Original Research Article

A statistical analysis of length-weight relationships (LWR) and Fulton's Condition Factor of Ocellated pufferfish, *Leiodon cutcutia* (Hamilton, 1822), from the Indo-Bangladesh Trans River: Icchamati, in West Bengal, India, with special emphasis on seasonal analysis

ABSTRACT

Aims: This study presents firsthand information on the length-weight relationship (LWR) and condition factor of the Ocellated pufferfish, *Leiodon cutcutia* (Hamilton, 1822) (family: *Tetraodontidae*), from the Ichhamati riverine estuarine zone (Indo-Bangladesh transboundary) in West Bengal, India, with a particular emphasis on morphometric relationships.

Study design: The length-weight relationship was established using $Log\ W = Log\ a + b\ Log\ L$, and the condition factor (K_n) was determined using $K = 100*W/L^3$. Ocellated pufferfish, economically significant as ornamental fish, and freshwater and estuarine fish from the Icchamati River in West Bengal, were examined for morphometric characteristics and total length (% of TL).

Place and Duration of Study: From June 2024 to August 2025, fish samples were collected seasonally (as per IMD) at 10- to 20-day intervals from various brackish water islands and fish landing centres in South 24 Parganas and the Sundarbans estuarine islands, West Bengal.

Methodology: A length-weight relationship (LWR) equation, usually written as $W = aL^b$, where W is weight, L is length, and 'a' and 'b' are species-specific constants, is frequently used to explain the link between a fish's body length and total weight. Understanding fish growth, condition, and biomass estimation is made easier by this relationship. Gillnets (4.0–40 mm), cast-nets (5 x 5 mm to 10 × 10 mm up to 4.5 m^2 areas), and scoop nets (1 × 1 mm to 6 × 6 mm) were used to gather the specimens from multiple fish landing centres.

Results: According to our findings, the Leiognathidae family showed negative allometric development ($b < 3$), which indicates that their length grows faster than their weight. seasonally, the values of the condition factor (K_n) and correlation coefficient (r) range from 1.323 and 0.944 (Pre-monsoon), 1 and 0.981 (Monsoon), 1.001 and 0.982 (Post-monsoon), and 1 and 0.992 (Winter), respectively.

Conclusion: From this Fishery research, stock assessment, conservation, and the assessment of the fish condition of the Icchamati river, West Bengal, India.

Keywords: Length-weight relationships; Growth factor; Correlation coefficient; seasonal aspects; morpho-meristic analysis; the Icchamati riverine trans boundary; Ocellated pufferfish.

1. INTRODUCTION

According to Beyer (1987), "the length-weight relationship (LWR) helps determine the weight of an individual fish of known length and offers fundamental information on fish biology" [1]. For fishery management reasons, this association is a significant biometric tool that has been widely exploited. [2,3] and uses the length frequency to "predict the condition factor of the fish species and fish biomass" [4]. "LWR offers data on several criteria, including fish fatness, physical traits, life history, conditions in the environment, growth pattern, and overall health" [5,6]. "This relationship assists in identifying if the somatic growth is isometric or allometric and provides a glimpse at the growing condition of fish," [7] and "essential in fishes and fish biology because they build a mathematical relationship between them to allow the determination of the average weight of fish of a certain length group" [8; 9; 10,11]. Multiple investigators have examined the length and weight of Indian major carps in connection to growth attributes [12,13]."In addition to LWR, condition factor (K_n) shows if a body of water is suitable for fish growth" [14]. Fish growth follows the Cube law ***(W=L^3)*** in an ideal environment, where isometric growth takes place [15,16]. However, the length and weight connection may differ from the Cube law in a natural setting due to a variety of environmental conditions. Thus, to determine the length-weight relationship across the life stages of fishes, the Cube rule using an alternate formula, ***W = aL^b*** [17].

"The relative condition factor is the ratio of the fish's calculated weight to its observed weight, whereas the condition factor is an indicator of the species' average size. Fish physiological characteristics, including maturity, spawning, ambient conditions, and food availability in a body of water, affect these parameters' values. Numerous research studies from various water bodies of different types in various locations and habitats around the nation have determined the condition factor for carps [18,19, 20,21]. Because it describes the mathematical relationship between the length and weight of an individual fish or a population of fish, the length-weight relationship (LWR) of fish is a fundamental concept in fisheries biology and ecology [22]. Biometric communications serve as a crucial the study and management of fisheries. They offer important insights into fish populations and their dynamics and assist in transforming unprocessed field data into meaningful indices [23].

