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GROWTH PATTERN AND BODY CONDITION OF *TRYPAUCHEN VAGINA* IN THE MEKONG DELTA, VIETNAM

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ABSTRACT

Trypauchen vagina is a potential commercial fish, but little is known about its growth pattern and body condition. This study aimed to understand its growth characteristics and condition factors during the dry (January–May) and wet (June–December) seasons. The data analysis was based on 328 specimens collected from May 2014 to April 2015. Sex ratio of this fish in the wet season was not significantly different from that in the dry season. Length-weight relationships were similar between female and male *T. vagina* as well as between dry and wet seasons, but differed between juveniles and mature fish. The slope of the length-weight regression was close to the isometric growth value of 3. The condition factors of this fish varied with seasonal change and fish size-classes, but they were similar in two genders and close to well-being value of 1. *Trypauchen vagina* showed isometric growth, adapted well, can become a potential fish for future aquaculture in this region, and provides useful information for our understanding on other gobies in monsoonal areas.

Keywords: Goby, isometric growth, length-weight relationship, condition factor.

INTRODUCTION

The length-weight relationship (LWR) provides an indirect measurement of fish biomass (Froese, 1998) and a hind for fish-size-selective exploitation (Froese and Pauly, 2000; Gonzalez Acosta *et al.*, 2004; Mahmood *et al.*, 2012). The slope value (*b*) of the LWR regression is used to predict fish growth pattern (Froese, 2006). The condition factor (*K*) varies with sex, fish size and seasonal changes (Froese, 2006) and used as an indicator to compare fish wellbeing between locations (Abdoli *et al.*, 2009a; Abdoli *et al.*, 2009b). Moreover, the condition factor is used to assess the effects of seasonal variation in food availability (Le Cren, 1951). However, little information is available on LWR and body condition in most benthic gobies, especially in the Mekong Delta where fishes widely diversify.

Many oxudercine fishes live on mud flats (Hajisamae *et al.*, 2006) and contribute to fishery catch in the Indo-Pacific region (Kong and Chen, 2013; Matics, 2000). *Trypauchen vagina* (Bloch and Schneider, 1801, Gobiidae) is an elongated goby (Salameh *et al.*, 2010; Siokou *et al.*, 2013), and is widely distributed in the coastlines and estuaries (Froese and Pauly, 2015). Although *T. vagina* is a potential commercial fish, its information is limited to morphology and environmental requirements (Salameh *et al.*, 2010; Talwar and Jhingran, 1991). Meanwhile, length-weight relationship and body shape variation of *T. vagina* has not been known yet, especially in the Mekong Delta. This study aimed to understand its body condition and growth pattern that can expand our knowledge to other burrow-dwelling fishes in the monsoonal region.

MATERIALS AND METHODS

Study site: This study was carried out in Kinh Ba River (9°34'12.41"N, 106°13'38.25"E), Cu Lao Dung, Soc Trang, Vietnam from May 2014 to April 2015. Soc Trang comprises a long coastline fringed by mangroves and a large number of muddy areas with semi-diurnal tide. Dry (January–May) and wet (June–December) are two main seasons in this area. With roughly 400 mm monthly precipitation in the wet season and the average annual temperature of 28–29ºC, Soc Trang is a typical region representing the natural environment in the Mekong Delta (Soc Trang Statistical Office, 2012).

Fish collection: Fish specimens were monthly collected using gill nets with 1.5 cm mesh in the cod end, 2.5 cm mesh in the mouth and 5 m in the long. After collection, specimens were anesthetized using benzocaine and stored in 5% formalin before transport to the Laboratory. Fish specimens, in the laboratory, were sexed based on genital papilla which was round in females and narrow in males before determination of their total length (*TL*, nearest 0.1 cm) and body weight (*W*, nearest 0.01 g). A thermometer (Model: HI98127, ±0.5ºC) and a refractometer (Model: 950.0100 PPT-ATC, ±1 ‰) was used to measure the surface water temperature and salinity, respectively. These factors were then used to test the influence of environmental factors on the sex ratio.

