Morphometric and meristic variations of *Butis butis* (Hamilton, 1822) along the coastline in the Mekong Delta, Vietnam

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Abstract. This study was carried out in four sites along the coastline of the Mekong Delta, including Duyen Hai - Tra Vinh, Tran De - Soc Trang, Dong Hai - Bac Lieu, and Dam Doi - Ca Mau, in order to provide knowing morphometrics and meristics variation of *Butis butis* – a commercial fish in the Mekong Delta, Vietnam. Seven hundred fifteen individuals fish (412 males and 303 females) were collected from March to August 2019 using trawl nets. The study results showed that the total length (TL) and weight (W) of this species were stable by gender and season but fluctuated widely between study sites. Similarly, some other morphometrics of *B. butis* such as eye diameter (ED), eye distance (DE), body height (BD), head length (HL) did not fluctuate by gender and season but fluctuated by study site. Besides, meristics of this fish like ED/HL, DE/HL, BD/TL and HL/TL also did not fluctuate by gender and season but fluctuated by study site. The results also showed that DHTV (the point with the lowest salinity) is the most appropriate point for the morphological development of this species. Besides, morphological changes in different environments took place in all morphological indicators of this fish. The study has provided essential data on the morphological changes of this fish species in the coastal provinces of the Mekong Delta. The findings are the basis for further studies, especially genetic studies of this fish in the future.

Key Words: goby, morphology, Bac Lieu, Ca Mau, Soc Trang, Tra Vinh.

Introduction. Both morphometric and meristic parameters are essential to classify fish living from the marine to freshwater region (Strauss & Bond 1990). But the data of gobies residing along the coastline regions in the Mekong Delta has been fragmented. *Butis butis* (Gobiiformes: Butidae) is widely distributed in the Indian and Pacific Oceans (Nelson et al 2016; Froese & Pauly 2021) and one of three species of the genus *Butis* including *B. butis*, *B. humeralis* and *B. koilomatodon* recorded in the Mekong Delta (Mai et al 1992; Nguyen 2005; Tran et al 2013; Tran et al 2020a; Tran et al 2020b). Allen et al (2002) indicate that the species lives in mangrove estuaries and adjacent brackishwater areas, and even the riverine regions. It plays an essential role in the food supply in the Mekong Delta (Dinh 2017a), but the knowledge on this goby is limited to reproductive characteristics (Dinh & Le 2017) and population structure (Dinh 2018a).

Some other congeners show sexual, spatial and seasonal changes in morphometric and meristics, e.g., *B. koilomatodon* and *B. humeralis* occurring along the coastline in the Mekong Delta (Lam & Dinh 2020; Dinh et al 2021a). As its width distribution, this study aims to verify if its morphometric and meristic parameters vary with different places along the coastline in the Mekong Delta. The sexual and seasonal variations of these parameters are also evaluated. The findings will be used for understanding fish ecological adaption in the study region.

Material and Method

Fish collection and analysis. Fish samples were collected at four study sites along the coastal area of the Mekong Delta, including Duyen Hai – Tra Vinh (DHTV), Tran De - Soc Trang (TDST), Dong Hai - Bac Lieu (DHBL), and Dam Doi - Ca Mau (DDCM) (Figure 1). The pH in Hoa Binh and Dam Doi were lower than the remaining places, but the reverse case was found in salinity (Dinh et al 2021b). Fish were collected once a month using trawl nets with a mesh size of 1.5 cm and continuously for six months (from March to August 2019). Fish samples were randomly collected with different sizes and fixed with 10% formol solution immediately after capture. In the laboratory, fish was identified based on external morphological features described by Tran et al (2013). Next, the fish gender was determined based on the genital spines (triangle in males and oval in females) (Dinh & Le 2017). Finally, fish were determined morphological indicators such as total length (TL), weight (W), eye diameter (ED), eye distance (DE), body height (BD) and head length (HL). The meristic parameters of this fish, such as ED/HL, DE/HL, BD/TL and HL/TL were determined from these morphological indicators.

