LENGTH-WEIGHT RELATIONSHIPS OF TWO GIZZARD SHADS *CLUPANODON THRISSA* AND *NEMATALOSA NASUS* (CLUPEIDAE) IN THE NHAT LE RIVER OF CENTRAL VIETNAM

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Abstract: *The length-weight relationships (LWRs) of Clupanodon thrissa and Nematalosa nasus are examined based on 140 specimens (74 C. thrissa and 66 N. nasus) collected from April to September 2018 in the Nhat Le River of central Vietnam. The LWRs of C. thrissa for total length (TL) and standard length (SL) are provided, which were not known earlier. The present study also provided supplementary data on LWRs of N. nasus in the research area. The provided LWRs of unsexed C. thrissa (2.9099 for TL and 2.7117 for SL) suggested an isometric growth pattern.The present study reported LWRs of unsexed N. nasus in central Vietnam (2.7288 for TL and 2.6284 for SL), indicating a negative allometric growth pattern.*

Keywords: *Shad, Clupanodon thrissa, Nematalosa nasus, length-weight relationship, Vietnam.*

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1. INTRODUCTION

Chinese gizzard shad *Clupanodon thrissa* (Linnaeus, 1758) and Bloch's gizzard shad *Nematalosa nasus* (Bloch, 1795) (Clupeiformes: Clupeidae) are distributed in the sea, brackish and occasionally entering freshwaters in the tropical region (Whitehead, 1985; Nguyen, 2005; Tran & Ta, 2014). *Clupanodon* is a monotypic genus, and *Nematalosa* consists of 11 species (Froese & Pauly, 2019). *Clupanodon thrissa* is found in the northwestern Pacific, while *Nematalosa nasus* seems to have a broader range from the Indian Ocean to the northwestern Pacific. Generally, local has low interest in these two species as fishery resources (Whitehead, 1985).

In Vietnam, the *Clupanodon thrissa* and *Nematalosa nasus* are high commercial value species mainly recorded in the coastal and estuarine habitats and the country (Nguyen, 2005; Ministry of Science and Technology of Vietnam, 2007). However, the knowledge about biological characteristics of these two species in Vietnam is scarce, including the length-weight relationship, which is an essential tool for the adequate management of any fish species (King, 2007) since the average weight could be referred from the given length group (Beyer, 1987). The parameter is also significant in fish biology and can provide data on stocks and fisheries management for comparative growth studies (Moutopoulos and Stergiou, 2002).

Of the two current species, *Nematalosa nasus* seem to have more available information on the length-weight relationship (LWR) than the other species (Froese and Pauly, 2019). Subsequently, the present paper aimed to elucidate the first description of the LWRs of *Clupanodon thrissa* and *Nematalosa nasus* from central Vietnam.

2. CONTENT

2.1. Materials and methods

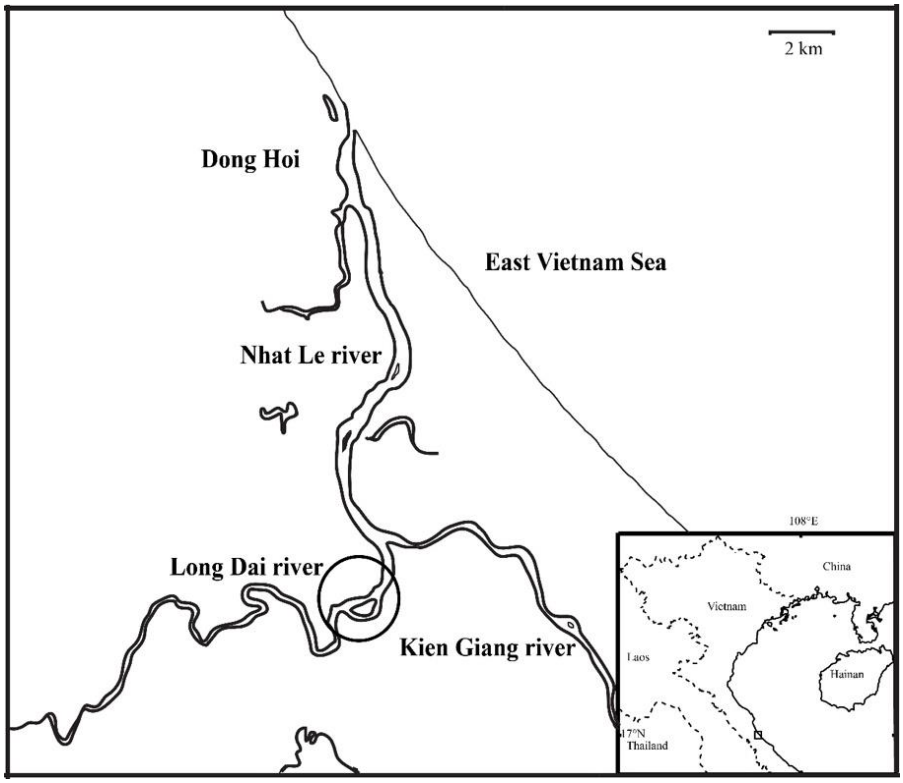

Figure 1. *Chart showing stations where gizzard shad samples were collected from April to September 2018 in central Vietnam.*

