Egyptian Journal of Aquatic Biology & Fisheries
Zoology Department, Faculty of Science,
Ain Shams University, Cairo, Egypt.
ISSN 1110 – 6131
Vol. 25(6): 181 – 191 (2021)
www.ejabf.journals.ekb.eg


# The variations of Clark and Gastrosomatic indexes of *Glossogobius giuris* living in some regions the Mekong Delta, Vietnam

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**ARTICLE INFO**
**Article History:**
Received: June 12, 2021
Accepted: Oct. 29, 2021
Online: Dec. 27, 2021

**Keywords**:
Clark index
Gastrosomatic index
*Glossogobius giuris*
Mekong Delta
Vietnam

**ABSTRACT**

This study lasted one year to describe the energy accumulating capacity and feeding intensity of *Glossogobius giuris* by analyzing the Clark index and Gastro-somatic (GaSI) indexes of this species. A total of 1,291 individuals were collected in four sites, including Cai Rang, Can Tho; Long Phu, Soc Trang; Hoa Binh, Bac Lieu and Dam Doi, Ca Mau. In each sampling site, fish were monthly caught using trawl nets from January to December 2020. The data analysis results showed that the fish species displayed high energy accumulating capacity due high value of the Clark index. This capacity varied between males and females, immature and mature groups, and four sites, but not between the dry and wet seasons as Clark changed with gender, fish size and location but not the season. With a high value of GaSI, the goby showed high feeding intensity. This fish showed intraspecific and spatiotemporal changes in feeding intensity since GaSI varied with fish size, season and location. The gender × season interaction affected GaSI but not Clark, whereas the reverse case was found in gender × site interaction. These indexes were influenced by the season × site interaction. The findings are helpful for fish's adaption understanding and future artificial cultivation study.

## INTRODUCTION

Out of 29 species of the genus *Glossogobius* distributed worldwide **(Hoese *et al.*, 2015)**, only three species are found in the Mekong Delta region of Vietnam **(Dinh, 2008; Dinh *et al.*, 2009; Dinh, 2011; Tran *et al.*, 2013; Le *et al.*, 2018; Tran *et al.*, 2020; Tran *et al.*, 2021b)**. Species in the genus *Glossogobius* belong to the fish group with economic value in the area, including *Glossogobius giuris*, *Glossogobius aureus* and *Glossogobius sparsipapillus* **(Tran *et al.*, 2013; Dinh and Ly, 2014; Dinh *et al.*, 2021a; Nguyen and**

**Dinh, 2021; Phan *et al.*, 2021)**. In particular, *Glossogobius giuris* is a reasonably large fish in this group of fish. In the world, they are widely distributed from Africa to Oceania **(Rainboth, 1996)**. In the Mekong Delta, they are often spread from freshwater rivers to coastal estuaries. According to **Hossain (2014)**, this is a highly fertile fish and has a spawning season twice a year. Pham and Tran **(Pham and Tran, 2013)** state that this species has a breeding season that occurs only once during the rainy season. Their gonadal development has been reported by **Dinh *et al.* (2021b); Dinh *et al.* (2021c)**. The primary food source of this fish is crustaceans such as shrimp, crab and some other small fish **(Hossain *et al.*, 2016)**. Due to it is high economic value, the meat of this fish is prevalent. Therefore, this species is at risk of overexploiting, leading to a sharp decrease in population size **(Diep *et al.*, 2014)**. However, at present, studies on the nutritional indicators of this fish are very limited. That is not enough basis for the application to artificial breeding of this fish.

The Clark index plays a vital role in determining the nutrition and ability of fish to accumulate nutrients. Besides, the GaSI index plays the role of checking the eating intensity of fish. This research aims to contribute data on these two parameters and their changes corresponding to gender, season, fish size and sampling site variables. The study supplements data on energy accumulating capacity and feeding intensity of this species as a basis for ecological adoption understanding and future cultivation study.

