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Research Article

Study of the Morphological Characteristics of Walton's Mudskipper (Gobioidei: Oxudercidae) in Musa Estuary, Northwestern Persian Gulf, Iran

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Abstract

Mudskippers are members of the Oxudercidae family and are amphibious fish that are able to spend long periods out of water. In the present study, Periophthalmus waltoni was sampled from Petroshimi and Jafari stations. Three different forms were observed among the samples of two stations. The morphometry of the main traits was also done and according to univariate and multivariate ANOVA tests, there was a significant difference in all traits between the two stations, and the PCA test divided the populations into two groups. Also, according to ANOVA, MANOVA, and PCA statistical tests, sexual dimorphism was observed between males and females. So in three attributes, males had a higher average than females. This can indicate the larger size of males, which they display during the breeding season to attract the attention of females. In order to determine the age, after dissection of the skull, the ear stones were separated and the annual rings were counted and the age of the samples was recorded. In determining the age and growth pattern of the population in both stations, the fishes were in the age range of 1-3 years, and the highest frequency was related to two-year-old fishes. The length, width, and weight of the left otoliths were similar to the right otoliths. Otolith length had a high correlation with total fish length due to the high correlation coefficient r2. The results show that the otolith length can be used to determine the size of the fish.

Keywords: *Periophthalmus Waltoni;* Color Polymorphism; Sexual Dimorphism; Otolith; Persian Gulf

Introduction

The term mudskipper refers to four genera of the Oxudercidae family, namely *Periophthalmus*, *Periophthalmodon*, *Boleophthalmus,* and *Scartelaos*, which are known as fish-amphibians and have different degrees of adaptation to terrestrial conditions [10,15]. *Periophthalmus waltoni*, which was recently separated from the Gobiidae family and placed in the Oxudercidae family [32], is classified under the Gobioidei order and the Gobiiformes order, and along the coasts of the Oman Sea and the Persian Gulf, It is distributed [6]. In total, there are more than 200 estuaries on the southern coast of Iran, and a significant part of them are located inside the Musa estuary or next to the sedimentary islands [3]. The present study was carried out in Khor Musa. Khor Musa is one of the most important and valuable marine ecosystems in the south of Iran, and it is a place for many fishes and other aquatic organisms to spawn and spend their larval stages [5]. This part of the Persian Gulf has attracted a lot of attention. Khor Musa is located northwest of the Persian Gulf and on the coast of Khuzestan province. It is among the ecosystems that have always been exposed to the threats of oil pollutants and heavy metals that are common in crude oil compositions because it is the place of transportation of oil tankers that are moving towards Imam Khomeini port and the complex Many petrochemical plants are located around this estuary. The depth of the estuary is between 20 and 50 meters and it has a width of 27 to 40 kilometers. The land around this estuary is a flower field whose height is 2 to 5 meters above sea level. Khor Musa has several branches, such as Samaili, Ghazaleh, Ahmadi, and Zangi creeks. Mahshahr port is located in the geographical range of "20°49-49°E longitude" and "32°30-15°N latitude" and includes eight khors: Darvish, Ghannam, Patil, Beyhad, Duraq, Ahmadi, Ghazaleh and Zangi [5,23].

Of the three species of mudskippers in the Persian Gulf, *Periophthalmous waltoni* is native to the Persian Gulf and the Oman Sea and is distributed only on the coast of the Persian Gulf and the Oman Sea [56,44]. Body length 121-91 mm, head width 14-22% standard length, pelvic ballet length 14-12% standard length, 16-22% standard length of standard length, external numbers 12-11, first numbers of the first back furnace, 13-10, the number of the second backdrop of 14-13 [19]. The color of the head and body is gray in this species and there is a white line on the body and a water cover, the first light gray, medium height, with a round margin without the strip and only a few spots. It is white, lacks tall thorns, and has a higher height than the second back furnace. The abdominal fins are attached to each other by a membrane fold and their color is gray with a white border. The second is gray brown, plus on the 3 -black tail stem [19]. According to research, this diet is carnivorous [34]. This species performs most of its activities, including nutrition, pairing, and a minute of territory on land [24]. This species is able to hunt and get prey by moving the fins. The presence of this fish on the onshore surface is less when it does not hunt [8].