"The condition factor dropped as length increased and is additionally impacted by the fish's reproductive cycle." [24]. The assessment of the relative health of the fish population is crucial" [25]. Researchers and fisheries managers can use the relationship to determine a fish's weight based on its length or vice versa. Fish can achieve isometric growth, negative allometric growth, or positive allometric growth [26]. When an organism grows, its body dimensions remain constant, a phenomenon known as isometric growth. Positive allometric growth means that the fish gets comparatively stouter or deeper-bodied as it gets longer. In contrast, negative allometric growth suggests that the fish gets thinner as it gets heavier [27]. It has been established that the condition factor in fish reflects information about the fish's physiological state and welfare through its changes [28]. Additionally, it provides information for comparing two populations under specific feeding, density, climate, and other conditions; determining when a species undergoes gonadal maturation; and monitoring the level of feeding activity of a species to ensure it is effectively utilising its feeding source [29]. Understanding the condition factor is crucial to comprehending the life cycle of fish species and aids in the proper management of the species, claim. Consequently, preserving the ecosystem's equilibrium [30]."As fish supplies from open water and lagoons continue to decline and the human population grows, fish farming has expanded strongly as an effective technique of creating food and revenue from diminishing land space" [31]. In recent years, there have been numerous applications of innovative approaches to fish production systems. These strategies seek to satisfy the rising demand for food while enhancing the sustainability, effectiveness, and environmental impact of fish farming [32]. According to developments in research, technology, and sustainable agricultural methods, creative techniques are always changing [33].

Leiodon cutcutia (Hamilton,1822), a member of the *Tetraodontiformes* order and family *Tetraodontidae*, also known as the ocellated pufferfish in common, is regarded as a garbage fish in the Indo-Gangetic basin [34]. In parts of Southern Asia, including India, Bangladesh, Sri Lanka, Myanmar, and the Malay

Archipelago, *L. cutcutia* can be found in ponds, beels, rivers, streams, canals, and creeks. Although the extent of wild populations and the quantity of individuals taken from the wild are unknown, this species is commercially collected for the aquarium trade. Since the collection for the ornamental trade is not regarded as a threat, the *Cutcutia* has been evaluated and is classified as a "Least Concern" species by the IUCN (International Union for Conservation of Nature). Due to its low food value, the species, which is extensively dispersed in the plains of northeastern India, is neglected. However, the fish is a possible aquarium fish that typically inhabits Assamese rivers and Beel (wetlands). Previously, upper Assam has produced reports on the length-weight relationship of *Leiodon cutcutia* [34]. However, the length-weight (LWR) connection and condition factor have not been previously produced, and this puffer has not been adequately reported from the West Bengal riverine water to understand this aquarium trading fish, which is neglected as an edible food source, and due to being one of the only generic species from the family *Tetraodontidae.* The new study of this distinct and single generic species is crucial for understanding its growth and habitat parameters, as it is challenging for the natural selection process to thrive.

One of the major transboundary rivers between Bangladesh and India is the River Ichhamati ('Icha' means fish and 'mot' means pearl). Its varied discharge pattern, varied habitat resulting from abiotic and anthropogenic activities, and brackish and freshwater characteristics give it a variety of biological, physical, and chemical characteristics. Due to siltation, the release of organic waste from populated areas, the growth of macrophyte biomass, poor sanitation, and overfishing, this river is currently experiencing several environmental issues [35]. Therefore, maintaining the diversity of aquatic plants and animals in this river is more crucial than ever to reduce the possibility of unanticipated, abrupt outcomes. Many studies have been published on the hydrochemistry and microbenthic community structure of distinct bodies of water [36].

To investigate the state of the Icchamati River's commercially available ornamental fish, such as puffer fish, etc. We assessed *the condition factor and length-weight relationship of L. cutcutia* in this investigation. Research on the LWR of economically significant fish is crucial for river population management and conservation. To support fisheries management, this study provides a length-weight key along with vital biological data for the Ocellated pufferfish in the Icchamati transboundary river basin. According to the IMD (India Meteorological Department), a recent study was conducted using seasonal characteristics to examine growth factors and development, as per LWR.

To the greatest extent of our understanding, there is currently no information available on the length-weight relationship (LWR) and condition factors (K_n) related to the *Leiodon cutcutia* (Hamilton, 1822) of the Icchamati River. This motivated us to conduct the current river study to determine: (i) the composition and structure of the population dynamics and length weight variations among in this trans boundary highly overfished river, especially when this fish is under a single genus species; (ii) Such a mathematical connection makes morphological comparisons and life cycle categorization easier by serving as a practical indicator for understanding survival, development, maturity, reproduction, and overall well-being across different fish species or populations; (iii) the current ecological status of the species; and (iv) the overall growth pattern of the current species through which we can understand the future availability of the particular species of this important river.

2. MATERIAL AND METHODS

2.1 Area of study (Surveyed Riverine plot)

One of the significant transboundary rivers that shares borders with India and Bangladesh is the Icchamati. The right bank of the Padma, in Munshigunj, Bangladesh's Kustia District, is where the River Mathabhanga begins. It splits into the Ichhamati and Churni rivers near Majhdia (Nadia District, West Bengal, India). After travelling over 216 km, the River Icchamati empties into the Kalindi River at Hasnabad in the North 24 Parganas district. It then enters the Bay of Bengal close to Moore Island as a component of the Kalindi-Raimangal estuary in the deltaic southern region of West Bengal. It travels roughly 19.5 km through India before returning to Bangladesh. Near Duttafulia in Nadia District (West Bengal, India), it crosses the boundary once more. It falls into Bangladesh's Bay of Bengal, near Hasnabad and Taki, after another 21 kilometres.