## MATERIALS AND METHODS

**Fish collection and analysis.** *Glossogobius giuris* were collected once a month at four sites in the Mekong Delta. Two of them were located along the Hau River extending from Cai Rang, Can Tho to Long Phu, Soc Trang. The remaining two sites were implemented in two coastal provinces extending from Hoa Binh, Bac Lieu to Dam Doi, Ca Mau (Fig. 1). The sample collection period was 12 months (01/2020-12/2020). The trawl nets were the fishing gear used to catch this fish. After collection, fish samples were stored in 10% formol solution. Then, the analysis of the sample was carried out in the laboratory. After sexing and measuring length and weight, fish was surgery to remove the digestive tract. The tracts were then weighted in order to determine the Clark and GaSI index, respectively.

The Clark index was determined through the weight of the fish without introspection ($W_o$, 0.01 g) and the total length of the fish (TL, 0.1 cm) **(Clark, 1928)**:

$$\text{Clark} = \frac{W_o \times 100}{TL^3}$$

The GaSI index was determined according to **Desai (1970)**, based on the weight of the gut (Wg, 0.01 g) and the weight of the fish (W, 0.01g):

$$\text{GaSI} = \frac{W_g \times 100}{W}$$

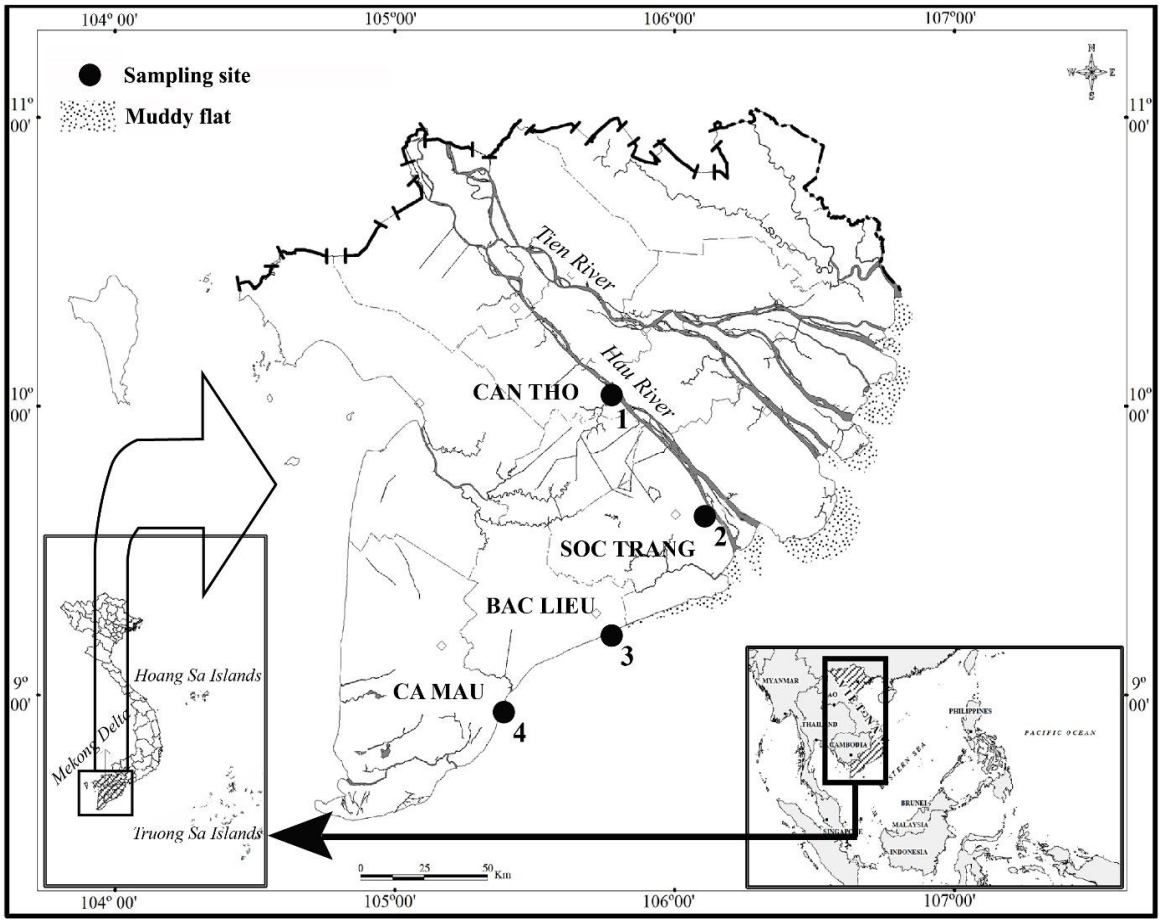


**Figure 1.** Sample collection map modified from figure 1 of **Dinh (2018)** (1: Cai Rang, Can Tho; 2: Long Phu, Soc Trang; 3: Hoa Binh, Bac Lieu; 4: Dam Doi, Ca Mau)