Polymeorphism or multimedia colored at the population level of a species can be an ecological response to habitat conditions and changes, such as temperature, intensity of sunlight, moisture percentage, water temperature, salinity, turbidity and substrate sex. It can affect aquatic color changes [3].

In many marine organisms that represent multicolored color, the relationship between color morphs and complex genetic structure patterns is complex. In some cases, color morphs are genetically distinct and may even be separate species [27]. There is a possibility that between color changes and diet, as well as the amount of water salinity. Although color multiplicity may also have a genetic background, the diversity of color on a regional scale is related to environmental control agents [9].

A variety of color patterns can be seen in the fishes, which are usually useful for animal camouflage and make it difficult and sometimes impossible to observe the members of this family in their environment [28].

One of the most effective features for identifying different species of mudskippers is the difference in the color patterns of the body and fins. However, the information about the color pattern of fishes is usually not provided in sufficient detail in the articles. Because they usually lose their body color quickly after being fixed [21]. Thus, due to the fact that the color polymorphism studies of the mudskippers living in the Persian Gulf and the investigation of their morphological traits have not been taken into account, in this research, an attempt has been made to investigate the pattern of polymorphism, sexual dimorphism and the study of the morphological traits of Periophthalmus species populations. waltoni in the selected habitats of Khor Musa.

Methods

The present study was conducted on 62 specimens (35 males and 27 females) of mudskipper *Periophthalmus waltoni* species. During a trip to several stations of Khor Musa (Petroshimi, and Jafari) in Khuzestan province (Figure 1 and Table 1), samples from the mentioned habitats were caught live and with a throwing net. Identification to the species level was done with the help of valid keys [19] and based on index traits. The samples were examined based on the color of the body background and dark stripes, as well as the presence of spots, and different forms were identified and recorded. Different samples were taken to the laboratory and necessary photographs were taken. In general, different forms of *P. walltoni* were divided into 3 groups and compared with each other.

Biometric measurements were taken at the catch site. In this way, the samples were measured based on 14 morphological traits with a digital caliper with an error rate of 0.02. The identification and confirmation of *P. waltoni* species were done while examining morphological index traits and it was done with the help of a valid identification key (Table 2), [19]. The SPSS software v21 was used for data analysis. All tests, including ANOVA, MANOVA and PCA were set at $P < 0.05$. Calculations, equations, and drawing regres-

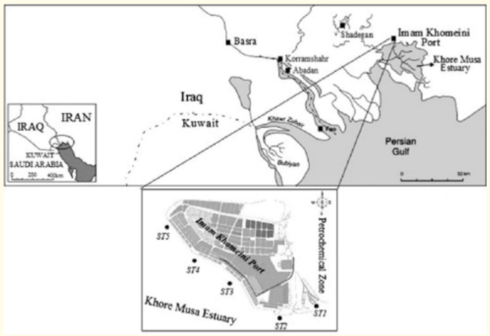

Figure 1: A map showing Musa estuary.

Area of Study	number of samples	Climate type	Geographical location of the station
Petroshimi	36	Hot and humid	49°-20′N30°-25′E
Jafari	29	Hot and humid	49°-20′N430°-27′E

Table 1. Characteristics of the studied stations.

sion diagrams by software Spss was done and ANOVA was used at the 5% probability level to analyze the data and investigate significant differences. Statistical processing was done in SPSS statistical software v21.

Results

In this research, 34 adult samples from petrochemical station and 28 samples from Jafari station of *P. waltoni* species were examined for morphological studies. Based on the background color of the body, the presence or absence of skin lines and spots, as well as the arrangement of lines and spots, color polymorphism was observed at the population level of the species, which included 3 morphs as follows:

Color polymorphism

- **Shape 1:** The body background of this fish is gray and earthy, the back surface and fins have an earthy background and the side surfaces of the body are gray, on the back surface of the

