Egyptian Journal of Aquatic Biology & Fisheries
Zoology Department, Faculty of Science,
Ain Shams University, Cairo, Egypt.
ISSN 1110 – 6131
Vol. 24(2): 525 – 533 (2020)
www.ejabf.journals.ekb.eg

Otolith dimensions and their relationship with the size of *Glossogobius sparsipapillus* fish along the coastline of Mekong Delta, Vietnam

Ton H. D. Nguyen[1] and Quang M. Dinh[2]*

1. BSc. Student at Department of Biology, School of Education, Can Tho University, 3/2 Street, Xuan Khanh Ward, Ninh Kieu District, Can Tho 900000, Vietnam
2. Department of Biology, School of Education, Can Tho University, 3/2 Street, Xuan Khanh Ward, Ninh Kieu District, Can Tho 900000, Vietnam

*Corresponding Author: dmquang@ctu.edu.vn

ARTICLE INFO

Article History:
Received: April 7, 2020
Accepted: April 26, 2020
Online: April 29, 2020

Keywords:
Mekong Delta,
goby,
Glossogobius sparsipapillus,
otolith,
Vietnam

ABSTRACT

This study provides knowledge on otolith morphometrics and the relationships between otolith dimensional length, weight, body height, and head length of *Glossogobius sparsipapillus.* A total of 572 individuals were measured in this study, of which 308 males and 264 females. The samples were collected from April 2019 to January 2020 at three studied sites from Vinh Hau, Hoa Binh, Bac Lieu to Dien Hai, Dong Hai, Bac Lieu and Tan Thuan, Dam Doi, Ca Mau. The length, width, and weight of the otolith did not differ between the left and right of otoliths as well as males and females. However, the differences in length, width, and weight of otoliths varied among the three studied sites. The weight of the otolith was closely related to the length, weight, body height, and head length of the fish. The results showed that otolith weight can be used to determine fish size.

INTRODUCTION

Glossogobius sparsipapillus Akihito & Meguro, 1976 is one of three goby species belonging to the Gobiidae family recorded in the Mekong Delta **(Tran *et al.*, 2013)**. The species *G. sparsipapillus* lives in from marine and brackish water to the freshwater region **(Nguyen, 2005)**. This species is first described and named by **Akihito and Meguro (1976)** from a sample collected in Can Tho, Vietnam. It is also a typical species of the lower Mekong River and plays an important role in food supplying.

Otoliths are the calcified structures at the inner ears of fish **(Popper and Lu, 2000; Campana, 2004)**. The structural differences are found in different fish species **(Furlani *et al.*, 2007)**. The functions of otolith are to receive sound and to stay balance **(Popper *et al.*, 2005)**. Besides, otolith is also used to determine the age of the fish **(Pino *et al.*, 2004; Metin *et al.*, 2011; Dinh *et al.*, 2015)**, fish classification **(Tuset *et al.*, 2006; Bani *et al.*, 2013)**, evaluate the amount of seafood **(Stransky *et al.*, 2008)**, and identify fish prey **(Waessle *et al.*, 2003; Tarkan *et al.*, 2007)**. During the development of the fish, otoliths continuously increase in size and weight **(Rodríguez Mendoza, 2006)**. In this study, hence, the length, width, and weight of otoliths were measured in order to determine the fish growth by quantifying the relationship of otolith dimensions and fish size.

MATERIALS AND METHODS

Study site

Fish samples were collected from April 2019 to January 2020, in three studied locations from Vinh Hau, Hoa Binh, Bac Lieu (VH, 9°12'24.8''N 105°42'54.9''E) to Dien Hai, Dong Hai, Bac Lieu (DH, 9°06'03.2''N 105°29'49.1''E) and Tan Thuan, Dam Doi, Ca Mau (TT, 8°58'17.5''N 105°22'51.8''E, Fig. 1). Two times in the dry season in April and May and seven times in the rainy season from June 2019 to January 2020.

