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ORIGINAL ARTICLE

A study on the length-weight relationship and condition factor of five small indigenous fish species of Sareswar Beel in lower Assam, Northeast India

Bichitra NARZARY, Bronson Kumar KHANGEMBAM*

Department of Zoology, Bodoland University, P. O. Rangalikhata, Debargaon, Kokrajhar, Assam, India.

Correspondence
kbronson173@gmail.com

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Abstract
Length-weight relationship (LWR) and relative condition factor are significant in fishery science as it provides information on fish wellbeing and biological data. The present study describes the LWR and condition factor of five small indigenous fish species of Sareswar Beel, Kokrajhar, Assam of Northeast India for the first time. A total of 443 specimens of five species viz. *Nandus nandus*, *Glossogobius giuris*, *Puntius sophore*, *Pethia conchonius* and *Trichogaster fasciata* were sampled from May 2021 to April 2022. All samples were collected using gill nets, bamboo traps, net traps and lift net. The total length and body weight were measured to determine the LWR and Fulton's condition factor (*K*). The statistical parameters *a*, *b*, and K_n (Relative Condition factor) were also analysed. All species recorded *K*>1 except *Glossogobius giuris* (0.909±0.178), and the highest value was recorded in *T. fasciata* (2.023±0.687). The values of '*b*' for all five species ranged from 1.643 to 2.961, indicating negative allometric growth pattern. This study is a first report on the LWR and condition factor of these species from Sareswar Beel, Assam. These results may be useful for sustainable management and comparison with future studies.

Keywords: *Glossogobius giuris*, Fultons's condition factor, *Nandus nandus*, Sustainable fishery.

INTRODUCTION

The physical growth is an important feature of all the living forms during development. When fish get suitable environment their length and weight increase as a part of overall physical development. Length-weight relationship is one of the most important tools used for analyzing the health conditions of fishery management (Türker et al. 2018) and its assessment helps in understanding the fundamental biological details that serve as vital tool for fishery science (Sheikh & Ahmed 2019; Roul et al. 2020). The study of length and weight relationship (LWR) is functional in sustainable resource management and fishery researches (Sonowal et al. 2019; Ergüden 2021). It is used to understand the biomass, condition factor, growth of fish species, fish stocks evaluation, the life cycle in fisheries and ontogenetic changes (Jafari et al. 2016; Salvador et al. 2018; Jafari-Patcan et al. 2018; Mouludi-Saleh & Eagderi 2019; Abbasi et al. 2019; Eagderi et al. 2020). In addition to the estimation of weight from length, it also has other uses such as comparison of morphological and biometric parameters between varied species or population from different geographical regions (Roul et al. 2018; Roul et al. 2019) and seasonal changes in growth pattern and conditions indices (Safran 1992; Richter et al. 2000; Zuev et al. 2018).

The condition factor (K=Fulton's condition factor) and relative condition factor (K_n) are vital aspects which indicates welfare, robustness of ichthyofauna in their ecosystem (Paswan et al. 2012; Datta et al. 2013; Singh & Serajuddin 2017; Kurbah & Bhuyan 2018). The condition factor of a fish helps to understand its health status in its environment (Froese 2006). It is an index considering interconnection between abiotic and biotic factors in fish's physiological state. Fulton's condition factor (K) of a fish varies due to various factors like physical maturity, accessible food sources, sex and age of individual fishes in their environment (Anibeze 2000). Consequently, condition factor is a vital parameter for the assessment of fish health condition and is, therefore, widely used in fish