Data analysis: Chi-square and Student t-test were performed to examine the difference in sex ratio. The length-weight relationship of male and female fish was quantified using equation $W = a * TL^b$ (Ricker, 1973), where, *W* is fish weight (g), *TL* is total length (cm), and *a* is the regression intercept and *b* is the slope that were estimated using the logarithm equation log*W* = log*a* + *b**log*TL* (Froese, 2006). The differences of the *b* values (e.g., slope or regression coefficient) between males and females, between fish size (immature, e.g., TL<14.5 cm and mature, e.g., TL>14.5 cm, Unpublished data), and between dry and wet seasons were confirmed using ANOVA. The Student t-test was performed to test whether the *b* values were significantly different from the cubic value of 3 (Froese, 2006).

The equation $K = \frac{W}{aTL^b}$ (Le Cren, 1951) was used to estimate the fish condition factor (*K*), where, *W* is fish weight (g), *TL* is total length (cm), and *a* is the regression intercept and *b* is the slope. The significant differences of condition factors between male and female fish, between wet and dry seasons, and between fish size-classes (8–10, 10–12, 12–14, 14–16, and 16–18 cm) were quantified using ANOVA. The fish size was divided using the equation $\frac{\text{TLmax-TLmin}}{\log_{10} n}$, where, *n* is the fish number, TLmax is the maximum total length, and TLmin is the minimum total length (Wand, 1997). Two-way ANOVA was used to test the possible interaction between season and fish size affecting to the fish condition factor (*K*) variation. Student t-test was performed to confirm whether the *K* was equal to one (Mahmood *et al.*, 2012). The level of significant difference for all tests was set at $P < 0.05$.

RESULTS AND DISCUSSION

Sex ratio and environmental factors: A total of 328 individuals (161 males and 167 females) was collected (Table 1). The male to female ratio in this study region was not significantly different within or between season (χ^2, $P > 0.05$ in all cases, Table 1). Water temperature in the dry season (29.07±1.32ºC) was not higher that than in the wet season (29.07±1.32ºC, t-test, $P > 0.05$), while salinity in the dry season (8.86±3.75‰) in the study site was significantly different from that in the wet season (2.68±2.28‰, t-test, $P < 0.001$). In some fishes, the sex ratio was strongly regulated by temperature variation, e.g., *Pomatoschistus minutus*, 33 *Apistogramma* species and *Oreochromis niloticus* (Abucay *et al.*, 1999; Baroiller and D'Cotta, 2001; Kvarnemo, 1996). However, the proportion of male *T. vagina* in this study was equal to females during dry and wet seasons, suggesting that variation of temperature and salinity did not significantly influence the sex ratio of this goby, which is also found in *Pseudapocryptes elongatus* distributed the Mekong Delta (Tran, 2008). Moreover, male and female ratio of *A. caeteiare* is not sensitive to temperature variations (Baroiller and D'Cotta, 2001) and *O. niloticus* is not strongly influenced by salinity change (Abucay *et al.*, 1999).

Length-weight relationships: Monthly male and female *T. vagina* weights could be estimated from fish length due to high coefficients of determination ($r^2 > 0.7$ in all cases, $P < 0.05$, Table 1). Length and weight of male and female fish in wet and dry seasons were strongly positively correlated ($r^2 > 0.8$, $P < 0.05$ in all cases, Fig. 1). Other than aforementioned data, a positive relationship was found between length and weight in juveniles (e.g., immature fish) and mature male and female gobies. These studies suggest that fish fauna estimated in this way can help in fishery management. Like goby, strong positive length-weight relationships were also found among *P. elongatus* (Tran, 2008), *Periophthalmus barbarus* (Chukwu and Deekae, 2011) and *Parachaeturichthys ocellatus* (Panicker *et al.*, 2013). The LWR coefficient value (*b*) in this study, however, was influenced strongly by fish age as mature fish (3.44±0.23) showed significantly higher *b* than that of juvenile fish (2.54±0.10, ANOVA, $P < 0.05$). It could be the gonad development which lead to a high value of *b* in mature fish.