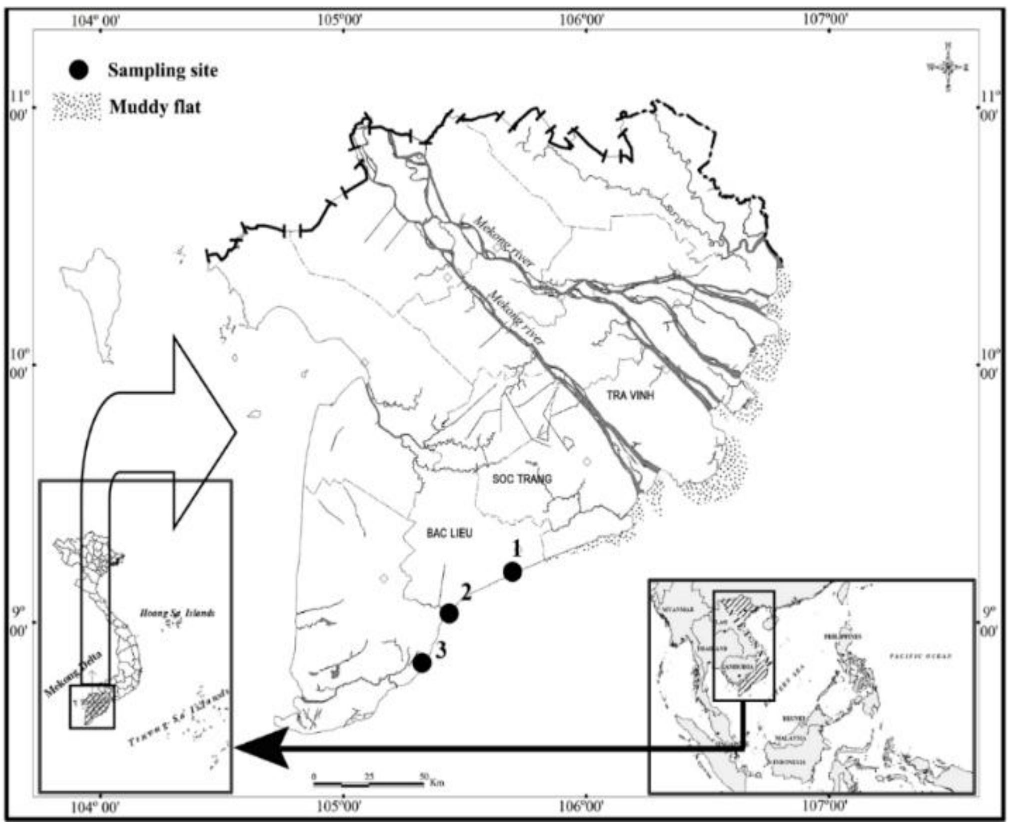

Fig. 1. The sampling map along the coastline in the Mekong Delta (•: sampling area; 1: Vinh Hau, Hoa Binh, Bac Lieu; 2: Dien Hai, Dong Hai, Bac Lieu; 3: Tan Thuan, Dam Doi, Ca Mau)

Fish collection and analysis

Fish specimens were collected at random with different sizes by bottom nets with a mesh size of 1.5 cm. The collected samples were stored in 10% solution of formol, then transported to the laboratory for analyses.

In order to determine the gender of a fish, one needs to rely on the morphology of the genital papilla which was triangle in males and oval females. The total fish length (TL) and body weight (W) were measured to the nearest 0.1 cm and 0.01 g, respectively. Digital scales weighed to the nearest 0.1 mg and stereo microscopes linked to video cameras for weighing and taking ear shots. These images were then used to measure the length and width of the otoliths (Fig. 2) in μm using the Motic Image Plus v2.0 software.

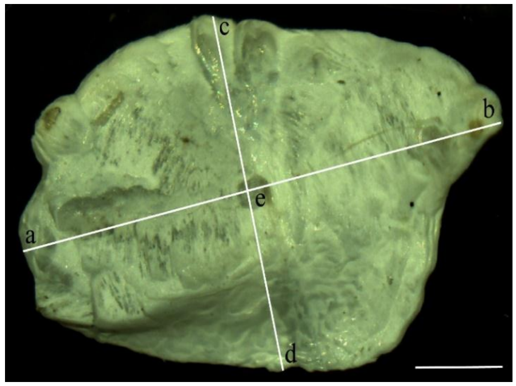

Fig. 2. Otolith of *G. sparsipapillus* (ab: otolith length, cd: otolith width, e: otolith core; scale bar: 1000 μm)

T-test was required to determine the difference between length, width, and weight of left and right otoliths **(Matic-Skoko *et al.*, 2011)**. One-way ANOVA was used to quantify for significant differences in OL, OW, WO, BH, and HL among three studied locations. If the left and right otolith weight were similar, only the right of WO was used to quantify its relationship with fish size (TL, W, HL, and BH). The relationship between fish size and otolith weight was described by linear equations such as: WO = a×TL + b; WO = a×W + b; WO = a×HL + b; OL = a×BH + b, where WO is otolith weight, TL is fish total length, W is fish body weight, HL is fish head length, BH is fish body height, a and b are the constant coefficients. The coefficient of determination (r^2) was used to confirm the quality of linear regression. SPSS v21 software was used for data analysis. All tests were set at $P<0.05$.

