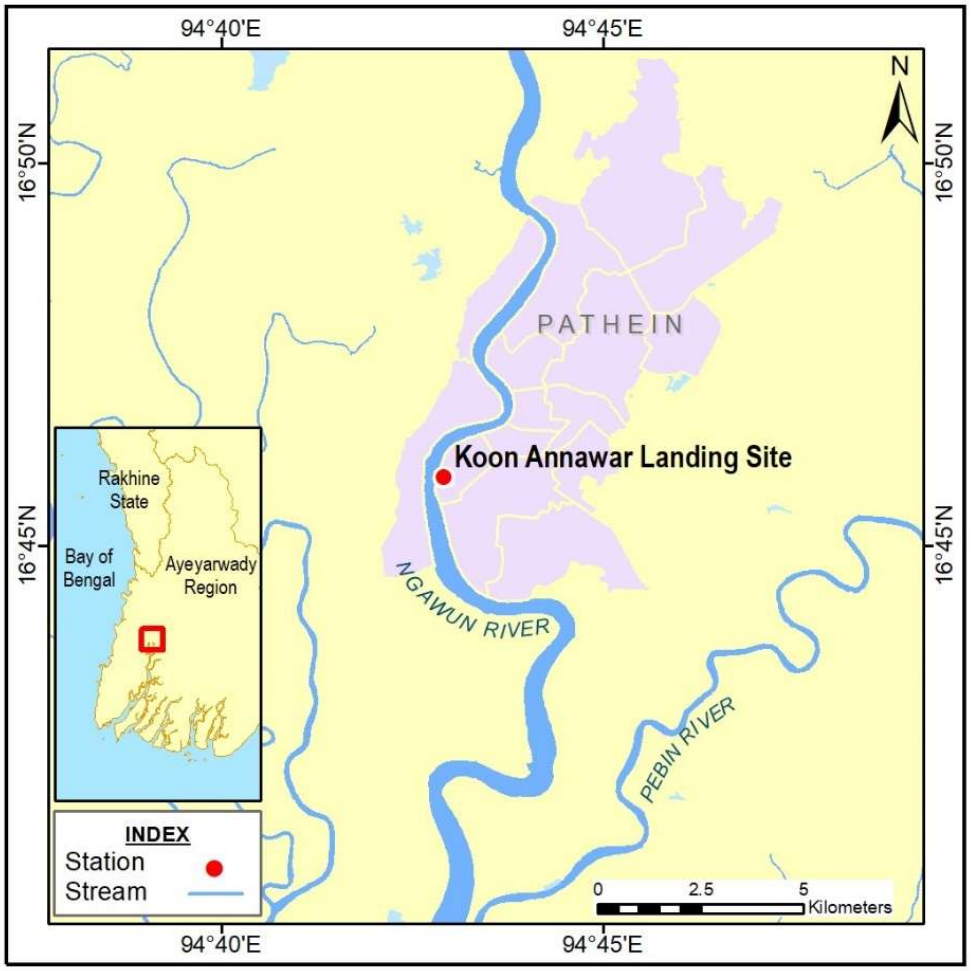

Fig. 1. Map showing the collection site of present study

2.2. Determination of Length-Weight Relationship

The total length (cm) of each fish was taken from the tip of the snout (mouth closed) to the extended tip of the caudal fin using a measuring board. Body weight was measured to the nearest gram using Electronic Digital Balance. The length-weight relationship (LWR) of identified fish species was analyzed by using the following equation:

$$W = aL^b \text{ (Ricker, 1975)} \quad (1)$$

where; W = weight of fish (g), L = total length of fish (cm), a = constant (intercept) and b = growth exponent (slope).

Logarithmic transformation of the LWR was done by using the above equation to determine the linear regression analysis scatter diagrams of length and weight were plotted and the outliers were excluded (Froese et al., 2011).

$$Log\ W = log\ a + b\ log\ L \quad (2)$$

2.2.1. Condition Factor (K)

The condition factor (K) was calculated by using the total length and body weight data of fish samples as follows:

$$K = 100\ x\ W/L^3 \text{ (Fulton, 1904)} \quad (3)$$

where; K = condition factor, W = total weight of fish (g), L = total length of fish (cm).