The larger ovaries during the spawning season may result in slight higher in slope value of female *T. vagina* compared to its counterparts. Similarly, Kalaycı *et al.* (2007) found that gonadal development leads to the difference in *b* value in *Gobius niger* in Turkey, but not in *P. barbarus* (Chukwu and Deekae, 2011; King and Udo, 1998) and *P. ocellatus* (Panicker *et al.*, 2013). The *T. vagina* can adapt well in this area and become a potential fish for future aquaculture as the slope value females (b = 2.89±0.08) was not significantly different from that of males (b = 2.85±0.09, ANOVA, $P > 0.05$) and was similar in dry and wet seasons (Table 1, ANOVA, $P > 0.05$). Likewise, Mahmood *et al.* (2012) reported that the growth patterns of *Ilisha melastoma* in Pakistan are not influenced by seasons including pre-monsoon (January–April), monsoon (May–September) and post-monsoon (November–December).

Trypauchen vagina showed isometric growth as its *b* value (2.88±0.09) was not significantly different from the cubic value of 3 (t-test, df = 11, $P > 0.05$), showing that the growth pattern of this fish fell into the "well-being" category as described by Froese and Binohlan (2000). The "well-being" category suggests that environmental conditions, where *T. vagina* lived, were suitable for fish feeding and growth, and these conditions could be imitated for fish culture. Isometric growth, additionally, is found in *Sardinella sindensis*, *Liza carinata*, *Alepes kleinii* and *A. melanoptera* (Khatoon *et al.*, 2013), *Barbatula barbatula* (Oscoz *et al.*, 2005), and *P. barbarus* (King and Udo, 1998). However, *I. melastoma* shows negative allometric growth ($b < 3$) (Mahmood *et al.*, 2012), whereas *Periophthalmus* *argentilineatus* and *P. spilotus* has positive allometric growth ($b > 3$) (Khaironizam and Norma-Rashid, 2002). Albeit the growth pattern is species-specific, environmental conditions can affect the growth outcome, e.g., the *b* value of *G. niger* varies in different habitats from 2.81 in Black Sea, 2.89 in Egypt, to 3.85 in Mediterranean (Kalaycı *et al.*, 2007).

The condition factor (*K*): The condition factor (*K*) of male *T. vagina* (1.02±0.01) was not significantly higher than that in females (1.00±0.01, t-test, df = 236, $P > 0.05$), indicating that both males and females lived in favorable conditions. However, *K* values were higher in the dry season (1.06±0.01) compared to the wet season (0.98±0.01, t-test, df = 236, $P < 0.001$), which suggests that gonadal maturation influencing the variation of *K* values of this goby. Mahmood *et al*. (2012), likewise, reported that the condition factor of *I. melastoma* is affected by fish gonadal developmental stages, whereas the condition factor of *P. barbarus* was similar in males and females during dry and wet seasons (Chukwu and Deekae, 2011; King and Udo, 1998).

The condition factor of *T. vagina* varied with fish size-classes (ANOVA, df = 4, $P < 0.001$, Fig. 2), and the smallest (e.g. pre-maturation) and largest (post-spawning) fish groups had higher *K* values than other fish groups. Moreover, body condition of this goby was monthly fluctuated (ANOVA, df = 11, $P < 0.05$, Fig. 3), and decreased to a low point in main spawning time. It seems that the spent gonad of mature fish could contribute to the lower *K* value compared to smaller juveniles and post-spawning fish. Similarly, while studying *I. melastoma*, Mahmood *et al.* (2012) found that its condition factor varies monthly, which is also true for *P. barbarus* (Chukwu and Deekae, 2011; King and Udo, 1998).