A vast network of floodplain lakes, known as "Baur," is formed by the Ichhamati River and its tributaries in the Bongaon area of North 24-Parganas. The majority of these boors closely supervise the entry and are unaware of an unexpected or successful association with the Ichhamati River of West Bengal saltwater. Both the Lentic and Lotic portions are credited in these later Baurs. During the growing season, a variety of extreme water fish travel from the stream's mouth to their burrows, where they take advantage of the abundant freshwater resources to accumulate. We concentrated on the biodiversity strategies of two such burrows, fish stocking, and water quality limitation.

The investigation's study period spanned from June 2024 to August 2025 at three locations along a 126-kilometre stretch from Majdiah (23°24'29"N 88°43'43"E; Elevation-12 m) to Hasanabad (22°34'38"N 88°55'40"E; elevation-15 m) (in West Bengal, India). Fish samples from different collection points, as discussed below, were gathered at seasonal intervals between June and August; One year, two months were divided into four IMD seasons, namely Monsoon (July to August), Post-Monsoon (September to November), Winter (December to February), and Pre-monsoon (March to June). Ichthyo-Samples were taken twice a month, separated by 15 days, from the fish landing locations in North 24 Parganas and the Sundarban Estuarine Islands in West Bengal. The following locations were chosen before they reach the southern river Kalindi: Hasanabad (downstream, site III); Tetulia (midway-stream, site II); and Majdiah (upstream, site I) are the three locations that are closest to the origin and adjacent areas. functioning at depths of 2 to 17 meters while utilising a hoist and surrounding nets with mesh sizes of 25 to 30 mm.

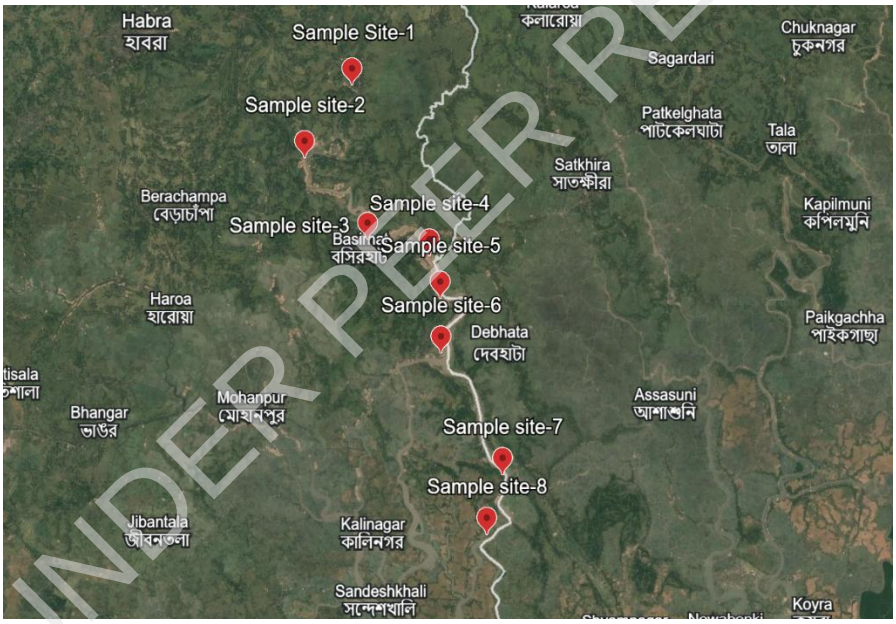

Fig. 1. Map showing the precise location of the sample-collection sites of the Indo-Bangladesh Trans-boundary the Icchamati River, W.B, India.

2.2 Collection of Samples

A range of fishing gear, including gillnets, cast nets, and drag nets, was used to collect samples of 389 examples of the Ocellated puffer fish, *Leiodon cutcutia* (Hamilton, 1822), (Fig.2), (*Fam. Tetraodontidae*) from different seasons (i.e., Pre monsoon, Monsoon, Post monsoon and Winter as per IMD) from Ichhamati river survey zones. To measure length, a Vernier calliper (Mitutoyo, Japan) was used to measure the distance between the snout tip and the enlarged caudal fin tip, with an accuracy of 0.1 mm. The digital weighing machine was then used to weigh the animal to the nearest 0.01 g (total weight). Specimens were collected using cast nets (5 × 5 mm to 10 × 10 mm mesh size, spanning up to 4.5 m² areas), scoop nets (1 × 1 mm to 6 × 6 mm mesh size), and gill nets

Fig. 2. *Leiodon cutcutia* (Hamilton, 1822) in different sizes from the study site.

(4.0–40 mm mesh size). Furthermore, they were obtained from the local fishing community. The acronyms TL (total length), SL (standard length), HL (head length), and P1L (length of the pectoral fin), eye diameter (ED), body depth (BD), dorsal fin length (DL), and anal fin length (AFL). The specimens were identified using the techniques of [37] and [38]. Fish species were identified using standard identification keys and published publications [39]. Scientific names were confirmed after consultation. To determine the length-weight connection, precise measurements of fish length (mm) and total weight (W) were taken to the nearest gram.

