

## Temporal Variation in Gastrosomatic and Clark Indices of *Caragobius urolepis* (Bleeker, 1852) in Bac Lieu and Ca Mau Provinces

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### ABSTRACT

This study provides information on nutritional characteristics through changes in the Gastrosomatic index (GI) and Clark in *Caragobius urolepis*. After one year of research (10/2022-9/2023), 628 individuals (324 males and 304 females) were caught using trawl nets in Dong Hai, Bac Lieu, and Dam Doi, Ca Mau. The results showed that the GI of this fish varied by season (Pseudo-F= 12.17;  $P < 0.01$ ) and sex (Pseudo-F= 7.47;  $P < 0.01$ ) and not site (Pseudo-F= 3.50;  $P = 0.06$ ). The value of Clark index did not vary by sex (Pseudo-F= 0.89;  $P = 0.76$ ) and site (Pseudo-F=3.26;  $P = 0.07$ ) but significantly changed by season (Pseudo-F=118.37;  $P < 0.01$ ). The sex  $\times$  season interaction did not affect GI and Clark indices, but sex  $\times$  site significantly affected GI (Pseudo-F= 9.23;  $P < 0.01$ ), and site  $\times$  season affected Clark (Pseudo-F= 23.20;  $P < 0.01$ ). The results of this study contribute to providing additional data on the nutritional characteristics of *Caragobius urolepis*, with a basis for future artificial breeding research of this species.

### INTRODUCTION

With an area of about 40,577km<sup>2</sup>, mainly freshwater and alluvial soil, the Mekong Delta (MD) has many advantages in developing agriculture and aquaculture, including the *Caragobius urolepis*, a common species (To *et al.*, 2016). This fish is caught and sold by fishermen in some coastal areas from Bac Lieu to Ca Mau at prices ranging from 80,000 to 110,000 VND/kg, depending on the time. The *Caragobius urolepis* is an attractive, delicious taste and can be quickly processed into many dishes with high nutritional value (Nguyen, 2000). Currently, in the Mekong Delta, the exploitation of aquatic species, including this fish, is taking place strongly, and some species are at risk of being overexploited (Trinh & Tran, 2012). Meanwhile, information about this fish

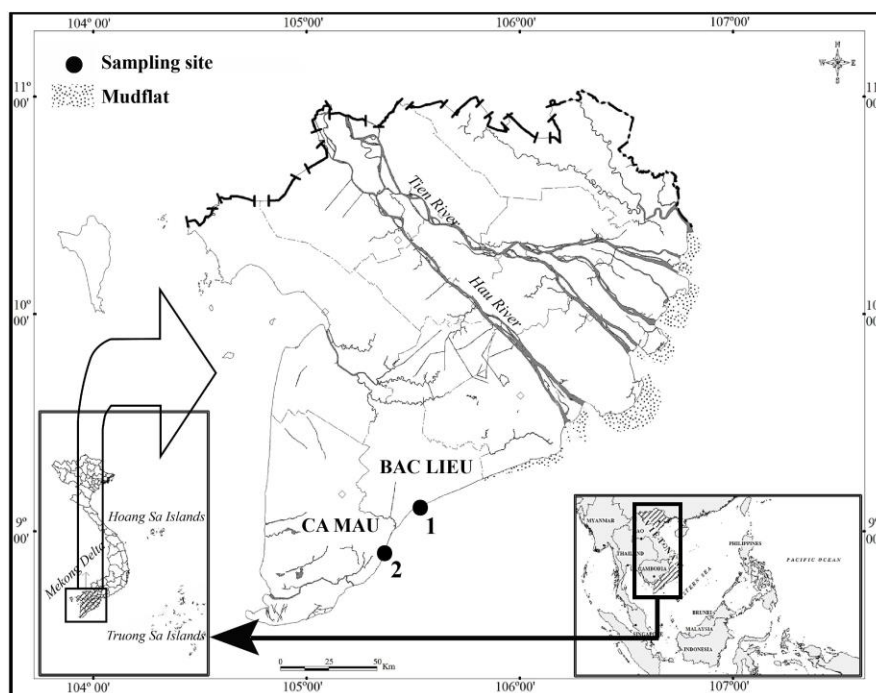
species in the MD is still limited, mainly about their appearance (Murdy & Shibukawa, 2003; Nguyen *et al.*, 2023).