RESULTS

1. Morphology and morphometry of otoliths

This study was the first study concerning the otolith parameters of this species. One end of the otolith, it was rounded while the other was slightly protruding on one side. There were also differences between the two sides of the otolith. The otolith view facing outwards had a smooth surface. Contrary, the view facing the fish's body had a rough surface.

The morphometry of otoliths of *G. sparsipapillus* was presented in Table 1. The analysis otoliths of 572 individuals (308 males and 264 females) showed that the left OL and OW (length: 3256.97±19.17 SE; width: 2322.79±15.44 µm) were not significantly different from the right OL and OW (length: 3259.48±20.84 SE µm; width: 2319.51±16.17 SE µm) (t-test, $P>0.05$ for two cases, Table 2). Similarly, the left WO (6.65±0.16 SE mg) was similar to the right one (6.51±0.11 SE mg) ($P>0.05$, Table 2).

Table 1. Morphometrics of *Glossogobius sparsipapillus* in three studied sites

Site	No		Total length (cm)		Weight (g)		Left OL (µm)		Right OL (µm)		Left OW (µm)		Right OW (µm)		Left WO (mg)		Right WO (mg)	
	F	M	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
VH	69	82	6.6	16.0	2.03	28.17	2513	5022	2414	5517	1536	3558	1569	3580	1.4	16.6	2.2	18.8
DH	88	101	7.0	16.6	3.26	28.21	2536	4871	2452	5523	1749	3567	1724	3636	3.1	19.0	2.9	18.0
TT	107	125	4.2	15.3	3.03	27.00	2046	4350	2166	4390	1569	3216	1635	3302	2.2	13.4	3.2	13.4

(F: Female; M: male; VH: Vinh Hau, Hoa Binh, Bac Lieu; DH: Dien Hai, Dong Hai, Bac Lieu; TT: Tan Thuan, Dam Doi, Ca Mau)

Table 2. The length, width, and weight of the left and right otoliths

Comparison	No. of fish	Mean	Standard error of mean	t-value	df	*P*-value
Left otolith length	572	3256.97	19.18	-0.28	571	0.78
Right otolith length	572	3259.48	20.84			
Left otolith width	572	2322.79	15.45	0.48	571	0.62
Right otolith width	572	2319.51	16.18			
Left otolith weight	572	6.65	0.16	1.12	571	0.26
Right otolith weight	572	6.51	0.12			

In terms of the studied site, both OL and WO showed significant differences. Specifically, in VH, the otolith length reached the largest value (left: 3310.61±45.20 SE; right: 3320.48±48.70 SE µm) and the lowest value was found in TT (left: 3199.78±24.38 SE; right: 3191.91±24.91 SE µm) (One-way ANOVA, F_{LOL}=3.19, F_{ROL}=3.74, P<0.05 for two cases, Table 3). The largest value of WO (left otolith: 7.30±0.24 SE mg; right otolith: 7.17±0.24 SE mg) was in DH, followed by VH (left otolith: 6.70±0.23 SE mg; right otolith: 6.70±0.25 SE mg); and the lowest value of otolith size was in TT (left otolith: 6.10±0.31 SE mg; right otolith: 5.87±0.12 SE mg) (ANOVA, F_{LWO}=1.55, F_{RWO}=0.71, P<0.05 for two cases, Table 3). Regarding the OW, there was no difference in both left and right sides of otoliths among three studied sites (ANOVA, P>0.05 for all cases, Table 3). The BH (1.23±0.01 SE cm, ANOVA, F=5.54, P<0.05) and HL (2.38±0.02 SE cm, ANOVA, F=11.63, P<0.05) of the fish differed in three studied sites (Table 3).