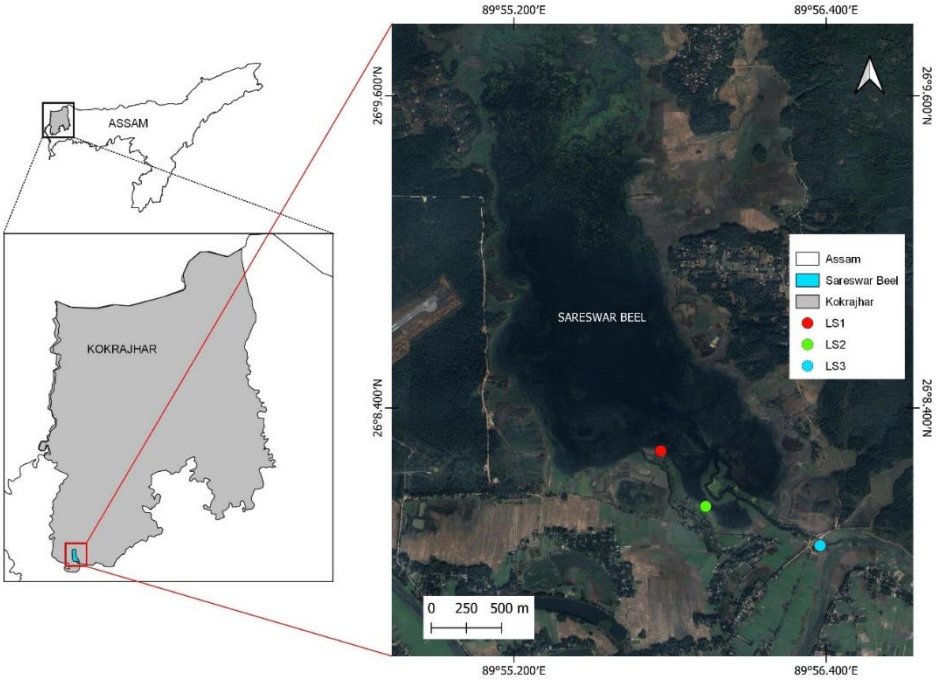

Fig.1. Map of the study area showing Sareswar beel in Kokrajhar district of Assam, India.

biology and fishery management.

Assam in northeast India has rich diversity of small indigenous fish species (SIFs) abundantly inhabiting it natural aquatic bodies especially the wetlands (beels). *Nandus nandus*, *Glossogobius giuris*, *Puntius sophore*, *Pethia conchonius* and *Trichogaster fasciata* are prime examples of such species important as food and are available throughout the year in the beels of Assam (Paul 2020; Malakar & Baruah, 2017). These species are considered rich in nutrients, and potential candidate for ornamental fish culture (Baro et al. 2014; Chetia et al. 2018; Duarah & Das 2019). However, very few studies are available on their fishery and biology from Assam, especially lower Assam. Although studies on fish diversity have been conducted in lower Assam, but studies on the growth and biology of the fishes in the natural water bodies of lower Assam are not available. To the best of the author's knowledge no such study exists from Sareswar beel of Kokrajhar in lower Assam which has a good potential for development of fisheries in the region. Therefore, this study aims to provide a first report on the relationship between the length and weight of the five different indigenous fish species found in the Sareswar Beel, Kokrajhar, Assam.

MATERIALS AND METHODS

Study Area: The study was conducted in Sareswar Beel of Kokrajhar district, Assam (Fig. 1). Three different landing sites (LS1 26°8'14.12"N, 89°55'45.89"E), (LS2 26°8'1.30"N, 89°55'56.22"E) and (LS3 26°7'52.29"N, 89°56'22.65"E) were selected for collection of the fish samples. The beel covers an area of about 476 hectares, and is connected with Brahmaputra River via the Gadadhar River. A dense Sal Forest (under Rupshi Range Bashbari, B.T.C., Government of Assam) and Rupshi Airport lies on its western side. The Beel is surrounded by Sareswar village (Rupshi: Part I, Part II & Part III) in the South, Bannyaguri in the East, Bashbari in the North and newly inhabited village Nayagram in the west.

Fish Sampling: Fish samples were collected using fishing gears like lifting net (*Henga*), gill nets (*Phansi jal*), and traditional gears like the bamboo trap and net trap every month from the landing sites from May 2021 to April 2022. A total of 443 individuals of *N. nandus* (80), *G. giuris* (117), *P. sophore* (94), *P. conchonius* (82) and *T. fasciata* (70) were collected in the study. Representative specimens of the freshly caught fishes were photographed on the spot for identification and

Table 1. Total length and body weight with Mean±SD of five studied species from Sareswar Beel.