**Data analysis.** The differences of Clark and GaSI between males and females, immature and mature, and dry and wet seasons were determined by t-test. A one-way ANOVA test tested the difference between the study sites of these two indices. A two-way ANOVA test was also used to test whether Clark and GaSI were affected by gender x season, gender × site and season × site. SPSS v.21 was used for statistical processing. All tests were determined at the 5% significance level

## RESULTS

**Clark index and energy accumulating capacity.** A total of 1,291 individuals were used to study the Clark index of this fish. The average value of this coefficient in *G.giuris* was 0.96±0.03 SE.

The study of the Clark index results showed that this coefficient did not change with the seasons but varied according to genders, sizes, and sites. The results show that this coefficient has a difference by gender (t-test, $t=3.11$, $P<0.05$). Specifically, this value of females (1.01±0.03 SE) was higher than that of males (0.92±0.02 SE) (Fig. 2). Similar to gender, this index of *G. giuris* also changed with fish size ($t=17.72$, $P<0.05$) (Fig. 3).

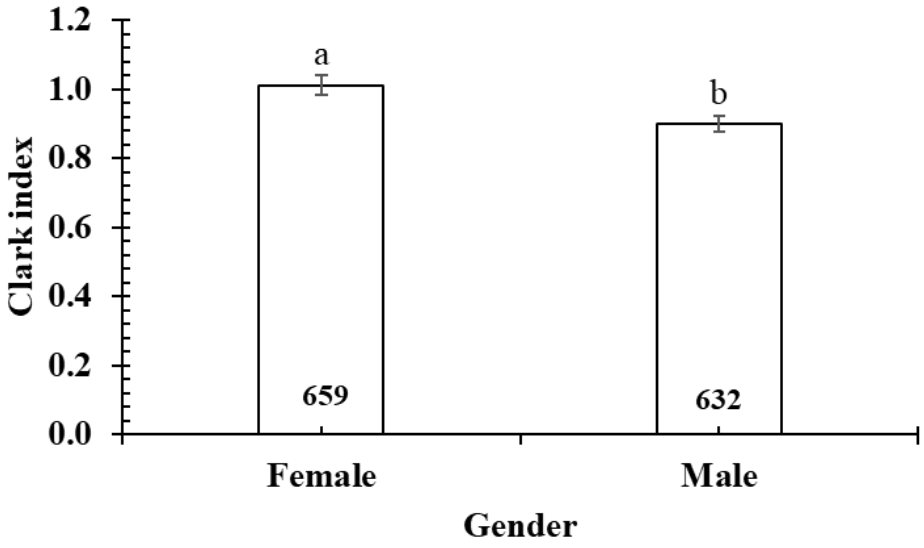


Figure 2. Variation of Clark index between male and female *Glossogobius giuris* (the different letters showed significant variation; vertical line: standard error of mean; number in column: number of individuals)

