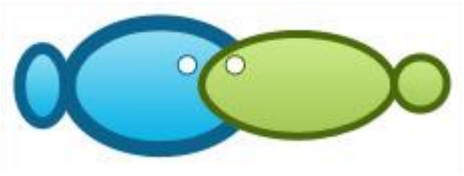

# Growth and condition factor of the commercial goby *Glossogobius sparsipapillus* living along Bassac River, Vietnam

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**Abstract**. The study contributes to the knowledge on growth and condition factor of the commercial fish *Glossogobius sparsipapillus*, based on the data analysis of 764 individuals (356 females and 408 males). Specimens were caught using gill nets in four sampling sites (Cai Rang, Can Tho to Long Phu, Soc Trang, Hoa Binh, Bac Lieu, and Dam Doi, Ca Mau) during the period from January 2020 to December 2020. The findings show that fish weights of females and males, for various sizes, seasons and sampling sites, can be estimated from the measured lengths, given the length-weight relationships (LWRs) with rather high determination coefficients. The species *G. sparsipapillus* showed a similar growth parameter (b) between genders and fish sizes, but not for seasons and sampling sites. As the b obtained from LWRs is lower than the three, this species displays a negative allometric growth and tends to face overexploitation. Although the condition factor (CF) shows intraspecific, seasonal, spatial and temporal changes, it still remains close to the favorable threshold of one, suggesting that the goby adapted well to the habitat. The results serve as a helpful reference to the fish biology, in support to the fish resources management.
**Key Words**: Bac Lieu, Ca Mau, Can Tho, Soc Trang, Mekong Delta, negative allometry.

**Introduction**. Froese (1998) indicated that the fish stock assessment and management are related to the fish total length and weight (LWR) and that the slope constant (b) of LWRs is used for fish growth pattern determination. The fish body condition factor (CF) is used to confirm whether the fish well-being varies between species and regions (Abdoli et al 2009) and is regulated by the fish size, season and reproductive variables (Froese 2006; Mahmood et al 2012; Dinh et al 2016a). By contrast, the understanding of fish growth pattern and CF in the Mekong Delta, where gobies are diversified (with 58 species) and are caught increasingly (Diep et al 2014), is limited to some gobiid species, e.g. *Parapocryptes serperaster* (Dinh et al 2016b), *Trypauchen vagina* (Dinh 2016) and *Stigmatogobius pleurostigma* (Dinh 2017).

As reported by Hoese et al (2015), *Glossogobius* is one of the largest genera with 29 species. *Glossogobius giuris*, *Glossogobius aureus*, and *Glossogobius sparsipapillus* are three species found in the Mekong Delta, Vietnam (Tran et al 2013). The morphology of *G. sparsipapillus* is described by Akihito & Meguro (1976). This species is distributed from brackish to freshwater from the Mekong Delta to Cambodia (Rainboth 1996; Tran et al 2013; Nguyen et al 2019; Froese & Pauly 2020; Nguyen et al 2020b; Tran et al 2020a). *G. sparsipapillus* lives from estuaries to the upper reaches of Hau and Tien River basins (Dinh 2009; Tran et al 2013) and shows spatiotemporal variation in morphometrics (Nguyen et al 2020b). This fish is a multiple spawner, releasing eggs throughout the year, with a prominent peak in the July-October period (Nguyen et al 2019; Ho et al 2020; Nguyen et al 2020a). The species displayed negative allometric growth and its growth pattern does not vary between genders and seasons (Dinh 2015). Albeit, *G.*

*sparsipapillus* in the Mekong Delta is a commercial fish (Diep et al 2014; Nguyen & Dinh 2020), its population is vulnerable to the overfishing based on our preliminary observation. Consequently, it is necessary to study growth pattern and condition factor of male and female *G. sparsipapillus* at different fish sizes, places, and seasons, which will be used for adaptive fish understanding and fishery management.

