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Length–weight relations of 11 goby species (Actinopterygii: Gobiiformes) from mangroves along the Ba Lat estuary of the Red River, Vietnam

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Abstract

Presently reported study examined the length–weight relations for 11 goby species collected from a mangrove estuary of the Red River, Vietnam. A total of 1097 individuals of the following species, representing three goby families, were analyzed: *Butis butis* (Hamilton, 1822); *Butis koilomatodon* (Bleeker, 1849); *Acentrogobius moloanus* (Herre, 1927); *Acentrogobius viridipunctatus* (Valenciennes, 1837); *Apocryptodon madurensis* (Bleeker, 1849); *Aulopareia unicolor* (Valenciennes, 1837); *Glossogobius giuris* (Hamilton, 1822); *Gobiopsis macrostoma* Steindachner, 1861; *Mugilogobius abei* (Jordan et Snyder, 1901); *Tridentiger barbatus* (Günther, 1861); and *Tridentiger trigonocephalus* (Gill, 1859). The regression slope values (*b*) ranged from 2.909 to 3.621. The majority of species had positive allometric or isometric growth pattern with $b \geq 3$, except for only one species (*G. giuris*) which had a negative allometric growth with $b = 2.909$. This study provided the first LWR information of four gobies that have not been reported in FishBase yet. Besides, the reference for LWRs of other gobies at an ecologically important area like Ba Lat Estuary is also provided.

Keywords

gobies, length–weight relations, LWRs, Xuan Thuy National Park

Introduction

The length–weight relation (**LWR**) of fishes is a crucial tool for fishery management, used to quantify the biomass while assessing the population dynamics and inferring the impact of the environment on fish (Tesch 1971; Froese 2006). The growth patterns of fishes can be estimated and compared between populations or species using the slope values of LWR regressions (Anderson and Gutreuter 1983). Moreover, the body condition that reflects the relative wellness of fish populations in a given environment can also be estimated from the LWR (Froese 2006).

The Ba Lat Estuary, composed of well-developed mangrove forests of Xuan Thuy National Park and Tien Hai Wetland Nature Reserve, is an estuary with diverse biotopes. It is the habitat for many wild species, including some rare migration birds and many fishes (Hoang et al. 2013). Despite this importance, there is a lack of informa-