*Caragobius urolepis* is found in the Indian Ocean - West Pacific region, in the Mekong Delta; this species can live in the sea, brackish water, and estuaries, sometimes migrating to live in freshwater, downstream rivers, and coastal lakes (Tran *et al.*, 2013). This fish is a carnivore (Truong *et al.*, 2024) and spawns mainly during the wet season (Nguyen *et al.*, 2024a, b). Characteristics such as Gastrosomatic and Clark indexes play a role in determining the nutritional type of fish (Dinh & Tran, 2018). According to some studies on fish species such as the biological characteristics of the *Onychostoma laticeps* (Vo *et al.*, 2019), *Butis koilomatodon* (Dinh *et al.*, 2020) or *Glossogobius sparsipapillus* (Tran *et al.*, 2021) and *Periophthalmus variabilis* (Tran & Dinh, 2021) showed that these two indices can vary according to the site, season or sex of the fish. Therefore, these factors can affect *Caragobius urolepis* in the Mekong Delta. These characteristics, once clarified, will form the basis for further research on the adaptability of *Caragobius urolepis* to environmental conditions and future farming research, thereby contributing to their protection.

## MATERIALS AND METHODS

### 1. Sample collection and analysis

*Caragobius urolepis* samples in this study were collected at two coastal sites in the Mekong Delta (Fig. 1), Dong Hai-Bac Lieu (DHBL) and Dam Doi-Ca Mau (DDCM). Fish samples were monthly collected for 12 months from 10/2022 to 9/2023. At the two sites, fish samples of various sizes were randomly caught using trawl nets with a mesh size of 1.0cm in the codend. All fish specimens were preserved in formalin solution at a concentration of 4% after sampling in the study area before being transferred to the laboratory for analysis.



**Fig. 1.** Sampling map

(1. Dong Hai-Bac Lieu; 2. Dam Doi-Ca Mau; Source: **Dinh (2018)**)

The fish samples were identified based on the description documented by **Tran *et al.* (2013)**. Their sexes were distinguished based on the characteristics of the genital spines (oval in females and triangular in males). Then, the fish were determined for parameters such as total length (TL), total weight (W), and weight of fish without internal organs ( $W_o$ ) before the fish were dissected to determine the weight of the intestines.

Gastrosomatic index (GI) plays a role in determining by the formula:  $GI = (W_r/W) \times 100$  ( $W_r$ : gut weight;  $W$ : fish body weight) (**Dinh & Tran, 2018**).

Clark index is used to determine the energy storage capacity of fish and is defined as follows:  $Clark = (W_o \times 100)/TL^3$  (TL: total length;  $W_o$ : fish weight without internal organs) (**Tran & Dinh, 2021**).

## 2. Data analysis

The effects of sex, season, and site on the variation of GI and Clark were determined by PERMANOVA (**Anderson *et al.*, 2008**). This test was also used to evaluate the simultaneous effects of sex  $\times$  season, sex  $\times$  site, season  $\times$  site and was performed using PRIMER v.6 software at a significance level of  $\alpha = 5\%$ .

## RESULTS

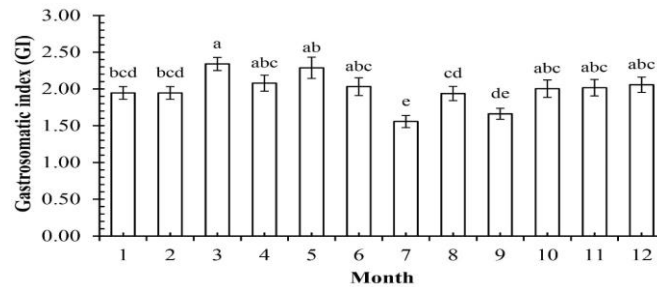
### 1. Gastrosomatic index (GI)