Samples of *Clupanodon thrissa* and *Nematalosa nasus* used in the present study were collected monthly from Hien Ninh area, about 15 km from the Nhat Le River mouth (ca. 17^o 38′N) in central Vietnam (Fig. 1), from April to September 2018.

Initially, fish were frozen in a refrigerator before fixing 70% ethanol in the laboratory for further analysis. Identification was based on external morphology, referring to Whitehead (1985) and Nguyen (2005). The fixed specimens were taken out one by one later to be weighed and measured. For each individual, total length (TL) and standard length (SL) measurements were made to the nearest 0.01 cm using slide calipers, and the whole body weight (BW) was taken on an electric balance with 0.1 g accuracy (Fig. 2).

Figure 2. *Clupanodon thrissa and Nematalosa nasus samples in Nhat Le River*

The length-weight relationship was calculated using the expression: $W=aL^b$. Where W is the body weight (g), L is the total length (cm) or the standard length (cm), a is the intercept

of the regression, and *b* is the regression coefficient (slope). Parameters *a* and *b* of the LWRs were estimated by linear regression analysis based on natural logarithms: $\ln(W) = \ln(a) + b\ln(L)$. Besides, 95% confidence limits of the *a* and *b* were estimated. The equation $t_s = (b-3)/S_b$ (Sokal and Rohlf, 1987), where t_s is the t-test value, b the slope and S_b the standard error of the slope (b), was utilized to confirm whether b values obtained in the linear regressions were significantly different from the isometric value of ±95%.

2.2. Results and discussion

A total of 140 specimens (74 *C. thrissa* and 66 *N. nasus*) were collected during the present study. The sample size (n), length range, weight range, parameters *a* and *b* of the LWR, 95% confidence intervals of *a* and *b*, the determination coefficient (r^2), t_s, and growth type of *C. thrissa* and *N. nasus* are given in Table 1. The maximum TL reported for *C. thrissa* (18.8 cm), and *N. nasus* (18.3 cm) were lower than the previous TL reported as 26.0 and 25.5 cm, respectively (Whitehead, 1985; Hussain, 2010). The sample weight ranges were relatively small to medium (3-54.7 g for *C. thrissa* and 13.8-43.1 g for *N. nasus*), while the maximum weight recorded in previous studies were 137 g and 190 g, respectively (Wang, 2015; Panda, 2016).

The *b* values for *C. thrissa* are 2.9099 for TL and 2.7117 for SL, which was not significantly different from three, indicating the isometric growth overall. For *N. nasus*, the regression parameter *b* is 2.7288 for TL and 2.6284 for SL, which significantly smaller than three suggesting a negative allometric growth trend. All the relationships were highly significant ($P < 0.001$), with r^2 values ranging from 0.6807 to 0.9762. All allometric coefficients *b* value evaluated in this study were within the expected range of 2.5-3.5.

Table 2 showed the comparison between data of the LWRs of C. thrissa and N. nasus in the present study and previous works. The b value for C. thrissa reported from China (Wang, 2015) was significantly different from the present study. Nevertheless, the present estimate (2.9099) was relatively close to the Bayesian length-weight prediction (2.93-3.23) made by Froese and Pauly (2019). This is probably due to variances in length standards used in particular studies. The b values reported for unsexed N. nasus in previous studies were higher than the present data. However, the b values for male N. nasus were 2.609 from India (Panda, 2016) and 2.87 from Pakistan (Hussain, Paperno, & Khatoon, 2010), which appeared to be moderately similar to the present data of 2.7288. The length-weight relationship was relatively weak for N. nasus, with low r2 values (0.6807 and 0.8283, Table 1), which may result from several factors such as stomach fullness or gonad maturity (Tesch, 1971).

Based on our field studies and literature review, this study provides the first basic information on LWRs of gizzard shads C. thrissa and N. nasus in the central of Vietnam that

would benefit fishery development well as the sustainable management of its numerous stocks in the region. In this study, samples were collected mainly during the rainy season in the study area (Kasbohm et al., 2006); therefore, parameters a and b should be treated as seasonal values. More detailed studies are suggested to provide further specific information on the annual variation of LWRs, condition factor, and gonadosomatic index of the gizzard shads.

