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# GROWTH AND BODY CONDITION VARIATION OF THE GIANT MUDSKIPPER *Periophthalmodon schlosseri* IN DRY AND WET SEASONS

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**ABSTRACT:** This study provides information on the growth and body condition variation of the giant mudskipper *Periophthalmodon schlosseri* between gender and fish size during dry and wet seasons. A total of 367 fish specimens was collected along mudflat and mangrove forest in Tran De from May 2014 to April 2015. The sex ratio of this fish was nearly 1:1. This species showed isometric growth as its slope value was close to the standard threshold (= 3), and its length-weight relationship was similar in both dry and wet seasons. Although the condition factor of this mudskipper varied with seasonal change and fish size, it was similar in males and females and close to well-being value (= 1). These results indicated that this fish lives well and can become a potential fish for aquaculture in this area, and provides useful information for our knowledge to other gobiid fishes.

*Keywords: Periophthalmodon schlosseri*, condition factor, isometric growth, length-weight relationship, mudskipper.

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## INTRODUCTION

Knowledge on the relationship between length and weight (LWR) is necessary for assessing fish population and converting fish length into weight estimation [7, 11, 17, 22]. The regression coefficient or slope value (*b*) obtained from LWR provides useful information for estimating fish growth pattern [8]. Moreover, the condition factor (*K*) has been used as an indicator to compare fish wellbeing between regions or between fish species [1, 2]. The *K* varied with fish size, season [8] and reproductive cycle [22]. Limited information, however, is available on LWR and body condition in numerous fishes in the Mekong Delta where fishes have been subjected to overfishing [24].

The goby *Periophthalmodon schlosseri* (Pallas, 1770) is an amphibious fish [4] widely distributing in the mangrove swamps in the Indo-Pacific region [10]. This gobiid species builds burrows in the estuarine mudflats for refuging, storing oxygen and laying eggs during the spawning season [13, 14, 15]. This fish actively transports $NH_4^+$ against a concentration gradient [31] and uses air for respiring through its skin [35]. It is also a commercial fish [12], and information on its age, growth and spawning season is described by Mazlan & Rohaya (2008) [23]. The slope value (b) of this goby is close to three in the mangrove areas of the Selangor coast, Malaysia [17] but was lower than three in the Naf River, Bangladesh [33]. In the Mekong Delta, Vietnam, this mudskipper is one of the important fishes for food and is being increasingly caught; however, little has been known about its length-weight relationship, growth pattern, and condition factor. Moreover, the influence of gender, fish size, and season on the variations of the slope value and body condition of this goby has been limited. The aims of this study were to understand its growth pattern and body conditions during dry (January - May) and wet (June - December) seasons.

## MATERIALS AND METHODS

Deep gill nets (1.5 cm mesh at the cod end) were used to catch fish along the mudflat and

mangrove forest in Tran De District, Soc Trang Province, Mekong Delta, Vietnam (9°28'47.41"N, 106°12'25.96"E) monthly from May 2014 to April 2015. Fish specimens were classified based on the external morphology [6] and stored in 5% formalin before transport to the laboratory. In the laboratory, the sex of *P. schlosseri* was identified based on the external morphology of urogenital papilla, which was round in female and narrow in male. Then, the total length (at 1 mm sensitivity) and weight (at 0.01 g sensitivity) of fish specimens were measured.

The male and female ratio was examined using $\chi^2$ test. The relationship between fish length and weight was estimated using equation $W = a \times TL^b$ [32], where $W$ is fish weight (g), $TL$ is fish total length (cm), and $a$ is the regression intercept, and $b$ is the slope. The values of $a$ and $b$ were then estimated from the $\log_{10}$ transformed length and weight values as $\log W = \log a + b \times \log TL$ [8]. The variation of the slope values between dry and wet seasons was tested using ANCOVA. The significant difference of $b$ values from the isometric threshold of three was confirmed using the Student t-test [8].

The fish condition factor was determined from the equation $K = \frac{W}{a \times TL^b}$ [21], where, $W$ is fish weight (g), $TL$ is total length (cm), and $a$ is the regression intercept, and $b$ is the slope. The difference of condition factors between males and females, dry and wet seasons and fish total length (<13, 13-15, 15-17, 17-19, 19-21, 21-23, >23 cm) were quantified using one-way ANOVA. Difference of fish condition factors in season and in fish size was analyzed to two-way ANOVA. The difference of condition factor from the standard value of a favorable condition of one was confirmed using the Student t-test [22]. The level of significant difference for all tests was set at $P<0.05$.