## Material and Method

***Study site and fish collection***. This research was performed along Bassac River from Cai Rang, Can Tho (CRCT) to Long Phu, Soc Trang (LPST), Hoa Binh, Bac Lieu (HBBL), and Dam Doi, Ca Mau (DDCM) (Figure 1), from January 2020 to December 2020. The semi-diurnal tide represents the study region with a range of ~1.2 m, a temperature of ~27$^{o}$C, and a pH of ~8. It rarely rains during the dry season (January–May) but torrential rains with monthly precipitation of 400 mm during the wet season (June–December). The salinity reached ~23 ‰ in HBBL and DDCM but was ~12 ‰ in LPST and zero in CRCT (Le et al 2006; Tran et al 2020b).

Fish specimens were collected according to Dinh et al (2015), during a period of 48 h in each study site by using gill nets. Nets, with 1.5 cm mesh in the cod end, were set at the highest tide and retrieved after 2–3 h, during an ebb. After identifying based on the external description given by Tran et al (2013), fish specimens were anesthetized with benzocaine and stored in 5% formalin buffer in order to transport to the laboratory.

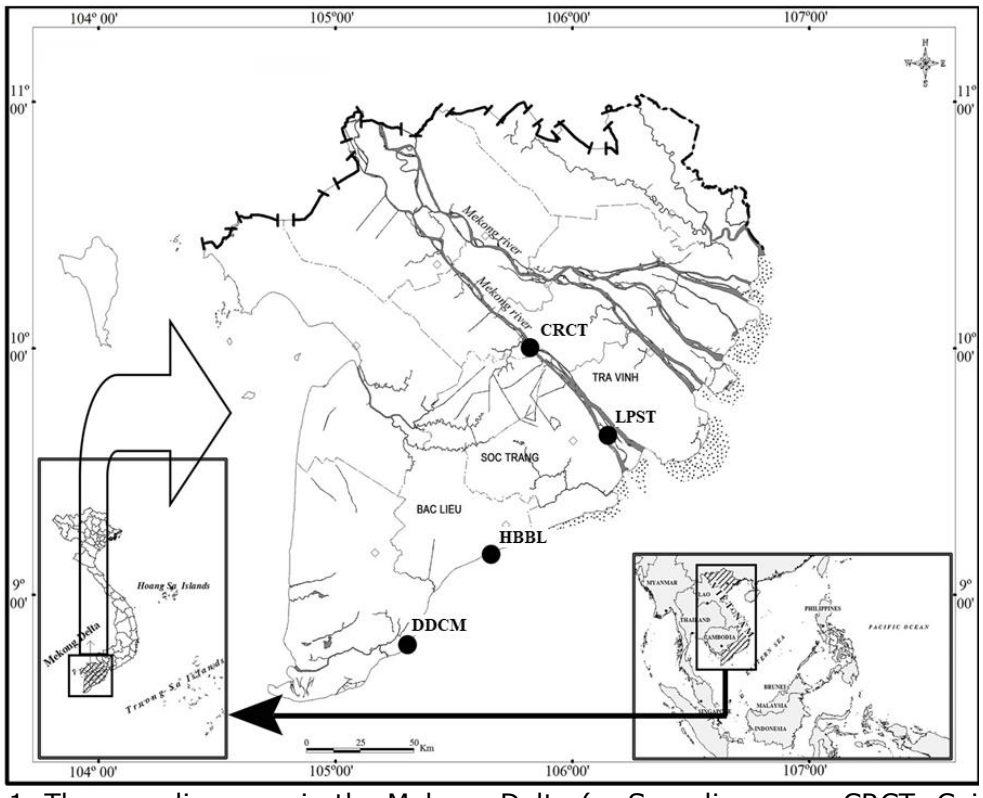


Figure 1. The sampling map in the Mekong Delta (•: Sampling area; CRCT: Cai Rang, Can Tho; LPST: Long Phu, Soc Trang; HBBL: Hoa Binh, Bac Lieu; DDCM: Dam Doi, Ca Mau). The figure was modified from Figure 1 produced by Dinh (2018) with permission.