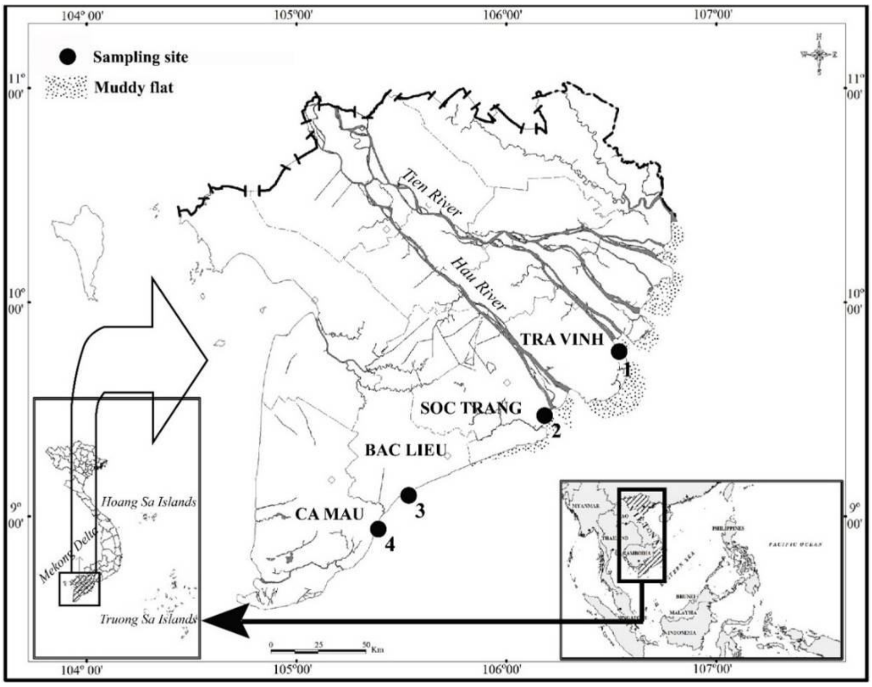

Figure 1. Sampling points in the Mekong Delta modified from Figure 1 produced by Dinh (2018b) (•: sampling point; 1: Duyen Hai - Tra Vinh; 2: Tran De - Soc Trang; 3: Dong Hai - Bac Lieu, and 4: Dam Doi - Ca Mau).

Data analysis. The difference of TL, W, ED, DE, BD, HL and ratios of ED/HL, DE/HL, BD/TL, HL/TL between seasons and sexes were qualified by t-test. A one-way ANOVA test confirmed the change of these coefficients in the four study areas. Besides, two-way ANOVA was used to determine the difference of TL, W, ED, DE, BD, HL and the ratios ED/HL, DE/HL, BD/TL, HL/TL by gender × season, gender × site, season × site. SPSS v21 was used to data performance. All tests were statistically tested at the 0.05 level of significance.

Results

Morphometric variation. Data analysis results of 715 individuals caught from four study sites showed that the variation of TL and W of *B. butis* was relatively stable according to gender and season (Table 1). Male weight (11.64±0.38 SE) and was not significantly more extensive than that of females (10.96±0.52 SE g, $t = -1.09$, $p > 0.05$). Similarly, the TL in male and female fish was not statistically significant, with mean values of 10.18±0.08 and 9.69±0.11 SE cm, respectively ($t = -1.71$, $p > 0.05$). Although the environment in the two seasons has different factors (temperature or salinity), differences in these factors did not have a significant effect on fish growth. The evidence was that fish weight in the dry season (10.33±0.42) was similar to that in the wet season (12.46±0.45 SE g, $t = -3.45$, $p > 0.05$). A similar trend was seen in the fish TL as TL in the wet season (10.32±0.10 SE cm) was not significantly longer than that in the dry season (9.65±0.09 SE cm, $t = -5.16$, $p > 0.05$). It showed that both W and TL of males and females increased evenly.

In contrast to this study, the *B. koilomatodon* species distributed from DHTV to DDCM showed that this fish's TL and W varied by gender and location (Lam & Dinh 2020). In addition, some fish species also had seasonal changes in TL and W, such as *Parapocryptes serperaster* (Dinh et al 2016), *Glossogobius sparsipapillus* (Nguyen et al 2020) and *Glossogobius giuris* (Nguyen & Dinh 2021). The stable development of this fish was similar to that of fish species such *Periophthalmodon schlosseri* (Dinh 2016a), *Trypauchen vagina* (Dinh 2016b) and *Boleophthalmus boddarti* (Dinh 2017b), which were not affected by environmental factors on the development of individuals.