Row	Symbol	Morphological characteristics	Description of specifications
1	W	Weight (gr)	total body weight
2	TL	Total length(mm)	From the beginning of the mouth to the end of the tail fin
3	SL	Standard length (mm)	From the beginning of the mouth to the beginning of the caudal fin
4	BH	body height (mm)	We make a perpendicular line from the front of the dorsal fin to the bottom of the abdomen
5	HL	head length (mm)	From the end of the dorsal fin to the beginning of the caudal fin
6	Laco	head width (mm)	We make a perpendicular line from the beginning of the tail fin to the bottom
7	Pro	muzzle length (mm)	From the tip of the snout to the beginning of the gill cover
8	Ed	eye diameter (mm)	From the beginning of the muzzle to the beginning of the eyeball
9	Io	Distance between two eyeballs (mm)	From the beginning of the eyeball to the end of the eyeball
10	DFH1	Height of the first dorsal fin (mm)	From the end of the eyeball to the end of the gill cover
11	DFH2	Height of the second dorsal fin (mm)	The transverse line between the two eyeballs
12	DFB1	The base of the first dorsal fin (mm)	From the beginning of the snout to the beginning of the first dorsal fin
13	DFB2	The base of the second dorsal fin (mm)	From the beginning of the upper part of the fin to the end of the fin
14	AFB	Denominator wing base (mm)	From the beginning of the upper part of the fin to the end

Table 2: Measurement of morphological traits in species *P. waltoni.*

skin there is no line and blank but on the side surface of the hind part. Large black and white spots can be seen on the body, there are white needle spots on the lateral surface, and brown spots on the lateral surfaces, the closer we get to the end of the body, the bigger and more numerous (Figure 2, A).

- Shape 2: In this form, the background of the body is light earthy, there are medium-sized black spots on the dorsal surface of the body from the eyes to the caudal fin of the fish, which are arranged in an almost regular manner, and there are dark stripes on the dorsal surface of the fish. (distance of 4 mm) can be seen, while the number of these spots on the surface of this fish's snout is very few and about two or three, the abdominal surface of this fish is white and free of spots and spots. It is colored, on the side of the head, there are many white and small needle-shaped spots that do not have a specific order (Figure 2, B).
- Shape **3:** The background color of the body is light gray with an earthy tendency, needle-shaped spots with dark brown and white colors can be seen on the surface of the fish's body. The head part of the fish, i.e. from the beginning of the snout to the end of the gill cover, can be seen on the side of the body, but on the back surface of the rear part of the body, brown needle spots can be seen, the skin of the abdominal part is white and free of any lines and voids. but at the base of the abdominal fin of this fish, there is a crescent-shaped dark strip, while the background color of this area is light gray (Figure 2, C).

Figure 2: Color polymorphism observed among populations in P. *waltoni*

Morphological characteristics

The results of univariate analysis of variance (ANOVA) showed that among the 14 traits measured, there is a significant difference between the two stations in terms of these traits ($P < 0.05$) in all traits (Table 3). Also, based on the multivariate analysis of variance (MANOVA) test (Table 4), based on the 14 morphological traits measured, population separation was confirmed in the two mentioned stations (Table 4). After performing the multivariate analysis test, using the PCA method (Table 5), using the Scatter plot method drawn for the *P. waltoni* species, (Figure 3), the effect of the first component on the separation of the populations of the studied species in It showed two stations in such a way that a significant geographical pattern was observed. Based on this, the population separation of this species was confirmed in two stations.

Character/Area		N	Mean ± Sd	Std. Eror Difference	Min-Max	P-value
W	Petroshimi	36	130.12 ± 1.7	0.36	4.87-16.21	0.956
	Jafari	29	47.34 ± 2.14	0.42	14.92-27.96	
TL	Petroshimi	36	142.6 ± 13.651	1.78	118.42-179.35	0.615
	Jafari	29	138.55 ± 9.18	1.16	153.39-200.14	
SL	Petroshimi	36	129.91 ± 11.71	1.53	97.74-148.96	0.346
	Jafari	29	151.03 ± 7.77	0.95	128.97-166.96	
BH	Petroshimi	36	41.64 ± 1.68	0.25	15.39-22.27	0.944
	Jafari	29	32.86 ± 1.72	0.22	20.5-28.8	
HL	Petroshimi	36	66.6 ± 3.24	0.47	17.97-29.41	0.835
	Jafari	29	22.5 ± 1.78	0.18	23.34-32.2	
Laco	Petroshimi	36	88.47 ± 1.69	0.31	17.22-27.46	0.101
	Jafari	29	17.37 ± 3.25	0.39	20.22-32.13	
Pro	Petroshimi	36	70.71 ± 2.7	0.22	8.49-15.3	0.259
	Jafari	29	120.18 ± 2.85	0.21	11.86-19.09	