3. Results

3.1. Description of Four Commercial Fish Species

3.1.1. *Lates Calcarifer*

Common name: Gaint Perch
Local name: ka-ka-dit
Fins: D VII+I/11-12; P_1 16-17; P_2; I/6; A III/8-9
Distribution, Biology, and Fisheries: Bangladesh, India, Pakistan, Myanmar, and Thailand; also, southward to Queensland (Australia) and westward to East Africa. Breed in the sea in summer. Juveniles enter estuaries at a length of 1-2 cm. Feed on copepods and amphipods. Larger prey on fish fry (Bloch, 1970) (Fig. 2).

Fig. 2. *Lates calcarifer*

3.1.2. Otolithoides pama

Common name: Pama Croaker
Local name: nga-poke-thin
Fins: D IX+I/41–45; P1 17; P2 I/5; A II/7; C 17
Distribution, Biology, and Fisheries: Indo-Pacific: Pakistan to Papua New Guinea found in coastal waters, estuaries and rivers. Some are distributed in the estuarine waters, even up to a depth of 350 m. Mature individuals are multiple spawners, breeding 2-3 times a year (Hamilton, 1822) (Fig. 3).

Fig. 3. *Otolithoides pama*

3.1.3. Polynemus paradiseus

Common name: Paradise Threadfin
Local name: nga-pon-nar/nga-hmwe-ni
Fins: D VIII; I/13-15; A II/15-17; P. 16-17/7 free filaments
Distribution, Biology, and Fisheries: Bay of Bengal; also, westward to Pakistan, Central Indo-west Pacific Regions. Live over shallow sandy bottoms, regularly entering fresh waters. Feed mainly on crustaceans (especially shrimps) small fishes and bottom living organisms. Caught in shallow waters of the continental shelf and lower reaches of rivers. Important in commercial products, fresh and frozen (Linnaeus, 1758) (Fig. 4).

Fig. 4. *Polynemus paradiseus*

3.1.4. Tenualosa ilisha

Common name: Hilsa Shad
Local name: nga-tha-lauk
Fins: D 17-19; P1 14-16; P2 8; A. 18-23; C 19
Distribution, Biology, and Fisheries: Indian Ocean: Persian Gulf eastward to Myanmar, including western and eastern coasts of India. Schooling in coastal waters and ascending rivers for as much as 600 km (usually 50-100 km). Feeds on plankton, mainly by filtering, but also by grubbing on muddy bottoms. Breeds are mainly in rivers during the southwest monsoon (also from January to February to March). It is known to be a fast swimmer, covering 71 km in one day. It is exclusively caught using Hilsa Shad drift and seine nets. It is marketed fresh or dried and salted (Hamilton, 1822) (Fig. 5).

Fig. 5. *Tenualosa ilisha*

3.2. Length-weight Relationship Aspects of Four Commercial Fish Species

The aspects of four commercial fish species were based on the following criteria.

Body shape classifications: Fish can be categorized into different shapes: fusiform (streamlined), laterally compressed (flattened), and elongated (like eels). Each shape has a distinct volume-to-length ratio, impacting weight for a given length.

Volume and surface area: The volume of a fish increases with the cube of its length, while surface area increases with the square. Fish with a more rounded or deeper body shape may have a higher volume for the same length compared to a more elongated fish, leading to differences in weight.

Growth patterns: Different body shapes have unique growth patterns. For instance, fish with a more streamlined shape often exhibit different growth rates and weight gain compared to bulkier fish. This affects how weight scales with length- some species may grow faster in weight than length as they mature.

Gonadal development: In many species, the body shape may also change with reproductive status, as fat and gonadal tissues can increase weight. For example, a female fish may become heavier when developing eggs, altering the length-weight relationship.