Sl. No.	Family	Species	N	Total Length (cm)			Body Weight (g)		
				max	min	mean±SD	max	min	mean±SD
1	Nandidae	*Nandus nandus*	80	15.92	6.50	11.31±2.13	56.01	3.11	23.03±12.68
2	Gobiidae	*Glossogobius giuris*	117	14.90	7.17	11.26±1.72	30.00	3.04	13.40±5.37
3	Cyprinidae	*Puntius sophore*	94	11.91	5.50	8.88±1.57	22.71	2.01	10.94±4.87
4	Cyprinidae	*Pethia conchonius*	82	10.95	5.30	8.08±1.13	16.53	4.21	8.54±2.37
5	Osphronemidae	*Trichogaster fasciata*	70	10.90	5.34	8.19±1.31	21.01	5.01	10.93±3.89

N: sample size; max: maximum; min: minimum; SD: standard deviation.

future reference. Samples of each species were preserved in 10% formaldehyde for identification following Talwar & Jhingran (1991) and Viswanath et al. (2017) and future reference.

Length-Weight Relationship (LWR) and Condition Factor: The total length of all fishes was measured from the tip of the snout to the terminal end of caudal fin using digital Vernier caliper to the nearest 0.1cm, and weights were determined using digital balance to the nearest 0.01g. The LWR was estimated by using the equation $W= aL^b$ (Le-Cren 1951; Ricker 1973), where, *W*=weight (g) and *L*=total length (cm). The values of constant '*a*' and '*b*' were estimated from coefficient of regression equation (log *W*=log *a*+*b* log *L*, where *a*=intercept and *b*=slope). The Fulton's condition factor (K) was calculated by using the formula, $K=100W/L^3$ (Pauly 1984; Wootton 1992; Paswan et al. 2012). The Relative condition factor (K_n) was also determined following standard method of Le-Cren (1951) using formula as $K_n=W/W'$, where, *W* is the observed weight, and *W'* is the calculated weight derived from length-weight study.

Statistical Analysis: All the data were represented as mean±SD. The average mean value, SD. of the total length, body weight and all the statistical regression analysis were evaluated using SPSS 20.0 and Microsoft Excel 2019.

RESULTS

The total length and mean in all the five species were as follows: *N. nandus* (6.5-15.92cm; 11.31±2.13), *G. giuris* (7.17-14.9cm; 11.26±1.72), *P. sophore* (5.5-11.91cm; 8.88±1.57), *P. conchonius* (5.3 to 10.95cm; 8.08±1.13) and *T. fasciata* (5.34-10.9cm; 8.19±1.31). The total weights (and mean weight) were found to range from 3.11 to 56.01g (23.03±12.68), 3.04 to 30g (13.40±5.37), 2.01 to 22.71g (10.94±4.87), 4.21 to 16.53g (8.54±2.37) and 5.01 to 21.01 g (10.93±3.89), respectively in the studied species (Table 1). The length weight statistical parameters value of *a*, *b*, SE (*b*), 95% of CI (*b*), r^2 and condition factor (*K*) are given in Table 2, and the regression graphs of LWRs are outlined in Fig. 1 (a-e). LWRs of all five species were found to highly significant ($P<0.001$). The values of *b* ranged from 1.643 (*P. conchonius*) to 2.961 (*N. nandus*). Our results showed that majority (four) of the species in this study showed a negative allometric ($b<3$) growth pattern whereas one species, *N. nandus* showed close to isometric growth ($b=3$). In the present investigation the minimum coefficient of determination was observed in *T. fasciata* and *P. conchonius* ($r^2= 0.743$) and maximum in *N. nandus* ($r^2= 0.938$). Further, the Fulton's condition factor (*K*) of four indigenous fish species ranged from 1.446±0.218 to 2.023±0.687 showing *K* value more than 1.0 except one species, *G. giuris* (0.909±0.178). The relative condition factor (K_n) for all the five indigenous species ranged from 1.010 to 1.624 (Table 2) showing good growth condition, and the highest was observed in *T. fasciata* (1.624).

Table 2. LWR statistical descriptions of the five studied species from Sareswar Beel.