Results of analysis of 628 *Caragobius urolepis* samples (324 males and 304 females) showed variations in GI according to sex (PERMANOVA,  $df=1$ ; Pseudo-F=

7.47;  $P < 0.01$ ) and season ( $df = 1$ ; Pseudo-F = 12.17;  $P < 0.01$ ). Specifically, when considering sex, the GI value in males ( $2.08 \pm 0.05$  SE;  $n = 324$ ) was higher than in females ( $1.92 \pm 0.03$  SE;  $n = 304$ ).

Like the sex-specific value, this value varied seasonally, with the mean GI of fish in the dry season ( $2.13 \pm 0.05$  SE;  $n = 268$ ) being higher than that recorded in the wet season ( $1.91 \pm 0.04$  SE;  $n = 360$ ). This may be because the dry season is the period when food sources are abundant in the environment, especially in coastal estuaries where this fish species lives, so it is more favorable for them to forage than in the wet season.

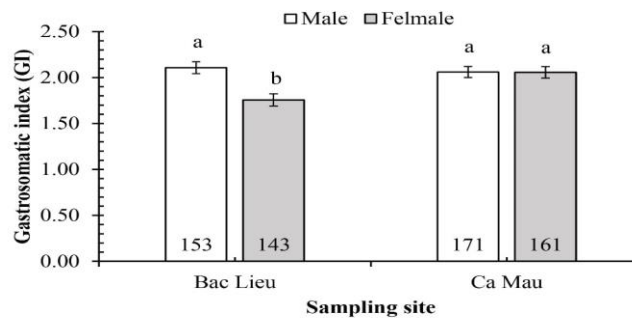
Research over 12 months has shown monthly variation in predation intensity in this species due to differences in GI values, with the highest recorded in March ( $2.34 \pm 0.09$  SE) and the lowest in July ( $1.36 \pm 0.08$  SE; Pseudo-F = 4.09;  $P < 0.01$ ; Fig. (2)). Upon considering the sites, the average GI of fish collected at DHBL ( $1.94 \pm 0.05$  SE,  $n = 296$ ) exhibited a lower value than that of DDCM ( $2.06 \pm 0.04$  SE;  $n = 332$ ). However, this difference was insignificant ( $df = 1$ ; Pseudo-F = 3.50;  $P = 0.06$ ).



**Fig. 2.** *Caragobius urolepis* GI variation regarding 12 month-study period

Different letters indicate statistically significant differences; vertical bars: standard error.

In addition to sex, season, and months, the interaction sex  $\times$  sites also impacted the GI ( $df = 1$ ; Pseudo-F = 9.23;  $P < 0.01$ ; Fig. (3)). However, this coefficient was not affected by the interactions: sex  $\times$  season ( $df = 1$ ; Pseudo-F = 0.48;  $P = 0.83$ ), season  $\times$  sites ( $df = 1$ ; Pseudo-F = 0.53;  $P = 0.45$ ), and sex  $\times$  season  $\times$  sites ( $df = 1$ ; Pseudo-F = 0.41;  $P = 0.50$ ).



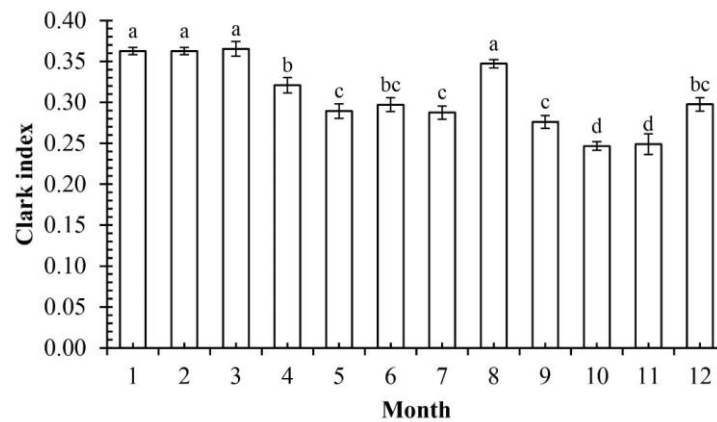
**Fig. 3.** *Caragobius urolepis* GI variation regarding the site and sex interaction

Different letters indicate statistically significant differences; vertical bars: standard errors; numbers in columns: number of individuals.