Habitat and behavior: Fish that inhabit different environments (e.g., predator vs. prey) may evolve distinct body shapes. For example, fish adapted for quick, agile movement may be more elongated, while those that need to store energy or withstand pressure might be rounder, affecting their weight relative to length.

a and b: b are constants that can vary based on body shape, species, and other factors. For instance, a higher value of b. b indicates a more significant increase in weight as length increases, which can correlate with depth and body shape. Understanding these influences is crucial for fisheries management, stock assessments, and ecological studies. During the present study, the length-weight relationship and condition factor of four commercial species belonging to 4 families were studied. The total number of 400 individual of fish, represented by the species of *Lates calcarifer, Otolithoides pama, Polynemus paradiseus,* and *Tenualosa ilisha* were calculated and observed from Koon Annawar Fishing Landing Center, Ayeyarwady Region, Myanmar.

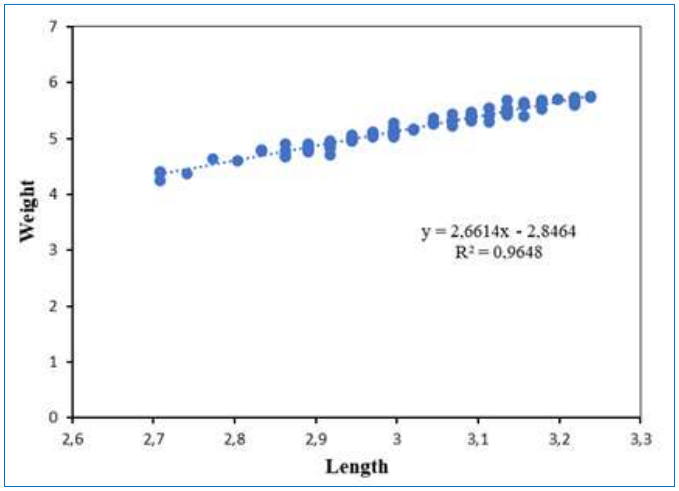

Fig. 6. Length-weight relationship of *Lates calcarifer*

The species, min-max length, min-max weight, and the standard division of mean and standard error are presented in Tables 1 and 2. Total length of four commercial fish species ranged from 15 cm to 25.5 cm (*Lates calcarifer*), 12 cm to 27.5cm (*Otolithoides pama*), 9 cm to 22 cm (*Polynemus paradiseus*) and 19 cm to 23.5 cm (*Tenualosa ilisha*) while the body weight ranged from 69.95 to 314.38 g (*Lates calcarifer*), 25.56 g to 343.6 g (*Otolithoides pama*), 10.76 g to 174.2 g (*Polynemus paradiseus*) and 148.45 g to 252.87 g (*Tenualosa ilisha*) respectively.