Table 1

Variation in total length and weight of *Butis butis* by gender and season

Morphometry	*Category*	*Number of fish*	*Mean±SE*
Fish body weight	Female	303	10.96±0.52
	Male	412	11.64±0.38
Fish total length	Female	303	9.69±0.11
	Male	412	10.18±0.08
Fish body weight	Dry season	372	10.33±0.42
	Wet season	343	12.46±0.45
Fish total length	Dry season	372	9.65±0.09
	Wet season	343	10.32±0.10

Although the TL and W of *B. butis* did not change with gender and season, both parameters were affected by the sampling point (Figures 2 and 3). This may be because the environmental conditions (pH and salinity) in these four regions differ greatly (Dinh et al 2021b). The results also show that this fish species was suitable for growing in areas with low salinity, as in DHTV and TDST. Some other fish species also have morphological changes to adapt to the living environment, such as *B. koilomatodon* (Lam & Dinh 2020), *G. sparsipapillus* (Nguyen et al 2020) and *G. aureus* (Phan et al 2021).

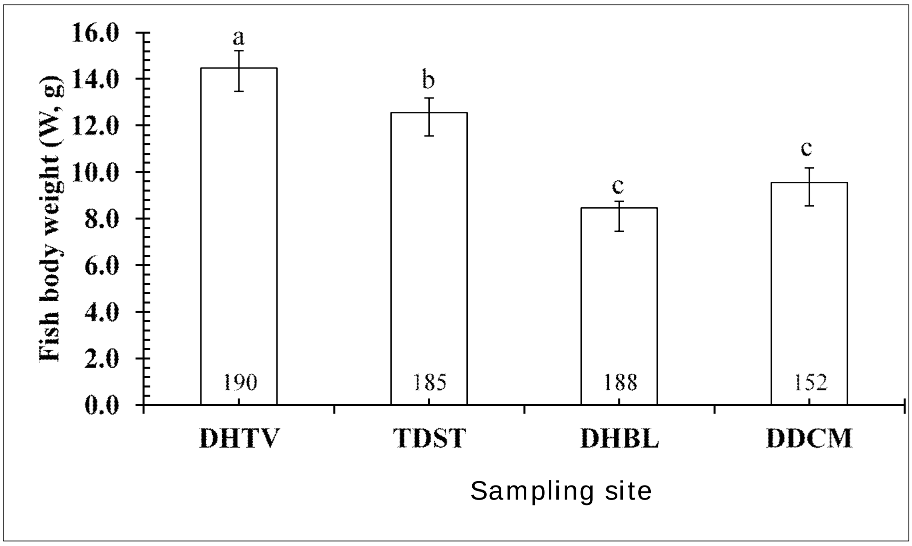

Figure 2. The variation of fish weight among four sampling sites (values are expressed as mean and standard error; the number in each column is the sample size; the letters a, b and c represent a statistically significant difference at the 5% level of significance).

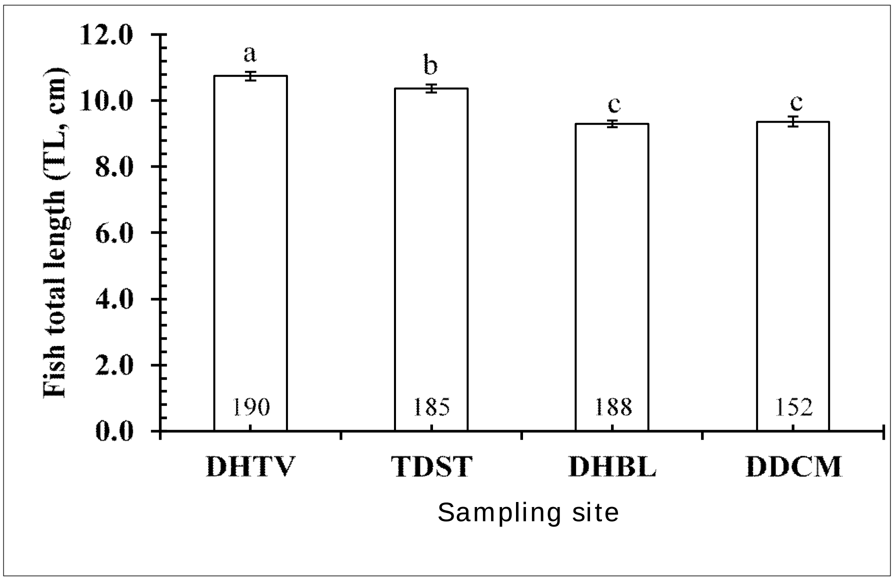

Figure 3. The variation of fish total length among four sampling sites (values are expressed as mean and standard error; the number in each column is the sample size; the letters a, b and c represent a statistically significant difference at the 5% level of significance).