2.3 Length-Weight Relationship (LWR)

In 2006, Froese utilised the parabolic equation to investigate the LWR of the Ocellated Puffer. ***W=aLb***, where ***W*** is the fish's weight in grams, ***L*** is its length in centimetres, ***a*** is a constant, and ***b*** is an exponential representing the length-weight ratio. The parameters "**a**" and "**b**" were estimated by taking the log of the equation. In logarithmic form, the link **($W = aL^b$)** appears as a straight line.

$$Log\ W = Log\ a + b\ LogL.$$

Log a is a constant, while b represents the line's slope. Values greater or less than 3 imply allometric growth, while the coefficients of regression for isometric growth are 3. Positive allometry occurs when the correlation coefficient exceeds three, while negative allometry occurs when it falls below three. The isometric growth null hypothesis was tested using the t-test [40].

The equation is ***Y = a + bX***, where Log W symbolises the dependent variable (Y), Log L represents the independent variable (X), b is the coefficient of regression or slope, and an is the intercept.

$$Log\ a = \frac{\sum Log\ W. \sum (log\ L)^2 - \sum Log\ L. \sum (Log\ L.\ Log\ W)}{N. \sum (Log\ L)^2 - (\sum Log\ L)^2}$$

$$Log\ b = \frac{\sum Log\ W - N.\ Log\ a}{\sum Log\ L}$$

2.4 The Fulton's Condition Factor (K_n)

The equation compares fish condition, fatness, and well-being in their natural environment [41].

$$K_n=100*W/L^3$$

A factor of 100 is utilised to get the value of K_n closer to unity. In this equation, 100 is used to bring K closer to cooperation, W is the weight (g), L is the length (cm), and b is the length-weight equation value.

2.5 Analysis of Mathematical Data

Microsoft Windows Excel 2021 was used to execute all of the mathematical calculations mentioned above.

2.6 Statistical analysis

Data were analysed using Microsoft Office Excel (2021) and SPSS software (Version 20), with $p < 0.001$ indicating significant differences.

3. RESULTS AND DISCUSSION

3.1 Length-Weight Relationship (LWR) of Ocellated puffer fish (*Leiodon cutcutia*)

Table 1 presents the morphometric study of TL% for each *Leiodon cutcutia* (Hamilton, 1822) under the Tetraodontidae family collected from the Icchamati river stretch along the Indo-Bangladesh border in West Bengal, seasonally, i.e., (Pre-monsoon, Monsoon, Post Monsoon and Winter period). For this study, 419 Ocellated pufferfish specimens from eight different fish collection sites from the Icchamati river were gathered from West Bengal, India. The total length (TL) and total weight (TW) ranges, species numbers (n), average total length ($\bar{x}$), and average total weight ($\bar{y}$) of *Leiodon cutcutia* species are all displayed in Table 2.

3.2 Pre-monsoon season analysis

3.2.1 Correlation coefficient 'r'

Since the correlation coefficient "r" indicates a strong relationship between length and weight, the study finds that growth performance is high in the post-monsoon season. There is a substantial positive association between length and weight, as shown by the correlation coefficient "r" of 0.944 for *Leiodon cutcutia* (Table 3 and Fig. 2). According to the current investigation, the pre-monsoon value of "r" for *Leiodon cutcutia* was found to be the lowest among the seasons.

3.2.2 Regression coefficient value 'b'

The regression coefficient value "b" in the present investigation for pre-monsoon was estimated to be 1.9539 for *Leiodon cutcutia*, indicating a negative allometric pattern of growth (Table 3 and Fig. 2). During the pre-monsoon season, discovered "b" values of 1.9539 for current puffer fish were found, indicating a negative allometric trend of growth that is consistent with current research. Current investigations reveal that negative allometric growth is consistent with the current research. Fish length-weight relationships can be determined by some factors, such as habitat, area, seasonal effects, stomach fullness, gonad maturity, sex, health, preservation methods, and variations in the observed length ranges of the specimens caught, which could be the cause of a deviation from the value of "b," which reflects the regression coefficient for Ocellated pufferfish.

3.2.3 Condition factor 'K' (Fulton's Condition)

The current research on ocellated pufferfish reveals that condition factor "K" values were 1.323 in pre-monsoon, which are greater than the value of 1, suggesting better fish condition (Table 3). The results of the current investigation are consistent with the condition factor value of 1.323, which is consistent

with the current study and suggests favourable environmental conditions. A fish's "condition," "fatness," or overall well-being is expressed by the condition factor "K," an index used to track feeding intensity and growth rate [42].