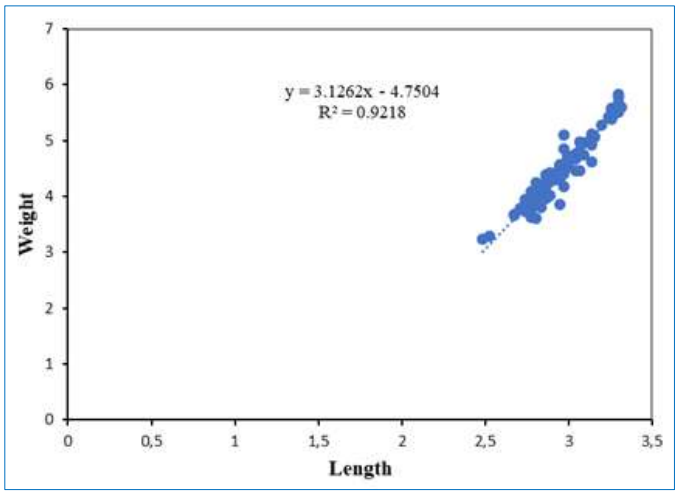

Fig. 7. Length-weight relationship of *Otolithoides pama*

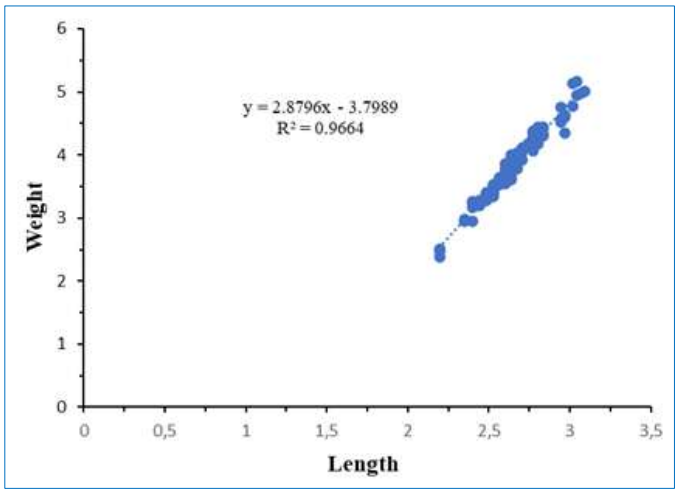

Fig. 8. Length-weight relationship of *Polynemus paradiseus*

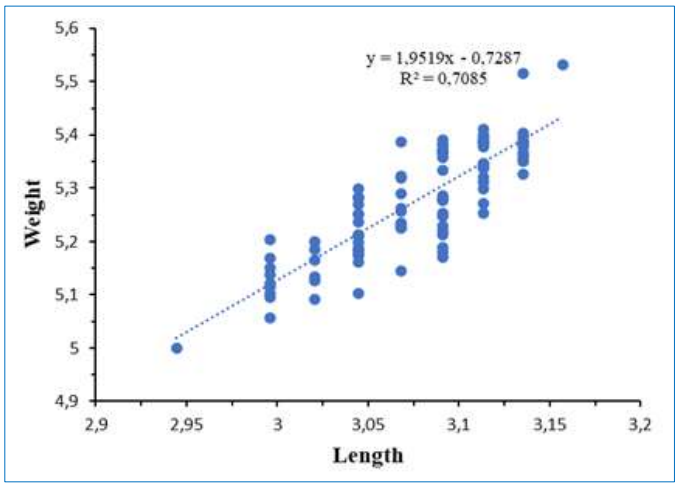

Fig. 9. Length-weight relationship of *Tenualosa Ilisha*

The length-weight relationship parameters of linear equation, regression coefficient (a, b, r), Z value, critical point and

standard deviation were described in table 3. The growth pattern in four fish species, *O. pama*, showed positive allometry (b > 3), *L. calcarifer, P. paradiseus* and *T. ilisha* showed negative allometry (b < 3).

During the study period three species showed negative allometric growth (b<3) and one species showed positive allometric growth (b>3). According to the result, the length weight relationship, showed that *L. calcarifer* (r = 2.09), *O. pama* (r = 1.27), *P. paradiseus* (r = 1.64) and *T. ilisha* (r = 1.93) are significantly correlated between length and weight (Table 3 and Figs 6–9)

The values of mean condition factors are described in table 3. The mean condition factor (K) among the four species of fish showed significant differences (P < 0.05), which was estimated to be elevated in *L. calcarifer* (2.09) followed by *T. Ilisha* (1.93), *P. paradiseus* (1.64) and *O. pama* (1.27), respectively. According to the result, the growth rate of the four species is good because the value of the mean condition factor (K) is greater than one. The maximum value of the mean condition factor was found in *Lates calcarifer* (2.09) and the maximum value of 1.27 was found in *Otolithoides pama.* The critical point of the four commercial species was non-significance in table 3. Difference of length and weight of four commercial fish species showed in Fig. 10.

4. Discussion

The present study was conducted on the length-weight relationship and condition factors of four selected fish species: *Lates calcarifer, Otolithoides pama, Polynemus paradiseus,* and *Tenualosa Ilisha.*

The length-weight data were considered to establish the growth patterns of the fish species. The value of "b" was calculated to find out whether the fish is growing allometrically or isometrically. If the "b" value is 3.0, the growth is isometric. If the value of "b" becomes greater than 3 as the fish becomes fatter, or when the "b" value is lower than 3, the fish is slimmer (Veeramani et al., 2010).