***Length-weight relationship, growth pattern and condition factor determination***. After sexual differentiation using the morphology of genital papilla, e.g. triangle for males and oval for females (Nguyen et al 2020b), the specimens' total length (TL) was measured to the nearest 0.1 cm and body weight (W) was measured to the nearest 0.01 g. The length-weight relationship (LWR), according to Ricker (1973), was determined as:

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

Where:
W - fish weight (g);
TL - fish total length (cm);
a - the regression intercept;
b - the regression slope.
The fish body condition factor (CF), as suggested by Le Cren (1951), was estimated as:

$$CF = \frac{W}{a \times TL^b}$$

***Data analysis***. Fish sizes were divided into immature and mature groups based on the males' and females' length at first gonads maturity, respectively. The determination coefficient ($r^2$) was used to confirm the quality of the LWRs (Metin et al 2011). The sexual, intraspecific and seasonal changes of LWRs and the growth parameter (b) were examined using ANCOVA (Dinh 2016). T-test was used to confirm if b (of males, females, immature group, mature group) was close to the threshold of 3 for the parameters season(dry and wet) and sampling sites (all four) (Morey et al 2003). The variation of CF between the months was tested using one-way ANOVA, and the interactions of sex, season, fish size and study site variables influencing CF were confirmed by two-way ANOVA (Mahmood et al 2012). The t-test was used to verify if CF varied within the sex, season and fish size when there was no interaction between these variables and the variability of the CF values with the environmental conditions was significant. All tests were set at $p<0.05$.

**Results**. The findings show that *G. sparsipapillus* had rather close relationships between fish length and weight ($r^2>0.7$, in all cases). The growth coefficient b of this fish changed over the study months. In general, this species belonged to the negative allometric growth type with dominant fish length increase because, in most months, this coefficient was lower than three (t-test, $p<0.05$, Table 1). The growth coefficient of this species reached the highest value in LPST (2.79±0.06 SE) and the lowest one in HBBL (2.57±0.05 SE, ANOVA, $F=2873.79$, $p<0.01$, Table 2). The b value of males (2.70±0.04 SE) was close to the b value of females (2.69 ± 0.04 SE, t-test, $t=62.72$, $p>0.05$), but its value in the dry season (2.84±0.04 SE) was higher than in the wet season (2.60±0.04 SE, $p<0.01$). Regarding fish size, *G. sparsipapillus*' b of immature fish (2.71±0.05 SE) was not different from the mature one (2.69±0.03 SE, $t=79.04$, $p>0.05$). Generally, the species *G. sparsipapillus* displays negative allometric growth patterns as b (2.68±0.03 SE) was significantly <3 ($p<0.05$).

The condition factor of *G. sparsipapillus* changed over the study months (ANOVA, $F=6.31$, $p<0.05$, Table 1), reaching high levels in four months, namely June, July, August and September. The CF of this species reached the highest value in DDCM (1.02±0.00 SE) and the lowest one in HBBL (0.94±0.01 SE, $F=13.28$, $p<0.05$, Table 2). The CF of this fish species did not change with the sex and season ($F=3.38$, $t=2.66$, $p>0.01$, Table 2), but only with fish sizes (0.95±0.00 SE in immature and 0.98±0.00 SE in mature specimens, t-test, $t=-3.43$, $p<0.01$, Table 2). Although the CF fluctuated by month, sex and season variables, it was generally close to a threshold of 1 ($p>0.05$), showing that this fish species was well adapted to its habitat.

**Discussion**. The determination coefficients ($r^2$) of *G. sparsipapillus* were rather high (>0.7 for all cases), indicating that the weight was directly proportional to the length and could be estimated from a given size. This result was similar in some other gobiid species, such as *Trypauchen vagina* (Dinh 2016), *Boleophthalmus boddarti* (Dinh 2014b), *G. giuris* (Dinh & Ly 2014), *P. elongatus* (Tran 2008), and to the previous findings on *G. aureus* (Dinh 2014a) distributions in the coastal and estuarine areas of the Mekong Delta. Besides, this positive relationhsip has been also found in the *Neogobius melanostomus* caught from the Southern Lake Michigan, USA ($r^2>0.9$) (Duemler et al 2016) and in the *N. melanostomus*, *Neogobius fluviatilis* and *Babka gymnotrachelus* caught from the Danube river in Serbia ($r^2>0.8$) (Krpo-Ćetković et al 2018).