Fulton's condition factor is computed using the condition factor (K) unit, which is an excellent indicator of appropriate biological habitat and an indicator of fish health or condition. For every length group in the current investigation, the condition factor analysis yielded a value of K greater than 1. Therefore, it can be said that the recommended fish species is a suitable fit for the surroundings. This suggests that both the fish and its surroundings are doing well. Fish size, sex, season, and gonadal development level are some of the variables that affect the K value. Fish health is greatly impacted by parasitism, the availability of food, and ecological factors [40].

3.3 Monsoon season analysis

3.3.1 Correlation coefficient 'r'

The correlation coefficient "r" was 0.981 in the monsoon season, indicating a significant and strong positive association between weight and length (Table 3 and Fig. 3). The value of "r" was higher than in the pre-monsoon season for ocellated pufferfish in the Icchamati riverine zone. Due to abundant food resources in the river belt, it is possible that food supplies were better than in the pre-monsoon season, resulting in a higher "r" value during the monsoon.

3.3.2 Regression coefficient value 'b'

The regression coefficient value "b" in the current study was estimated to be 1.0105 for *L.cutcutia*, indicating a negative allometric pattern of growth (Table 3 and Fig. 3). During the monsoon season, "b" values were discovered as negative value indicating a hypo allometric trend or a negative growth that is consistent with current research. It also shows a negative allometric growth pattern. Variations in the regression coefficient value "b" mostly indicate changes in the fish's body form when environmental factors such as temperature, food supply, spawning conditions, and other factors like life stages affect the fish's weight.

3.3.3 Condition factor 'K' (Fulton's Condition)

The condition factor "K_n" values were 1 found in Monsoon, and a perfect standard value for K in the case of the condition factor relationship. The fish are in good condition, as shown by the value of 1 (Table 3), which is consistent with the current study's findings. Fish in good condition are also indicated by a secure "K_n" value of 1 for *L. cutcutia*. Variations in the condition factor of numerous fish were noted in connection with their age, physiological status, feeding patterns, reproductive cycle, and physico-chemical aspects of the surrounding habitat, as well as the availability of food for the growth of the specimens.

3.4 Post Monsoon season analysis

3.4.1 Correlation coefficient 'r'

For Ocellated pufferfish, the correlation coefficient "r" was 0.982 in the post-monsoon period, indicating a highly significant positive association between length and weight (Table 3 and Fig. 4). This higher "r" value in the post-monsoon population is nearly identical to the current study's value, suggesting a highly favourable relationship between length and weight. After the monsoon, this is a clear sign of a long-term relationship in the species under investigation. According to the current study, there is a strong positive association between length and weight in the experimental fish's growth rate.

3.4.2 Regression coefficient value 'b'

For *L. cutcutia,* the regression coefficient "b" in the present investigation was determined to be 1.0052, indicating a negative allometric growth pattern (Table 3 and Fig. 4). The "b" values were negative during the post-monsoon season, consistent with recent research and indicating a hypoallometric trend or negative growth. Additionally, the fish exhibits a negative allometric growth trend. When environmental

factors such as temperature, food supply, spawning conditions, and life stages affect the fish's weight, variations in the regression coefficient "b" primarily reflect changes in the fish's body form.

3.4.3 Condition factor ‘K’ (Fulton's Condition)

During the post-monsoon season, the condition factor "K" value is 1,001, and the condition factor relationship has a flawless standard value for K. The value of 1 (Table 3) suggests the fish are in good condition, which aligns with the results of the current investigation. A secure "K" value of 1 for L. cutcutia likewise indicates fish in good condition. Variations in the condition factor among several fish were observed in relation to their age, physiological status, feeding habits, reproductive cycle, the physical and chemical characteristics of the surrounding habitat, and the availability of food for the specimens' growth.

3.5 Winter season analysis

3.5.1 Correlation coefficient ‘r’

Weight and length were significantly and strongly positively correlated throughout the winter season, as indicated by the correlation coefficient "r" of 0.992 and its highest r value in this investigation (Table 3 and Fig. 5). For ocellated pufferfish in the Icchamati riverine zone, "r" was greatest in the winter season. A greater "r" value during the winter may have resulted from improved food supply compared to the winter season due to the abundance of food resources in the river belt after the post-monsoon.

3.5.2 Regression coefficient value ‘b’

For *L.cutcutia*, the regression coefficient value "b" in the current study for the winter was determined to be 1.0051, confirming a negative allometric pattern of growth (Table 3 and Fig. 5). Current fish sample were found to have "b" values of 1.0051 during the winter season, demonstrating a negative allometric tendency of growth that is consistent with current research. Negative allometric growth is compatible with the existing studies, according to current investigations. A deviation from the value of "b," which represents the regression coefficient for fish length-weight relationships, may result from many factors, including habitat, area, changing seasons, stomach fullness, gonad maturity, sex, health, preservation techniques, and variations in the observed length ranges of the specimens caught.

3.5.3 Condition factor ‘K’ (Fulton's Condition)

The condition factor "K" values in Winter were 1, indicating a flawless standard value for K in the condition factor relationship. The fish are in good health, as evidenced by a value of 1 (Table 3), which is consistent with the findings of the current study. A secure "K" value of 1 for *L. cutcutia* indicates fish in good condition. Variations in the condition factor of several fish were seen in relation to their age, physiological status, feeding behaviours, reproductive cycle, physicochemical features of the surrounding habitat, and the availability of food for the specimens' growth.