Ed	Petroshimi	36	6.1 ± 0.75	0.1	6.47-8.21	0.124
	Jafari	29	7.5 ± 0.54	0.07	6.31-8.61	
Io	Petroshimi	36	0.75 ± 0.45	0.14	5.52-10.27	0.232
	Jafari	29	2.25 ± 0.45	0.19	6.01-11.08	
DFH_1	Petroshimi	36	19.8 ± 1.32	0.38	14.86-28.98	0.042
	Jafari	29	27.3 ± 0.27	0.45	18.46-36.54	
DFH_2	Petroshimi	36	10.65 ± 1.36	0.29	7.47-14.84	0.269
	Jafari	29	13.8 ± 0.6	0.46	11.17-28.32	
DFB_1	Petroshimi	36	45.54 ± 3.27	0.45	21.34-33.85	0.524
	Jafari	29	10.9 ± 3.33	0.38	26.95-41.02	
DFB_2	Petroshimi	36	73.62 ± 3.3	0.41	25.53-39-85	0.893
	Jafari	29	75.03 ± 3.37	0.37	34.47-47.4	
AFB	Petroshimi	36	93.61 ± 1.72	0.32	18.28-27.40	0.457
	Jafari	29	106.27 ± 1.77	0.31	24.18-34.58	

Table 3: Results of univariate analysis of variance and descriptive statistics of morphological traits in populations of *P. waltoni*, in Khor Musa.

Criterion	Test statistic	DF			
		F-Value	NUM	Denom	P-Vaue
Walk׳s	0.24365	19.09	15	92	0.000
Lowley-Hotelling	3.10420	19.039	15	92	0.000
Pillai׳s	0.75365	19.039	15	92	0.000
Roys	3.10420	19.039			

Table 4: Results of multivariate analysis of variance of morphological traits in populations of *P. waltoni*, in Khor Musa.

Character	PC1	PC2
W	0.44145045	-0.15516756
TL	0.44375835	-0.1306009
SL	0.43118085	-0.1860576
BH	0.401469	0.09390894
HL	0.3990519	0.0841376
Laco	0.4030662	0.1931709
PRO	0.3507744	0.65122329
ED	0.3009501	-0.25296537
IO	0.26210565	0.88017225
DFH1	0.35839935	0.34330506
DFH2	0.2709591	0.75751107
DFB1	0.41758485	0.2775737
DFB2	0.41523075	0.07728951
AFB	0.4173027	0.06284692

Table 5: Morphological traits among the populations of *P. waltoni* based on PCA analysis.

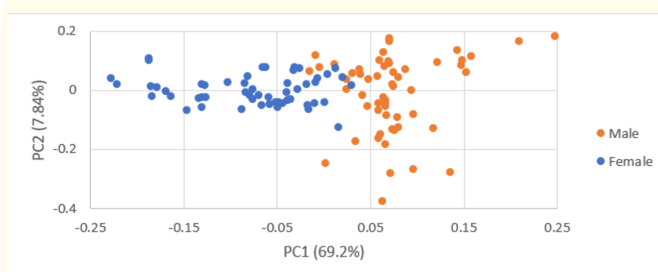

Figure 3: PC1 vs. PC 2 in morphometric traits among populations belonging to the P. waltoni species in both males and females.

According to the studies conducted through multivariate analysis of variance (MANOVA) in order to investigate the possibility of sexual dimorphism in *P. waltoni* species, it can be seen in table 6 that among the 14 morphological traits measured between the two sexes of this species, there was a significant difference in terms of the height of the first dorsal fin, the base of the first dorsal fin and the length of the intestine, so the presence of sexual dimorphism in this species was confirmed.