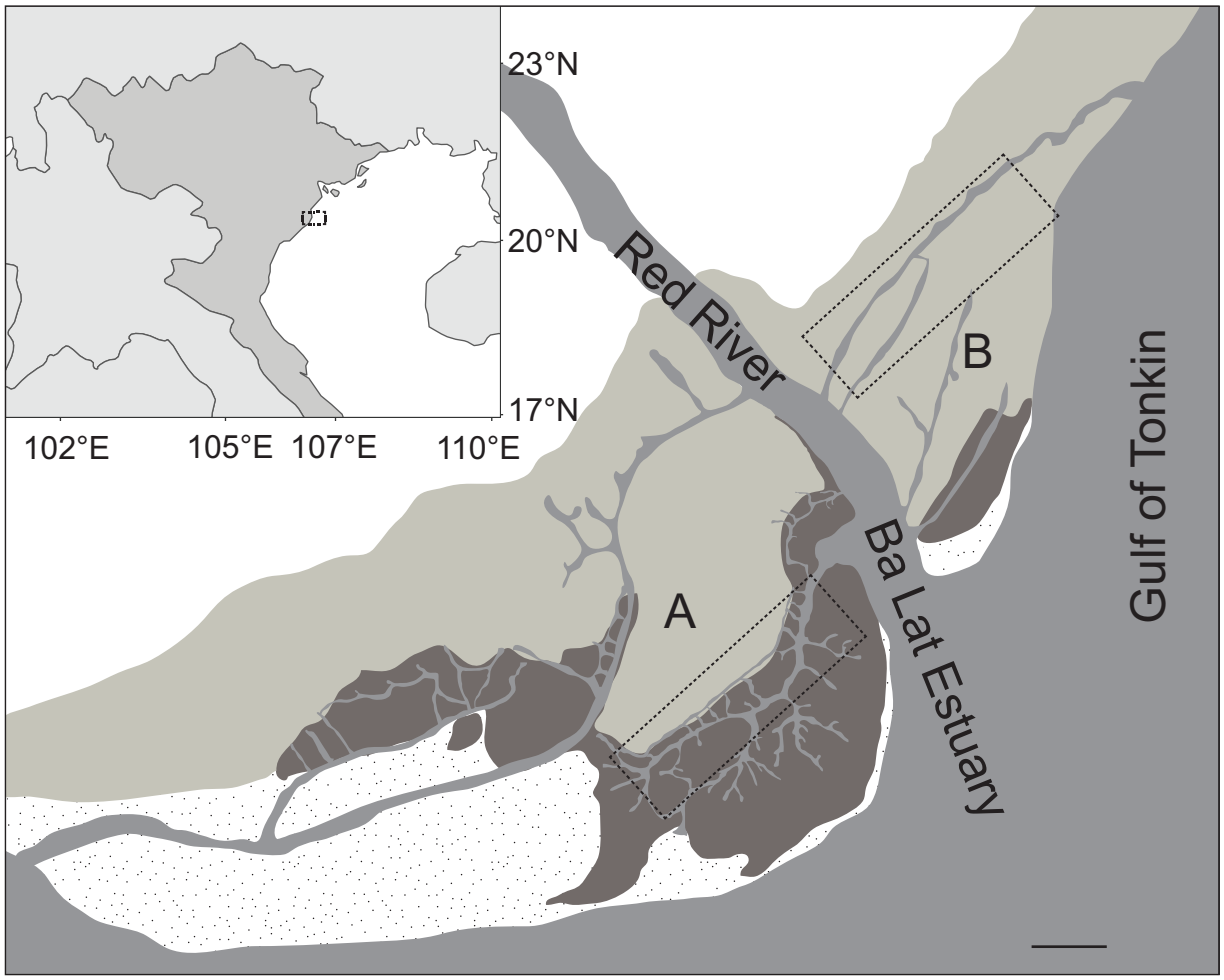

Figure 1. Map of the study area along Ba Lat Estuary, Vietnam. (**A**) Xuan Thuy National Park; (**B**) Tien Hai Wetland Nature Reserve; dashed rectangles indicate sampling sites. Scale bar: 2 km.

tion about LWRs of fishes in this area that may be useful for fisheries management.

This study intended to provide necessary information on LWRs for a better management of fishery resources in the area of Ba Lat Estuary.

Materials and methods

Fishes were collected monthly using hand nets and eight-hole fishing nets at Xuan Thuy National Park from March 2018 to February 2019 and Tien Hai Wetland Nature Reserve from March 2019 to February 2020 (Fig. 1). Total length (TL) and body weight (W) of fresh anesthetized fish samples were measured using a digital caliper and a digital balance to the nearest 0.01 cm and 0.1 g (except for *Mugilogobius abei* was measured to nearest 0.01 g), respectively.

The LWRs were estimated using the following formula:

$$W = a\mathrm{TL}^b$$

where W is total body weight [g], TL the total length [cm], a is the regression intercept, and b is the slope. The values of a and b were obtained from linear regression analysis using the natural logarithm of the variables, i.e., $\ln W = \ln a + b \times \ln \mathrm{TL}$ (Ricker 1973). Student's t-tests were performed to examine the growth type of fishes by comparing b with 3 (isometric growth if $b = 3$, negative allometric if $b < 3$ or positive allometric if $b > 3$). Basic functions in R software version 4.0.2 were used to perform all statistical analysis (R Core Team 2020).

Results

A total of 1097 specimens belonging to 3 families (Butidae, Gobiidae, Oxudercidae), and representing 11 species were examined: *Butis butis* (Hamilton, 1822); *Butis koilomatodon* (Bleeker, 1849); *Acentrogobius moloanus* (Herre, 1927); *Acentrogobius viridipunctatus* (Valenciennes, 1837); *Apocryptodon madurensis* (Bleeker, 1849); *Aulopareia unicolor* (Valenciennes, 1837); *Glossogobius giuris* (Hamilton, 1822); *Gobiopsis macrostoma* Steindachner, 1861; *Mugilogobius abei* (Jordan et Snyder, 1901); *Tridentiger barbatus* (Günther, 1861); and *Tridentiger trigonocephalus* (Gill, 1859). Table 1 shows the estimated LWRs and related information.

Table 1. LWR parameters for 11 goby species collected from mangroves along Ba Lat Estuary, Vietnam.

Family/Species	*n*	Total length [cm]	Weight [g]	Regression parameters						*b* (in FishBase)	Length [cm] (on FishBase)
				a	95% CI of *a*	*b*	95% CI of *b*	*b* compare to 3 (*P*, *t*-test)	r^2		
Butidae											
Butis butis	18	6.78–12.20	2.7–22.6	0.003	0.001–0.007	3.621	3.180–4.061	0.008	0.950	3.000[1]	8.6 TL[1]
Butis koilomatodon	65	3.96–9.24	0.8–12.8	0.010	0.006–0.016	3.208	2.936–3.480	0.132	0.898	3.260[2]	1.4–5.1 SL[2]
Gobiidae											
Acentrogobius moloanus	36	5.77–8.17	1.2–5.9	0.003	0.001–0.010	3.408	2.816–3.999	0.170	0.801	—	—
Acentrogobius viridipunctatus	109	2.34–13.75	1.8–29.3	0.008	0.006–0.010	3.164	3.067–3.262	0.001	0.975	3.230[1]	4.3–12.3 TL[1]
Apocryptodon madurensis	188	4.58–8.94	0.7–7.0	0.005	0.004–0.007	3.266	3.098–3.433	0.002	0.888	—	—
Aulopareia unicolor	196	4.43–10.74	0.8–15.8	0.004	0.003–0.006	3.451	3.298–3.605	< 0.001	0.910	—	—
Glossogobius giuris	270	5.81–27.00	1.4–162.0	0.009	0.008–0.011	2.909	2.843–2.974	< 0.001	0.966	2.682–3.298[3]	2.3–23.6 TL[3]
Gobiopsis macrostoma	56	5.35–9.90	1.7–12.0	0.005	0.003–0.009	3.391	3.144–3.637	0.002	0.934	—	—
Oxudercidae											
Mugilogobius abei	43	1.54–3.20	0.04–0.33	0.009	0.008–0.010	3.240	3.096–3.383	0.002	0.981	2.876[1]	1.2–5.0 TL[1]
Tridentiger barbatus	53	3.56–9.16	0.5–10.1	0.006	0.003–0.010	3.416	3.137–3.695	< 0.001	0.922	3.237[4]	3.5–10.4 SL[4]
Tridentiger trigonocephalus	63	5.21–8.88	1.4–10.3	0.008	0.004–0.015	3.291	2.949–3.633	0.094	0.859	3.000[1]	2.3 TL[1]