## 2. Clark index

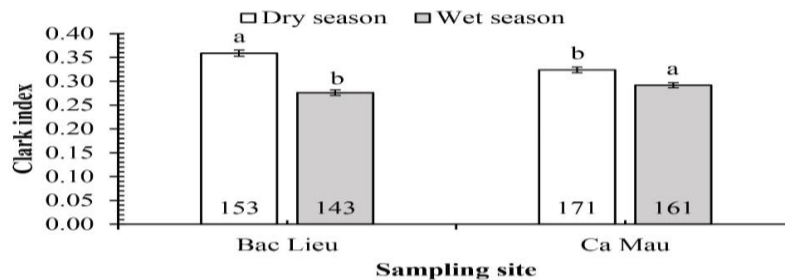
Data analysis showed that the Clark value of *Caragobius urolepis* did not display a sexual change ( $df=1$ ; Pseudo-F= 0.89;  $P= 0.76$ ), with an average of  $\sim 0.31$ . When considering the season, the Clark mean of fish in the wet season ( $0.28 \pm 0.00$  SE;  $n= 268$ ) was lower than that in the dry season ( $0.34 \pm 0.003$  SE;  $n= 360$ ) ( $df=1$ ; Pseudo-F= 118.37;  $P < 0.01$ ). In terms of sites, the Clark mean of fish in Bac Lieu ( $0.31 \pm 0.00$  SE;  $n=296$ ) was similar to that of Ca Mau ( $0.30 \pm 0.00$  SE;  $n= 332$ ) ( $df=1$ , Pseudo-F= 3.26;  $P= 0.07$ ).

Clark index of *Caragobius urolepis* was continuously recorded over 12 months and assessed statistical differences ( $df=1$ ; Pseudo-F= 27.18;  $P < 0.01$ ), with the highest value recorded in March ( $3.66 \pm 0.09$  SE) and the lowest in October ( $2.47 \pm 0.13$  SE) (Fig. 4).



**Fig. 4.** *Caragobius urolepis* Clark variation regarding 12 month-study period. Different letters indicate statistically significant differences; vertical bars: standard error.

The Clark of this fish was affected by interactions such as season  $\times$  site ( $df= 1$ ; Pseudo-F= 23.20;  $P < 0.01$ ; Fig. (5)) but not by sex  $\times$  site ( $df= 1$ ; Pseudo-F= 0.35;  $P= 0.59$ ), sex  $\times$  season ( $df= 1$ ; Pseudo-F= 0.23;  $P= 0.64$ ), and sex  $\times$  season  $\times$  site ( $df= 1$ ; Pseudo-F= 0.27;  $P= 0.95$ ).



**Fig. 5.** *Caragobius urolepis* Clark variation regarding the site and season interaction. Different letters indicate statistically significant differences; vertical bars: standard errors; numbers in columns: number of individuals.