Criterion	Test statistic	DF			
		F-Value	NUM	Denom	P-Vaue
Walk's	0.76314	1.904	15	92	0.033
Lowley-Hotelling	0.31037	1.904	15	92	0.033
Pillai's	0.23686	1.904	15	92	0.033
Roys	0.31037				

Table 6: Multivariate analysis of variance to investigate sexual dimorphism at the species population level.

Character/Area		N	Mean ± Sd	Std. Eror Difference	Min-Max	P-value
W	Male	42	0.11 ± 53.39	0.64	14.12-27.34	0.085
	Female	23	0.10 ± 53.40	0.22	8.43-16.76	
TL	Male	42	1.112 ± 63.11	0.78	153.43-202.54	0.255
	Female	23	1.109 ± 94.25	0.15	118.12-149.32	
SL	Male	42	94.1 ± 1.28	1.53	126.53-165.96	0.062
	Female	23	1.90 ± 46.93	0.12	95.47-123.58	
BH	Male	42	2.14 ± 0.4	0.56	15.39-22.27	0.692
	Female	23	0.14 ± 31.20	0.11	20.5-28.8	
HL	Male	42	0.17 ± 29.89	0.76	17.97-29.41	0.369
	Female	23	17.5 ± 34.43	0.31	17.24-24.2	
Laco	Male	42	9.15 ± 34.90	0.18	23.22-28.46	0.065
	Female	23	0.15 ± 37.09	0.39	20.22-32.13	
Pro	Male	42	0.9 ± 17.18	0.28	12.43-21.34	0.347
	Female	23	0.8 ± 25.84	0.31	9.86-18.09	
Ed	Male	42	0.4 ± 64.83	0.19	9.43-16.29	0.160
	Female	23	0.4 ± 07.69	0.17	7.13-9.16	
Io	Male	42	5.65 ± 12.34	0.4	7.52-13.27	0.299
	Female	23	5.25 ± 14.15	0.89	14.11-19.18	
DFH_1	Male	42	0.16 ± 46.50	0.18	8.21-11.98	0.000
	Female	23	0.14 ± 48.08	0.25	7.1-13.54	
DFH_2	Male	42	0.8 ± 30.14	0.28	14.47-22.84	0.109
	Female	23	0.20 ± 39.45	0.33	11.17-28.32	
DFB_1	Male	42	0.20 ± 39.45	0.57	21.34-33.85	0.038
	Female	23	10.9 ± 3.33	0.38	26.95-41.02	

DFB_2	Male	42	22.93 ± 0.40	0.44	34.32-46-85	0.294
	Female	23	22.22 ± 0.46	0.73	25.11-38.4	
AFB	Male	42	17.25 ± 0.31	0.32	25.28-34.43	0.144

Table 7: Comparison of morphometric traits of *P. waltoni*, between male and female.

The results obtained from ANOVA, MANOVA and PCA analyzes showed, there is no separation between male and female (Table 8). As well as figure 4 for male and female species of *P. waltoni* showed that there is no significant difference between male and female individuals in terms of the first and second components.

Character	PC1	PC2
W	0.2943003	-0.10344504
TL	0.2958389	-0.08706727
SL	0.2874539	-0.12403840
BH	0.2676460	0.06260596
HL	0.2660346	0.05609173
Laco	0.2687108	0.12878060
PRO	0.2338496	0.43414886
ED	0.2006334	-0.16864358
IO	0.1747371	0.58767815
DFH1	0.2389329	0.22887004
DFH2	0.1806394	0.50500738
DFB1	0.2783899	0.18504913
DFB2	0.2768205	0.05152634
AFB	0.2782018	0.04189195

Table 8: Morphological traits among the populations of *P. waltoni* based on PCA analysis, between males and females.