Like other fishes in the same habitat such as *P. elongatus* (Tran, 2008), *T. vagina* lived above the average condition as its *K* value (1.01±0.01) in this study was close to one (t-test, df = 327, $P > 0.05$). *Ilisha melastoma* also lives in a suitable environmental condition for fish growth as its condition factor is close to the well-being value of 1 (Mahmood *et al.*, 2012). The change of condition factor between male and female *T. vagina* did not depend on seasons (two-way ANOVA, df = 1, $P > 0.05$). The two-way ANOVA showed that there had no interaction between season and fish size on the variation of *K* values of *T. vagina* (df = 4, $P > 0.05$). It seems that both male and female fish lived well in the study site, which was similar to *I. melastoma* (Mahmood *et al.*, 2012) and *P. barbarus* (Chukwu and Deekae, 2011; King and Udo, 1998).

Table 1. The sex ratio, regression slope (*b*) and morphometrics *T. vagina* in the study site

Sampling time	Female	Male	Sex ratio	*P*-value	*b* (Mean±SE)	*a*	r^2	Range of *TL* (cm) and *W* (g)			
								Female		Male	
								TL	*W*	*TL*	*W*
May-14	16	14	1:0.88	0.715	2.60±0.23	0.0124	0.817	14.4–17.7	11.89–23.71	11.1–17.9	7.84–23.52
Jun-14	16	14	1:0.88	0.715	2.38±0.27	0.0187	0.729	11.7–15.6	7.14–14.11	11.4–17.0	6.20–16.97
Jul-14	17	13	1:0.76	0.465	2.95±0.14	0.0040	0.944	11.1–15.8	4.63–12.96	11.0–16.5	4.37–16.55
Aug-14	16	14	1:0.88	0.715	3.09±0.14	0.0027	0.946	11.0–14.8	2.51–12.82	11.0–16.8	4.62–16.24
Sep-14	14	16	1:1.14	0.715	2.70±0.27	0.0075	0.788	8.7–13.7	2.64–9.37	10.9–15.3	5.18–12.63
Oct-14	17	13	1:0.76	0.465	3.15±0.18	0.0024	0.919	11.8–14.3	6.06–9.83	10.2–16.1	3.36–18.70
Nov-14	15	14	1:0.93	0.853	3.29±0.20	0.0008	0.921	13.0–17.6	6.21–19.92	12.0–17.7	4.42–20.20
Dec-14	10	16	1:1.60	0.239	2.99±0.29	0.0039	0.821	11.0–15.7	5.81–16.63	12.0–17.2	6.19–21.22
Jan-15	11	13	1:1.18	0.683	3.02±0.17	0.0034	0.933	11.4–15.8	5.60–15.20	11.5–16.6	5.52–18.09
Feb-15	10	8	1:0.80	0.637	2.77±0.34	0.0060	0.808	9.7–14.5	2.64–10.70	9.8–16.1	3.43–16.51
Mar-153	16	14	1:0.88	0.715	2.37±0.34	0.0187	0.832	9.7–13.8	3.62–11.78	9.2–16.3	2.96–13.64
Apr-15	9	12	1:1.33	0.513	3.29±0.20	0.0017	0.968	10.0–14.6	2.41–11.17	11.2–16.8	5.21–21.70
Dry season sum	62	61	1:0.98	0.928	2.99±0.09	0.0053	0.911	9.7–15.8	2.41–11.78	9.2–17.9	2.96–23.52
Wet season sum	105	100	1:0.95	0.727	2.84±0.08	0.0039	0.859	8.7–17.6	2.51–19.92	10.2–17.7	3.36–20.20
Total	167	161	1:0.96	0.740	2.88±0.09	0.0049	0.883	8.7–17.7	2.41–12.92	9.2–17.9	2.96–23.52