Sl. No.	Species	*a*	*b*	SE. (b)	95% CI. of *b*	r^2	*K* (mean±SD)	K_n (mean±SD)	Growth type
1	*N. nandus*	0.0157	2.961	0.087	2.789 - 3.134	0.938	1.446±0.218	1.011± 0.156	NA
2	*G. giuris*	0.0293	2.507	0.104	2.301 - 2.714	0.834	0.909±0.178	1.014±0.176	NA
3	*P. sophore*	0.0498	2.438	0.107	2.227 - 2.650	0.851	1.509±0.352	1.016±0.187	NA
4	*P. conchonius*	0.2699	1.643	0.108	1.428 - 1.859	0.743	1.658±0.426	1.010±0.149	NA
5	*T. fasciata*	0.2154	1.848	0.124	1.602 - 2.095	0.743	2.023±0.687	1.624±0.491	NA

a: intercept; *b*: slope; SE: standard error; CI.: confidence interval; r^2: coefficient of determination; *K*: Fulton's condition factor, K_n: Relative condition factor; NA: Negative Allometric.

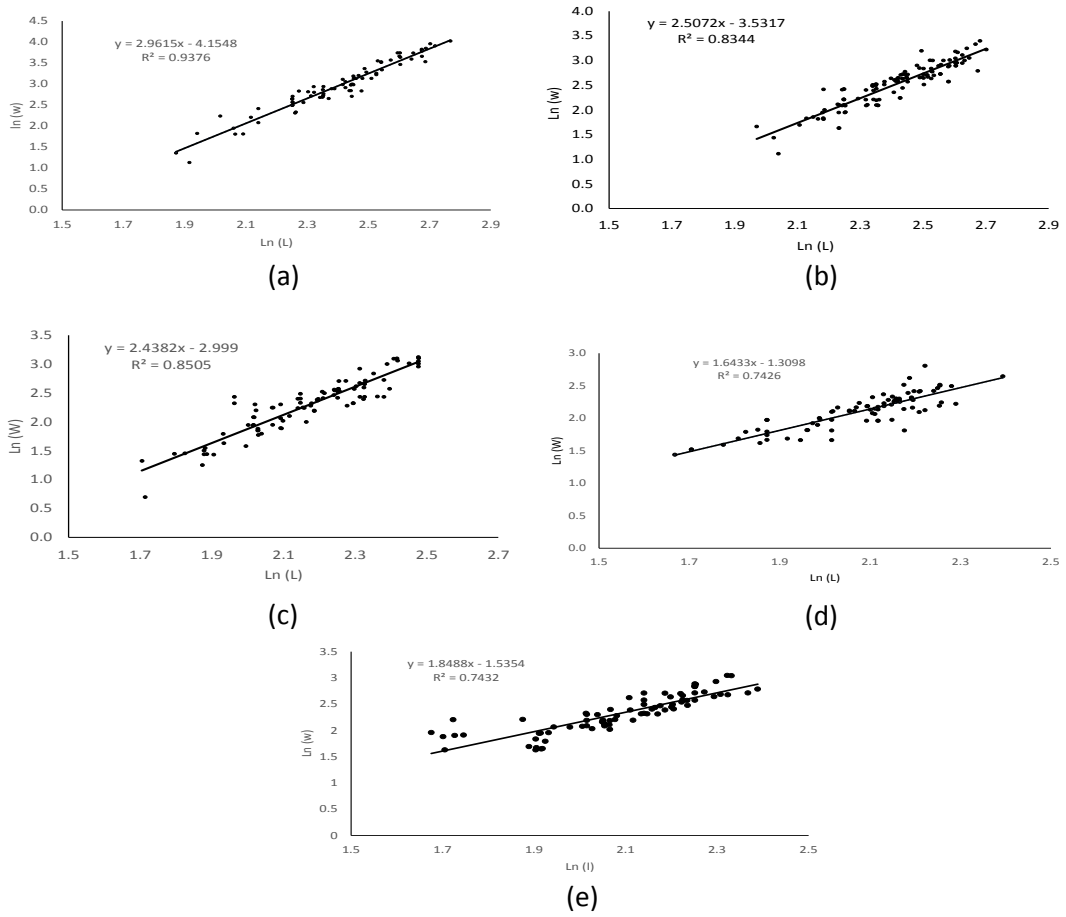

Fig.2. Graphical representation of LWR in five small indigenous fish species from Sareswar Beel, Kokrajhar, Assam: (a) *Nandus nandus*, (b) *Glossogobius giuris*, (c) *Puntius sophore*, (d) *Pethia conchonius* and (e) *Trichogaster fasciata*.