## DISCUSSION

The variations in the Gastroscopic index (GI) and Clark index of *Caragobius urolepis* observed in this study suggest significant seasonal and spatial influences on the nutritional characteristics of this species. Specifically, the GI was found to vary with sex and season, while the Clark index varied with season but not with sex. These findings align with those of previous studies on other fish species, indicating that such indices were reliable indicators of nutritional and energy storage variations in response to environmental factors. The higher GI values observed in males compared to females could be attributed to differences in feeding habits or reproductive strategies between the sexes. Sex-specific variation was also found in species, such as *Butis koilomatodon* (Nguyen *et al.*, 2020), *Glossogobius giuris* (Phan *et al.*, 2021), and *Glossogobius sparsipapillus* (Tran *et al.*, 2021). Similarly, the higher GI values during the dry season might reflect increased food availability, supporting higher foraging intensity. This seasonal variation in GI is consistent with findings in other goby species, where food abundance during certain seasons increases the GI values. In addition, seasonal differences were detected in *Parapocryptes serperaster* (Dinh *et al.*, 2017) and *Glossogobius sparsipapillus* (Tran *et al.*, 2021). However, no seasonal variation existed within the same distribution area regarding *Eleotris melanosoma* (Vo *et al.*, 2014) and *Stigmatogobius pleurostigma* (Dinh & Tran, 2018). The GI value in *Caragobius urolepis* is higher than that in *Parapocryptes serperaster* (Dinh *et al.*, 2017), *Butis koilomatodon* (Nguyen *et al.*, 2020), and *Glossogobius sparsipapillus* (Tran *et al.*, 2021). However, this coefficient is lower than that recorded for *Glossogobius giuris* (Phan *et al.*, 2021), showing that this species displayed a higher foraging intensity than others in the same distribution range.

Some species distributed in the same area, such as *Eleotris melanosoma* (Vo *et al.*, 2014), *Parapocryptes serperaster* (Dinh *et al.*, 2017), *Stigmatogobius pleurostigma* (Dinh & Tran, 2018), and *Butis koilomatodon* (Dinh *et al.*, 2020) showed that the fish sex did not regulate Clark variation. In this context, the Clark index, which reflected energy storage capacity showed significant seasonal variation, with higher values recorded during the dry season. This could be ascribed to reduced food intake during the wet season, possibly related to reproductive activities or changes in environmental conditions such as salinity. Furthermore, the larger water volume during the wet season may reduce the salinity of the aquatic environment (Juliette *et al.*, 2017; BioBlue, 2023), seeming to affect the adaptation of fish to the environment and to cause fluctuations in nutrition and growth, which may lead to a decrease in the number of fish. Meanwhile, *Pseudapocryptes elongatus* (Tran, 2008), *Parapocryptes serperaster* (Dinh *et al.*, 2017), *Stigmatogobius pleurostigma* (Dinh & Tran, 2018), and *Butis koilomatodon* (Dinh *et al.*, 2020), displayed that Clark index did not vary with season. The interaction season  $\times$  site could regulate the variation of the Clark index of *Caragobius urolepis*, suggesting the

importance of local environmental factors in shaping the nutritional status of this fish. The Clark index of this fish is smaller than that of *Stigmatogobius pleurostigma* (Dinh & Tran, 2018), *Butis koilomatodon* (Dinh *et al.*, 2020), *Glossogobius girus* (Phan *et al.*, 2021), and *Glossogobius sparsipapillus* (Tran *et al.*, 2021) living in the same area, assuming that the energy storage capacity of the species may be related to the salinity difference between sites. According to Dinh and Nguyen (2022), the salinity in the DDCM (26.8‰) was significantly lower than that in the DHBL (30.0‰). The salinity difference in the aquatic environment might affect the energy storage capacity of some fish species (Phan *et al.*, 2021; Tran *et al.*, 2021) and the biological development of fish species (BioBlue, 2023). Furthermore, salinity differences could cause changes in foraging and access to food sources for fish species (Tran *et al.*, 2021). Overall, the results of this study would provide valuable insights into the nutritional ecology of *Caragobius urolepis*, highlighting the influence of seasonal and spatial factors on its feeding and energy storage patterns. These findings contributed to a better understanding of the species' adaptability to environmental changes and provided a foundation for future research on its artificial breeding and conservation.

## CONCLUSION

The GI and Clark values of the species varied with season and site but not with sex. The GI value of this species was simultaneously affected by sex  $\times$  site but was not simultaneously affected by sex  $\times$  season, season  $\times$  site, and sex  $\times$  season  $\times$  site. The Clark value of the species varied depending on the simultaneous effects of season  $\times$  site but not depending on the simultaneous effects of sex  $\times$  site, sex  $\times$  season, and sex  $\times$  season  $\times$  site. The results of this study provide additional information on the nutritional characteristics of *Caragobius urolepis*, forming the basis for future research on the artificial aquaculture of this species.