* SE: Standard error

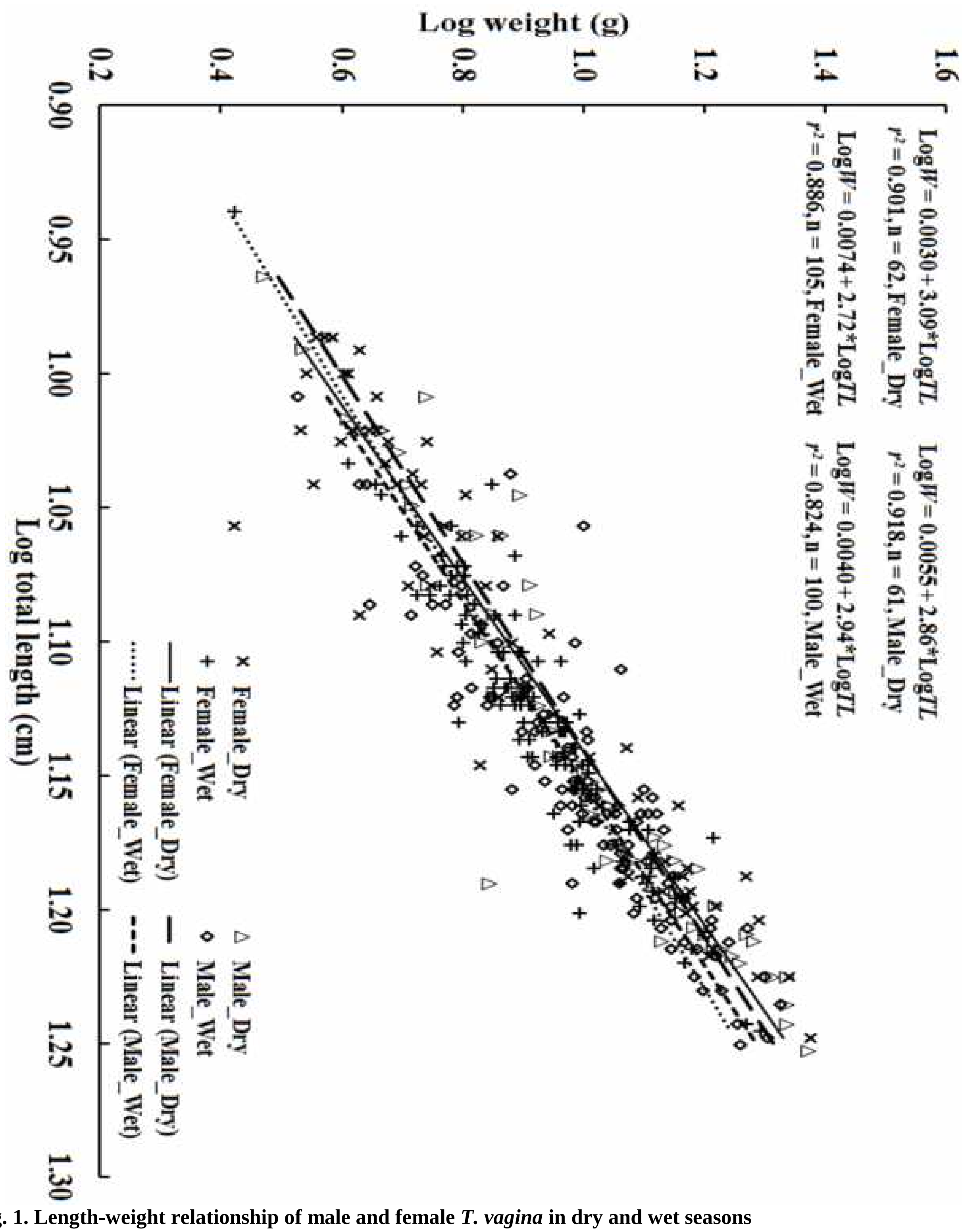

Fig. 1. Length-weight relationship of male and female *T. vagina* in dry and wet seasons