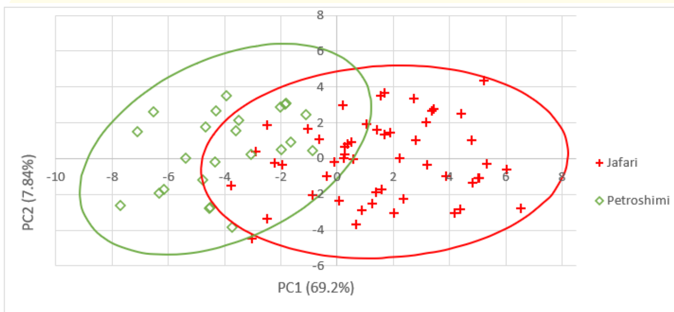

Figure 4: PC 1 vs. PC 2 in morphometric traits among the populations belonging to the species P. waltoni in two Jafari and Petroshimi stations.

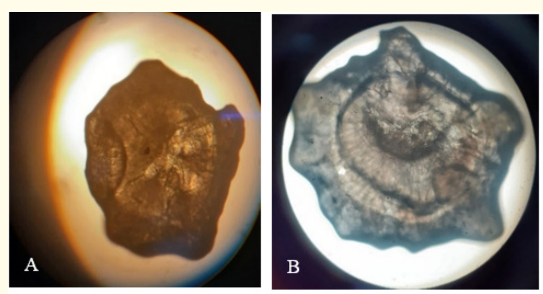

Figure 5: Otolith (Saggita) of one and to-year-old *P. waltoni* species. A: one-year sample, B: two-year sample.

Conclusion

The difference in color is one of the most important diagnostic characteristics in many groups of animals. Therefore, a detailed description of the general color pattern and the correct state of various colors in many taxonomic groups is very important. Subspecies differences in many vertebrates are predominantly based on color. Color evolution can proceed through two main processes: first, natural selection, which can act directly on colorability. If this trait has a direct role in camouflage, social interactions or thermoregulation, the second phenomenon, which is of particular importance in cold-blooded organisms, especially fish [29], indicates that colorability can be an indirect effect of selection on traits. Related to genetics resulting from linkage disequilibrium between genes coding for color and other phenotypic traits evolve [18].

One of the most beautiful pigmentation patterns in nature can be seen in fish [21]. In general, it can be said that more polymorphism occurs in a single population of different species of organisms such as fish, amphibians, and birds, and this process may be caused by phenotypic diversity, genetic differences, or a combination of both. Meanwhile, different species of fish have high diversity in terms of polymorphism in single populations, and most of these fish live in habitats such as open water and coastal areas [10].

Since the color polymorphism in the Persian Gulf mudskippers has not been noticed so far, in this research, the pattern of color polymorphism at the level of the population of the mudskippers in the tributaries of the Big Musa estuary was investigated. In the present study, which was based on the introduction of color morphs at the population level of *Periophthalmus waltoni* species, three color morphs were observed and described respectively. According to the ecological and heterogeneous conditions of Khoriat, it can be said that the higher the morphological diversity of the species in these areas, the higher the chance of survival of the species. Therefore, it is expected that other color forms of this species can be identified in other stations of Khor Musa, such as Khanak, Goban, Ghazaleh, Ghanam, Zangi, etc.

So far, color polymorphism has been done by different biologists with different methods and on different species, for example.

Beak stated in 2008 regarding the species *Periophthalmus modestus* and *Periophthalmus magnuspinnatus* that these two species have intra-population color differences in their fins and that these color differences can be seen in adults when this species of fish has a relative length between 40-60 observed mm reach [4]. In another research, the color of the body and dorsal fin was used in several species of mudskippers in the northern regions of Australia with the aim of species identification [26]. In this way, it can be concluded that one of the effective features for identifying different species of mudskippers is the difference in the color patterns of the body and fins. However, the information about the color pattern of the body is usually not presented in sufficient detail in the literature. They usually lose their body color quickly after being fixed and undergo a change in body color [31].

In some cases, color polymorphism acts as a limited tool to identify gender and increase the fertility and reproductive power of species, for examples.

In the studies conducted by Magnus in 1972, it was determined that in the male species of *Periophthalmus kalolo*, during reproduction, color differences are created for courtship purposes, which are probably due to the genetic effects of sex and the seasonal reproduction period, i.e., ecological conditions [17].

Also, Nursall stated in 1981 that in the species *Periophthalmus Argentilineatus*, the male sex has a lighter color than the female sex, so that the color change of this species in the male sex varies from gray to yellow and orange colors. While the females of this species are gray with a dark area on the head and under the eyes [20].