Table 3. The length, width, and weight of left and right otoliths in three studied sites

Sites	No. of fish	Otolith sides	Otolith length (µm)		Otolith width (µm)		Otolith weight (mg)		Body height (cm)		Head length (g)	
			Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
VH	151	Left	3310.61[a]	45.19	2323.99[a]	35.21	6.70[a]	0.23	1.19[a]	0.02	2.44[a]	0.04
		Right	3320.48[a]	48.70	2323.73[a]	36.47	6.70[a]	0.25				
DH	189	Left	3284.31[a]	33.81	2357.43[a]	27.08	7.30[a,b]	0.24	1.29[a]	0.03	2.48[b]	0.04
		Right	3293.68[a,b]	38.65	2342.71[a]	28.81	7.17[b]	0.24				
TT	232	Left	3199.78[a]	24.38	2293.79[a]	20.87	6.10[b]	0.31	1.20[b]	0.02	2.67[b]	0.02
		Right	3191.91[b]	24.92	2297.85[a]	21.87	5.87[b]	0.12				

(VH: Vinh Hau, Hoa Binh, Bac Lieu; DH: Dien Hai, Dong Hai, Bac Lieu; TT: Tan Thuan, Dam Doi, Ca Mau; SE: Standard error of mean; The different letters (a and b) in each category represent significant differences between the three sampling locations)

2. Relationship between fish size and otolith size

The otolith weight was closely related to the fish length (r^2> 0.6) and fish body weight (r^2> 0.6). The most positive relationship between the otolith weight and fish total length was in VH with r^2 = 0.803, the least one was in TT with r^2 = 0.676. Similarly, the most positive relationship between the otolith weight and the fish weight was in DH (r^2= 0. 783), and the least one was still in TT (r^2= 0.677). The otolith weight was also closely related to the head length (r^2> 0.6) and body height (r^2> 0.5). The most positive relationship between otolith weight and the head length was in DH (r^2= 0.791) and the least one was in TT (r^2= 0.655). Likewise, the relationship between otolith weight and the body height was the most positive in VH (r^2= 0.666) and the least in TT (r^2= 0.535). From these relationships, the volume of otoliths increased depending on the size of the fish, being used as a parameter to determine the size of the fish.

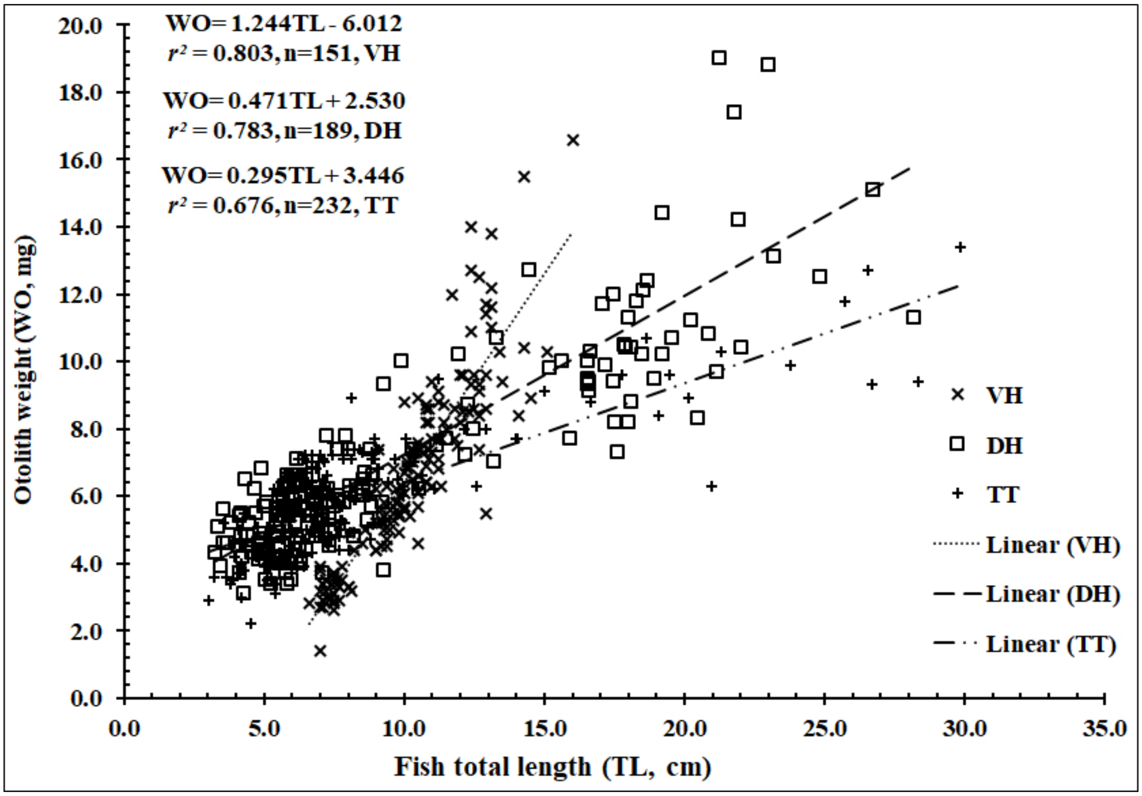

Fig. 3. Relationship between otolith weight and total fish length in the three sampling locations (VH: Vinh Hau, Hoa Binh, Bac Lieu; DH: Dien Hai, Dong Hai, Bac Lieu; TT: Tan Thuan, Dam Doi, Ca Mau)