Table 1. Length analysis of four commercial fish species Koon Annawar Fishing Landing Center

No	Species	Min	Max	Mean±SD	Confidence level	SE
1	*Lates calcarifer* (Bloch, 1970)	15	25.5	20.83±2.78	0.55	0.28
2	*Otolithoides pama* (Hamilton, 1822)	12	27.5	19.64±3.57	0.71	0.37
3	*Polynemus paradiseus* (Linnaeus, 1758)	9	22	14.38±2.81	0.56	0.28
4	*Tenualosa ilisha* (Hamilton, 1822)	19	23.5	21.69±0.96	0.19	0.10

Table 2. Weight analysis of four commercial fish species Koon Annawar Fishing Landing Center

No	Species	Min	Max	Mean±SD	Confidence level	SE
1	*Lates calcarifer* (Bloch, 1970)	69.95	314.38	195.19±67.47	13.39	6.75
2	*Otolithoides pama* (Hamilton, 1822)	25.56	343.6	108.16±70.70	14.0.3	7.07
3	*Polynemus paradiseus* (Linnaeus, 1758)	10.76	174.2	53.62±32.84	6.52	3.28
4	*Tenualosa Ilisha* (Hamilton, 1822)	148.45	252.87	196.42±20.13	3.99	2.01

Symbols: *SD = Standard deviation, SE = Standard error*

Table 3. Estimated parameters of the Length-weight relationship of four commercial fish species from Koon Annawar Fishing Landing Center

No	Species	Linear Equation	Regression coefficient			Z *(P 0.05)* value	Critical point	Stdev. Diff	K
			a	b	r				
1	*Lates calcarifer* (Bloch, 1970)	y = 2.6614x - 2.8464	-2.85	2.66	0.96**	NS	NA	64.76	2.09 (1.70-2.50)
2	*Otolithoides pama* (Hamilton, 1822)	y = 3.1262x - 4.7504	-4.75	3.13	0.92**	NS	PA	67.34	1.27 (0.69-2.23)
3	*Polynemus paradiseus* (Linnaeus, 1758)	y = 2.8796x - 3.7989	- 3.80	2.88	0.97**	NS	NA	30.17	1.64 (1.04-1.97)
4	*Tenualosa ilisha* (Hamilton, 1822)	y = 1.9519x - 0.7287	-0.73	1.95	0.71*	NS	NA	19.33	1.93 (1.65-2.20)

Symbols: *NS = Non-significance, NA = Negative allometric, Stdev. Diff = Standard deviation difference, K = Condition factor of coefficient, a = intercept, b = slope of the linear regression, r = coefficient of determination, ** = very strong positive correlation, * = strong positive correlation*

In the present study, the LWR of the *Lates calcarifer* was negative allometric growth because the value of 'b' is less than 3 (b<3). Negative allometric growth grows faster in length than in weight. The LWR is $W = 0.0581\ L^{2.661}$ and the 'r' value is 0.96.

The present study revealed a negative allometric growth pattern for *Lates calcarifer*, with similar findings b =2.683, r =0.988 (for male), b =2.661, r =0.964 (for female,) and the "K" value was smaller than the present finding occurs in Chilika Lagoon, India (Karna et al., 2012). The regression value obtained in the present study is found to be less than that of the previous report for *L. calcarifer* reared seabass in the laboratory (b = 3.0347) (Volvich and Appelbaum, 2001).

In *Otolithoides pama*, the 'b' value is greater than 3 (b>3), indicating positive allometric growth, where weight increases at a faster rate than length. The length-weight relationship (LWR) for *O. pama* is expressed as $W = 0.0086\ L^{3.126}$, and the coefficient value 'r' is 0.92, demonstrating a strong correlation between length and weight.