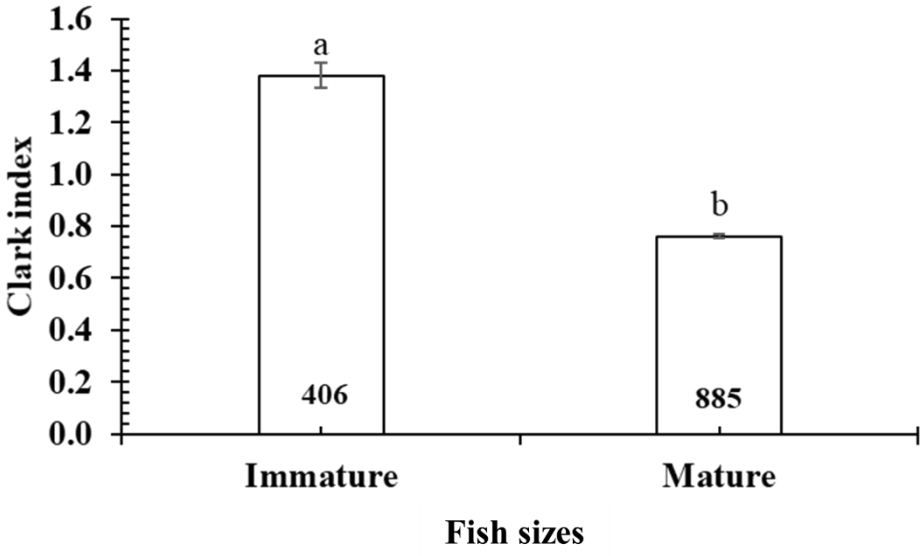


Figure 3. Variation of Clark index between immature and mature *Glossogobius giuris* (the different letters showed significant variation; vertical line: standard error of mean; number in column: number of individuals)

Clark index did not change with the season but varied with gender and size. Accordingly, this coefficient in the dry season (0.98±0.03 SE) was similar to that in the wet season (0.93±0.03 SE, $t=1.29$, $P>0.05$) (Fig. 4).

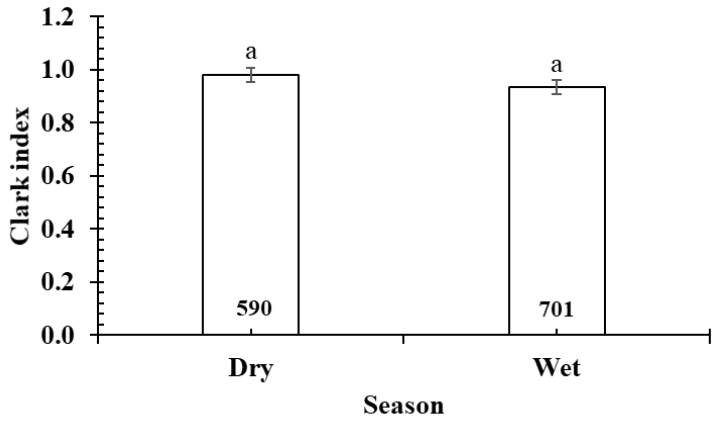


Figure 4. The varation of Clark index of *Glossogobius giuris* between the dry and wet seasons (vertical line: standard error of mean; number in column: number of individuals)

Considering the mean value of the Clark index, the four sampling points in this study were divided into two groups. The first group, including LPST and DDCM had a higher mean value of this coefficient than the other group (one-way ANOVA, F=46.52, P<0.05; Fig. 5), showing that this goby displayed a spatial variation in energy accumulating capacity.

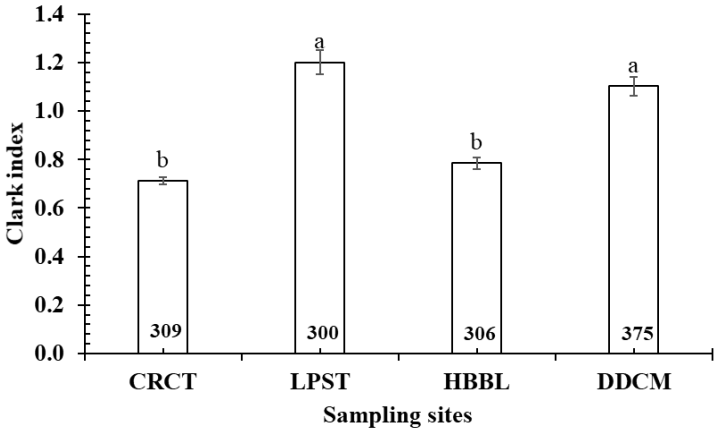


Figure 5. The variation of Clark index of *Glossogobius giuris* among four sites (CRCT: Cai Rang, Can Tho; LPST: Long Phu, Soc Trang; HBBL: Hoa Binh, Bac Lieu; DDCM: Dam Doi, Ca Mau; the different letters showed significant variation; vertical line: standard error of mean; number in column: number of individuals)

In addition, the Clark index was also influenced by the factors of gender × site (two-way ANOVA, F=3.19, P<0.05) and season × site (F=9.89, P<0.05). However, it is not affected by gender × season (F=2.02, P>0.05).