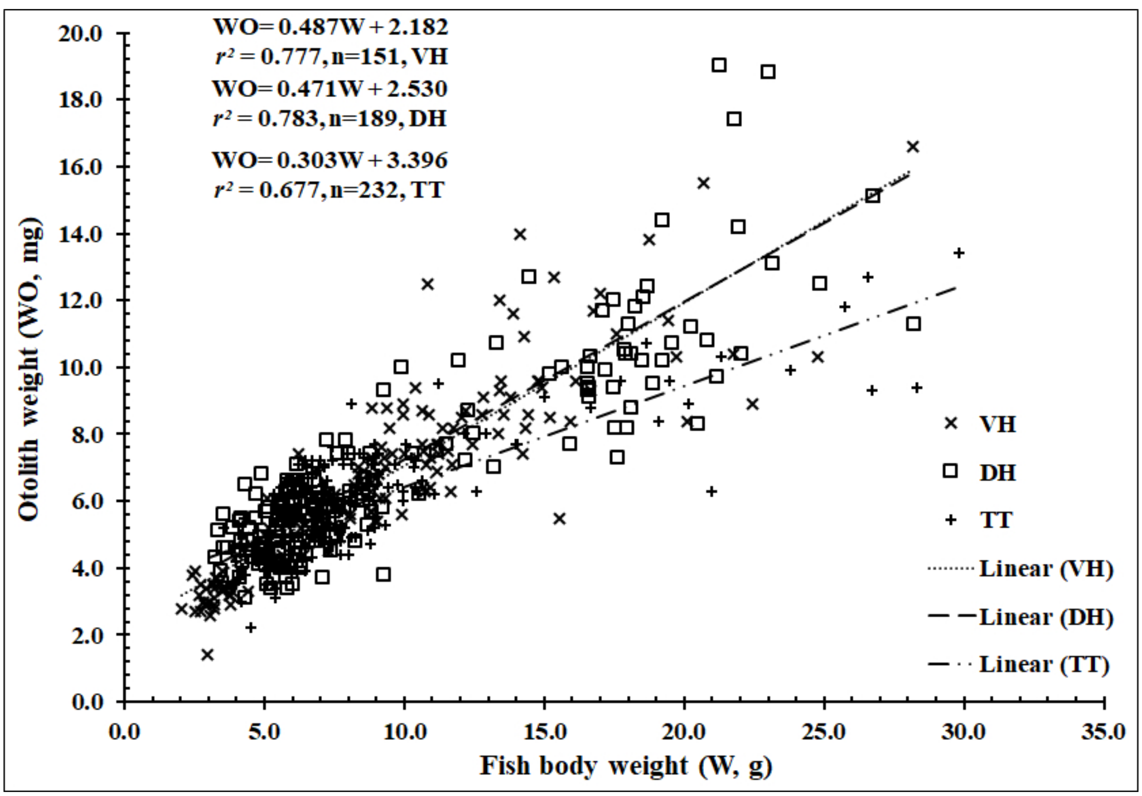

Fig. 4. Relationship between otolith weight and fish weight in the three sampling locations (VH: Vinh Hau, Hoa Binh, Bac Lieu; DH: Dien Hai, Dong Hai, Bac Lieu; TT: Tan Thuan, Dam Doi, Ca Mau)