DISCUSSIONS

Our results on the LWR study of the five SIFs viz. *N. nandus*, *G. giuris*, *P. sophore*, *P. conchonius* and *T. fasciata* of Sareswar beel showed that the LWRs of all the fives species were highly significant (P<0.001). The growth pattern was found to be either nearly isometric in *N. nandus* (b=2.961) or negative allometric as observed in the remaining other species (b<3). The observed results in *N. nandus* were found to agree with that of Kalita et al. (2016),

where the '*b*' value of male and female *N. nandus* from Garjan beel, Assam were reported to be 2.70 and 2.80, respectively. The negative allometric growth of *G. giuris* was also reported by Phan et al. (2021) which also agrees with the results of the present study. Negative allometric growth pattern in fish may be due to the physio-chemical parameters or low feeding habit and environmental factors (Kalita et al. 2016; Remya et al. 2021). However, some studies have also reported positive allometric growth of fish from different water bodies, which may be due to rich aquatic food source, high feeding rate, seasonal variability and other related associated factors for allometric growth (Das et al. 2015; Kalita et al. 2016; Zuev et al. 2018; Zare-Shahraki et al. 2020; Ergüden 2021). Tarkan et al., (2006) also reported that the fish size may fluctuate/change based on season, gender, feeding rate, water condition and gonadal growth. The coefficient of determination (r^2) of all five species in this study ranged from 0.743-0.938 which indicated a high degree relationship between the length and weight of the all the species. Hasan et al. (2020) also studied the LWR and observed negative allometric growth in *N. nandus* (b= 2.66; r^2= 0.950) and *P. sophore* (b= 2.83; r^2= 0.977). However, contrary to our results the studies of Hossain et al. (2015), Hossain et al. (2017), Baitha et al. (2018), and Sandhya et al. (2020) showed positive allometric growth for the three fish species *T. fasciata* (b= 3.19; r^2= 0.985), *N. nandus* (b= 3.150-3.27; r^2= 0.994-0.958) and *P. conchonius* (b= 3.077-3.33; r^2= 0.969-0.977). *N. nandus* in our study may be considered to have isometric growth as its b value was close to 3 (b= 2.961). Similar to our finding from Sareswar beel, Borah et al. (2017) also reported negative allometric growth of *T. fasciata* (b= 2.778) from the Deepor beel, Assam. All these results indicate that the value of b indicating the growth pattern of a fish may be different in different environment for the same species. These differences may be due to combination of multiple factors including preservation methods, feeding rate, fishing gears or uncaught of larger sized fishes, ecosystem of the aquatic body (Hossain et al. 2015).

Fulton's condition factor (K) indicates overall health condition or healthy status of fish species. In the present investigation the value of K for four species varied from 1.446 to 2.023 indicating the good health condition (K>1) of these species. Although the K value was minimum in *Glossogobius giuris* (0.909) among studied species, its value was very close to 1 which indicates good health of the species in the study area. The relative condition factor (K_n) is a well-accepted indicator of fish general well-being in an environment (Kurbah & Bhuyan 2018), and often regarded as a marker to assess growth rate, feeding potency and wellbeing of Ichthyofauna (Oni et al. 1983). K_n values equal or close to 1 indicates overall fitness in a given habitat. $K_n \geq 1$ indicates good growth status in fish, while $K_n < 1$ reflects the poor growth quality of the fishes in their ecosystem (Jisr et al. 2018). K_n>1 indicates better/good general health status of the species (Gohain & Deka 2017; Kurbah & Bhuyan 2018) and its higher value may be due rise in body weight due to tissue growth and differentiation or development of egg components (Zakaria et al. 2000). According to Le-Cren, (1951) LWR and K_n also provides the detailed information such as welfare of fish in connection to habitat, spawning time, maturity period, etc. K_n has been reported widely as an indicator for health of a species in a habitat (Kurbah & Bhuyan 2018). In the present study, K_n was ≥1 for all the five indigenous species found in Sareswar beel. Similar result of $K_n \geq 1$ was also reported by Kazemi et al. (2013) in the Persian Gulf and Oman Sea. These high K_n values may be attributed to the increase in feeding intensity of the fishes (De Giosa et al. 2014) in the particular habitat. On the other hand, lower value of K_n may be due to decrease in feeding activity and the use of lipid reserves during spawning which may ultimately lead to decline in fish health condition (Lizama & Ambrósio 2002). Ahmadi (2021) also reported good growth condition for Kissing Gourami, *Helostoma temminckii* from a