Table 1

Length-weight relationship and growth pattern of *Glossogobius sparsipapillus* from four different study sites from January to December 2020

| *Sampling times* | *Number of fish* | | | | *Sum* | *b* | *a* | $r^2$ | *Growth pattern* | *K* |
|---|---|---|---|---|---|---|---|---|---|---|
| | *CRCT* | *LPST* | *HBBL* | *DDCM* | | *Mean±SE* | *Mean±SE* | | | *Mean±SE* |
| January-20 | - | - | 8 | 13 | 21 | 2.37±0.32 | 0.037±0.030 | 0.735 | Negative allometry | $0.99±0.03^{a.b.c.d}$ |
| February-20 | 13 | 17 | 22 | 30 | 82 | 2.91±0.06 | 0.009±0.001 | 0.965 | Negative allometry | $0.93±0.00^{a.b}$ |
| March-20 | 14 | 18 | 22 | 7 | 61 | 3.13±0.07 | 0.006±0.001 | 0.969 | Positive allometry | $0.96±0.01^{a.b.c}$ |
| April-20 | 11 | 15 | 10 | 24 | 60 | 2.61±0.08 | 0.019±0.004 | 0.945 | Negative allometry | $0.95±0.01^{a.b.c}$ |
| May-20 | 10 | 15 | 15 | 21 | 61 | 2.97±0.15 | 0.009±0.003 | 0.872 | Isometry | $0.97±0.01^{a.b.c}$ |
| June-20 | 12 | 12 | 8 | 24 | 56 | 2.53±0.13 | 0.026±0.008 | 0.882 | Negative allometry | $1.06±0.02^{d}$ |
| July-20 | 17 | 29 | 9 | 22 | 77 | 2.73±0.11 | 0.016±0.004 | 0.893 | Negative allometry | $1.01±0.02^{b.c.d}$ |
| August-20 | 21 | 30 | 12 | 27 | 90 | 2.89±0.08 | 0.011±0.002 | 0.942 | Negative allometry | $1.03±0.01^{c.d}$ |
| September-20 | 23 | 15 | 17 | 16 | 71 | 2.76±0.09 | 0.014±0.003 | 0.933 | Negative allometry | $1.00±0.01^{a.b.c.d}$ |
| October-20 | 16 | 21 | 18 | 11 | 66 | 2.57±0.12 | 0.021±0.006 | 0.885 | Negative allometry | $0.96±0.01^{a.b.c}$ |
| November-20 | 10 | 13 | 19 | 12 | 54 | 2.68±0.16 | 0.016±0.006 | 0.847 | Negative allometry | $0.94±0.01^{a.b}$ |
| December-20 | 12 | 11 | 27 | 15 | 65 | 2.22±0.09 | 0.050±0.012 | 0.903 | Negative allometry | $0.92±0.02^{a}$ |

CRCT: Cai Rang, Can Tho; LPST: Long Phu, Soc Trang; HBBL: Hoa Binh, Bac Lieu; DDCM: Dam Doi, Ca Mau; Different letters (a, b, c and d) in condition factor (CF) category show significant differences ($p<0.05$).