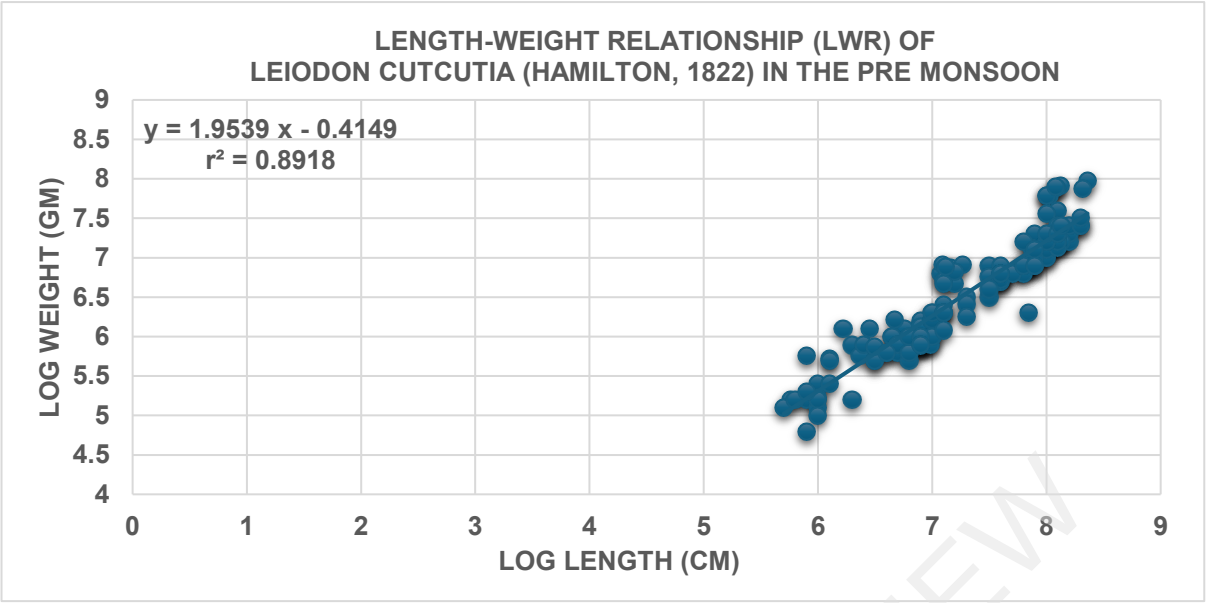

Fig. 2. Scatter Graph plot between Log TL and Log TW of *Leiodon cutcutia* (Hamilton, 1822) in the Pre-monsoon

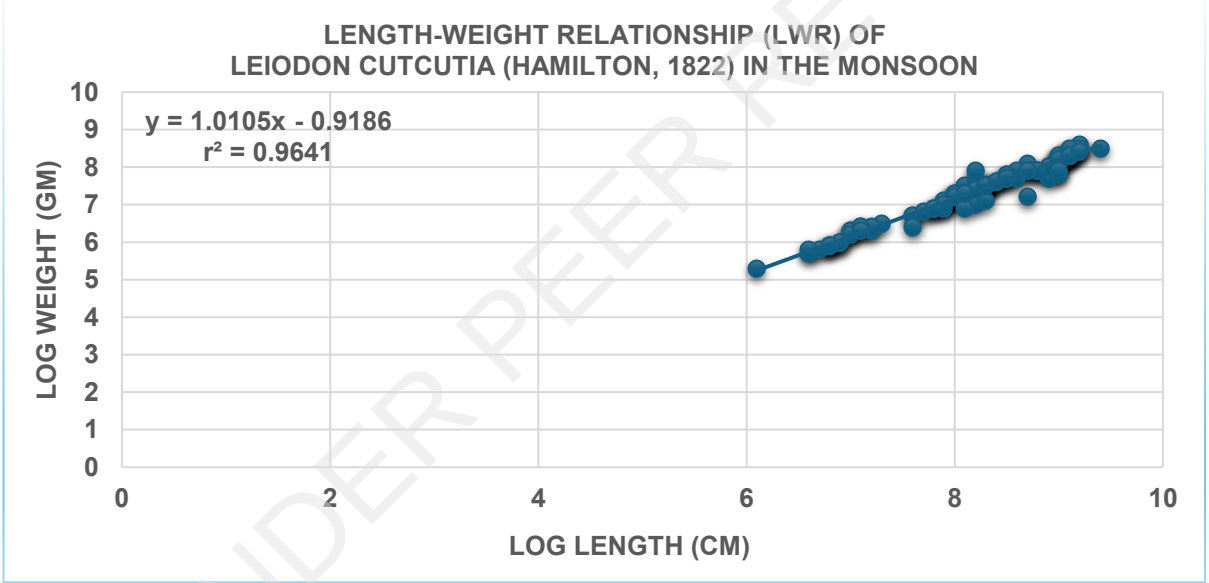

Fig. 3. Scatter Graph plot between Log TL and Log TW of *Leiodon cutcutia* (Hamilton, 1822) in the Monsoon