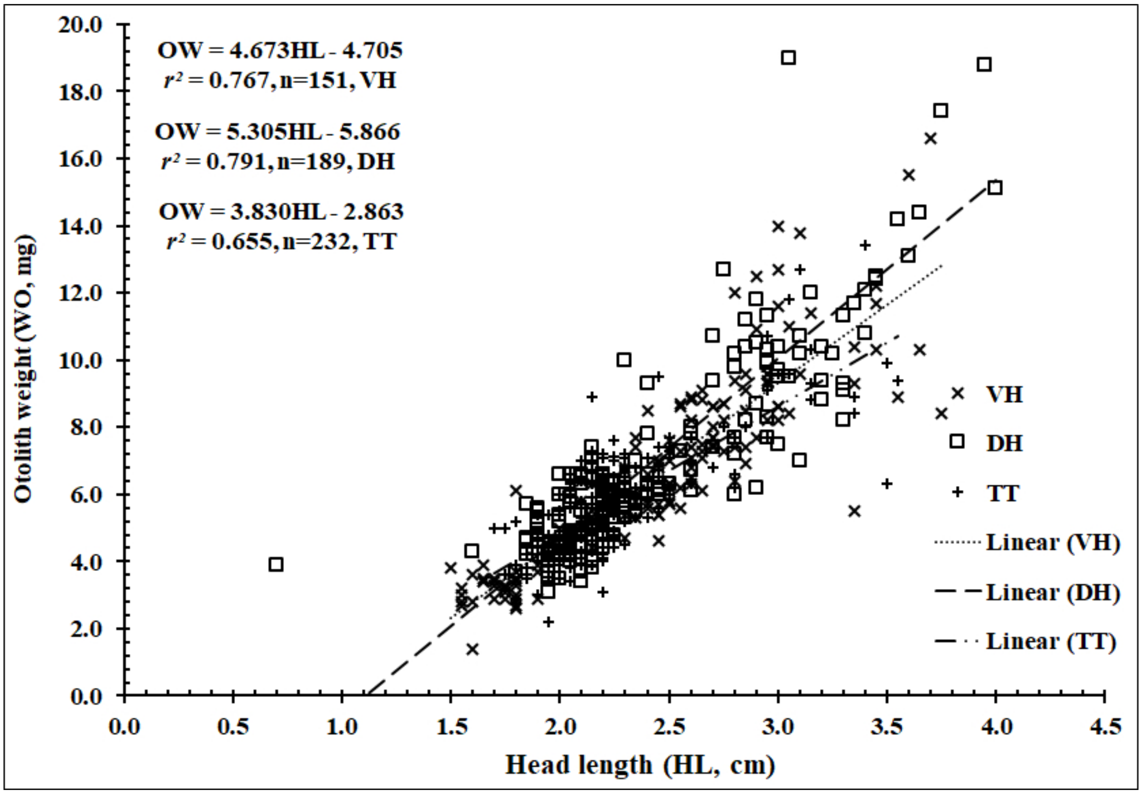

Fig. 5. Relationship between otolith weight and head length in the three sampling locations (VH: Vinh Hau, Hoa Binh, Bac Lieu; DH: Dien Hai, Dong Hai, Bac Lieu; TT: Tan Thuan, Dam Doi, Ca Mau)