In another research, it was found that in the species *Periophthalmus Gracilis*, the male sex had a more noticeable color change in the color of the body surface during courtship than the female sex, and this color change is described from brown to golden color very faint [12].

The polymorphism difference based on the habitat is mostly due to the life periods of different fish species and their better adaptation in both coastal and marine habitats. While color diversity in fish has a genetic basis in addition to non-genetic factors such as nutrition, growth stages, and habitat conditions. In other words, specific genes control the diversity of pigmentation [21].

In fact, the polymorphism of the color pattern is more hereditary and the result of selection. Many species of amphibians and fishes significantly show the pattern of color polymorphism and thus they will be suitable models for studies in this field [14]. In the end, in this research, as well as in other research related to the creation of polymorphisms in the populations of gill fish, it can be concluded that two factors heredity and environmental ecological conditions play a decisive role in the creation of color polymorphism in populations mudskipper all over the world.

One of the remarkable features in animal biology is sexual size dimorphism (SSD) or the presence of morphological differences between males and females of any species, which can be used to investigate and detect the possibility of sexual dimorphism Since reproduction is the most important factor for the survival of species, adequate knowledge of the morphology of the sexes and the effective factors in sexual selection is of great importance [11].

Two hypotheses regarding habitat effects and the increase in sexual dimorphism were presented by Butler and Losos. One is that females and males may have different mutual effects on the nature around them, which ultimately causes a slight gender difference in the relationship between morphology and habitat use. Second, there is no difference in terms of morphology and habitat use, but both sexes use some habitats more or less so that environmental factors are one of the most important influencing factors in the morphology of species and effective in evolution. They are individual [30].

SSD is widely seen in most animals because it is related to the behavior and life history of the animal, thus the mechanism of variation is very complex, such that it is usually found in male warm-blooded animals and in cold-blooded female animals in terms They are bigger [2].

In the present study, the presence of sexual dimorphism was investigated by morphometry of 15 traits and statistical analysis. The results showed that there was a significant relationship between gender and the measured morphometric traits, based on the morphological results obtained in the mudskipper population. *Periophthalmus waltoni* fish species, there was a significant difference between males and females in terms of the height of the first dorsal fin (DFH1), the base of the first dorsal fin (DFB1), and the length of the intestine (il), so that all three traits in the genus The male had a higher average than the female, which can indicate the larger size of the male, which is displayed during the breeding season to attract the attention of the female.

In similar studies in New Guinea on the population of *Baleophthalmus poti* species, it was determined that there is sexual dimorphism based on the base of the first dorsal fin, in such a way that males are larger in terms of this trait [22].

In another research conducted by Yodo., *et al.* in Nigeria on the *Priophthalmus barbarous* species, it was found that the length and base of the first dorsal fin were longer in the male of this species than in the female. In addition, males and females can be distinguished from each other through an appendage. It was possible that it is on the ventral surface of the fish near the denominator, as this appendage is wider in females but appears to be somewhat depleted in males [30].

The study of the biology of *Baleophthalmus dussumeri* species in Hormozgan province showed that while the average length of females in the Dumigz estuary of Bushehr was higher, in another estuary (Khor Abi) this trait was more in males, which could indicate The effect of habitat conditions (food, water temperature, and humidity, etc.) on sexual dimorphism [1].

In the present study, among the 14 morphological traits measured, it was observed that the height and base of the first dorsal fin, as well as the length of the intestine, were greater in males than in females. These results are similar to the results of similar studies in other parts of the world and indicate that Sexual dimorphism can be observed in most species of flounder fishes, for example, in male flounder fish species *Periophthalmus septemadiatus*, two dorsal fins are connected and the first radius of the fin is longer in the first dorsal fin. However, in females, the two dorsal fins are separate and the first dorsal fin is noticeably reduced [13].

Since the multivariate analysis showed the existence of population separation of *Periophthalmus waltoni* in two petrochemical and Jafari stations, it can be concluded that the changes in ecological conditions and their impact on different habitats can be one of the reasons for this. Other factors indirectly affect this population separation [16].

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