## RESULTS AND DISCUSSION

### Sex ratio

Table 1. The sex ratio and regression slope (b) P. schlosseri in the study site

| Months | Female | Male | Sex ratio | *P*-value | *b* | *a* | $r^2$ |
|---|---|---|---|---|---|---|---|
| May-14 | 22 | 23 | 1 : 1.05 | 0.881 | 3.026 | 0.0086 | 0.875 |
| Jun-14 | 17 | 13 | 1 : 0.76 | 0.465 | 2.861 | 0.0154 | 0.959 |
| Jul-14 | 13 | 17 | 1 : 1.30 | 0.465 | 3.032 | 0.0132 | 0.890 |
| Aug-14 | 16 | 14 | 1 : 0.88 | 0.715 | 2.964 | 0.0199 | 0.863 |
| Sep-14 | 11 | 16 | 1 : 1.45 | 0.336 | 2.927 | 0.0194 | 0.919 |
| Oct-14 | 12 | 15 | 1 : 1.25 | 0.564 | 2.843 | 0.0293 | 0.930 |
| Nov-14 | 13 | 11 | 1 : 0.85 | 0.683 | 2.816 | 0.0287 | 0.920 |
| Dec-14 | 16 | 13 | 1 : 0.81 | 0.577 | 2.963 | 0.0100 | 0.954 |
| Jan-15 | 17 | 19 | 1 : 1.12 | 0.739 | 2.991 | 0.0096 | 0.872 |
| Feb-15 | 17 | 13 | 1 : 0.76 | 0.465 | 2.941 | 0.0105 | 0.905 |
| Mar-15 | 13 | 17 | 1 : 1.31 | 0.465 | 2.997 | 0.0102 | 0.852 |
| Apr-15 | 15 | 14 | 1 : 0.93 | 0.853 | 3.103 | 0.0078 | 0.828 |

A total of 367 individuals (185 males and 182 females) were collected (table 1). In this study, the monthly male to female ratio was not significantly different from 1:1 ($\chi^2$, $P>0.05$ every month, table 1). Also, male to female ratio in the dry and wet seasons was not significantly different from each other ($\chi^2$, $P>0.05$). The male nest tending results in the outnumber of female *Gobius vittatus* are caught from the northern Adriatic Sea in the spawning season compared to males [20], which is similar to the goby *Gobius niger* caught from Obidos Lagoon, Portugal [34]. However, the 1:1 of sex ratio is also found in co-occurring gobiid fish such as *Pseudapocryptes elongatus* [5], *Boleophthalmus boddarti* [28], *Parapocryptes serperaster* [29, 30], suggesting that these gobies shared the same reproductive behavior.

In the present study, the sex ratio of *P. schlosseri* is similar to that caught in the mangrove areas of the Selangor coast, Malaysia [23], seeming that male to female ratio of this fish was similar in the tropical regions.

**Length-weight relationships and the growth pattern**

Weights of male and female fish could be determined from fish length ($r^2$>0.8 in all cases, $P$<0.05, Table 1), showing that fish can be estimated for fishery assessment. The strong positive length-weight relationships are also noted in *P. elongatus* [5], *Periophthalmus barbarus* [3], *Parachaeturichthys ocellatus* [26], *B. boddarti* [27] and *P. serperaster* [29].

The slope value obtained from *LWR* of *P. schlosseri* was higher in the dry season ($b$=3.012±0.027) compared to that in the wet season ($b$=2.915±0.029, t-test, df=10, $P$<0.05), which indicated that the seasonal change of environmental factors can influence the variation of slope value of this fish. In contrast, growth patterns of the goby *P. serperaster* [29] and *Ilisha melastoma* [22] in Pakistan are not influenced by the seasons. The slope value (b) of *P. schlosseri* in this study was near to the isometric threshold of 3.0 ($b$= 2.956 ± 0.024, df=11, $P$>0.05), falling into the "well-being" category as described by Froese & Binohlan (2000) [9]. The present study results coincided well with those of *P. schlosseri* caught in the mangrove areas of the Selangor coast, Malaysia [17]. These results suggest that this fish species can adapt well to Southeast Asian mangrove areas and can be a potential fish for aquaculture in future. Other fish species such as *Sardinella sindensis*, *Liza carinata*, *Alepes kleinii* and *Alepes melanoptera* [18], *Barbatula barbatula* [25], *Periophthalmus barbarus* [19], and *Boleophthalmus boddarti* [17] also show isometric growth as their slope values are not significantly different from 3.0. In contrast, *Ilisha melastoma* [22], *Scartelaos histophorus*, *Periophthalmus chrysospilos*, *Periophthalmus gracilis*, *Periophthalmus novemradiatus*, and *Periophthalmodon septemradiatus* [17] showed negative allometric growth ($b$<3), while *Periophthalmus argentilineatus* and *Periophthalmus spilotus* show positive allometric growth ($b$>3) [17]. Although the growth pattern is species-specific, environmental conditions can affect the growth pattern of fish. For example, the *b* value of *Gobius niger* is different depending on the regions, ranging from 2.81 in the Black Sea, 2.89 in Egypt, to 3.85 in Mediterranean [16]. The growth pattern of the goby *Periophthalmodon schlosseri* was also influenced by environmental conditions as this fish showed isometric growth in the Mekong Delta (the present study) and the mangrove areas (Selangor coast, Malaysia) [17], but negative allometric growth in the Naf River in Bangladesh [33].