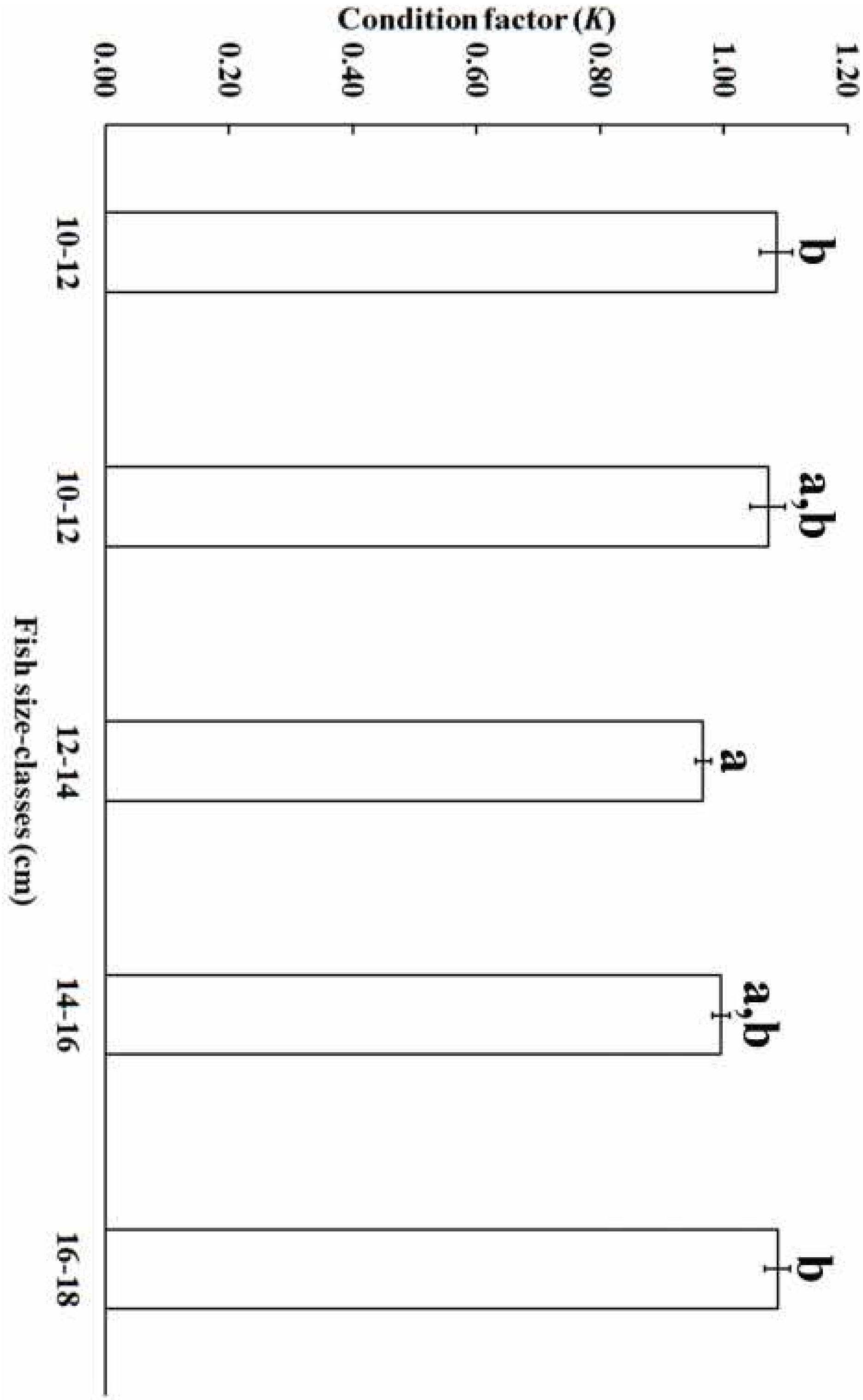

Fig. 2. Condition factors of *T. vagina* in five size-classes. Different letters show significant difference between fish size-classes. Vertical lines represent standard error