Table 1

Length-weight relationship, growth pattern and condition factor by sex, size, season, study area in *Glossogobius sparsipapillus*

| *Fish groups* | | *Number of fish* | *b* | *a* | $r^2$ | *K* |
|---|---|---|---|---|---|---|
| | | | *Mean±SE* | *Mean±SE* | | *Mean±SE* |
| Sexes | Male | 408 | $2.70±0.04^{a}$ | 0.016±0.001 | 0.924 | $0.97±0.01^{a}$ |
| | Female | 356 | $2.69±0.04^{a}$ | 0.017±0.002 | 0.916 | $0.98±0.01^{a}$ |
| Fish size | Immature | 325 | $2.71±0.05^{a}$ | 0.016±0.002 | 0.886 | $0.95±0.00^{a}$ |
| | Mature | 439 | $2.69±0.03^{a}$ | 0.016±0.001 | 0.935 | $0.98±0.00^{b}$ |
| Season | Dry | 285 | $2.84±0.04^{a}$ | 0.011±0.001 | 0.951 | $0.96±0.01^{a}$ |
| | Wet | 479 | $2.60±0.04^{b}$ | 0.020±0.002 | 0.905 | $0.97±0.01^{a}$ |
| Study area | CRCT | 159 | $2.65±0.07^{b,c}$ | 0.018±0.003 | 0.909 | $0.97±0.01^{a.b}$ |
| | LPST | 196 | $2.79±0.06^{a}$ | 0.013±0.002 | 0.921 | $0.98±0.01^{b}$ |
| | HBBL | 187 | $2.57±0.05^{c}$ | 0.021±0.002 | 0.940 | $0.94±0.01^{a}$ |
| | DDCM | 222 | $2.75±0.05^{a,b}$ | 0.015±0.002 | 0.923 | $1.02±0.00^{c}$ |

CRCT: Cai Rang, Can Tho; LPST: Long Phu, Soc Trang; HBBL: Hoa Binh, Bac Lieu; DDCM: Dam Doi, Ca Mau; Different letters (a and b) in each category (gender, fish size, season and study area) show significant differences ($p<0.05$).

The fish species displayed a higher growth rate in the dry season than in the wet season. It is possibly due to a higher salinity in the dry season, more suitable for the fish, as indicated by a higher growth factor. However, it can be seen that this species was different from other fish species, as it has a high growth coefficient in the rainy season. A similar result was found in the previous study of Dinh et al (2016b) on the *Parapocryptes serperaster* in the Mekong Delta.

The results show that *G. sparsipapillus* belonged to a negative allometric growth pattern (b<3). Therefore, during the development process, the fish might have an advantageous development of their length, compared to its weight. Typically, females were often larger than males because the female was usually in fatness and gonadal development to optimize reproductive capability (Le Cren 1951). However, in this species, the difference in b value between females and males was not statistically significant, suggesting that both males and females had the role of developing the body to prepare for reproduction.

This fish species adapted to the living environment in areas with a different salinity as its growth coefficient did not change with studied sites, and its CF was close to 1. This species could live in both saltwater environments such as DDCM and HBBL, water with variable salinity like LPST, and freshwater as in CRCT. Therefore, the growth of this species was less dependent on environmental factors. Some other gobies exhibited a positive allometric growth pattern, such as the rock goby *Gobius paganellus* in Portugal (Azevedo & Simas 2000), the *Periophthalmus argentilineatus* and the *Periophthalmus spilotus* (Khaironizam & Norma-Rashid 2002) and the mature *Trypauchen vagina* in the Mekong Delta of Southern Vietnam (Dinh 2016). There was a statistically insignificant difference in this coefficient between male and female fish specimens, between the dry and wet seasons. Therefore, this species' adaptation was relatively homogeneous in both sexes and independent of environmental conditions.

**Conclusions**. Fish weight can be estimated from their length, due to the high correlation coefficients of LWRs. *G. sparsipapillus* showed a similar growth parameter (b) between sexes and throughout the fish sizes, but not between seasons and sampling sites. This goby species present a negative allometric growth and faces overexploitation, as b was lower than 3. The condition factor shows intraspecific, seasonal, spatial and temporal changes; CF is close to the favorable threshold of one, suggesting the goby adapted well to the habitat. The results serve as a reference on the fish biology, useful in the fish resources management.

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**Conflict of interest**. The authors declare no conflict of interest.

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