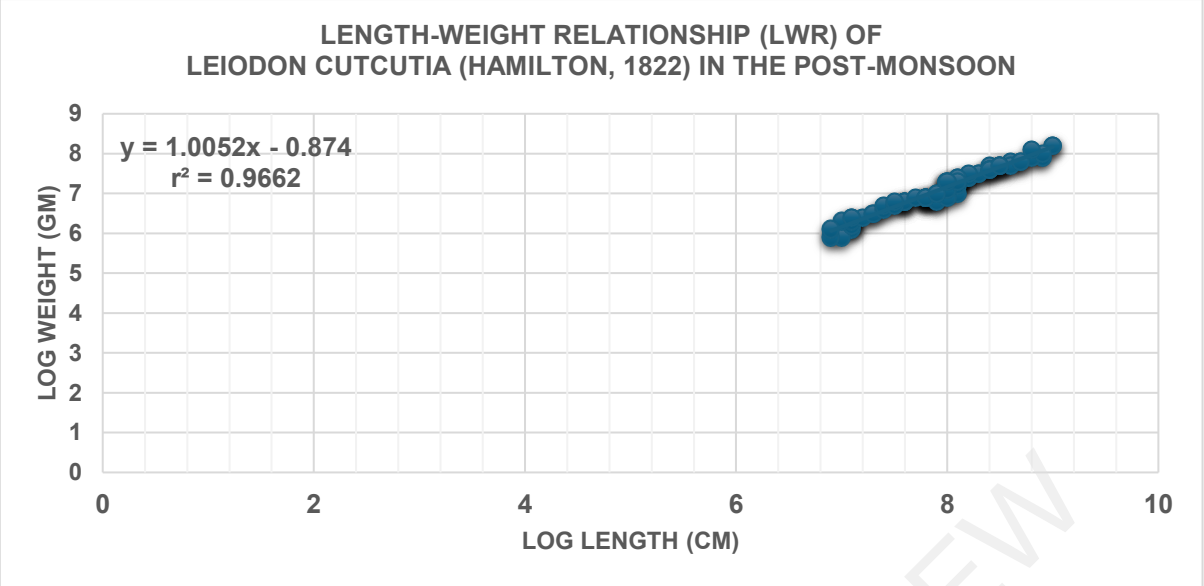

Fig. 4. Scatter Graph plot between Log TL and Log TW of *Leiodon cutcutia* (Hamilton, 1822) in the Post-monsoon

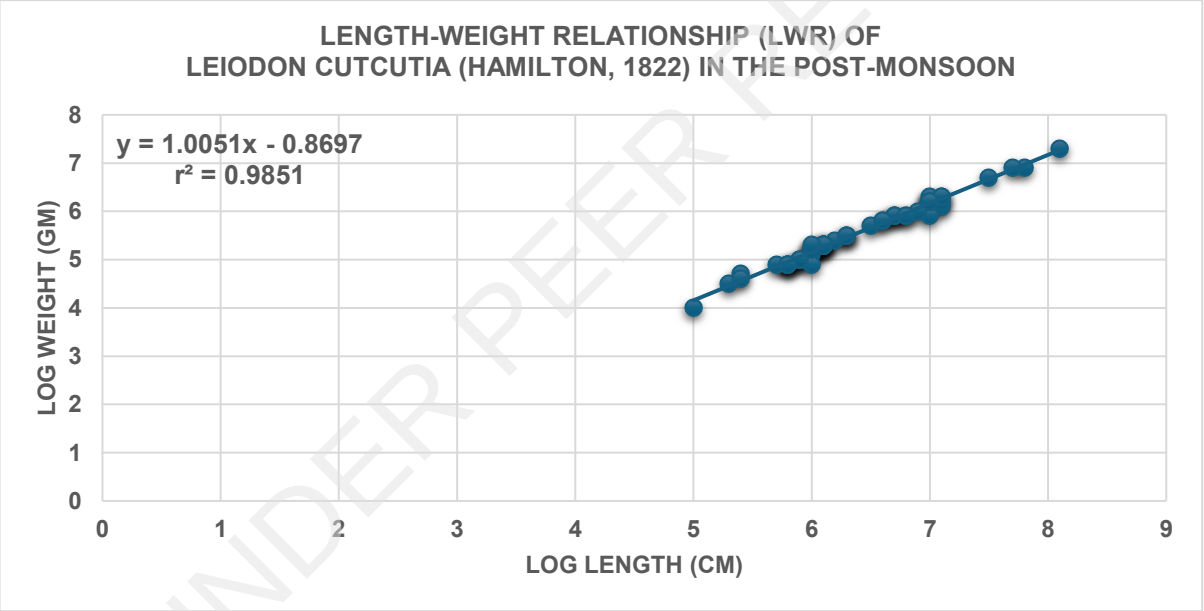

Fig. 5. Scatter Graph plot between Log TL and Log TW of *Leiodon cutcutia* (Hamilton, 1822) in the Winter