**GaSI index and feeding intensity.** The GaSI index of *G. giuris* has an average value of 2.22±0.06 SE. The GaSI index varied with fish size (t=-1.24, P<0.05), season (t=-3.97, P<0.05) and sites (F=10.75, P<0.05). However, this index was not significantly different between males and females (t=-0.76, P>0.05).

The average GaSI of males was 2.26±0.06 SE and similar to that of females (2.19±0.06 SE, P>0.05, Fig. 6), showing its feeding intensity did not change with gender. Although males had a higher energy accumulation than females, their feeding intensity was similar. Like Clark, the GaSI of the mature group was different from that of the immature group (Fig. 7). This index in mature fish (2.26±0.05 SE) was higher than in juveniles (2.14±0.05 SE).

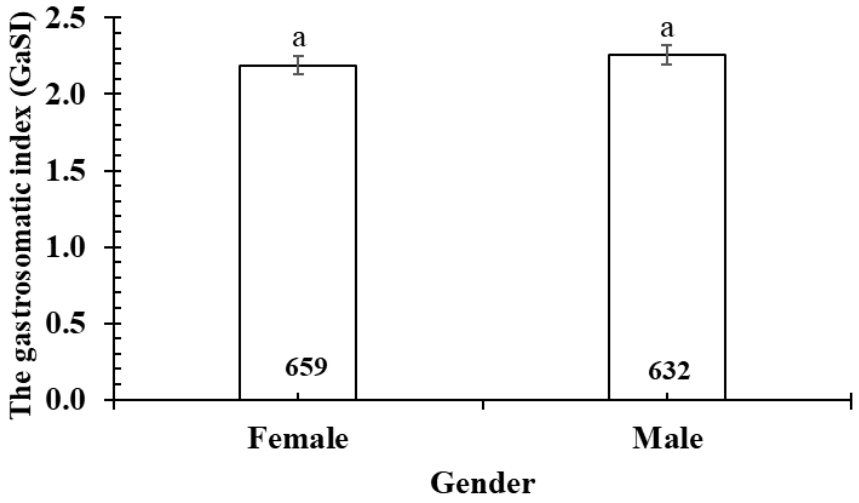


Figure 6. The variation of GaSI of male and female *Glossogobius giuris* (vertical line: standard error of mean; number in column: number of individuals)

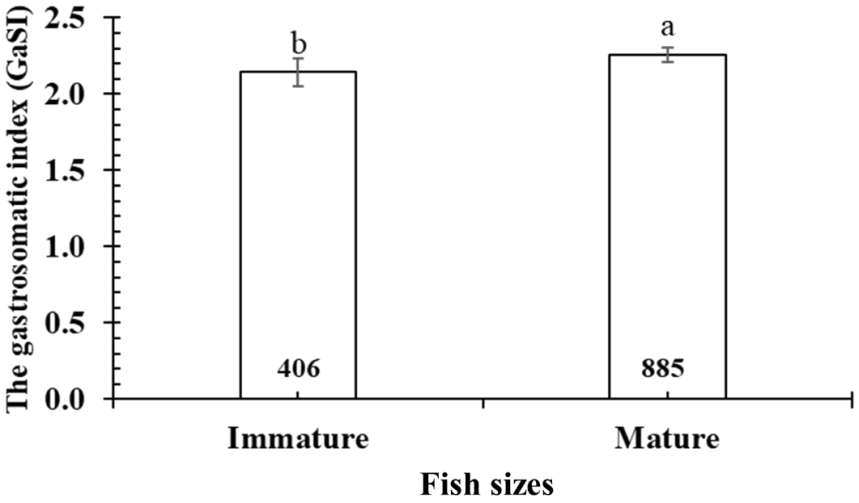


Figure 7. The variation of GaSI of immature and mature *Glossogobius giuris* (the different letters showed significant variation; vertical line: standard error of mean; number in column: number of individuals)

If there was no difference in the Clark between the dry and wet seasons, there was a difference in the GaSI between the two seasons (Fig. 8). Specifically, in the wet season (2.38±0.06 SE), the GaSI was higher than in the dry season (2.04±0.06 SE).