## ACKNOWLEDGMENT

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## REFERENCES

- Anderson, M. J.; Gorley, R. N. and Clarke, K. R. (2008). *PERMANOVA+ for PRIMER: Guide to software and statistical methods*. United Kingdom: PRIMER-E, Plymouth.
- BioBlue (2023). Effects of rain on shrimp ponds.
- Dinh, Q. M. (2018). Aspects of reproductive biology of the red goby *Trypauchen vagina* (Gobiidae) from the Mekong Delta. *Journal of Applied Ichthyology*, 34(1), 103-110. doi:10.1111/jai.13521

- Dinh, Q. M. and Nguyen, T. H. D.** (2022). Burrow behaviour, structure and utilization of the amphibious mudskipper *Periophthalmus chrysospilos* Bleeker, 1853 in the Mekong Delta. *Saudi Journal of Biological Sciences*, 103525.
- Dinh, Q. M.; Nguyen, T. N. Y.; Lam, T. H. T. and Phan, T. G.** (2020). The digestive tract morphology and Clark index of Mud Sleeper *Butis koilomatodon* living in some coastal and estuarine areas belonging to Tra Vinh, Soc Trang, Bac Lieu and Ca Mau. *VNU Journal of Science: Natural Sciences and Technology*, 36(3), 61-69. doi:10.25073/2588-1140/vnunst.5051
- Dinh, Q. M.; Qin, J. G.; Dittmann, S. and Tran, D. D.** (2017). Seasonal variation of food and feeding in burrowing goby *Parapocryptes serperaster* (Gobiidae) at different body sizes. *Ichthyological Research*, 64(2), 179-189. doi:10.1007/s10228-016-0553-4
- Dinh, Q. M. and Tran, M. T. D.** (2018). Digestive tract morphology, food and feeding habits of the goby *Stigmatogobius pleurostigma* (Bleeker, 1849) from the Coastline in Soc Trang. *VNU Journal of Science: Natural Sciences and Technology*, 34(2), 46-55. doi:10.25073/2588-1140/vnunst.4740
- Juliette, S.; Théodore, T.; Andy, T.; Ambeondahy and Adolphe, R. A.** (2017). Impact of precipitation on the salinity of the Ocean. *Laboratoire Univers et Particules de Montpellier*, 1-6.
- Murdy, E. O. and Shibukawa, K.** (2003). A revision of the Indo-Pacific fish genus *Caragobius* (Gobiidae: Amblyopinae). *Zootaxa*, 301(1), 1-12.
- Nguyen, N. T.** (2000). *Fauna of Vietnam - Gobioidae* (Vol. 5). Ha Noi: Sciences and Technics Publishing House.
- Nguyen, Y. T. N.; Lam, T. T. H. and Dinh, Q. M.** (2020). The relative gut length and gastro-somatic indexes of *Butis koilomatodon* living in the coastal estuaries of some provinces in the Mekong Delta. *TNU Journal of Science and Technology*, 225(08), 358-365.
- Nguyen, P. L. H.; Tran, L. T. C.; Phan, T. T. A.; Nguyen, T. K.; Vo, L. T. T. and Dinh, Q. M.** (2023). Morphometrics allometry changes and sexual dimorphism in *Caragobius urolepis* (Gobiiformes: Gobiidae). *Veterinary Integrative Sciences*, 21(1), 29-36. doi:10.12982/VIS.2023.003
- Nguyen, P. L. H.; Vo, L. T. T.; Tran, L. T. C.; Nguyen, T. K.; Phan, T. T. A. and Dinh, Q. M.** (2024a). Ovarian traits, spawning pattern and season, length at first maturity, and batch fecundity of *Caragobius urolepis* (Bleeker, 1852) caught from the Vietnamese Mekong Delta. *Heliyon*, 10(20), e39281. doi:10.1016/j.heliyon.2024.e39281
- Nguyen, P. L. H.; Vo, L. T. T.; Tran, L. T. C.; Nguyen, T. K.; Phan, T. T. A. and Dinh, Q. M.** (2024b). Testicular traits, sperm-releasing season, and length at first maturity of *Caragobius urolepis* in southwest Vietnam. *Egyptian Journal of Aquatic Research*, 50(3), 391-399. doi:10.1016/j.ejar.2024.03.008