The changes of TLs and Ws of this species were not affected by gender × season interaction (two-way ANOVA, $F_{TL} = 0.85$, $F_W = 2.28$, $p > 0.05$ for two cases) (Figures 4 and 5). Similarly, both TL and W did not change by gender × site ($F_{TL} = 1.06$, $F_W = 0.59$, $p > 0.05$ for two cases) (Figures 6 and 7). However, both of these indices changed between the dry and wet seasons at the study sites ($F_{TL} = 7.89$, $F_W = 6.20$, $p < 0.05$ for two cases) (Figures 8 and 9).

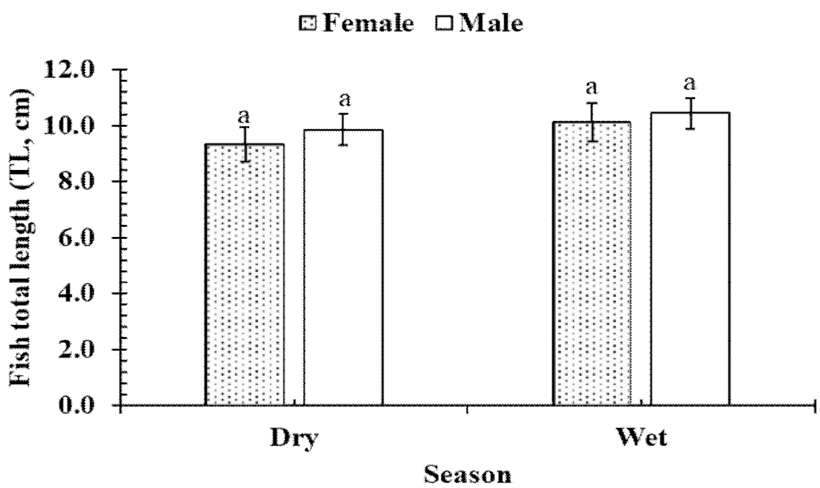

Figure 4. The fish total variation with the interaction of sex and season (values are expressed as mean and standard error).

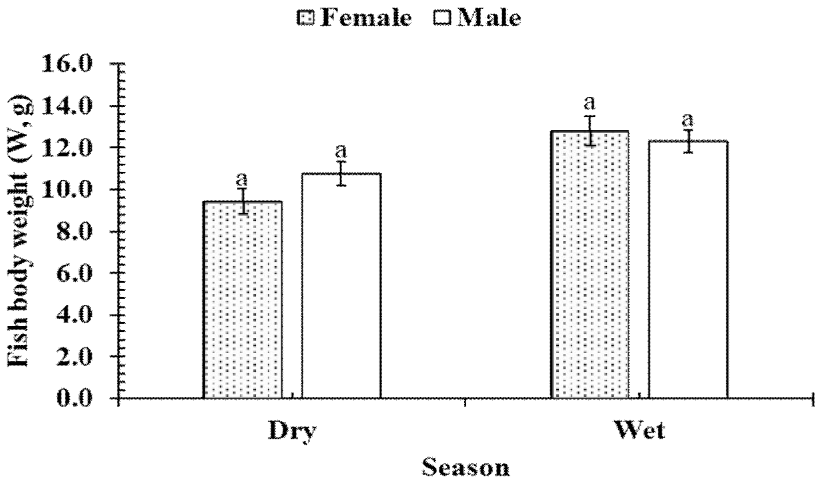

Figure 5. The fish weight variation with the interaction of season and sex (values are expressed as mean and standard error).