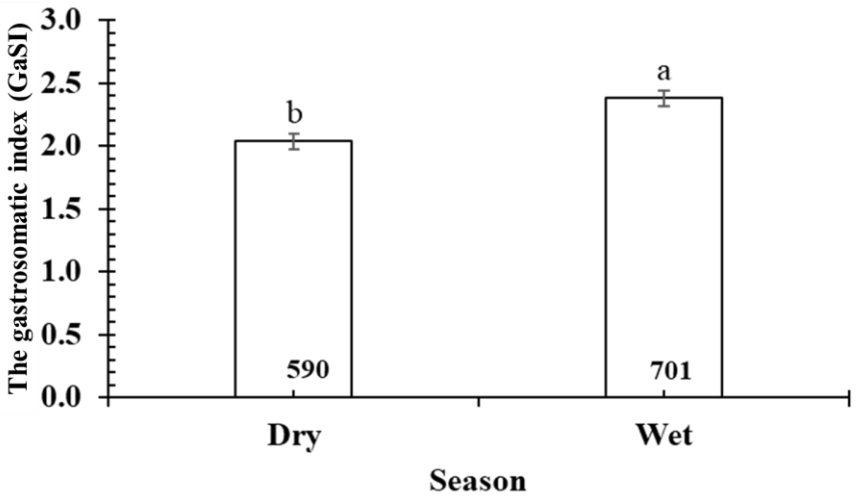


Figure 8. The variation of GaSI of *Glossogobius giuris* between the dry and wet seasons (the different letters showed significant variation; vertical line: standard error of mean; number in column: number of individuals)

The GaSI also varied by study sites and was shown in Fig. 9. The most significant difference was the CRCT area. CRCT was an area with fresh water all year round, so the amount of food was always stable over time, leading to higher fish feeding intensity than other regions. In contrast, in the remaining areas, the environment is often disturbed. Significantly, the change in salinity over each month. That has affected the eating intensity of the fish. It suggested that the climate in different locations impacted the GaSI index of fish.

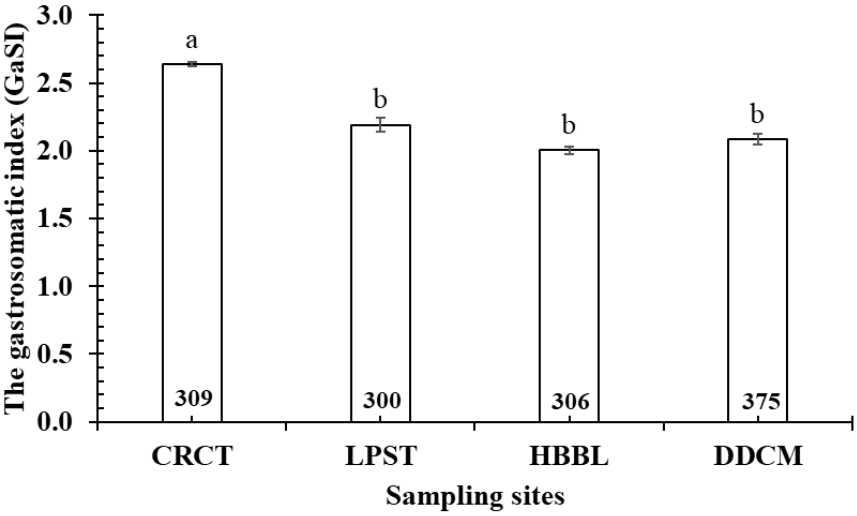


Figure 9. The variation of GaSI of *Glossogobius giuris* among four sites (the different letters showed significant variation; vertical line: standard error of mean; number in column: number of individuals)

Similar to the Clark, the GaSI was also affected by the interaction of season × site ($F=12.09$, $P<0.05$). However, the GaSI of this species was not affected by gender × season ($F=5.08$, $P>0.05$) and was influenced by gender × site ($F=0.28$, $P>0.05$).