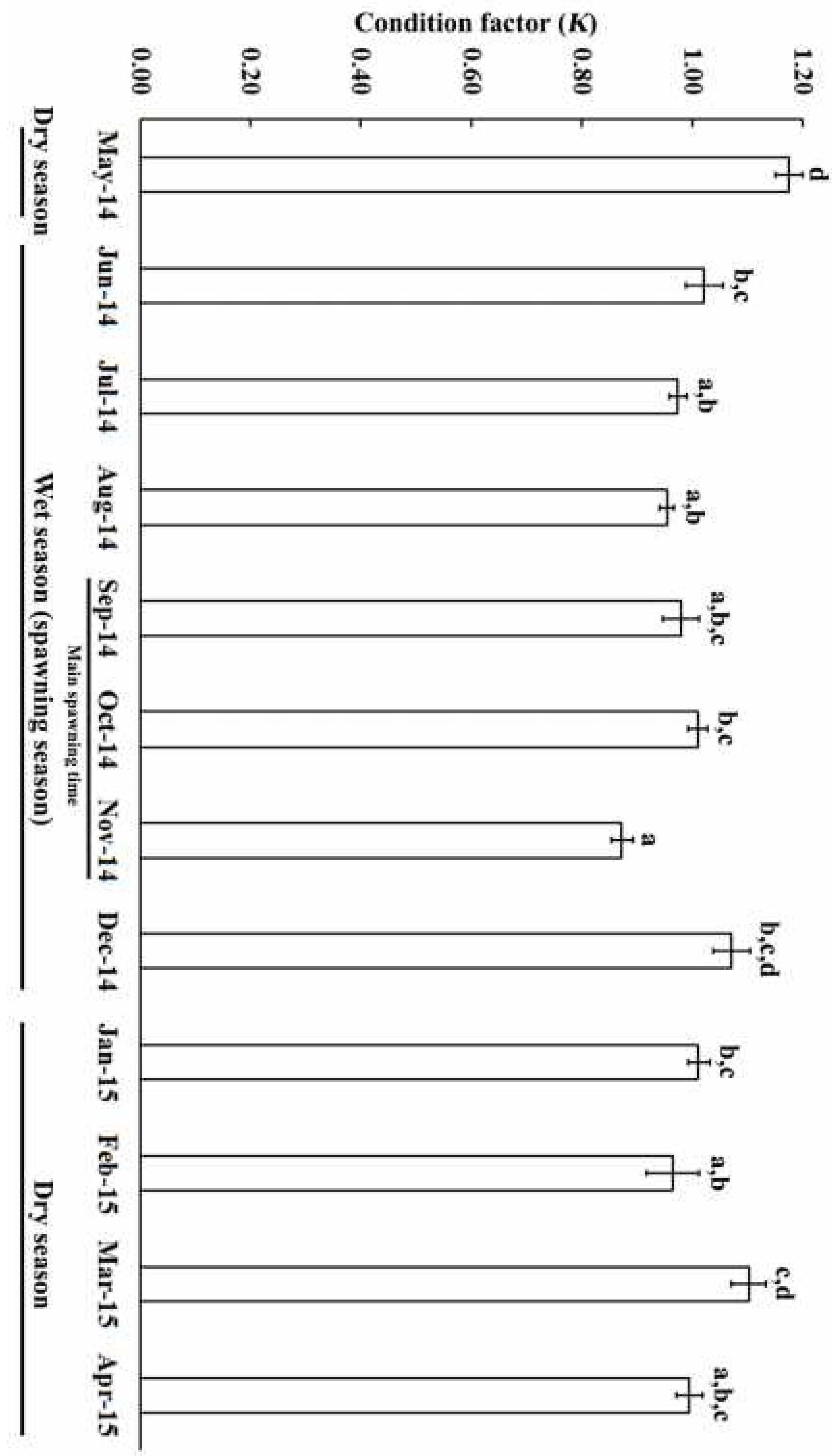

Fig. 3. Monthly variation of condition factors of *T. vagina* crossed wet and dry seasons. Different letters show significant difference between fish size-classes. Vertical lines represent standard error

Conclusion: The sex ratio was not significantly different between dry and wet seasons, and *T. vagina* growth pattern fell into isometric growth category as its regression slope value was near 3. The slope values of this goby were significantly different between juveniles and mature fish, but not between two genders and seasons. Although the condition factors of this goby varied with seasons and fish sizes, they overall were close to 1. These observations suggest that this fish adapts well and can become a potential fish for future aquaculture in this region, and provides some helpful information to our knowledge on other gobies in the monsoonal region.

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