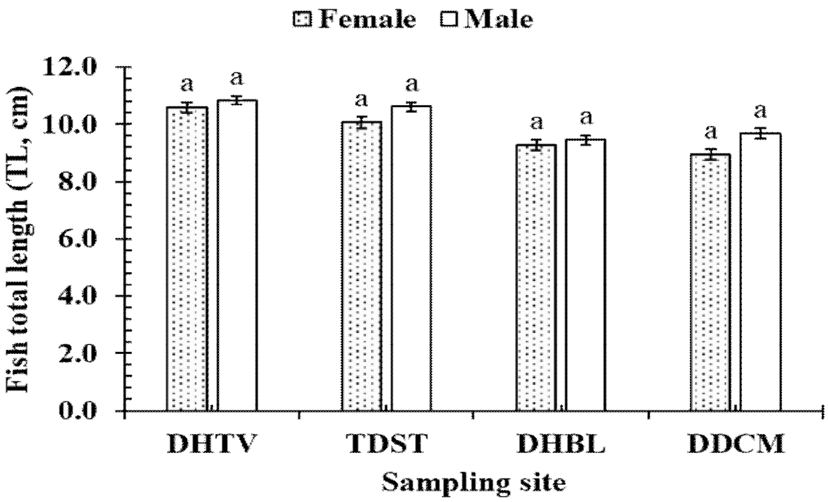

Figure 6. The fish total variation with the interaction of sex and site (values are expressed as mean and standard error).

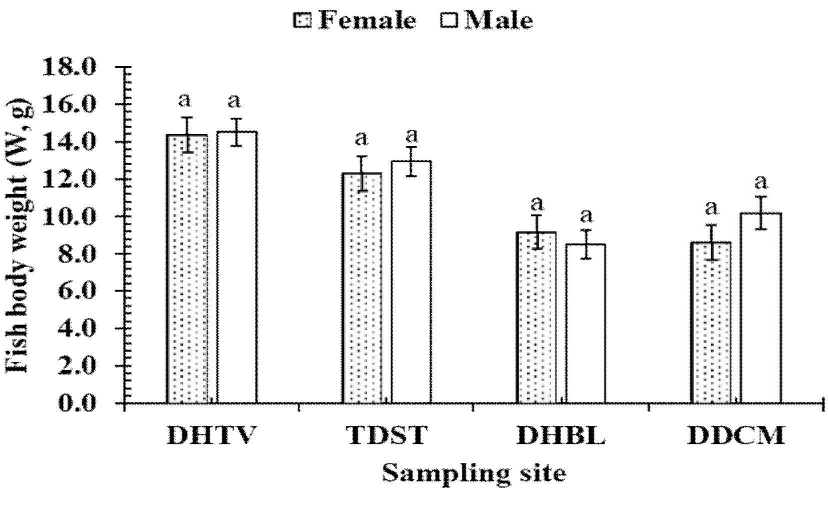

Figure 7. The fish weight variation with the interaction of site and sex (values are expressed as mean and standard error).

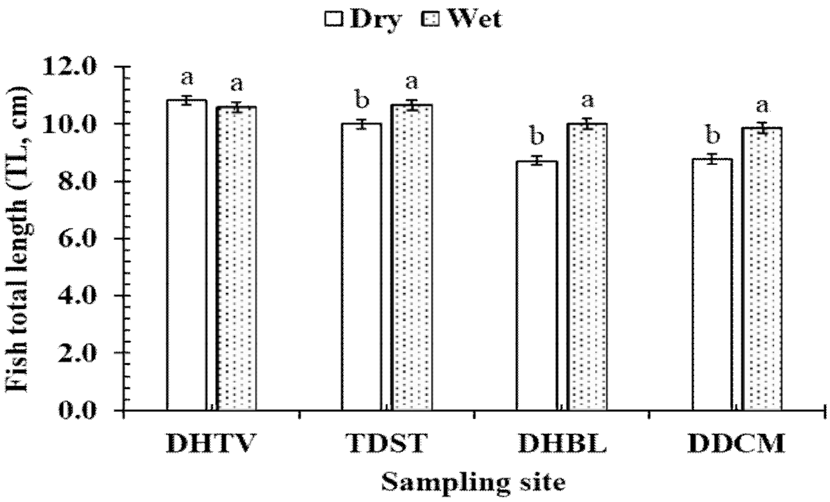

Figure 8. The fish total length variation with the interaction of season and site (values are expressed as mean and standard error; the letters a and b represent a statistically significant difference at the 5% level of significance).