n = sample size, *a* = intercept, *b* = slope, CI = confidence interval, r^2 = coefficient of determination, TL = total length, SL = standard length; [1]Froese and Pauly (2020), [2]Lobato et al. (2018), [3]Hossain et al. (2009), [4]Xu et al. (2016).

The coefficients of determination r^2 ranged from 0.801 (for *A. moloanus*) to 0.981 (for *M. abei*). All 11 examined species had r^2 larger than 0.800 and were highly significant ($P < 0.001$ for all cases). The estimated values of intercepts (*a* value) ranged from 0.003 (*B. butis* and *A. moloanus*) to 0.010 (*B. koilomatodon*). The values of parameter *b* ranged from 2.909 for *G. giuris* to 3.621 for *B. butis* (Table 1), all remained within the expected 2–4 range (Tesch 1971), and mostly within the range 2.5–3.5 as suggested by Carlander (1969) or the range of 2.7–3.4 reported for 90% species examined by Froese (2006). The *b* values for the majority of the species were significantly higher than or at least equal to three, except for only *G. giuris* (Table 1).

Discussion

The LWRs of *A. moloanus*, *A. madurensis*, *A. unicolor*, and *G. macrostoma* were hitherto not available in FishBase (Froese and Pauly 2020). Hence, present study represents the first reference on LWRs for these four species. Besides these first records, we provided more robust data of LWRs for *B. butis*, and *T. trigonocephalus* than those were estimated with single data points on FishBase (Froese and Pauly 2020). For *B. butis*, we recommend another robust LWR data estimated by using 141 individuals at the size of approximately 4.5–15.5 cm TL from the Mekong Delta, southern Vietnam that has been reported with $b = 2.74$ lower than in the present study (Dinh 2017).

Additionally, the maximum lengths of *A. moloanus* (8.17 cm) and *A. unicolor* (10.74 cm) at present were longer than those reported on FishBase as 8.0 cm and 8.8 cm, respectively (Froese and Pauly 2020), constitute new records of these species' maximum length. Although the sample sizes were relatively small for the above-mentioned species, the LWRs from this study can be used confidently since the specimens were collected monthly covering a complete year and a wide size range of each species.

This study also reported supplementary information on LWRs of the remaining species, in which the *b* values of *B. koilomatodon* (3.208), *A. viridipunctatus* (3.165), *G. giuris* (2.909), and *T. barbatus* (3.416) were quite similar to the *b* value listed on FishBase presented in Table 1 (Hossain et al. 2009; Xu et al. 2016; Lobato et al. 2018; Froese and Pauly 2020). Remarkably, the estimated *b* value for *M. abei* (3.240) was higher than the value reported as 2.876 by Li et al. (2013). From the Mekong Delta area, the proximal area of our study site, the LWR of *G. giuris* was reported with a higher *b* value than in the present study with $b = 3.407$ (Dinh 2014). Given that, many factors can affect the parameters of LWR of fish, such as season, gonad maturity, sex, preservation methods, and differences in environmental conditions (Froese 2006). The dissimilarities found between this study and the others may be due to the differences in habitat conditions.

Concerning the growth type, our result showed that only one species had negative allometric growth ($b < 3$, $P < 0.01$), three species had isometric growth ($b = 3$, $P > 0.05$ for all cases), seven species had positive allometric growth ($b > 3$, $P < 0.01$ for all cases). The positive allometric growth indicates that fish grow in body weight faster than growth in body length, and fish will possess a plump shape as they grow. At this same study area, we also observed the positive allometric growth for another goby namely *Periophthamus modestus* with general $b = 3.094$ (Tran et al. 2021).This suggests that the estuary composed of mangroves in northern Vietnam is suitable for these fishes as providing sufficient food for them to grow and gain robust body shapes.

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