- Phan, H. G.; Dinh, M. Q.; Truong, T. N.; Nguyen, H. D. T.; Tran, S. N. and Nguyen, T. K. T.** (2021). The variations of Clark and gastroscopic indexes of *Glossogobius giurus* living in some regions the Mekong Delta, Vietnam. *Egyptian Journal of Aquatic Biology and Fisheries*, 25(6), 181-191. doi:10.21608/ejabf.2021.211009
- To, Q. T.; Tang, D. T.; Tran, B. H.; Le, M. H. and Duong, X. M.** (2016). *Impacts of climate change, upstream development, internal development on the Mekong Delta, challenges and response solutions*. Paper presented at the Workshop on solutions to control salinity and store fresh water to serve production and people's livelihood in the Mekong Delta, Hau Giang.
- Tran, C. C. and Dinh, Q. M.** (2021). Gastrointestinal tract morphology and Clark index of Dusky gilled mudskipper *Periophthalmus variabilis* caught in coastal regions from Tra Vinh to Soc Trang, Bac Lieu, and Ca Mau provinces. *Science and Technology Journal of Agriculture & Rural Development*, 10, 179-184.
- Tran, C. C.; Nguyen, H. D. T.; Nguyen, T. T. H. and Dinh, Q. M.** (2021). Gastrointestinal tract morphology and Clark index of the Linecheek tank goby *Glossogobius sparsipapillus* caught from coastal estuaries of Bac Lieu and Ca Mau Provinces. *Vietnam Agricultural Science Journal*, 19(4), 535-543.
- Tran, C. C.; Nguyen, T. H. D.; Nguyen, H. T. T.; Vo, L. T. T. and Dinh, Q. M.** (2021). Diet composition and feeding habit of *Glossogobius sparsipapillus* caught from estuarine regions in the Mekong Delta. *Egyptian Journal of Aquatic Research*, 47(3), 313-319. doi:10.1016/j.ejar.2021.06.001
- Tran, D. D.** (2008). *Some aspects of biology and population dynamics of the goby Pseudapocryptes elongatus (Cuvier, 1816) in the Mekong Delta*. (PhD thesis), Universiti Malaysia Terengganu, Malaysia.
- Tran, D. D.; Shibukawa, K.; Nguyen, T. P.; Ha, P. H.; Tran, X. L.; Mai, V. H. and Utsugi, K.** (2013). *Fishes of Mekong Delta, Vietnam*. Can Tho: Can Tho University Publisher.
- Trinh, K. N. and Tran, D. D.** (2012). The status of capture fisheries and management of marine fishes in Soc Trang Province. *Can Tho University Journal of Science*, 24b, 46-55.
- Truong, L. Y.; Tran, P. T. H.; Nguyen, V. Q.; Le, T. M. T.; Nguyen, Q. L.; Nguyen, T. H. D. and Dinh, Q. M.** (2024). Feeding habits and diet composition of *Caragobius urolepis* in the Vietnamese Mekong Delta. *Egyptian Journal of Aquatic Research*, 50(4), 545-551. doi:10.1016/j.ejar.2024.07.005
- Vo, T. T.; Tran, D. D. and Duong, O. H. T.** (2014). *Study on nutritional characteristics of broadhead sleeper (Eleotris melanosoma Bleeker, 1853) distributed along the Hau River*. Paper presented at the 2<sup>nd</sup> National Conference on Marine Biology and Sustainable Development, Hai Phong.

**Vo, V. B.; Nguyen, H. S. and Nguyen, Q. H.** (2019). Study on biological characteristics of *Onychostoma laticeps* Gunther, 1896. *Vietnam Journal of Agricultural Sciences*, 17(8), 637-644.