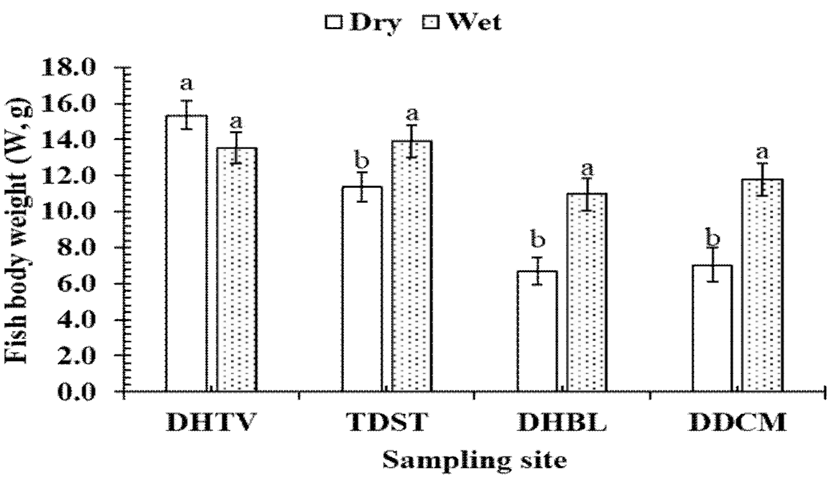

Figure 9. The fish weight variation with the interaction of season and site (values are expressed as mean and standard error; the letters a and b represent a statistically significant difference at the 5% level of significance).

Meristic variation. Besides changes in TL and W, other morphological parameters of fish such as eye diameter (ED), eye distance (DE), body height (BD) and head length (HL) were also observed to play an essential role in determining the morphological adaptability of *B. butis*. Not only that, but these morphological indexes also help to determine the specific morphological ratios of ED/HL, DE/HL, BD/TL and HL/TL. The results showed that there was no change in morphological parameters and body-specific proportions of males and females ($p > 0.05$ for all cases) (Table 2). This confirms again the stability of morphological parameters of this fish by gender. This result was similar to that of *G. sparsipapillus* (Nguyen et al 2020) and *B. koilomatodon* (Lam & Dinh 2020).

Similar to the change in TL and W, the other morphological indices of this fish did not change in the dry and wet seasons ($p > 0.05$ for all cases) (Table 3). However, the specific ratios show that in the wet season, these ratios were higher than in the dry season ($p < 0.05$ for all cases). This indicates that fish develop an eye advantage overhead size in the wet season and an edge in body height over total length. The environment can have an abundant food source in the wet season, so the fish thrives, especially in body height.

Table 2

Changes in morphological indicators of *Butis butis* by gender

Morphometric and meristic parameters	*Gender*	*Number of fish*	*Mean*	*SE*	*p*	*t*
ED (cm)	Female Male	303 412	0.43 0.44	0.00 0.00	2.31	-1.59
DE (cm)	Female Male	303 412	0.63 0.67	0.01 0.01	3.16	-2.39
BD (cm)	Female Male	303 412	1.43 1.50	0.02 0.02	1.54	-2.07
HL (cm)	Female Male	303 412	2.70 2.79	0.03 0.02	4.74	-2.01
ED/HL	Female Male	303 412	0.16 0.16	0.00 0.00	9.01	1.39
DE/HL	Female Male	303 412	0.24 0.24	0.00 0.00	0.95	-0.72
HL/TL	Female Male	303 412	0.28 0.27	0.00 0.00	0.08	2.91
BD/TL	Female Male	303 412	0.15 0.15	0.00 0.00	5.40	0.38

Table 3

Changes in morphological indicators of *Butis butis* by season

Morphometric and meristic parameters	*Season*	*Number of fish*	*Mean*	*SE*	*p*	*t*
ED (cm)	Dry Wet	372 343	0.42 0.44	0.00 0.00	0.22	-4.08
DE (cm)	Dry Wet	372 343	0.61 0.69	0.01 0.01	0.11	-6.34
BD (cm)	Dry Wet	372 343	1.36 1.58	0.02 0.02	0.96	-7.28
HL (cm)	Dry Wet	372 343	2.65 2.86	0.03 0.03	0.45	-5.42
ED/HL	Dry Wet	372 343	0.16 0.16	0.00 0.00	0.00	2.91
DE/HL	Dry Wet	372 343	0.23 0.24	0.00 0.00	0.00	-1.93
HL/TL	Dry Wet	372 343	0.27 0.28	0.00 0.00	0.00	-1.79
BD/TL	Dry Wet	372 343	0.14 0.15	0.00 0.00	0.01	-7.86