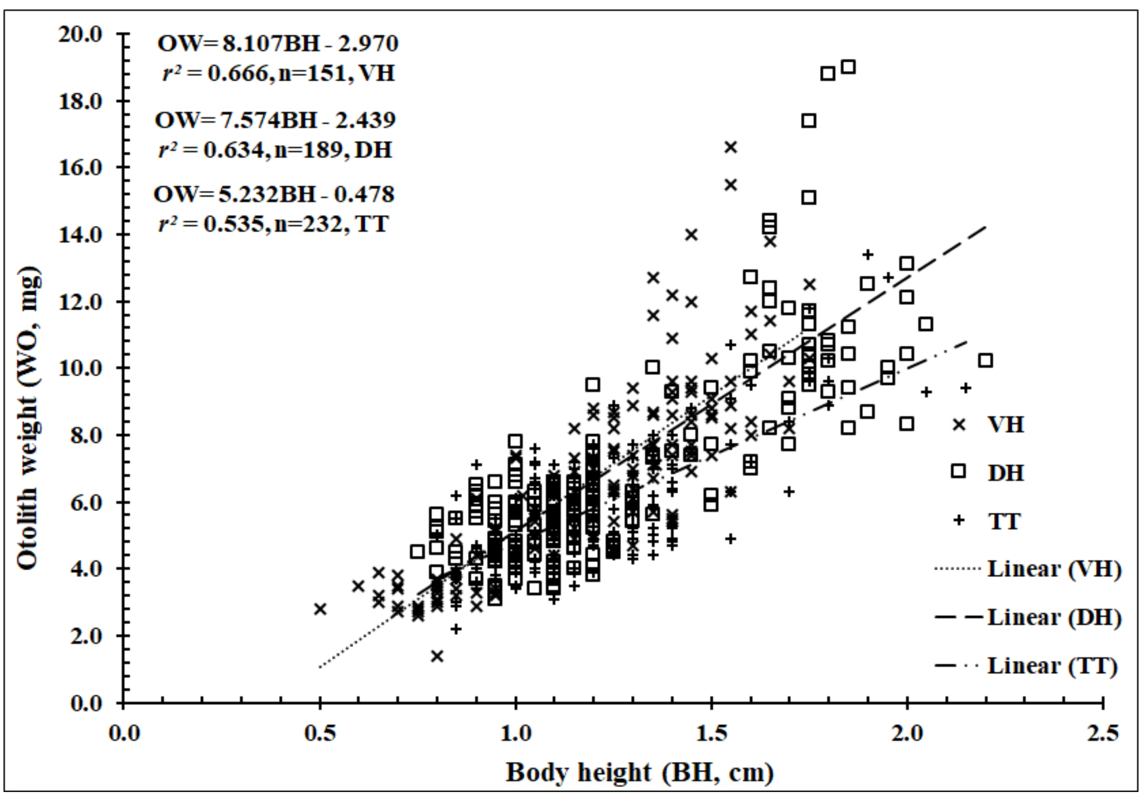

Fig. 6. Relationship between otolith weight and body height in the three sampling locations (VH: Vinh Hau, Hoa Binh, Bac Lieu; DH: Dien Hai, Dong Hai, Bac Lieu; TT: Tan Thuan, Dam Doi, Ca Mau)

DISCUSSION

Otolith size was quite uniform on the left and right sides of the fish, and the size of the otolith did not differ significantly in gender, suggesting that otolith data could be used to classify *G. sparsipapillus* from other fish species. A similar in left and right otolith size was also found in *Parapocryptes serperaster* in the Mekong Delta **(Dinh *et al.*, 2015)**, which was also found some other fish species including *Kurtus gulliveri* in northern Australia **(Berra and Aday, 2004)**, *Thunnus thynnus* in the Mediterranean Sea **(Megalofonou, 2006)**, *Pagrus auratus* and *Platycephalus* in south- eastern Australia **(Hamer and Jenkins, 2007)**, and *Neogobius caspius, Ponticola bathybius* and *Ponticola gorlap* in Iran **(Bani *et al.*, 2013)**. The size of the otolith varied significantly in different three studied locations. This difference may be due to different environmental conditions and food in the study sites. There were also differences in W and TL in the three studied sites leading to such differences.

The change of otolith size was positively related to the fish size due to the positive relationship between otolith and fish size, showing that the otolith size was constantly growing and proportional to the fish size. Similarly, the positive relationship between otolith and fish size was also found in *Parapocryptes serperaster* in the Mekong Delta **(Dinh *et al.*, 2015)**. Similarly, the positive relationship between fish and otolith size was found in some other gobiid species living in Iranian water such as *Neogobius caspius, Ponticola Bathybius,* and *Ponticola gorlap* **(Bani *et al.*, 2013)**. The Japanese anchovy and sardine larvae like *Engraulis japonicus* and *Sardinops melanostictus* caught from the western North Pacific also displayed a strong relationship between fish and otolith size **(Takasuka *et al.*, 2008)**. Besides, the Indian mackerel *Rastrelliger kanagurta* collected from the Oman Sea had a positive relationship between fish length and otolith length, width and weight **(Jawad *et al.*, 2011)**, which was also found in nine demersal fishes caught from north-eastern Tasmanian waters, Australia including *Trachurus declivis, Parequula melbournensis, Neosebastes scorpaenoides, Platycephalus aurimaculatus, Platycephalus bassensis, Platycephalus conatus, Lepidotrigla mulhalli,* and *Lepidotrigla vanessa* **(Park *et al.*, 2018)**. The results showed that WO could be used as an indicator of fish growth.

CONCLUSION

This study provided new knowledge of the otolith morphology and morphometry of the species *Glossogobius sparsipapillus*. The otolith dimension measurements of this fish were differences among the three studied sites. The OW was closely related to TL, W, HL, and BH, suggesting that OW could play as an indicator of fish size increase.

ACKNOWLEDGMENTS

This research was funded by Can Tho University under grant number TSV2019-111. We are grateful to Nguyen Thi Thuy Hien, Tran Chi Canh, Nguyen Thi Nha Y, and Dang Hoa Thao for fish collection and analyses.

REFERENCES

Akihito, P. and Meguro, K. (1976). *Glossogobius sparsipapillus*, a new species of goby from Viet Nam. Japanese Journal of Ichthyology, 23(1): 9-11.

Bani, A.; Poursaeid, S. and Tuset, V. M. (2013). Comparative morphology of the sagittal otolith in three species of south Caspian gobies. Journal of Fish Biology, 82(4): 1321-1332.

Berra, T. M. and Aday, D. D. (2004). Otolith description and age-and-growth of *Kurtus gulliveri* from northern Australia. Journal of Fish Biology, 65(2): 354-362.