river in their environment. The present study for the five SIFs found in the Sareswar beel indicated a good growth condition which may be due to the abundance of food organism for the five species in the beels. However, unsustainable fishery practices, overexploitation and anthropogenic interference may threaten the existing balance of the beel.

This study has established a first report on the length-weight relationship of five important SIFs viz. *Nandus nandus*, *Glossogobius giuris*, *Puntius sophore*, *Pethia conchonius* and *Trichogaster fasciata* found in Sareswar beel, Kokrajhar, Assam for the first time. Our results indicated good condition factor for all the species in the beel. All the species showed a negative allometric growth pattern except *N. nandus,* which showed a growth pattern close to isometric growth. All this information may serve as a baseline data for further investigations on the biology, distribution and management of the fishery resources of the beel. The present study may offer new insights on implementing appropriate policy for sustainable fishery exploitation, and overall conservation of the beel.

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مقاله کامل

مطالعه رابطه طول-وزن و شاخص وضعیت پنج گونه ماهی کوچک بومی تالاب سارسوار در بخش پایین آسام، شمال شرقی هند

بیچیترا نرزری، برونسون کومار خانگیمبام

گروه جانورشناسی، دانشگاه بودولند، نگالیختا، دبرگان، کوکراجار، آسام.

چکیده: رابطه طول-وزن (LWR) و شاخص وضعیت نسبی در علم شیلات مهم هستند زیرا اطلاعاتی در مورد سلامت ماهی و داده‌های زیست‌شناختی را ارائه می‌دهند. مطالعه حاضر برای اولین بار رابطه طول-وزن و شاخص وضعیت پنج گونه ماهی بومی تالاب سارسوار در بخش پایین آسام، شمال شرقی هند را توصیف می‌کند. در مجموع ۴۴۳ نمونه از پنج گونه *Nandus nandus*، *Glossogobius giuris*، *Puntius sophore*، *Pethia conchonius* و *Trichogaster fasciata* از مه ۲۰۲۱ تا آوریل ۲۰۲۲ نمونه‌برداری شدند. نمونه‌ها با استفاده از تورهای گوشگیر، تله‌های بامبو، توری و توری بالابر جمع‌آوری شدند. طول کل و وزن بدن برای تعیین LWR و شاخص وضعیت فولتون (K) اندازه‌گیری شد. پارامترهای آماری a، b و K_n (ضریب شاخص نسبی) نیز مورد تجزیه و تحلیل قرار گرفتند. همه گونه‌ها به‌جز *Glossogobius giuris* K>1 (۰/۹۰۹±۰/۱۷۸) را ثبت کردند و بیشترین مقدار در *T. fasciata* (۲/۰۲۳±۰/۶۸۷) ثبت شد. مقادیر "b" برای هر پنج گونه از ۱/۶۴۳تا ۲/۹۶۱ متغیر بود که نشان‌دهنده الگوی رشد آلومتریک منفی است. این مطالعه اولین گزارش در مورد LWR و شاخص وضعیت این گونه‌ها از تالاب سارسوار در بخش پایین آسام است. این نتایج ممکن است برای مدیریت پایدار و مقایسه با مطالعات آینده مفید باشد.

کلمات‌کلیدی: *Glossogobius giuris*، شاخص وضعیت فولتون، *Nandus nandus*، شیلات پایدار.