In contrast to the factors of gender and season, ED, DE, BD and HL at the study sites all fluctuated ($p < 0.05$ for all cases) (Table 4). Comparing these indicators at the study sites showed similarity with the change in TL and W. In general, the individuals obtained in DHTV have the largest size, possibly a favourable environment for fish growth because of its relatively low salinity. In contrast, at DDCM and DHBL, the indicators showed that fish had a smaller body size than other regions. It shows that at these two points, the habitat was not the most optimal for this fish. In addition, the characteristic ratios at the four study sites of *B. butis* did not differ significantly. This showed that the environment affects all morphological indicators of this species and does not have an isolated effect. Some fish species such as *G. sparsipapillus* (Nguyen et al 2020) and *G. giuris* (Nguyen & Dinh 2021) also change morphology to adapt to different habitat conditions.

Table 4

Changes in morphological indicators of *Butis butis* by sites

Morphometric and meristic parameters	*Site*	*Number of fish*	*Mean*	*SE*	*F*	*p*
ED (cm)	DHTV	190	0.46	0.01	25.46	0.00
	TDST	185	0.44	0.01		
	DHBL	188	0.42	0.00		
	DDCM	152	0.41	0.01		
DE (cm)	DHTV	190	0.72	0.01	21.50	0.00
	TDST	185	0.68	0.01		
	DHBL	188	0.60	0.01		
	DDCM	152	0.61	0.01		
BD (cm)	DHTV	190	1.60	0.03	28.75	0.00
	TDST	185	1.60	0.03		
	DHBL	188	1.32	0.02		
	DDCM	152	1.34	0.03		
HL (cm)	DHTV	190	2.98	0.04	29.18	0.00
	TDST	185	2.85	0.04		
	DHBL	188	2.58	0.03		
	DDCM	152	2.56	0.05		
ED/HL	DHTV	190	0.16	0.00	1.74	0.16
	TDST	185	0.16	0.00		
	DHBL	188	0.16	0.00		
	DDCM	152	0.16	0.00		
DE/HL	DHTV	190	0.24	0.00	1.63	0.18
	TDST	185	0.24	0.01		
	DHBL	188	0.23	0.00		
	DDCM	152	0.24	0.00		
HL/TL	DHTV	190	0.28	0.00	1.14	0.33
	TDST	185	0.27	0.00		
	DHBL	188	0.28	0.00		
	DDCM	152	0.27	0.00		
BD/TL	DHTV	190	0.15	0.00	15.77	0.00
	TDST	185	0.15	0.00		
	DHBL	188	0.14	0.00		
	DDCM	152	0.14	0.00		

All morphological indices of this fish were not affected at the same time by gender × season (two-way ANOVA, $F_{ED} = 0.22$, $F_{DE} = 0.45$, $F_{BD} = 1.28$, $F_{HL} = 2.89$, $p > 0.05$ for all cases) and gender × site ($F_{ED} = 1.50$, $F_{DE} = 1.31$, $F_{BD} = 1.40$, $F_{HL} = 1.32$, $p > 0.05$ for all cases) but season × site ($F_{ED} = 7.50$, $F_{DE} = 6.79$, $F_{BD} = 6.74$, $F_{HL} = 10.52$, $p < 0.05$ for all cases). Except for the ratio of HL/TL and BD/TL which changes according to the interaction of season × site ($F_{HL/TL} = 8.69$, $F_{BD/TL} = 6.73$, $p < 0.05$ for two cases), the remaining ratios are not affected by gender × season ($F_{ED/HL} = 2.11$, $F_{DE/HL} = 1.23$, $F_{HL/TL} = 2.84$, $F_{BD/TL} = 1.62$, $p > 0.05$ for all cases), gender × site ($F_{ED/HL} = 0.86$, $F_{DE/HL} = 1.47$, $F_{HL/TL} = 1.29$, $F_{BD/TL} = 1.49$, $p > 0.05$ for all cases) and season × site ($F_{ED/HL} = 1.62$, $F_{DE/HL} = 0.51$, $p > 0.05$).

Conclusions. Morphometrics and meristics of this fish did not change with gender and season but vary with sampling site, showing that it adapted well to the study areas. It should continue to work on COI and Cytb genes to verify if this goby showed a genetic change among these studied sites.

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