Campana, S. E. (2004). Photographic atlas of fish otoliths of the Northwest Atlantic Ocean, NRC Research Press, Canada.

Dinh, Q. M.; Qin, J. G. and Tran, D. D. (2015). Population and age structure of the goby *Parapocryptes serperaster* (Richardson, 1864; Gobiidae: Oxudercinae) in the Mekong Delta. Turkish Journal of Fisheries and Aquatic Sciences, 15(2): 345-357.

Furlani, D.; Gales, R. and Pemberton, D. (2007). Otoliths of common Australian temperate fish: a photographic guide, CSIRO publishing, Australia.

Hamer, P. A. and Jenkins, G. P. (2007). Comparison of spatial variation in otolith chemistry of two fish species and relationships with water chemistry and otolith growth. Journal of Fish Biology, 71(4): 1035-1055.

Jawad, L.; Ambuali, A.; Al-Mamry, J. and Al-Busaidi, H. (2011). Relationships between fish length and otolith length, width and weight of the Indian mackerel *Rastrelliger kanagurta* (Cuvier, 1817) collected from the Sea of Oman. Croatian Journal of Fisheries, 69(2): 51-61.

Matic-Skoko, S.; Ferri, J.; Skeljo, F.; Bartulovic, V.; Glavic, K. and Glamuzina, B. (2011). Age, growth and validation of otolith morphometrics as predictors of age in the forkbeard, *Phycis phycis* (Gadidae). Fisheries Research, 112(1-2): 52-58.

Megalofonou, P. (2006). Comparison of otolith growth and morphology with somatic growth and age in young-of-the-year bluefin tuna. Journal of Fish Biology, 68(6): 1867-1878.

Metin, G.; Ilkyaz, A. T.; Soykan, O. and Kinacigil, H. T. (2011). Age, growth and reproduction of four-spotted goby, *Deltentosteus quadrimaculatus* (Valenciennes, 1837), in İzmir Bay (central Aegean Sea). Turkish Journal of Zoology, 35(5): 711-716.

Nguyen, V. H. (2005). Freshwater fish of Viet Nam, Agriculture Publishing House, Ha Noi.

Park, J. M.; Gaston, T. F.; Riedel, R. and Williamson, J. E. (2018). Biometric relationships between body and otolith measurements in nine demersal fishes from north-eastern Tasmanian waters, Australia. Journal of Applied Ichthyology, 34(4): 801-805.

Pino, C. A.; Cubillos, L. A.; Araya, M. and Sepúlveda, A. (2004). Otolith weight as an estimator of age in the *Patagonian grenadier*, *Macruronus magellanicus*, in central-south Chile. Fisheries Research, 66(2-3): 145-156.

Popper, A.; Ramcharitar, J. and Campana, S. (2005). Why Otoliths? Insights from inner ear physiology and fisheries biology, 497-504.

Popper, A. N. and Lu, Z. (2000). Structure–function relationships in fish otolith organs. Fisheries Research, 46(1): 15-25.

Rodríguez Mendoza, R. (2006). Otoliths and their applications in fishery science. Croatian Journal of Fisheries: Ribarstvo, 64(3): 89-102.

Stransky, C.; Baumann, H.; Fevolden, S.-E.; Harbitz, A.; Høie, H.; Nedreaas, K. H.; Salberg, A.-B. and Skarstein, T. H. (2008). Separation of Norwegian coastal cod and Northeast Arctic cod by outer otolith shape analysis. Fisheries Research, 90(1-3): 26-35.

Takasuka, A.; Oozeki, Y.; Aoki, I.; Kimura, R.; Kubota, H.; Sugisaki, H. and Akamine, T. (2008). Growth effect on the otolith and somatic size relationship in Japanese anchovy and sardine larvae. Fisheries Science, 74(2): 308-313.

Tarkan, A. S.; Gursoy Gaygusuz, C.; Gaygusuz, O. and Acipinar, H. (2007). Use of bone and otolith measures for size-estimation of fish in predator-prey studies. Folia Zoologica, 56(3): 328-336.

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 University Publisher, Can Tho.

Tuset, V. M.; Rosin, P. L. and Lombarte, A. (2006). Sagittal otolith shape used in the identification of fishes of the genus *Serranus*. Fisheries Research, 81(2-3): 316-325.

Waessle, J. A.; Lasta, C. A. and Favero, M. (2003). Otolith morphology and body size relationships for juvenile Sciaenidae in the Río de la Plata estuary (35-36 S). Scientia Marina, 67(2): 233-240.