In the present finding, the 'b' value of 3.13 for *Otolithoides pama* is not similar to Bhakta et al. (2019) who stated the "b" values of 2.8758 (male), 2.8355 (female) and 2.8585 (pooled). Nath et al. (2004) stated a "b" value of 3.17 for *O. pama*, which is similar to the present study, and Baitha et al. (2018) reported a pooled 'b' value of 2.86 from the lower Ganga River of West Bengal., which is not similar with the present

study. Hossain et al. (2015) reported the LWR of *O. pama* from the Tetulia River of Bangladesh, and 'b' values were mentioned as 3.02. The observed differences in 'b' values may be due to the combination of one or more factors like habitat, area, seasonal effects, the degree of stomach fullness, gonad maturity, sex ratio, health condition, preservation techniques, and length groups of studied specimens (Tesch, 1971).

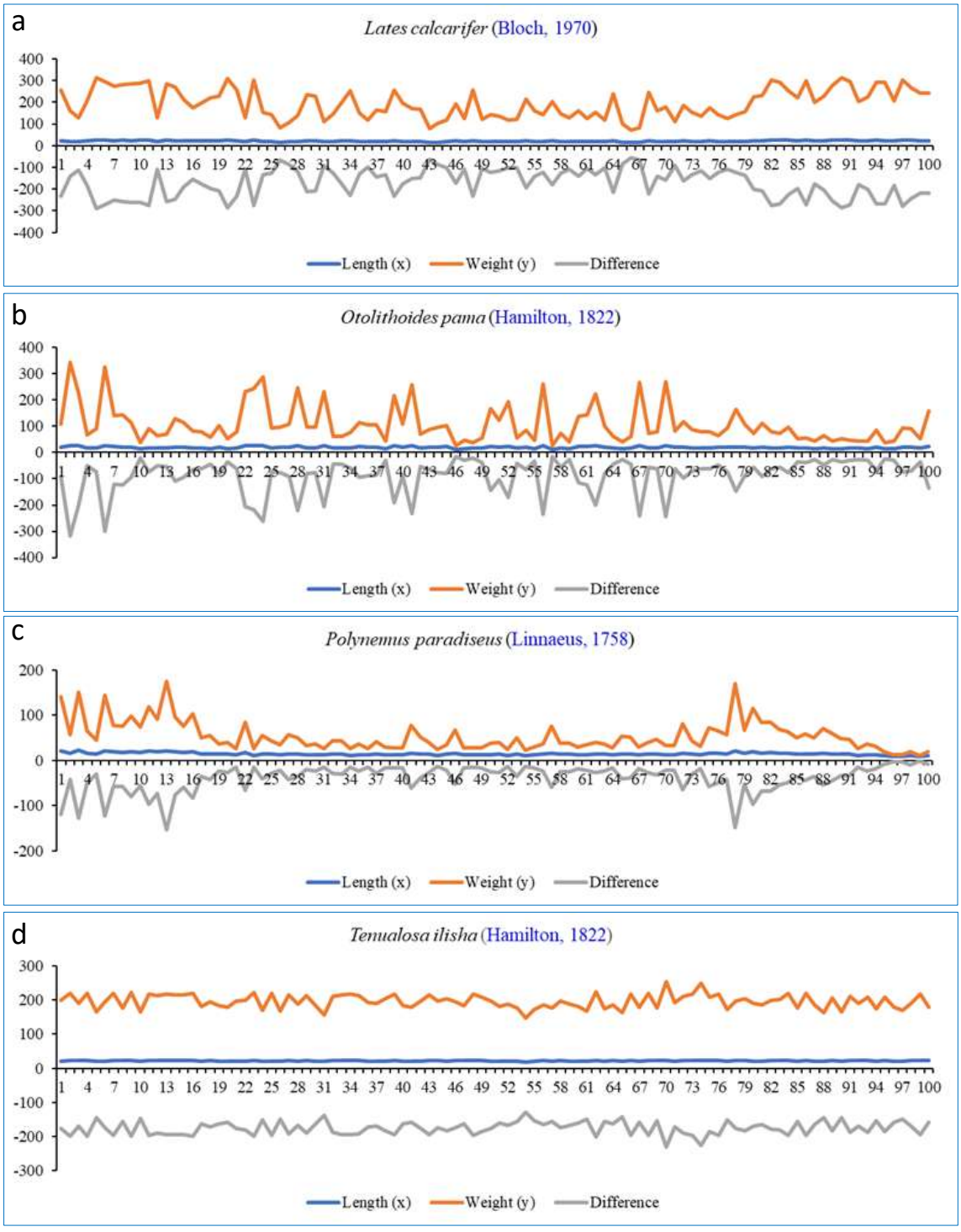

Fig. 10. Difference of length and weight of four commercial fish species: a) *Lates calcarifer,* b) *Otolithoides pama,* c) *Polynemus paradiseus* and d) *Tenualosa ilisha*

The LWR of *Polynemus paradiseus* was $W = 0.022\ L^{2.88}$ where the correlation coefficient value (r) was 0.97. The negative allometric growth of *P. paradiseus* was found so that the 'b' value is less than 3 (b<3). A similar finding was reported in the population dynamics of *Polynemus paradiseus* from the estuarine set bag net fishery of Bangladesh and found the 'b' value as 2.740 with negative allometric growth (Nabi et al., 2007). Nabi et al. 1999 found the positive allometric growth of *P. paradiseus* with 'b' values was 3.389 and 3.512 for male and female species, respectively from the Bay of Bengal of

Bangladesh and Hossain et al. (2015) found a 'b' value of 3.23 from the Tetulia River, southern Bangladesh, which are not similar with present study.

The LWR of *Tenualosa ilisha* was W= 0.483 L1.952 where the correlation coefficient value (r) was 0.71. The negative allometric growth of *T. ilisha* was found so that the 'b' value is less than 3 (Fig. 9). Similarly, Mohanty and Nayak (2017) mentioned the relationship between the length and weight of *T. ilisha* was the negative allometric was found in Chilika Lake, Odisha, and the negative growth of *T. ilisha* from the northeast coast of India (b<3) was described by Dutta, et al. (2012).