Table 1. Study of Morphometric measurements as a percentage of total length (TL), seasonal diversity-wise, of the *Leiodon cutcutia* (Hamilton, 1822) from the Icchamati River, West Bengal

Season	n	SL	HL	ED	P1L	BD
Pre-monsoon	n=154	78.8% TL	22.4%TL	8.9% TL	19.5% TL	46,1% TL
Monsoon	n=106	79.4% TL	26.9% TL	10.5% TL	16.6% TL	37.6% TL
Post-monsoon	n=76	75.7% TL	23.3%TL	9.7%TL	19.2% TL	32.3% TL
Winter	n=53	71.6% TL	21.8%TL	8.2% TL	14.6% TL	38.1% TL

*Abbreviation n=species numbers, SL=Standard Length, HL= Head Length, ED= Eye diameter, P1L=Pectoral fin length, BD=Body Depth

Table 2. The study evaluated the Total length, Total weight, and Average length-weight association variables of fish from the Ichhamati River stretch at the Indo-Bangladesh border in West Bengal.

Season	n (number of species)	Total length (cm)	Total weight (g)	Length Mean ± sd ($\bar{x}$)	Weight Mean ± sd ($\bar{y}$)
Pre-monsoon	n=154	5.76-8.36	5.2-7.98	7.31±0.50	6.56±0.65
Monsoon	n=106	6.1-9.4	5.3-8.5	8.19±0.49	7.36±0.54
Post-monsoon	n=76	6.9-8.9	5.9-7.9	7.93±0.56	7.1±0.47
Winter	n=53	5-7.8	4-6.9	6.41±0.72	5.58±0.58

Table 3. Correlation coefficient "r", value of constant "a" and "b", Conditional factor (K), and Growth pattern of family: *Tetraodontidae* (*Leiodon cutcutia*) fishes from the Ichhamati River stretch in Indo-Bangladesh Border in West Bengal.

Season	Regression equation	a-value	b value	r^2	r	K-value	Growth pattern
Pre-monsoon	Log W= - 0.4149+1.9539 LogL	0.4149	1.9539	0.8918	0.944	1.323	Hypo-allometric
Monsoon	Log W= - 0.9186+1.0105 LogL	0.9186	1.0105	0.9641	0.981	1	Hypo-allometric
Post-monsoon	Log W= - 0.874+1.0052 LogL	0.874	1.0052	0.9662	0.982	1.001	Hypo-allometric
Winter	Log W= - 0.8697+1.0051 LogL	0.8697	1.0051	0.9851	0.992	1	Hypo-allometric

4. CONCLUSION

The first and ever extensive investigation of the LW relationship study with special reference to Seasonal variations according to Indian Climate for Ocellated Puffer (*Leiodon cutcutia*) from the Icchamati riverine stretch, Indo-Bangladesh Trans boundary in West Bengal, India. Ocellated Puffer fish species—a total of n=389—in this fresh water and semi brackish mangrove zone from the Sundarban delta estuarine mouth of the Bay of Bengal in West Bengal, the first LWR in this specific *Tetraodontidae* family, has illuminated the morphometric differences between the species under investigation and provided insight into their general health and welfare, with a focus on length, weight, and condition parameters. By examining the length and weight parameters of these fish species, significant information on their growth patterns and size distribution has been uncovered with respect to seasonal variations. The finding is very interesting because *Leiodon cutcutia* exhibits the growth performance represented by the "b" value, which is in the lower range in all seasons, except the pre-monsoon time when its range goes up (b=1.9539) and in all seasons from the Icchamati river its shows hypoallometric or negative growth of this species. The growth rate and feeding intensity indicated by the "K_n" value indicate that the majority of the fish in all four seasonal aspects are in good health and maintain a similar range of fluctuations.

Furthermore, the computation of condition variables has provided a comprehensive picture of the fundamental fitness and health status of the fish populations. In addition, fishing in the Icchamati river stretch is a basic livelihood for humans, and this zone is also a sensitive Indo-Bangladesh transboundary zone and a common river stretch for both countries. Along with this, taxonomically, the Leiodon genus is the only genus from the family Tetraodontidae (puffer fish group), and it is very obvious that if this unique and interesting genus is affected by ecological habitat degradation, such as overfishing and unexpected capture for economic trade, particularly as ornamental fish, it may move into a scheduled category from its near-threatened (NT) position in the near future.

Both government agencies and non-governmental organisations (NGO's) must regularly monitor the organisations that manage fisheries to maintain the delicate equilibrium and ensure the long-term health of the fishing practice in the Icchamati riverine zone and estuarine environment. Estuary mouths in

India, particularly those near the Bay of Bengal, are especially significant commercially. It is believed that this information will open a new chapter for educators and scholars interested in studying India's tiny ornamental and indigenous single-genus species. The information gathered from this study will be crucial for the management and preservation of this species.

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