Table 1. *Descriptive statistics and estimated parameters of the LWRs for gizzard shads C. thrissa and N. nasus in Vietnam's central.*

Species /n	Length (cm)				Weight (g)			Regression parameters		95% CI of a	95% CI of b	r^2	t_s	Growth type
	Type	Min	Max	Mean ± SD	Min	Max	Mean ± SD	a	b					
C. thrissa/74	TL	7.87	18.08	13.03 ± 3.60	3	54.7	17.89 ± 13.33	0.008	2.9099	-5.041 - -4.499	2.795 - 3.007	0.9762	-1.8566	I
	SL	6.04	14.63	10.32 ± 3.20	3	54.7	17.89 ± 13.33	0.017	2.7117	-4.010 - -3.281	2.554 - 2.869	0.9421	-3.6381	A-
N. nasus/66	TL	11.88	18.03	14.27 ± 1,39	13.8	43.1	23.34 ± 1.39	0.016	2.7288	-4.972 - -3.295	2.413 - 3.045	0.8283	-1.7157	A-
	SL	9.31	14.19	11.02 ± 1.03	13.8	43.1	23.34 ± 1.39	0.040	2.6284	-4.266 - -2.110	2.179 - 3.078	0.6807	-1.6514	A-

Note: *n, sample size; Min, minimum; Max, maximum; SD, standard deviation; a, intercept; b, slope; CI, confidence intervals; r^2, coefficient of determination; t_s, t-test value; A+, positive allometric growth; A-, negative allometric growth; I, isometric growth.*

Table 2. *LWRs comparison between the present study and the previous studies*

Species	Ref.	Sex	a	b	L_{min}	L_{max}	Length type	r^2	n	Country
C. thrissa	Wang, 2015	unsexed	0.0067	3.22	10.4	21.9	FL	0.989	50	China
	Present study	unsexed	0.008	2.9099	7.87	18.08	TL	0.9762	74	Vietnam
N. nasus	Panda, 2016	male	0.0145	2.87	11.4	23	TL	0.94	82	India
		unsexed	0.007	3.13	5.1	25.2	TL	0.99	648	India
	Hussain, 2010	male	0.0356	2.609	12.7	25.5	TL	0.835	782	Pakistan
		unsexed	0.0134	2.946	10.2	25.5	TL	0.922	2088	Pakistan
	Present study	unsexed	0.016	2.7288	11.88	18.03	TL	0.8283	66	Vietnam

3. CONCLUSION

-The provided LWRs of unsexed *Clupanodon thrissa* (2.9099 for TL and 2.7117 for SL), which were not known before, suggested an isometric growth pattern.

-The present study reported supplementary data on LWRs of unsexed *Namatalosa nasus* in the central part of Vietnam (2.7288 for TL and 2.6284 for SL), which showed a negative allometric growth pattern.

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KẾT QUẢ NGHIÊN CỨU TƯƠNG QUAN CHIỀU DÀI TRỌNG LƯỢNG CÁ MÒI CỜ HOA *CLUPANODON THRISSA* VÀ CÁ MÒI MÕM TRÒN *NEMATALOSA NASUS* (CLUPEIDAE) Ở SÔNG NHẬT LỆ

Tóm tắt: *Kết quả tương quan chiều dài trọng lượng của cá mòi cờ hoa Clupanodon thrissa và cá mòi mõm tròn Nematalosa nasus được nghiên cứu dựa trên 140 mẫu vật (74 C. thrissa and 66 N. nasus) thu được từ tháng 4 đến tháng 9 năm 2018 trên khu vực sông Nhật Lệ. Nghiên cứu lần đầu tiên cung cấp số liệu tương quan chiều dài trọng lượng dựa trên chỉ số chiều dài tổng và chiều dài chuẩn của cá mòi cờ hoa. Nghiên cứu cũng góp phần bổ sung vào dữ liệu đã có của cá mòi mõm tròn trong khu vực: Cung cấp dữ liệu tương quan chiều dài trọng lượng của cá mòi cờ hoa C. thrissa (2.9099 cho TL và 2.7117 cho SL), cho thấy xu hướng tăng trưởng đồng bộ; Cung cấp dữ liệu tương quan chiều dài trọng lượng của cá mòi mõm tròn N. nasus (2.7288 cho TL và 2.6284 cho SL), cho thấy xu hướng tăng trưởng ưu thế chiều dài hơn trọng lượng.*

Từ khóa: *Cá mòi; Clupanodon thrissa; Nematalosa nasus; tương quan chiều dài trọng lượng; Việt Nam.*