However, Htwe (2012) reported positive allometric (b = 3.027) in Kyaikkhami Fish Landing Center and negative allometric (b = 2.423) in Mawlamyine Fish Landing Center and Ko (2020) mentioned the 'b' is 3 in Kyaikkhami Fish Landing Center, Mon Coastal Area, Myanmar, which values differ from the present study. Nurul et al. (2005) also reported that the growth relationship between the length and weight of the fish was positive allometric (b = 3.381, b >3).

The variations in the 'b' value may also depend upon various factors like some specimens examined, condition of places of sampling, sampling season, etc. (Gokce and Cengiz, 2007). Even though the change of b values depends primarily on the shape and fatness of the species, also depends upon various factors like temperature, salinity, food (quantity, quality and size), and stage of maturity (Pauly, 1984; Sparre and Venema, 1992).

The coefficient of determination 'r' for LWR is significant in all four species (*Lates calcarifer*, 0.96; *Otolithodes pama*, 0.92; *Polynemus paradiseus*, 0.97; and *Tenualosa ilisha*, 0.71) respectively which indicates that the weight increases together with the increase of length. The difference may be due to the availability of food, habitat, stomach fullness, and gonadal maturity. It may be suggested that the variation of 'r' was due to the habitat and difference in the observed length ranges of the four selected fish species.

Condition factor is an index reflecting an interaction between biotic and abiotic factors in the physiological condition of fish. Therefore, the condition factor may vary among fish species in different locations. Condition factor greater than or equal to 1 indicates a good level of feeding and proper environmental conditions (Ujjania et al., 2012). Based on the results, the highest value of "K" > 1 showed the perfect condition for four species.

5. Conclusion

In this present study, the length-weight relationship of four species showed strong positive correlation and non-significance variation which support for management system of these fish species in this region. The condition factors indicate healthy status between the biological characteristics of these fish species. In the Ayeyarwady region, further research is still required to examine the seasonal effect of length-weight relationships and environmental parameters, hence, such studies are also important to improve fishery management and conservation.

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