**The condition factor (*K*)**

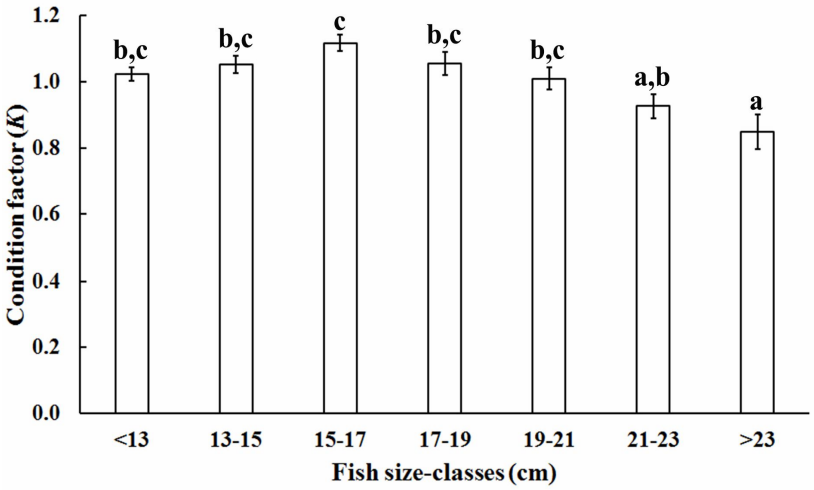


*Figure 1.* Condition factors of P. schlosseri of various sizes. Different letters show significant difference between fish size-classes. Vertical lines represent standard error

In this study, the condition factor (*K*) of *P. schlosseri* was not significantly different between males (1.01±0.01) and females (1.03±0.02, t-test, df=365, *P*>0.05), between dry (1.01±0.01) and wet seasons (1.03±0.02, t-test, df=365, *P*>0.05), and was close to 1. It suggests that both male and female fish lived well in environmental conditions of this study area, and sexual maturation did not affect on the *K* values of this fish. Similar to the present study results, the *K* values of *Periophthalmus barbarus* were not significantly different between dry and wet seasons [3, 19]. The *K* values of *Ilisha melastoma* in Pakistan, however, is affected by fish sexual developmental stages [22]. Similarly, the goby, *Parapocryptes serperaster*, living in the same habitat with *P. schlosseri* in the Mekong Delta showed K value variance depending on the sex [29].

As shown in fig. 1, the *K* values of *P. schlosseri* varied with fish sizes (ANOVA, df=6, *P*<0.001, fig. 1) and was low in the smallest (e.g. pre-mature) and the largest (post-spawning) fish groups compared to other fish sizes. These suggest that the spent gonad is related to the lower *K* value in mature fish compared to that in smaller juveniles or post-spawning fish. The variance of the *K* factor in relation to the fish size was also observed in the goby, *P. serperaster*, in the Mekong Delta [29], but not in *Ilisha melastoma* in Pakistan [22]. The *K* value of this fish fluctuated monthly (ANOVA, df=11, *P*<0.001, fig. 2). The similar monthly fluctuation of the *K* factor was observed in *I. melastoma* [22], *Periophthalmus barbarus* [3, 19], and *P. serperaster* [29].