## DISCUSSION

The Clark index of this fish was smaller than that of *Glossogobius sparsipapillus* of the same genus *Glossogobius* distributed in the Mekong Delta **(Tran *et al.*, 2021a)** and *Butis koilomatodon* have the same family Gobiidae **(Dinh *et al.*, 2020)**. However, this index was larger than that of *Stigmatogobius pleurostigma* **(Dinh and Tran, 2018)** and *Periophthalmodon schlosseri* **(Tran *et al.*, 2019)** distributed in the same area. Clark index of female fish is higher than that of male fish showed that females have better energy accumulation than males. The reason may be that the female fish needs more nutrients for the reproduction of the fish. However, in some other fish species distributing in the same area, such as *Parapocryptes serperaster* **(Dinh *et al.*, 2017)**, *Stigmatogobius pleurostigma* **(Dinh and Tran, 2018)**, *Periophthalmodon schlosseri* **(Tran *et al.*, 2019)**, *Eleotris melanosoma* **(Vo *et al.*, 2014)** và *Butis koilomatodon* **(Dinh *et al.*, 2020)** have no difference between two genders. Changes in Clark index in immature and mature fish suggesting the energy accumulating capacity changed as fish grew. This assumption was also observed in some fish species that live in the same area as in *Periophthalmodon schlosseri* **(Tran *et al.*, 2019)** and *Butis koilomatodon* **(Dinh *et al.*, 2020)**. It suggested that this fish had the same level of energy accumulation in both seasons. Thus, their food sources might be quite diverse and less affected by the weather. In *Parapocryptes serperaster* **(Dinh *et al.*, 2017)**, *Stigmatogobius pleurostigma* **(Dinh and Tran, 2018)**, *Pseudapocryptes elongatus* **(Tran, 2008)**, *Periophthalmodon schlosseri* **(Tran *et al.*, 2019)**, *Eleotris melanosoma* **(Vo *et al.*, 2014)** *Butis koilomatodon* **(Dinh *et al.*, 2020)** and *Butis koilomatodon* **(Dinh *et al.*, 2020)** the Clark index was also not affected by the seasonal factor. This change in value at the study sites is similar to the study of*Butis koilomatodon* living in the same habitat **(Dinh *et al.*, 2020)**.

GaSI value in *Glossogobius giuris* (2.22±0.06 SE) was higher than *Glossogobius sparsipapillus* (0.02±0.00 SE) **(Tran *et al.*, 2021a)** and *Parapocryptes serperaster* (1.57±0.30 SE) **(Dinh *et al.*, 2017)**. This showed that this species was a relatively higher feeding intensity than other fish species with a distribution area. This change in index was also found in *Parapocryptes serperaster* **(Dinh *et al.*, 2017)** and *Glossogobius sparsipapillus* **(Tran *et al.*, 2021a)**. GaSI was higher in the rainy season than in the dry season showed that the amount of food in the environment was higher in the wet season, leading to a higher eating intensity of fish. Similarly, in two species, *Parapocryptes serperaster* **(Dinh *et al.*, 2017)** and *Glossogobius sparsipapillus* **(Tran *et al.*, 2021a)**, it was also this different. However, in the same distribution area, *Eleotris melanosoma* **(Vo *et al.*, 2014)** and *Stigmatogobius pleurostigma* **(Dinh and Tran, 2018)** had no seasonal difference.

## CONCLUSION

The results showed that *Glossogobius giuris* had a Clark index that did not change with the season but with the maturation length and gender. This index was affected by gender × site and season × site but is not affected by gender × season. Meanwhile, the GaSI was not changed between males and females but varied between dry and wet seasons, between immature and mature. The GaSI is affected by gender × season and season × site interactions but not gender × site. Both of these coefficients vary by study

site. The results of this study added to the data on the energy accumulating capacity and feeding intensity of *G. giuris* to serve as a basis for future artificial culture of this species.

## ACKNOWLEDGEMENTS

This study is funded in part by the Can Tho University Improvement Project VN14-P6, supported by a Japanese ODA loan.

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