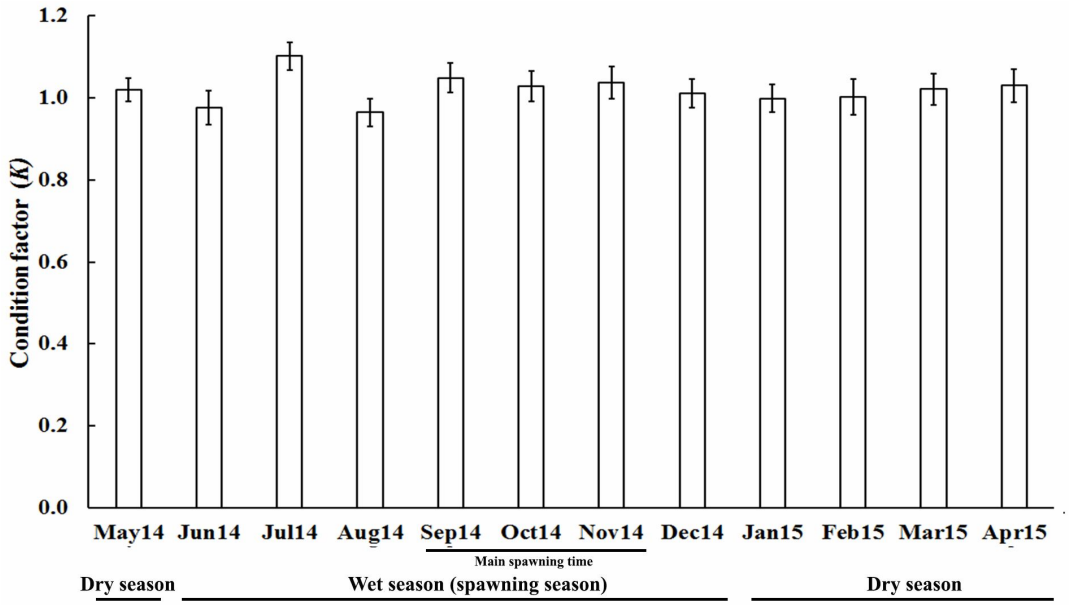


*Figure 2.* Monthly variation of condition factors of *P. schlosseri* crossed wet and dry seasons. Vertical lines represent standard error

The *P. schlosseri* in this study assumed to live above the average condition as its *K* value (1.02±0.01) was significantly higher than 1.0 (t-test, df=365, *P*<0.05). High *K* values of >1.0 was also noted in *P. elongatus* [5] and *P. serperaster* [29]. The fish *Ilisha melastoma* also is also assumed to live in a favorable environmental condition as its *K* value was close to the wellbeing value of 1.0 [22]. The variance of the *K* values of *P. schlosseri* correlates to the sex and the season (two-way ANOVA, df=1, *P*>0.05, fig. 3), but not correlate to the fish size (two-way ANOVA, df=6, *P*>0.05). It seems that both males and females adapted well to the environmental conditions of this study site.

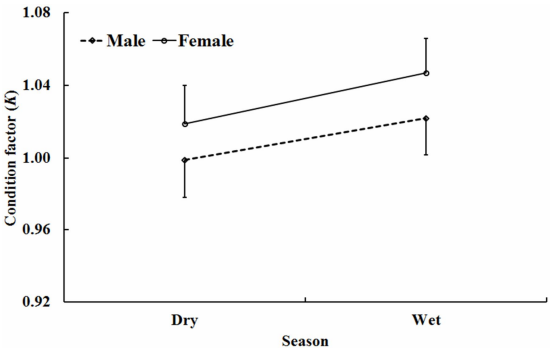


*Figure 3.* The correlation between *K* values and sex and seasons. Vertical bars represent standard error.

## CONCLUSION

The male/female ratio of *P. schlosseri* in the Mekong Delta was close to 1:1, and this fish showed isometric growth as its slope value was near 3.0. Its *K* value varied with season and fish size, but was close to 1.0 as an overall. Thus, this fish live in a favorable condition, and can become a potential fish for future aquaculture.

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# HÌNH THỨC TĂNG TRƯỞNG VÀ SỰ BIẾN ĐỘNG CỦA HỆ SỐ ĐIỀU KIỆN CỦA CÁ THÒI LÒI *Periophthalmodon schlosseri* Ở MÙA MƯA VÀ MÙA KHÔ

**Đinh Minh Quang**

Trường Đại học Cần Thơ

**TÓM TẮT**

Nghiên cứu này cung cấp thông tin về hình thức tăng trưởng và sự dao động của hệ số điều kiện của cá thòi lòi *Periophthalmodon schlosseri* theo giới tính và kích cỡ cá ở mùa mưa và mùa khô. Tổng số 367 cá thể thu được ở vùng bãi bồi ven rừng ngập mặn ở Trần Đề từ tháng 5 năm 2014 đến tháng 4 năm 2015. Tỷ lệ giới tính của loài này gần như cân bằng, 1:1. Loài cá này thuộc nhóm tăng trưởng đồng đẳng vì hệ số dốc gần bằng giá trị chuẩn (=3), và mối tương quan giữa chiều dài và trọng lượng của loài này giống nhau ở hai mùa mưa và khô. Mặc dù hệ số điều kiện của loài này dao động theo mùa và kích cỡ cá, nhưng hệ số này giống nhau ở cá đực và cá cái và tương đương với giá tăng trưởng tốt (=1). Kết quả nghiên cứu cho thấy loài cá này sống trong môi trường tốt và sẽ có nhiều tiềm năng cho việc nhân nuôi nhân tạo ở khu vực nghiên cứu.

*Từ khóa: Periophthalmodon schlosseri*, cá thòi lòi, hệ số điều kiện, tăng trưởng đồng bộ, tương quan chiều dài trọng lượng.

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